7th International Conference

on

CLIMATE SMART AGRICULTURE: INNOVATIONS AND ADAPTATIONS

June 15-17, 2022

ABSTRACT BOOK

FACULTY OF AGRICULTURE, UNIVERSITY OF POONCH RAWALAKOT
AZAD JAMMU AND KASHMIR, PAKISTAN

Preface

It is our pleasure to welcome you to the 7th International Conference in Rawalakot, Azad Kashmir. The June 15-17, 2022, International Conference on "Climate Smart Agriculture: Innovations and Adaptation" is the seventh in the series of conferences organized by Faculty of Agriculture, University of Poonch Rawalakot. The major goal and feature of it is to bring academic scientists and researchers together to exchange and share their experiences and research findings about climate smart agriculture, and discuss the practical challenges encountered and the solutions, innovations, and adaptations.

Over five hundred abstracts from all over Pakistan and Azad Jammu & Kashmir are accepted for oral and poster presentation after peer review by the scientific committee. These are selected on the basis of originality, significance, and clarity for the purpose of the conference. We are grateful to all authors for submissions to this conference and for sharing the information and experience they've acquired. We feel honored and privileged to serve the best recent developments in climate smart agriculture to you through this conference.

The conference promises to be both stimulating and informative with a wonderful array of national and international keynote and invited speakers. Participants will have a wide range of sessions in all thematic areas of the conference. The program consists of plenary and technical sessions, poster presentations and discussions with eminent speakers covering all thematic areas of the conference. This rich program provides all attendees with the opportunities to meet and interact with one another. We hope your experience will be fruitful and long lasting one.

We thank Prof. Dr. Rattan Lal, Distinguished University Professor of Soil Science, The Ohio State University, Columbus, USA, Dr. Awais Khan, Cornell University, USA, Dr. Ajit Singh, Nottingham University Malaysia campus, Prof. Dr. Abu Hassan bin Ahmad, Prof. Dr. Che Salmah binti MD Rawi, Universiti Sains Malaysia for sharing their insights with us.

The organization of the conference represents the efforts of many people. We want to express our gratitude to the heads and members of scientific, fund raising, hall management, accommodation/transport, publicity, registration, entertainment, decoration, campus maintenance, session coordination, print and publication, fund utilization and stall management committees. They all worked very hard to make this conference a reality. We are also thankful to administration of the University of Poonch Rawalakot for their continuous support during the organization of this conference.

The conference would not be possible without the excellent contributions by our sponsors. We thank Higher Education Commission of Pakistan (HEC), Pakistan Science Foundation, Islamabad, Gulf Empire Pvt (Ltd), Rawalakot, Multiline books, United Bank Limited, Escience press, Islamabad, Rawalakot Agriculture Graduate Association (RAGA), Kanzo, Habib Bank Limited, National Bank of Pakistan, Pak Book Corporation, Allied Books, Punjab Book, Engro, FFC and Fatima Fertilizers, Rays Technologies, Pak Qatar Takaful, Real Life Sciences, Bahawalpur, Pepsi and Coca Cola, Rawalakot, Petro Gas, Rawalakot, Inayat, Freshco, National and Hibba Bakers, Rawalakot and Wullar water, Rawalakot.

We wish all attendees of 7th International Conference an enjoyable scientific gathering in Rawalakot, Azad Kashmir. We hope you will have a technically rewarding experience and will use this occasion to meet old friends and make many new ones. Do not miss the opportunity to explore diverse attractions in Rawalakot, Azad Kashmir. We look forward to seeing all of you in our next conference.

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ORAL

THEME 1

CLIMATE SMART CROP PRODUCTION TECHNOLOGIES

CLIMATE SMART CEREAL CROP PRODUCTION THROUGH BIOFORTIFICATION OF PGPR

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Management of crops under the scenario of climate smart agriculture is an emerging task amongst five key elements to mitigate food security and upgrade the livelihood of farmers. Biofortification of crops with the help of microbes is an innovative approach to deal such challenges of adaptations and mitigation. Due to alkaline-calcareous nature of soils of the Punjab, micronutrient deficiency especially iron is prominent. During Fe-deficient conditions, plants and plant growth promoting rhizobacteria (PGPR) produce siderophore that capture iron molecules present in the soil and make it available for plant uptake in a soluble form. Iron is an essential nutrient for both plants and animals for their proper growth and development. Seed treatment with iron-based inoculum is a cost-effective approach of bio-fortification. The study based on isolation of PGPR from rhizosphere soils of different cereal crops wheat, maize, sorghum, millet of Ayub Agricultural Research Institute, Faisalabad through standard dilution plate technique. The siderophore producing activity of isolates was screened though CAS shuttle (quantitative) and CAS agar assay (qualitative). Isolates were tested on the basis of nutrient solubilization, organic acid production and Indole acetic acid production characteristics. Out of 50 isolates, 15 isolates show positive results for siderophore production. Out of 15 siderophore positive isolates 7 shows improved root and shoot plant growth when tested on plants. On the basis of field trials (July-September), we conclude that inoculations with siderophore showed improved plant height, grain weight of cereals. The study shows that PGPR plays a greater role in the Fe-translocation to plant improving quality of cereal crops thus mitigating emerging food security threat to some extent.

Keywords: PGPR, siderophore producing bacteria, biofortification, wheat, maize

YIELD ESTIMATION OF COTTON (*Gossypium hirsutum* L) GENOTYPES UNDER DIFFERENT PLANT SPACING

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Cotton (*Gossypium hirsutum* L.) is an important crop in Pakistan, along with a variety of other crops. Cotton primarily considered a key position in Pakistan's economic standpoint. Cotton has clearly demonstrated its ability to boost Pakistan's Gross Domestic Product and economy when compared to other neighboring countries in the region. A field experiment was conducted at the Cotton Research Institute in Multan, Pakistan, between 2019 and 2020. A split-plot layout in a randomized complete block design with three replications was used in the experiment. The main plot included three different plant spacings: 15cm, 22cm, and 30cm, while the subplot had three different varieties: MNH-886, FH-Lalazar, and FH-142. The study's goal was to assess the production potential of various cotton genotypes under various plant spacing regimes and determine the appropriate plant spacing for maximum yield. During both years, 2019 and 2020, the greatest seed cotton yield was obtained at 30cm plant to plant distance for all genotypes. In terms of plant height, boll weight, and seed cotton yield, MNH-886 outperformed all other genotypes. MNH-886 produced 3888.9 and 3205.6 kg ha-1 of seed cotton yield in 2019 and 2020, respectively, followed by FH-Lalazar, which produced 3100 and 2956.3 kg ha-1 in 2019 and 2020. This research aids in the optimization of plant spacing in order to meet plant population requirements and increase seed cotton yield.

Keywords: Genotypes, yield potential, seed cotton yield, plant spacing

BORON IMPROVES PRODUCTIVITY AND PROFITABILITY OF BREAD WHEAT UNDER ZERO AND PLOUGH TILLAGE ON ALKALINE CALCAREOUS SOIL

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In Indo-Gangetic plains, rice-wheat cropping system (RWC) is often practiced on alkaline soils low in organic matter and plant available boron (B). However, switching towards conservation tillage and B nutrition may help sustain the productivity of bread wheat in RWC. This study was conducted to evaluate the effect of B application on the productivity, profitability and grain B concentration of bread wheat sown under plough tillage and zero tillage systems. Boron was delivered through seed priming (0.01 M), foliage application (0.01 M) and soil application (1 kg ha-1). There existed significant interaction between B application methods and tillage systems for grain yield and quality traits in bread wheat. Seed priming was the most cost-effective method of B application in improving the grain yield of zero tillage wheat. However, soil applied B was the best in terms of yield improvement of plough tillage wheat. Soil and foliage applied B was better in improving the grain quality through increasing grain B and N concentrations irrespective of both tillage systems. Zero tillage in wheat increased the total soil organic matter by 8.2% than plough tillage wheat. Improvement in soil organic carbon (28%), soil microbial biomass nitrogen (45%) and soil microbial biomass carbon (27%) was also noted in zero tillage than plough tillage at 0-10 cm depth. In conclusion, B application, by either method, improved the performance and profitability of wheat planted in plough tillage and zero tillage systems. However, seed priming and soil application were the most economical and cost-effective methods of B application in zero tillage and plough tillage wheat, respectively. Zero tillage system improved the soil health, physical properties and nutrients availability than plough tillage systems.

Keywords: Economics, grain quality, rice-wheat cropping system, Seed priming, Soil health

UNRAVELING KABULI CHICKPEAS RESPONSE AGAINST HEAT, IRRIGATION, AND COMBINED STRESS THROUGH MORPHO-PHYSIOLOGICAL, BIOCHEMICAL INDICES AND FIELD PERFORMANCE UNDER DIVERSE ENVIRONMENTS

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Under continuous changing global climatic patterns, high temperature and limited water availability either in combination or alone are becoming a serious threat to chickpea (cicer arietinum L.) production worldwide. To alleviate the yield losses, screening of input responsive and improved stress-tolerant genotypes through understanding the morpho-physiological and biochemical indices at the early growth stage is imperative. In the present study, an early-stage screening strategy was devised to (i) reconnoiter the morpho-physiological and biochemical tolerance response of 8 kabuli chickpea genotypes under irrigation (I), heat stress (H), and combination of both (I+H), along with (ii) estimation of their yield potential across multiple locations of the country. One-month seedling experiment was performed under net house and glasshouse conditions of NIAB. Data of 8 morphological, 9 Physiological, and 15 biochemical traits were collected and yield potential was estimated across 8 diverse locations of the country. To elucidate the results, data was analyzed by

XLSTAT 2014.5.03 software. In case of irrigation supply, all the genotypes performed well with increased vigor, while genotypes K-09015 and K0039-09 exhibited the best performance with 30% and 24% increase in yield over check respectively. Under heat stress, CM1235/08 were highly tolerant with 16% increase in yield over check, and 9KCC-166 as sensitive genotypes with -6% decrease in yield over check. In case of combined (I+H) conditions, CM 1235/08 and K-09015 were observed as highly tolerant with 16% and 30% increase in yield over check respectively, while BKK 02174 was the most sensitive genotype depicted only 3% increase in yield over check. Results manifested that an integrated approach involving phenomics and physio-biochemical markers efficiently reflected the relative heat, irrigation, and combined stress tolerance of chickpea genotypes along with insights into mechanisms involved under these stresses. Identified promising genotypes can further be utilized in chickpea breeding programs to develop multi-stress tolerant climate-smart cultivars.

Keywords: *Cicer arietinum*, antioxidants, seedling, yield, white seeded

LONG-TERM MANURE APPLICATION INCREASED SOIL ORGANIC CARBON AND NITROGEN MINERALIZATION THROUGH ACCUMULATION OF UNPROTECTED AND PHYSICALLY PROTECTED CARBON FRACTIONS

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Soil organic carbon (SOC) and nitrogen (N) mineralization are important biogeochemical processes associated with soil fertility. These processes are influenced by physically, chemically, and biologically stabilized organic carbon (C) fractions, and the mechanisms involved are not well-known. The present study was conducted to evaluate the combined effect of manure and mineral fertilizers on the content of C fractions to promote the mineralization of SOC and N. Treatments included: i) unfertilized control (CK), ii) combination of nitrogen, phosphorus and potassium (NPK), iii) manure (M), iv) manure combined with NPK (MNPK), and v) high dose of manure combined with NPK (hMNPK). The combined use of manure and mineral fertilizers enhanced the accumulation of unprotected C fraction (cPOC) by 44-72% compared to the CK. Manure application enhanced physical (µagg), physico-chemical (H-µsilt), and physico-biochemical C fractions (NH-µsilt) fractions by 30-56%, 62-150%, and 27-51%, respectively. Whereas chemically and biochemically protected fractions showed a minor response to manure application. Accumulation of cPOC, C in µagg, and physico-chemically protected C fractions (H-µsilt, H-µclay) had a significant contribution to mineralization of SOC and N, resulting in a significant increase in rice grain yield under long-term manure additions. Conclusively, long-term use of manure and mineral fertilizers improved C accumulation in unprotected and physically protected fractions, which enhanced SOC and N mineralization, and benefit soil productivity in the rice-wheat cropping system.

Keywords: Fertilization strategies, mineralization, grain yield, SOC fractionation, SOC protection mechanism

AL-KHALID RICE, A NEW SALT TOLERANT FINE RICE VARIETY POSSESSING HIGH YIELD, EXTRA-LONG GRAIN WITH EXCELLENT COOKING QUALITY CHARACTERISTICS

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Rice (*Oryza sativa* L) ranks 2nd amongst the staple food grain crops in Pakistan. It occupies 2.5 million hectare that is 10.9% of the total cultivated area with production of 5.1 million tonnes of milled rice and ranked 2nd for earning foreign exchange for the country. Rice is considered as principal reclaiment crop for salt affected soils during rehabilitation program. According to an estimate in Pakistan, out of 22 million hectares under agriculture, 6.68 million hectare is salt affected. In Punjab salt affected area is about 2.22 million hectares. Rice cultivars (Coarse and fine) vary widely in their relative salt tolerance. Generally, the relative salt tolerance of a crop depends upon its genetic make-up, rooting behaviour, growth stage, nature, amount and distribution of salts in the soil profile and climatic conditions of the area. Keeping all this in view as a result of an attempt Al-Khalid Rice was evolved through conventional and backcross methods of hybridizing using the high yielding coarse grain rice variety "KS 282" as a female parent with Basmati 385 (a high yielding, long grain and better salt tolerant line carrying the Basmati 370 genome) as a male parent. Its performance was tested in varietal yield trials in 2016 to 2017 and in NUYT-2018 & 2019 and it produced higher paddy yield than Shaheen Basmati (16.75%) and PK 1121 aromatic (15.12%) on average basis. Its average grain length (9.96 mm) was better than PK 1121 aromatic (8.15 mm). Its stiff stem makes it lodging resistant and suitable for mechanical harvesting. The potential paddy yield of 7.2 t ha^{-1} was recorded during the study. Al Khalid Rice proved salt tolerant [EC 6 dS m^{-1}, pH 8.7, SAR 40 $(mmol\ L^{-1})^{1/2}$] with 50 % paddy yield potential making it a suitable choice for the growing rice in salt affected soils. Punjab seed council has approved it in 2021 for general cultivation preferably in salt affected areas of the province to enhance paddy production.

Keywords: Al-Khalid Rice, salinity tolerance, high yielding fine rice variety, extra-long grain, cooking quality

CORRELATION NETWORKS IN DEFINING GRAIN YIELD POTENTIAL OF BREAD WHEAT GENOTYPES UNDER WATER DEFICIT ENVIRONMENTS

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Field-based studies are central for effectively meeting the objectives of plant breeding programmes pointing to screen and enhance the drought tolerance of wheat genotypes. Fifty exotic wheat genotypes along with 03 local checks were subjected to water-deficit (2-irrigations) and water stress (no-irrigation) conditions. Analysis of variance, correlation, PCs and stress indices were calculated. The indices were accustomed on the basis of grain yield under deficit irrigation (Yd) and no-irrigation (Ys) conditions. Grain yield had strong positive correlation with biological yield (r=0.98), (r=0.82) and moderately with harvest index (r=0.58), (r=0.52) in both the conditions, respectively. Genotype SAWYT-10, SAWYT-37, SAWYT-39 produced higher grain yield unde deficit irrigation, whilst SAWYT-47 produced the highest grain yield (3383.33) under stress, followed by SAWYT-49 (3358.33) kg ha^{-1} compared to genotypes and checks. Grain yield under deficit irrigation was highly and significantly related to TOL, however, negatively correlated with yield under stress. TOL and SSI are important indicators for breeding under severe water stress, whilst all others YSI, YI, STI, GMP, MP and HM for deficit/mild stress. Biplot analysis recommended SAWYT-2, SAWYT-26, SAWYT-33, SAWYT-39, SAWYT-44, SAWYT-45, SAWYT-48, SAWYT-50 genotypes for both stress and non-stress environemnts. However, SAWYT-1, SAWYT-3, SAWYT-9, SAWYT-19, SAWYT-31, SAWYT-37, SAWYT-40, were superior genotypes for water stress environments.

Keywords: Wheat, drought, grain yield, biplot analysis, stress indices

ALLEVIATION OF TERMINAL HEAT STRESS IN COTTON (*Gossypium hirsutum* L.) BY CHITOSAN FOLIAR SPRAY

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Concurrence of heat stress of different spells at cotton flowering stage accelerates phenology and declines the fiber quality of cotton. A two-year field trial was conducted to examine the effect of exogenous chitosan application in alleviating the effects of heat stress on seed cotton yield, quality, phenology, and glycine betaine synthesis. Three levels of heat treatments were assigned to the main plots. Five levels of foliar spray of chitosan, i.e., 0, 0.2, 0.4, 0.6, and 0.8 g L^{-1}, were applied in each subplot during heat stress imposition. Treatment plan was comprised of H_0 (control, no heat stress), H_1 (heat stress at flowering for 4 days), and H_2 (heat stress at flowering for 8 days). Heat stress at flowering for 8 days resulted in a remarkable decrease in glycine betaine synthesis, phenological traits, seed cotton yield, and quality attributes than control. The effects of heat stress were more pronounced when the exposure time was 8 days compared to 4 days. Chitosan foliar application significantly improved glycine betaine, seed cotton yield, earliness of maturity, and fiber quality, whereas decreased the malondialdehyde contents in heat-stressed cotton. In contrast, premier dose (0.8 g L^{-1}) of chitosan proved to be more efficient than lower doses. It is concluded that exogenous application of chitosan at 0.8 g L^{-1} was beneficial to arbitrating heat stress effect owing to its positive effect on fiber quality and seed cotton yield (increased by 22% over control).

Keywords: Cotton fiber quality, lipid peroxidation, osmoprotectants, high temperature

SALT INCLUSION MECHANISM OF SALINITY TOLERANCE IN BREAD WHEAT (*Triticum aestivum* L.)

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Biotic and abiotic stress factors exert detrimental effects on the growth and productivity of wheat plant. Among abiotic stresses, salinity significantly reduces the crop yield. Productivity of wheat plant in relation to salt stress is lagging behind due to lack of well-planned research on the salt tolerant mechanism under salinity stress in bread wheat. The current research was done to identify a comprehensive mechanism of salinity tolerance in bread wheat. An in-vitro experiment was conducted to study the effect of salt stress on various seedling growth parameters. Salinity tolerance mechanism was assessed in two different elite lines 9515, 9493 in comparison with Fsd. 2008 and Kohistan-97 taking as standard cultivars. The seeds of each genotype were grown in plastic pots under complete randomized design (CRD) with factorial structured treatments. Three different levels of NaCl were applied at sowing time i.e., T_1=100 mM NaCl T_2=150 mM NaCl, T_3=200 mM NaCl and were compared with control (T_o). To fulfill the nutritive requirement, half strength Hogland solution with respective amount of salt was applied after one week and this practice was continued till four leaf stage. Various morphological, physiological and biochemical parameters were recorded after four weeks and data were analyzed. The result of present study indicated that the genotype FSD-2008 and 9515 perform best under all levels of salinity. By increasing the salt stress, the fresh and dry root and shoot weight increased. The fresh and dry root and shoot weight of other two genotypes 9493 and Koh-97 decreased by increasing the NaCl concentration i.e., 200 mM. On the basis of biochemical and physiological analysis, it is concluded that Fsd-2008 and 9515 showed high level of salinity tolerance which could be utilized in future breeding program.

Keywords: Lagging behind, detrimental effect, physiological, parameters

INFLUENCE OF DIFFERENT PLANTING DATES ON YIELD AND FIBER QUALITY TRAITS OF COTTON ADVANCE LINES UNDER CHANGING CLIMATIC CONDITIONS OF TANDO JAM, PAKISTAN

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Cotton plays an important role in Pakistan economy. It faces various environmental conditions which restricts its growth and production. Climate changes bring a head new pressure for cotton cultivation in Pakistan especially in Sindh province. The present study was carried out at Nuclear Institute of Agriculture (NIA), Tandojam in 2021. Four advance lines NIA-88,M-32, NIA-Bt. 89 and NIA-Bt.90 along with two local check varieties IUB-2013 and CRIS-121 were evaluated under two sowing dates viz. 1st April and 1st May having three replicates under randomized complete block design factorial arrangements. The results indicated that crop sown on 1st April produced more seed cotton yield (2855.5kgha^{-1}) than sown on 1st May with (1674.4 kgha^{-1}). Comparing the average varietal performance in both sowing dates, NIA-88 produced maximum seed cotton yield (2339.2 kgha^{-1}) while minimum seed cotton yield (2137.2 kgha^{-1}) was exhibited by check variety CRIS-121. Boll retention % was maximum (44%) in advance line NIA-88. The maximum number of bolls plant^{-1}, sympodial branches plant^{-1}, ginning out turn percentage, seed index and staple length (42.0), (26.0),(42.0), (8.1g) and (29.0mm) respectively was obtained in 1st April sowing date while minimum number of bolls plant^{-1} , sympodial branches plant^{-1}, ginning out turn percentage, seed index and staple length (33.0), (15.0), (36.3), (6.0g) and (27.0mm) took in 1st May sown crop. Associating the average varietal performance in both sowing dates NIA-88 produced maximum number of bolls plant^{-1}(44.0), sympodial branches plant^{-1}(23.0), ginning out turn percentage (40.4), seed index (9.0g) and staple length (28.35mm) respectively. The results indicated that the planting dates and genotypes influenced seed cotton yield and associated traits in current changing climate scenario for cotton crop.

Keywords: Cotton, climate change, fiber quality, planting dates, yield

ATTITUDE AND MOTIVATION OF THE FARMERS TOWARDS CLIMATE SMART AGRICULTURE IN DISTRICT MUZAFFARGARH OF PUNJAB, PAKISTAN

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Agriculture remains the distinctive sphere for the rural segment of Pakistan and is the prime source of bread and butter for farming community. Climate change on the other hand, is their biggest antagonist to bar them doing so. Pakistan is to be conceded in top ten most vulnerable states of the world. Agriculture is one of the most precincts disciplines, affected by the climate change, breeding food scarcity and food insecurity and also influencing food production. Underscoring these effects on economy and farmers' livelihood, it is high time to move on adopting modern solutions like climate smart agriculture (CSA) for sustainability in agriculture. Therefore, present study designed to gauge attitude and motivation of the farmers. For this purpose, the questionnaire was designed and pretested. Finally, the data from 150 respondents were collected through simple random sampling technique. The results indicate that more than half (51.3%) of the respondents had positive attitude towards climate smart agriculture. additionally, more than 60% of the respondents were motivated to apply CSA techniques on their farms. However, the farmers displayed concerns regarding meeting the CSA standards. The respondents disclosed that more awareness (85.3%) and educational programmes (90.7%) would help in adopting and adapting CSA. The study suggests to chalk out clear government policies with strong implementing and monitoring measures and joint venturing with other stakeholders can be panacea to combat and overcome the climate change which is ravaging the agriculture sector.

Keywords: Attitude, motivation, farmers, climate smart agriculture, Muzaffargarh.

EVALUATION OF SHEDDING OF FRUITING STRUCTURES EFFECT ON FERTILIZER MANAGEMENT IN COTTON UNDER CHANGING ENVIRONMENT

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Climate change can affect cotton production through increasing the shedding of fruiting structures (square/buds, flowers, bolls, leaves). Shedding of fruiting structures can also affect availability of nutrients in soil consequently affecting nutrient management in cotton. Keeping in view, a field study was conducted to assess the effect of shedding of fruiting structures on fertilizer management in cotton under changing environment at three different locations (Cotton Research Station, Ghotki, Central Cotton Research Institute Sakrand, Sindh Agriculture University, Tandojam) in Randomized Complete Block Design-Factorial with three replications. Treatments comprised on three factors including [Factor-1: three locations (Sakrand, Tandojam and Ghotki), Factor-2: Two fruiting structure (+fruiting structures and -fruiting structures), Factor-3: Six fertilizer levels (T_1= No fertilizer, T_2= 100% RDF, T_3= 80% RDF, T_4= 60% RDF, T_5= 40% RDF, T_6= 20% RDF). Results of study depicted that interaction of three factors varied non-significantly but individual effect of shedding, fertilizer on cotton was significant at each location. Results indicated that significant increase in plant height, sympodial branches per plant, bolls per plant, fruiting points per plant, boll weight, yield and chlorophyll content were observed by different fertilizer levels regardless of the fruiting structures treatment at Sakrand, Tandojam and Ghotki locations. The greatest seedcotton yield and associated components were observed in T2 (100% RDF) followed by T3 (80% RDF), T4 (60% RDF), T5 (40% RDF) and T6 (20% RDF) over the T1 (Control) respectively at Sakrand followed by Tandojam and Ghotki in fruiting than without fruiting structures with an estimation that about 20% fertilizer could be reduced by shedding of cotton fruiting structures than the recommendations. Most of quality parameters were significantly affected by fertilizer levels regardless of location and shedding of fruiting structures. The collection of shedded material was observed greater at Ghotki followed than Sakrand and Tandojam during the growing season respectively. Further, shedding of fruiting structures of cotton contributed in 7.6% to 9.8% % in yield of cotton. The findings of this study are expected to help formulate fertilizer plan for cotton during changing environment.

Keywords: cash crops, insecticides, agronomy, plant nutrition

CLIMATE CHANGE IMPACT, COTTON PREDICTION FROM WEATHER PARAMETERS OF DIFFERENT CITY OF PAKISTAN USING MACHINE LEARNING TECHNIQUE

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This study seeks a distinctive and efficient machine learning system for the prediction of Cotton Production using weather parameters and climate change's impact on cotton production. The study analyses the impact of weather parameters on the productivity of cotton in Pakistan using the district level disintegrated data of yield, area, and climate variables (temperature, cloud cover, rainfall, and wind) from 2005 to 2020, also uses the Production of cotton from 2005-2020. The data collected from Pakistan Meteorological Department. These fifteen years moving averages for each month, climate variables are used. The production function approach is used to analyze the relationship between crop yield and weather parameters up and down each month. Cotton has a great dependence on environmental factors during its growth, especially climate change. The occurrence of cotton pests and diseases has always been an important factor affecting total cotton production. Pests and diseases are also caused by environmental factors. Apply a Machine learning algorithm to analyze the pests and diseases of cotton because of environmental factors. I use many algorithms to analyze and predict cotton production. In research, these algorithms are Decision Tree, Forest, linear regression, and XGB (Extreme Gradient Boost). The best algorithm is XGB; the cotton prediction result is 0.26 (RMSE) 0.07 (MSE). In this research work, the correlation between weather parameters and cotton production are analyzed for the impact of a climatic variable. The cotton correlation to Temperature is 0.34, rainfall is 0.27 and cloud is 0.2 from the range of -1 to 1. So because of these factors indication on time action can increase the production and overcome on the cotton declined production. In the future there are many improvement ways one thing we can do that is daily base weather parameters use for prediction and diseases related to weather elements. Increase of other weather parameters will be more affective in future.

Keywords: global warming, machine learning, modelling, lint production

MITIGATION OF MOISTURE STRESS BY USING FOLIAR APPLICATION OF CHITOSAN TO IMPROVE GROWTH AND YIELD OF LENTIL (*Lens culinaris* L.)

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Increasing temperatures and water stress reduce lentil growth and production potential, especially during reproductive stage and seed development. The current study aimed to study the effect of moisture stress on growth, biochemical and yield parameters of lentil and to find out optimum level of foliar application of Chitosan to improve productivity of lentil under moisture stress. The experiment was designed using Completely Randomized Design (CRD) with three replications in a factorial arrangements. Experiment was consisted of two factors including two levels of field capacity (80% and 40%) and seven levels of foliar application of Chitosan (0 $mg.L^{-1}$, 5 $mg.L^{-1}$, 10 $mg.L^{-1}$, 15 $mg.L^{-1}$, 20 $mg.L^{-1}$, 25 $mg.L^{-1}$and 30 $mg.L^{-1}$). Moisture stress was applied by maintaining required field capacity levels from sowing to maturity. In order to mitigate moisture stress, different concentrations of chitosan were applied at 30 DAS and 60 DAS. Moisture stress significantly reduced relative water content, chlorophyll and carotenoid contents, plant height, number of branches, number of pods, biological and seed yield. Whereas biochemical parameters like MDA, H2O2, electrolyte leakage, were significantly increased under moisture stress. The application of chitosan appreciably reduced the induced moisture stress effects and caused a significant increase in yield and other related traits. The application of 25 $mg.L^{-1}$ of chitosan remained best to improve lentil growth and yield through improving leaf water content, chlorophyll and carotenoid contents and reducing MDA, H2O2 and electrolyte leakage through improved activities of anti-oxidant enzymes. Therefore, these findings suggested that the foliar application of chitosan at the rate of 25 $mg.L^{-1}$ may be used in moisture stress conditions to obtain better yield of lentil.

Keywords: Moisture stress; chitosan; growth; biochemical; yield; lentil

ALLEVIATION OF TERMINAL DROUGHT STRESS IN WHEAT THOROUGH FOLIAR APPLICATION OF SYNTHETIC CYTOKININ (6-benzylaminopurine)

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Drought is one of the most critical factors limiting crop production and output. Crops respond to drought stress in a variety of ways, including physiological, morphological, molecular and biochemical responses. Cytokinin (CK) is a growth mediator that not only regulates plant growth and development but also improves plant adaptation under drought conditions. In this study we explored drought mitigating role of synthetic cytokinin 6-benzylaminopurine (6-BAP). The experiment was designed using Randomized Complete Block Design (RCBD) with split plot arrangement and three replications. Drought treatments consisting of two levels W1 (Normal irrigation) and W2 (Skipped irrigation at heading stage) were assigned in main plot. Whereas foliar application of different levels of 6-BAP (0µM, 15µM, 30µM, 45µM and 60µM) were assigned in sub-plots. The induced drought significantly affects wheat performance by reducing its growth, biochemical and yield traits. 6-BAP application under drought stress significantly increased growth and yield characteristics by reducing the production of MDA, H2O2 and electrolyte leakage and improving the activities of antioxidant SOD, CAT and POD. Increase in grain yield was recorded with 6-BAP application @ 45µM. The findings of this study suggested that the application of synthetic cytokinin (6-BAP) at the rate of 45µM may be used as foliage spray to recover wheat growth and production under terminal drought stress conditions.

Keywords: Drought stress; synthetic cytokinin; 6-benzylaminopurine; growth; biochemical; yield; wheat

GROWTH, YIELD AND QUALITY TRAITS OF DIFFERENT WHEAT GENOTYPES UNDER DUAL PURPOSE PRODUCTION OF FODDER AND GRAIN YIELD

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The provision of green fodder is one of the most critical issues for animals, especially during the winter season. The focus of this study was to investigate the performance of different wheat genotypes for their potential to be used for dual purpose of fodder as well as grain yield on the basis of growth, yield and quality parameters. This experiment was carried out at the Agronomic Research Area, College of Agriculture, BZU, Bahadur Sub-Campus, Layyah. Experiment consisted of 13 wheat genotypes (Ghazi-2019, Seher-2006, Akber-1019, Ujala-2016, PAK-13, Zincol-2016, Markaz-2019, Bourlag-2016, Galaxy-2013, Johar-2016, Anaj-2017, Fakhr-e-Bhakkar and Desi Wheat). All the genotypes were grown under two growing conditions (cut, for fodder; uncut, without fodder cutting). The performance of wheat genotypes for different parameters number of tillers, plant height, spike length, number of spike-lets, biomass, grain yield, fodder yield, neutral detergent fiber (NDF), acid detergent fiber (ADF) and seed protein were measured under both growing conditions. Significant variation among genotypes was observed for growth, yield and quality parameters under dual purpose production system. Wheat varieties Anaj, Akbar-2019, Zincol-2016, Bourlag-2016 and Galaxy-2013 performed better for fodder production. Wheat varieties Galaxy-2013, Bourlag-2016, Markaz-2019 and Anaj gave comparatively better grain yield than other varieties. Wheat varieties Markaz-2019, Bourlag-2016, Galaxy-2013 and Anaj gave higher values of quality parameters than other varieties. Therefore, our findings suggest that wheat varieties Bourlag-2016, Galaxy-2013 and Anaj may be used for dual purpose production of fodder and grain.

Keywords: Wheat, dual purpose, neutral detergent fiber, acid detergent fiber, grain yield, seed protein

ENHANCING THE YIELD OF DESI AND KABULI CHICKPEA THROUGH SOIL APPLICATION OF BORIC ACID

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Chickpea (*Cicer arietinum* L.) is the third most important pulse crop, after dry bean and peas, produced in the world. In Pakistan it is grown over an area of 940 thousand hectares with a production of 545 thousand tones. Chickpea is a good source of energy, protein, minerals and vitamin. Boric acid plays an important role in new cell development in meristemetic tissues, proper pollination and fruit or seed formation and nodule formation in legume. Boric acid also ensures the healthy transport of water, nutrients and organic compounds to these growing portions. There are many causes of low yield of chickpea are Unpredictable and erratic rainfall, drought stress, limited use of improved cultivars, inadequate plant population, improper weed control measures, and deficiency of micronutrient including boron. Soil application of boric acid is effective in pod formation. A pot experiment was conducted at College of Agriculture, Bahadur Sub-campus Layyah with CRD factorial design containing three replications. The objective of this research was to study the deficiency effects of boric acid and improve the yield of kabuli and desi chickpea through its soil application. Manual sowing of desi (Thal-2020) and Kabuli (Noor-2009) with treatments level control, 0.2 mg/kg soil, 0.4 mg/kg soil, 0.6 mg/kg soil, 0.8 mg/kg soil, 1.0 mg/kg soil application of boric acid. After careful data collection and using statistical analysis, it was observed that desi chickpea produced higher seed yield as compared to kabuli chickpea at the rate of 0.6 mg/Kg soil application of boric acid. By this study, it is recommended to apply boric acid at the rate of 0.6mg/Kg soil in order to get more seed yield.

Keywords: Desi chickpea, Kabuli chickpea, Boric acid, Soil application, Yield.

IMPROVING THE PRODUCTIVITY OF CANOLA THROUGH THE APPLICATION OF ORGANIC, INORGANIC AND BIOFERTILIZERS

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Canola (*Brassica napus* L.) is the second most important oil crop, after soyabean produced in the world. In Pakistan it is grown over an area of 31.16 thousand hectares with a production of 49 thousand tones seed and 19 thousand tones oil. Canola oil is a good source of energy, protein, minerals and vitamins. Plant growth promoting rhizobia plays an important role in new cell development in meristemetic tissues, proper pollination and fruit or seed formation. Organic amendments like Biochar, compost, poultry and animal manure also ensure the healthy transport of water, nutrients and organic compounds to these growing portions. There are many causes of low yield of canola are drought stress, limited use of improved cultivars, inadequate plant population, improper weed control measures, and deficiency of adequate nutrients for the growth and development. A field experiment was conducted at College of Agriculture, Bahadur Sub-campus Layyah with RCBD factorial design containing three replications. The objective of this research was to study the effects of organic and inorganic biofertilizers on canola and improve the yield of canola. Hand drill sowing of goldstar canola ere carried out by seed priming of two plant growth promoting rhizobia strains including soil application of 2t/ha Biochar, 2t/ha compost, 2t/ha poultry manure, 2t/ha animal manure, and a control. After careful data collection and using statistical analysis, it was observed that plant height along with primary and secondary branches, biological yield and grain yield was maximum at PGPR-1 with Biochar and poultry manure treatment. By this study, it is recommended to use PGPR-1 with Biochar and poultry manure at the rate of 2 t/ha in soil to get better yield.

Keywords: canola, biochar, compost, poultry, animal manure, PGPR, yield

KAOLIN AND JASMONIC ACID IMPROVE VEGETATIVE GROWTH, GAS EXCHANGE, REPRODUCTIVE TRAITS OF COTTON UNDER WATER DEFICIT CONDITION

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Drought is one of the most emerging threat that causes a severe reduction in cotton plant growth and development. Being cotton is a major cash crop has great threat to prevailing drought events in Pakistan. A field experiment was conducted in Kharif season 2018 at Research Area of MNS-University of Agriculture, Multan, Pakistan to assess the role of foliar applied Kaolin and Jasmonic acid on vegetative growth, gas exchange and reproductive traits of cotton under normal irrigated and artificial water deficit conditions. The experiment was laid -out in a factorial randomized complete block design with split-split plot arrangement. Main plots were allocated for irrigation levels, sub-plots for two-cotton genotypes viz. NIAB-878 and SLH-19 while sub-sub plots for treatments of Kaolin and Jasmonic acid. Water deficit stress was created by skipping irrigation at flowering for 21 days. Foliar sprays of Kaolin (5%, w/v) and Jasmonic acid (100 µM) were applied alone or in combination at 60 days after planation both to normal irrigated and water-stresse skip irrigation while irrigation water alone was sprayed in control plots. Both cotton genotypes responded variably to normal irrigated and skip conditions. Skipping irrigation for up to 21 days at flowering caused a significant decrease in leaf relative water content, SPAD values, net photosynthetic rate and seed cotton yield in both the genotypes. Seed cotton yield showed an overall decline of 24.7% in skip over Normal irrigated crop. The genotype NIAB-878 produced maximum seed cotton yield of 3.304 Mg ha^{-1} in normal that dropped to 2.579Mg ha^{-1} in skip, thus showing an average decline of 21.9 %. Similarly, SLH−19 produced 2.537 Mg ha^{-1} seed cotton under normal that dropped to 1.822 Mg ha^{-1} in skip, showing an average decline of 28.2%. The application of Kaolin and Jasmonic acid, either applied individually or in combination, improved vegetative and reproductive development of both cotton varieties in normal and skip regimes. However, combined Kaolin and Jasmonic Acid application proved to be more beneficial in terms of seed cotton production and other parameters studied.

Keywords: Cotton, kaolin, jasmonic acid, water stress, gas exchange characteristics, yield

EFFECT OF SOWING DATES AND GENOTYPES ON YIELD AND YIELD CONTRIBUTING TRAITS OF UPLAND COTTON (*Gossypium hirsutum* L.)

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Cotton is an important cash crop that generates a large amount of revenue in Pakistan. Cotton production was decreased due to climate change, biotic and abiotic factors, unpredictable rain patterns, high temperatures. Therefore, it needs to identify cultivars with suitable sowing time in a specific environment. The objective of this experiment was to evaluate the yield potential of different cotton genotypes under different sowing dates (early to late). In 2019 and 2020, a field experiment was conducted at Cotton Research Station, Sahiwal, Pakistan. The experiment was conducted using a split-plot arrangement in a randomized complete block design with three replicates. The main plot comprised six sowing dates with an interval of 15 days starting from 16th March, and the subplot consisted of four varieties: SLH-8, FH-Lalazar, CIM-622 and FH-142.It was observed that maximum seed cotton yield was recorded for sowing date 16th March during both years, i.e., 2019 (1583.63 kgha-1) and 2020 (1741.96 kgha-1). SLH-8 was the best performing variety among all studied genotypes for plant height, boll weight, and seed cotton yield. The mean seed cotton yield during both years ranged 1434.58 to 1983.77 kg ha-1. Maximum seed cotton yield during both years was showed by SLH-8 that was 1726.82 and 2240.71 kg ha-1. Correlation analysis showed that seed cotton yield was positively correlated with the boll weight (0.738**) and number of bolls per plant (0.53**). Sowing dates in March, April, and May were grouped together in cluster no. 2, whereas sowing dates in June were grouped together in group 1. This study helps to optimize the sowing date to meet the climate changes and enhance the seed cotton yield.

Keywords: Sowing dates, cotton, Gossypium hirsutum L. yield attributes

MORPHO-PHYSIOLOGICAL EVALUATION OF RAPESEED (*Brassica napus L.)* GERMPLASM FOR SALINITY TOLERANCE

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Salinity is a major and complex abiotic stress that disrupts plant growth and diminishes crop yield. *Brassica napus* L. is an important oil seed crop of Pakistan with some level of salt tolerance. Given the rapid increase in saline soils and increasing edible oil requirements, it is exigent to introduce salt-tolerant genotypes of *B. napus*. Present study was conducted to investigate the morpho-physiological responses of *Brassica napus* germplasm subjected to salt stress and to ascertain the salt tolerant ones. The study was conducted at Department of Agronomy, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi. The seeds of one hundred genotypes of *Brassica napus* were collected from NARC and Ayub Agricultural Research Institute Faisalabad. At first step, the optimum concentration of NaCl within 50, 100, 150, 200, 250, 300 and 350 mmol NaCl was determined for randomly composite seed sample of genotypes. NaCl stress of 200mM was found optimum for screening of B. napus germplasm at germination stage. In the second step, the genotypes were evaluated for their level of salt tolerance at germination stage. The seeds of genotypes were germinated with optimum concentration of NaCl (200mM) along with control (distil water) and various germination and seedling traits (Various germination indices were recorded (germination rate, root length, shoot length, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight and seedling fresh weight (fresh weight of root + fresh weight of shoot) and root, shoot dry weight, seedling water content (%), promptness index, emergence Index, germination index (GI), germination vigor index (GVI), germination Energy (GE), relative seed germination (%), relative seedling growth rate) were recorded. The salt-tolerance index

of all studied traits was computed. The salt tolerance index of each trait was used for computing Membership Function Value (MFV) employing the fuzzy comprehensive evaluation method. The MFVs of all genotypes ranged from 0 to 1. Each genotype has its own mean MFV, the greater the mean MFV, the higher the salt tolerance was. The mean MFV was subjected to Hierarchical cluster analysis to divide the genotypes into four groups viz; highly salt tolerant, moderate salt tolerant, moderate salt sensitive and highly salt sensitive. Based on mean MFV of all genotypes, out of 100 genotypes, 10 were identified as salt tolerant (mMFV 0.855- 0.720), 36 moderate tolerant (mMFV 0.704- 0.612), 40 moderate sensitive (mMFV 0.608- 0.474) and 14 salt sensitive (0.463- 0.279). Genotype RBN-03046, RBN-11049, Abasian-95 and 19-h (Rapa) were found moderate Tolerant, Dunkled, Con-II(Rape), Shiralee and Nifa Gold Moderate Sensitive, and Hyola-401, PARC Canola Hybrid, AARI Canola and Punjab Canola highly Sensitive. It was concluded that Faisal Canola and Super Canola are highly salt tolerant and should be preferred to cultivate in saline soils. These genotypes are also ideal where crop is irrigated with saline tubewell water. Accessions CBN-11, CBN-69 are potent salt tolerant and should be incorporated in B. napus improvement breeding program. Hyola-401, PARC Canola Hybrid, AARI Canola and Punjab Canola are sensitive to salinity stress and are not recommended for saline soils.

Keywords: Brassica family, oil seed crops, drought, global warming, climate change

COMPARATIVE EFFICACY OF FOLIAR AND MEDIUM SUPPLEMENTED DIAMMONIUM PHOSPHATE IN IMPROVING REPRODUCTIVE GROWTH IN WHEAT

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Wheat (*Triticum aestivum* L.) is a member of the Poaceae family which is commonly known as the grass family. Diammonium phosphate (DAP) is among the most basic granulated manure with white, dark or dark granules. It contains 18% nitrogen in ammonia and 46% phosphorus (P_2O_5) as ammonium phosphate, which can be applied both as foliar as well as a soil supplement. A Field experiment was designed in the New Botanical Garden of the University of Agriculture, Faisalabad to analyze the impact of foliar and medium supply of DAP in improving the reproductive and growth of wheat. In this field experiment soil fertilization with 136 g DAP and 5%, DAP Foliar was sprayed in two beds of each plot respectively, whereas the other two beds of each plot in the field experiment were treated as water spray and control, individually. The research experiment was a completely randomized factorial design with three replicate. The measurement was taken after three days interval during 12 different harvests for leaf morphological parameters, photosynthetic gas exchange attributes, photosynthetic pigments analysis, grain yield, yield components, and grain mineral elements composition. The results of all these parameters significantly highlighted the use of DAP foliar spray as an effective strategy to improve wheat growth and production as compared with medium supplementation.

Keywords: plant nutrition, agronomic practices, production technology, foliar feeding

SEED PERFORMANCE OF NEW PROMISING ALFALFA (*MEDICAGO SATIVA* L.) GENOTYPES TO DROUGHT STRESS

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Among abiotic factors, drought stress is a widespread natural threat to forage production of alfalfa worldwide. The increased risks of drought have worsened the challenged related to higher forage yield of alfalfa for livestock, hence, needs essential approaches to counteract the drastic effects of drought in current climate change scenarios. The exploring new promising alfalfa germplasm diversity in extreme areas that are normally subjected to drought periods, could be effective to ensure its higher forage production. The current study was, therefore, conducted to explore the potential of exotic alfalfa genotypes for their higher forage production under drought stress conditions. The exotic alfalfa genotypes (44) were evaluated based on morphological traits for their drought tolerance potential under well-watered (80% FC, field capacity) and drought stress (60% and 40% FC) conditions. The experiment comprised of 132 treatments and arranged randomly under completely randomized design (CRD) with factorial arrangement in three replicates. In scattered biplot of alfalfa genotypes (PC 1 and PC 2) for gain in shoot and root lengths, shoot fresh and dry mass, root dry mass and trifoliate leaves encountered three main distinct groups including tolerant, moderate and sensitive to drought stress. Based on genotype distribution in each group, genotypes (24, PI502452 and 43, PI478844) with higher mean values (351.54 and 335.18), respectively were exhibited as drought tolerant. Genotypes (16, PI162459; 17, PI162457; 23, PI502453; 26, PI502449) in second group were moderate drought tolerant with less means values (321.40, 305.75, 286.11, and 274.80), respectively in contrast to drought tolerant group. Most of the genotypes (2, PI172982; 4, PI172190; 29, PI502445; 30, PI502438; 35, PI494661) with least mean values 74.69, 79.73, 126.03, 131.11 and 140.89), respectively were considered as drought sensitive.

Key words: Drought stress, alfalfa, forage production, genotypes, livestock feed

EXPLORING NITRIFICATION INHIBITION POTENTIAL OF CHILLA (*Casearia tomentosa*) FOR IMPROVING NITROGEN USE EFFICIENCY OF MAIZE (*Zea mays* L.)

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The judicious use of N is necessary for improving fertilizer use efficiency for better crop yields. The present study explored the nitrification inhibition potential of an indigenous plant Chilla (*Casearia tomentosa*) in comparison with Dicyandiamide (DCD) in urea-treated soil. During experimentation, the process of nitrogen (N) transformations was studied to observe the fate and recovery of N in soil and its effect on maize growth. The (DCD) and proposed plant materials (leaf and bark powder) was applied @ 1 % and 20 % of the applied urea, respectively. The treatments was comprised of T_1-(control)-soil with no amendment, T_2-Urea nitrogen (UN), T_3- {UN + 2 mg/kg (DCD)}, T_4-{UN + 40 mg/kg leaf powder (LP)}, T_5-{UN + 40 mg/kg bark powder (BP)}, T_6-{UN + 20 mg/kg LP + 20 mg/kg BP}. The soil amended with treatment materials was incubated for 60 days to observe N transformation and same treatments were also be applied to soil in pots and maize plants were grown using a completely randomized design (CRD). The significant difference was observed in dynamics of NH_4^+-N and NO_3^--N during incubation, therefore compared to control urea added singly or in combination with DCD and plant material influence the growth of maize growth in pots. The study concluded that the tested plant Chilla (*Casearia tomentosa*) has potential the inhibit nitrification and improve N use efficiency of maize. Among all treatments, leaf power of selected plant material was superior to better growth and increase N recovery efficiency than bark material or synthetic nitrification inhibitor (DCD). Therefore, it is recommended to incorporate the residues of Chilla as useful soil amendment to improve crop yield and N use efficiency.

Keywords: Nitrogen transformation, maize growth, N use efficiency, nitrification inhibition

MORPHOLOGICAL AND BIOCHEMICAL EVALUATION OF SOYBEAN (*Glycine max* L.) CULTIVAR RAWAL-1 IN RESPONSE TO THE SEED TREATMENT AND FOLIAR APPLICATIONS OF GA3 AND 2,4-D

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Plant growth regulators might work on the physiological proficiency, photosynthetic ability and can improve the successful partitioning of accumulates from source to sink in the field crops. There is a little data on the role of growth regulators in the manifestation of yield components and seed quality of soybean (*Glycine max* L.) An endeavor has been made to elaborate the subject with emphasis on the importance of plant growth regulators, viz. Auxin (2,4-D) and gibberellin (GA_3) in a ratio of 30:60:90 mg L^{-1}. Growth regulators were used as seed treatment before sowing and foliar treatment at physiological stage of flower initiation. The experimental arrangement charted a complete randomized block design with three replicates. The study was hypothesized with the aim of increasing yield of soybean through foliar application of growth regulators. The data was statistically analyzed by using Tukey's Honest Significant difference test at $p \leq 0.05$. Seed treatment with 2,4-D at 90 mg L^{-1} revealed highest plant height, first node height, number of branches per plant, root length, stem diameter, number of pods per plant, seed yield, biological yield and harvest index. The GA3 Seed treatment at 90 and 60 mg L^{-1} showed significantly maximum number of nodules per plant, nodule fresh weight and nodule dry weight. The number of seeds per pod exhibited non-significant results during the study. Foliar application of 2,4-D at 90 mg L^{-1} showed a significantly maximum leaf area as compared to seed treatment. Growth regulators also significantly affected quality traits. Response of plant growth regulators was outstanding in promoting the soybean as a successful oilseed crop. So it is proved that the application of plant growth regulators is very helpful for gaining maximum growth, higher yields and quality of soybean under rainfed conditions.

Keywords: Growth regulators, soybean, seed treatment, foliar application, GA3, 2,4-D

GROWTH AND ION UPTAKE BEHAVIOUR OF SAFFLOWER (*Carthamus tinctorius* L.) GROWN UNDER TWO DIFFERENT TEXTURED SOILS USING SALINE WATER IRRIGATION IN AGRO-CLIMATIC CONDITIONS OF ARID ZONE OF DERA GHAZI KHAN

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Arid climate of Dera Ghazi Khan along with poor quality ground water are among the major constraints of growing oilseed crops in this region. A pot experiment was carried out in order to evaluate the growth response of safflower on two different textured soils. Five treatments were used i.e., T_1: Control (canal water); T_2: saline water; T_3: 50% canal water+ 50% saline water; T_4: 25% canal water+ 75% saline water; T_5: canal water + organic matter. Growth parameters like plant height, root length, shoot length, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight and ionic parameters like K^+, Na^+, K^+/Na^+ ratio were measured in root, shoot and leaves of safflower during and after the experiment. The experiment was completely randomized with factorial arrangement having three replications. On the basis of all measured parameters, it was noted that among all treatments, T_5 improved all growth parameters like root fresh weight (6.21g), root dry weight (5.11g), shoot fresh weight (14.54 g), shoot dry weight (9.77 g), root length (17.50 cm), shoot length (54.66 cm), chlorophyll contents (46.50), seed yield per plant (71.33 g) and 1000-seed weight (35.50 g). The maximum K/Na ratio (2.22) was noted in leaves of safflower at T_5. Loam textured soil improved growth and yield of safflower due to high water holding capacity and nutrient availability when compared with sandy loam soil. However, K^+/Na^+ ratio root and shoot of safflower was more in sandy loam soil as compared to loam soil while it was observed high in safflower leaves in loam soil. It might be due to the high rate of K^+ transfer in leaves of safflower in loam soil. Blending of saline ground water with canal water has good impacts on growth and yield of safflower crop (T_3 and T_4) when compared with saline water application (T_2). It also minimized the hazards of toxic ions like Na^+. Thus blending of saline and canal water along with organic matter application can be used successfully for growing safflower in the light and medium textured soils of Dera Ghazi Khan.

Keywords: Blending, loam, safflower, organic matter, K^+/Na^+

PHYTOHORMONE PRODUCING RHIZOBIAL COMBINATION TO ENHANCE MAIZE YIELD IN WATER SCARES CONDITIONS

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Drought seriously affects the plant physiology, biochemistry and yield. To ameliorate the effect of drought different ways can be adopted. The most economical and simplest way is the use of rhizobial inoculants. Plant growth is stimulated by phytohormones even at micromolar or even at lower concentrations. Also, all physiological and developmental processes in plant life cycle are regulated by phytohormones Maize, one of the most important cereals is known to be vulnerable to even moderate scarcity of water particularly at tasseling stage. Three different phytohormone producing rhizobial combinations were tested to enhance the maize yield in water scares conditions. In general, drought applied at any critical growth stage of the crop, negatively influenced the crop growth compared to un-stressed plants, but the magnitude of severity varied with respect to growth stage. Irrigation skipped at vegetative stage, significantly disturbed the physiology and water relations of maize crop whereas; water deficit stress at tasseling reduced the crop yield. Inoculation increased the grain yield 4% in compare to uninoculated control.

GENOME-WIDE SURVEY OF HMA GENE FAMILY AND IDENTIFICATION OF ITS FUNCTION DURING DROUGHT STRESS TOLERANCE IN WHEAT (*Triticum aestivum*)

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Abiotic stress, which includes drought and heavy metal toxicity, has presented a significant risk to long-term agricultural output around the world. Although the HMA (heavy-metal-associated domain) gene family has been widely explored in Arabidopsis, it has not been thoroughly studied in *Triticum aestivum*. The purpose of this study was to investigate the effect of wheat HMA genes under water deficit. To analyze the phylogenetic relationships, gene structure, gene ontology, and conserved motifs, a comparative study of wheat HMA genes with the Arabidopsis genome was performed. A total of 27 *Triticum aestivum* proteins belonging to the HMA gene family were discovered in this investigation, with amino acid counts ranging from 262 to 1071. HMA proteins were found to be divided into three subgroups in a phylogenetic tree, and closely related proteins in the tree showed the same expression pattern as motifs found in distinct subgroups. Gene structural study found that intron and exon arrangement differed by family. As a result, the current work offered important information regarding HMA family genes in the *Triticum aestivum* genome under drought stress, which will be valuable in understanding their putative functions in other wheat species.

Keywords: HMA (heavy-metal-associated domain), drought-stress, wheat, phylogenetic analysis

GROWTH, NODULATION AND YIELD OF PEA (*Pisum sativum* L.) IN RESPONSE TO PHOSPHORUS AND MOLYBDENUM APPLICATIONS

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Both phosphorus (P) and molybdenum (Mo) are considered important for nodulation, nitrogen fixation and overall plant growth. The present study was carried out to evaluate the comparative and combined effectiveness of P and Mo on the growth, nodulation and yield of pea (*Pisum sativum* L.) under greenhouse conditions in the University of Poonch Rawalakot Azad Kashmir. There were four P (0, 25, 50 and 75 kg P_2O_5 ha^{-1}) and four Mo (0, 0.5, 1.0 and 1.5 kg Mo ha^{-1}) levels. Pea variety "Meteor" was sown as a test crop in the experiment. Results showed that the application of P, Mo and P+Mo combination significantly increased growth, nodulation and yield of pea compared to the control. Co-application of 50 or 75 kg P_2O_5 +1.0 kg Mo ha^{-1} (P_2Mo_2) increased the growth characteristics and nodulation of pea with alone P, Mo and combined P+Mo treatments. The yield and yield attributes of pea differed significantly with the application of P, Mo and their combinations over their respective controls. In conclusion, the individual and combined application of P and Mo proved effective in improving growth, nodulation and yield attributes by pea.

Keywords: Pea, phosphorus, molybdenum, growth, nodulation, yield

IMPACT OF IRON OXIDE NANOPARTICLES ON SEEDLING OF PEA (*Pisum sativum* L.) TO CONQUER SANITY STRESS TOLERANCE

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Pea (*Pisum sativum* L.) being an important crop is mostly consumed as fresh vegetable, salads and soups. The aim of this study was to explore the impact of iron oxide nanoparticles on pea (*Pisum Sativum L.*) to alleviate salinity stress. Iron oxide nanoparticles were prepared from the extracted obtained from green tea (*Camellia sinensis* L.) leaves by green synthesis method using ferric chloride. This experiment was conducted in the botanical garden of University of Gujrat- Gujrat, Pakistan by using two varieties of pea (Meteor and Green Gold). During the cropping season pot experiment was conducted in mid-October 2018-19 and after eight (8) days of seed germination, salt treatment was applied. After ten (10) days of salt treatment, iron oxide nanoparticles were applied. At seedling stages different parameters were recorded *i.e.* Root lengths (cm), Shoot length (cm), Root/Shoot Length, Fresh weight of root (g), Fresh weight of shoot (g), Root dry weight (g), Shoot dry weight (g), Root/Shoot ratio (%). Results revealed that pea variety Meteor have better adoptability then Green Gold as it have good root shoot ratio. Meteor performed best under salinity stress and iron oxide nanoparticles (300 ppm NaCl+10 ppm FeO NPs) for majority of physiological traits which showed Meteor performance under salinity was good at iron oxide nanoparticles. Results also showed that 10 ppm FeO nanoparticles concentration is suitable and recommended to overcome salt stress in pea. Further investigations are required to discover the most effective method for application of iron oxide nanoparticles for yield maximization of pea under salt stress.

Keywords: Iron oxide, nanoparticles, pea and salinity

PLANT GROWTH PROMOTION ABILITY OF PHOSPHATE SOLUBILIZING BACTERIA IN CEREAL CROPS

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Phosphorus can be major limiting factor for plant growth due to its slow diffusion and high fixation in soil. Pakistani soils are rich in phosphorus, but it exists in unavailable form due to alkaline nature of soil. Phosphate solubilizing bacteria (PSB) have the ability to transform unavailable form of phosphorus into available form. Unavailable phosphorus can be categorized into organic and inorganic sources which are principally transformed to available phosphorus form by the low molecular weight organic acid production. Phosphate solubilizing bacteria have the ability to produce phytohormones, nitrogen fixation, remediate metal contaminated soils and biological control of plant diseases. These bacteria could be used as biofertilizers to provide a sustainable solution to this vicious cycle of chemical fertilizers dependency. Development of phosphate solubilizing biofertilizers as alternative of chemical fertilizers has a promising strategy to produce healthy food at low cost and without causing any environmental hazard. PS-Biofertilizers could eliminate the use of DAP and producing healthy and nutritious food in large quantity. Controlled condition trials of phosphate solubilizing bacteria on rice and wheat. Plant beneficial bacteria were collected from culture collection of plant lab of department of Bioinformatics and Biotechnology GCUF. Purified bacteria were further tested qualitative and quantitative phosphate solubilizing assay. Later phosphate solubilization ability of bacteria was confirmed by the amplification of pqq gene assay. Potential phosphate solubilizing bacteria were evaluated for plant growth promotion under controlled condition. Experiments were conducted in the growth chamber and growth rooms. Phosphate solubilizing bacteria were screened to develop phosphate solubilizing biofertilizers for wheat and rice.

FARMERS' PERCEPTIONS AND ADAPTATIONS TO CLIMATE-SMART AGRICULTURE IN PUNJAB: RESULTS OF A PILOT SURVEY

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Climate change is identified as one of the most serious challenges affecting agricultural productivity and farmers' livelihoods worldwide. The purpose of this study was to examine farmers' perceptions and adaptations to climate-smart agriculture. The preliminary results are based on a pilot survey in which data were collected from wheat farmers in Punjab. In this study, pre-designed questionnaire was used to evaluate farmers' perceptions of climate-smart agriculture as well as local indicators regarding farmers' their skills and adaptability. The most important climate-smart agricultural (CSA) practices that local farmers have implemented in the area include crop rotation, mixed cropping, changing the planting and harvesting time, and diversifying their crop selection. Farmers demonstrated a positive attitude toward climate-smart agriculture to learn, adopt and adapt. However, some factors affecting their motivation to adopt and adapt were increased income, high yield, and the smartness of technology for income and production enhancement related to CSA. The majority of the farmers perceived personal experience and agricultural extension advisory services important however, illiterate farmers rely on fellow farmers for motivation and knowledge acquisition about climate-smart agriculture. Adoption of climate-smart agriculture practices was significantly related to educational level, experience, and land size. According to the findings, the most significant barriers that farmers faced were lack of education and trainings as well as inadequate support from the local government. Importantly, any intervention that encourages the use of climate change adaptation measures may take into account location-specific factors that influence farmers' perceptions of climate change and adaptive responses to it. Moreover, the study recommends that climate-smart agriculture be incorporated and prioritized in the development plans to increase the adoption and adaption of climate-smart agricultural practices.

SCREENING OF SUNFLOWER GENOTYPES IN RESPONSE TO WATER AND NUTRIENTS SEED PRIMING UNDER LABORATORY CONDITIONS

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Seed priming with water and plant nutrients improves seed germination, seedling establishment and crop growth. This study was accomplished to determine the screening of sunflower genotypes in response to water and nutrients seed priming. Sunflower genotypes HO-1, Charnika, Hysun-33 and NK-278 with four priming treatments i.e. No priming , Seed priming with canal water, Seed priming with 1.0% Urea and Seed priming with 0.2% Zinc sulphate. The effect of these priming on seed germination (%), vigor index, root length (cm), shoot length (cm), root fresh weight (g), shoot fresh weight (g), root dry weight (g) and shoot dry weight (g) and seed of test genotypes were investigated under laboratory conditions was conducted at Seed Testing Laboratory, Department of Agronomy Sindh Agriculture University Tandojam. The statistical analysis of data showed that different seed priming sources, genotypes and their interactions caused significant ($P<0.05$) effect on seed germination and subsequent growth of seedlings. Seed priming with 0.2% $ZnSO_4$ was found superior in terms of highest seed germination (92.30%), vigour index (1499), root length (6.07 cm), shoot length (16.82 cm), root fresh weight (16.82 g), shoot fresh weight (5.02 g), root dry weight (0.14 g) and shoot dry weight (0.31 g) followed by 1.0% urea where as minimum results on no priming. Among genotypes, HO-1 proved maximum performance on all parameter like seed germination (83.80%), vigour index (1316), root length (5.40 cm), shoot length (16.20 cm), root fresh weight (16.20 g), shoot fresh weight (3.89 g), root dry weight (0.11 g) and shoot dry weight (0.29 g) followed by Hyssun-33 performed better than other tested genotypes. The interaction of 0.2% $ZnSO_4$ × genotype HO-1 gave greatest results. In respect of the above findings it was screened out that the priming with 0.2% $ZnSO_4$ produced better results. The results further indicated that the genotype HO-1 produced highest results in all aspects followed by Hysun-33.

Keywords: Sunflower genotypes, priming, seeds

LOW DOSES OF CAFFEINE AS SEED PRIMING ARE EFFECTIVE FOR THE INDUCTION OF WATER STRESS TOLERANCE IN WHEAT AT GERMINATION AND EARLY VEGETATIVE STAGE

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Better crop stand establishment is a major problem in agronomic crops for better production especially under rainfed conditions. Rapid and uniform seed germination contributes maximally in the establishment of better crop stand that is a problem under water deficit conditions. Different methods/ techniques are being used to overcome this problem. These include the hydro priming osmo-priming, chemo-priming, chilling treatment etc. The chemo-priming includes the priming with different organic and inorganic chemical and it is found successful in better crop production by improving the seed germination and seedling emergence potential. The present experiment was conducted in growth room to find out the effects of seed priming with different levels of caffeine under PEG-induced water stress under growth room conditions in the Department of Botany, Government College University Faisalabad. The PEG-8000 with 16% (-0.65 M.Pa) concentration was used to create water stress. The experiment was arranged in CRD with four replication of each treatment. Wheat cultivar S-24 was used for the experimentation. The experiment was comprised of two sets of Petri-dishes corresponding to each level of water stress. One set was supplied with half strength Hoagland's nutrient solution and the other set was supplied with 12% PEG-8000 in half strength Hoagland's nutrient solution as water stress treatment. There was 6 seed soaking treatments i.e. no soaking, water soaking, and 4, 8, 12, 16 ppm doses of the caffeine. Water stress negatively impacted the seed germination and seedling emergence, seedling growth, biosynthesis of photosynthetic pigments, and antioxidative defence mechanism but increased the membrane lipid peroxidation. Seed priming with different caffein levels significantly reduced the adverse impacts of water stress on seed germination, seedling growth, leaf photosynthetic pigments and antioxidative defence mechanism but the positive responses were found only due to seed priming with 4 and 12 ppm levels of caffeine. The maximum amelioration was found due to seed priming with 12 ppm level of caffeine as compared with other levels. In conclusion seed priming with 12 ppm level of caffeine is recommended for better germination and better crop stand establishment in rainfed or water deficit areas.

Keywords: caffein, nutrient solution, PEG-8000

RESPONSE OF CHINESE WHEAT HYBRID LINES TO DIFFERENT LEVELS OF NPK

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Pakistan's average wheat production is significantly lower than that of the rest of the world, including adjoining countries like India and China. NPK are the major primary nutrients needed by the plants in large amount. Optimum amount of these nutrients has to be maintained in soil for achieving the yield potential. High yielding varieties of wheat have high nutritional requirements and generally give prominent response to the applied levels of NPK. A field research entitled "Response of Chinese wheat lines to different levels of NPK" was conducted at Agronomy Research Farm, The University of Agriculture Peshawar during Rabi season 2020-2021. The research was carried out in randomized complete block design (RCBD) having three replications. Treatments were consisted of Chinese wheat lines (18A1, JM-1215, JM-1683, H-1 and WS-1) with two local check (Wadan-17 and Pirsabak-15) and two NPK levels (F_1: 120-90-60 and F_2: 150-112-75 kg ha^{-1}). The results of the experiment indicated that wheat line WS-1 produced higher tillers (444 m^{-2}), leaf area (32.7 cm^2), leaf area index (5.0), plant height (105.4 cm), spike length (22.0 cm), spikes (336 m^{-2}), grains $spike^{-1}$ (59), thousand grain weight (62.2 g), biological yield (9769 kg ha^{-1}). Grain yield was recorded higher for wheat lines WS-1 (4236 kg ha^{-1}), JM-1683 (4204 kg ha^{-1}), H-1 (3923 kg ha^{-1}) and 18A1 (3812 kg ha^{-1}) while higher harvest index (55%) was noted in JM-1683. Application of NPK at the rate of (150-112-75 kg ha^{-1}) took less days to emergence (13) and increased emergence (87 m^{-2}), number of tillers (432 m^{-2}), leaf area (22.7 cm^2), leaf area index (3.4), plant height (98.3 cm), spike length (16.0 cm), spikes (319 m^{-2}), grains $spike^{-1}$ (43), thousand grain weight (56.6 g), biological yield (9057 kg ha^{-1}) and grain yield (3702 kg ha^{-1}) followed by lower level of NPK (120-90-60 kg ha^{-1}). It is concluded that wheat lines WS-1, JM-1683, H-1 and 18A1 produced higher grain yield with the application of NPK at the rate of 150-112-75 kg ha^{-1} is therefore recommended.

Keywords: wheat lines, biological yield, spike length

ADAPTING CLIMATE CHANGE THROUGH SMART AGRICULTURAL INNOVATIONS BY USING HYBRID EXTENSION APPROACHES IN RURAL AREAS OF PAKISTAN

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Agriculture is critical to Pakistan's economic growth, employment generation, poverty alleviation, and food security, with particular implications for rural communities. Agriculture the largest sector of Pakistan's economy contributes 19.2% to the country's GDP and provides jobs to a 38.5% labour force. Approximately 65 to 70% of the country's population derives their livelihood from agriculture, either directly or indirectly. As such, small growers account for nearly 90 percent of all farmers in Pakistan; however, because of changing rain patterns and temperature variations, as well as the intensity of extreme weather events, these small producers (including women) are particularly vulnerable to climate change, which has had a negative impact on food security and well-being. According to Global Climate Risks Index, the country has been ranked at 8th number in terms of losses and devastation due to changing weather conditions. The adverse impacts of climate change on agriculture are: moisture and heat stress; short growing period; risks of pests and enhance diseases; changes in water requirements and soil characteristics. Considering agriculture's vulnerability to climate change, there is a need to identify, promote, and adopt climate-smart agricultural innovations and practices, such as heat-resistant crops, climate-smart poultry, and livestock breeds, biogas, solar energy, and irrigation, across frontline farming communities. To introduce these climate-smart agricultural interventions, comprehensive extension and outreach services are required to carry out. These innovative extension approaches, with a focus on information communication technologies (ICTs), along with the use of traditional extension methods may well contribute to the effective mobilization of farming households to tackle climate risks through adaptation of CSA technologies in the context of threatened livelihoods, which can ultimately improve the well-being of rural communities.

Keywords: Climate change adaptation, innovation, rural, farmers, ICTs

EFFECT OF IRON AND ZINC EXOGENOUS APPLICATION ON BARLEY (*Hordeum vulgare* L.)

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Barley (*Hordeum vulgare L.*) is the fourth principal yield in "Poaceae family" and shows several applications in food production. Micro-nutrient accumulation in plants become more important in research aimed at solving human malnutrition. Now a day's deficiencies of Fe and Zn in crops production is very common. The pot experiment was conducted at Old Botanical Garden, University of Agriculture Faisalabad, Pakistan. The experiment was arranged in a completely randomized (CRD) with 2-factor factorial arrangement with three replicates. Five distinct barley varieties i.e., Sultan-17, Jao-83, Pearl-21 and Talbina-21 and three treatments used in this research T_o (Control), T_1 (+Fe, -Zn), T_2 (-Fe, +Zn), T_3 (+Fe, +Zn). The source of Fe was $FeSo_4.H_2O$ and Zn was $ZnSO_4$. In different treatments of iron and zinc, the combined application of Zn and Fe have great impacts on barley crop as compared to other treatment. Combined application increased the yield and photosynthetic rate of plant and enhanced the growth parameters like plant height. Iron and zinc is essential component for all living cellular material and its combined effect improved the production and nutrient insufficiencies. Fe and Zn foliar spray was very helpful to maximize the barley yield.

Keywords: Barley, iron, zinc

IMPROVING PRODUCTIVITY OF WHEAT THROUGH IRON AND BORON PRIMING UNDER DROUGHT CONDITION

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Drought is one of the most environmental stresses that affect growth and yield of crops including wheat. Wheat production is decreasing due to drought that is associated with climate change. To tackle drought, different techniques are being applied to improve wheat yield. Priming is an important technique used for improving wheat yield. A pot experiment was carried out to check the "effect of iron and boron priming on yield of wheat under drought condition" at lath house, College of Agriculture, Bahauddin Zakariya University, Bahadur Sub-Campus Layyah. Two wheat genotypes (Johar-2016 and Fakhr-e-Bhakkar) were grown under well watered and severe drought (Terminal drought at booting stage) conditions with priming treatments of iron and boron as hydro-priming (HP), Fe priming (Fe), boron priming (B) and iron + boron priming (Fe + B). Amongst wheat genotypes, Fakhr-e-Bhakkar produced the highest spikelets per spike, 100-grain yield and grain yield. Hydro-priming maintained more RWC compared with Fe and B priming. However, highest grain yield was recorded with Fe priming under well-watered conditions as well as drought conditions. From the results it is concluded that Fakhr-e-Bhakkar should be grown under drought condition to attain the highest wheat yield by priming seed with Fe.

Key words: Wheat, drought stress, seed priming, iron and boron, relative water contents

DYNAMICS OF ORGANIC FARMING IN PAKISTAN: AN INTEGRATED STUDY

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Agriculture has 21% contribution to the GDP of Pakistan and sustains the livelihood of 60% rural population. Pakistan is the 5th populous country of the world facing social, economic and environmental issues. Conventional farming dominates the agriculture sector of Pakistan which is leading to alarming environmental consequences. The study explores the global and regional trends to identify the status of organic farming. In Asia, Pakistan ranks 9th with highest organic agricultural land but its share to total agricultural area is quite minute. The study depicts that organic farming is the best substitute of conventional farming in Pakistan and a key to sustainable agriculture in the country. In Pakistan, organic farming is being influenced by a number of factors affecting the production and consumption of organic food such as consumer behavior and farmer willingness. The factors of cost, profitability and yield show that organic farming has 4 times more potential than conventional farming in Pakistan. As climate change is impacting the agriculture sector of Pakistan, organic farming is a Climate-Smart Agriculture approach for the country. The suggests that policy, financial and financial hurdles need to be minimized to promote certified organic farming in Pakistan. Ultimately, certified organic farming can make big contribution to agricultural economics of the country by boosted international trade. A comparative study has been included as well. The present review fulfills the gap in the existing literature by providing an integrated study by covering various aspects. Hence, the dynamics of organic farming in Pakistan have been explored comprehensively.

Keywords: Organic farming, sustainable agriculture, certified organic farming, climate-smart agriculture, food security

TIME-COURSE CHANGES OF CHLOROPHYLL, CAROTENOIDS, AND LYCOPENE IN LEAVES LAMINA AND PETIOLE OF *Glycyrrhiza glabra* L.

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In the last years, consumers are paying much attention to natural medicines due to the general sense of their safe nature. *Glycyrrhiza glabra* Linn (Licorice) is a small perennial herb belonging to the Fabaceae family and has been recognized since ancient times for its ethnopharmacological values. Its rhizomes and roots are the most important medicinally enriched parts for the treatment of many digestive and respiratory disorders, cough asthma tonsillitis and sore throat, epilepsy, fever, jaundice, and anticancer. An experiment was performed in order to explore the time-course changes of chlorophyll, carotenoids, and lycopene contents in leaves lamina, and petiole of the licorice plant. The sampling of upper-middle and lower leaves and petioles of licorice were taken after 10 days interval from the University of Agriculture Faisalabad. The sample was divided into three different plastic zipper bags as upper-middle and lower leaves with petioles. After collection, the samples were analyzed for different biochemical analyses such as chlorophyll, carotenoids, and lycopene contents. The data was handled statistically by applying statistics 8.1 software. The results showed differential accumulation of secondary metabolites and phytochemicals in different leaves parts with time-course changes, suggesting the involvement of seasonal variations in up-regulating their biosynthesis.

Keywords: lamina, petiole, Fabaceae family, plastic zipper bags

ROLE OF POTASH AND MICRONUTRIENT FOR IMPROVING YIELD AND QUALITY OF SUGARCANE GROWN IN PUNJAB (DIAGNOSIS AND MANAGEMENT)

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Sugarcane is an important industrial cash crop in Pakistan and many countries in world, but its production in Pakistan is low as compared to other countries because of climate, poor crop husbandry, imbalanced use of nutrients. Amongst the nutrients neglecting K and micronutrients may be one of the reasons responsible for low yield. To investigate nutrient syndrome in major sugarcane grown areas of Punjab nutrient indexing surveys of Rahim Yar Khan and Sargodha areas was conducted to determine extent and severity of nutrients deficiencies. Consequently, to establish the role of K and micronutrient fertilization in balance nutrient management of sugarcane for improving the yield and produce quality, field experimentation was undertaken in three Districts of Punjab, Pakistan. Three treatments; T1= N and P @ 200 & 100 kg ha-1, T2= N, P & K @ 200,100 & 150 kg ha-1 and T3= Zn (0.1%) + Fe (0.1%) + B (0.06%) + T2 were included. The micronutrients (Zn, Fe and B) were applied in 3 foliar sprays; 50, 90 and 120 days after germination. The results of nutrient indexing surveys revealed that all the soils of the surveyed areas were deficient in N, 90% in P and 40 % in K. Similarly, the surveyed soils were found 40% deficient in Zn, 50% in Fe and 40 % in B. The plant composition showed that 45% leaves samples were deficient in N and 40% in P. While the K deficiency was site and variety specific. The results of field experimentation indicated that on over all basis the yield increased upto15% by potash application and it varied from site to site. Response of sugarcane to applied micronutrients (Zn, Fe and B) varied and yield increase ranged from 3-5%. The quality parameters (Brix, Polarity and Sugar recovery) of the sugarcane also improved with K and micronutrients. The increase in Brix with K ranged from 1-4.5%, POL 2-5% and Sugar recovery by 0.5-1.5%.

Keywords: Sugarcane, potassium, micronutrients and balanced fertilization quality

RESPONSE OF SUGARCANE TO POTASH, MICRONUTRIENTS AND IRRIGATION WATER UNDER TWO AGRO-ECOLOGICAL CONDITIONS

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Sugarcane irrigation with tubewell water and imbalanced fertilizer use not only stagnated crop yields but also has hampered quality of the crop produce. The present study was designed to estimate irrigation water quality of the samples collected from Rahimyar Khan and Mardan/Charsadda (and evaluate the impact of K and micronutrients on sugarcane under the influence of tubewell and canal water irrigation. The water samples were collected from Rahimyar Khan (tubewell source) and Khyber Pakhtunkhwa (canal water source). Two field experiments were also done at both sites irrigated with two different sources (tubwell and river) but similar treatments including: T_1= control/farmer practice (N+P recommended), T_2= Farmer practice + K (160 $kgha^{-1}$), T_3= N+P+K+ Zn (0.1 % three foliar spray), T_4= N+P+K+ Fe (0.1 % three foliar spray) and T_5= N+P+K+ B (0.075 % three foliar spray). Results indicated that EC of the tubewell water samples was three times greater than the canal water and 83.33 percent of the total samples were suitable for irrigation compared to canal water (100 percent) on the basis of EC and TDS. The SAR calculated showed that only 4.76 percent of tubewell water samples were suitable and 35.71 percent marginally suitable while 100 percent water samples from canal water sources were suitable accordingly showing that canal water is fit for sugarcane cultivation as compared to tubewell water. Study of the growth yield and quality characteristics depicted that K application to soil alone and in combination with micronutrients foliar spray including zinc (Zn), iron (Fe) and boron (B) significantly improved cane height, cane girth and cane yield over farmer practice at each site individually and average over two sites. Sugarcane quality was positively improved by the soil application of K with micronutrients in term of brix contents, polarity and sugar recovery. Average over all treatments brix, polarity and sugar recovery were produced better with canal water irrigation than the tubewell water where sugar recovery was highest recorded 13.4 percent at Mardan site with canal water irrigation. It is concluded that canal water produced better sugarcane yield and improved cane quality. Furthermore, K and micronutrients use may support sugarcane to tolerate and yield better under salt stress.

Keywords: Potassium, micronutrients, sugarcane, irrigation water, agro-ecological conditions

SPATIAL CONFIGURATION AND GENETIC DIVERGENCE BOOST COWPEA HERBAGE YIELD AND NUTRITIVE QUALITY

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Under changing climate scenario, biologically viable exploration of the genetic divergence of spreading and towering cultivars of forage cowpea in different row configuration systems hold potential to boost sustainable feed supply for dairy animals. A field study was undertaken for sorting out the most nutritive and higher biomass producing cultivar (Cowpea-2007 and Rawan-2010) of cowpea along with optimization of row configuration (R×R of 15, 30, 45 and 60 cm). The results revealed that Rawan-2010 remained superior in 15 cm row configuration by recording 39% lesser weed density (WD) than the corresponding value recorded by same cultivar sown in 60 cm row configuration. The same treatment combination recorded 20% lesser weeds fresh weight than cowpea-2007 sown in the same row configuration, while it exhibited 5.6 g m-2 lesser corresponding value of weeds dry weight. In contrast, Cowpea-2010 sown in 45 cm row configuration recorded the maximum yield attributes (stem girth, leaf and branch numbers, leaf area, fresh and dry weights per plant), except plant height (PH), which resulted in 7% and 13% higher green herbage yield (GH) and dry matter biomass (DM) respectively than same cultivar sown in 30 cm row configuration. Pertaining to nutritional value, Rawan-2010 in row configuration of 45 cm yielded the maximum crude protein and minimum crude fiber content, while same cultivar gave greatest ash content in the wider row spacing. With GH, the correlation analyses indicated the antagonistic association for PH, moderately linear relationship for stem girth and branch numbers and strong direct association for leaf area and plant fresh weight.

Keywords: Planting geometry, biomass; crude protein, correlation analysis, leguminous forages

PARTHENIUM HYSTEROPHORUS HERBAGE MULCHING: A POTENTIAL SOURCE OF WEEDS CONTROL IN SOYBEAN (*Glycine max*)

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Weeds have indirect effects on crop plants. Crop development is affected by allelopathy from certain weed species. Allelochemicals from allelopathic weeds can disturb the root and shoot growth of emerging crop seedlings, as well as cause several other types of damage. A study was carried out to investigate the allelopathic potential of *Parthenium hysterophorus* for weed response in soybean. The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangements and replicated thrice. Sowing methods (broadcast and line sowing) were kept in the main plot and mulching treatments (surface mulching and soil incorporation) were kept in the sub-plots. Mulching of *Parthenium hysterophorus* was applied at the rate of 1.0 t ha-1, 2.5 t ha -1 , 5 t ha-1 with control (no *parthenium*). Manual weed control was also used as treatments. The results revealed that significantly higher shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weigh, root dry weight, number of nodules per plant, nodules fresh and dry weight, number of branches, number of pods per plant, thousand seed weight biological yield, economic yield, dry matter yield and harvest index were recorded with the soil incorporation of *Parthenium* herbage at the rate of 2.5 t ha -1. Maximum weed density and weed dry biomass were recorded in control plots while weed control efficiency was seen greater in plots where *Parthenium* herbage was applied to surface at the rate of 5 t ha -1. The results suggested that the use of *Parthenium hysterophorus* herbage mulching can reduce infestation of weeds by its allelopathic effects and increase the yield of soybean under sub-humid agro-climatic conditions.

Keywords: *parthenuim* weed, ground cover, allelopathy

SOIL CARBON AND NITROGEN DYNAMICS AFFECTED BY ALLELOPATHIC CROP RESIDUE MULCHES AND NITROGEN APPLICATION UNDER RICE-WHEAT CROPPING SYSTEM

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Returning of crop residue mulches/agricultural wastes to soil may be one of the best management practices (BMPs) to sustain the productivity and soil health under RWCS. A 2-year study was conducted to assess the influence of different mulches (plastic, wheat straw, rice residues, sorghum residues) on soil carbon (C) and nitrogen (N) dynamics. Different nitrogen sources (urea, calcium ammonium nitrate, ammonium sulphate) were also used to determine the impact of nitrogen fertilization on C and N cycle as well as on productivity of wheat crop. Results indicated that crop residue mulches significantly ($p \leq 0.05$) improved soil organic soil organic carbon (SOC), total nitrogen (TN), Nitrate-N and Ammonium-N over control during both the years. The highest SOC (5.7; 10.87 g kg^{-1}), the maximum TN (0.49; 0.90 g kg^{-1}), were recorded with the rice residue mulch; however, different crop residue mulches (CRMs) were similar in response. Response of CRMs with NS for Nitrate-N and Ammonium-N was different during both the years; likewise, the maximum soil nitrate-N (44.5; 41.8 mg kg^{-1}) was recorded with Wheat residue mulch + AMS and Rice residue mulch + CAN, respectively, and highest Ammonium-N (8.5; 9.3 mg kg^{-1}) was observed with Sorghum residue mulch + Urea and Wheat residue mulch + AMS, respectively. Crop residue mulches improved N uptake and protein contents in grains, nitrogen use efficiency (NUE) and nitrogen harvest index (NHI) by 8.5, 17.8, 42.6 and 33.0% over CT. Soil health in terms of SOC (8.7%) and TN (15.1%) was also influenced by the N sources vis-a-vis the control. Biological and grain yield of wheat was enhanced by the retention of CRMs by 25.0 and 29.7% over CT. Sorghum mulch + CAN and urea produced highest marginal net benefits; likewise, sorghum mulch + CAN and AMS ensued highest NUE over CT. Hence, adopting CR management practices in conjunction with the CAN and urea is effective to improve soil health, attain higher harvests and sustain productivity of soils in RWCS.

Keywords: Crop residue (CR), mulches (Ms), productivity, nitrogen use efficiency (NUE), soil health, C dynamics, N dynamics, best management practices (BMPs)

EFFECT OF SEED INOCULATION, ORGANIC MANURES AND CHEMICAL FERTILIZERS ON THE YIELD AND YIELD COMPONENTS OF GREEN GRAM (*Vigna radiata* L.)

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Green gram (*Vigana radiata* L.) is one of the most important pulse crops in Pakistan which can fix atmospheric nitrogen through the symbiotic relationship between the host mungbean roots and soil bacteria and thus improves soil fertility. The average yield of mungbean is very poor in comparison to mungbean growing countries in the world that can be improved by adopting proper fertilizer management. Effect of seed inoculation, organic manures and chemical fertilizers on yield and yield components of mungbean varieties was studied at research area of University of Arid Agriculture Rawalpindi, Pakistan during summer 2005. Two varieties of green gram viz. NCM-209 and Chakwal-97 were sown with treatments as, control, seed inoculation @ 10 g kg^{-1}, seed inoculation + 20 tons FYM ha^{-1}, seed inoculation + 20 tons poultry manure ha^{-1} and seed inoculation + 20 kg N ha^{-1} and 60 kg P ha^{-1}. The results showed that various yield components like, number of pods $plant^{-1}$, pod length, number of seeds pod^{-1}, 1000-seed weight and seed yield were affected significantly by seed inoculation, organic manures and chemical fertilizers. Seed inoculation + 20 kg N + 60 kg P ha^{-1} gave maximum seed yield. This increase in seed yield was mainly due to more number of pods $plant^{-1}$, number of seeds pod^{-1} and 1000-seed weight.

Keywords: Inoculation; farm yard manure; poultry manure; nitrogen; yield; green gram.

BIODIVERSITY OF SUNFLOWER (*Helianthus annuus* L.) PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) ISOLATED FROM TEMPERATE AND TROPICAL RAINFED REGIONS OF PAKISTAN

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Sunflower (*Helianthus annuus* L.) is member of family *asteraceae*. It is the world's fourth largest oil-seed crop. The seeds are used for oil production and as food, while the dried stalk is used as fuel. Pakistan has a continual deficiency of edible oil production and the country has been the third largest edible oil importer worldwide. Henceforth, one of the efforts would be the production of high yielding sunflower on large scale, to shrink gap between oil production and consumption. Moreover, Sunflower is used in the industry for making paints and cosmetics. In addition, some parts of the plant are used in making dyes for the textile industry and decorations. Yet, sunflower is well known for its phytoremediation potential, being an important environment friendly component. Plant Growth Promoting Rhizobacteria (PGPR), are a group of free-living bacteria that colonize the rhizosphere, beneficial for root growth, ability to survive as inoculant, reduce the populations of root pathogens. They promote plant growth directly, either through their ability of nutrient supply (nitrogen, phosphorus, potassium and essential micronutrients), or modulating plant hormone levels and/or indirectly by decreasing the inhibitory effects of various pathogens on plant growth and development as biocontrol agents, root colonizers and environmental protectors. In the present study, root associated bacteria have been isolated from the rhizosphere of the Sunflower plants. The root and soil samples were collected from the two regions of Wah located 33.7715° N, 72.7511°E Punjab and Rawalakot located 33.8584°N, 73.7654° E Azad Jamu & Kashmir, Pakistan, respectively. Both being rain-fed areas but differ mainly for natural temperature conditions, Wah area being considered as tropical and Rawalakot as temperate region. Soil texture of Wah varied from clay to sandy loam and acidic in nature, while that of Rawalakot soil is silt loam, having neutral pH value. Seventeen 17 bacterial isolates, seven from Rawalakot and ten from Wah were identified on the basis of cell morphology, Gram's staining, biochemical and molecular techniques, as well as the plant microbe interaction was also established through ultrastructural studies using transmission electron microscopy. Seventeen bacterial isolates were screened initially for *in vitro* growth, all showing standard growth curve for all phases of growth. The PGPR isolates were characterized for plant growth promoting traits of nitrogen fixation, phosphorous solubilization and Indole -3- Acetic Acid (IAA) production. Nine isolates show P- solubilization ability, showing more number of P solubilizers are present in tropical environment of Wah region, with maximum values of phosphorous solubilization shown by isolate from Wah, WIS3 (173.34µg mL^{-1}), followed by Rawalakot isolates, RIS1 (83.45 µg mL^{-1}). Moreover, twelve isolates, four from Rawalakot and eight from Wah

region had shown nitrogen fixing ability, with prevalence of higher number of nitrogen fixers in the tropical region of Wah. Bacterial isolates were also checked for catalase activity and twelve were found positive. RIS1, RIS2, RIS6 isolates from Rawalakot soil and WIS1, WIS3, WIS5, WIS7, WIS10 from Wah soil showed maximum catalase activity. Six isolates, three from Rawalakot and three from Wah, were IAA positive. Two (2) of the bacterial isolates RIS1 & WIS3 with multi-functional characters were used in colony PCR for 16S rRNA gene amplification and rDNA sequencing. Ultrastructure studies through transmission electron microscopy (TEM) of sunflower roots showed presence of the PGPRs in close vicinity of root hair rhizosphere. Pot and field experiment were conducted to establish effectiveness and biodiversity of selected PGPR isolates. The inoculated plants showed significant plant growth as compared with the un-inoculated control. The three PGPR isolates, one from Rawalakot (RIS1) and two from Wah area (WIS3, WIS7), showed better performance for all growth parameters compared with the control, on both soil types, indicating diverse adaptability and performance under varied environmental and soil conditions. From this study, it may be concluded that the selected PGPR isolates can be effectively used as biofertilizer in a consortium, for enhanced sunflower crop yield for sustainable agriculture in the country.

ORAL

THEME 2

CLIMATE RESILIENT PLANT PROTECTION STRATEGIES

DEVELOPING ATTRACT & KILL TRAPS FOR MANAGEMENT OF CARPOPHILUS DAVIDSONI (COLEOPTERA: NITIDULIDAE) BASED ON THEIR GUT-ASSOCIATED YEAST SPECIES

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Carpophilus davidsoni is an economically important insect pest of stone fruit orchards in Australia. It's current management practices majorly rely on attract & kill (A&K) traps which include male aggregation pheromone together with a "co-attractant" derived from fruit juice fermented using "baker's yeast", *Saccharomyces cerevisiae*. After identifying the two most prominent yeast species, *Pichia kluyveri* and *Hanseniaspora guilliermondii,* from beetles' gut, we explored whether volatiles from the yeasts might improve the effectiveness of the co-attractant in A&K traps. Field trials using live cultures of the two yeast species revealed that *P. kluyveri* trapped higher number of *C. davidsoni* compared to *H. guilliermondii*. Using GC-MS, we analysed volatile emissions of the two yeasts and selected two esters, isoamyl acetate and 2-phenylethyl acetate, from *P. kluyveri* (the more attractive yeast in the field) for further investigation. Attraction to these esters was evaluated in the field by adding them individually or in combination to the co-attractant. Trap catches of *C. davidsoni* were significantly increased when 2-phenylethyl acetate was added, compared to that of isoamyl acetate, or isoamyl acetate together with 2-phenylethyl acetate. Our study demonstrates how exploring volatile emissions from microbes that are ecologically associated with insect pests can result in more potent lures for use in attract & kill system to be employed in integrated pest management strategies and these strategies, in turn, may be incorporated in the climate resilient agriculture system.

Keywords: *Pichia kluyveri,* Trap catches, *Hanseniaspora guilliermondii,* yeast

COMPENDIUM OF THE GENUS QUINISULCIUS (TYLENCHIDA: TELOTYLENCHIDAE) AND OBSERVATIONS ON OCCURRENCE OF *Q. Capitatus*

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The compendium of *Quinisulcius* comprised of 17 species that based on the characters of the total body length, stylet, ratio of a, b, c, c', V%, head annules, tail annules, lip region and tail terminus. The allometric and morphometric characters were derived from the original descriptions. An up-to-date list of valid species of *Quinisulcius* along with illustrations and diagnostic key is provided. Detailed surveys of cereals, fruits and vegetables were conducted from district Hunza, Nager, Gilgit and Ghizer of GilgitBaltistan, Pakistan during 2014-2016 to determine the temperature dependent property of *Quinisulcius capitatus*. About 280 root and soil samples were taken from 47 locations and 28 agricultural crops. Complicated data from the world has shown that *Q. capitatus* has the potential to survive and propagate proficiently at low temperature (-2 to -15 ºC).

Keywords: *Quinisulcius capitatus,* Hunza, Gilgit, Temperature

EVALUATION OF SELECTED INDIGENOUS *Trichoderma harzianum* ISOLATES FOR THEIR BIOCONTROL POTENTIAL AGAINST PANAMA WILT PATHOGEN, *Fusarium oxysporum* f. SP. *Cubense*

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There is no workable method to control Panama wilt (banana disease) which is a serious threat to the banana industry for the last 20 years. This study was designed to analyze biocontrol efficacy of *Trichoderma harzianum* isolates against Panama wilt pathogen, *Fusarium oxysprum* f. sp. *cubense* (Foc), under *in-vitro* and greenhouse conditions. Three *T. harzianum* isolates TS1, T2R1, and T4R1 and 28 Foc isolates were collected from Fungal Pathology Laboratory, Crop Disease Research Institute. The biotype profiling of *T. harzianum* isolates clustered together with the Th1 BCA biotype. A significant inhibition in growth was noted in all pathogen isolates in dual culture test with TS1 showing highest inhibition while least inhibition was recorded for T4R1 strain. The research trial in greenhouse showed that wilt attack reduced significantly in biocontrol treated plants compared to pathogen only control plants. Maximum reduction in disease severity was noted in TS1 and T2R1 strain whereas minimum reduction in disease severity was observed with T4R1 strain. Reduction in disease severity was linked with improvement in agronomic characters like plant height and leaf area index. It was concluded that the recovered *T. harzianum* TS1 and T2R1 isolates can be promising biocontrol candidates in future field research studies.

Keywords: Panama wilt disease, *Fusarium oxysprum* f. sp. *cubense*, *Trichoderma spp.*, Biological control, Disease severity.

GEOSTATISTICAL ANALYSIS OF SPATIO-TEMPORAL VARIABILITY AND MAPPING GENUS BACTROCERA IN APRICOT ORCHARD IN NORTHERN PAKISTAN

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Apricots are the most important cash fruit in the region, and they play a key role in its socio-economic development. It is, however, susceptible to several diseases and pests, resulting in decreased yields and substantial financial losses. One of them is the genus Bactrocera, which has almost no data on its Spatio-temporal variability. Between July and September 2021 in district Hunza, Gilgit-Baltistan, Pakistan, this study aimed to determine the spatiotemporal variability of two species of fruit fly, *Bactrocera zonata* and *Bactrocera dorsalis*, in apricot fruit orchards. Results revealed a significant difference between the species and month to month. *B. zonata* had a substantially larger population than *B. dorsalis*. Geostatistical analytic approaches were utilized to predict the spatial variability of fruit fly species. The spatial distribution maps were created using an inverse distance weight with a spherical semivariogram model. Both species had nugget/sill ratios of 0.00, 0.69, 0.61, and 0.73, indicating moderate to strong spatial dependence. The semivariogram graph also displayed moderate to high spatial dependence. Both fruit fly species' east-west and south-north trend lines crossed the sample point's predicted region, indicating the overall variation trend of *B. zonata* and *B. dorsalis*. Interpolated distribution maps were also created to represent the spatial distribution of *B. zonata* and *B. dorsalis* in the study using different colors. Together with meteorological data (temperature, precipitation, and relative humidity), this data seems to promote a high population of fruit fly species in July and August. The most common practice used to manage the *Bactrocera* species in the world is pheromone traps, which are costly and not affordable for poor small farmers. The authors are currently working on bioinsecticides and plant-based attractants derived from medicinal and aromatic plants to build traps and bioinsecticides that will hopefully replace the costly chemicals used in pheromone traps and make traps more affordable to small farmers. This knowledge will help develop integrated pest management strategies for fruit fly species and reduce insecticide use, which will benefit both growers and the environment.

Keywords: Fruit fly, *Bactrocerazonata*, *Bactrocera dorsalis*, Spatialvariability GIS, meteorological data, Gilgit-Baltistan.

GEOSTATISTICAL ANALYSIS OF SPATIAL DISTRIBUTION OF APRICOT SHOT HOLE DISEASE, CLIMATE SCENARIOS, AND CONTROL THROUGH TRUNK INJECTION DELIVERY SYSTEM IN NORTH PART OF PAKISTAN

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The most common fruit in Gilgit-Baltistan (GB) is the apricot (*Prunus armeniaca*. L), grown in all districts. It accounts for a large portion of agricultural income and plays an integral part in its socio-economic growth. However, apricots are susceptible to various diseases and pests, resulting in lower yields and severe financial losses. Amongst apricot shot hole disease caused by *Wilsonomyces carpophilus* is a polyphagous fungus and a severe problem for stone fruits, especially the apricot tree. Geostatistical analysis and mapping of disease distribution is an essential operation as it plays a vital role in the knowledge about control. The research goal was to learn more about disease distribution, climatic situations, and the synthesis of a plant-based biopesticide that could be applied by trunk injection technique in the District Gilgit. Results revealed that the disease is spatially distributed within the study area, even within valleys and orchards. The range of disease prevalence was 59.20-75.0%, incidence 23.74-52.80%, index 20.63-27.06% and mean severity 0.133-0.18. Geostatistical analysis was used to illustrate the spatial variability and mapping of disease using the soil properties by using IDW interpolation techniques. Results showed a weak spatial variability for disease prevalence and incidence, while disease index and mean severity were moderate spatial variability. GIS maps and trend analysis graphs also showed the disease's spatial distribution in east-west and south-north directions and the disease's overall variation trend. Climate data favors disease development and pathogen perpetuation, and climate variables can influence the prevalence, incidence, and severity of plant disease. Farmers employed synthetic chemicals and portable sprayer devices to combat apricot shot hole disease. Both have a major negative impact on the environment. The indiscriminate use of synthetic chemicals has caused numerous problems in the general ecosystem, including contamination of water, soil, animals, food supplies, and eradication of non-target beneficial creatures. Furthermore, according to research findings, sprayer machines are less efficient, with only 0.4% of chemicals reaching their goals. It is the first time that a plant-based biopesticide and trunk injection delivery system has been used to combat apricot shot hole disease and other stone fruits. The current research finds that the spatial distribution of disease is triggered by complicated interactions between apricot varieties, cultural practices, fallen trees, and environmental variables. Disease management techniques for intensive smallholder systems could be developed using this interaction and alternative control strategies.

Keywords: Apricot, Shot hole disease, Geostatistical analysis, Climatic data, Trunk Injection Delivery system.

EFFICACY OF PLANT ACTIVATORS ON MINERAL PROFILE OF EGGPLANT INFECTED WITH FUSARIUM OXYSPORUM

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Eggplant (*Solanum melongena*) is the most important vegetable crop from family *Solanaceae*. Several biotic and abiotic factors are involved in limiting the yield of eggplant, but Fusarium wilt caused by *Fusarium oxysporum* is the most destructive. It causes 10-70% losses in temperate region of the world. Symptoms of this disease ranges from leaf yellowing to plant death due to obstruction of xylem vessels. So, the present study was conducted for activation of defence mechanism of eggplant against the Fusarium wilt. The experiment was conducted in research area of the Department of Plant Pathology, University of Agriculture, Faisalabad under randomized complete block design (RCBD). The activators like ferric chloride, KH2PO4, calcium chloride and salicylic acid were applied @ 0.5, 1 and 1.5% concentration at 10 days interval. For the assessment of activation of defense mechanism of treated plant ionic contents (N, P, K, Na, Ca, Mg) was also analyzed. Result showed that Calcium chloride gave the most effective result with 5.2 % D.I at 1.5% concentration by increasing the ionic content Ca (4.76), Mg (3.17), N (2.52), P (3.14), K (2.16) and Na (0.84). So, it was concluded that activation of defence mechanism by the plant activator is the most recent, environment friendly and economical approach for the management of disease.

Keywords: Brinjal, *Fusarium Oxysporum*, Activators, Defense mechanism

BIOLOGICAL APPROACH TO REDUCE THE HCN TOXICITY OF SORGHUM UNDER WATER DEFICIT CONDITIONS

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World population is rising continuously and to meet the needs of this ever-growing population, efficient use of available resources is inevitable. To meet the milk and meat requirements of this burgeoning population there is a dire need to improve production and quality of fodder. Among fodders, sorghum alone contributes 12.6% to feed the livestock. Sorghum yield is limited by various abiotic and biotic stresses including salinity, drought, temperature, and pH. Drought is one of the most common problems faced by the farming community nowadays, which have negative effects on plant yield, physiology, and biochemistry. Due to drought, hydrogen cyanide (HCN) is produced in sorghum and accumulates in leaf sheaths and grazing on this toxic fodder results in animal death. It also negatively affects the physical, chemical, and biological properties of soil by disturbing the soil enzymatic activities. Microorganisms such as plant growth-promoting rhizobacteria (PGPR) are the primary source of these enzymes in the soil. PGPR tends to not only survive under drought stress but can also support plant growth under these adverse conditions. Therefore, in this study, several PGPR and *Rhizobium* strains were isolated from the rhizosphere of sorghum and root nodules of berseem, respectively. These bacteria were screened for drought tolerance followed by ACC-deaminase activity. The drought tolerant rhizobacterial strains possessing ACC-deaminase were evaluated further for growth promotion and HCN reduction within the plant of sorghum under axenic conditions and best combinations exhibiting better HCN reducing activities, growth, and physiological parameters of sorghum were subjected to pots at different field capacity levels. The main objective of this research was to decrease the HCN level of sorghum and surprising results were found. All the data were analyzed statistically by using CRD under factorial arrangements. Most of the strains (Z14, EN12, N25, N39 and CP9) were observed efficient in minimizing HCN contents within plant. The strains Z14 and CP9 showed a 69.4 and 66.5% decrease in HCN contents respectively at -1.23 MPa under axenic conditions and shoot length was improved 54.7 and 45.5% at the same level of water stress by stain N39 and Z14 respectively. A pot experiment was also observed excellent in minimizing HCN contents, combination C30 and C27 were observed the same (82.7%) in decreasing HCN contents and C20 was also showed a significant decrease of 76.1% respectively at 50% of field capacity. It was concluded that ACC-deaminase containing microbes can be an efficient technique to improve the quality of sorghum crop.

Keywords: Sorghum, HCN toxicity, Drought, PGPR

EVALUATION OF LIGHT COLORS EFFECT ON CAPTURES OF *SOGATELLA FURCIFERA* AND YIELD RESPONSE OF IRRI 6 UNDER FIELD CONDITION

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The purpose of this research study was to evaluate phototactic response of white backed plant hopper (*Sogatella Furcifera*) to find out convenient and environment friendly ways to control the population size and epidemic seasonal outbreak on paddy crop. The response of *Sogatella Furcifera* was observed under different wavelength lights of blue, green, red, yellow and traditional black colors under field condition. The yield response of IRRI 6 was also observed under those light colors. This research study revealed significant effects on captures of *Sogatella Furcifera* and yield response of IRRI 6 in relation to those light colors. The blue light was observed more effective in capturing of *Sogatella Furcifera* followed by red and green lights. However, yellow light and traditional black light was little attractive to *Sogatella Furcifera*. Similarly, yield response of IRRI 6 was mush higher under blue light followed by red and green light respectively. Comparatively, under filed condition, blue light color was found very effective in controlling population of *Sogatella Furcifera* and could significantly be increased yield response of IRRI 6. Therefore, light color traps particularly blue light may be effectively used to monitor and control the population of *Sogatella Furcifera*.

Keywords: Phototactic response, Plant hopper, Seasonal outbreak, *Sogatella furcifera*, Yield response

STRIGOLACTONE IS EMERGING WITH INNOVATIVE ROLE FOR CROP MANAGEMENT STRATEGIES

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Agriculture is currently facing two major challenges in improving sustainability and increasing productivity to feed a growing human mass, dealing with the concerns of environment conservation and health maintenance of living beings in a globally changing climate. Therefore, it needs to adopt innovative systems to improve the food quality and to preserve ecosystems. Low-input farming is considered main factor in the greatest food insecurity, thereby crop varieties with improved pest resistance, enhanced nutrient uptake and tolerance to abiotic stresses are required to increase productivity. Furthermore, high-input farming, which deals with intensive use of fertilizers and pesticides leading to environmental deterioration, can be moderated by developing new crop varieties and improved methods of agricultural management in the future. Strigolactones (SLs) are known as a class of natural and synthetic compounds that is attracting the scientific community not only for their intriguing biological roles as a plant hormone, but also for their potential use in agriculture. SLs play a number of roles in plant biology for controlling parasitic weeds, optimizing crop architecture, enhancing nutrient acquisition, and increasing resilience to abiotic stresses. Therefore, manipulations of SL signaling for agricultural gains is evolving not only as a promising genetic target in breeding programs to develop new crop varieties to resolve some critical problems, such as nutrient acquisition, resource allocation, stress tolerance and plant–parasite interactions, but also as a potential source of agrochemical for its exogenous applications SLs, SL analogs, or SL inhibitors. Proofs for principal application of strigolactone (SL) in agriculture have been shown through field-trial experiments for parasitic weed control, increasing fruit yield, enhancing nutrient uptake, and improving yield under drought conditions. As agrochemicals, application of SL analogs has shown to be effective in controlling parasitic weeds by suicidal seed germination, thereby depleting the seed bank of parasites in the soil where germination of the parasites cannot survive in the absence of a host. Beyond the control of parasitic weeds, there is evidence that exogenous utilization of SLs as agrochemicals improves drought tolerance and mitigates yield losses under conditions of low water and high salinity in several commercially grown crop species. Particularly, SLs may also be significant targets for the optimization of crops to grow in low-fertility soils, due to their collective roles in various nutrient acquisition processes. SLs have also increased crop yields of zucchini squash (*Cucurbita pepo*) and 'Hamlin' sweet oranges (*Citrus sinensis*) under normal growth conditions. Spray application of SL analog Fenyl 7-isomer along with nitrogen fertilizer to field grown zucchini squash and GR24 to glasshouse grown 'Hamlin' sweet oranges increased fruit yield. Modification of plant architecture for agricultural gains after direct stem application of a SL analog, EGO10 can be demonstrated by reduced branching in olive (*Olea europaea*), rose (*Rosa hybrida*), pomegranate (*Punica granatum*) and Ikram (but not Shirez) cultivar of tomato seedlings under commercial nursery conditions. The activation of herbicide metabolization and detoxification-related genes by exogenous SL also suggested how pathways of this phytohormone alleviate herbicide toxicity in watermelon. In conclusion, the diversity of SLs signaling pathways may open new ways for its potential use in innovative management strategies for high value agriculture to increase their yield in future.

Keywords: Agriculture, Olive, Rose, Pomegranate, Ikram

POTENTIAL OF ELECTROMAGNETIC WAVES, INTEGRATED WITH BOTANICALS FOR THE IN-VITRO CONTROL OF WHITEFLY IN COTTON

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Sucking insect pests are considered as lethal pests of many crops. Insect pest management (IPM) must bear some serious ecological and economic consequences due to the use of pest control measures. Conventional formulations of insecticide are ominously endangering the health of farm operators, environment and consumers because its toxicity. Some other techniques are hortative over conventional pesticides that affect targeted species, decomposes quickly and provide the residue free food. The use of botanicals and electromagnetic waves appears to be promising. The present study was conducted to assess the integrated efficacy of electromagnetic waves (Microwaves) and botanicals *Azadirachta indica* (L.), *Moringa oleifera* (L.) and *Citrus limon* (L.) for the management of *Bemisia tabaci* (L.). Microwaves with 2.4 MHz power were induced under different exposure times as 5, 10, 15 and 20 seconds. Current study revealed exposure time of 20 seconds as highest mortality (27.34) for *Bemisia tabaci* (L.) and with four concentrations (5, 10, 15 and 20%) were integrated with 10 seconds of exposure time of microwaves on pests and applied cohesively on hourly bases, after 0, 6, 12 and 24 hours of botanical application. Maximum mortality was observed at 20% concentrated solution with integration of microwave after 24 hours of botanical application for all the botanicals. For *Azadirachta indica* (L.) maximum mean mortality was 24.38 for *Bemisia tabaci* (L.), For *Moringa oleifera* (L.) maximum mean mortality was 22.00 for *Bemisia tabaci* (L.). For the botanical extract of *Citrus limon* (L.) maximum mean mortality was 21.54 for *Bemisia tabaci* (L.), From above findings we concluded that microwaves and their integration with plant extracts can be helpful in a cohesive way for the management of sucking insect pests.

Keywords: *Moringa oleifera, Citrus limon, Bemisia tabaci, Azadirachta indica*

STUDY OF ANTIMICROBIAL ACTIVITY AGAINST CHARCOAL ROT PATHOGEN IN MAIZE

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Macrophomina phaseolina causes damping-off and charcoal rot diseases which can persist in soil for longer period in the form of sclerotia. Many management strategies have been made to reduce the incidence of disease either by chemical or biological means. Maize is the third most important cereal crop in Pakistan after wheat and rice considered as C4 plant having high genetic and photosynthesis explorative crop which is greatly rich in edible nutrients, vitamins and essential phytochemicals. Recently, use of fungicide causes drastic environmental hazards that led to researchers to focus on eco-friendly methods. For biocontrol, microbial antagonists such as *Aspergillus terreus* (GenBank with accession numbers MW570850) and *Purpureocillium lilacinum* (GenBank with accession numbers MW566158) inhibit the growth of *Macrophomina phaesolina* (GenBank with accession numbers OK336365) *in vitro* and *in vivo* conditions. Seeds coated with tested microbial fungi (*A. terreus* and *P. lilacinum*) while soil was drenched with *M. phaseolina in vivo* improved the growth parameters and physiology but also reduced the infection of pathogenic fungi as compared to control.

Keywords: *Macrophomina phaseolina,* Damping-off, *Aspergillus terreus,* Biocontrol

ROOT-KNOT NEMATODES (*Meloidogyne* SPP.) INFECTING *Prunus persica* L. IN THE POTHWAR REGION OF PAKISTAN

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The overall incidence of 19.8% and prevalence of 65.7% of root-knot nematodes on peach was recorded in the Pothwar region of Pakistan. As regards districts, the maximum prevalence (71.43%) and incidence (34.29%) were observed in district Attock and the minimum (50.5 and 10% respectively) was found in district Islamabad. During the survey, five peach varieties were encountered in the region. Maximum prevalence of root-knot nematodes (85.71%) was observed on Early Grand while it was the minimum in case of Local Aroo (50.0%). No infestation of root-knot nematodes was found on Florida Gold and Aroo-5. On the other hand, the maximum incidence of root-knot nematodes was recorded on Florida King whereas, the minimum incidence of 15% was observed on Local Aroo. Two species of root-knot nematode (*Meloidogyne incognita* and *M. javanica*) were found infecting peach in the region. The overall prevalence of *M. javanica* was recorded to be higher as compared to *M. incognita*. *M. javanica* was found dominant in all the districts except Attock where *M. incognita* was observed in dominance. No infestation of *M. incognita* was recorded in district Islamabad. As a sole population, *M. incognita* was found in 26.09% and *M. javanica* in 43.48% root-knot infested peach orchards. On the other hand, as mixed population, both the species were recorded in 30.43% infected orchards. The overall galling index of root-knot nematodes in the region was 1.33. Maximum galling index was found in district Attock while it was found to be the minimum in Islamabad district. Similarly, Early Grand showed the maximum galling index of 1.46 while it was the minimum on Local Aroo. No galling index was observed on Florida Gold and Aroo-5 as these cultivars were found free of root-knot nematode infestation.

Keywords: *Meloidogyne* spp., Incidence, Prevalence, Galling index, *Prunus persica*

INTERACTIVE EFFECT OF HEAVY METAL TOLERANT ENDOPHYTIC BACTERIUM AND SEAWEED AMENDMENTS TO AMELIORATE THE TOXIC EFFECT OF NICKEL (NI) IN SUNFLOWER PLANT

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Heavy metals are introduced to the soil and water through many sources top of which are automobile and industrial effluents. These metals accumulate in the soil profiles and contaminate water bodies which effect the growth and production of several crops. Endophytic plant growth promoting bacterium (PGPR) *Pseudomonas aeruginosa* is known to accumulate heavy metals in their cell walls, increasing metal uptake by plant via changing their forms, solubility and promote plant growth with increasing nutrient availability and improving physiological performance for stress tolerance. Seaweeds are rich in nutrients and have ability to improved soil conditions, adding nutrients and organic contents to soil and adsorbing metal contaminants from soil. This research showed that enhanced nutrient availability by using *Sargassum ilicifolium* as organic amendment with *P. aeruginosa* improved sunflower growth which was grown under 0.5 mM of nickel (Ni) contaminations. The morphological characteristics of plants like shoot, root length and dry and fresh weights were improved under stress and non-stressed condition. The heavy metal tolerant ability of *P. aeruginosa* was proved by minimum inhibitory concentration (MIC) and biodegradability of nickel. Biochemical analysis of proline (Pro), total phenolic content, antioxidants like peroxidase (POD), superoxide dismutase (SOD) and DPPH-radical scavenging activity also indicated that plant tolerance improved under heavy metal stress. The individual and combined treatment of *Sargassum ilicifolium* with endophytic bacterium *P. aeruginosa* alleviate the toxicity of nickel in soil and improved plant yield by recovering physiological parameters of plants.

Keywords: Heavy metal, Endophytic bacteria, Seaweed, Sunflower

IN VITRO STUDIES OF TEMPERATURE DEPENDENT DEVELOPMENTAL BIOLOGY OF ENDOPARASITIC WASP (*AENASIUS ARIZONENSIS* (GIRAULT) (HYMENOPTERA: ENCYRTIDAE): AN EFFECTIVE BIOCONTROL AGENT FOR THE CONTROL OF COTTON MEALYBUG, *PHENACOCCUS SOLENOPSIS*

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Aenasius arizonensis (Girault) (Hymenoptera: Encyrtidae), a species specific, solitary nymphal endoparasitic wasp of the cotton mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera, Pseudococcidae) is a potential insect control tool. Effects of temperature on different biological traits of *A. arizonensis* were studied at different constant temperatures. 20±1 °C, 25±1 °C, 30±1 °C and 35±1 °C with humidity of 65±5 %. Host insect mealybugs were reared on sprouted potatoes or green bottle gourds. Total developmental period at different constant temperatures was recorded along with daily and total fecundity (number of hosts parasitized). At respective temperatures oviposition and post-oviposition periods was also be observed along with longevity of the male and female of the wasp. Sex-ratio (male: female), reproductive rate, intrinsic rate of increase and finite rate of increase were also calculated at all the temperatures. Our data reveals that the most favorable temperature for the development and reproduction of the parasitoid is 30±1˚C. The information obtained from this preliminary study would be helpful in establishing a mass rearing Programme for field releases of the parasitoid for the control of mealybugs.

Keywords: *Aenasius arizonensis,* Temperature, *Phenacoccus solenopsis*

Cortinarius vernus: A MYCORRHIZAL SPECIES FROM DRY HIMALAYAN FORESTS OF PAKISTAN

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Ectomycorrhizal association describes a functional structure that results from a mutualistic symbiosis between the roots of higher plants and root-inhabiting fungi. These ECM fungi are known to impart tolerance in host plants against biotic and abiotic stresses. Forests in Pakistan harbor rich diversity of these fungi and represent a sustainable example of ECM associations that have the potential to be exploited as a tool for plant protection against climate change. First step is the taxonomic and molecular characterization of mycorrhizal symbionts. During mycological expeditions to dry Himalayan coniferous forests of Gilgit Baltistan, *Cortinarius vernus* was collected and characterized on morpho-anatomical and molecular basis (ITS region) from Fairy meadows, Diamer District, Pakistan. The target internal transcribed spacer (ITS)-rDNA of species was amplified using polymerase chain reaction (PCR) with universal fungal primers (ITS1F and ITS4). The sequencing of amplified products and their subsequent blast analysis and phylogenetic analysis confirmed the identification of said species. Therefore, *Cortinarius vernus* forms a natural part of our native mycoflora and can thus be used as an ecofriendly and natural plant protection strategy. However, research is still at incipient stages to better understand the functional and molecular mechanisms involved in fungus-plant and fungus-soil interactions.

Keywords: Mycorrhizal, Mycoflora, Climate protection, Fungal communities

ASSESSMENT OF PRE-HARVEST INTERVAL (PHI) OF SYNTHETIC AND BIO-INSECTICIDES SPRAYED ON SOLANACEOUS (POTATO AND EGGPLANT) CROPS

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The industrialization of the agricultural sector has increased the threat to human health and natural ecosystems. Pesticides are a concern for sustainability of environment and global stability. In order to avoid their adverse effects on human health, it is imperative to assure maximum residue limits (MRLs) in food commodities. In view of the concerns about pesticide residues in food and their environmental impacts, the present study was designed to assess the pre harvest interval (PHI) of conventional and bio pesticides sprayed on solanaceous crops i.e., potato and eggplant. Imidacloprid, and profenofos were selected as convectional, while Spinosad and biosal (neem compound) as bio pesticides, and were sprayed at the rates of 49.4, 988, 35.5 and 158 g i.e., ha-1 respectively. The pesticide residues were analyzed after 0, 1, 3 and 7 days of application using high performance liquid chromatography. Degradation rate constants and half-life were calculated using first order degradation kinetics by fitting on the data obtained. Conventional pesticides were more persistent in the crops (Average half-life: in eggplant 2.9, and 2.27 days for imidacloprid and profenofos respectively and in potato it was 2.64, and 2.82 respectively), while, for bio pesticides (Spinosad average half-life: 2.73 and 2.83 in eggplant and potato respectively). Whereas average half-life of Azadirachtin was observed 0.98 and 1.67 in eggplant and potato respectively. The crops treated with bio pesticides were found safer for human consumption even after few hours of spray compared with codex and EU MRLs. Whereas profenofos treated crop was not found to be fit for consumption even after 7 days of application, as they were not degraded down to the EU and Codex MRL within usual pre-harvest interval (PHI). Imidacloprid being bio-rational (low risk) pesticide degraded quickly and the crop was also safe for consumption on the next day of application.

Keywords: Pre-Harvest Interval, Synthetic and Bio insecticides, MRLs, Half life

DEVELOPMENT OF PREDICTION MODEL AGAINST CITRUS CANKER UNDER CHANGING CLIMATE

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Citrus canker caused by a notorious bacterium *Xanthomonas citri* pv. *citri* (*Xcc*) is one of the major threats being faced by citrus industry. Ecosystem of crops changing in most of the world due to the climatic effect. In present study, impact of environmental parameters (Max. and min. temperature, rainfall, relative humidity and wind speed) were examined in the major citrus growing areas of Punjab, Pakistan. Significant positive correlation was observed on all varieties between environmental variables and citrus canker. A multiple regression model ($Y = +24.02 + 0.5585\ X_1 + 0.2997\ X_2 + 0.3534\ X_3 + 3.590\ X_4 + 1.639\ X_{5)}$ was also developed to find out the relationship between environmental parameters and disease projection. Goodness of model on statistical ground is indicated by coefficient determination value (97.5%). On conclusion, it was established that all the environmental factors like max. temperature (37 ^{0}C), min. temperature (27 ^{0}C), relative humidity > 55%, rainfall (4.7-7.1 mm) and wind speed 8 km/h were the conducive for the development of citrus canker.

Keywords: Climate change, Canker, *Xanthomonas citri* pv. *citri,* Environmental variables, Correlation, Multiple regression model

ISOLATION AND CHARACTERIZATION OF ORYZA SATIVA RHIZOSPHERE ASSOCIATED BACTERIA ANTAGONISTIC TO *Xynthomonas oryzae* AND *Bipolaris oryzae*

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Biological control is an innovative, cost effective and eco-friendly approach to control biotic stress of plant. The present study was conducted to evaluate the antagonistic potential of rice rhizosphere associated bacteria against rice pathogens, *Xynthomonas oryzae* and *Bipolaris oryzae*. A total of 107 bacteria were isolated from diseased and healthy rice plants from Pindi Bhattian, Faisalabad and Lahore. Initially, these bacteria were tested for plant growth promoting properties including phosphate solubilization, indole acetic acid production, nitrogen fixation, and biofilm formation. Based on these properties, 35 bacteria were subjected to the biocontrol study. These bacteria were tested for antagonistic activity against rice pathogen by dual culture assay. Almost all these bacteria inhibited the pathogen growth at varying level. However, bacterial isolates LAR7 and LAR16 showed highest fungal growth inhibition. LAR7 inhibited 82% growth of *Bipolaris oryzae*, while LAR16 inhibited 76% growth of *Xynthomonas oryzae*. Full-length 16S rRNA gene sequence analysis of isolates LAR7 and LAR16 revealed maximum similarity with *Bacillus aerius* and *Bacillus amyloliquefaciens* respectively. This is the first report which highlights the isolation of *Bacillus amyloliquefaciens* from rice rhizoshpere. The data suggest that superlative isolates of this study could have the potential to control diseases and improve growth of *Oryza sativa*.

Keywords: Rice, *Bacillus aerius*, *Bacillus amyloliquefaciens*, *Xynthomonas oryzae*

APRAISAL OF PHYTOEXTRACTS AGAISNT *Xanthomonas citri* PV. *Citri* CAUSING CITRUS CANKER

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Citrus canker is one of the potential threats to the production of citrus. Conventionally it is managed by chemicals but it cause environmental issue therefore, in present study to address this critical issue, four phyto-extracts were evaluated against *Xanthomonas citri* pv *citri* under in-vitro conditions. Results showed that *Eruca vesicaria* expressed minimum inhibition zone (1.31 mm) while *Eucalyptus globus* exhibited (1.64), *Trigonella foenumgraecum* (2.68), *Nigella sativa* (2.82) and *Citrullus colocynthis* (3.22 mm) inhibition zone in as compared to control. Effective extracts of *C. colocynthis* and *N. sativa* were assessed under greenhouse conditions alone and in combination against citrus canker. Minimum disease was observed when phyto-extracts of *C. colocynthis* and *N. sativa* applied in combination against canker on susceptible variety of citrus i.e. Grape fruit (18.74%) as compared to other treatments.

Keywords: *Eruca vesicaria*, *Eucalyptus*, *Trigonella foenum-graecum*, *Nigella sativa*, *Citrullus colocynthis*

SCREENING OF BRINJAL CULTIVARS AGAINST LEAF BLIGHT CAUSED BY *Curvularia lunuata* IN RELATION TO EPIDEMIOLOGICAL FACTORS

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Brinjal (*Solanum melongena* L.), is susceptible to most disastrous curvularia leaf spot disease which severely effects the eggplant yield, quality and leads to severe economic losses and become an alarming situation for farming community. Best management strategy for the control of leaf blight disease of brinjal is the use of resistant genome. That's why in current study fifteen varieties/advance lines of brinjal were screened out against leaf blight. Result showed that two varieties/advance lines (Sandhya-F1, Chaudry (54)-F1) showed resistant response with 4.72 and 3.95% disease incidence respectively. Four varieties (Twinkle star, Janak-F1, Rani, Brinjal-3715) showed moderately resistance response against leaf blight. While two (Dilnasheen, EP-273) of them exhibited moderately susceptible and two (Pahuja Black round, Black pearl long) showed susceptible response towards leaf blight. Highly susceptible response was showed by five varieties/advance lines including Local-II Ever green, Black Beauty SSI, Global Round-Desi, Green Gold and Local-I Ever green with 96.68, 94.62, 93.67, 87.66 and 87.43% disease incidence respectively. Epidemiological factors play their significant role in disease development and spread. Study of epidemiological factors with disease development is very necessary for the proper management of disease before appearance. That's why in current study different environmental factors including maximum & minimum temperature, wind speed, rain fall and relative humidity were studied with reference to leaf blight development. It was observed that all these epidemiological factors showed highly positive correlation with disease development. It is concluded that Sandhya-F1 and Chaudry (54)-F1 can be used as resistant varieties against leaf blight disease of brinjal. Moreover, disease prediction can be helpful in future for in time proper management of leaf blight of brinjal.

Keywords: Fungi, Eggplant, Relative humidity, Sporulation, Rainfall.

SUSTAINABLE MANAGEMENT STRATEGIES FOR FUSARIUM WILT OF SWEET PEPPERS (*Capsicum annuum*) AND OTHER SOLANACEOUS CROPS

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Pepper fusarium wilt is caused by the fungal pathogen, *Fusarium oxysporum* f.sp. *capsici*. It is the most destructive disease of many Solanaceous crops such as pepper, tomatoes and eggplant and is a significant source of crop loss worldwide. Physical, cultural and chemical controls have been employed to combat this destructive disease. However, none of these strategies has been able to control the disease completely due to the broad host range and genetic diversity of the pathogen, its prolonged survival in the soil and survival on vegetation as a latent infection. Owing to co-management strategies, biological control is the best approach for human health and environmental friendly motivations. It makes use of various antagonistic rhizobacteria and epiphytic species such as *Bacillus cereus*, *Pseudomonas putida*, *Bacillus subtilis*, *Paenibacillus macerans*, *Serratia marcescens*, *Bacillus pumilus* and *Pseudomonas fluorescens*, which compete with and ultimately inhibit the growth of the pathogen. The possible mechanisms of biocontrol by these species involve multifaceted interactions between the host, pathogen and the antagonists. These can involve competition for nutrients and space, plant-mediated systemic resistance, siderophore production and production of extracellular cell wall degrading enzymes to inhibit or suppress the growth of the fusarium wilt agent.

Keywords: Fusarium wilt, Sweet pepper, Bio-control, Sustainable management

FIRST REPORT OF BEGOMOVIRUS AND ASSOCIATED DNA-SATELLITES COMPLEX INFECTING MULBERRY FROM PAKISTAN

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Begomoviruses are transmitted by vector whiteflies in the family *Geminiviridae* which infect dicotyledonous hosts. These plant infecting viruses usually infect herbaceous plants, recent study investigating that these are also infecting woody plants. Foliage plant parts of mulberry were collected from Lahore-Pakistan exhibiting leaf yellowing and curling symptoms. Old world begomovirus associated with DNA-satellites complex were amplified by using RCA product as PCR, cloned and sequenced. Two full length begomoviruses clones; *Ageratum enation virus* (AEV) associated with geminivirus associated alphasatellite in the genus *Colecusatellite*; *Ageratum enation alphasatellite*, sub-family *Geminialphasatellitinae* and Papaya leaf curl betasatellite have been first time reported from mulberry. *Ageratum enation virus* and associated *Ageratum enation alphasatellite* were showing recombination, usually infecting crops and weeds. Weed infecting monopartite begomovirus AEV and associated DNA-satellites complex is the first time reported in a woody plant (*Morus alba*) and also the first report from Pakistan.

Keywords: Old world, Recombination, DNA-satellites, *Colecusatellite*, *Geminialphasatellitinae*

PROMOTION OF PARADOXICAL AGRICULTURE THROUGH CLIMATE SMART PEST MANAGEMENT IN GILGIT-BALTISTAN, PAKISTAN

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Gilgit-Baltistan is one of the focused areas under China Pakistan Economic Corridor that provides root of the corridor connecting Pakistan and China. This region is known to produce variety of fruits & vegetables which can meet the dietary requirements of public. But deterioration in quality of the fresh produce especially due to heavy infestation of insect pests leads towards reduced production and poor quality of the produce. This causes economic loss to the growers and contributes towards food security issues for the region. Primarily, fruit fly is reported to cause heavy losses to fruit & vegetables in Gilgit-Baltistan, which can cause total crop failure in case of heavy infestation. Growers adopt multiple management practices which are confined to poor agronomic practices and dependency on chemicals results in reduced management of insect pests. Management of this pest complex below economic threshold level and implementation of biological control program along with capacity building of farmers proved beneficial to ensure safe food production with conservation of the natural ecosystem, this contributes towards regional economic growth as well as played pivotal role to meet the dietary requirements of the consumers and trading personals. This knowledge based eco-friendly pest management practices provides way forward to address the phytosanitary issues and make farmers aware of the international standards of farming system and necessary post-harvest treatments of produce acceptable for consumers, improving packaging products contents and traceability in compliance with international standards.

Keywords: Paradoxical, Climate, Smart, Pest, Management, Gilgit-Baltistan

EVALUATION OF NUTRIENTS AND PHENOLIC ANTIOXIDANTS AGAINST CITRUS CANKER

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Citrus is an important fruit grown all over the world including Pakistan. It is good source of nutrition for mankind and has high economic and medicinal value. But its production is affected by several biotic (fungal, bacterial, viral and nematodes) and abiotic (Extreme or low temperature, high humidity, Rainfall and Wind speed) factors. Citrus canker caused by *Xanthomonas citri pv. citri* is one of the biotic stress to the successful production of citrus. The current research was designed to check the efficacy of nutrients and antioxidants against citrus canker disease. For this purpose, macronutrients NPK (compound) and Zn, B, Fe, Mn, Ca and Mg (Nutriotop) and phenolic compounds (Benzoic Acid, Salicylic Acid, Citric Acid, KH_2PO_4, Isonicotinic acid and K_2HPO_4) were assessed under greenhouse as well as under field conditions. Among phenolic compounds, Salicylic acid (14.18 %) expressed the disease incidence followed by citric acid (15.18), KH_2PO_4 (18.64), benzoic acid (20.18), KH_2PO_4 (21.68) and Isonicotinic acid (24.18) % as compared to the control treatment. Nutriotop+ Compound expressed disease incidence (17.22%) as compared to (25.73%), nutritop (33.21%) and control treatment. Among nutrient mixture, combination of Compound+ Nutritop and salicylic acid expressed minimum disease incidence among phenolic antioxidants.

Keywords: Compound, Nutriotop, Disease incidence, *Xanthomonas citri pv. citri, Phenolic antioxidants*

SCREENING OF DIFFERENT VARIETIES OF (*Rosa indica* L.) AGAINST SUCKING INSECT PESTS

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Rose (*Rosa indica* L.) is an important flower grown on large scale in Pakistan for commercial purpose. Insect pests of rose cause a huge loss upon its yield and beautification. Its major insect pests include aphids and thrips. An experiment was conducted under field conditions at the Gosha-e-Gulab, The Islamia University of Bahawalpur. The experiment was conducted in Randomized Complete Block Design (RCBD). Field was divided into four experimental plots. Each plot size was kept 182 square feet, from which population of insect pests were recorded. Distance between each plot was 3 feet, while the plant to plant distance was 2 feet, and row to row distance was 2.5 feet. Total experimental area was consisted on 728 square feet. There were four treatments with three replications of each treatment. Population dynamics of insect pests were checked on four different varieties of rose including Pink (*Rosa rubiginosa*), Sureya (*Rosa Santana*), Miniature (*Rosa gallica*), and Hybrid Tea rose (*Kordes perfecta*). The data for population dynamics of these insect pests were recorded from mid Feb. to April from three portions of the plant viz., flowers, buds, and leaves. Data were recorded from three plants from each replication. It was recorded on weekly basis by visual observation and by using magnifying lens where necessary. Insect pests were appeared in last week of February and their population was at peak in mid of March. The population of insect pests again declined in first week of April. The mean population of aphid and thrips revealed that Sureya rose was highly resistant because it showed the lowest population of aphid and thrips. The Miniature variety showed the moderate population of insect pests. Pink rose was recorded moderate susceptible variety and Hybrid tea rose was recorded highly susceptible variety as there was maximum attack of aphid and thrips. The experiment was subjected by using appropriate software Statistix 8.1 to check the mean population.

Keywords: Rose, Aphid, Thrips, Varieties, Field.

DIFFERENT CONCENTRATION OF SUGAR AND HONEY SOLUTION EFFECT DEVELOPMENTAL STAGES OF BUMBLEBEE BOMBUS TERRESTRIS

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Bumblebees, more efficient than honeybees, provide important services for pollination especially in tomato, pepper, cucumber, strawberries and other crops grown under tunnel farming or glasshouse conditions to yield maximization. These bees require pollen and nectar to meet their dietary needs and maintain their colony structure, development and reproduction. Keeping in view their economic importance, the effect of five concentrations of sugar and honey solutions (1:1, 1:1.5, 1:2, 2:1,1.5:1) each as alternative to nectar were used to observe their effect on life history parameters of *Bombus terrestris*. The 1:1 ratio of sugar solution was found most effective followed by 1.5:1, 1:1.5, 1:2 and 2:1 and also more effective of all five concentrations of honey solutions on all three stages of colony development i.e., at colony initiation, colony development and colony maturation stages. At colony initiation stage, early pre-oviposition period (6.40± 0.97 days), early emergence of first worker in the first batch (25.40±1.21 days) and maximum numbers of workers (6.20±0.24) emergence in the first batch were observed at 1:1 ratio of sugar solution. Colonies reared on 1:1 ratio of sugar solution reached earlier (52.13±1.28 days) at colony foundation stage with minimum mortality (3.27±0.54 workers). At colony maturation stage, maximum numbers of workers, sexual (males, queens) and maximum mother queen longevity was observed at the same 1:1 ratio of sugar solution. It can be suggested from present study that sugar solution as alternative of nectar at 1:1 ratio was better than other sugar concentration levels and also from those of honey solution.

Keywords: Bumblebee bee, *Bombus terrestris*, Colony developmental, Honey solution, Sugar solution

NEW RECORD OF *Pseudomonas syringae* PV. *Syringae* CAUSING BACTERIAL CANKER ON PLUM IN AZAD JAMMU AND KASHMIR

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Bacterial canker disease caused by the *Pseudomonas syringae* pv. s*yringae* is economically important and occur worldwide on plum, and as a plum pathogen that has not been the object of studies in Azad Jammu and Kashmir (AJK). In comparison with the world's plum production that was 12.6 million tons, Pakistan is contributing about 55.6 thousand tons that ranked Pakistan at 28th position in plum production globally. Disease incidence and severity was calculated from the plum producing areas of Poonch division AJK. Maximum disease incidence and highest disease severity score was recorded 34% and 6, respectively from district Poonch. Leaves and fruits with water-soaked dark brown lesions and gum execution from stem, following isolation initially yielded fluorescent bacterial colonies on King's B media. These colonies were characterized phenotypically using biochemical test followed by diagnostic polymerase chain reaction (PCR) for the identification of *Pseudomonas syringae* pv. *syringae* isolates. A universal gene (16S rRNA) and a house keeping gene (*gyrB*) amplification was done for the identification of obtained *P. syringae* pv. *syringae* isolates. All the isolates were gram negative, rod shaped, and produced fluorescent on KB media; positive for levan production, tobacco hypersensitivity, and syringomycin production, while negative for oxidase, potato soft rot, arginine dehydrolase, and aesculin hydrolysis. Sequences of the 16S rRNA (GenBank Accession Nos. OM407405 and OM406347) and *gyrB* gene (OM470908 and OM470910) of these isolates were 99-100% homologous to the already reported sequences of *P. syringae* pv. *syringae* deposited in GenBank (GenBank Accession Nos. MK789722 and MK453205, respectively) include the type strain. To our knowledge, this is the first report of *P. syringae* pv. *syringae* from Azad Jammu and Kashmir (AJK), and the information will help in devising quarantine measures to limit the pathogen prevalence.

Keywords: Bacterial canker, Plum, *Pseudomonas syringae*

LATE BLIGHT OF POTATO (*Phytophthora infestans*) MANAGEMENT THROUGH BOTANICAL AQUEOUS EXTRACTS IN TEMPERATE CLIMATIC CONDITIONS

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Phytophthora infestans causing late blight is one of the most devastating potato diseases that cause considerable yield losses globally including Pakistan. Due to repeated and injudicious synthetic fungicides applications for the control of late blight of potato, the fungicide resistance in *P. infestans* led to persistence and surveillance late blight of potato. The study was carried out to evaluate the efficacy of Garlic (*Allium sativum*), Neem (*Azadirachta indica*), Turmeric (*Curcuma longa*), Mint (*Mentha*) at 10%, 20% and 30% concentration as bio-fungicides against late blight of potato. In-vitro effect of plant extracts of *A. sativum*, *A. indica*, *C. longa* and *Mentha* were evaluated on percent inhibition and radial growth of pathogen. *A. sativum* and *A. indica* at 30% concentration was found more effective in minimizing the mycelial growth of *P. infestans* with inhibition of 58.4% and 43.9% respectively as compared to control. In the greenhouse trial, overall potato late blight disease incidence was minimum 5.81% where *A. sativum* extract was used followed by *A. indica* at 30% concentration resulted 8.45% incidence as compared to control 61.18%. Furthermore, the 30% aqueous extracts of *A. sativum* found highly effective against late blight disease with 15.4% severity, as compared to control with 54.13% disease coverage. Application of *A. sativum* and *A. indica* aqueous plant extracts with a concentration of 30% was found most promising and effective measure against late blight pathogen. Study provides environmentally benign mileage in organic vegetable production against hazardous synthetic agro-chemicals.

Keywords: Garlic, Late blight, Neem, Potato, Plant extracts, Turmeric

AN UPDATED RECORD OF FRUIT FLIES (TEPHRITIDAE: DIPTERA) IN POONCH DIVISION OF AZAD JAMMU & KASHMIR

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Fruit Flies (Diptera: Tephritidae) are invasive pests in temperate region of Azad Jammu & Kashmir (AJ&K) transported via fruits and vegetables of Punjab and Khyber Pakhtunkhawa (KPK) markets. Present Study has been conducted to record the fauna of this pest from Poonch division of AJ&K and with special emphasis on species taxonomic characterization. For this purpose adult fruit flies were collected by using McPhail traps containing cotton pieces treated with 10-12 drops of attractant (Methyl Eugenol and Cue lure) mix with chemical insecticides (Malathion). Infested fruits and vegetables were also collected from the marketplaces, orchards and fields and transferred to the laboratory of Entomology Department for rearing of fruit flies. The collected and reared adult specimens were identified under microscope (Leica MZ6) up to specie level with the help of available literature and pictorial keys. Eleven species of fruit flies *Bactrocera diversa. B. scutellaris, B. tau, B. cucurbitae, B. dorsalis, B. nigrofemoralis, B.zonata, B. correcta, Dacus ciliatus, D.longicornis and D. sphaeroidalis* under two genera *Bactrocera* and *Dacus* of family Tephritidae were recorded. Among which *Bactrocera diversa* and *Dcaus cilitus* were new record to this area. A key to the local species of fruit flies has also been constructed.

Keywords: Azad Jammu and Kashmir, *Bactrocera, Dacus*, Fruit flies, Tephritidae, Poonch

SPATIO-ECO-BIOLOGICAL STUDIES OF *Bombus simillimus* (HYMENOPTERA: APIDAE) FROM TOLIPIR NATIONAL PARK, AZAD JAMMU AND KASHMIR, PAKISTAN

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From the last decades use of commercial bumblebee species for crop pollination in managed cropping systems is increasing and on other hand *Bombus* pollinators are in decline, becoming endangered species around the globe. *Bombus simillimus* is native bumblebee species of Azad Kashmir and Northern Pakistan and this study was designed to explore their ecological behavior like seasonal distribution, habitat preference and floral host range from Tolipir National Park Azad Jammu and Kashmir, Pakistan. Results explore that hibernating queens of *B. simillimus* emerged in April and start of May, workers recorded from July to last of September and sexual (male and daughter queens) were found in September and October. Maximum population was observed in August and there was no population from November to March. Queens of *B. simillimus* mostly preferred the forest boundaries for nesting place and their least preference was forest area to build their nests. Individuals of *B. simillimus* were recorded on 33 floral host plants during the foraging activities and Asteraceae plant family found with maximum foraging plants of *B. simillimus*. Hibernating queens emerged from April to May and preferred the forest boundaries for nesting place. Maximum population of *B. simillimus* found in August and Asteraceae plant family was major foraging host family for this species. This study will be helpful to develop conservation strategies for this important native bumblebee pollinator in future.

Keywords: *Bombus. Simillimus,* Ecological studies, Tolipir national park, Pakistan

EFFECTS OF TEMEPHOS RESISTANCE ON LIFE HISTORY TRAITS OF AEDES ALBOPICTUS (SKUSE) (DIPTERA: CULICIDAE), A VECTOR OF ARBOVIRUSES

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The effects of temephos resistance on the fitness cost of the wild populations of Aedes albopictus was evaluated. The larvae of two wild populations were exposed to the diagnostic dose of 0.02 mg and 0.012 mg/L. The larvae which survived after the 24 h exposure to diagnostic dose were considered as resistant and F1 generations were chosen for the comparisons of fitness parameters with the control strain, which includes larval developmental time, adult longevity, fecundity, wing length and hatchability. We found that temephos resistance had negative effects on larval developmental time which was longer for Gelugor strain among the populations with the median range of 10 days and a shorter longevity was observed with the median range of 13 days for males and 16 days for females. Whereas, an effective reduction of 29.8 and 38.6% was observed in fertility and fecundity of Gelugor strain as compared to control strain. In contrast, no clear differences were found in biological parameters of Balik Palau and USM strain, except fecundity and fertility with a reduction of 13.4 and 15.5%, respectively. Whereas, no significant differences were seen in the wing size between the populations with the mean length (mm) of 2.40 for Gelugor, 2.44 for Balik Palau and 2.46 for USM control ($p > 0.05$). Present results indicated that the temephos resistance is associated with the developmental and reproduction potential of resistant population of *A. albopictus* and the fitness has been compromised.

Keywords: Temephos, Insecticides resistance, Fitness cost, *Aedes albopictus*, Dengue

EVALUATION OF MAJOR AND ENVIRONMENTALLY DRIVEN GENES FOR RESISTANCE IN PAKISTANI WHEAT LANDRACES AND THEIR PROSPECTED POTENTIAL AGAINST YELLOW RUST

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Yellow rust is caused by *Puccinia striiformis tritici* (*Pst*), the most devastating wheat disease with continuous challenge of emerging virulence breaking vertical resistance worldwide resulting in epidemics. Vertical resistance genes incorporation is sustainable, economical and environment-friendly approach to control rust diseases. Wheat landraces (WLR) acquired vertical resistance through long time exposure of host pathogen survival competition in specific area having unique agronomic traits, genetic base and resistance against biotic and abiotic agents can be exploitable commodity for future food production. Fifty Pakistani WLRs already with known vertical resistance were screened against seven potential Pakistani *Pst* races at seedling stage under glasshouse conditions to postulate resistance genes. Resistance magnitude was compared among the landraces. Six genes *Yr1, Yr8, Yr9, Yr43, Yr44,* and *YrTr1* were successfully postulated either singly or in combination along with unidentified genes in 45 landraces. Pakistani *Pst* races are avirulent to *Yr5, Yr10*, *Yr15*, *Yr24*, *Yr32, YrSp* and *YrTye*. Most frequently postulated genes are *Yr44* found in 22 genotypes, *YrTr1* in 21, *Yr9* in 19, *Yr43* in 18, *Yr8* and *Yr1* in 14 wheat landraces. Multiple *Yr* gene pyramiding was observed in (B-74, B-281, B-530) with the presence of *Yr8, Yr9, Yr43, Yr44,* and *YrTr1* and single gene were postulated from 12 genotypes. WLRs (B-03, B-158, B-160, B-171) reaction was immune showing presence of novel *Yr* genes. Study provides information regarding yellow rust resistance genes originated independently against localized *Pst* races with desirable agronomic traits since long and can be option for food security in changing environmental challenges.

Keywords: Wheat Landraces, Yellow rust races, Gene postulation, Resistance, Virulence

MANAGEMENT OF POST-HARVEST FUNGAL ROT DISEASES OF PEACHES FROM COMMERCIAL FRUIT MARKETS OF PAKISTAN WITH BIOCIDES

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Market diseases of stone fruits are a continuous threat deteriorating quality and quantity of produce worldwide. A survey of commercial fruit markets was conducted during year 2019, where rotted peaches were observed in fruit markets of Rawalpindi (33° 37' 33.8052'' N and 73° 4' 17.1912'' E) district, Punjab province, Pakistan. Based on morphological, cultural and multi-gene characteristics, isolates were identified as different species of Aspergillus, Penicillium and Fusarium. The extensive use of fungicides as a disease control agent has resulted in the emergence of fungicide-resistant pathogens and concerns have been raised over the residual effects on the environment and human health. Plant EO's are thought to play a significant role in plant defense mechanisms acting in contradiction of phytopathogenic microorganisms. Plant essential oils of *Trogonella foenum, Vachellia nilotica, Syzygium aromaticum, Eucalyptus golobulus, Cinnamomum verum, Curcuma longa,* and *Allium Sativum* were tested against suppression of fungal post-harvest rots to 90% at different concentrations. Both *in-vitro* and *in-vivo* studies in different environments indicated that essential oils hold excellent anti-fungal activity against these post-harvest fungal rots on peaches in a concentration dependent manner where lesion diameter was effectively lessened followed by reduction in disease severity. After application of essential oils in the form of packaging material against fungal rots of peaches, average weight of peach fruits were not altered significantly as compared to control where maximum average weight loss was observed and measured after all odd DPI. Taken together, the results of the current study provide an eco-friendly management strategy using plant EO's for peach fruits protection against postharvest fungal decay problems and to enhance the shelf-life of peaches.

Keywords: Fungal post-harvest rots, Peaches, Pakistan.

DETECTION OF MAJOR SOIL-BORNE VIRUSES AND ASSESSMENT OF VIRUS-VECTOR ASSOCIATION IN POTATO GROWING AREAS OF NORTH-WESTERN PAKISTAN (KHYBER PAKHTUNKHWA) AND AZAD JAMMU AND KASHMIR

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Soil-borne potato viruses are an increasing economic threat to crop yield in the future. Potato mop-top virus (PMTV) and Tobacco rattle virus (TRV) and their vector association in field infection in North-western region of Pakistan and Azad Jammu and Kashmir were surveyed in this study. Incidence and distribution of these soilborne viruses were estimated by field sample collection from Malakand and Hazara divisions of KPK and selected areas of Azad Kashmir. PMTV incidence was 22% in Malakand (highest of 40% in Swat II and Swat V), 24% in Hazara (highest 50% in Galliyat), and 23% from selected areas of Azad Jammu and Kashmir (AJK) (Highest with 40% in Rawalakot and Trarkhal). TRV incidence was 49% in AJK (100% highest field incidence in Khaigala Rawalakot), 53% in Malakand division (80% highest field incidence in Swat II), and 24% in Hazara division (70% highest field incidence in Abbottabad and Mansehra districts). PMTV, TRV vectors are *Spongospora subterranea* and *Trichodorus*, *Paratrichodorus* spp. were found distributed in all surveyed areas. Eighty percent (80%) fields were found infested with S. subterranean, while *Trichodorus* and *Paratrichodorus* were found in 64% in Malakand. In Hazara, 84% of surveyed fields were found infested with *S. subterranea* while 65% were found to be infested with *Trichodorus*, *Paratrichodorus*. In AJK *S. subterranea* was found distributed in 79% of fields. A significant relationship (P value=0.000) between viruses (PMTV and TRV) and their respective vectors were detected in proportionate. The corresponding R2 (0.70 and 0.82) indicates positive relation between viruses and their vectors. Positive Pearson correlation was found among incidence and severity of virus infection (PMTV and TRV) and vectors (*S. subterranea; Trichodorus minor*, *Paratrichodorus*), indicating increased disease severity with vector presence and activity. The study will be a tool in vector virus management to economical potato harvest.

Keywords: Potato, Incidence, PMTV, TRV, *Spongospora subterranean*, *Trichodorus, Paratrichodorus*, Association

IMPACT OF INSECTICIDES ON FEEDING BEHAVIOR, FOOD CONSUMPTION AND SURVIVAL POTENTIAL OF *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE)

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Fall armyworm, *Spodoptera frugiperda* is an economic pest of maize crop where it causes huge economic losses if left unattended or is not managed properly. The feeding behavior and food-consumption efficiency of insects were affected by various biotic and abiotic factors specifically insecticides to which they are exposed, directly or indirectly, in agroecosystem. Present research was designed to assess the impact of seven commercial insecticide formulations including Karate 5EC (lambda-cyhalothrin), Kento14.5 SC (indoxacarb), Delegate 11.7 SC (spinetoram), Coragen 18.5 SC (chlorantraniliprole),Fitrest 5 SG (emamectin benzoate),Fame 480 SC (flubendiamide) and Rimon 10 EC (novaluron)on the feeding behavior, food consumption and survival potential of *Spodoptera frugiperda* under laboratory conditions. In the first experiment, the 1st generation populations were utilize for mortality bioassay studys. A leaf dips bio-assay method by using little changes were employed to establish the sublethal (LC_{20}), medians lethal, (LC_{50}), lethal (LC_{80}) and super-lethal (LC_{95}) concentrations for different insecticides. In lab the Coragen 18.5 SC (chlorantraniliprole) causing over 90% mortality after 24 hours of application, Emamectin benzoate, flubendamide spinetoram, lamda-cyhalothrin and indoxacarb had moderate to high activity with (77%, 78%, 76%, 72%, 67%) mortality respectively while Novaluron was less effective with 24% mortality and distilled water was used in control treatment with 0% mortality. In the second experiment, second instar larvae were subjected to treated leaves. Subsequently, the surviving larvae were shift individually in to plasted cups (5 cm in diameters by 6 cm in heights) applied without treated diet. The total life of the larvals stage, food intakes, larvae weight gains, productions of waste materials by larvae, & larvals mortality was recorded. Consumption of food after treatment resulted in suppressed feeding, retarded weight gain and prolonged development time. Relative consumption rate, efficiency of conversion of ingested food, relative growth rate, approximate digestibility, and assimilation rate of food were reduced after treatment with insecticides, especially by the higher concentrations. Treatments influenced insect growth, food consumption, and digestion when nutritional variables were analyzed.

Keywords: Chlorantraniliprole, Mortality, Fall armyworm

ASSESSMENT OF RESISTANCE OR SUSCEPTIBILITY OF EIGHT AUBERGINE CULTIVARS TO *MELOIDOGYNE JAVANICA*

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Variations were observed in resistance or susceptibility among eight aubergine cultivars to *Meloidogyne javanica*. Brinjal Jamak was the only cultivar found to be moderately resistant. Two cultivars namely Brinjal Shilpa and Singh Nath 666 appeared moderately susceptible. Five cultivars *viz*. Round Black, Short Purple, Brinjal PPL, Global Brinjal PPL and Namyal Ratchburi behaved as susceptible. All the cultivars behaved differently regarding formation of galls, egg masses, number of eggs per egg mass and reproductive factor. Maximum galls, egg masses, eggs per egg mass and reproductive factors were observed on Round Black followed by Global Brinjal PPL and the minimum were recorded on cultivar Brinjal Jamak. Similarly, significant effects of *M. javanica* were observed on growth parameters of these cultivars. The reductions in moderately resistant cultivar were significantly lower as compared to the moderately susceptible and susceptible cultivars. The maximum reductions in shoot and root lengths and shoot weight were recorded in case of Round Black followed by Global Brinjal PPL. On the other hand, the minimum reductions in these parameters were found in Brinjal Jamak. Similarly, the infection of *M. javanica* caused an increase in root weights of all the cultivars. The increase in root weight was the minimum in cultivar Brinjal Jamak while it was the maximum in case of Round Black followed by Global Brinjal PPL. Regression analysis showed positive and significant relationships between number of galls and reductions in shoot and root lengths and weights. As the plants of moderately resistant cultivar Brinjal Jamak suffered less damage and suppressed nematode infection considerably and therefore, recommended for cultivation in root-knot nematode infested fields to abate yield losses and repress the nematode from further multiplication.

Keywords: *Meloidogyne javanica*, Eggplant, Brinjal

ENHANCING THE RESILIENCE OF TRANSGENIC COTTON FOR INSECT RESISTANCE

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The efficacy of *Bt* crystal proteins has been compromised due to their extensive utilization in the field. The second-generation *Bt* vegetative insecticidal proteins could be the best-suited alternative to combat resistance build-up due to their broad range affinity with midgut receptors of insects. The codon-optimized synthetic vegetative insecticidal proteins (Vip3Aa) gene under the control of CaMV35S promoter was transformed into a locally developed transgenic cotton variety (CKC-01) expressing *cry1Ac* and *cry2A* genes. Transformation efficiency of 1.63%. was recorded. The highest Vip3Aa expression (51.98-fold) was found in the MS3 transgenic cotton plant. Maximum Vip3Aa protein concentration (4.23µg/mL) was calculated in transgenic cotton plant MS3 through ELISA. The transgenic cotton plant (MS3) showed one copy number on both chromatids in the homozygous form at chromosome 8 in the telophase stage. Almost 99% mortality of *H. armigera* was recorded in transgenic cotton plants expressing double crystal proteins pyramided with Vip3Aa gene as contrasted to transgenic cotton plant expressing only double crystal protein with 70% mortality. The results obtained during this study suggest that the combination of *Bt cry1Ac, cry2A*, and *Vip3Aa* toxins is the best possible alternative approach to combat chewing insects.

Keywords: Cotton, *Bt cry1Ac, cry2Ac, Vip3Aa*

EXPLORING SPRING WHEAT MAPPING POPULATION FOR GENETIC RESISTANCE TO KARNAL BUNT UNDER FIELD CONDITION

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Karnal bunt is a seed, soil and air borne disease of wheat caused by the fungus *Tilletia indica* Mitra. The floret-infecting fungi damages the grains and affects wheat quality adversely through production of trimethylamine. It is one of the major emerging threats for Pakistani wheat grain industry. Deployment of host-plant resistance is the best strategy to combat this disease. The present study was carried out to explore sources of genetic resistance in the spring wheat mapping population received from CIMMYT. The research material, comprising of 277 genotypes; two parents and 275 recombinant inbred lines (RILs), was evaluated for reaction to Karnal bunt infection through artificial inoculation under field condition. Four experiments were carried out at WRI, Faisalabad, during two consecutive cropping seasons (2018-19, 2019-20) and two planting dates. In each experiment, the genotypes were screened for resistance to Karnal bunt by injecting inoculum suspension with a hypodermic syringe at boot stage. Maximum values for disease incidence were 8.13% and 6.69% during 2018-19 and 2019-20 respectively. Three resistant genotypes (KB-95, KB-131 and KB-145) were identified with higher yield. Biplot analysis identified stable and resistant genotypes in different environments. This study has identified several RILs with durable resistance against pathogen isolates. The identified RILs may serve as breeding material for the development of wheat variety resistant against Karnal bunt.

Keywords: Wheat, Karnal bunt, Genetic resistance, RILs, Pre-emptive breeding

APPRAISAL OF ENDOPHYTIC BACTERIA AGAINST SUGARCANE SMUT CAUSED BY *SPORISORIUM SCITAMINEUM* UNDER GREEN HOUSE

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Sugarcane is 2nd largest cash crop of Pakistan. Smut is most devastating disease and emerging threat to sugarcane industry. This pathogen is transmitted through setts. Smut disease significantly decrease yield and sugarcane recovery. In ratoon crop disease incidence increase as compared to newly transplanted. In green house assessing of five endophytic bacteria against *S. scitamineum* was carried out. Endophytic bacteria strains EPB 42, EPB 55, EPB 13, EPB 94 and EPB 36 were taken from Plant Pathology laboratory. Endophytes were applied on moderately susceptible sugarcane buds and artificial inoculum was applied on them. Pots were arranged under CRD with three replications in greenhouse conditions. It was observed that they reduced disease severity; enhance the germination and quality of cane. Minimum smut disease severity (12.5 %) was recorded in EPB 94 treated plants followed by EPB 55 (18.2%), EPB 36 (23.1%), EPB 13 (29%) and EPB 42 (45%).

Keywords: Sugarcane, *Sporisorium scitamineum*, Management, Entophytic bacteria

NEW DISTRIBUTIONAL RECORDS OF OXYA GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE: OXYINAE) FROM AZAD JAMMU & KASHMIR ANSA TAMKEEN, KHALID MAHMOOD, REHAN INAYAT

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Short horned grasshoppers of genus *Oxya serville* (Orthoptera: Acrididae: Oxyinae) were considered as the most destructive phytophagous pests of Agriculturally important crops like rice, maize, barley and fodder crops. The current study was designed to explore the fauna of this economically important group. Adult specimens were collected from open fields, maize, rice fields, forest area and pastures. This study added two new records to the fauna of Acrididae (Oxyinae). Five species viz. *Oxya fuscuvitata. O. hyla hyla, O. hyla intricate, O. bidentata, O. velox* were found. Among these *Oxya bidentata and O. velox* are first time reported from this area. Micrograph of identified species, diagnostic characters, distribution, habitat and remarks also provided. During present study adult specimens of genus *Oxya* were collected from various localities of Azad Jammu & Kashmir. The specimens were generally collected from open areas, maize, rice fields, forest area and pastures by hand picking and by using aril net during 2019.The collected specimens were killed in glass jar containing Potassium cyanaid. Identification of collected specimens was done by following the literature (Bei- Bienko & Mishchenko, 1951; Hollis, 1973; Bhowmik 1986; Usmani and Naeem 2012).The identified specimens were deposited in Department of Entomology, Faculty of Agriculture, University of Poonch Rawalakot. Members of Subfamily Oxyinae were reported from different localities of three subdivisions of Azad Jammu and Kashmir including Rawalakot, Mirpur and Muzaffrabad during 2018-19. Adult specimens of five species viz. Oxya *fuscuvitata. O. hyla hyla, O. hyla intricate, O. bidentata, O. velox* were collected. Among these *Oxya bidentata and O. velox* are first time reported from this area. Morphometric studies which includes, total body length dorsal midline length of insects from fastigium to the abdominal tip and measurements of 9 body parts including head length, body length, tegmen length, hind femur length, tibial length, forewing expanse, tegmen width, pronotum length and pronotum width of adult grasshoppers were done for taxonomic comparison

Keywords: Short horned grasshoppers, Taxonomy, *Oxya bidentata*

DISTRIBUTION OF POTATO CYST NEMATODES FROM DISTRICT SKARDU, GILGIT BALTISTAN

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Potato cyst nematodes (PCN) are important constraint to potato production and its marketing even after it is produced due to its pathogenic and quarantine nature. Potato is among most important tuber crop of the world used as staple food, mostly in European countries and other cool areas of the world. Potato is vulnerable to various biotic and abiotic stresses among them cyst nematodes are of prime importance. *Globodera pallida* and *Globodera rostochiensis* are two important species that cause potential threat to potato production. Keeping in view the importance of potato and PCN, these studies were designed to know the status of PCN in potato producing areas of District Skardu due to its wide adaptation and its high production value around the country. Keeping in view the nature of the pathogen mostly transmitted through the seed potato. A survey was conducted to know the status of PCN and its population in different potato growing areas of Skardu. More than 50 sites having potato grown were visited and potato fields were sampled for the presence and absence of PCN. Protocol for extraction developed by European union was used to isolate the cyst from the soils. Most of the sampled locations were found with dead cysts. It is our future plan to identify the cysts and determine their real threat level to local agricultural economy. A distribution map of PCN was prepared. Desiree was used for multiplication of cyst nematode. It was found fortunate that most of the potato fields were found free from live cyst. This study is a step towards the certification of the potato cyst nematode fields for future potato seed production.

Keywords: Potato, Cyst nematode, *Globodera pallida*, *Globodera rostochiensis*

IMPACT OF LIGHT DURATION ON TWO COMPETITIVE WEEDS: *PARTHENIUM HYSTEROPHORUS* AND *CANNABIS SATIVA* IN PAKISTAN

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After invasion of invasive weed *Parthenium hysterophorus* into Pakistan, this weed not only create health issues in both human and animals but also start replacing the native weed *Cannabis sativa*. These weeds are rapidly escaping not only in the plane areas of the country but also to the high elevated mountain areas of Pakistan. The instant study was designed to check the response of both these weeds against light duration for estimating the growth of these weeds in those hilly areas where light duration is comparatively very low compared to the plane areas. During pot studies both the weeds were exposed to different light durations i.e., 2, 5, 7, 9 hours a day and the control pots were also included for comparison. The results revealed that under reduced light duration (2 hours) plant growth performance i.e., plant biomass, plant height, leaf area and No. of branches of the tested species found reduced. In addition, with increasing light duration (9 hours) both species grew faster and recorded maximum biomass plant height, leaf area and No. of branches. Further, both weed species grown under reduced light duration was unable to reach its maturity and complete its life cycle. Here we concluded that both these weeds will be unsuccessful in term of rapid growth in the hill areas of Pakistan where light duration is less.

Keywords: *Cannabis sativa, Parthenium hysterophorus,* Weed, Health

PROGRESS ON DEVELOPMENT OF EPF: AN EMERGING TREND IN SUSTAINABLE AGRICULTURE

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The overproduction and excess rapid expansion in human lifestyle have augmented food supply globally, which has prompted destruction of forest at large scale and disbalanced the ecosystem. Each year a large portion of agricultural crops are sprayed by different kinds of pesticides, which ensures health and environmental issues. Entomopathogenic fungi are potentially the most versatile microbial agent due to their wide host range and natural occurrence, which makes them less damaging to the environment. The study was carried out to test the efficacy of different concentrations of Green Guard (*Metarhizium anisopliae Var. acridum*) against *Schistocerca gregaria* Desert Locust (DL) nymphs in field and laboratory conditions. Field experiments were performed at Agrani, Mahendrani, Jam-ji-Dhani, Saadan-j-Dhani, Jamal-ji-Dhani, Senhrani, Ramlani Mehlani , and Sekhario localities of Thar , a permanent zone of outbreaks for this pest. Four different concentrations were applied against 1st and 2nd nymphal instar of DL. A significant higher mortality was recorded after 8, 10 and 12 days in all concentrations compared to control. *Metarhizium* treatment was found more affected against DL N1-N3 and significant mortality was noted during the earlier days. Similarly in case of adult's maximum mortality was observed on i-e 6.9±1.41 and control was 1.9±0.46. Basic information was collected on the behavior of the insects, Insect basking in the sun at unusual times of the day, reduction in speed and less coordination with each other, reduction in feeding, increased predation, etc. however, at 14 days post-spraying, mortality caused by the bio-pesticide in the field was approximately 75-80%. Higher doses at optimum temperature and humidity showed higher mortality. Further study with different does in diverse ranges is in progress. This study is financially supported by HEC under GCF Project No. 290.

Keywords: Green guard, Agrani, *Metarhizium*

GENETIC DIVERSITY AND MANAGEMENT OF PATHOGEN ASSOCIATED WITH BLAST OF RICE

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Rice blast is the most damaging disease of rice that is responsible for heavy yield reduction globally. To find out the pathogenic diversity, one twenty five *P. oryzae* isolates were collected from diseased rice plants in different geographical locations in Punjab Province, Pakistan, in 2018 and 2019. The associated pathogen was isolated, purified and multiplied by using the potato dextrose agar nutrient medium. Based on the morphological identification, four distinct sub-specific groups were found. Pathogenicity assays has showed that one of these groups (G-I) was highly pathogenic, with disease severity of 47% four weeks after inoculation. DNA sequence analysis of the internal transcribed spacer (ITS) region conducted with MUSCLE alignment found an identical single-base-pair substitution in thirty-five isolates. Phylogenetic analysis of the ITS region, ß-tubulin, actin and calmodulin genes using maximum parsimony (MP) with tree bisection reconnection (TBR) confirmed the identification of all the isolates as *P. oryzae* when compared with the available data set of *P. oryzae* on NCBI with 100% bootstrap value. The variated isolates of *P. oryzae* collected from Punjab, Pakistan were existed as a sub-clade under the main clade of *P. oryzae* with 95-100% bootstrap values. *In vitro* and greenhouse experiments were conducted to evaluate the growth inhibition ability of commercially available fungicides (difenoconazole, mancozeb, tetrachlorophthalide, tebuconazole + trifloxystrobin, carbendazim, propiconazole, thiophanate-methyl) and botanical extracts (black pepper, clove, aloe vera, neem, and ginger). We concluded that a new ecotype of *P. oryzae* has been prevailed in different geographical areas of Punjab, Pakistan. Difenoconazole inhibited the *in vitro* mycelial growth of *M. oryzae* more than other compounds (83.55%), followed by black pepper (70.68%).

Keywords: *Oryza sativa,* Rice blast, Morphology, Genetic diversity, Molecular markers

EFFECT OF CLIMATE ON DIVERSITY OF *LOCUSTA MIGRATORIA* (ACRIDIDAE: ORTHOPTERA) IN SINDH

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Locusta migratoria is a significant part for terrestrial and grassland ecosystems. Its diversity is influenced by temperature, precipitation and food availability. Due to favorable conditions Locust swarm may reuin the green vegetations, vast field crops within time because of these are fly over great distance. *L. migratoria* and other species cause serious agricultural damage by feeding upon crop plants. The mandibular modification enables them as a mix feeder, plants including various trees and bushes. Insect behavior and environmental conditions co-influence the population density and spatial distribution pattern of this pest. Generally, the locust population is regulated by temperature. Each year the number of generations of the locust species vary from one to five and this is dependent on climate warming, which enhances its numbers and speeds up their hatching ratio. Beside this, soil with moisture content 10- 20% is most favorable for laying of eggs, but excess water can destroy locust eggs. We need to enhance our knowledge on aspects which are correlated with the reasons causing locust outbreaks and dramatic increases in population sizes due to change in temperature, by which we can improve our locust management policy.

Keywords: *Locusta migratoria,* Locust swarm, Pest, Grassland

CLIMATE INFLUENCE ON THE DIVERSITY OF DARKLING BEETLE (TENEBRIONIDAE: COLOPTERA) IN CHOLISTAN DESERT PUNJAB

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Darkling beetles are an important insect group in grassland and desert ecosystems. Despite their importance, little is known about the relationships between environmental variables. We studied the effects climate on beetles' community parameters (abundance, richness, diversity, dominance, and evenness) in three types of ecosystems of Cholistan. Climate factors were the most important drivers of community structure, whereas the effects of soil and vegetation were less important. Desert steppe showed the highest Tenebrionidae abundance, richness, diversity, and evenness, and the highest dominance. temperature regulates insects' physiology and metabolism. An increase in temperature increases physiological activity and, therefore, metabolic rates. Insects must eat more to survive and it's expected that insect herbivores consume more and grow faster. In the result of this change following 9 species were captured in significant numbers i-e *Promethis semisulcata* (Faimaire, 1882), *P. coracina* (Knoch, 1801), *P. punctulator* (Fairmaire, 1883), *P. opaca* (Carter, 1914).*Rophobas asperatus* (Fairmaire, 1882), *Eucyrtus pretiosus* (Lacordaire, 1859), *Eucyrtus anthracinus* (Fairmaire, 1882), *Strongylium varinas* (Pascoe, 1883), *Strongylium orientaie* (Fairmaire, 1893). In addition, because of climate change, both crop distribution ranges and insects will shift. As they seek out conditions that ensemble them, insects move to new areas that lack their natural enemies. This will cause their populations to grow, resulting in more crop damage in future.

Keywords: Darkling beetles, *Promethis semisulcata, Strongylium orientaie*

PLANT VIRUSES, CLIMATE CHANGE AND FUTURE FOOD INSECURITY IN KHYBER PAKHTUNKHWA

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Plant-infecting DNA viruses are divided into two general types with either circular double-stranded DNA (dsDNA) or circular single-stranded DNA (ssDNA) genomes. Caulimoviruses and badnaviruses (family *Caulimoviridae*) are dsDNA viruses, whereas nanoviruses (family *Nanoviridae*) and geminiviruses (family *Geminiviridae*) are ssDNA viruses. *Geminivirdae* includes large number of plant viruses (fourteen genera containing ~450 virus species) that infect both monocots and dicots. These viruses are responsible for extreme yield reduction in numerous economically important plants including staple food crops, vegetable crops, medicinal and aromatic plants, ornamental plants, weeds, and pose a serious threat to many crops in tropical and sub-tropical regions of the world. Currently, these viruses have also been reported in temperate regions due to changes in climatic conditions and international human trade. In this study, geminiviruses and their associated components were investigated in Khyber Pakhtunkhwa. The region under investigation has a comparatively temperate environmental conditions but the area is highly rich with a diverse range of plants such as vegetable crops, ornamental plants, medicinal and armoatic plants etc. Interestingly, this area has never been comprehensively studied with regard to plant viruses (geminiviruses in particular) that are present and cause constraints to food security. Thus, the area remains mostly unexplored, and management of viral diseases and their insect vectors have not been possible due to the huge gap in knowledge. Here, we discovered numerous geminiviruses and satellites that cause diseases in broad range of economically important crops. The viruses had a diverse range of distribution, disease incidence, and disease severity amongst differnt crops. However, furthur comprehensive research would be needed to validate the current observations. The informations gained from this study will become the baseline datatbase and knowledge for future screening of viruses in the region and will also determine the ultimate range of viruses that actually infect plants in the region.

Keywords: Geminiviruses, Begomovirus, Satellites, Swat, *Bemicia tabaci*

MANAGEMENT OF MELOIDOGYNE INCOGNITA WITH ENTOMOPATHOGENIC BACTERIA AT VARIOUS STORAGE TIMES

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Entomopathogenic bacteria and culture filtrate have abundant substantial traits that mark them excellent bio-control agent against root knot nematodes. These bacteria involved in direct suppression of plant parasitic nematodes and facilitate the activity of microbial antagonists. Shelf life study for the pathogenicity of entomopathogenic bacteria (*Photorhabdus* spp., X*enorhabdus* spp.), isolated from, *Heterohabditis bacteriophora* and *Steinernema asiaticum* and their culture filtrate were performed for the storage period of 2, 3, 4 and 5 months against *Meloidogyne incognita*. Current study was conducted in CRD under factorial arrangements with five replication. The results revealed that *Xenorhabdus* spp. significantly reduced the no. of females, no. of galls and reproduction potential as compared to other treatments, whereas, egg masses and root weight was significantly reduced in case of *Xenorhabdus* spp. (Bacteria) applied after 2 months of storage time. In crux, results of given study exhibited that *Xenorhabdus* spp. with its used forms (Bacteria) can inhibit the impact of root knot nematodes and remain viable after 2-5 months of storage time.

Keywords: *Photorhabdus* spp., *Xenorhabdus* spp., Storage time, Cell suspension

HOST INFLUENCE ON THE BIOLOGICAL CHARACTERIZATION OF EGG PARASITOID, *TRICHOGRAMMA CHILONIS*

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Trichogramma chilonis was identified as potential endoparasitoid of many destructive lepidopteran pests, raising the chance of utilizing this egg parasitoid as an inundative biological control agent that can be commercially produced. Studies were conducted to evaluate the biological parameters of this parasitoid under laboratory conditions. Host diet significantly influenced the parasitoid developmental period, level of parasitism, emergence rate and sex ratio. Developmental period and parasitism rate also varies when the age of host (S*itotroga cerealella*) eggs and parasitoid (*Trichogramma chilonis*) changed. Maximum oviposition rate was recorded in 12 hours old host eggs, whereas maximum parasitism was observed by 12 hours old parasitoid i.e. *Trichogramma chilonis*. Results strongly suggested that better host diet i.e. oat can be used to improve the quality of *Trichogramma chilonis* and 12 hours old host eggs and parasitoid is suitable for maximum parasitism.

Keywords: Emergence rate**,** Endoparasitoid, Inundative, Oviposition, Parasitism

ALTERNANTHERA YELLOW VEIN VIRUS (AYVV); A BETASATELLITE INDEPENDENT BEGOMOVIRUS INFECTING SONCHUS PALUSTRIS IN PAKISTAN

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Satellites associated begomoviruses are the most diverse group of plant viruses in tropical and subtropical regions. In Pakistan, during field surveys in 2019-2020, *Sonchus Palustris* (a weed plant) was observed showing begomovirus symptoms i.e., vein yellowing and mosaic patterns on leaves. Rolling circle amplification from total isolated DNA of symptomatic leaves was performed to amplify circular viral genomes. Subsequent cloning and sequencing showed that a new strain of Alternanthera yellow vein virus (AlYVV) is associated with vein yellowing disease of *S. Palustris*. The identity percentage analysis through BLAST search and SDT analysis showed that the new strain is 94-98% identical to AlYVV isolates reported from Pakistan, India and China. In phylogenetic tree, it clustered with AlYVV-[PK:E prostrata:15-KX710155], AlYVV-[PK:E prostrata:13]-KX906697] and AlYVV-[PK:E prostrata:11]-KX906694] previously reported from Pakistan. There was no detectable level of betasatellite or any other satellite molecule in the samples studied here. Phylogenetic analysis of Rep and CP genes of AlYVV with corresponding genes of closely related viruses circulating in South East Asia showed intra-specific recombination involving both complementary and virion sense region of virus. Relaxed clock and Bayesian Skyline Plot analysis based on CP gene sequences indicated slight higher substitution rates (4.75×10^{-3} substitutions/nucleotide/year). In the Indian subcontinent satellite-associated monopartite begomoviruses predominately infect crops and non-crop plants. But AlYVV is found infecting mostly non-crop plants independent of satellite molecules. We hypothesize here that AlYVV evolved as a true monopartite begomovirus in the Indian sub-continent and could be a great threat to introduced crops under suitable conditions. Such studies are crucial to understand probable future epidemics of begomoviruses in the region.

Keywords: Begomovirus, Phylogeny, Recombination, Bayesian analysis, Mutation

THE HIGH GENETIC DIVERSITY AMONG ALPHASATELLITES INFECTING GOSSYPIUM SPECIES AND CHANGING CLIMATIC CONDITIONS REVEAL A POSSIBLE NEW EPIDEMIC OF CLCUD

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Alphasatellites are single stranded small circular DNA molecules associated with geminiviruses and nanoviruses. In this study, a high-throughput metagenomic analysis of the known alphasatellites isolated from the genus gossypium (cotton) over the last two decades is performed. The phylogenetic and pairwise sequence identity analysis suggested that cotton-infecting begomoviruses are associated with at least 12 different alphasatellites globally. Three out of 12 alphasatellite species are associated with cotton leaf curl geminiviruses but have never been isolated from cotton plant. Cotton leaf curl Multan alphasatellite, which was initially isolated from cotton has a very broad host range including monocot plants like sugarcane. The recombination analysis suggested that the three species namely Cotton leaf curl Luckhnow alphasatellite, Cotton leaf curl Multan alphasatellite and Ageratum enation alphasatellite evolved through recombination. Additionally high genetic variability was detected among cotton infecting alphasatellites at genome level. The mutation rate estimation based on the yearwise sequence information for alphasatellites replication protein (Alpha-Rep) suggested a very high mutation rate of ~ 1.56 X 10^{-3} nucleotide substitution/nucleotides. The correlation of yearwise seqeunce data with the disease severity index suggested that after the first two epidemics of cotton leaf curl disease (CLCuD) there was relatively slow spread of alphasatellites. However, with the current spread of CLCuD into China and Philipines in combination with climate change it seems that we are entering into a new phase alphasatellites spread in the Old World. This study highlights the increased biodiversity of alphasatellites in combination of enivornmental factors which can potentially result into a new epidemic on cotton crop.

Keywords: Alphasatellite, Epidemic, Begomoviruses, Genetic recombination, Diversity, Cotton

EFFICACY OF DIFFERENT FUNGICIDES FOR THE CONTROL OF RICE BLAST DISEASE AT DISTRICT BAHAWALNAGAR

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The present study on the efficacy of fungicides in reducing the incidence of Rice Blast disease was conducted during 2017 and 2018. The seed of rice (PS-2) was sown in the fourth week of June and transplanted in the fourth week of July. The distance between row to row and plant to plant was maintained at 20cm. The experiment had eight treatments replicated three times in Randomized Complete Block Design. At the time of harvest, the number of filled grains and yield recorded. The results obtained indicated that application of fungicide (Azoxystrobin+Difenconazole) significantly reduced the incidence of rice blast disease compared with control treatment. Application of (Azoxystrobin+Difenconazole) was found most effective with the minimum didease incidence (2%) in 2015 and 3% disease incidence 2016 compared with control treatment 65% in 2015 and 70% disease incidence in 2016. Application of fungicides also significantly increased no.of grains/panicle, 1000grain weight and yield of rice crop.

Keywords: Rice, Rice blast, Fungicides, Grains

INDUCTION OF DISEASE RESILIENCE IN TOMATO AGAINST EARLY BLIGHT (EB) CAUSED BY *ALTERNARIA SOLANI* IN TOMATO

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Early blight (EB) caused by *Alternaria solani* (*A. solani*) pose a serious challenge for sustainable tomato production in tropics and subtropics with comparatively high temperature accompanied by humid conditions. During the study, EB incidence was found vary from 22 to 44% in tomato fields. Koch's postulates were performed tomato cultivar Reograndi and line-95017. Line-95017 gave more susceptible reaction, therefore, further used in resistance induction experiment. Line-95017 was exogenously sprayed with methyl jasmonate (MeJA), salicylic Acid (SA), chitosan (CH) and sodium nitroprusside (SNP) as donor of nitric oxide (NO). Capsules containing calcium carbide (CaC_2) as donor of ethylene (ET) were placed 6cm deep into pot. Plants sprayed with distil water spray were used as a mock treatment. Treated plants were challenged with *A. solani* spores present in distil water through hand sprayer after 2 days post inoculation (dpi) with inducers. Plants without any prior exposure of resistance inducer were also used challenged and marked as positive control. It was observed that symptoms of EB appeared 5 days earlier on positive control compared to plants treated with inducers. Severity data taken 10 dpi showed that MeJA (14.15%) treated plants showed least susceptibility compared to positive control (44.98%). However, increased resistance is non-significant when compared to CaC_2 (16.58%) and CH (18.21%) treated plants. SNP (23.80 %) treatment also enhanced resistance in tomato plants against EB. Though, SA (30.13%) treated plants showed improved resistance compared to positive control but still unable to make plants moderately resistant. Our findings re-affirmed though inducers improve resistance significantly but effectiveness directly related to pathogen's mode of nutrition. *A. solani* is necrotroph therefore MeJA and ET donor gave best results while SA treatment showed least improvement in resistance. However, effectiveness of CH and SNP against EB can be interrupted that inducers not only enhanced induced systemic resistance (ISR) but also pathogen associated trigger immunity (PTI) and basal resistance. Therefore, resistance inducers must be incorporated in integrated disease management vegetable program but only effective complemented by the life style of pathogen involved.

Keywords: *Alternaia solani*, Tomato, Inducers, Methyl jasmonate, Calcium carbide

FIELD BASED IDENTIFICATION OF WILT RESISTANT GENOTYPES UNDER NATURAL CONDITIONS USING ARTIFICIAL INOCULUM

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Chickpea (*Cicer arietinum*) is an important pulse crop of Pakistan. It is ranked as top pulse crop regarding area and total production. It is mainly grown in the south Punjab region commonly known as Thal region. Thal region is desert area suitable for chickpea having very low water needs and mainly depends on rainfall. Many diseases like wilt, stem rot, botrytis gray mold and Ascochyta blight are frequently reported from the fields. Fusarium wilt is considered as the major disease in the area as it assault crop at two of the important growth phases at seedling and pod formation stage. The disease is caused by *Fusarium oxysporum* f. sp. *ciceris*. Since Fusarium is a soil borne fungi and complete eradication of the pathogen is not possible with traditional chemical control having environmental concerns as well. The more safe and environment friendly approach would be use of cultivars having enough resistance to such adverse biotic environmental stresses. In the current work, germplasm consisting of 40 diverse genotypes were sown in the field conditions. The wilt pathogen was isolated and purified with standard protocols. The standardized inoculum was applied on the germplasm for screening of resistant sources. Based on disease incidence, severity and other agronomic traits were recorded after application of quantified inoculum. The result concluded that, the cultivar Noor-2019 was found the most resistant genotype against wilt disease. This approach was helpful to screen out resistant sources in the germplasm. Moreover, the resistant genotypes identified in this research could be used in the wilt resistant breeding program.

Keywords: *Fusarium oxysporum,* chickpea, Gray mold, Noor-2019

INTEGRATED MANAGEMENT OF THE WHEAT STRIPE RUST DISEASE USING COMMERCIALLY AVAILABLE FUNGICIDES IN PAKISTAN

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In Pakistan, the use of foliar fungicides against wheat stripe rust disease has become an important component of integrated management however the information on the effects of these sprays on the control and yield response is unavailable. In this research, we have provided the impact and role of commercially available fungicides for the integrated management of the wheat stripe rust disease. The main objectives of this research were to check (i) the efficacy of commercially available fungicide active ingredients, optimal fungicide timing, and the number of applications in controlling the wheat stripe rust disease, and (ii) the effect of these fungicides on wheat grain yield response. Out of six commercially available fungicide formulations for their efficacy in controlling the wheat stripe rust disease under controlled and uncontrolled conditions, three sprays of Propiconazole (250 EC) @ 200 ml/acre was found most effective in controlling the disease incidence 88.7% as compared to the other fungicides. This treatment also recorded a maximum grain yield of 60.9 mounds/acre with an increase of 36.4% over the control.

Keywords: Stripe rust of wheat, Integrated management, Foliar fungicides.

BIOMANAGEMENT OF PYTHIUM ROOT ROT DISEASE IN TOMATO MILL USING *Epicoccum purpurascens*

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Epicoccum purpurascens isolated from infected tomato field of Swat region, Khyber Pakhtunkhwa has been investigated for its pathogenicity potential against *Pythium* spp. in *in vitro* and Screen house conditions. Five isolates of fungus were isolated from 15 locations. Culture filtrates of all these isolates were evaluated for growth inhibition of *Pythium* spp. Six dilution (0, 40, 60, 80 and 100 %) were tested. Maximum growth inhibition was recorded in EP-1 with 57.76% and minimum by EP-3 with 55.66%. Effect of temperature on growth of *Epicoccum purpurascens* showed that maximum growth for all isolates were observe at 37˚C with OD_{600} range 0.23 to 0.28. whereas optimum was pH 6.5 recorded with OD_{600} range 0.21 to 0.27. Histopathological examination on the interaction of the *Epicoccum purpurascens* and *Pythium* spp., showed visible cellular alteration among treatments. Both *Epicoccum purpurascens and Pythium* spp., established their selves on the surface on root system at initial phase and later they showed endophytic growth. Treatment with *Pythium* spp., and *Epicoccum purpurascens* showed that both fungus spread over outer surface of root. A few pathogenic hyphae succeeded to penetrate and enter into the epidermis region and established itself in the epidermis and cortex of the root with little damaging the cells. A little cellular alteration in cortex and vascular tissues when compared with treatment with only *Pythium* spp. No histological alterations were observed in heathy plants and plants treated with *Epicoccum purpurascens* alone. The isolate EP-1 of *Epicoccum purpurascens* was selected for screen hose trail for determine biocontrol potential against *Pythium* spp. Result indicated *E. purpurascens* significantly improved over all agronomic features and yield component of tomato crops in screen house.

Keywords: *Epicoccum purpurascens,* Histopathological, *Pythium,* Root rot

COMPARATIVE TOXICITY OF INSECTICIDES AGAINST *Chrysoperla carnea* (STEPHENS) UNDER LAB CONDITIONS

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The commonly used new chemistry and conventional insecticides, *viz.*, Tracer (spinosad, 240 SC), Match (lufenuron, 5 EC), Belt (flubendiamide, 480 SC), Coragen (chlorantraniliprole, 20 SC), Proclaim (emamectin benzoate, 1.9 EC), Lorsban (chlorpyrifos, 40 EC) and Decis (deltamethrin, 2.5 EC) @198, 494, 100, 75, 494, 2470 and 618 ml/ ha, respectively were tested against *C. carnea* larvae of 1st2nd and 3rd instar. The results showed emamectin benzoate found comparatively less toxic followed by lufenuron and flubendimide against chrysoperla, while chlorpyriphos and deltamethrin proved highly toxic against all three instars of chrysoperla larvae.

Keywords: Toxicity, Chrysoperla, Insecticides

DIFFERENTIAL INSECTICIDE RESISTANCE IN *Bemisia tabaci* (HEMIPTERA: ALEYRODIDAE) FIELD POPULATIONS IN THE PUNJAB PROVINCE OF PAKISTAN

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The cotton whitefly *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) has a propensity for developing high-level resistance to insecticides. Management of *B. tabaci* in cotton grown in Pakistan depends on insecticide use, resistance monitoring has become essential to minimize the development of resistance. In this study, resistance was monitored in adult whiteflies collected from cotton fields in the Bahawalpur, Faisalabad, Lodhran, Multan, and Vehari districts in the Punjab Province, Pakistan during 2017, 2018, and 2019. Resistance monitoring was carried out for two insect growth regulators, Pyriproxyfen and Buprofezin, four neonicotinoids consisting of Acetamiprid, Imidacloprid, Thiamethoxam, Thiacloprid, and the historically used pyrethroid, Bifenthrin and organophosphate, Chlorpyrifos. Based on resistance ratio (RR) measurements, populations in all four districts showed moderate-to-high resistance to all insecticides tested, compared to a laboratory-susceptible strain. Also, in all four districts, whiteflies exhibited very low to low resistance to Pyriproxyfen and Buprofezin, and moderate to high resistance to the neonicotinoids. The RRs for Acetamiprid, Imidacloprid, Thiamethoxam, Thiacloprid varied from 7.60 to 50.99, 19.32 to 65.72, 17.18 to 54.65 and 6.49 to 47.49-fold, respectively. Bifenthrin and Chlorpyrifos showed very low efficacy in whiteflies in all districts except Faisalabad, with RRs of 12.28 to 50.56-fold and 7.94 to 26.24-fold, respectively. In several districts, whitefly resistance levels were variable from year-to-year, overall, and ranged from 12.74 to 7.94-fold. The results will facilitate 'smart' selection and guide rates of insecticide applications for whitefly management in cotton for effective whitefly management while also delaying the development of resistance.

Keywords: Insecticide resistance, Insect growth regulators, Neonicotinoids, Whitefly

IMPACT OF TEMPERATURE REGIME ON THE EFFICACY OF CRY TOXIN AGAINST *HELICOVERPA ARMIGERA*

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Temperature influenced the developmental process of the immature stages when fed on Bt cotton and the toxin expression also increased with respect to temperature. A laboratory diet incorporation bioassay was performed to record the activation / de-toxification of Cry1Ac at different temperature regime (25-45˚C) at environment growth chamber. The results indicated that neonates are very sensitive to 04, 01 and 0.25 ug/gm concentrations. The alive population was recorded at 25˚C followed by 45, 30, 35 and 40˚C, in 0.063, 0.016 and 0.004 ug/gm. The pupation (%), adult emergence (%), pupal weight (mg), larval and pupal duration (days) was recorded maximum at 25˚C followed by 45, 30, 35 and 40 ˚C. Relative Enhanced Toxicity Factor (RETF) was increased gradually and consistently from 25˚C to 40˚C but decreased substantially at 45˚C. These finding could be very useful in planning control program against this voracious pest.

Keywords: Cotton, Relative enhanced toxicity factor, Temperature,

ROLE OF PHEROMONES IN *BACTROCERA CUCURBITAE* FOR THE DEVELOPMENT OF TRAPPING DEVICES

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The Melon fruit fly, *Bactrocera cucurbitae* is one of the most significant insect pests of horticultural vegetables in tropical and sub-tropical regions. *B. cucurbitae* has been described to result in a significant loss in the overall economy by infestation to mainly cucurbit crops, resulting in a minimum of 41% losses recorded in the preferred host plant, bitter gourd. Chemical application is only the effective management strategy against fruit flies resulting in the environmental hazards, maximum residual level (MRL) of pesticides in fruits & vegetables, and resistance development. This study investigated the role of pheromones in *B. cucurbitae* by employing a Y-tube olfactometer to develop eco-friendly strategies for the management of fruit flies. The attraction of sexually mature flies to different concentrations of different pheromones was examined. As per results, females of *B. cucurbitae* were significantly attracted to pheromones at low concentrations, while males were significantly attracted to higher concentrations of pheromones. There was a significant difference in the attraction of females and males of *B. cucurbitae* on N µl concentrations of key pheromone components; Zingerone, Raspberry ketone, Ethyl 4-hydroxy benzoate, Methyl eugenol. Current work brings attention to the development of environment-friendly strategies for the management of fruit flies.

Keywords: Melon fruit fly, *Bactrocera cucurbitae,* Chemical application

EVALUATION OF ENDOPHYTIC AND PATHOGENIC POTENTIAL OF SOME ENTOMOPATHOGENIC FUNGI FORMULATIONS AGAINST TOMATO LEAF MINER

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The tomato leaf miner, *Tuta absoluta* (Lepidoptera: Gelechiidae) is the most devastating pest of field and greenhouse grown tomatoes as its larvae and adults both make injuries to the leaves and disrupt the photosynthesis process around the world. A study was conducted to evaluate the endophytic and pathogenic potential of three entomopathogenic fungi i.e. *Beauveria bassiana, verticillium lecanii and Metarrhizium anisoplae* with five concentrations (1×10^2, 1×10^4, 1×10^6, 1×10^8 and 1×10^{10}) of each along with control treatment to suppress the population of *Tuta absoluta*. Three different application methods of entomopathogenic fungi Leaf dip bioassay, potted plant or root dip method and foliar spray method were adopted for the pathogenicity assessment under laboratory conditions. The highest concentration 1×10^{10} of *verticillium lecanii, Beauveria bassiana and Metarrhizium anisoplae* showed maximum mortality in all application methods after 5, 10 and 15days interval of application. Mortality was found increasing with time interval of application. In leaf dip bioassay *Metarrhizium anisoplae* showed maximum mortality 59.25% followed by *verticillium lecanii* 58.14% and then *Beauveria bassiana* 51.84% after 10days application interval. In root dip method *Beauveria bassiana* was found most effective 61.57% after 15days application interval. Verticillium lecanii showed highest mortality 76.38% in foliar application method after 15days interval while *Beauveria bassiana* lowest. Results indicated that entomopathogenic fungi can be successful management approach for the suppression of tuta absoluta population and further can be used in field conditions.

Keywords: Entomopathogenic fungi, Endophytic fungi, *Tuta absoluta*, Tomato crop.

BIO-EFFICACY OF SOME MICROBIAL INSECTICIDES AGAINST RED PUMPKIN BEETLE, *AULACOPHORA FOVEICOLLIS LUCAS* (COLEOPTERA: CHRYSOMELIDAE) IN LAGENARIA SICERARIA

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The red pumpkin beetle, *Aulacophora foveicollis* (Coleoptera: Chrysomelidae**)** is cautiously more vital leaf-feeder insect that is blamable for direct damages to leaves at vegetative stages and indirect losses on yield of vegetable crops. A study was conducted to evaluate the bio-efficacy of microbial insecticides (one Bt and three fungus based microbial insecticides) in bottle gourd under laboratory and filed conditions. Five concentrations @ 200, 400, 800, 1600 and 3200 ppm of each of microbial insecticide formulations was applied along with control treatment. Pre and post treatment data was recorded after 24, 48, 72 and 168 hours. Population and damaged leaves/plant were observed in field conditions and percent reduction/infestation was counted. In laboratory experiment, the *A. foveicollis* individuals exposed to different treatments was observed daily till their death. The dead individual was placed on fungal (in case of fungal treatments) or bacterial (in case of bacterial treatments) growth media to confirm the causes of their death. The results showed that among all microbial insecticides *V. lecanii* showed maximum mortality of red pumpkin beetle followed by *B. bassiana*, *M. anisoplae* and *B. thuringiensis* under lab conditions. Among all microbial insecticides *V. lecanii* showed maximum mortality of red pumpkin beetle followed by *B. bassiana*, *M. anisoplae* and *B. thuringiensis* under field conditions. Results showed that there was maximum mortality at higher concentrations (3200ppm) and minimum at lower concentration (200ppm). So the application of microbial insecticides can also be recommended to manage the insect pests of bottle gourd.

Keywords: Microbial insecticides, *B. thuringiensis*, *B. bassiana*, *M. anisoplae*, *V. lecanii*, Red pumpkin beetle.

INTEGRATED BIOLOGICAL MANAGEMENT OF ROOT ROT DISEASE CAUED BY SOIL BORNE FUNGAL PATHOGENS ON WHEAT VARIETES OF USA AND AZAD KASHMIR

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The current research work explored the two soil borne pathogens *Fusarium graminearum* and *Rhizoctonia solani* caused root rot disease against wheat crop varieties cultivated in Nebraska state of USA and Azad Kashmir (AK). These two pathogens originated from soil of USA and AK indicated a significant loss of wheat crop. Integrated biological management (IBM) of the root rot disease causing pathogens through beneficial microbes, fungicides and commercial products were conducted during controlled conditions under greenhouse conditions. Firstly, the disease incidence (DI) was calculated against two fungal pathogens as preliminary assessment. It was observed that Rhizoctonia was more virulent to cause root rot disease on wheat crop and reduced yield and biomass significantly. It was measured that the IBM method reduced severity of root rot and enhanced growth and yield Wheat varieties after treatments. The maximum rating was observed against *R. solani* in variety Seher-06 while lowest shown by variety Galaxy-13. On the other hand, maximum rating was observed in Seher-06 while minimum in Punjab-11 against *F. graminearum*. It was observed that growth characters were also improved after the IBM treatments. Comparatively, it was estimated that *F. graminearum* was more vulnerable as comparison to *R. solani*. The biological control activity of *Trichoderma viride* and *Bacillus subtilis* secreted enzymes. Hence, secondary metabolites induced systemic disease resistance against *Fusarium graminearum* and *Rhizoctonia solani*. Therefore, it is concluded that IBM applications are very effective for the eradication of root rot fungal pathogens of wheat crop.

Keywords: Integrated biological management, Root rot, Wheat crop, *Fusarium graminearum*, *Rhizoctonia solani*

ANTIFUNGAL ACTIVITY OF MEDICINAL AND AROMATIC PLANT EXTRACTS AGAINST *RHIZOCTONIA SOLANI* CAUSING ROOT ROT DISEASE OF CHILLI

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Chilli (*Capsicum annum* L.) is cultivated throughout the world as spice crop. Pakistan is the fifth largest producer of chilli crop throughout the world. Chilli is mostly cultivated in the province of Sindh and Punjab. It is attacked by several biotic disorders and abiotic stresses. The significance of this study was to control the *Rhizoctonia solani* by medicinal and aromatic plant extracts. Three medicinal and aromatic plant extracts of *Azadirichta indica*, *Ferula oopoda* and *Cuminum cyminum* including their crude and oil extracts were tested against pathogen (*Rhizoctonia solani*) and they exhibited the anti-fungal properties against *R. solani* and also reduce the mycelial growth of fungus as compared to control (un-inoculated soil). Among the tested three medicinal and aromatic plants the oil extract of *A. indica* reduced the fungal mycelium by 86 % having mycelium growth of (1.22mm) at 1.0 % concentration. The crude extract of *A. indica* reduce the fungal mycelium growth by 70 % having mycelial growth of (2.59mm) at 1.0 % dose. Whereas the fungal mycelium growth was (3.65mm) and mycelial colony was retarded 58 % at 0.1 % dose and (3.14mm) hyphal growth was observed at 0.5 % dose with reduction of colonial growth by 63 % correspondingly. The total mycelial growth of *R. solani* was (2.15mm) recorded at the dose of 1.0 % and reduced the mycelial growth by 75 %, treated with *Cuminum cyminum* (zeera) oil extract. The 0.1 % & 0.5 % concentrations were also effective and reduced the mycelial growth by 4.55mm (52 %) and 5.55mm (62 %) respectively. The maximum mycelial growth of *R. solani* was (3.14mm) recorded at 1.0% crude extract of *C. cyminum* and reduced the mycelial growth by 63%. The 0.1 & 0.5 % doses were also effective and reduced the mycelial growth by 39 % (5.25mm) and 48 % (4.45mm) respectively. Ferula oopoda (Hing) oil extract reduced the fungal mycelium by 62% (3.28mm) at 1.0 % dose. The crude extract of Ferula oopoda (Hing) reduce the fungal mycelial growth by 53% (4.85mm) at 1.0 % dose. On the other hand, fungicide comparison test was also done with standard fungicide (Antracol) where mycelial growth was 0.64 mm and reduction percentage was 92% of the target pathogen. It is stated that the oil extracts were more effective against the targeted pathogen *R. solani* as compared with crude extracts of *Azadirichta indica*, *Ferula oopoda* and *Cuminum cyminum*.

Keywords: *Azadirichta indica, Ferula oopoda*, *Cuminum cyminum*

EFFICACY OF DIFFERENT MEDICINAL PLANT EXTRACTS AND FUNGICIDES AGAINST RHIZOCTONIA SOLANI CAUSING DAMPPING OFF TOMATO

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Tomato (*Lycopersicum esculentum*. L) Crop is main vegetable in the world, which is infected by several biotic diseases and abiotic stresses. Among them damping off is dangerous disease caused by *Rhizoctonia solani*. The objective of this research experiment was to control *Rhizoctonia solani* by application different plant extracts. Three distinct medicinal plant extracts of *Cuminum cyminum* (Zeera), *Ferula oopoda* (Hing) and *Azadirachta indica* (Neem) and fungicide are used against *Rhizoctonia solani*, Also decreased the mycelium growth of *Rhizoctonia solani* as contrasted with control. However, among the three medicinal plant. The *Cuminum cyminum* (Zeera) reduce the fungal mycelium growth by 86 %, fungal mycelium growth reduced by 77 % treat with *Azadirachta indica* (Neem) and *Ferula oopoda* (Hing) decreased the fungal mycelium growth by 59 %. The fungicide showed that high efficacy to control the *Rhizoctonia solani* and reduce the mycelium growth by 95% and the extract of *Cuminum cyminum* (Zeera) is more effective against *Rhizoctonia solani* as compared to extract of *Azadirachta indica* (Neem) and *Ferula oopodo* (Hing). The crude extract of *Cuminum cyminum* (Zeera) have ability to inhibit *Rhizoctonia solani*. It is recommended to control of *Rhizoctonia solani* causing damping off tomato seedling for future aspects with no dithering, since it is cheapest, an eco-friendly and without side effects in environment. Additional exposed to be affordable route for disease management.

Keywords: Tomato (*Lycopersicum esculentum*) crop, Mycelium growth, *Rhizoctonia solani*, Medicinal plant extracts

MEDICINAL POTENTIAL OF CORROLA OF *BUTEA MONOSPERMA* AND *CALOTROPIS PROCERA* EXTRACTS AGAINST DOMINANT FUNGAL DISEASES OF WHEAT CROP IN DISTRICT BHIMBER AJK

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The present study was documented the dominant fungal diseases of wheat crop and their biological management was conducted by use of petals extract of two medicinal plants '*Butea monosperma* and *Calotropis procera*' grown in District Bhimber, Azad Kashmir. Fungal infected parts of wheat crop were collected from different regions of District Bhimber, Azad Kashmir and nine fungal species were examined under field and lab conditions. The most dominant fungal species were recognized as *Fusarium graminearum. Alternaria triticina, Blumeria graminis, Ustilago trtici* and *Bipolaris sorokhiniana*. Highest infection rate (57.14 %) was observed against *F. graminearum* while minimum infection rate (20.8 %) was observed against *B. graminis* pathogen. The highest severity rate was recorded 80% while the minimum severity rate was recorded as 40%. The antifungal action of two plant's petals crude extracts have been applied against the dominant identified fungal pathogens during lab experimental trials as well as field experimental trials. It was indicated that the treated wheat plants produced better yield than non-treated plants. The highest zone of inhibition (33.6 mm) was observed in methanolic extract of *Butea monosperma* petals against fungi *A. triticina.* Similarly, the maximum zone of inhibition (36.67 mm) was observed in methanolic extract of *Calotropis procera* against fungi *F. graminearum*. It was observed that the *Calotropis procera* showed better management of fungal diseases than *Butea monosperma.* So, it was concluded that the *C. procera* petals are more efficient because they have rich chemical compositions. Therefore, these are very effective against selected fungal pathogens. We can isolate organic compounds from petals of these two plants for future study.

Keywords: *Butea monosperma*, *Calotropis procera*, Infection rate, Severity, Wheat Pathogens

SCREENING ANTIBIOTIC SENSITIVITY OF PATHOGENIC BACTERIA DURING COMPOSTING OF AGRICULTURAL WASTES FOR PROMOTING RESOURCE CONSERVATION

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The sizable contribution of agriculture production in climate change repercussions emerges in the form of 19–29% of total greenhouse gas (GHG) emissions arising from agricultural wastes, which could be composted to promote nutrient recycling and reduce GHGs emissions. Pakistan generates around 82.12 MT/yr of crop residue and over 365 MT/yr of animal manure with its management leading to emission of GHGs. Recycling agricultural wastes through composting necessarily requires screening of feedstock borne pathogens for its subsequent inactivation. The current study was aimed at screening feedstock borne pathogens from rice husk, wheat bran, rice bran, molasses, plant leaves, grass clippings, mustard oil cake, cow dung, and cow urine with their 12, 14, 18, 10, 6, 11, 15, 9, 4 % contribution respectively in the composting pile. The isolation of *E. coli*, *Aeromonas* spp. and *Staphylococcus* spp. from samples collected at 30 cm depth of compost pile at its prevailing pH, temperature, and electrical conductivity (ECe) was done through dilution, membrane filtration and culturing on MacConkey, Aeromonas and Mannitol agar media before screening their antibiotic susceptibility profile using disc diffusion method against different recommended antibiotics and interpretive chart of Performance Standards for Antimicrobial Disk Susceptibility Tests, Dec. 1993 (Hi-Media). After 40 days of composting, screening from compost at pH = 8.10, ECe = 5.01 $mScm^{-1}$ and 28°C showed presence of *E. coli*, *Staphylococcus* spp. and *Aeromonas* spp. with their antibiotic resistance being 50 % (against Amoxicillin, Ampicillin and Ceftriaxone), 37.5% (against Ceftazidime 30 Erythromycin 30 and Ampicillin), and 40 % (agains Macrolides and Penicillins) respectively. It was further witnessed that with compost maturation, most of the gram-negative disappeared; however, *Aeromonas* spp. stayed persistent and resistant to antibiotics. This could possibly be attributed to the antibiotic resistant biota arising from animal feed and poor microbial thermogenic prevalence throughout composting duration. Although presence of multiple strains of bacteria indicated enrichment of microbial community in the mature compost, the persistence of pathogenic spp. in the mature compost of poor quality; however, could raise emerging concerns for human and plant disease.

ENHANCING NET SOIL ORGANIC CARBON RECYCLING THROUGH NON-PESTICIDAL MANAGEMENT OF AGGRESSIVELY INVASIVE WEED BIOMASS AS REGENERATIVE AGRICULTURE PRACTICE

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Beside competing directly with the cultivated agricultural crops in the arable lands for all types of basic plant growth requirements, the aggressively invasive weeds pose severe challenges for their effective management due to their high biomass yield with large viable seed bank. For example, *Parthenium hysterophorus* is one of the world's most reported aggressively invasive weeds called "Famine weed" due to its indictment of huge losses to the biodiversity, agriculture, economy, and health of livestock and human beings. To manage this problem, synthetic weedicides chemicals are applied which leave multiple unhealthy impacts on the environment as it accumulates in soil and underground water resources. The current study was aimed at using no-chemical weed control approach *P. hysterophorus* with least environmental footprints through mechanical and cultural practice like ploughing and manual weeding at its critical stages. For recording the weed occurrence and percentage cover of the *P. hysterophorus,* customized quadrate sample frame (m^2) was used that was placed randomly at 15 spots in the experimental site of about 1 acre. Ecological indicators such as occurrence, frequency, density etc. was recorded prior and throughout the cultivation period of the wheat crop. Good field preparation and manual weeding at the rosette stage prior to its flowering showed more than 80% reduction in the frequency and density of weed occurrence. March to April is the most critical time to control this noxious weed as it was observed in its full bloom in the wheat crop. Our study suggests that ploughing the field 2 to 3 times after thorough irrigation and letting the seeds to germinate for about 2 weeks after each ploughing and rooting out the *P. hysterophorus* prior to its flowering stage of crop cultivation period gives successful weed management results. It also renders enhancement of net soil organic carbon over time due to humification of the weed biomass.

Keywords: weed seed bank; famine weed; critical stage of weed germination; regenerative agriculture.

ROLE OF PAKISTANI STUDENTS GRADUATED FROM CHINESE INSTITUTES IN THE TRANSFER OF TECHNOLOGY UNDER BRI WITH RESPECT TO EMERGING ENTOMOLOGICAL CHALLENGES AND THEIR GREEN CONTROL IN AGRICULTURE

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Since the foundation of Belt and Road Initiative (BRI), being witness to this global program towards sustainable developmental goals (SDGs) of no poverty, zero hunger, good health, quality education, decent work, climate action, peace, justice and strong institutions, and partnership for these goals, China Pakistan Economic Corridor (CPEC) is playing a vital role to focus the poverty alleviation, educational upgradation, transfer of technology and business progress in addition to fighting against locust plague and COVID19 in Pakistan that really enables me to reproduce the overview of current challenges in entomology and their green control under the umbrella of BRI in Pakistan. Moreover, how the Pakistani students graduated from Chinese institutes could play their vital role (i) to act as a bridge between Chinese and Pakistani peers (students, researchers and teachers) for transfer of technology and exchange of faculty and students; (ii) future collaborative opportunities with Chinese organizations; and (iii) to fight against the invasion of insect pests through modern monitoring techniques in Pakistan. The current situation of Fall Armyworm in Pakistan is major threat to food security. For this, transfer of green control and sustainable approaches between BRI countries may play a vital role to combat the emerging issues by following and contacting their Chinese peers at respective organizations under the umbrella of China Pakistan Economic Corridor (CPEC) that is flagship project of Belt and Road Initiative. Overall, this work will highlight the importance of CPEC in terms of scientific research and academic exchange programs not only for the students of university but also for the newly appointed faculty.

Keywords: BRI, CPEC, Students, Exchange program, Mutual benefits, Working environment spirit

MONITORING OF RICE INSECT PESTS BY USING PHEROMONE TRAPS IN ORGANIC RICE

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The delta traps for adult white stem borer, yellow stem borer, pink stem borer and leaffolder were used to monitor their population under organic rice field conditions during the year 2018-2021. The data was collected by counting the trapped insects on weekly basis. Results of maximum number of insect pests indicated that during 2018, white stem borers (37.67) and leaffolder (104.33) were recorded during the month of September, while yellow stem borers (7.33) and pink stem borer (12.00) were recorded during the month of October. During 2019-2021, maximum number of white stem borer (46.33, 31.33 and 17.67), yellow stem borer (2.67, 1.33 and 11.67) and leaffolder (151.33, 54.67 and 21.00) was recorded during the month of October, while no population of pink stem borer was recorded during the entire rice season, respectively. The study will be helpful to monitor the occurrence of rice stem borers and leaffolder for their temporal mapping and proper control.

APPLICATION OF UNMANNED AERIAL VEHICLES TO CONTROL CROP DISEASES AND INSECTS PESTS

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Unmanned aerial vehicles (UAVs) are a recently developed aerial spraying technology. Site-specific agriculture practices consider the right input at the right time, place, and rate. The little attention has been paid on this advance technology in Pakistan. The ability to use UAV in precision farming, crop health analysis, monitoring pests, and other agricultural uses has been deemed a game-changer. Thus, the usage of the unmanned aerial vehicle (UAV) is an alternative to manage a farm properly to increase its yield, reduce pesticide dosage, and increase its efficiency. we used a comprehensive review from our team's research in China. We study the effect of different spray parameters using UAVs on wheat, rice, cotton, sugarcane, citrus, potato, peanuts, vegetables in different provinces of China. As a result, we found that the UAV had comparable performance and efficiency control to the other sprayer at a higher spray volume. Furthermore, extensive field experiment results showed that treatments similar to those routinely conducted in the field by local farmer's sprayers led to run-off and lower deposition, which reduces the control efficacy on pests and diseases. Compared with the traditional sprayer, the spray volume of the UAV sprayer was an order of magnitude lower. The efficacy of the UAV depends on the spray volume using different nozzles. The use of UAV is an environmentally sustainable approach by using a combination of practices and control methods to manage pests with high efficiency. The research results could provide the theoretical basis and technical support for UAV operations in China as well as in Pakistan for better pest management, data quality and precise analysis.

Keywords: Unmanned aerial vehicles, Plant Protection; Insect Pest; Pesticides Deposition, Control efficiency

BIOMAGIC™ BIOFUNGICIDE, WET-ABLE POWDER FORMULATION CONTROLLING FOLIAR AND SOIL BORNE FUNGAL PLANT PATHOGENS

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Emerging plant pathogenic fungal pathogens infecting cereal crops are posing serious threat to food security worldwide. Use of chemical pesticides has not only adversely affected nature but also triggered resistance in pathogens. Biomagic™ is a systemic biofungicide from a microbial source to cope with wide range of fungal phytopathogens. It has been designed for prevention and control of wide range of high-impact fungal diseases. This wetable powder (WP) formulation contains native strain *Bacillus velezensis* (BS2) isolated from canola rhizospheric soil sample. Its affectivity is tested against various plant pathogens fungi in vitro using dual culture method. While, field trials on chili crop confirmed its in vivo biocontrol efficiency equally. Hydrolytic enzymes, siderophores, antibiotics including pyocyanin, biosurfactants and volatile organic compounds are included in action mechanism of BS2. Active metabolites have been identified as being produced by BS2, including fungicidal peptides. In the bioformulation the shelf life/viability of BS2 was well sustained for two years at room temperature and CFU count was dropped from $8x10^8$ to $4x10^8$. In field experiments, Biomagic™ reduced disease incidence up to 35.28% over *Fusarium oxysporum* inoculated plot and 38.88% over *Macrophomina phaseolina* treated plots of chillies. Similarly it reduced disease mortality up to 28.60% over *Fusarium oxysporum* inoculated plot and 26.13% over *Macrophomina phaseolina* treated plots.

Biomagic™ is different from other *Bacillus* based biofungicide products on the market in terms of its metabolite production, effectiveness in field and shelf life stability; hence it offers an effective alternative to chemicals for control of fungal plant diseases in agriculture.

Keywords: Biocontrol, phytpathogens, biofungicide

IMPACT OF ANTAGONIST RHIZOBACTERIA ON THE GROWTH AND PHYSIOLOGY OF EGGPLANT AND THEIR NEMATICIDAL POTENTIAL AGAINST ROOT KNOT NEMATODE (*M. incognita*)

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In Pakistan, the low yield of eggplant is ascribed to legions of biotic constraints. Among biotic restraints, root-knot nematodes, *Meloidogyne* spp. are economically very important and cause losses to the tune of $ 125 billion per year throughout the world. Therefore, this study was planned to investigate the impact of Plant Growth Promoting Rhizobacteria on the growth and physiology of eggplant and also check the nematicidal potential of PGPRs against root knot nematode *M. incognita*. Three-week-old seedlings of eggplant (Dilnasheen) were transplanted singly in each 30-cm-dia. earthen pots filled with 3 kg sterilized soil. One week after transplantation, 30 ml of each PGPR (*Bacillus subtilis*, *Pseudomonas flourescens*, *Azotobacter chroococcum*, *Azospirillum* sp., and *Rhizobium leguminosarum*) having 10^7 cfu/ml was applied to each pot. Plants without PGPRs were kept as control. The effect of cell free cultural filtrates of PGPRs was assessed on inhibition of eggs hatching and juvenile mortality of *M. incognita*. Two ml of toxins of each PGPR was poured into each 5-cm-dia. petri plate and 100 microliters of egg suspension containing approximately 100 eggs and juveniles were put in each petri plate. Petri dishes having distilled water were kept as control. The effect of PGPRs was also significant on growth and physiological parameters of eggplant. All the PGPRs significantly increased root and shoot lengths and weights and increased IAA, evaporation, stomatal conductance, photosynthesis rate, internal CO_2, respiration, transpiration and chlorophyll content. *B. subtilis* was found the most effective PGPR as compared to others. All the PGPRs caused juvenile mortality and inhibition in egg hatching with varying degrees. The maximum percentage egg hatching was inhibited (99.00, 89.76, 83.42, 80.80, and 78.31) by *B. subtilis* while *R. leguminosarum* showed the minimum percent egg inhibition (83.62, 73.24, 69.40, 71.09, and 64.23) while all other treatments revealed intermediary results after 24, 48, 72, 96 and 120 hours respectively. In the case of juvenile mortality after 120 hours, the maximum J2s mortality over control was observed in *Bs* (94.5) while *Rhiz* showed the minimum J2s mortality (75.5) while the rest of the treatments showed intermediary results.

Keywords: PGPR, RKN, Eggplant, IAA, Physiological parameters, Juvenile, Enzyme

EVALUATION OF ESSENTIAL OILS FOR THE MANAGEMENT OF *ALTERNARIA ALTERNATA* CAUSING FRUIT ROT IN *ERIOBOTRYA JAPONICA*

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Loquat (*Eriobotrya japonica* Lindl.) is an economically important subtropical evergreen fruit tree and commercially cultivated in more than 30 countries worldwide. Up to 40% losses of fruits are estimated in postharvest conditions including fungal decays. Postharvest losses, especially fungal infections pose a critical challenge causing fruit decay, affecting fruit quality and shelf life. Fruit decay caused by *Alternaria alternata* is one of the major postharvest diseases deteriorating the quality of various fruits and vegetables during handling, transportation, and distribution. However, the use of morpho-molecular identification approaches of a fungal pathogen provides accurate diagnose and effective management. In the study, 10 isolates were recovered from symptomatic loquat fruits from the main fruit markets of Rawalpindi, Punjab province. Based on morphological data isolates were identified as *Alternaria alternata* which was further confirmed using a DNA amplification tool. Meanwhile, a pathogenicity test was performed, and isolates were screened. Mycelial growth inhibition (%) in *invitro* treatment of eight selected essential oils viz. Lemon Grass (*Cymbopogon citratus*), Lemon (*Citrus* x *limon*), Thyme (*Thymus vulgaris*), Eucalyptus (*Eucalyptus globulus*), Pomegranate peel (*Punica granatum*), Moringa (*Moringa oliefera*), Ginger (*Zingiber Officinale*), and Teatree (*Melaleuca alternifolia*) at concentrations of 0.2, 0.4 and 0.6 mg/mL was checked against *Alternaria alternata* and results showed MGI% of all essential oils at different levels whereas thyme oil evident the most effective antifungal ability. Fungitoxicity assay of thyme depicted fungicidal and fungistatic at different concentration levels. Direct application of the most significant concentration of thyme oil was found effective against *Alternaria alternata* with a varying decrease in decaying percentage. Investigation of this study proved thyme oil as a potential and eco-friendly botanical fungicide effectively used against *A. alternata* on loquat fruit. The current study explored that thyme oil could be potentially used against *A. alternata* and its compounds could be further investigated for the development of eco-friendly approaches for the control of postharvest fruit rots.

Keywords: Fruit decay, Essential oils, Postharvest disease, Management, Fungitoxicity

FUNGI ASSOCIATED WITH SPOILAGE OF POMEGRANATE AND THEIR MANAGEMENT BY BIO CONTROL AGENTS

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Different fruits (*Punica granatum*) rot fungi were isolated from rotted fruits.These were *Botrytis cinerea, Alternaria alternata, Aspergillus niger, Penicillium digitatum.*During pathogenicity test two fungi *Aspergillus niger* and *Penicillium digitatum* were proved to be most pathogenic.The *Aspergillus niger* fungi during dual culture with *Bacillus substilis, Bacillus substilis srtain2, Pseudomonas fluorescens, Pseudomonas aeruginosa , Bacillus methylotrophicus, Bacillus cereus, Bacillus aryabhattai* and *Streptomyces strain* showed different level of inhibation zones. *Bacillus cereus* was the most effective and caused 66.67% inhibition and *Pseudomonas aeruginosa* was least 52.80% and others *Bacillus substilis, Bacillus substilis srtain2, Pseudomonas fluorescens, Bacillus methylotrophicus , Bacillus aryabhattai* ,and *Streptomyces strain* caused 64.29%, 62.55%, 60.71%, 58.81, 56.71% and, 54.30%, respectively. *Penicillium digitatum* fungi during dual culture with *Bacillus substilis, Bacillus substilis srtain2, Pseudomonas fluorescens, Pseudomonas aeruginosa , Bacillus methylotrophicus, Bacillus cereus, Bacillus aryabhattai* and *Streptomyces strain* showed different level of inhibation zones. *Bacillus methylotrophicus* was the most effective and caused 64.80% inhabition and *Pseudomonas fluorescens* was least 55.80% respectively. During experiment on fruits the most effective biocontrol agent *Bacillus cereus* and *Bacillus methylotrophicus* were tested on fruits and it was found that *Bacillus cereus* and *Bacillus methylotrophicus* were effectively control the rot by *Aspergillus niger* and showed data 57.27%, 52.19%. During experiment on fruits the most effective biocontrol agent *Bacillus cereus* and *Bacillus methylotrophicus* were tested on fruits and it was found that *Bacillus cereus* and *Bacillus methylotrophicus* were effectively control the rot by *Penicillium digitatum* and showed data (52.27%). Experiment were performed for protective and curative effects. During protective effect the two biocontrol agents *Bacillus cereus* and *Bacillus methylotrophicus* reduced the percentage rottenig by 77.67% and 74.27 of *Aspergillus niger* respectively and in case of *Penicillium digitatum* the effect of Biocontrol agents *Bacillus cereus* and *Bacillus methylotrophicus* caused 47.67% and 45.37% respectively reducuction in decaying. During curative effect the two biocontrol agents *Bacillus cereus* and *Bacillus methylotrophicus* reduced the percentage rottenig 75.81% and 72.45% respectively but in case of *Penicillium digitatum* the effect of the two Biocontrol agents *Bacillus cereus* and *Bacillus methylotrophicus* caused 45.72% and 41.17% respectively reducuction in decaying. Use of Biocontrol agents as protective is better than the curative.

Keywords: Biological control, *Bacillus subtillus*, *Bacillus cereus*, *Aspergillus niger*

ANTIFUNGAL ACTIVITY OF SOME SELECTED FUNGICIDES AND PLANT EXTRACTS FOR THE CONTROL OF CHILI ANTHRACNOSE DISEASE

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Chili (*Capsicum annuum* L.) is the utmost significant cash crop of Pakistan. Annually, about 50 % chili yield is reduced by chili anthracnose disease caused by a fungus *Colletotrichum capsici*. The current study was conducted to explore the antifungal potential of plant extracts and fungicides against *C. capsici.* Morphologically recognized strains of *C. capsici* were subjected to pathogenicity assay where fungal strain CC-2 showed a highly virulent response. Results from *in-vitro* studies exposed that Nativo and Antracol at 1000 ppm and Ginger at 15 % significantly inhibited mycelial growth and fungal spore germination. From the protective and curative trials, among plant extracts Ginger at 15 % showed maximum crop protective activity (84 %) and maximum curative activity (70 %). Consequently, among fungicides Antracol at 1000 ppm showed the highest crop protective activity (92 %) and maximum curative efficacy (96 %). The results of pot experiments exposed that among the plant extracts, Ginger significantly inhibited the *C. capsici* and increased the plant growth while among fungicides, Antracol was found most effective than Nativo. PCA explored the correlation between growth parameters of chili plants treated with plant extracts and fungicides. Biochemical profiling and phytochemical characterization indicated the presence of tannins, phenols, terpenoids, flavonoids, alkaloids, reducing sugars, and anthraquinones in ginger and chicory extracts. Ginger showed highest DPPH scavenging activity (64.9 ± 1.85) as compared to chicory (54.6 ± 2.8). GC-MS analysis of plant extracts revealed the presence of various bioactive compounds including 2-Butanone, Trichloromethane, 2-Butanone, 4-(4-hydroxy-3-methoxyphenyl)-, Gingerol, 1, 2-Benzenedicarboxylic acid, diisocotyl ester, Glycerin, Hexadecanoic acid, methyl ester, 9-Octadecenoic acid (Z)-, methyl ester, 1, 2-Benzenedicarboxylic acid, mono (2-ethylhexyl) ester, n-Hexadecanoic acid, cis-Vaccenic acid, 1-Monolinoleoylglycerol trimethylsilyl ether, and 9,12,15-Octadecatrienoic acid, 2-[(trimethylsilyl)oxy]-1-[[(trimethylsilyl)oxy] methyl]ethyl ester, (Z,Z,Z). FTIR analysis showed 12, 8, and 13 peak values respectively indicating the presence of important functional groups. NMR analysis showed 4 and 7 peak values of ginger and chicory extracts indicating the structures of functional groups. Under changing environmental conditions, there is a dire need to explore the disease suppressive potential of various plant extracts for sustainable agriculture.

Keywords: *Capsicum annuum*, Chili anthracnose, *Colletotrichum capsici*, Plant extracts, Fungicides, GC-MS, FTIR, NMR, Disease suppression, Plant growth promotion.

ORAL

THEME 3

NOVEL FOODS AND FOOD SECURITY

QUALITY AND SENSORY ATTRIBUTES OF APPLE POMACE

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The research was conducted on the quality and sensory attributes of apple pomace. The aim of the research was to observe the apple waste and to evaluate the physicochemical properties of apple pomace. The research was carried out with two different varieties of apple Gaja and Golden delicious. Two types of extraction methods were used: manual and electrical. Manual extraction by squeezing and electrical extraction by juicer/blender. Six treatments were applied for each variety. The statistically analyzed results of juice observed highest 42.66% juice in Gaja variety and lowest 41.72% juice was observed in golden delicious variety, followed by 11.54% peel, 38.94% total waste 4.04 pH value, 0.58% ash, 15.80 °Brix TSS, 1.86% protein, 2.23% fiber, 1.0327 specific gravity, 0.2472 titratable acidity, 10.43% moisture, 128.40 g weight of Gaja variety and, 12.36% peel, 39.58% total waste 3.96 pH value, 0.63% ash, 19.03 °Brix TSS, 2.16% protein, 2.22% fiber, 1.0379 specific gravity, 0.2421 titratable acidity, 9.87 % moisture, 146.15 g weight were observed in Golden delicious variety. The statistically analyzed result of Gaja variety turned out to be comparatively better due to its high 42.66%, juice content. Golden delicious variety was found better due to its bigger size 146.15 grams of fruit, Golden delicious variety had maximum 12.36% peel content, and 39.58% waste**.** Golden delicious Variety resulted in a significant increase in physico-chemical properties like specific gravity, protein, TSS, and ash. Moreover, the Gaja variety brought a significant increase in moisture, titratable acidity, fiber**,** and pH value.

Keywords: Apple Pomace, Analysis, Juice, Waste, Quality.

PHYSICO-CHEMICAL ATTRIBUTES OF WILD AUTUMN OLIVE (*ELAEAGNUS UMBELLATA*) RAWALAKOT VALLEY, AZAD KASHMIR

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The present study was conducted to analysis the basic physico-chemical properties of wild autumn olive, and its by-products was prepared in Rawalakot valley. Fresh autumn olive berries were picked or harvested when they begin to soften and the colour change indicates maturity. Then washed, cut in quarters, pulped and then the pulp was processed into jam and squash. The physicochemical analysis i.e. pH, total soluble solids (TSS), titratable acidity, reducing sugar, moisture content and ash content of autumn olive (four different locations) were determined while physico-chemical analysis of by-products (Jam and squash) prepared from these locations was also determined. The results showed that pH and moisture content were gradually decreased in all samples during storage interval whereas TSS, titratable acidity, reducing sugar and ash content increased. Regarding physico-chemical analysis of by-products TSS, acidity, reducing sugar, non-reducing sugar and total sugar increased while pH decreased during storage interval. The maximum mean value for pH, moisture content, ash content, TSS , reducing sugar, titratable acidity highest value was recorded from wild fig. Furthermore physicochemical properties of by-products shows that maximum mean value of pH, Maximum value of acidity, TSS, reducing sugar and total sugar was recorded from figs, Moreover it is concluded that processing of fruit pulp into jam resulted in a significant increase in physicochemical characteristics such as TSS, titratable acidity and sugar content however decreases its pH. The processing of fruit pulp into jam ensures the safety and quality of the by-products without losing its nutritional and antioxidant benefits.

Keywords: Autumn olive, By- product, Physico-chemical properties

UTILIZATION OF DAIRY INDUSTRIAL WASTE BY BIOLOGICAL MEANS INTO THE VALUABLE PRODUCTS

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With developments and innovations in food/dairy processing technologies, the number of processed dairy/food products have been increased. As a result a large quantity of waste being generated which is the major concern of the present era. Several practices have been utilized for the dairy industrial waste management to ensure sustainable environment. Dairy Industrial waste has high organic and nutrient waste which can be treated through aerobic or anaerobic processes. The former technique has low yield, high kinetics, safe products and high energy operations whereas the anaerobic process is simple having low energy demand and is conservation technique. Treatments such as wetlands, physical, chemical, mechanical and biological are employed to treat dairy effluents. Out of these biological treatment is not widely adapted. It consists of either aerobic or anaerobic processes through the utilization of microorganisms. Microorganisms can be utilized to convert dairy effluents into different valuable products such as several bioactive peptides using a proteolytic enzyme *Macluea Pomifera.* Similarly *pseudomonas auregenosa* and its recombinant strains have been able to synthesize bio-surfactant from milk whey waste. Likewise, biofuels release less polluting agent, can be synthesized by using viable source of dairy effluents as a substrate for fermentation by a yeast *kluyveromyces fragilis* to produce ethanol. *Bacillus Megatarium* can be employed to ferment dairy waste into polyhydroxy butyrate (PHB), a plastic. *Geotricum Candidum* can be utilized in the production of biomass for the reduction in levels of the pollution. There are several factors that affect these processes, optimizing the process conditions can result in low energy costs and increased yields. These approaches are profitable for the production of valuable compounds through the utilizing dairy effluents which might untreated lead to increase in the levels of pollution.

Keywords: Dairy effluents, waste utilization, bioactive peptides, biofuels, sustainable environment

DEVELOPMENT OF PICKERING NANO EMULSION FROM DIETARY FIBER

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In the past few decades, the interest in development of greener and ecofriendly processed foods had significantly increased owing to higher consumer demand and stricter environmental regulation. Also, the increased prevalence of sedentary lifestyle among the masses, which is the one of most leading cause of various chronic diseases, such as, obesity, diabetes, hypertension, cardiovascular diseases, gastrointestinal disorders and cancers. The intake of dietary fiber together with meal tend to reduce the risk of chronic diseases along with improving general health. Dietary fibers, because of their exceptional bioactive as well as functional potential, had been a very economic effective approach against the chronic diseases while keeping the emulsified product stable. Emulsions, an interface between water and oil, with wider applicability in various food products, are stabilize by mean of traditional surfactants. Also, in case of Nano-emulsions, which require even greater amount of these surfactants, some of which have been associated with allergic well as carcinogenic response. Pickering Nano emulsion, a trending approach in last decade, with inherent characteristic to resist various drawback associated with emulsions such as creaming or sedimentation, ostwald ripening, flocculation, coalescence, and phase inversion. Although the technique uses various non-food grade material Pickering agents such as Silica, clay, and hydroxyapatite (Hap) because of their exceptional techno-functional properties, the increased consumer awareness of green label have shifted the attention toward the use of plant-based Pickering agents such as dietary fiber. A review is thus conducted on exploring the use of dietary fiber from various plant sources in developing Pickering Nano emulsions. The review thus, indicated, the use of dietary fiber from various plant sources, as a potential tool in the hand of food technologist and scientist toward development of Pickering Nano-emulsions that are both heathy and stable.

Keyword: Dietary fiber, Pickering, Nano Technology, Emulsion, Chronic Diseases

ECONOMIC UTILIZATION OF WILD FRUITS AND VEGETABLES BY THE NATIVES POPULATION RESIDING IN PIPLI PAHAR PLANTATION, DISTRICT OKARA, (PAKISTAN)

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Background: Several studies in diverse worldwide areas have pointed out the importance of wild fruits and vegetables (WFVs) for assuring not only the food sovereignty but also the other economic elements of the communities; however, the tradition of their utilization is at risk of disappearing, hence present research was conducted to investigate the economically utilized wild fruits and vegetables by the natives of Pipli Pahar Plantation, District Okara Pakistan. **Methods:** For the collection of data, intermittent field visits were arranged during December 2020 to August 2021. Data related to their utilization was collected through interviews from 70 informants via a semi-structured questionnaire and interviews. Various quantitative indices (RFC, UV, RI, FIV, FUV and Jaccard Similarity Index) and SPSS 25 (Descriptive Analysis, Correlation) were also used to evaluate the ethnobotanical data. Furthermore, the present findings were compared with previous reports to assess data novelty.

Results: A total of 65 wild fruits and vegetables (WFVs) belonging to 54 genera and 31 families were observed from the Pipli Pahar. Majority of species were consumed as vegetables (~49%), followed by fruits (~43%) or as both fruit and vegetables (~8%). Predominantly utilizing species by the native people were identified as herbs (~48%) followed by trees (~40%), shrubs (~11%) and arborescent grasses (~1%) in their habit. Majority of wild fruits and vegetables species were found in wild and semi-wild environment (~67%) while fewer species (~33%) occurred in cultivated and semi-cultivated type of environment. In aspect to edible part, fruits were at the top (40%) which were mostly eaten as raw or in pickles; however, vegetables were mostly used in cooked forms. Quantitative results reported that Moraceae was the dominant plant family with 7 plants species (~10%) and highest FIV (650), while Myrtaceae was the most used plant family with Family Use Value of (2.14). Twenty (20) plant species were found to have highest RFC values of (1.00) because these plants were well known to everyone. However, in concern with use values (UV), highest value was found for *Cappris decidua* (Forssk.) Edgew. i.e. 2.29 while highest Relative Importance (RI) was found for *Moringa oleifera* Lam. (2.00). it was quite surprisingly found that among these edible plants, only ~26% species were being sold in the markets. Apart from the edible values these wild fruits and vegetables were also explored for their medicinal and fodder value from the inhabitants of the Pipli Pahar Area. The

current data were compared with previously published literature of aligned areas and reported 21 novel WFVs that been rarely documented for human food in the studied ethnobotanical literature of Pakistan.**Conclusions:** Wild fruits and vegetables of the Pipli Pahar had great economic significance but the trend of their utilization was decreasing because of unawareness amongst the people regarding utilization of such resources. The community's traditional knowledge about the potential utilization of wild edible species could be sustained through community education for the conservation of natural resources and proper utilization of plants for domestic usages as well as raising the economy of natives from the Pipli Pahar Plantation.

DEVELOPMENT OF NOVEL DAIRY PRODUCTS THOUGH THE UTILIZATION OF INDIGENOUS RESOURCES OF PAKISTAN

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As per the National Economic Survey, 2021, Pakistan livestock population accounts for 51.5 million cattle, 42.4 million buffalo, 31.6 million sheep, 80.3 million goat and 1.1 million camel population. However, as far as the milk production is concerned, majority of milk contribution is of buffalo milk i.e. 38,363 tones followed by cow, goat, camel and sheep milk. For consumption and processing into new products only cow and buffalo milk is mainly utilized. Camel, goat and sheep only satisfy the needs of the farmers rearing these animals. These milk have limited production but their composition accounts for greater milk solids which make them suitable for processing into valuable products. These milks or blends of different type of milk in varying concentrations can be employed to manufacture several novel value added products. Taking cheese in to consideration, Roquefort cheese also known as blue cheese is an Italian cheese which can be produced from the blend of different type of milk. Similarly *Pecorina Romano* another Italian cheese made from sheep milk using the ricotta whey as a starter. Likewise, by-products of processed products can be utilized into another value added product. Such type of cheese is Mizithra cheese which can be manufactured by the whey of different type of milk. Also these type of milks can be utilized into cheese powders, flavored milk and sweets as well. Thus utilizing the milk of indigenous breeds will not only lift the burden on the products manufactured by using cow and buffalo milk but also will pay a promising role in waste management and food security.

Keywords: Novel dairy products, Indigenous resources, milk and milk products, waste management, food security

THERAPEUTIC POTENTIAL OF CAMEL MILK AGAINST LIVER INJURY AND CARCINOMA

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The liver is the 2nd largest organ in the body that is involved in different functions exposing it to toxins, drugs, microbes, chemicals, and microbes resulting in liver damage. This damage can lead to pre-neoplastic lesions, hepatocellular carcinoma, fibrosis, hepatomegaly, and cirrhosis due to hyperproliferation, oxidative DNA damage, altered DNA methylation, and aberrant estrogen signaling. There is a need to introduce indigenous natural sources for treatments of liver disorders to reduce cost and side effects. Camel milk is considered a superfood leading to its increased popularity due to its therapeutic potential for liver disorders. The purpose of this review is to explore the medicinal and therapeutic potential of camel milk with special reference to hepatic injury and carcinoma. Immunologically important molecules such as lactoferrin, lactoperoxidase, lysozymes, etc. are present in camel milk. Tissue damaged by toxic substances is prevented by vitamins and minerals that show anti-oxidant activity. Ascorbic acid that is present in high amounts helps in improving liver function. Alpha-lactalbumin has the potential to prevent the proliferation and self-destruction of cancer cells. Camel milk colostrum tends to prevent cell DNA damage through the enhancement of oxidative stress biomarkers and natural killer activity. Iron is made unavailable for the proliferation of cancer cells and stopping the metastasis. Camel milk reduces the MCF7 and HepG2 cells proliferation by activating caspase-3 mRNA and death receptors induction. Camel milk is a super nutritious food but unfortunately, it is mostly wasted. Taste is not familiar to the general public and that's why it is not consumed. Scientists must focus on developing new products using camel milk to make it acceptable to the public.

Keywords: colostrum, oxidative markers, immunoglobulins, metastasis

A GLANCE AT THE THERAPEUTIC POTENTIAL OF BASIL SEEDS

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Basil seeds *(Ocimum basilicum L)* are plant-based seeds widely found in the tropical regions of Asia, Africa and South America. They expand into a gel-like structure after soaking in water. Basil seeds contain dietary fibre, vitamin K, iron, protein, phytochemicals, phenolic compound, orientin, vicentin, and other powerful antioxidants. They are traditionally believed to be used as a therapeutic food to improve digestion, weight loss, regulate blood sugar, lower body temperature, regulate blood pressure, relieve stress and lower cholesterol. Moreover, basil seeds are very beneficial in the summer season preventing dehydration and lowering the body temperature to avoid heatstroke. Weight loss experts recommend basil seeds to their clients for a healthy weight loss journey. Basil seeds mainly contain polysaccharides in the outer layer which can improve gut health and helps in the proper absorption of other nutrients in the body. In South Asia (mainly Pakistan and India) basil seeds are widely used in drinks, ice desserts, and simple water to avoid dehydration and gastric issues. Along with positive effects, basil seeds have some negative effects. According to research, basil seeds can decrease the level of estrogen in females which can lead to pregnancy complications so avoid basil seeds in pregnancy. Basil seeds can lower the blood sugar level and blood pressure levels beyond the normal levels if consumption is more than the normal recommendation. But their health benefits cannot be denied if used in moderation.

Keywords: Basil seeds, polysaccharide, dietary fibre, South Asia, plant-based seeds

DIGITALIZATION OF FOOD SUPPLY CHAIN IN PAKISTAN: TRACEABILITY, BLOCKCHAIN AND SUSTAINABILITY

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The agriculture sector is referred to as the backbone of Pakistan's economic structure. The ideal weather conditions of tropical and sub-tropical regions of Pakistan make it possible to cultivate a wide range of crops. The food supply chain is what ensures that all commodities are safely handled, transported, delivered to the doorstep and eventually into the plate of the end consumer. Importance of the concept of farm-to-fork is highlighted at every level to reduce the postharvest loses and to maximize the utilization of the yield achieved of our agricultural produce. Over the recent years the process of supply chain has been digitalized by using various technologies and different systems to enhance its efficiency and reduces the line losses. Focus has been given on developing data-driven approaches which can further maximize the application of digitalized food supply chain at various levels. Qualitative and quantitative analysis in food supply chain demand a traceability system which can help in providing the product information throughout its life cycle, this further helps in tracking and tracing an error or issue along with providing system for recorded identification. Similarly, the blockchain develops a pool of data which can be accessed by all the stakeholders involved in the supply chain. This strengthens the communication, reduces the time and margin of error which contributes to enhancing the efficiency of the system. Combining such tools potentializes the whole system of food supply chain in identifying counterfeits, fake transactions, tracking and tracing the product origin or product related issues as well. This process is also capable in providing ease in paperwork processing. The implementation and adoption of these systems is a step towards achieving the sustainability by reducing the food waste and minimizing the losses along the whole food supply chain.

Keywords: Agricultural sector, food supply chain, digitalization, food waste, food sustainability

DELVING INTO THE CERAMIDE MODULATING POTENTIAL OF PHYTONUTRIENTS IN METABOLIC SYNDROME

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Ceramides are a novel biomarker for metabolic syndrome including obesity-related diseases, notably atherosclerosis and type 2 diabetes. They are synthesized intracellularly via different metabolic pathways under a variety of physiological circumstances. Regulation of ceramides production and degradation in specific cellular components strongly influences metabolic equilibrium. Oxidative stress and inflammatory conditions are frequently observed in metabolic syndromes due to the disturbance in glucose homeostasis and insulin sensitivity. The two most abundant ceramides identified in metabolic tissues are C16:0 and C18:0 which can potentially enhance insulin resistance due to their accumulation in cell organelles during the progression of obesity, particularly cell membranes and mitochondria. These metabolic disruptions can be corrected by the regulation of ceramides synthesis. Specific ceramides in metabolic syndrome can be decreased by intake of plant-based foods containing phytonutrients predominantly polyphenols of both non-flavonoid and flavonoid sources. Different phytonutrients may alter the influence of NF-κB on insulin resistance and adipogenesis owing to their anti-inflammatory and antioxidant potential. Furthermore, plant-based bioactive compounds have been shown to attenuate free fatty acid-induced dyslipidemia and insulin resistance in peripheral tissues. These elements aid in the reduction of oxidative stress by regulating the adenosine monophosphate-activated protein kinase (AMPK) cascade and insulin signaling pathway.

Keywords: Metabolic syndrome, ceramides, insulin resistance, plant-based foods, phytonutrients

INFLUENCE OF DIFFERENT ROASTING TEMPERATURES ON PROXIMATE COMPOSITION AND FATTY ACID PROFILE OF PEANUT

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Roasting is a thermal treatment usually applied on different edible seeds/nuts/ grains etc. for improving their nutritional and sensorial attributes. In roasted peanuts, the degree of peanut roasting (i.e., time and temperature) plays a major role in its overall attributes therefore, selecting right roasting conditions is important for availing optimum quality attributes in roasted peanuts. Present study was carried out to investigate the impact of roasting temperatures on proximate composition and fatty acid profile of peanut kernel. The peanut kernels were dry roasted at two different temperatures (T1=140 °C and T2=170 °C) in hot air oven for 20 minutes whereas unroasted peanut kernel (T0) was served as control. The roasted and unroasted peanut kernels were analyzed for their proximate composition and fatty acid profile. The results for roasted (T1 and T2) and unroasted (T0) peanut kernel remained statistically different ($P \geq 0.05$) for proximate composition and fatty acid composition. It was found that T0 exhibited significantly higher ($P \geq 0.05$) average value for moisture (6.01 %), carbohydrate content (20.08 %), caproic acid (0.167 g/100g), palmitic acid (13.21 g/100g), erucic acid (0.09 g/100g), linoleic acid (38.35 g/100g), palmitoleic acid (0.07 g/100g), alpha-linoleic (0.06 g/100g), total unsaturated fatty acids (82.54 g/100g), total unsaturated fatty acids (38.37 %), total omega-9 fatty acids (38.29 %) and total trans-fat (0.013 %). Among roasted peanut kernels, T1 showed to have significantly higher ($P \geq 0.05$) average value for myristic (0.043 g/100g), stearic acid (3.14 g/100g), arachidic acid (1.313 g/100g), eliadic acid (0.013 g/100g), oleic acid (43.04 g/100g), alpha-linolenic acid (0.063 g/100g), Cis-11, 14, 17-eicosatrienoic acid (0.04 g/100g), total monounsaturated fatty acids (43.75 %), total omega-3 fatty acids (0.136 %) and total omega-3 fatty acids (43.68 %). Significantly higher ($P \geq 0.05$) average values were recorded for T2 i.e., fat (49.40 %), protein (29.17 %), ash (4.02 %), fiber (6.12 %), energy value (588.85kcal/100 g), Behenic acid (1.95 g /100g), Lignoceric acid (0.949 g/100 g), Cis-11-eicosatrienoic acid (0.64g /100g), Cis-5, 8, 11, 14, 17-eicosatrienoic acid (0.04 g/100g), total saturated fatty acids (19.24 %). It is concluded from the present study that roasting temperatures have influenced the proximate composition and fatty acid profile of peanut up to a reasonable extent. It is therefore suggested that roasting peanut at recommended temperatures (140 and 170 °C) brought promising alteration in overall compositional attributes of peanut kernels.

Keywords: Roasting, temperature, peanut, fatty acids

DEVELOPMENT OF FISH POWDER AND ITS UTILIZATION IN MAKING PASTA

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Fish is an excellent nutritious aquatic food commodity which is mainly rich in good fats, proteins, vitamins and minerals. Flesh from small ignored fishes may be transformed to powder after an appropriate drying method and may be used in making baked, extruded and snack foods. Present study on the development and quality evaluation of fish powder-based pasta was conducted for determining proximate composition and sensorial attributes of pasta samples with varying levels of fish powder (T1= durum wheat flour 99 g + fish powder 1 g, T2= durum wheat flour 98 g + fish powder 2 g, and T3= durum wheat flour 97 g + fish powder 3 g T2 and T3) and control pasta sample (T0= pasta sample without fish powder). For this reason, fish powder was developed from freshly harvested freshwater fish (*Ompok pabda* locally known as *Pallu*) and used for pasta preparation. The samples were analyzed as per standard methods for proximate composition and sensorial properties. The results revealed that all attributes (proximate and sensorial) remained statistically ($P \leq 0.05$) different from one another. It was recorded that, among all treatments, T3 performed better for most of the attributes and had significantly higher ($P \leq 0.05$) average values for fat (1.77 %), protein (15.86 %), ash (1.19 %), Fiber (0.37 %), carbohydrate (19.76 %), energy value (441.93 kcal/100g), titratable acidity (0.045 %), color (8.33), flavor (8.33), texture (9), taste (8.33) and overall acceptability (8.50). Furthermore, T0 showed to have significantly higher ($P \leq 0.05$) average values merely for moisture (68.55 %) and pH value (6.7). However, T2 and T1 also showed satisfactory results for proximate composition and sensorial properties. It is therefore, concluded from the present findings that incorporation of fish powder in pasta may improve its nutritional and sensorial properties. Consequently, it is recommended to utilize fish powder in making different pasta with other different formulations.

Keywords: Fish powder, proximate composition, pasta

DEVELOPMENT AND ASSESSMENT OF FRYING QUALITY ATTRIBUTES OF VEGETABLE ENRICHED SNACKS

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The snack foods are gaining great much popularity due to their desirability and palatability. The innovation for developing more nutritious and tasteful snack foods is becoming a continuous subject in the field of food processing. Present study was therefore undertaken to develop a popular snack food namely papad using different types of dried vegetable powders (garlic, ginger mushroom and tomato) in order to enhance the nutritional profile of papad and to examine the impact of adding dried vegetables on the frying quality attributes, physicochemical and sensorial properties of papad. A total of four different vegetable powder were developed (i.e., ginger, garlic, mushroom and tomato powder) and individually used for the development of vegetable-based rice papad treatments (i.e., T0= control, T1= ginger papad, T2= garlic papad, T3= mushroom papad and T4= tomato powder). The quality attributes such as frying characteristics, physicochemical properties and sensorial evaluation were performed as per standard analytical methods. The obtained data was analyzed using Statistical Package for Social Sciences (SPSS-20). he results regarding frying quality attributes, physicochemical and sensorial properties of all papad treatments remained statistically different ($p < 0.05$) from one another. The results revealed that T3 showed to have significantly higher average values for linear expansion (24.66%), diameter increase (18.33%) and moisture gain after frying 4.10%. T4 found to have significantly higher average values for frying time (sec), frying temperature (180.53 °C), Puffiness (42.33%) and oil uptake (26.10%). For physicochemical properties, T1 remained significantly higher for pH (7.27), T3 for moisture (4.69%) and T4 for fat (18.08%). The average sensory score was better perceived by T2 for color (8.33), flavor (8.66), appearance (9.00) and overall acceptability (8.66) while T4 secured significantly higher score for crispness (8.66) and taste (8.66). It is concluded form the present study that all vegetable based-rice papad samples attributed suitable frying attributes, physicochemical properties and sensorial attributes. Moreover, the T3 and T4 exhibited superior outcomes in respect to the studied attributes whereas in case of sensorial attributes T2 and T4 showed to perceived more score for likeliness.

Keywords: Snack, vegetable powder, frying quality attributes

EFFECT OF CAFFEINE ON BRAIN

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Methylxanthines are widely consumed because of their stimulating effect primarily on the central nervous system. Their diuretic and respiratory stimulant action is used in clinical medicine. L-Arginine metabolism in the brain is very important for normal brain function. In addition to brain protein synthesis, arginine is a substrate for the production of urea, creatine, nitric oxide, agmatine, glutamic acid, ornithine, proline and polyamines. As known, many of these compounds are very important in brain function. There is no information relating to effects of caffeine on arginine metabolism in the brain, however, there is a lot of new information about arginine metabolism and caffeine action on the central nervous system. So, we have hypothesized the existence of a relationship that may be of interest in understanding mechanisms of caffeine effects on the central nervous system that may have utility in the clinical applications. In our experiment protocol we used male Wistar rats weighing about 200 g. Caffeine was added to the drinking water in gradually increasing amounts, from 2 gil over the first 3 days, to 4 gil over the last 7 days. A control group was given drinking water without caffeine. The level of lipid peroxidation, arginase and diarnine oxidase (DAO) activity in the brain was measured. The results of our study show that arginase and diamine oxidase were decreased in animals treated with caffeine. The level of lipid peroxidation (MDA) was decreased also.

Keywords: Methylxanthines; Caffeine; brain; arginine; glutamic acid

FREEZING TEMPERATURE AND DURATION AFFECTS MICROBIAL LOAD, BIOCHEMICAL AND SENSORY ATTRIBUTES OF MINIMALLY PROCESSED ARIL OF 'SAWA' POMEGRANATE FRUIT (*PUNICA GRANATUM*)

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Pomegranate fresh cut arils are nutritious and popular among consumers, however, aril quality and taste under prolonged freezing has been reported to compromise due to aril browning and microbial contamination. Therefore a study was executed to investigate the effect of various freezing temperature and duration on fresh cut aril quality of pomegranate. In this research study, fresh cut arils of mature fruit of pomegranate cv. 'Sawa' were stored at three different freezing temperature (0˚, -20, -40˚) for six months duration. The stored arils were analyzed with two months interval for 6-months for various biochemical, microbial and sensory attributes. Experimental design was two factors factorial under CRD (Completely Randomized Design) arrangement. Overall, the quality and taste of fresh cut aril was lost as the freezing duration progressed, however, pomegranate aril stored at -20˚, irrespective to freezing duration, exhibited comparative higher aril antioxidative attributes, lower microbial contamination and higher organoleptic attributes as compared to arils stored at 0˚ or -40˚ temperature. After 6-months of freezing, higher vitamin C (405 mg 100 mL^{-1}), total antioxidants (66.1 % DPPH), activities of superoxide dismutase (40.17 Units mg^{-1} protein) and catalase (8.36 Units mg^{-1} protein) enzymes, taste scoring (7.2 score), overall acceptability (7.6 score) and lower bacterial count (0.99 Log CFU g^{-1}), titratable acidity (0.8 %) and activity of peroxidase (2.04 Units mg^{-1} protein) enzyme were found in aril frozen at -20˚ as compared to aril stored at other freezing temperature. Conclusively, fresh cut aril frozen at -20˚ retained higher quality, sensory attributes and lower microbial contamination by maintaining aril biochemical, anti-oxidative and consumer acceptability after extended freezing duration of 6-months.

Keywords: Fresh cut aril, total phenolic contents, total antioxidants, colour, taste, acceptability, bacteria count

NUTRITIONAL COMPARISON OF LITCHI PULP, PEEL AND SEED GROWN IN SOUTHERN PUNJAB

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Litchi (*Litchi chinensis*) is an ever green tree. It belongs to family *Sapindaceae* and genus *soapberry*. The purpose of current research was to evaluate nutritional composition of litchi pulp, peel and seed. Therefore, proximate composition, titratable acidity, pH, total soluble solids, mineral profiling, total phenolic content, 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing/antioxidant power (FRAP) were measured in respective components of litchi. Results showed that higher crude protein (6.15±0.30 %) was observed in seed while lower in peel (0.33±0.16%). Higher crude fat in seed (6.50±0.32%) was analysed in seed while lower crude fat content was noted in peel (0.75±0.33%). Crude fiber value was higher in peel (19.09±0.95%) while lower in pulp (1.7±0.08%). Higher total phenolic content was observed in pulp (140.32±7.01mgGAE/100g) while lower in seed (79.64±3.98mgGAE/100g). Higher FRAP value in seed (21.80±1.09) was analysed whereas decreased value in pulp portion (0.59±0.02). DPPH value was higher in pulp (86.67±4.33) as compared to peel (48.54±2.42). TSS value in pulp was maximum (49.88±0.02) while lower in seed (6.22±0.01). Higher titratable acidity was analyzed in pulp (0.37±0.01%) and lower in seed (0.09±0.02%). Ascorbic acid in pulp was analyzed as 32.07±0.01 mg/100g (higher) while lower was noted in seed (11.13±0.02). Maximum pH was observed in seed (5.1±0.01) while lower in pulp (4.3±0.01).

Keywords: Litchi, Peel, Seed, Pulp, Phenolic, DPPH, FRAP

COMPARISON OF OVEN AND FREEZE-DRIED BER (*ZIZIPHUS MAURITIANA*) VARIETIES

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Ber *(Ziziphus mauritiana*) also known as "Chinese date" or "jujube" belongs to *Rhamnaceae* family. Although it is a cheaper option among fruits but still underutilized. The study was planned to compare physico-chemical properties of fresh, oven and freeze-dried ber varieties to develop value added product. Fresh fruit was analyzed for proximate composition, antioxidant activity (DPPH assay), mineral content, total phenolic content (TPC), ascorbic acid content, titratable acidity (TA) and total soluble solids (TSS). First batch of fresh fruit was dried in hot-air oven at 70°C for 8 hours and second batch was freeze-dried at -50°C for 48 hours. Oven and freeze-dried ber varieties were analyzed for comparative evaluation of total phenolic content and antioxidant activity by DPPH assay. Best dried jujube variety (Dil Bahar) on the basis of drying method and content of total phenolic content and DPPH was selected for value-added product development (dried berry cake) as per treatment plan i.e. T_0 (controlled), T_1(5% freeze-dried jujube powder), T_2(10% freeze-dried jujube powder) and T_3(15% freeze-dried jujube powder). Freeze-dried berry cake was subjected for sensory evaluation by using 9-point hedonic scale. Shelf life study of freeze-dried berry cake was conducted at 0, 7th, and 14th day of storage by considering following parameters *i.e.* total phenolic content, DPPH, hardness and color (L*, a* and b* value). Results showed that total phenolic content and DPPH value of freeze-dried berry cake increased with increase in treatment percentage and decreased with storage. Moreover, hardness level of freeze-dried berry cake was increased with increase in treatment percentage and storage time. L*, a*and b* value also showed highly significant values during storage. Statistical analysis showed highly significant results during storage.

Keywords: Ber, Oven, Drying, Freeze, Varieties, Physicochemical, Cake

THE ROLE OF GAMMA RADIATION IN THE PHYTOSANITARY TREATMENT OF FRESH FRUIT AND CONTROL OF INSECT PESTS OF QUARANTINE IMPORTANCE

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The citrus psyllids and scale insects are the key pests of citrus and mangoes in Pakistan and regulated in many parts of the world. Pakistan consequently loose export of its high quality citrus and mangoes to the pest free countries as the eggs and nymphs of these pests can be transmitted with fresh fruits commodities to the importing countries. The WTO regulations for export of fresh commodities require phytosanitary treatment of these pests. Studies on disinfestation of fruits with gamma irradiation from a Cobalt Co^{60} source as phytosanitary measure for citrus scale *Aonidiellla aurantii*, mangoe's scale *Aspidiotus destructor* and citrus psyllids *Diaphornia citri* was conducted for the first time in Pakistan to investigate mortality and growth inhibition of these pests. Dose response tests were conducted with eggs, 1st, 2nd stage and 3rd stage nymphs, and adult females without eggs and with eggs in a series of radiation doses between 100 and 300 Gy. All life stages of *A. aurantii*. *A. destructor*, and *D. citri*, were affected by the gamma irradiation. The pattern of tolerance to irradiation was eggs <1st instar<2nd instar<3rd instar and adults. The adult females of *A. aurantii* did not produce F1 generation at 222 Gy. Similarly, a dose of 200 Gy was determined to completely stop *A. destructor* and *D. citri* development to subsequent stages. Results from large scale validation tests indicated a dose of 220 Gy. for 99.99% inhibition of *A. aurantii*, *A. destructor*, and *D. citri* pests and therefore, recommended to provide quarantine security to citrus and mangoes fruits from these pests. Thus use of gamma irradiation as phytosanitary treatment plays an important role in the in the production of pest free commodities for trade promotion in Pakistan.

Keywords: Phytosanitary, Trade, Agriculture, Mango, Kino

NUTRITIONAL HEALTH STATUS ASSESSMENT OF TRANSGENDERS

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This cross sectional study was carried out in Fountain House, Sargodha. Total participants (150) who belong to third gender community were selected for Nutritional Health Status Assessment (NHS). Eunuchs / transgender who were agreed for NHS were included in study and those who were having any serious health problems were excluded. The purpose was as Eunuchs experience unique health disparities but are the subject of life focused health research. Demographic performa with dietary guidelines was used to maintain the record for calculations and health assessing equipment were used to check height, weight, body fats, water composition, muscle mass, bone mass, AMR, pulse rate, oxygen saturation rate, blood pressure. Results using descriptive statistics showed that average mean height among 90% of Eunuch's ranged within 164.64cm, body fats were 31.38% higher than normal. Water content was very low (50.025%) and should be more than 65%, whereas muscle mass was in range (36.39%). It was concluded that 90%-95% transgenders were facing many nutritional deficiencies and were categorized as being obese

Keywords: Nutritional Health Status, Transgenders, Active Metabolic Rate

QUALITY EVALUATION OF TOMATO KETCHUP USING DIFFERENT THICKENING AGENTS DURING STORAGE AT AMBIENT TEMPERATURE

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Consumer demand over food quality and safety has increased with time. In Pakistan, ketchup industry is dependent on starch as a thickening agent and most of the starch used in ketchup is a refined starch that has many harmful effects on human body such as diabetes, high blood pressure and weight gain. In this study the basic objective was to evaluate the effect of thickening agents on the quality attributes of ketchup during storage at ambient temperature (27±2°C). The CMC (carboxymethylcellulose) 0.5%, Xanthan gum 0.5% and Guar gum 0.5% were used as thickening agents while a treatment adding starch at the rate of 3% served as control. The tomato ketchup was analyzed for organoleptic (changes in color, flavor, flow ability, taste and overall acceptability) as well as physicochemical characteristics (Total soluble solids, acidity%, pH, vitamin C, color and viscosity) for six months. Statistical findings revealed that the tomato ketchup added with 0.5% Xanthan gum had the highest viscosity (4.47 ± 0.14 dPs) and total soluble solids (36.24 ± 0.05) than the other thickeners. The amount of vitamin C (6.86 ± 0.43 mg/100g) and titratable acidity (1.66 ±0.03 %) were higher in ketchup added with 0.5 % guar gum at the end of six month period. Overall, tomato ketchup having 0.5% Xanthan gum was found more suitable in maintaining quality and organoleptic characteristics like flavor (8.13 ± 0.12) and taste (8.39 ± 0.04) and flow ability (8.29 ± 0.34) of ketchup.

Keywords: Tomato Ketchup, Starch, Xanthan Gum, Cmc, Guar Gum, Viscosity

COVER CROPS- HORIZON TOWARDS CONSERVING AGRICULTURE

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Cover crops are plants that are planted to cover the soil rather than for the purpose of being harvested. Cover crops are important components of sustainable agricultural systems. They increase surface residue and aid in the reduction of soil erosion. They improve the structure and water-holding capacity of the soil and thus increase the effectiveness of applied N fertilizer. Legume cover crops fix nitrogen and contribute to the nitrogen requirements of subsequent crops. They can also suppress weeds, provide suitable habitat for beneficial predator insects, and act as non-host crops for nematodes and other pests in crop rotations. Pesticides, weedicides and insecticides not only damage the human health but also pollute the air, soil, water and becoming part of food chain. One of the options to minimize weed infestation is intercropping of cover crops between cash crops to reduce the weed suppression. Regardless of much importance of cover crops and their worth in agricultural systems, cover crops have certain negative aspects as well. They compete with cash crops for moisture, solar radiation and nutrients which ultimately decrease the return of cash crops. Farmers are still hesitating to grow cover crops in their farming systems due to lack of knowledge about these crops. According to Daily Times, in Pakistan soil erosion is 20% and organic matter is less than 1%. So, cultivation of cover crops helps to minimize the adverse effect of erosion and enhances the organic matter content in soil. Cover crops may decline the yields but cover crops are one of the steps that leads to a sustainable or conservation agriculture. This paper reviews the agronomic and economic literature on using cover crops in conserving agriculture as well as food production system and reports on past and present research.

Keywords: Cover Crops, Sustainable Agriculture, Fertilizer, Soil Erosion

REGENERATIVE AGRICULTURE- A SMART AGRICULTURAL APPROACH TOWARDS THE CLIMATE

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Agriculture has a significant environmental footprint. It is associated with approximately one third of global land use, and is a key driver of land use change globally including across the biodiverse tropics. Food production is also associated with ~15% of global greenhouse gas emissions. At the same time, global food needs are anticipated to grow, as a consequence of increases both in population and in per capita demand. In response to these various pressures, many actors are seeking more sustainable ways of producing food. Regenerative agriculture has been proposed as an alternative means of producing food that, its advocates claim, may have lower or even net positive environmental and/or social impacts. It leads to the production of highly nutritious food, free from biocides, at high yields. It enhances and sustains the health of the soil by restoring its carbon content, which in turn improves productivity just the opposite of conventional agriculture and estimates that regenerative annual cropping could reduce or sequester 14.5–22 gigatons of CO_2 by 2050. Worryingly, these practices are generally promoted with little regard to context. Practices most often encouraged (such as no tillage, no pesticides or no external nutrient inputs) are unlikely to lead to the benefits claimed in all places. The objective of this review paper is to summarize existing concepts and future of regenerative agriculture while keeping in view the descriptions of regenerative agriculture used by scholars and practitioners.

Keywords: Regenerative Agriculture, Greenhouse Gas Emission, CO_2

ELEVATING CROP NUTRIENT STATUS TO COMBAT MICRONUTRIENT MALNUTRITION

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Malnutrition is one of the major themes of public health implication, which is significantly related with food type, dietary intake, mineral content and vitamin availability. Role of agriculture in promoting better nutrition outcomes and health has gained momentum in recent years in developing countries including Pakistan. Integrative approaches that link agriculture to nutritional quality of product along with production, productivity and food security are now being considered in research frame works. United Nation Sustainable Development Goals also include link of agriculture to nutrition to give it a global recognition. Adequate concentration of essential mineral elements in crops are not only required for optimum crop yields under changing climate scenarios, but also need to improve quality food production to mitigate the malnutrition elevating public health. Most of the Pakistani population is still dependent on three cereal crops wheat, rice, and maize to fulfill a major portion of their daily food requirements. It is established that cereals are genetically poor in total as well bioavailable mineral nutrients leading to cause deficiency disorders. Breeding approaches focused to improve crop yield has further decreased the nutritional status of cereals. Several soil factors including high soil pH, low organic matter and decreasing fertility status due to intensive agriculture and poor management has further accelerated the issue of micronutrient malnutrition. In a recent survey-based case study in major wheat-based food system of east-central Pakistan, we found strong and positive correlation between Zn or Fe deficiency prevalence in human and wheat grain due to their deficiencies in soil. Initiation of several global research initiatives including biofortification of staple crops has improved the nutrient status of poor resource public throughout the globe. In Pakistan efforts are being made to improve the zinc and iron status in cereals and some success have been reported, nevertheless the pace is very slow to harvest the real potential of biofortification to mitigate the micronutrient malnutrition. There is a great need to work on all possible aspects to biofortify the cereals with essential nutrients adopting agronomic and genetic strategies using modern rapid techniques. Furthermore, legumes especially pulses, which have almost been ignored to date, need further focus to include in biofortification programs in Pakistan. Gradual inclusion of nutrient enriched new food crops can also play a significant role to mitigate the human nutrition issues. Policy interventions or innovations can play a strategic role in addressing agriculture–nutrition discontinuities and improving crops nutritional outcomes.

Keywords: Malnutrition, Food Security, Public Health, Pulses, Policy

DIETARY DIVERSIFICATION BY EXPLORING THE POTENTIAL OF UNCONVENTIONAL FOOD SOURCES

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Despite the extensive research and development programs, the globe is facing severe challenges to food security. Diets of many regions are restricted to a few plant species even in the presence of vast floral diversity. Technological moves, soil degradation, massive cultivation, urbanization and lack of data on many plants are limiting factors to nutritional security. The exploration of the ethnobotanical perspectives of regional communities on the unconventional plant species and their scientific evidencing can provide us with information of great interest. In the present era, food biodiversity is the only solution to deal with food and nutrition insecurity. The study aimed to explore the nutritional potential of various unconventional food plants i.e., (*Solanum nigrum L*, *Rumex dentatus*, *Bauhinia variegate*, *Atropa belladonna*, *Digera muricata*, *Portulaca oleracea, Physalis minima L, Cordia myxa*, *Cucumis melo L* and Lotus roots) in the Punjab province. In this way, the regional unconventional natural flora can contribute value addition to the daily intake, enrich diet diversity and ensure nutrition security.

Keywords: Diet Diversity, Unconventional Food Plants, Scientific Exploration, Food Security

APRICOT SEED KERNEL AS UNTRADITIONAL SOURCE TO COMBAT MALNUTRITION

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Apricot is the foremost and most important traditionally consumed fruit; however, their kernels are a rich source of nutritionally interesting substances, too. Apricot kernel showed a pronounced effect against different medical disorders and conditions based on its nutraceutical potential including antioxidant effect, antiatherosclerosan, anticancer, antiparasitic, antiaging, antianginal, and cardio/ hepato/renoproective, sedative effect, antispasmotic, antisestradial, antimicrobial, antimutagenic, antiinflamatory and many others have already been reported. These medicinal properties are directed related to its chemical composition. Nutritionally, the kernel is regarded as the best source of a wide range of photochemical including protein, fatty acids, soluble sugars, vitamins, minerals, organic acids and fiber. Apricot kernels could represent a good potential source of proteins with the ability to generate bioactive peptides. Numerous reports mention a substantial amount of dietary protein in apricot kernels, which ranges from 14.1% to 45.3%. The main proteins are albumin (84.7%), globulin (7.65%), gluteline (3.54%) and prolamin (1.17%). It is estimated that Apricot kernel flour is also rich in many amino acids such as arginine, aspartic acid, phenylalanine, valine, methionine, threonine, and glutamic acid. Its oil is rich in unsaturated fatty acids, especially oleic (31-80%), arachidic acid (0.08 to 0.39%), linoleic (14.13-51%) acids stearic acid (0.34 -1.22%), palmitic acid (305- 5.04%), palmitoleic acid (0.56-0.91%) and ecosenoic acid in small quantity. It is also a good source of α-tocopherol, and in addition contains high levels of potassium, sodium, calcium, iron, selenium, phosphorus and magnesium minerals and B group vitamins in addition to different valuable phytochemicals. Conclusively the application of apricot kernels as a diet or alternative source will promote the nutritional status of communities with the mitigation of disposal problems caused by discarded fruit seeds.

Keywords: Apricot Kernel, Nutritional Properties, Novel Food,

RECENT TRENDS IN INNOVATION OF DAIRY INDUSTRIAL WASTE MANAGEMENT: CHEESE WHEY AND BUTTERMILK

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Dairy waste management to reduce environmental pollution and improve climate status through its utilization in various food and non-food products is a major concern of the dairy industry. Whey and buttermilk are regarded as the major waste materials of the dairy industry. Though considered waste material, both buttermilk and cheese whey are recently gaining significant attention and numerous applications in the food industry because of their high nutrient content. In microencapsulation technology, these have been used to encapsulate various essential oils, probiotics and several bioactive substances. Whey and buttermilk based beverages have also been prepared to accentuate their application in the beverage industry. Whey and buttermilk based microbial fermented products have a significant role in value-added food production. Edible coatings prepared from whey protein concentrate are more accessible, environmentally friendly, non-toxic and low cost. In addition, several bioactive substances such as exopolysaccharides, bioactive peptides, essential fatty acids and organic acids have been extracted from the whey and buttermilk. Moreover, these have potential to improve the physicochemical, organoleptic and rheological properties (i.e. water absorption, gelatinization temperature, dough development time) of baked goods in the bakery industry.

Keywords: Cheese Whey, Buttermilk, Dairy Industry, Microencapsulation Technology, Dairy Waste Management

BIOTECHNOLOGICAL APPLICATIONS IN FOOD PROCESSING: RECENT TRENDS AND FUTURE PERSPECTIVE

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Biotechnology has revolutionized the world scenario by introducing automated techniques in every field of biosciences, especially the food processing industry. Biotechnological applications have become the fundamental need in processing of several food products. It has a paramount role in producing various components used in improvement of processed food commodities. Biotechnological applications gained much popularity in several fermentation processes to produce health promoting products i.e. proteins, enzymes, antibiotics, and bacteriocins. Bacteriocins as natural preservative are used in food processing industries especially dairy and baked products can be improved by adding biotechnological derived additives and shelf-life enhancers. Foods with various tastes and flavors are being produced with the addition of naturally extracted flavoring compounds from plants and animals through biotechnological tools. Moreover, it has prominent potential in improvement of food quality and food safety through the eradication of health hazard components. However, further research in this field is required to produce such kinds of food commodities that are low caloric, highly nutritious, and are proficient enough to combat and eliminate the various ailments induced due to multiple factors. Therefore, the researchers and investigators are suggested to focus on biotechnological applications in recombinant DNA technologies, DNA fingerprinting, fuel synthesis, bio-pulping (paper manufacturing), bio-plastics, and genetics improvements to produce the high yield varieties of food commodities used in processing industries.

Keywords: Biotechnology, Food Processing, Fermentation process, Food Quality, Food Safety

POTENTIAL OF EGGSHELL POWDER AS A NATURAL SOURCE OF CALCIUM

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Due to the increase in the world's population, the consumption of eggs has also increased. In 2018, the total production of eggs in the world was almost 76.7 million tonnes. Almost 30% of the total eggs produced annually are processed in food industries. Eggshell is considered a waste byproduct and is directly disposed of in landfills ultimately resulting in environmental pollution. It accounts for almost 10% of the egg weight. Eggshell is the cheapest and most natural source of calcium. Calcium is one of the minerals present in the human body, which plays an important role in bone formation. Bones and teeth contain almost 99% calcium. The deficiency of calcium in the human body leads to osteoporosis and hypocalcemia. The major component in eggshells is calcium carbonate, so the utilization of eggshell powder in different food products can be used as a natural and alternative source of dietary calcium.

Keywords: Waste Utilization, Calcium, Eggshells

MEAT QUALITY PACKAGING BY APPLICATION OF NOVEL EDIBLE FILM AND COATINGS: A REVIEW

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Meat is an important component of modern diet and perishable food commodity. In 2021 all over the world 346.14 million tons meat was consumed and expecting to increase 453 million tons within 10 years. So it gain greater attention, proper processing and packaging practices are need to extend its shelf life and reduce the quality degradation of meat. In quality preservation, packaging is a supreme important factor but there is a need that packaging material should be environment friendly and non-toxic to human health. As consumer also demands for high quality, low cost, sustainable and natural food packaging. In this regard there is an increasing demand of organic and edible source based film and coatings that reduces the packaging waste. The organic compounds used in edible packaging are protein (milk, collagen and soy protein), polysaccharides (cellulose, pectin and starch) and lipids (essential oil and waxes). They act as barrier properties against water, light and gasses with excellent transparency, mechanical strength, sensory perceptions and extend the shelf life. The functionality of edible film and coating can be improved by adding the novel agents such as antioxidants (essential oils), antimicrobial (gallic acid and lactoperoxidase) and plasticizers (glycerol and sorbitol). Application of edible film and coatings in the meat industry by foaming, spraying, casting, brushing, wrapping and rolling. The purpose of study is to briefly explain the novel component of edible film and coatings; their formulation, application methods, research and developments of film wrapped or coated meat or meat products and their future trends.

Keywords: Meat, Packaging, Film and Coatings

FOOD SECURITY IN PAKISTAN

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Food security mean all peoples at all-time having access to enough, safe and nutritious food for their healthy life. In Pakistan (a low-to-middle income country) agriculture sector is the main source of income for about 66% of population directly or indirectly, also plays a key role in national food security reducing poverty. About 33.4% out of this 66% population is afflicted with any sort of food insecurity. In our country this sector is facing various challenges i.e. national political uncertainty, inflationary oil prices, poor law enforcement conditions, national and global economic changes, the floods, stagnant production of wheat and other crops. Pandemics covid-19 also made an additional adverse impact on agriculture and food security system of country. There need to have an equilibrium among all these factors for sustainable development to food security, particularly the poor with access to food. All the policymakers, professionals and researchers debates and discussions can result in a solution to cope all the major issues. In this review we have discuss and compare the solution policies in food system and security of different developed countries.

Keywords: Food, Security, Problems, Pakistan

RECASTING BANANA PEEL POWDER IN THE FOOD INDUSTRY TO PRODUCE FUNCTIONAL FOODS

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Food waste totals 1.6 billion tons each year. It's a huge problem with global and domestic implications for the economy, the environment, and society. While attempts are being made to reduce losses and redistribute resources, massive amounts of food waste must still be dealt with. Banana peel powder has been classed as a repercussion with the potential to be used in the development of novel foods. Banana peel powder has two targets in the food industry: to aid the environment and to provide a fresh perspective for the food market in terms of providing value-added food items. Scientists are attempting to transform banana peel powder into unique food items such as plant-based meat (patties and sausages, etc.), confectionery goods (jams, cakes, muffins, etc.), and snacks (biscuits and cookies, etc.) due to its benefits. Aside from imparting nutritious value to food goods, banana peel powder stands out for not producing waste, implying that the fruit is fully used, improving productivity, and lowering labor costs owing to the absence of peeling.

INSTRUMENTAL AND INTRINSIC VALUES OF BIODIVERSITY FROM DIVERSIFIED REGIONS OF PAKISTAN

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Biodiversity is the variety of life among living organisms. Variety is the spice of life. Biodiversity comprises mainly of Ecological diversity, Species diversity and Genetic diversity. Total organisms estimated in the world are about 100-300 million, out of which about 1.7 to 2.1 million are known and remaining are still to be explored. Almost all basic human needs like food, shelter, clothing and medicine totally depend on biodiversity. The present review study was conducted to assess the diversity and variations among flora fauna of the diversified regions of Pakistan like Soon valley, khushab, different botanical gardens, zoos, national parks and sanctuaries to evaluate the instrumental and intrinsic values of biodiversity and its role in ecology and we also reviewed the diversity in wildlife for their economic, medicinal, ecological and commercial importance.

Keywords: Biodiversity, Instrumental, Intrinsic Value, Ecological Diversity, Species Diversity, Pakistan

THERAPEUTIC APPLICATIONS OF BIOACTIVE PEPTIDES GENERATED THROUGH ENZYMATIC HYDROLYSIS OF MEAT BYPRODUCTS

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Meat industry produces huge amount of waste which have potential to be used as the valuable source of proteins and derived bioactive compounds. Dietary interventions have augmented the use of bioactive components with increased awareness for healthy life of individuals. Efforts have been endured to develop functional constituents that offer therapeutic responses towards physiological disorders. The current study was designed to investigate the therapeutic potential of meat byproducts hydrolysates derived after enzymatic hydrolysis with special reference to anti-hypertension and antioxidant activity. Meat byproducts were subjected to physicochemical assays and hydrolysis assessment were also carried out to estimate the release of peptides through RP-HPLC. Moreover, the hydrolysates containing bioactive peptides obtained after hydrolyses were further evaluated for antihypertensive and antioxidative activities. Liver and kidney showed higher enzymatic hydrolysis at maximum hydrolysis time. The ACE inhibitory activity of liver hydrolysate increased significantly with increase in hydrolysis time. The kidney hydrolysates have significantly higher ABTS radicals scavenging activity than liver and heart. The results indicated that hydrolysates of liver and kidney showed significantly higher oxygen radical absorbance capacity (ORAC) activity after given hydrolysis time. In conclusion, meat byproducts can be utilized for generation of functional bioactive peptides that therapeutic applications to cure human ailments.

Keywords: Meat Byproducts, Enzymatic Hydrolysis, Hydrolytic Peptides, Therapeutic Potential

UTILIZATION OF DATE SEEDS WASTES AS A VALUE-ADDED PRODUCT AND THEIR BENEFITS

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Date seeds (*phoenix dactylifera L.*) are regarded as a waste product. On average, it contributes about 10 to15% of total date fruit weight, depending on maturation, type, and quality. Date seeds also known as pits or stones, are the inedible component of the date and are wasted, causing an environmental hazard as well as a financial loss. Date seeds have a significant bioactive component, making their use a highly desirable by-product for the date industry while also being good to the environment. Date seed is commonly used as poultry and livestock feed, as well as a fertilizer. Date seed includes 60 to 80% dietary fiber, 4 to 14% oil, and a small amount of protein, according to chemical composition research. Date seed is a rich source of fiber that can assist with conditions including obesity, diabetes, cholesterol, and gastrointestinal issues. Date seed contains a variety of polyphenols like saponin, flavonoids, anthraquinone, etc., as well as vital minerals including calcium and potassium. Hesperidin is a major flavonoid with health advantages such as cancer prevention, atherosclerosis prevention, and bone preservation, whereas phenolic acids include protocatechuic, hydroxybenzoic, coumaric, ferulic, and caffeic acids. Date seeds are used in both the food and non-food industries. Date seed can be ground into a fine powder and utilized as a low-cost way to improve crude fiber and micronutrients in cereals and bakery items. In the water purification process, date seed may be processed into activated carbon, which has high adsorption characteristics for removing contaminants such as synthetic colors, toxic metals from sewage water, and brominated hazardous by-products from drinkable water. Date seeds contain a rich source of oil ranging from 5 to 13% which is abundant in phytosterols, tocopherols, and phenolic compounds. Date seed oils have a high proportion of oleic acid. They're also yellower than other vegetable oils and help protect against UV rays, which causes a lot of cell damage. Due to their great oxidative stability, date seed oils may be easily preserved. The date seed oil has been used to replace the proportions of other vegetable oils in body lotions, shampoos, and shave soap recipes, with generally positive results.

Keywords: Date Seeds Wastes, Value-Added and Their Benefits

EFFECT OF BARLEY ADJUNCT ON NUTRITIONAL VALUE OF SOYBEAN TEMPEH

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Tempeh is basically Indonesian fermented food product obtained by aerobic fermentation of cooked soybeans. It can be used as meat alternative for vegetarians, having protein, prebiotic and probiotics contents. Tempeh can serve in different forms like roasting, steaming and frying. Presence of all type of essential amino acids, protein, dietary fiber, potassium, vitamin B6 and minute amount of saturated fat make it valuable food for consumption. Current study was planned to enhance prebiotic and probiotic content of tempeh by addition of barley. Product formation will be done by fermentation of soybeans and barley by incorporating starter culture commonly *Rhizopus oligosporus*. Addition of barley will be done for enhancing nutritional value of product. Flowline of tempeh manufacturing involves dehulling, heating, inoculation and fermentation. Addition of barley was done for enhancing nutritional value of product especially the crude fibers. Soybean and barley having ratio of 70:30 was used for value added product. After product development, it was subjected to shelf life study at 0, 7th day 14th day by considering chemical and sensory parameters. Results showed highly significant values of crude fiber, fat, and protein. Crude fiber content in soybean tempeh was 9.33±2.08 after addition of barley with soybean crude fiber content raise up to 11.00±1.00. With respect to storage of 21 days crude fiber was 11.86±0.92. Ash content was also increased from 1.87±0.02 to 5.13±5.08. A little bit change was observed in crude protein concentration. There was also good response of sensory penal according to the altered product having good appearance. Crude fat was decreased from 17.67±0.44 to 16.84±0.01bcd. Statistical analysis showed highly significant results during storage.

Keywords: Tempeh, Fermented Product, Soy Product

NUTRITIONAL AND ORGANOLEPTIC CHARACTERISTICS OF FUNCTIONAL DRINKING YOGURT DURING STORAGE

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The trend of making functional food has been increasing day by day. Fruit yogurt is a popular functional food which provides additional health and nutritional benefits and is also liked by children who disliked the sour taste of plain yogurt. Current study focused on the preparation of mulberry based yogurt and investigated the influence of adding mulberry pulp on physico-chemical (pH, acidity, fat, protein) functional (antioxidant and phenolic contents), and sensory characteristics. Mulberry pulp was added 0%, 5%, 10%, 15% and 20%, 25% and 30% into yogurt and stored for 30 days. Antioxidant activity and phenolic contents were increased with increasing quantity of mulberry pulp into the yogurt. On the other hand, syneresis and acidity was also increased while pH and fat contents were decreased. Yogurt with 15% mulberry pulp showed better sensory score. Overall, yogurt with 15% mulberry pulp stored for 20 days is acceptable with regard to different characteristics.

Keywords: Mulberry Pulp, Yogurt, Functional Properties

EXTRACTION OPTIMIZATION OF RED KIDNEY BEAN (*Phaseolus vulgaris* L.) PROTEIN USING RESPONSE SURFACE METHODOLOGY

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Response surface methodology was used to finalize the optimum conditions for protein extraction from red kidney bean seeds. Central composite design was used to investigate the effect of three independent variables, namely pH (8, 9, 10, 11 and 12), temperature (20, 40, 60, 80 and 100°C) and time (15, 30, 45, 60 and 75 min) on the selected response variable (percent protein recovery). Second-order model obtained for protein recovery revealed a good coefficient of determination (98.79%). Maximum protein recovery was obtained when pH, temperature and extraction time were 10.1, 31.4°C and 75 min, respectively. The experimental values for protein recovery were in close agreement with that of predicted results, thus signifying the appropriateness of the model used. The study can instigate the production of protein isolates or concentrates from red kidney beans for use as promising food ingredients in the industry.

Keywords: Red Kidney Beans; Protein Extraction; Optimization

MORINGA LEAVES SUPPLEMENTED YOGURT

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Supplemented yogurt is a dairy product fermented by the lactic acid fermentation of milk over the action of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Moringa is a good source of protein and contains valuable vitamins and minerals and it is called miracle tree. It has pharmacological properties. Its leaves have 7 times more vitamin C as compared to oranges. Supplemented yogurt is a valuable food commodity due to its digestibility, bioavailability, energy and increased protein contents. Supplemented yogurt contains higher proportion of milk solids along with probiotics that promotes health and metabolic activities in the body. In this study, supplemented yogurt was prepared by the use of moringa leaves powder at different concentrations (0.5%, 1%, and 1.5%) and the product was stored at 6-8°C and evaluated for different physicochemical, functional, Textural analysis and sensory evaluation to check the acceptability of final product. This result showed with an increase in the acidity and decrease in the pH with the increase of storage time. Maximum value of pH was created at T_2 that was 5.27and minimum value of pH found at T_3 (1.5% moringa leave powder). Syneresis also decreases and water holding capacity increases with the storage time. Synersis was found maximum value (26.923%) at treatment T_1 and minimum at 21.777% at T_3 at 21th storage day.

Keywords: Moringa, Metabolic activities, Viscosity, Yoghurt.

ASSURANCE OF FOOD SECURITY THROUGH BREADFRUIT

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In the tropics, protein insufficiency has been identified as a primary cause of malnutrition and child death. Essential amino acids are frequently in higher demand in children and newborns. Children who do not have enough protein or necessary amino acids in their diets are underweight, which can lead to major health problems. The majority of underweight cases occurred in developing nations, with Africa accounting for nearly half of all deaths and Southeast Asia accounting for over 800,000 deaths. Staples are ingested in such large quantities in the daily diet that they account for the majority of nutrient intake, including protein intake. The most prevalent staples are corn, wheat, and rice, which account for two-thirds of global energy consumption. However, most grains are deficient in tryptophan (particularly maize) and/or lysine and have poor protein quality (especially wheat). People typically augment their needed amino acid intake with meat, fruit, vegetables, and other dairy products, but these options are not always accessible, especially for undernourished people. Furthermore, 349 million undernourished people (almost half of the world's hungry population) live near the equator. The warm, rainy climate and lack of winter freeze, which can allow pathogenic microorganisms to multiply, may hinder the production of common staple crops like wheat and corn. As a result, ensuring food security in tropical areas requires a viable, inexpensive, and nutritious replacement staple. Breadfruit is a high-energy food in terms of nutrients. Carbohydrates, protein, dietary fiber, fatty acids, pro-vitamin A, potassium, and calcium are all abundant in the fruits and seeds, which also contain considerable levels of ascorbic acid, niacin, and iron. Breadfruit contained all of the necessary amino acids (*Artocarpus altilis*). Breadfruit has a low protein content (0.7–3.8 g/100 g), whereas breadfruit seeds have a moderate protein content (7.9–8.1 g/100 g). Breadfruit (*Artocarpus altilis*) has been advocated as an underutilized crop with huge potential to alleviate global hunger and change tropical agriculture methods.

Keywords: Malnutrition, tryptophan, Breadfruit, undernourished people

CHIA (*Salvia hispanica* L.) - A POTENTIAL CROP TO PROMOTE FOOD SECURITY

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A lot of focus is on the one-dimensional impact of climate change on food security. Increased food production does not guarantee appropriate food access and utilization, and it has gotten little scholarly attention in recent years. Cereals and pseudocereals are the foods that have sustained humanity since the dawn of time. They're high in carbohydrate and fibre, as well as proteins with high amino acid quality, lipids, B vitamins, and minerals like calcium, potassium, magnesium, iron, zinc, and phosphorus. In affluent countries, they are commonly consumed as bread, morning cereals, or cereal bars. Chia (*Salvia hispanica* L.) is a pseudo cereal with preventive, functional, and antioxidant qualities attributable to the presence of lipids, dietary fibre, protein, phenolic compounds, vitamins, and minerals. Calories: 486, Nutrients: 6% water 16.5 gramme of protein 42.1 gramme carbohydrate 0 gramme of sugar 34.4 g of fibre, 30.7 g of fat 3.33 g saturated fat, 2.31 g monounsaturated fat, 23.67 g polyunsaturated fat, 17.83 g omega-3, 5.84 g omega-6, 0.14 g trans-fat Chia seed extract possesses hypoglycemic, anti-inflammatory, antioxidant, anti-hypersensitive, and cardio-protective properties. Chia is strong in omega-3 fatty acids and anti-inflammatory. The presence of high concentrations of essential fatty acids, dietary fibre, antioxidants, flavonoids, anthocyanins, vitamins, carotenoids, and minerals in this seed has boosted consumption due to its favorable effects on obesity, cardiovascular disease, diabetes, and some types of cancer. Chia seeds generate a gel with strong water binding, oil retention, viscosity, and emulsion activity that can be easily removed for use as a thickening, emulsifier, and stabilizer in frozen meals. Food security is a critical issue that affects the entire world. Due to their vast nutritious composition, greater utilization of underused grains like chia seeds can be a useful choice for combating nutritional security. People are becoming more interested in industrial applications because to its superior physical and functional qualities.

Keywords: Food security, chia seed, pseudocereals, emulsifier, anti-hypersensitive

CLIMATE SMART NATURAL RESOURCES MANAGEMENT

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In an era of global environmental difficulties such as climate change, expanding population, and natural resource degradation, particularly soil degradation and biodiversity loss, sustainable food production is one of the primary challenges of the twenty-first century. The one of the most serious dangers to agriculture is climate change. Climate change, both current and projected, is largely driven by human-induced changes. Climate change has become one of the most serious risks to global food security in recent years. Food output declines as a result of climate change, resulting in higher food prices. Agriculture is one of the most important category for sustaining livelihoods and contributing to climate change. The two most important requirements for reducing the effects of global warming are adaptation and Climate change mitigation. To reach the 2030 targets of decreasing hunger and poverty while also dealing with the effects of climate change, agriculture will need to adopt a climate-smart strategy. The aims of CSA (Climate-Smart Agriculture) is to improve food production while also addressing climate adaptation and resilience and lowering GHG emissions. The CSA is a concept that combines the requirement for climate change adaptability with agricultural mitigation techniques to ensure food security. For example, agricultural tactics such as the utilization of renewable energy, i.e., solar panels, pyrolysis units, water pumps, and windmills are critical for food production. The CSA strategy has three goals: (1) enhancing agronomics productiveness to enable equitable increases in income, food security, and development through boosting adaptive ability and resistance to shocks at different levels, from farm to national (2) where possible, minimizing GHG emissions and boosting carbon sequestration and (3) Increasing agricultural production in a sustainable manner to enable an equitable growth in income, food security, and development.

Keywords: Climate-Smart Agriculture (CSA), Climate Change (CA), Sustainable Food Production, Food Security

EXTRACTION AND UTILIZATION OF NATURAL PIGMENTS FROM POMEGRANATE PEEL

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Colors play an important role in the food acceptance by the consumers and quality of food products. Anthocyanin's are water soluble phenolic natural colorants impart red, blue and purple color to food commodities. The research was planned for extraction and utilization of water-soluble anthocyanins from the pomegranate peel source. To achieve the purpose, anthocyanin was extracted using water as solvent. To maximize the yield of anthocyanin, the extraction conditions were optimized at different extraction temperatures and time through response surface methodology using antioxidant potential and total phenolic contents as response variables. The best selected extraction condition (75°C for 140 min) was employed to extract anthocyanin followed by development of water melon jam using this extract. Results indicated that maximum yield of water soluble anthocyanin was obtained at best selected extraction condition. The antioxidant activity of anthocyanin through DPPH and ABTS was observed in pomegranate peel extract whereas the total phenolics were also obtained. The physio-chemical attributes of anthocyanin aqueous extract supplemented water melon jam showed titrable acidity as 8.6±0.023% and the maximum vitamin content was 0.93±4.713mg/ml whereas TSS showed 20.2±0.2° Brix and pH was 3.1±0.1. Sensory evaluation of anthocyanin aqueous extract supplemented water melon jam was indicated that it was highly acceptable by the panel of judges. It is concluded from the results of study that water soluble anthocyanin can be utilized to develop various food products at industrial scale.

Keywords: Anthocyanin, anti-oxidant, optimization, watermelon, Brix

MINERALS FORTIFICATION OF PIZZA AND SHAWARMA BREAD; A WAY TO TACKLE JUNK FOOD AND MALNUTRITION

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A high malnutrition rate is prevailing among developing countries like Pakistan. Deficiency of certain micronutrients like iron and zinc is common, especially among women and children. The deficiency of these micronutrients causes various severe diseases like anemia due to the poor intake of iron. Around 600 million school-going and preschool children are anemic globally, and half of these cases are thought to be because of iron deficiency. As per WHO, 0.8 million deaths per year are caused by iron deficiency, and 25% children of age below 11 years have zinc plasma concentration under 65 micromole per liter globally. So, there is a dire need to develop nutrient-rich products, especially those commonly consumed by people of different age groups. Today's generation desires tasty foods, resulting in various junk food products production. Those junk food products provide a more significant proportion of macronutrients and are primarily deficient in micronutrients. Pizza and shawarma are among these junk food products that people of different age groups widely consume. Therefore, it's the prime responsibility of food technologists to tackle this junk. Production of pizza and shawarma from biofortified wheat verities or fortification of different nutrients like iron and zinc in pizza and shawarma bread can be an excellent strategy to do so and improve the nutritional status of these products. Food processors/ producers can use these nutrient-rich bread to develop nutrient-rich pizza and shawarma, which can help tackle malnutrition, especially in people fond of eating pizza and shawarma.

Keywords: Malnutrition, Pizza, Shawarma, Fortification, Junk food,

PROBING THE FUNCTIONAL PROPERTIES OF MANGO SEED OIL AND ITS APPLICATION IN BAKED PRODUCTS

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Mango fruit is said to be king of fruits owing to its very rich and diverse nutritional profiling, the aroma as well appearance. Our country, Pakistan is one of the largest mango fruit producing country. Mango is majorly consumed as a fresh commodity meanwhile a mere small fraction of produce is utilized for commercial processes i.e. production of mango pulp and some more products on industrial scale. Furthermore, a large quantity of mango is lost as peel and seed of mango. Both peel and seed possess nutritional and functional ingredients which also includes good amount of mango seed edible oil. The waste also poses a problem for environment as it is bio-waste. This study was aimed at mango seed for oil's extraction, its characterization and its utilization in baked commodities as a functional component in baking products. The seeds of various varieties of locally grown mango were collected from local mango processing facilities of Multan. The values of oil yield, using solvent extraction method (n-hexane solvent) were chaunsa (10.09%), fajri (9.82%), anwar ratool (9.57%), langra (9.11%) and lastly desi (12.49%) respectively. The extracted oil was analyzed for its core compositional analysis which exhibited that *Desi* variety had best results among the other main varieties grown in Pakistan. The results of moisture%, ash content, crude fat%, crude fiber%, crude protein% and nitrogen free extract were 9.83, 2.36, 12.49, 2.37, 7.22 and 68.31 in order. The study also presented, the percentages of saturated FAs which were 54.36% saturated fatty acid, 45.64% unsaturated fatty acid, 44.56% oleic acid, 37.19% stearic acid, 7.43% linolenic acid, 2.78% linoleic acid and 6.17% palmitic acid. Hydrogenated oils are normally utilized in baked goods that contains a higher fraction of trans-FAs i.e. upto 20 percent. Nevertheless, mango seed oil is semi-solid at ambient temperature and that this oil needs no partial hydrogenation. To check the in vivo status of extracted oil, prepared cupcake was used as an experimental diet to feed rabbits to evaluate the antihyperlipidemic and antihyperglycemic effects of mango seed kernel oil on rabbits. On the basis of the results, it was concluded that the mango seed kernel oil possessed significant antihyperlipidemic and antihyperglycemic potential. There were healthy changes due to feeding of rabbits on mango seed kernel oil with respect to blood lipid profile, liver function enzymes and kidney function assays.

Keywords: Mango seed antihyperlipidemic and antihyperglycemic potential

SUITABILITY OF WHEAT GERMPLASM FOR BISCUIT PREPARATION

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Wheat (*Triticum aestivum)* belongs to family *"Poaceae"* is the basic grain consumed in many countries as a staple food and categorized on the basis of protein like hard wheat (more than 10%) and soft wheat (7-10%). Hard wheat is used for bread preparation while soft wheat is used in biscuits and cakes preparation. In Pakistan medium to hard wheat was grown, therefore mixed wheat was supplied to miller which affect the biscuit quality. The current study was planned to explore the potential of locally grown germplasm for biscuit with special reference to physicochemical and sensory evaluation. For this purpose, wheat germplasm were inspected on the basis of desired color (medium brownish, light brownish dark brownish and yellowish) and selected genotypes will be subjected to TKW (Thousand kernel weight), NIR and color analysis. In the next stage, wheat was milled into flour and compositional (proximate, gluten and mineral) and rheological analysis (like farinograph and viscosity) was done. In the next, wheat was milled into straight grade flour and used for biscuit preparation. Furthermore, biscuits prepared from flour were evaluated for quality characteristics like spread factor, color, hardness and sensory. On the basis of results achieved, it was concluded that wheat germplasm like Line-3, Zincol, A-84 and A-21 was found to be best regarding biscuit preparation because of low protein (10.3**±0.50,** 9.20**±0.34,** 10.61**±0.54 and** 11.82**±0.63 respectively). A-21 give best results regarding spread factor (**59.767±3.39), Hardness (3.41±0.37), color (l^*=68.98±1.81, a^*=3.04±0.72 and b^*= 30.31±0.85) and overall acceptability (8.05±1.16^{ab}). It was suggested that germplasm i.e., A-21 should be grown as a variety in Pakistan to obtain straight grade flour used for biscuit preparation.

Keywords: Soft wheat, Straight grade flour, Farinograph, NIR, Color, Spread factor

USE OF MANGO PEEL AND ITS IMPORTANCE TO PROTECT ENVIRONMENT FROM POLLUTION

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Mango peel is a byproduct obtained during the processing of mango products like mango pulp. Mango peel is used as a waste which causes environmental pollution. It is a source of natural bioactive components such as dietary fiber, polyphenols and carotenoids. Mango peel powder has 3.4% moisture, 3.8% protein, 2.6% fat, 8.9% crude fiber and 87% carbohydrates. Mango peel extract is a source of lipid peroxidation inhibitors and co-pigments. Mango peel is used to develop edible or biodegradable food packaging materials. It is used to incorporate into fish gelatin films to check its physical, barrier and antioxidants characteristics for active food packaging. Mango peel has triterpenes and triterpenoids that used as anticancer and antidiabetics. Dietary fibers in mango peel are used in bakery products to improve its glycemic index. Phytonutrients in mango peel has antioxidants that fight some harmful disease. Tea of mango peel is a rich source of essential vitamins. Intake of mango peel protect from any external bacteria or viruses that enter the human body and cause some serious diseases. Mango peel has vitamin A and C which prove that it is highly effective in loosing excessive weight. As it is a good source of fiber it can be chopped and added to some other foods that have fruity acidic taste in it. Mango peel syrup is also a good source of some essential nutrients. So mango peel is used in many food products and environment is protected from pollutions.

Keywords: Mango peel, Pollution

UTILIZATION OF AS A VALUE-ADDED PRODUCT AND THEIR BENEFITS DATE SEEDS WASTES

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Date seeds (*phoenix dactylifera L.*) are regarded as a waste product. On average, it contributes about 10 to15% of total date fruit weight, depending on maturation, type, and quality. Date seeds also known as pits or stones, are the inedible component of the date and are wasted, causing an environmental hazard as well as a financial loss. Date seeds have a significant bioactive component, making their use a highly desirable by-product for the date industry while also being good to the environment. Date seed is commonly used as poultry and livestock feed, as well as a fertilizer. Date seed includes 60 to 80% dietary fiber, 4 to 14% oil, and a small amount of protein, according to chemical composition research. Date seed is a rich source of fiber that can assist with conditions including obesity, diabetes, cholesterol, and gastrointestinal issues. Date seed contains a variety of polyphenols like saponin, flavonoids, anthraquinone, etc., as well as vital minerals including calcium and potassium. Hesperidin is a major flavonoid with health advantages such as cancer prevention, atherosclerosis prevention, and bone preservation, whereas phenolic acids include protocatechuic, hydroxybenzoic, coumaric, ferulic, and caffeic acids. Date seeds are used in both the food and non-food industries. Date seed can be ground into a fine powder and utilized as a low-cost way to improve crude fiber and micronutrients in cereals and bakery items. In the water purification process, date seed may be processed into activated carbon, which has high adsorption characteristics for removing contaminants such as synthetic colors, toxic metals from sewage water, and brominated hazardous by-products from drinkable water. Date seeds contain a rich source of oil ranging from 5 to 13% which is abundant in phytosterols, tocopherols, and phenolic compounds. Date seed oils have a high proportion of oleic acid. They're also yellower than other vegetable oils and help protect against UV rays, which causes a lot of cell damage. Due to their great oxidative stability, date seed oils may be easily preserved. The date seed oil has been used to replace the proportions of other vegetable oils in body lotions, shampoos, and shave soap recipes, with generally positive results.

Keywords: Date Seeds Wastes

UTILIZATION OF POMEGRANATE BIO-WASTE

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Pomegranate is a bioactive compound-rich fruit with a problem of producing bio-waste during processing. Its waste includes rind, seed and a number of beneficial products can be made from it. Pomegranate biowaste have a considerable commercial worth due to complicated blend of distinct bioactives that provide many health advantages. In order to increase the recovery of these bioactives less expensive, environmental friendly and excellent strategies should be used. In cotton and wheat fields, against Microcerotermes besoni termite species, pomegranate rind methanol extract was proven to be efficient. A natural antifungal compound (PP extract) was proven to be harmful against pests. In addition to generating immune response in tissue of host plant, PP extract possess antibacterial actions. On tubers of potato which are inoculated with Fusarium sambucium dry rot development can be greatly reduced by PP methanol extract. There is a growing demand for natural alternatives against synthetic, particularly synthetic antioxidants, which have been banned from utilizing in food commodities due to their carcinogenic effects. Natural antioxidant including pomegranate rind extract that can be used in place of synthetic antioxidants like butylated hydroxytoluene (BHT). Antioxidant and antibacterial characteristics are also found in pomegranate seeds. Pomegranate biowaste can change nutritional components and also acts as a natural counterpart. The rind of a pomegranate can be used as a pectin alternative. Pomegranate rind consists of 6.8-10.1% pectin. Food degradation due to microbes is prevented by edible coverings consisting of pomegranate rind extract and chitosan. Most abundant flavonoids in pomegranates are anthocyanin. Pomegranates red, purple, and orange colors are due to anthocyanin. PS oil is a good source of co linolenic acids, particularly punicic acid and helps to enhance functional and nutritional characteristics of ice cream.

Keywords: Pomegranate Bio-Waste

EVALUATION OF PHYTOCHEMICAL, NUTRITIONAL AND ANTI-MICROBIAL CAPACITIES OF KARONDA FRUIT FOR ITS POTENTIAL UTILIZATION TO COMBAT FOOD INSECURITY ISSUES

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Karonda is a tough, evergreen, spiky, and native shrub, belongs to the family Apocynaceae commonly grown in Asia. Its local name is Garanda and common name is karonda in Azad Kashmir, Pakistan. The *Carissa caranda* is a rich source of vitamins and minerals, carbohydrates, phenol, flavonoid, etc. The lack of awareness and knowledge among the community results in the wastage of fruits so, the present research is designed to investigate the physicochemical and antioxidant profile of *C. caranda* fruit and to evaluate the nutritional potential of the underutilized karonda fruit. The biochemical analysis was conducted by following the standard official methods. The phytochemical analysis was done via spectrophotometric bioassays. The mineral contents (calcium, potassium, iron, phosphorus and zinc) of the berries were examined by the atomic absorption spectroscopy analysis. The antibacterial potential of fruit extract was observed by using both pathogenic and nonpathogenic strains. The results revealed that the fruit have an appreciable amount of vitamin C followed by 67% moisture content, 28% of total acidity with a minimal total sugars ranged between 6 to 7%. The total carb content of fresh berries was estimated around 7.67% whereas in dried berries carbs were observed with an increased level of upto 8 folds. The increased level of antioxidant, total phenolic and total flavonoid contents was observed in sun dried berries as compared with fresh fruit. The fruit was rich in mineral contents followed by iron, calcium, phosphorus and zinc. The fruit extract showed clear zone of microbial growth inhibition of *Bacillus subtilis* and a pathogenic strain, *Stenotrophomonas pavinii* on nutrient agar plates. The highest annthocyanidine content and mineral profile of fruit revealed that the fruits of *Carissa caranda* have potential to cure many diseases such as fever, liver diseases cure anemia and also used to purify the blood etc. Hence it can be concluded that this undervalued fruit can be potentialized by its utilization in manufacturing of a wide range of food products which will ultimately reduce the risk of food insecurity.

Key words: Carissa caranda, underutilized, flavonoids, atomic absorption spectroscopy

NANO-EMULSION BASED DIP COATING TO IMPROVE SHELF LIFE OF FRESH FRUITS AND VEGETABLES

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Advanced Nano-engineering is an emerging technology to enhance agricultural productivity along with ensuring sustainability and achieving food security. The ability of Nano-sensors to perceive and recognize environmental conditions make it more sustainable. Fresh fruits and vegetables are perishable commodities that necessitate the use of post-harvest shelf life extension technology. Edible coatings have been employed to preserve fresh fruits and vegetables in addition to cold storage or controlled settings. Nanotechnology has arisen in recent years as a novel method for the said purpose. On comparison among various coatings (ordinary emulsions, coatings based on plant-source & Nano-emulsions) nano-emulsions provide a better water barrier as well as improved mechanical, optical, and microstructural capabilities. These are significant to provide long term release of antibacterial and antioxidant compounds during food storage for extending shelf life and boosting nutritional produce quality.

This review enlighten the efficiency of nano-emulsion based coating aiming to reduce postharvest losses of fruits and vegetables, which may aid in meeting rising food demand while also ensuring environmental sustainability. This technology might be the best possible option for preserving fresh fruits and vegetables as well as to ensure food security in the future.

Keywords: Nano-emulsions; anti-bacterial, anti-oxidant, Fruits and vegetable preservation

ORAL

THEME 4

CLIMATE ADAPTIVE MARKETABLE HORTICULTURE

GROWTH, QUALITY AND NUTRITIONAL PROFILING OF KINNOW MANDARIN AUGMENTED THROUGH ROOTSTOCKS UNDER AGRO-CLIMATIC CONDITIONS OF SARGODHA, PAKISTAN

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Citrus fruit production is getting much popularity throughout world, due to its high minerals and vitamin contents. The nutritional quality of citrus fruits primarily depends upon the selection of rootstock. Kinnow 'Mandarin' is a major citrus cultivar being cultivated in Pakistan. The current study aimed to investigate the nutritional status and growth and yield of Kinnow mandarin grafted on four overseas and two indigenous rootstocks in Pakistan. Experiments were conducted at experimental station of Citrus Research Institute, Sargodha from 2016 to 2020. Results revealed over all good adaptability, while no significant difference in juice contents was observed among all the tested cultivars. Physical quality of fruit (weight, firmness, size etc.,), and TSS were significantly affected by varying rootstocks. Cox mandarin was found as best cultivar as imparting maximum weight (180.7 g), size (74.10 mm), TSS (12.0˚B). Overall, cox mandarin budded with Kinnow performed well under local climatic conditions of Sargodha Pakistan.

Keywords: Kinnow, exotic rootstock, canopy volume, yield, bio-chemical fruit quality

FOLIAR APPLICATION OF ANTIOXIDANTS ALONGWITH MICRONUTRIENTS IMPROVED FRUIT QUALITY AND SHELF LIFE OF MANGO CV SUFAID CHAUNSA

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Quality of horticultural crops is directly related to the management practices, cultivar, and climate of the area. Mango is mainly grown in tropical and sub-tropical regions of the world where high temperature reduces fruit set, increases fruit drop, and causes sunburn at different stages of fruit development in sufaid Chaunsa. Moreover, fruits exposed to sun, bear small size as compared to shaded fruits. The individual application of antioxidant and micronutrient are found helpful to reduce the high temperature effect in subtropical region, but limited studies are available on their combine application to reduce the high temperature impact on fruit yield and quality in subtropical region. Therefore, a three-year study (2015-2018) on Sufaid Chaunsa in Multan, Pakistan at Mango Research Institute Orchard was conducted to evaluate the effect of pre-harvest foliar application of antioxidants citric acid and ascorbic acid (1000 mg kg^{-1}) alone and alongwith micronutrients Zn, Cu, Fe and Mn (0.15% and 0.30%) on fruit yield and quality. The experiment was laid down in randomized complete block design with four replications. The foliar application of citric acid alongwith micronutrients (0.30%) was found helpful in increase of fruit weight, volume, yield, TSS, beta carotene, total sugar, and shelf life by 14, 13, 15, 35, 14, 14 and 33%, respectively while acidity decreased by 22% over untreated plants (control). The average size (11x7.5cm) and 100 % green color of fruit at harvesting was obtained with citric acid alongwith micronutrients (0.30%). Fruit Mineral content's nitrogen, phosphorus, potassium, copper, and manganese were increased 20, 42 and 29% 35 and 23%, respectively as compared to control with application of citric acid alongwith micronutrient application (0.30%). The treatment effect on fruit quality was more pronounced in year 2018 as compared to 2016 and 2017. The foliar application of citric acid alongwith micronutrients (Zn, Cu, Fe and Mn @ 0.30%) can be recommended based on the current study to improve fruit yield and quality in Sufaid Chaunsa in subtropical regions.

Keywords: sufaid chaunsa, antioxidants, micronutrients, shelf life

SILICON AS A GROWTH REGULATOR UNDER HEXAVALENT CHROMIUM STRESS IN ICEBERG AND GREEN RAPID LETTUCE (*Lactuca sativa var. Capitata*)

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During the last few decades, environmental contamination caused by the presence of hazardous metal elements has spread throughout the world, posing serious hazards to plants, soil, humans and animals. The primary causes are quick and injudicious industrialization, intense farming, erroneous mining operations, and wastes that build in the soil and accumulate at toxic concentrations as a result of long-term exposure to poisonous substances. Even a minor increase in the concentration of heavy metals above the allowed limit has negative consequences on all living organisms, including humans. Silicon (Si) has an important role in reducing heavy metal poisoning in plants. By incorporating multiple mechanisms, amending soil with silicates lower the harmful effects of heavy metals and stimulates crop development by reducing various strains caused by biotic and abiotic factors. The present study was aimed to reveal the protective role of silicon (Si) for lettuce plants grown in hydroponic conditions under two different levels of Cr (VI). In a hydroponic system with or without potassium silicate, seedlings of two different lettuce varieties, iceberg lettuce and rapid green lettuce were treated with Cr (VI). Six treatments with two levels of Si (0, 2mmol L^{-1}; K_2SiO_3) against three levels of Cr (VI) (0, 50, 100 µmol L^{-1} ; $K_2Cr_2O_7$) with three biological replicates. To assess the tolerance and accumulation of Cr (VI) by these plants, the uptake and distribution of Cr (VI) through roots and shoots, as well as silicon content in root and shoots, were analyzed. The results of the study demonstrated that lettuce grown in Cr (VI) treated in hydroponic conditions developed overall chlorotic leaves, interveinal chlorosis in young leaves, reduced leaf and root growth compared with the control, and the old leaves of lettuce grown in Cr treatment. Chromium is known to be toxic to plants and its toxicity depends on the oxidation states of Cr. The Si incorporation with cultured media having Cr 50ppm and Cr 100ppm demolished the toxic effects of Cr on the leaves of lettuce plants by increasing plant dry biomass, leaf area and total chlorophyll content. According to the findings, Si is a quasi-essential element that improved lettuce tolerance to Cr toxicity by decreasing Cr uptake, accumulation, and translocation and by regulating antioxidative defense systems.

Keywords: lettuce, heavy metal, hydroponic, toxicity, silicone

UNRAVELING THE EFFECTS OF ELEVATED TEMPERATURE AND DROUGHT STRESS ON FRUIT COLORATION IN MANGO (*Mangifera indica* L.)

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Color of every fruit is an important horticultural attribute contributing to nutritional components, market value and consumer demand. The present study was carried out to determine the impact of elevated atmospheric temperature and drought stress on the coloration of mango fruits. The fruit skin color, as well as the content of anthocyanins, carotenoids and chlorophyll under different atmospheric temperature and drought stress treatments were analyzed for a traditional mango cultivar 'Langra'. The elevated temperature (1.5–2.5˚) significantly increased the fruit redness and the content of anthocyanins and carotenoids by 23.05 %, 11.40 % and 33.20 %, respectively, in three different stages of fruit ripening. The drought stress, with soil moisture at 30–45 % of the field capacity, significantly decreased the fruit redness and the content of anthocyanins and carotenoids but increased the content of chlorophyll under the same temperature. Significant temperature x drought interactions were observed for fruit color and pigments, showing that the positive effect from the elevated temperature was reduced as the drought stress increased. The present results suggest that under the scenario of a 2˚ increase in atmospheric temperature, fruit coloration of mango can be enhanced. However, drought stress negatively affected fruit coloration and reduced the positive effects resulting from the elevated temperature. Research findings provide novel information for understanding environmental effects on fruit quality attributes and to devise appropriate management strategies for mango production.

Keywords: Climate change, Fruit color, drought, mango.

IMAGING BASED ETHNO BOTANICAL STUDIES OF DISTRICT POONCH, AZAD JAMMU AND KASHMIR

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Present paper aims to study each plant in natural habitat including live imaging of field plant, leaf dorsal, ventral view and flower. A set of standardized digital images with enough features of a plant representsignificant role in unambiguous plant identification, gross morphology of a species and taxon recognition, as a supplement herbarium collection. A total of 24 MAPs species belong to 24 families and 24 genera including 9 herbs 3 shrubs, 4 trees and 8 vines were documented. The important plants *Aster thomsonii* C.B. Clarke., *Aquilegia pubiflora* Wall. ex Royle, *Boerhavia procumbens* Banks ex Roxb., *Bombax ceiba* L., *Clematis orientalis* L., *Dioscorea deltoidea* Wall. ex Griseb., *Hypericum oblongifolium* Choisy, *Hedera nepalensis* K. Koch, Hort., *Ipomoea cairica* (L.) Sweet, *Litsea tomentosa* Heyne ex Wall, *Leycesteria formosa* Wall., *Mucuna pruriens* (L.)DC., *Morina longifolia* Wall. ex DC, *Oxyria digyna* (L.) Hill, *Polemonium caeruleum* L., *Punica granatum* L., *Rubus fruticosus* Loureiro, *Reinwardtia indica* Dumort., *Symplocos paniculata* (Thunb.) Miq., *Solena heterophylla* Loureiro, *Trifolium pratense* L., *Tylophora hirsuta* (Wall.) Wight, *Viola odorata* L., *Ziziphus jujuba* Mill. Were investigated. It is an effort to solve privilege identification errors, adulteration and misconception for end users due to routine lists of ethno botanical information solely based on botanical names and interviews.This fundamental ethno botanical study will provide opportunity to re-examine botanical information and paved the way for effective and sustainable utilization of local medicinal flora.

Keywords: digital image, ethno botany, medicinal and aromatic plants (MAPs), photography

ACHIEVING SUSTAINABLE NUTRITION WITH MINOR FRUITS UNDER CHANGING CLIMATIC SCENARIOS

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Numerous minor fruit species worldwide have been reported to be rich in vitamins, minerals and other micronutrients, suggesting that they have the potential to play a role in addressing the major problem of malnutrition. Using indigenous minor fruits species to address this acute problem could be the cheapest and sustainable solution for local as well as global communities. However, to unlock the full potential of these naturally grown minor fruit species, many barriers exist. These barriers include non-availability of nutritional information and non-existence of proper supply chain systems. Therefore, this current study was designed to analyze some selected naturally grown fruits (Amlok, Autumn olive, Quince, Fig, Wild raspberries and Barberries) for their nutritional value. In this regard, locally grown fruits were collected and analysed for physical (fruit diameter, total weight of fruit, fruit colour, fruit firmness) and biochemical (vitamin C, total soluble solids, total ash content, titratable acidity, pH and antioxidant properties such as total antioxidants and total phenolics) parameters. Results showed that there is a huge potential of these minor fruit species to be promoted for commercial scale cultivation. However, further efforts are required to establish certified nurseries, small scale value addition plants and a supply chain system for these fruit species.

Keywords: Minor fruits, Malnutrition, Nutritional security, Sustainable food supply

DIFFERENT MULCHING MATERIALS AFFECT WEED EMERGENCE, PLANT GROWTH AND FRUIT QUALITY OF STRAWBERRY GROWN IN RAWALAKOT, AZAD JAMMU & KASHMIR

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Strawberry is one of the most attractive fruit among berries. The current study was designed to test the efficacy of different mulching materials on weed control, morphological and physico-chemical characteristics of strawberry cv. Chandler under rain fed conditions of Rawalakot. The experiment was laid out in randomized complete block design (RCBD) with six mulching treatments which included control (no mulch), popular leaves, wood chips, coconut coir, newspaper and black polythene. Data was recorded for various parameters and was subjected to analysis. Results showed that maximum weed control (89.67%) was found in strawberry plants grown in black polythene mulch. However, maximum survival percentage (95.75%), leaves per plant (8.0), flowers per plants (7.33), fruits per plant (5.33), runners per plant (8.33), chlorophyll a (8.55 g/ml), chlorophyll b (9.26 g/ml), total chlorophyll (18.14 g/ml), fruit weight (2.93 g), fruit diameter (2.73 cm) were found in strawberry plants grown in mulching material amended with coconut coir. Bio chemicals parameters like total soluble solids (TSS) (8.50%), titratable acidity (TA) (1.89%), vitamin C (0.25 mg/100g), total anthocyanins (40.06 mg/100g), total phenolics (0.60 mg gallic acid/100 g), total flavonoids (2.86 mg/100 g FW), and antioxidant activity (0.89 µg/100 mg FW) were also found maximum in plants grown in coconut coir. Based on current findings it can be concluded that mulching material black polythene was found better for weed control and coconut coir was found better for morphological and physico-chemical characteristics of strawberry.

Keywords: Mulching, Strawberry, Fruit, Quality, Weed control.

MORPHOLOGICAL AND BIO-CHEMICAL CHARACTERIZATION OF ALOE VERA (*Aloe barbadenisis)* COLLECTED FROM DISTRICT BAGH, AZAD JAMMU AND KASHMIR

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Aloe vera (*Aloe barbadensis*) is the member of genus aloe and considered as significant functional plant of the world. It has great economic and medicinal values. It grows wild and is also cultivated in Azad Jammu & Kashmir, Pakistan. *Aloe vera* was collected from seven locations of Bagh including Dhirkot (L1), Jahla (L2), Banipasari (L3), Awaira (L4), Nindari (L5), Rehara (L6) and Kotari (L7). This research work was done at Laboratory of Horticulture Department. The study aimed to evaluate the effect of morphological and biochemical characteristics compared with the performance of wild *aloe vera* Ecotype under climatic conditions of district Bagh. The research was carried out according to Randomized completely block design (RCBD). Data was composed for morphological qualities like plant height (cm), leaf area (cm^2), number of leaves, plant weight (g), leaf length (cm), leaf weight (g) and gel waste ratio. The biochemical analysis was done as total soluble solids, pH, total phenolic content, vitamin C, total acidity, flavonoid, antioxidant activity. Data were collected and subjected to analysis of variance (ANOVA), their means were compared using LSD test at $P \leq 0.05$. L7 showed maximum plant height, plant weight, number of leaves, leaf area, leaf length, leaf weight and minimum pH, TSS, VIT.C, Anti- oxidant, Phenol and Flavonoids due to favorable environmental factors and climatic factors. This research was beneficial for the optimum yield of wild ecotype of Aloe Vera to be used in the future under the climatic conditions of Bagh Azad Kashmir.

FROM WASTE TO WEALTH: CHITOSAN PREPARATION FOR EDIBLE COATING OF CITRUS FRUITS

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The post-harvest loss of food crops is a major problem globally. Approximately, one-third of the food produced is lost during the postharvest system every year. There are many factors for this, which include environmental conditions, mechanical damage during harvesting and handling, improper post-harvest sanitation, poor cooling and environmental control, as well as infection caused by several pathogens. Pakistan has a wide range of agro-climatic conditions, varying from tropical to temperate. The production of different types of perishable food crops faces similar problem of post-harvest losses. Various technologies are used for the reduction of postharvest losses of fruit crops such as hot water treatments, controlled atmospheres, low-temperature storage, use of ultraviolet light, and chemical treatments. Unfortunately, most of the treatments have adverse effects on color, flavor, aroma, and texture. The main objective of this study is to find out a promising environmental friendly postharvest treatment for extending the market life of short-lived food crops. This study focuses on the extraction of chitosan from marine waste. For the extraction of chitosan raw waste material was processed through a sequence of treatments that involved pretreatment, demineralization, deproteinization, purification, and deacetylation. The extracted chitosan reached a yield of 21.62% with 98.8% solubility. The ash value and moisture content of the chitosan sample were 3.0% and 4.3% respectively. The recovered chitosan shows a high yield with very high solubility. Studies are being under consideration for the formation of chitosan-based edible coating for citrus fruits.

EFFECT OF NITROGEN AND PHOSPHORUS ON GROWTH AND YIELD OF BROCCOLI (*Brassica oleraceae* L.) UNDER AGRO CLIMATIC CONDITIONS OF RAWALAKOT

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This study was conducted to examine the effect of nitrogen (N) and phosphorus (P) on growth and yield of broccoli (*Brassica oleraceae* L.)Experiment was laid out in a Randomized complete Block Design (RCBD) with three replications and four levels of N (0, 60, 80 and kg ha^{-1}) and four levels of P (0, 80,100 and 120 kg ha^{-1}). Each response of broccoli. (*Brassica oleraceae*) To these added amendments was also studied during the investigation. Nitrogen was applied in the form of urea while P was applied in the form single superphosphate (SSP) The parameters studied during the course of the experiment were plant height(cm), number of leaves per plant, leaf area (cm^2), leaves fresh weight (g), leaves dry weight (g), days to head formation, diameter of heads (cm), fresh weight of heads (g), chlorophyll content of leaves (mg cm^{-2}), average yield (kg ha^{-1}), plant N (%), plant P(%), soil N(g kg^{-1}), soil P (%) and soil pH. Total soluble solids and pH of extract showed non significance results for different levels of N. Results showed significant effect of different treatments on the growth, yield and nutrient content of broccoli. Highest plant height (53.54 cm) ,maximum number of leaves per plant (29.66) ,maximum chlorophyll content (23.54 $mgcm^{-2}$) ,maximum leaf area (294.33 cm^{-2}), maximum fresh weight of leaves per plant (344.63 g), maximum dry weight of leaves per plant (201.67 g) ,minimum days to head formation(48.15), (1.96 mg kg^{-1}) and maximum head yield (1195.8 kg ha^{-1}) were observed in N at 100 kg ha^{-1} and P at 120 kg ha^{-1}. So the recommended doses for maximum broccoli production in study area were N at 100 kg ha^{-1} and Pat 120 kg ha^{-1}.

EFFECT OF NITROGEN AND COPPER FERTILIZATION ON GROWTH, NODULATION AND YIELD OF GREEN PEA

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The proposed was carried to examine to examine the effect of phosphorus and copper fertilization on growth, nodulation and yield of green pea at experimental field Department of Agriculture, Extension center subri ,District Muzaffarabad ,during 2020-2021.Experiment was laid out in randomized complete block design(RCBD) with seven treatments and three replications. Data on following parameters were recorded respectively; germination %,number of leaves per plant, number of flowers per plant, number of branches per plant, plant height(cm),number of pods per plant, pod length(cm),fresh weight of pod(g) number of seeds per pod,100 seed weight(g),number of nodules per plant, nodule fresh weight(mg) shoot length (cm) ,root length (cm), seed yield kg $ha^{-1.}$. Following results were obtained; maximum germination percentage (%), minimum germination percentage (66.55), utmost number of leaves per plant (60.43), least number of leaves (53.88), highest number of flowers(53.81), lowest number of flowers (45.30), greatest number of branches per plant (7.46), minimum number of branches (5.93), maximum value of plant height (63.13), smallest value of plant height (48.63), highest number of pods per plant (30.60), smallest number of pods per plant(23.70),maximum fresh weight of pod(7.83),minimum fresh weight of pod (5.33),maximum pod length value (9.25),minimum pod length value (6.62),maximum number of seeds per pod (8.13),minimum number of seeds per pod(6.13), maximum value of hundred seed weight (21.60) ,minimum value of hundred seed weight (19.10),maximum number of nodules per plant (7.80) minimum number of nodules per plant (5.46), maximum nodules fresh weight value (0.0854),minimum nodules fresh weight value (0.0634), maximum shoot length (14.36) ,maximum root length (8.60), minimum root length (7.36), maximum seed yield kg ha-1 (147.33) ,minimum seed yield kg ha^{-1} (96.33)

BIOCHEMICAL VARIATIONS IN WILD ROSES OF RAWALAKOT AZAD JAMMU AND KASHMIR

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Rawalakot is naturally blessed with climatic conditions which are ideal for the growth of wild rose (*Rosa canina* L.). Lots of health benefits e.g common cold, cough, gastrointestinal disorders, respiratory problems, cardiovascular diseases and cancer are associated with it. Rose hips are rich in antioxidants, ascorbic acid, tocopherol, carotenoids and anthocyanins. Currently, no studies have been reported on Biochemical Variations in Wild Rose of Different Locations in Rawalakot. Hence, the present research was designed to collect and characterize wild rose from four different locations (Khai Galah, Chota Galah, Dreak and Mutyal Mehra) in Rawalakot. During this study biochemical compounds (vitamin C, total soluble solids, total flavonoids, total phenols, anthocyanins and antioxidants) was measured data was statistically analysed at 0.05% level of significance while the treatment means were compared using LSD test. Biochemical parameters (total soluble solids, vitamin C, total anthocyanins, total flavonoids, total phenolics and total antioxidant activity). Results showed vitamin C, (46.8 mg $100g^{-1}FW$) total antioxidant activity (3.03 mg $100g^{-1}FW$), total soluble solid (3.66%), total flavonoids (1.56 mg $100g^{-1}FW$), total phenolics (3.30µg gallic acid $100g^{-1}FW$), total anthocyanins, (3.25 mg $100g^{-1}FW$), and pH (3.85), were observed in location L1(Khai Gala). Results revealed that the highest values for biochemical parameters of wild roses were found at Khai Galah which is located at high elevation but the parameters like total phenols, anthocyanins and total flavonoids were observed highest at low elevations. This study will be helpful and base to select the most promising species for further analysis and future studies.

PERI-URBAN VEGETABLE PRODUCTION-SUSTAINABILITY AND PROFITABILITY

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The sustainable agricultural development is referred to the adoption of those practices and technologies, which are socially acceptable, economically viable, and technically appropriate to ensure food security. Being a sub-sector of agriculture, horticulture is recognized as a core supplier of human nutrition requirements in the form of minerals and vitamins. This sector has also played a stem role in employment generation, enhancing farmers' economic status, provision of nutritional security to plethora of people, and enhancing exports. Balanced human diet is a prerequisite for health, and vegetables supply the food nutrients needed for the balanced human diet. Being an essential component of human diet, vegetables are consumed all over the world to have a reduced risk of some chronic diseases. By increasing consumption of fruits and vegetables, lives of about 2.7 million people could be saved each year. In these days, vegetables are not being used merely for cooking purposes but many valuable commodities such as pickles, soups, ketchup, sauces, chutney and salads are the daily used products of these vegetables. Among different provinces of Pakistan, Punjab holds the largest share of 63 and 74% in vegetables' area and production, respectively. The devastating factors behind the drop in vegetable exports include a change in supply and demand dynamics in the foreign markets, natural disasters and unfair profiteering by middlemen.

Keywords: Peri-Urban, Vegetables, Profitability

DEVELOPMENT OF SHORT DURATION STRAINS OF POTATO (*Solanum tuberosum* L.) TO MITIGATE CHANGING CLIMATIC CONDITIONS

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Potato is 4th most important agricultural crop widely grown in different agro-climatic conditions of Pakistan. It is rich in starch and having highest productivity per unit area, it has the great potential to address the challenge of food security. A research experiment was conducted for screening and development of short duration strains of Potato in changing climate during October to March, 2019-20 at research area of Potato Research Institute, Sahiwal. The Potato entries include SH-5, Sante, Kuroda, Sahiwal White, FD-74-38 and FD-74-28. The trail was laid out under split plot design with 4 treatments (harvesting after 60, 80, 100 & 120 days) and three replications keeping plant to plant distance 20 cm, row to row distance 6.0 m×0.75 m. Treatments were placed in main plots keeping in view their secondary importance and varieties in sub plots due to their primary importance. Standardized agronomic practices and plant protection measures were adopted during the crop period. The four treatments were harvested accordingly and data regarding emergence %age, tuber grades, marketable yield and total tuber yield were recorded. The highest tuber yield in T_1 was recorded from the locally developed Potato Strain Sahiwal White (15.3 t/ha) followed by the commercial variety Sante (14.9 t/ha). The highest tuber yield in T_2 was recorded from the Sahiwal White and FD-74-38 (28.6 t/ha) followed by commercial check variety Kuroda (22.8 t/ha). The highest recorded yield in T_3 was recorded for Sahiwal White (39.4 t/ha) followed by FD-74-38 (36.7 t/ha). In T_4, highest tuber yield was given by Sahiwal White (45.2 t/ha) followed by the strain FD-74-38 (43.1 t/ha). The recoded data showed that overall yield of strain Sahiwal White can be cultivated as early bulking Potato strain as compared to commercially cultivated Potato varieties with respect to changing climatic condition.

Keywords: Potato, Changing Climate, Early Bulking, Short Seasoned

EXOGENOUS APPLICATION OF MELATONIN IMPROVES THE GROWTH, PHOTOSYNTHETIC CAPACITY AND ANTIOXIDANT DEFENSE SYSTEM OF BROCCOLI (*Brassica oleracea* L.) CULTIVARS UNDER SALT STRESS CONDITIONS

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Salt accumulation in irrigated soils is one of the main factors that diminish crop productivity. Broccoli is moderately tolerant to salinity. Melatonin is an important molecule with a diverse role in plant abiotic stresses. In this study, we studied the role of exogenously applied melatonin in alleviating salt stress in broccoli cultivars. For this experiment, two popular cultivars (Marathon and Greenport) were selected. Three levels of melatonin, control (0µM), 50µM and 100µM were applied on broccoli plants subjected to salt stress (0mM, 40mM, 80mM, 120mM) and under non-stressed conditions. The results showed that exogenous melatonin application could improve morphological characteristics of broccoli i.e. plant height, the number of florets, head weight, head diameter, root length, shoot length, the number of leaves, relative water content, shoot fresh weight, root fresh and dry weight. The application of 50µM melatonin as foliar spray increased TSS, acidity, vitamin C, β-carotene, Total phenolics and Antioxidants in the broccoli head. Additionally, the foliar spray of melatonin improved chlorophyll a, b and total chlorophyll (head and leaves) and reduced antioxidant damage under salinity stress by enhancing the activity of antioxidant enzymes such as superoxide dismutase (SOD), peroxidase (POD), catalase CAT. Lower malondialdehyde (MDA), H_2O_2, and Proline content were observed in exogenously applied melatonin than in controlled plants under salinity stress in both cultivars of broccoli. The exposure to NaCl salinity determined an increase in Na^+ and K^+ concentrations in plant tissues. However, exogenously applied melatonin reduced the uptake of Na+ from the soil. Among, the cultivars, Marathon showed more tolerance against salt stress than Greenport. Collectively, our data provide evidence that exogenous application of melatonin may ameliorate the salt-induced damage to broccoli plants.

Keywords: Melatonin, Broccoli cultivars, Salt stress, Photosynthetic capacity, Antioxidant enzymes, Vitamin C

COMPARATIVE NUTRITIONAL & STORAGE STUDY OF TWO MANDARIN VARIETIES BY APPLICATION OF VARIOUS SALTS INCORPORATED IN WAX

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Citrus crop postharvest losses can be minimized by investigating different innovations for extension in storage period and shelf life. Various fungicides and salts are incorporated in wax to limit postharvest fruit decay and fungal attack. In the present study two salts were incorporated in commercial wax to control postharvest decay in Willowleaf mandarin *(Citrus deliciosa Tenore)* and Kinnow mandarin *(Citrus reticulata Blanco)*. Sodium bicarbonate and Potassium sorbate incorporated (6% w/v concentration) in wax were used to compare with commercially used fungicide (Thiabendazole). Study was conducted at 4±1 C° with 90±05% relative humidity for 60 days followed by one week of storage at ambient conditions. Least decay incidence 1.2% and 1.8% respectively in Kinnow and Willowleaf was observed in fruit treated with fungicide in wax followed by fruit treated with Potassium sorbate in wax (2.8% and 3.6%). TSS and acidity showed conversely increasing and decreasing trends respectively in both type of fruits with extension of storage period. Willowleaf proved as a close second with respect to various aspects of quality and nutritional value during the fresh fruit analysis undertook prior to storage. Kinnow and Willowleaf didn't differ significantly in juice percentage (46.33 & 43.16), total soluble solids (TSS) (11.20& 10.23), percent acid (0.69 & 0.73), total sugars percent (10.75 & 9.83), crude protein, crude fat and in DPPH activity respectively. The study depicts that incorporation of salts to wax in substitution to the fungicide is an effective application to control postharvest citrus fruit decay with perks of safety and convenience.

Key words: Salts, Kinnow, Willowleaf, Thiabendazole, Potassium Sorbate

EFFECTS OF CLIMATE CHANGE ON CULTIVATION OF CITRUS IN PAKISTAN

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Citrus is one of the main fruits in Pakistan and all over the world. In 2020, citrus fruit production for Pakistan was 2.3 million tonnes. Citrus fruit production of Pakistan increased from 466,000 tonnes in 1971 to 2.3 million tonnes in 2020 growing at an average annual rate of 4.05%. Citrus can be grown in different climatic zones ranging from tropical, subtropical, arid and semi-arid areas, citrus grows properly in the range from 12.8 to 37˚C, which considered the optimum temperature for citrus growth and fruiting, while, sever high temperature (above 44-45˚C) stopped citrus growth completely. Low temperature considered the limiting factor for the geographical distribution of citrus, low temperature could stoop metabolism activity, whereas, chilling and frost cause severe injuries and demolish the whole tree. Temperature fluctuation affects negatively growth, decreases total yield, and reduces fruit quality particularly when occurred during the maturity stage, also, there are negative effects of heatwaves on the production of different citrus varieties particularly seedless varieties like Navel orange, and some Mandarin and lemon cultivars. On another side, rising carbon dioxide has positive effects on the growth of citrus seedlings and trees productivity. Climate change has a dramatic effect on growth and productivity of various crops, there are various environmental elements affect the life cycle of annual and perennial plants, like high temperature, heatwaves, drought, cool temperature and frost, rising carbon dioxide (CO_2) levels. Climate change represents a dangerous challenge for mankind, there need for an efficient strategy to guarantee adequate crop production for humanity.

Keywords: Citrus, Climate change, Temperature fluctuation, CO_2, Yield, Fruit quality

DOCUMENTATION AND NUTRITIONAL STATUS OF WILD VEGETABLES OF TEHSIL HAJIRA, DISTRICT POONCH, AZAD KASHMIR (PAKISTAN)

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This study is based on exploration and nutritional profiling of indigenous vegetables of Tehsil Hajira, District Poonch in Azad Kashmir (Pakistan). Information on edible indigenous vegetable was documented from the local peoples all the way through participatory rural reviews and through questionnaire survey. Ninety informants included elder persons, farmers, students, housewives and children were interviewed to collect data on uses of a variety of indigenous vegetables. During this survey, a total of 50 indigenous plants were recorded that local inhabitants use as vegetables. These plant species were belonged to 31 different families with Asteraceae, Fabeaceae, Lamiaceae, and Brassicaceae being the dominant families. Leaves were the most dominant plant parts used as vegetables. According to frequency of citation, *Taraxacum officinale, Cichorium intybys, Soncus asper, Nasturtium officinale* and *Rumex dentatus* were the most cited plant species and further selected for nutritional analysis. All these plant species were found to have a wide range of nutritional components. The energy value was found for *R. dentatus* (259.74 Kcal/100g) followed by *C. intybus* (250.72 Kcal/100g), *S. asper* (240.59 Kcal/100g), *T. officinale* (240.74 Kcal/100g) and *N. officinale* (236.10 Kcal/100g). In conclusion, there is a diversity of plants which are still present and use as vegetables among the local inhabitants of Hijra, Azad Kashmir. Pharmacological study, proficiency training in home farming and genetic engineering techniques have proved helpful to get better yields and profits manufacture throughout huge level encouragement of these indigenous edible fruits and vegetables. Further biological assays and phytochemical screening of this plant will be performed for better scientific interpretation of traditional knowledge of these plants.

Keywords: Wild vegetables; Nutritional analysis; Hajira

VARIOUS NUTRITIONAL AND BIOSTIMULANT REGIMES IMPACT GROWTH, YIELD AND QUALITY OF CUT SUNFLOWER (*Helianthus annuus* L.)

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Sunflower (*Helianthus annuus* L.) a member of family Asteraceae, is a popular summer annual, which is gaining popularity as specialty cut flower in Pakistan. An experiment was conducted to evaluate the efficacy of various macro and micronutrient applications on growth, yield and quality of cut stems of sunflower cv. 'Vincent's Choice 2'. Experiment was laid out in a randomized complete block design (RCBD) having six treatments replicated thrice. Treatments included no nutrient application (control), N @ 90 kg ha^{-1}, NPK @ 90:45:45 kg ha^{-1}, NPK @ 90:45:45 kg ha^{-1} + micronutrients, viz. Zn, Fe and B @ 1% each, NPK @ 90:45:45 kg ha^{-1} + Isabion @ 4 mL L^{-1} and NPK @ 90:45:45 kg ha^{-1} + Ticamin Max @ 4 mL L^{-1}. Micronutrients were applied as foliar sprays three times at 10-days interval after transplanting, while full dose of phosphorus and potassium and half dose of nitrogen was applied at second irrigation and remaining half dose of nitrogen was applied at fourth irrigation. Data were collected on stem length, leaf area, leaf total chlorophyll content, production time (days), flower diameter, stem fresh & dry weight, stem diameter, flower quality and vase life. Application of NPK plus micronutrients produced tallest plants (95 cm), greatest stem fresh weight (210.8 g) stem dry weight (50.3 g), greatest leaf area (287 cm^2), high total chlorophyll contents (95.4 SPAD), excellent flower quality (9), longest vase life (6.0 days), stem diameter (20.45 mm) and minimum production time (36 days). NPK + Ticamin Max exhibited longest vase life (6.0 days). Whereas, NPK exhibited greatest flower diameter (18.5 cm). Plants supplied with no nutrients (control) had least leaf area, flower diameter, flower quality and vase life. In summary, NPK plus micronutrients performed best for majority of indices and may be used for quality cut stems of this new specialty cut flower crop.

MODERN INNOVATIONS IN FLORICULTURE & POTENTIAL INTERVENTIONS FOR AZAD KASHMIR

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Floriculture is gaining momentum around the globe day by day on account of its potential for higher returns among different horticultural crops. However, Pakistan floriculture is still not so developed and lot of potential exists to fetch foreign exchange from global markets. There are several interventions being done in producing high quality ornamentals and rapid shift towards floricultural crops is being witnessed both locally and internationally. This talk describes some of the modern technologies and practices which are being practices in different parts of the world, developments in local floriculture and potential in Azad Kashmir to fetch maximum from these interventions. These interventions may not only help improve floricultural production in AJK but also improve socio-economic livelihood of local farmers by growing off-season high value floricultural crops.

OPTIMIZING INDIGENOUS BULB PRODUCTION PROTOCOLS FOR *Lilium* L. HYBRIDS USING VARIOUS PROPAGULES

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Lilium, a member of family Liliaceae, is one of the prime bulbous crops cultivated throughout the world as cut flower and potted plant. Production of cut flowers in Pakistan is increasing day by day and majority of the seeds and flowering bulbs are imported from Netherlands by spending a lot of foreign exchange. Moreover, imported planting material may contain pathogens of exotic origin and shipments may also get delayed during transit. Therefore, a study was conducted to evaluate the effect of exogenous application of various plant growth regulators on growth and development of bulblets of *Lilium* L. hybrids. Two cultivars of *Lilium* L. LA hybrids, viz. 'Indian Summerset' and 'Bach' were used for indigenous bulb production. Treatments included no PGR application (control), or NAA, IBA, BA or GA applied individually @ 150, 200, or 300 mg L^{-1}. Data were collected on number of bulblets per scale, weight of bulblets (g), circumference of bulblets (cm), root length (cm), shoot length (cm), number of scales per bulb, weight of bulb (g) and circumference (cm) after first year of growth. Treatments were applied on scales and experiment was laid out according to completely randomized design (CRD) having three replications. Application of different plant growth regulators significantly improved bulb production as highest number of bulblets per scale (5.1 bulblets) and heaviest bulblets after scaling (7.36 g) were recorded when NAA was applied at 200 mg L^{-1}. Lilium cv. 'Indian Summerset' had longest roots after scaling (8.61 cm) with application of IBA at 200 mg L^{-1}, while bulblets with highest circumference after first year (9.8 cm) with application of BA at 150 mg L^{-1}. Both cultivars produced similar number of scales per bulblet (3.9 and 3.8 scales) when BA was applied at 200 mg L^{-1}. Lilium cv. 'Batch' produced minimum weight of bulblets (1.56 g) when BA was applied @ 200 mg L^{-1}. Lilium cv. 'Batch' produced least number of bulblets per scale (1.46 bulblets), minimum weight of bulblets (3.0 g) after first year of growth and no shoot emerged from bulblets when GA was applied @ 300 mg L^{-1}. Application of Auxins viz., NAA and IBA improved growth of bulbs significantly, while application of GA resulted in minimum number of bulblets per scale with highest circumference but without emergence of shoots.

A COMPARATIVE STUDY ON QUALITY SEED POTATO PRODUCTION IN VALLEYS OF GILGIT BALTISTAN

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A comparative study on adaptability of various exotic and high yielding potato varieties was conducted at three different agriculture research stations of Gilgit Baltistan (GB). A randomized complete block design was used with three replications for collection of DATA and a uniform layout was used in all experimental areas. The furrows were prepared having a distance of 75 cm and seed to seed distance was kept at 15 cm apart from each other. Initial dose of Nitrophos @ 25 kg/kanal was applied during sowing time of seed potato and Urea @ 08 kg/kanal was applied at three different stages. The standard agronomic practices were applied in the field during the cropping season. In the current study Lady Rosita, Roko, Kuroda and Bartina showed 100% germination at Yaseen followed by Melanto, Asterix and Sante (99%) while, the least germination rate (78%) was recorded in the var. Zena Red in all locations. Maximum plant height was recorded in Pameela in all locations with highest plant height in Yaseen region (100.3 cm). Maximum number of stems (05) was recorded in Bartina at Naltar followed by Lady Rosita (4.4) and Roko (4) stems plant^{-1}. In the current study potato variety Roko produced 32.1 mt/ha at Babusar and 31.8 mt/ha at Naltar. On the other hand the potato variety Sante and Zena Red were found as least productive in these areas with a production of 8-10 mt/ha at Naltar and Yaseen. The high yielding varieties on basis of their acclimatization and yield performance will be multiplied on large scale though progressive farmers in collaboration of the extensive activites of agrituclute extension department

Key word: Gilgit Baltistan, potato, seed potato variety, adaptation, yield

FERTILIZER USE EFFICIENCY OF VEGETABLE CROPS IS IMPROVED BY THE USE OF ROOTSTOCKS

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The fertilizer application is essential to improve the growth, development and yield of vegetables. Considering the finite sources of nutrients and higher costs of inorganic fertilizers, improvement of fertilizer use efficiency remains a long adhered aim of plant biologist. Different approaches such as development of improved cultivars, modification of root architecture, use of efficient fertilizer application methods and soil microbiota are implemented to maximize the crops yield with minimum use of fertilizer. The use of rootstocks provides an alternative to improve the fertilizer use efficiency of fruit and vegetable crops. The use of rootstocks is comparatively new for vegetable crops. The selected species are utilized as a rootstock for the elite scion cultivars. Normally, vigorous rootstocks are utilized that have the capacity to explore more soil area and absorb water and nutrient and transport to the above ground plant parts (scion). Additionally rootstocks improve the nutrient assimilation by improving the supply of cytokinins to the scion. According to one of our study, pumpkin rootstock improved the nitrogen use of efficiency (NUE) of watermelon under normal and low nitrogen supply. Several other reports suggest that rootstocks can improve the nutrient use efficiency of vegetable crops. The use of rootstocks/grafting for vegetable crops is a new concept in Pakistan and this can be utilized to improve the fertilizer use efficiency without compromising the yield and quality. The development of protected cultivation further necessitates the use of rootstocks for vegetables.

Key words: Grafting, fertilizer use efficiency, ion uptake and transport, NUE, rootstocks, grafted transplants

EFFECT OF SALICYLIC ACID AND ALOE VERA GEL ON THE SHELF LIFE OF STRAWBERRY

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Strawberry (*Fragaria ananassa*) is considered an important fruit crop all over the world due to its high nutritious values but it has a minute postharvest and storage life. The study was conducted to observe the capacity of salicylic acid (SA) and Aloe Vera (AV) as a pre-storage coating material on strawberries to increase their shelf life. The fruit was treated with different concentrations (o%, 1%, 2%, 3%) of salicylic acid and aloe Vera gel. Then fruits were air-dried and placed at room temperature for 3 days. Physical Parameters include fruit color, total weight, rotting, and fruit weight loss biochemical parameters such as total soluble solids, titrable acidity, total sugars, reducing sugars, non-reducing sugars, vitamin C, and antioxidants (DPPH, TFC, and TPC) were analyzed after the one-day interval. The use of SA and AV gel coating material showed a low weight loss of 7.128% in fruits that were coated with 1% of SA and AV and more weight loss (15.043%) was recorded in the fruits which were uncoated. Furthermore higher amount of total sugars (41.278%) was recorded from the fruit of the same treatment as compared to non-coated fruits. A higher score of Vitamin C (4.2667mg) and non-reducing sugars 25.144%were also found in the fruits which were treated with 1% SA and AV gel. The coating of SA and AV gel also reduced the rate of acidity, delayed the rotting percentage, and retained all the postharvest quality and parameters of strawberry fruits as compared to control fruits during storage. According to the results, it was concluded that 1% of SA and AV gel can use safely as a coating material to improve the shelf life and maintain the fruit quality of strawberries for 3 days at room temperature.

BORON: IMPORTANCE, DEFICIENCY SYMPTOMS AND TECHNIQUE OF GRAFTING TO ENHANCE ITS UPTAKE IN WATERMELON

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Boron (B) is a micro-element essentially required for physiological functioning of plants. In watermelon, B is involved in structural integrity of cell wall and plasma membrane, ion flux across plasma membrane, cell division and elongation, plasmalemma-bound enzymes, nucleic acid metabolism, photosynthesis, sugar transport, and pollen growth and fruit development. Deficiency of B negatively affects watermelon growth and results in thick, curled, brittle chlorotic leaves with reduced leaf expansion, corky veins, water-spots on entire leaves and short inter-nodal distance giving plant bushy appearance. Several approaches such as structural modification of root system, application of biostimulants including mycorrhizal fungi and rhizobacteria, nanotechnology, melatonin application and grafting can be utilized to overcome B deficiency in plants. Grafting is an environment friendly technique that can be utilized to mitigate B deficiency in watermelon. Vigorous root system of wild type watermelon and pumpkin rootstock enable plant to capture B deeper in the root zone that is unevenly distributed under less available B conditions. Moreover, these rootstocks have ability to up-regulate the expression of B transporters genes and antioxidants related genes that help enhance B uptake and reduce oxidative damage under less available B conditions. The improved B concentration mediated by rootstocks has positive impact on plant growth and photosynthetic efficiency of the plants that ultimately improves watermelon growth. In conclusion, we suggest that the B efficient rootstocks can be utilized to improve B uptake of watermelon under limited available B conditions.

Keywords: *Citrullus lanatus*, boron efficient rootstocks, boron deficiency, boron uptake and transport

SCREENING OF GUAVA (*Psidium guajava* L.) GERMPLASM FOR PLANT GROWTH AND PHENOLOGY

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Like other fruit crops guava varieties show differential phenological behavior in vegetative and reproductive growth depending upon the climatic conditions and cultural interventions. Hence, the study was initiated to establish different phenological stages in the available guava germplasm at GPU of the Institute following standard BBCH general scale and Fleckinger's coding. Minimum number of days for vegetative bud emergence (5), bud swelling (10) and growth beginning (14) were taken by Round varieties G1 followed by G2 whereas among Pyriform varieties minimum number of days for these stages (8, 12 and 15 respectively) were taken by S4. Similar trend of minimum number of days required for 1st leaf sprouting, leaves unfolding and leaves developed stages was observed in G1 (22, 26, 31), G2 (20, 25, 29) and S4 (19, 25, 30) varieties, respectively. Regarding flower bud appearance, visibility and elongation varieties G1 (35, 38, 42), G2 (33, 36, 41) and S4 (34, 37, 42) took minimum number of days for these stages, respectively. Similarly, 50% flower opening, petal fall and fruit setting was also earlier and took minimum number of days in G1 (49, 54, 59), G2 (49, 53, 58) and S4 (50, 55, 59) varieties, respectively. Regarding fruit growth stages, 80% fruit growth was attained by Round varieties G6 and G7 in 83 and 94 days, respectively followed by Pyriform variety S4 which took 119 days. Fruit color change and ripening was earlier in G1 (115, 124 day), G2 (118, 126 days) and S4 (124, 132 days). Conclusively, Round varieties G1 and G2 and Pyriform variety S4 showed an early plant and fruit growth compared with other guava varieties. This study established diverse genotypic behavior for the expression of various pheno-stages and their interplay with the environmental components. The outcome will be useful for better management of crop under changing climatic conditions.

Keywords: Genotypic variability, floral bud development, fruit setting, fruit growth, environmental cues.

ECONOMIC POTENTIAL OF TURMERIC (*Curcuma longa* L.) FOR VALUE ADDITION

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Turmeric (*Curcuma longa* L.) belongs to the family zingiberacae and it is a perennial herbaceous spice crop that is also known as queen of spices. It is considered as a medicinal crop with high drug yielding potential mainly due to the presence of three main compounds viz., volatile oil, curcumin and oleoresin. These compounds highlight its functional feature in the form of antioxidants, anti-inflammatory, antimicrobial properties and as a treatment agent against cervical cancer. Turmeric nutritional profile makes its usage as a spice and medicinal crop in flavoring, coloring and cosmetic industry and a diverse range of value added products can be obtained from the turmeric crop including medicinal creams, soaps, cosmetics, candies, drinks, tablets etc. Among these the most important is the turmeric powder that is a common ingredient used in our daily cooking is obtained by the drying of rhizome. Along with these products, fresh juice is also extracted from the turmeric rhizome. Due to its potential for value addition there is need to focus on the value addition of turmeric crop with main emphasis on the composition, quality and its marketing that may results in the production of various products linked with with various industries that ultimaely results in novel food production.

Keywords: Antioxidant; anti-inflammatory; anti-microbial; Curcumin; oleoresin; rhizome; volatile oil

MARIGOLD (*Tagetes erecta*) SEED GERMINATION META METAMORPHIC IMBIBITION WITH UNDER DIFFERENT NUTRIENTS

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Global warming and change of climate triggers to combat the feeding need of population, seed represent the basic requirement for a quality plant material. Present study has been formulated to discuss and analysis version or seed quality attributes for better selection and seed evaluation. Therefore, Seeds of marigold were emerged in 1% solution of Ammonium sulphate, Boric acid and Potassium Nitrate to get the accuracy of seed germination. Experiment was laid out in CRD design with three replications. Results for seed germination (Table-1) showed that seeds imbibed in potassium Nitrate (KNO_3 1%) induced maximum seed Pearson correlation showed a very strong positive correlation observed in MGR with CVG=0.4482, FDP=0.3696, G=0.4554, GI=0.4551, GP=0.4499 and GRI=0.3766). This study showed that seed vigor is directly related with germination and germination related traits in seeds. It has a great impact on crop yield and climate.

Keyword: Marigold, Imbibition, Germination, Ammonium sulphate, Boric acid and Potassium Nitrate

CONVENTIONAL AND MODERN DEHYDRATION TECHNIQUES USED FOR PLUM (*Prunus domestica*) PRESERVATION

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Plum (*Prunus domestica* L.) is the economically important stone fruit species having a high market value and possess a marvelous nutritional profile. It is considered as a functional food as it contains bioactive compounds like dietary fibers, minerals, phenolic compounds, vitamins, etc. Due to its nutritive value plums have an influence on the human health and protects from several diseases. Worldwide fresh and processed form of plum are highly consumed. However, dehydrated plums are best for the production of instant products such as powder, drink, sauces and pickle as dehydration facilitate long term storage, easy packing and transport. Traditionally it is done through drying under sunlight, hot air drying and osmotic dehydration. Currently molecular press dehydration technique is used but the cost of this method is high. Further, red algae extract is another cost-effective dehydrating agent that is used in plum dehydration. However, its optimum dose is required for the extension shelf life of processed plums. Besides all these available techniques, there is a need to access such technique that is energy efficient and cost effective and may be used at commercial scale.

Keywords: Agarose, dehydration, maltodextrin, red algae

GROWTH AND PRODUCTION OF CHILIES (*Capsicum annum* L.) UNDER SUN DIRECTION AND SLOPE TOPOGRAPHY

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Growth of chillies has always been under influenced of climatic conditions and edophic factors, among then sun direction and slope topography are the most affecting crop growth and yield. Present study was carried out on growth and production of chillies (capsicum annum L.) in relation to slope topography and sun direction at the experimental field of horticulture department. Sindh Agriculture University Tandojam, during 2021-22**.** The seedlings of about 45 days old of were transplanted in north and west sun directions in slope and flat topography. The results revealed that the sun directions and topography had a statistically ($P<0.05$) influence on all of the examined parameters in this study. Most of the chillies growth and production characteristics were observed to be the best in slope topography(0.86%) in direction north producing the highest plant height (29.50 cm), leaves plant^{-1} (13.01), branches plant^{1} (3.05),minimum days to flowering (25.48), length of leaf after transplanted (8.17), chlorophyll content(Spad) (33.41), days to fruit set (33.57), fruit yield plant^{1} (362.54 g), single fruit length (9.66cm) and single fruit weight (10.82 g). The plants transplanted on flat topography north direction showed plant height (19.89 cm), leaves plant^{1} (9.13), branches plant^{1} (2.15), minimum days to flowering (29.72) length of leaf (4.68 cm), Spad (24.53), days to fruit set (40.13), fruit yield plant^{1} (284.15 g), single fruit length (6.84 cm) and single fruit weight (6.51 g). The lowest results for plant height (19.07 cm), leaves plant^{-1} (8.49), branches plant^{1} (2.03), length of leaves (3.88 cm), Spad (21.03), fruit yield plant^{1} (239.65 g), single fruit length (6.27cm) and single fruit weight (5.22 g) were recorded from the flat topography in north direction. Days to flowering (24.23) and days to fruit set (30.62) was recorded in slope topography in north direction. Best results from present study more obtained in chillies seedling when transplanted an slope in north sun direction.

Key words: Chillies growth, Chillies production, Sun directions, Slope topography, Flat

PULSING TREATMENTS AND TEMPERATURES TO ENHANCE POSTHARVEST QUALITY IN ORCHID GENOTYPES

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Orchids are valued throughout the world due to their shapes, and fragrance, well known for their antioxidant properties in pharmaceuticals and cosmetics industries. Highly significant results were generated on various postharvest parameters of "Dendrobium Sonia". Maximum bud opening percent 100 %, flower diameter (31.84cm), flower freshness 30.28 days, flower longevity 30.28 days, color quality 30.28 days,vase life 30.28 days, flower drop percent (0.00), water uptake 20.86 ml was observed pulsing with 30 mg L^{-1} $AgNO_3$ for 30 minutes followed by 0.5mM STS for 24 hours. "Mokara Dieheart Red" were highly significant at temperature 22°C±2°C maximum bud opening %age observed under pulsing with 30 mg L^{-1} $AgNO_3$ for 30 minutes which gave highly significant results (100%). Flower diameter 11.91 cm was observed under pulsing treatment of 0.5mM STS for 24 hours, maximum days to flower freshness 15.05, flower longevity 14.20 (days), color quality 14.28 (days), vase life 15.05 (days), water uptake 14.07 ml and minimum flower drop percentage 5.38%, NOTED with pulsing treatment of 30 mg L^{-1} $AgNO_3$ for 30 minutes followed by 0.5mM STS for 24 hours. At temperature 30°C±2°C best treatment was pulsing with 0.5mM STS for 24 hours. Oncidium had improved postharvest parameters under pulsing with 50 mg L^{-1} $AgNO_3$ for 30 minutes, for maximum flower diameter 3.87 cm, flower freshness 18.88 days, flower longevity 16.77 days, flower color quality 18.56 days, vase life of 19.16 days, flower drop percentage 3.51% and water uptake 5.13 ml followed by 4.23 ml 30 mg L^{-1} $AgNO_3$ for 60 minutes.

Key words: Orchids, $AgNO_3$, Silver Thiosulphate, 22°C±2°C, Postharvest, vase life

EVALUATION OF DIFFERENT CULTIVARS OF CHERRY (*Prunus avium*) IN ZIARAT IN TERMS OF REPRODUCTIVE GROWTH AND FRUIT QUALITY ATTRIBUTES

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Cherry is an important fruit of the temperate zone and has tremendous economic potential. Therefore, in order to know the best performing cultivar of Cherry, six different cultivars of cherry (Black Cherry, White Cherry, Van, Ferrovia, Stella, and Lambert) grown in ziarat were evaluated for their reproductive and fruit quality parameters. One plant of each cultivar was randomly selected and data was taken from four different healthy branches. The experiment was laid out according to RCBD and replicated thrice. Different reproductive growth parameters including time of budburst, time of flower opening, time of full bloom, flowering intensity, fruit set %, time of fruit maturity, fruit drop %, and fruit yield per tree (Kg) were recorded. For fruit quality assessment, fruits were harvested at physiological maturity. 'Black cherry' has proved to be a superior cultivar having the maximum fruit diameter (26.90 mm), fruit weight (7.63 g), stone weight (0.68 %), pulp weight (3.55 %), maximum pulp stone ratio (16.96) but the drawback is late maturity (79 days) as compared to all other cultivars. The highest fruit drop (43.69 %), and weight loss (14.05 %) were observed in Ferrovia. Further, 'lambert' showed maximum flower intensity but late flower opening so it proved inferior in comparison with Black cherry. The highest fruit setting (40.29 %) was noticed in 'van' so this proved to be a vital cultivar after black cherry. The study provides preliminary information about the growth and fruit quality attributes of cherry cultivars being grown in ziarat.

Keywords: Black cherry, Ferrovia, Ziarat, Fruit quality, Cherry cultivars

RESPONSE OF OKRA TO VARIOUS INTEGRATED NUTRIENT MANAGEMENT PRACTICES

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Judicious use of organic and inorganic fertilizers can improve crop yield and soil health. Effects of different organic fertilizers in combination with various doses of nitrogen were investigated on the growth and yield attributes of okra (*Abelmoschus esculentus* L.) cv. 'Sabaz pari'. Eight different combinations of organic (Vermicompost @ 5 tons/ha, Azotobacter, and + Azotobacter + vermicompost @ 5 tons/ha) and inorganic fertilizers (Nitrogen 75 Kg/ha and Nitrogen 150 Kg/ha) were used. In control, only organic fertilizers were used. Combined use of Azotobacter + vermicompost @ 5 tons/ha + Nitrogen 150 Kg/ha showed a significant increase in plant height, fruit per plant, fruit length, and fruit yield per hectare. Moreover, fruit quality parameters such as nitrogen, protein, and crude fiber contents were also improved by the combined use of azotobacter, vermicompost @ 5 tons/ha, and nitrogen @ 150 Kg/ha. These results suggest that the combined use of azotobacter, vermicompost @ 5 tons/ha, and nitrogen @ 150 Kg/ha can positively affect okra fruit quality attributes and yield.

Keywords: Azotobacter, Vermicompost, Bio-fertilizer, Okra, Fruit Quality

PROFILE AND NUTRITIONAL ANALYSIS OF SELECTED INDIGENOUS FRUIT ETHNOBOTANICAL PLANTS OF DISTRICT POONCH AZAD KASHMIR

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Food security, a global challenge faced by the humanity in 21st century is worsening by climate change. Factors like pandemics, world population growth and disparity and loss of biological diversity are aggravating the situation. Historically, the human kind has being relying on wild Fruit and edible plants for most of his day to day nutritional requirements. Despite of innumerable gains, modern agriculture has shrunk the food basket size down to a few cereals and handful of commercially grown fruits. One adaptation strategy therefore, is to reinvigorate wild edible plants (WEPs) by harnessing folklore into organic food market as already being practiced in certain western countries. Due to their substantial medicinal and nutritional potential WEPs are becoming more popular. Present study was based on Ethnobotanical exploration and nutritional profiling of selected five indigenous fruit plants of District Poonch Azad kashmir including viz; *Prunus persica*, *Elaeagnus umbellata, Pyrus communis*, *Ficus carica and Diospyros lotus* .Information about major uses of these fruits was documented from the study area through an ethnobotanical survey conducted in the area during summer-fall, 2021. A total of (50) locals were interviewed as informants those included elders, students, farmers, teachers and housewives. During the survey *Prunus persica* was recorded by (42) participants as edible fruit followed by *Ficus carica* recorded by (39) people. *Pyrus communis* was reported as dominant plant for commercial purpose by maximum number of participants (26). The selected plants were followed for their nutritional analysis and medicinal values. The nutritional characterstics of these fruits were analyzed according to standard methods (constituted by the Association of Official Analytical Chemists and other well- known researchers) on a fresh weight (fw) basis. Highest values of total sugars was found in *Ficus carica* (28.1%) followed by *E.umbellata* (11.79%). Maximum for ascorbic acid contents were recorded in *P. communis* (6.5%), maximum moisture content was found in *E. umbellata* (47.63%) followed by *P. persica* (32.96%). *P. communis* showed highest antioxidant activity whereas highest flavonoid content was found in *E.umbellata (*64.2%). In our study *P.communis* was found to be the most significant fruit with maximum number of uses and highest values during nutritional analysis, followed by *F. carica* Pharmacological study, proficiency training in home farming and genetic manipulation may be helpful to get better yields, longer shelf life and nutritional value. Moreover, the commercialization of these fruits through value addition can boast local economy.

GERMINATION CAPACITY AND VIABLITY OF STORED POLLEN OF TWO ECONOMICALLY IMPORTANT PRUNUS L. SPECIES OF FAMILY ROSACEAE AND THEIR MAINTENANCE

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Palynology is the study of pollen and spores science. Palynology towards the functional aspects of pollen or Biopalynology. The successful pollen preservation, maintaining the germination capacity of stored pollen can be useful in time saving and hybridization programmed. During present study Pollen germination capacity and viability of two economically importance fruit species viz., *Prunus domestica* L., and *Prunus persica* (L.) Seib & Zuce belong to family Rosaceae were examined up to 48 weeks. Viability was determined on the basis of germination ability of pollen on sucrose medium with boric acid solution. Fresh pollen were stored at different storage conditions including refrigerator (4°C), freezer (-20°C, -30°C), freeze drier (-60°C), vacuum chamber and organic solvents. Fresh pollen of *P. domestica* showed 75.0% and 70.0% germination was recorded in *P. persica.* Among stored conditions 32.6% and 42.5% of germination was noted at 4°C, whereas 29.4% and 39.0% on -20°C, and 42.7% and 40.0% on -30°C in *Prunus persica* and *Prunus domestica* respectively. Pollen stored at low temperature -60°C showed better germination as compared to pollen stored at 4°C and fresh. *Prunus domestica* showed much better germination percentage at -60°C (50.00%) whereas, *Prunus persica,* showed 43.40% germination after 48 weeks of storage. Pollen stored over silica gel in vacuum of both the species showed good germination as compared to organic solvents. Freeze drying treatment method seems to be better for long term pollen storage.

DETERMINATION OF ASCORBIC ACID AND BETA-CAROTENE FROM (*Capsicum annuum* L.) GERMPLASM USING HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

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A simple, accurate and rapid method for analysis of ascorbic acid and beta carotene from *Capsicum annuum* germplasm has been developed. It was based on separation of the studied compounds using high performance liquid chromatography (HPLC). Due to the difference of physical and chemical properties of both antioxidants, two different procedures were performed. Their identification was based on their retention time (RT), whereas quantification was carried out by using the areas of respective peaks comparing with standard calibration curves. Antioxidants (ascorbic acid and beta carotene) showed wide variation among the genotypes. Ascorbic acid ranged from 85.99 to 317.65 mg/100g whereas beta-carotene varied from 129.37 to 1318.07 ug/g among 133 genotypes. This method was used for selection of high quality pepper genotypes having these health related components, which could be further utilized as a parent plants in hybridization studies for crop improvement programs.

Keywords: Ascorbic acid, Antioxidant, Beta carotene, Pepper germplasm, HPLC

FLORISTIC DIVERSITY AND ECOLOGICAL CHARACTERISTICS OF FLORA OF KHARAWO TALASH, DIR LOWER, KHYBER PAKHTUNKHWA, PAKISTAN

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In the Present study, the floristic composition, phenology, life structure, leaf size and plant habit for the different plant in Kharawo Talash Dir Lower were investigated during March 2015 to November 2017. The flora of Kharawo Talash was found to have 165 species, belonged to 79 families and 129 genera. As per the plant habit, there are 115 species of herb, 27 species of shrub, 18 species of the tree, 02 species of grasses and climbers and one species sedge. The well-represented families were Asteraceae contributing 19 taxa, Lamiaceae 14, Rosaceaae or Solanaceae 07, Papillionaceae and Polygonaceae and Euphorbiaceae 05, Brassicaceae contributing 04 taxa. The Life form classes were controlled by Raunkiaers strategy which uncovers that the most predominant living thing was Therophytes half species, followed by Nanophanerophytes 15%, Megaphenerophytes 09%, Chameophytes 08%, Hemicryptophytes 07%, Geophyte 05%, Cryptophyte 4.6%, and Liana 02%. As for as the leaf size is concerned, Microphyll was the most pervasive leaf size with 52% species, followed by Nanophyll 25%, Mesophyll 15%, Leptophyll 7% and Megaphyll with 1.2%. Study the overall ecological scenario and might be helpful as a reference study for protection and manageable utilization of plants.

Keywords: Floristic composition, Ecological characteristics, Kharawo Talash, Pakistan

MORPHOLOGICAL DIVERSIRT OF FIG (SPP.) COLLATED FROM AZAD JAMMU & KASHMIR

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Figs (*Ficus* spp.) are among high value fruits, well known for their nutritive value, unique taste and high medicinal properties. Fruits are consumable in both fresh and dry form. Azad Jammu & Kashmir (AJ&K) is enriched with variety of diverse fig species. Despite enriched diversity, their morphological characterization needs thorough investigation. Therefore, the present study was conducted in ten districts of AJ&K to evaluate and characterize the local fig germplasm based on morphological variations. Morphological investigations led to the identification of 50 fig accessions from three species i.e. *Ficus palmata, Ficus racemosa* and *Ficus carica.* Experiment regarding morphological study was performed in three biological replicates. Analysis of variance was performed at 5% level. The coding of accessions was made as per district name. Morphological study revealed significant variability among 50 fig accessions. Shoot length and number of leaf per shoot was found maximum in BG4 (*F. carica*) with values of 23.77cm and 10.14 respectively, while minimum values (8.14 cm, 5.00) were observed in KT3 accession belonging to *F. racemosa*. Leaf area was found with highest value in BG5 (210.97 cm^2) while lowest value was observed in MP4 (41.90 cm^2). Petiole length was measured with higher values in NL1 (72.50 mm) while least values were found in PN3 (17.31 mm). Fruit weight was found maximum in JV4 (55.39 g) while minimum value was found in MP4 (2.37 g). Fruit colour lightness (L*) values were found higher in MZ1 (70.87), whereas lesser values were found in HV4 and MP4 (24.93 and 2.11). Moreover, dendrogram based on morphological traits grouped 50 fig accessions into two main clusters. Cluster-I comprised of fig accessions belonging to *F. racemosa*. While, cluster-II was comprised of 8 accessions of *F. carica* and 35 accessions of *F. palmata*.

Keywords: Fig accessions, Morphology, Diversity, AJ&K

RECENT ADVANCES FOR DEVELOPMENT AND COMMERCIALIZATION OF PLANT TISSUE CULTURE FOR THE SYNTHESIS OF NATURAL PRODUCTS

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A rapid increase in population is directly linked to the limited production of natural and domestically cultivated crops. There is a dire need to adopt novel methods for enhanced crop productivity to circumvent this concern. Crop improvement has taken the lead to improve the per capita yield of the crops with the advent of different techniques, for example, plant tissue culture. Recently, plant-derived chemicals are being utilized in various pharmaceutical, pharmacological, medicinal, and other industries. However, the domestication of the plant sources of valuable natural products is restricted, thus, restraining their production on a commercial scale. There are various production systems for plants such as natural harvest, semi-synthesis from isolated precursors, and expression of plant pathways in microbial systems. Plant tissue culture is a sustainable and environmentally friendly tool for the industrial production of plant natural products. It serves as an alternative supply for the production of medicinal natural products, which are associated with low yields in nature. Further, advances in cell line selection, biotransformation, product secretion, cell permeabilization, extraction, and scale-up improve plant natural product yields. Advances in plant cell and tissue culture techniques could be an alternative for the cost-effective and commercial production of exotic plants and their natural products. In vitro production of secondary metabolites in plant cell suspension cultures has been reported in several medicinal plants by exploiting bioreactors for their commercial production.

Keywords: Plant tissue culture, Natural products, Cell suspension cultures

MITIGATION OF CLIMATE CHANGE EFFECT IN SWEET PEPPER (*Capsicum annuum* L.) THROUGH ADJUSTMENT OF PLANTING TIME

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Sweet pepper (*Capsicum annuum* L.) is one of the most popular and high value vegetable crops grown for its immature fruits throughout the world. In Pakistan it is cultivated as warm season crop in open fields during summer and in plastic tunnels during winter. Optimum planting date in sweet pepper production is key to better yield as it determines the period of maximum crop potential, efficient use of resources, lesser competition of plants with weeds and insect pests. It is the need of time to understand the negative impact of climate change on phenological development of sweet pepper. Therefore, the current study was designed to mitigate the effect of climate on growth and yield of sweet pepper cultivars at agro-ecological area of Multan, Pakistan by adjusting planting date. Three transplanting dates (viz. February 15th, March 2nd and March 16th) were evaluated during year 1 whereas five transplanting dates (viz. February 1st, February 15th, March 2nd, March 16th and April 1st) were assessed during year 2. There were three sweet pepper cultivars (Ganga, Winner and Savio) under study. Overall plant growth (stem height, average canopy diameter, number of leaves per plant and fresh and dry mass of plant parts) was significantly higher in the earliest planting dates (viz. February 15th in year 1 and February 1st in year 2) and it reduced as the planting was delayed. Plant yield, number of fruits and average fruit weight were also significantly greater in the earliest planting dates, and significantly lesser in later planting dates. During year 1, the effect of cultivar was prominent, and Winner performed better regarding growth characteristics while the effect was non-significant on yield attributes except average fruit weight which was also significantly higher in Winner as compared with other two cultivars. During year 2, cv. Winner performed better in growth attributes, whereas significantly greater number of fruits was found in cv. Savio, average fruit diameter was greater in cv. Winner and average fruit length was higher in cv. Ganga. It is concluded that nursery of sweet pepper should be planted in 1st week of February to achieve maximum growth and yield of fruits. In cultivar selection, cv. Winner should be preferred among sweet pepper hybrids.

Keywords: *Capsicum annuum*, growth attributes, leaf area index, planting dates, sweet pepper cultivars, yield attributes

CAUSES AND CURES FOR PRE-MATURE APPLE FRUIT DROP IN AZAD JAMMU & KASHMIR

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Apple (*Malus domestica* Borkh.) is one of the most popular temperate fruit. It grows well in areas with low temperatures, and fortunately Rawalakot lies at an altitude of 1800-2000 m and latitude of 33-36° in North Eastern Pakistan, under the foothills of Himalaya and its climate is very much suitable for growing apples. Currently, apple is being cultivated as a major fruit crop in five Districts of AJK including Poonch, Bagh, Sudhnoti, Muzaffarabad and Neelum. A number of cultivars including Kashmiri Amri, Star Crimson, Red Chief and Red Delicious can be found in these districts. However, due to multiple factors including nutritional deficiencies, insect pest and diseases, and quick variations in climate fruit yield has been observed low during the last few years. These factors resulted in a severe pre-mature fruit drop of apples in this area. In some cultivars this drop was up to 20% while in some other cultivars it was up to 50%. In recent past, this pre-mature fruit drop of apples in Rawalakot has resulted in severe economic losses to the local growers. Due to high humidity in this area most of the apple trees and fruits are susceptible to different fungal diseases. Climatic conditions of this area are also suitable for insect pest attack. Whereas, heavy rains causes' disturbance in physiological growth of pedicle due to excessive secretion of polygalacturonase enzymes may results in pre-mature fruit drop. So far, no studies have been conducted to find out the actual cause of this problem and its management under Rawalakot conditions. Fruit drop at pre-mature stage with inadequate size causes severe losses.

POTENTIAL OF DIFFERENT COMMERCIAL COMPOSTS AS A SOURCE OF COMPOST TEA FOR ORGANIC FARMING

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Compost is a cultivation medium that can support healthy growth of plants even without application of chemical fertilizers. The bioavailable nutrients are always in solution form and solutions derived from composts called compost tea could indicate their quality by act as balanced or imbalanced nutrient cultivation medium. The current study is aimed at deriving compost tea form different types of composts procured from commercial market and its application as a nutrient medium for growing plants through organic farming. Compost tea prepared with cold and hot water and methanolic extracts with different ratios (1:4, 1:5, 1:10, 1:20) of 5 different types of compost (C1, C2, C3, C4, C5) were applied to Lettuce seedlings and the growth was measured. Different quality parameters of composts were assessed, and it was observed that hot water extract of compost with ratio 1:4 showed the highest growth of lettuce seedlings and methanolic extracts of all compost showed significantly lower growth of lettuce seedlings. The potential of 1:4 hot water extracted compost tea was strongly correlated with quality of the source compost.

ASSESSING QUALITY OF COMPOSTS BASED ON ITS DEGRADATION METABOLITES AND ITS EFFECTS ON CULTIVATED PLANTS

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High quality composts are derivatives of extreme activity of microbes, macrobes and compost critters. Hence, mature compost of high quality would be having multiple biodegradation compounds derived during aerobic decomposition of multiple types of organic feedstock. The current study was aimed at assessing quality of composts based on its composting biodegradation derivates taken from five different types of commercial composts (C1, C2, C3, C4 and C5) and its effects on healthy growth of Okra (*Abelmoschus esculentus*) against control taken as mixture of perlite and vermiculite. The plant growth parameters of okra ware correlated with biodegradation derivatives of the composts. The results showed that seed germination of okra was healthier in C1 and C4, being distinctively well in C3, while being extremely poor in C2 and C5. The color and texture of C1 and C4 was darker and more amorphousness (ingredients being unidentifiable) respectively than other composts i.e. it had apparently more maturity than other composts.

FLORISTIC DIVERSITY AND PHYTOSOCIOLOGY OF SHRUBS AND TREES OF DISTRICT BHIMBER, AZAD JAMMU KASHMIR, PAKISTAN

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The floristic diversity and phytosociological studies on vegetation of Bhimber hills, Azad Jammu and Kashmir were analyzed and carried out using quadrate method by randomly selecting 9 communities in moonsoon and spring seasons in 2020-2021 at an elevation range of 200 meters- 370 meters from sea level based on topographic variations and edaphology. Quadrate of 10×10 m^2 was used for trees and 5×5m^2 was used for shrubs. Floristic table was prepared with scientific names, common names, families, life form and leaf spectra. Floristic diversity consisted of 83 species of trees and shrubs belonging to 28 families of Angiosperms and 5 families of gymnosperms. So, 92.77% (77) were angiosperms and 7.3% (6) were gymnosperms. Fabaceae family was most dominant with 10 species and 30.30%age followed by Moraceae(7), Rosaceae(6), Malvaceae(5), Myrtaceae(5) and Rutaceae(4) with 21.21%, 18.18%, 15.15%, 15.15%, and 12.12% remaining families were 9%, 6% and 3% with number of species as 3, 2 and1. Density (D), frequency (F %), Crown cover (CC) and their relative values of relative density (RD %), relative frequency (RF %) and relative crown cover (RCC %) were recorded from each species after collection of data from different communities and localities. Importance value index (IVI) was also found for each species and communities were named after 3 leading species with greater values of IV. Other parameters measured were life form, leaf spectra, species diversity its components, species maturity and soil analysis. Community number one showed greater species diversity. Life forms showed the greater variety of Megaphenarophytes (62.65%) and nanophanerophytes were 37.34%.Maturity index showed that five communities were immature and four were mature. Nine communities were recorded from District Bhimber during sampling and these communities include: Albizia-Acacia-Ziziphus community, Mangifera-Justicia-Cordia community, DelbergiaToona-Justicia community, Eucalyptus-Ziziphus-Justicia, Delbergia-Butea- Lantana community, Acacia-Ziziphus-Justicia community, Acacia Lantana Butea community, Pinus-Dodonia- Mallotus community, Pinus-Dodonia-Acacia community. Leaf size classes showed the dominance of Microphylls with 37 species (44.57%). Soil texture was loam to sandy loam. PH of soils ranged from 7.31- 8.63. Phosphorus (P) content was greater in community one and two. Organic matter content was greater in Acacia-Ziziphus Justicia community and Pinus-Dodonia- Mallotus community. Organic matter ranged from 0.21 to 0.98%. Species diversity was high in lower elevations areas while it gradually decreases in higher elevations.

Keywords: Floristic diversity, Community, Phytosociological studies, Quadrate method

MORPHO-NUTRACEUTICAL CHARACTERIZATION OF INDIGENOUS AND EXOTIC MANGO GENETICS OF MULTAN

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Mango fruit is famous for its delicious taste, health benefiting and high nutritional composition. However, nutritional and quality parameters of mango vary from variety to variety. Therefore, the present study was an attempt for the fruit nutraceutical and morphological characterization of different mango varieties grown in Agro-climatic conditions of Multan district. Fruits were harvested from Mango Research Station (MRS) Shujabad and Durani Farm (DF), Multan at physiological mature stage and were kept at ambient conditions for ripening and further morpho-nutraceutical characterization. In 65 different varieties, physical parameters such as fruit length (14.07±1.26mm) was observed maximum with lowest stone length (5.4±0.08 mm) in "Haider shah". Average stone diameter (3.9±0.04 mm), weight (77.3±3.38 g) and peel weight (85.0±3.25 g), firmness level (78.80±5.08 N) were noted highest in Bullock's Heart", "Fajri", "R□E□" and "Haider shah" respectively. Lightness values of L at maturity stage were observed higher in "Dusehri long" (285.19±245.9), chroma a^* values in "Kensington pride" (10.9±0.69) and chroma b^* values in "Late Sindhri" (31.9±111.1) while at ripening stage L values were greater in "Faiz Kareem" (71.9± 0.72), a^* values in "Palmer" (23.2±2.63) and chromaticity values of b^* in "Sindhri" (243.9±208.57) as compared to other varieties. Similarly, bio-chemical parameters including TSS, TA, pH and Vit. C ranged from 14.17-30.51, 0.02-0.74 and 3.71-6.25 respectively. Highest brix level was noted in "Batana long" (30.6±1.13 ºBrix), acidity in "Olour" (0.74±0.08%), pH in "3No.Ratol" (6.25±0.04). From the present findings, it is concluded that a great variation in physical and bio-chemical parameters exist in different mango varieties which is helpful for development of new varieties and to conserve this germplasm for future pandemics.

GRAPE (*Vitis vinifera* L.) CULTIVATION IN PAKISTAN: A STEP TOWARDS CLIMATE SMART AGRICULTURE

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Grape (*Vitis vinifera* L.) is economically the most important fruit crop grown in the world. It is native to the Mediterranean region and can withstand varied conditions. This paper aimed to find out suitable grape varieties, soil and micro climatic conditions for propagation and extension in semi-arid subtropical and dry temperate Mountainous valleys of the Hindu-Himalayan Range. The step has been taken as a step towards climate smart agriculture in the changing climatic patterns. The data were collected using questionnaire method during summer (May-July) 2018 to identify suitable grape varieties. A total of one hundred thirteen soil samples were collected at a depth of 0.3 m. Soil tests i.e., pH, electrical conductivity, soil micro and macro nutrients/elements like sodium, nickel, iron, cadmium, calcium, chromium, lead, potassium, manganese, zinc, magnesium and copper, were analyzed using Atomic Absorption Spectrophotometry technique and other standard protocols. Three demonstration plots were developed based on climatic and edaphic factors. Once the grapes plants reach a specific height, the pillars for support were constructed. Trainings were arranged for the local farmers. The grape varieties were distributed among the local community and farmers of Ex-FATA regions. The morphological data of different grape varieties were taken, including Plants Height, Flag Leaf Area and Internodes Length in centimeter. Grapes fruit data were recorded and analyzed at all three demonstration plots. It included the assessment of vitamin C (ascorbic acid), reducing and non-reducing sugars, pH, electrical conductivity, iron, sodium, zinc, copper, calcium and magnesium concentrations. Grape biochemical contents were also determined that includes sugar contents, salicylic acid, indole-3-acetic acid, total phenolic & flavonoid contents, total antioxidant capacity and 2,2-diphenyl-1-picryl-hydrazyl free radical scavenging assay. All the collected were statistically analyzed using Pearson correlation, Analysis of Variance (ANOVA), Regression Analysis, Detrended Correspondence Analysis (DCA), Canonical Correspondence Analysis (CCA) and Structural Equation Modeling (SEM). Initially, the successfully grown grape varieties were identified as Crimson Seedless,

Alpanso, Superior, Tarkaya Tarlkalyn, Red Globe Seedless, Thomson Seedless, Flame Seedless, Oval Red and Round Black (each with 100% survival rate) followed by NARC-Black (92.85% survival), King Ruby (83.33% survival), Perlette (76.47 % survival), Sultania-C (66.67% survival), Early Green Seedless (50% survival) and Autumn Royle (20% survival). The maximum number of grape bunches per plant was reported higher in the NARC-Black, Perlette, Sultania-C, King Ruby, Alpanso, Red Globe Seedless, Thomson Seedless, Crimson Seedless, Autumn Royle, Early Green Seedless, Flame Seedless and Round Black varieties. Regression and canonical correspondence analysis showed that the grape plant growth, survival percentage and fruit production are significantly affected by internode length, the number of bunches per plant, soil pH, electrical conductivity, magnesium, nickel, potassium, sodium, iron, cadmium, mean annual temperature and precipitation in the studied regions. The structural equation modeling revealed that the climate, soil, and plant height significantly impact grape plant survival and fruit production.

ORAL

THEME 5

EMERGING BIOTECHNOLOGICAL AND BREEDING INNOVATIONS

HERITABILITY ESTIMATES FOR DROUGHT RELATED MORPHOLOGICAL TRAITS UNDER DROUGHT STRESS CONDITION IN ADVANCE LINES OF COTTON (*GOSSYPIUM HIRSUTUM* L.)

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Cotton Research Institute Multan, Pakistan conducted a two-year study in glasshouse settings in 2019 and 2020 to investigate heritability, genotypic and phenotypic correlations for key seedling parameters in four elite advanced cotton lines and one control line (FH-142). Three replications of the randomized full block design were used to sow the material in plastic tubes. Tube-sown plants were deprived of water for seven, twelve, and fifteen days, resulting in a drought. All of the plant's components were weighed and measured at 50 days: root length, shoot length, root weight, shoot fresh weight, number of lateral roots, root weight, shot weight, and total weight (g) (g). All seedling traits showed significant genotypic variation and a higher overall heritability. Root lengths of 11.89 and 15.23 cm, lateral root counts of 0.82 and 3.75 cm, and shoot lengths of 1 and 5.26 cm were all measured for line MNH-1020 in 2019 and 2020 correspondingly. It is possible to use the correlation coefficients between root and shoot lengths, as well as root dry weight, fresh shoot weight, and total plant weight as selection measures for drought resistance. Study shows that drought- and heat-tolerant, MNH-1020 could be planted in dry areas.

Keywords: Advance lines, Heritability, Root length, Correlation

GENOME-WIDE IDENTIFICATION AND EXPRESSION ANALYSIS OF *PSEUDO-RESPONSE REGULATOR* (*PRR)* GENE FAMILY IN WHEAT

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Pseudo-response regulator (*PRR)* gene family members play a significant role in plant circadian clocks, flowering time inflorescence architecture development during transition from vegetative growth phase to reproductive phase. In current study, we analyzed the expression profiling, phylogenetic relationship and molecular characterization of *PRR* gene family members of common wheat by using IWGSC Ref seq v1.1 wheat genome database with a coverage rate of 90%. By using bioinformatics approach total 20 candidate gene sequences were identified and divided into six groups and four clades. It was found that mostly genes have same number of exons and introns showed similar features because they originated through duplication events during evolution processes. Although all the proteins have conserved PRR domains, but some are distinct in their sequences suggesting functional divergence. By comparative synteny analysis it was revealed that Group 1, 2, 3 and 11-D of group 4 have duplication events while group 5 and TaPRR9-B,10-D showed conservation with previously identified PRR members from rice. While expression variations of six groups from each analysis matches with each other. Five groups highly expressed in leaf, spike, and roots in pattern like leaf >spike>root at all three stages booting, heading and anthesis of spike development. This suggests that *TaPRR* genes play important roles in different photoperiod signaling pathways in different organs at different stages of spike development and flowering via unknown pathway. These findings will also provide comprehensive knowledge about future investigations on wheat PRR family members involved in complex network of circadian system for plant development.

Keywords: Pseudo-response regulator, Expression, Functional divergence, Bioinformatics

ASSESSMENT OF BREEDING MATERIAL OF RICE (*ORYZA SATIVA*) FOR SUBMERGENCE TOLERANCE IN FLOOD PRONING AREAS OF PUNJAB

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Climate change adversely effects the global hydrological resources extended to detrimental flood events. Flooding or submergence is one of the major environmental stressors affecting many man-made and natural ecological unit worldwide. The increase in the frequency and duration of heavy rainfall due to climate change has negatively affected plant growth and development, which eventually causes the death of plants if it persists long. Most crops, especially rice, being a semi-aquatic plant, are greatly affected by flooding, prominent to yield losses each year. Therefore, there is a dreadful necessity to develop a high yielding rice lines to deal with this scenario. For this purpose, a large scale experiment was conducted including one hundred and five (105) rice genotypes having SUB1 gene imported from International Rice Research Institute (IRRI) Philippines and high yielding local cultivars/ approved varieties. The Swarna SUB-1 tolerant check and IR64, IR 6 as susceptible check was used. The genotypes was assessed in terms of plant survival percentage, submergence tolerance index, and physical condition, and stem elongation, number of grains per panicle, thousand grain weight, grain yields and deviations in these traits after submergence stress. The PCR results suggested that SC3 may be used as potential PCR-based marker for molecular screening of rice genotypes for SUB1 QTL. Furthermore, it confirmed the presence of SUB1 gene in all the lines imported from IRRI, while it was absent in some of the local cultivars studied. All the genotypes with submergence tolerant gene (SUB1) showed significantly greater tolerance level in submergence stress of 07 days, as compared to other local cultivars/ varieties, authenticating the effectiveness of SUB1 QTL in conferring submergence tolerance. Significantly, different performances of all the SUB1 genotypes in terms of all the studied traits indicate high Genotypic and Genotypic Environment Interaction (GEI) of SUB1 QTL. Employment of SUB1 seven (7) lines in breeding programs for developing flood tolerant rice varieties might further upsurge rice yields in flash flood areas. Correlation analysis revealed that plant survival percentage after submergence, reduced stem elongation during submergence and submergence tolerance index are very important traits for developing submergence tolerant lines.

Keywords: Rice, Submergence, SUB 1, Flooding

ENGINEERING *SHSP17* IN *ZEA MAYS* TO DEVELOP THERMOTOLERANCE

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SHSP17 from Nicotiana tabacum have been transformed in maize to play its role under biotic and abiotic stresses. Gene sequences were codon optimized to enhance protein expression in maize, synthesized, and cloned into plant expression vectors. In vitro transformation protocols were optimized using reported protocols involving i) scarification and puncturing of germinating embryos treatment with agrobacterium to generate chimeric cell lines for recovery of transformed seeds in cobs, ii) Pollen tube mediated transformation was tried. This transformation system resulted in the recovery of transgenic plants carrying reporter gene and gene of interest (sHSP-17). The transgenic plants carrying reporter gene were checked for the presence of reporter protein which proved to have integrated and expressed reporter gene. The transgenic plants carrying sHSP-17 were grown till maturity, confirmation for the presence of gene in maize genome was done using PCR and Southern blot while expression was checked using reverse transcriptase PCR. Seed of the transgenic plants were grown to get T1 generation. Only 5 plants could survive basta screening in T1 and these plants could not reach maturity, bolted at very young stage to not to produce any progeny. Therefore, phenotypic characterization could not be possible in T1 generation. The plants those got dead and could not bear selection pressure were also negative for PCR. It indicates that may be the expression of this gene too was deleterious for embryo survival and only those seeds could be developed where transgene was not available due to normal gene reshuffling during sexual reproduction.

Keywords: *Nicotiana tabacum, sHsp17, Zea mays,* Codon optimization

EXPLOITATION OF RICE (ORYZA SATIVA) GENETIC DIVERSITY THROUGH RICE BREEDING FOR MORPHOLOGICAL CONSIDERATION OF DROUGHT TOLERANCE

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Water stress in a climate change scenario is one of the major threats for sustainable rice productivity. A certain level of drought can cause considerable yield losses. Combining drought resistance with yield potential and other desirable economic traits is the most promising challenge for the rice breeders. In this study, a set of 23 rice lines of diverse origin were evaluated under irrigated and drought stress conditions including one drought tolerant check 'BT-241'. All the entries were subjected to drought stress at reproductive phase i.e. panicle initiation stage for 21 days. Impact of water stress along with induced behavior of the genotypes were observed. Drought susceptibility indexed (DSI) defined by International Rice Research Institute, Philippines was used to identify the most drought tolerant genotypes. In the experiment high genetic variation among the genotypes was observed for the traits. Seven rice genotypes viz. Basmati 385, Punjab Basmati, Chenab Basmati, KSK133, N22, IR-6, Basmati 2000 showed moderately drought tolerant behavior with tolerance index level in the range of 3-5. Whereas eight rice genotypes comprising of PK1121aromatic, Kissan Basmati, Punjab Basmati, PK10029, PK10683, KS282, Shaheen Basmati, PK434 were categorized under tolerance index level of 5-7 indicating moderately susceptible response of the genotypes. On contrary, susceptible response at tolerance level 7-9 was recorded for seven genotypes. A wide range of dehydration response in the form of leaf rolling and leaf drying depicted the genetic diversity among these genotypes. In order to develop drought tolerant rice genotypes with sustainable yield under water stress environment, breeders should emphasize on relative water content, and drought susceptibility index during selection. Furthermore, drought recovery rate can be considered as drought tolerant parameter.

Keywords: Rice (*Oryza sativa*), Basmati rice, Drought tolerance, Breeding, Genetic diversity

A COMPUTATIONAL APPROACH FOR DECIPHERING DROUGHT RESPONSIVE CANDIDATE GENES IN TOMATO (*SOLANUM LYCOPERSICUM*)

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Abiotic stresses including drought stress adversely affect crops. Drought stress is critical to crop yield and sustainable agriculture. The threat of global climate change escalates the incidence of drought stress in crops. Tomato is one of the most cultivated crops worldwide and sensitive to drought stress. Currently, a scarce literature is available for genetic bases of drought tolerance in tomato. Keeping this in view, the aim of this study was to decipher the drought responsive candidate genes of tomato through *in silico* analysis. *Arabidopsis thaliana* was used as a reference specie. The drought stress responsive genes of *A. thaliana* were extracted from STIFDB (Stress Responsive Transcription Factor Database) V.2.0 database and subjected to BLAST analysis for identification of related homologous sequences from *S. lycopersicum* using NCBI database. Among 816 drought responsive genes of *A. thaliana,* 69 were found to have sequence similarity in *S. lycopersicum*. Further**,** string analysis of these 69 drought responsive genes for protein-protein interactions were carried out. Cytoscape software was used to analyze protein-protein interaction network. The analysis revealed two hub and bottleneck genes i.e., Delta-1-pyrroline-5-carboxylate synthase and plastidial glyceraldehyde-3-phosphate dehydrogenase A. Identification of these drought responsive candidate genes in tomato will help in the genetic manipulation of drought tolerance in tomato through genetic engineering and molecular mutation breeding approaches.

Keywords: Drought, tomato, *In silico*, STIFDB, NCBI, Cytoscape

OPPORTUNITIES FOR THE DEVELOPMENT OF NEW GENOTYPES OF COTTON SUITABLE FOR WATER DEFICIT CONDITIONS

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Cotton is a miraculous plant that is commercially grown in more than 80 countries around the globe. In Pakistan, cotton industries perform the vital role in the economy by providing the raw fiber to fulfill the demands of approximately 521 textile factories. Approximately, 19 million people are engaged in cotton business. Drought is one of the most important abiotic stresses, this is due to shortage of about 51% of irrigation water. The effects of drought stress vary depending on plant type, stage of biological growth, growth conditions, and environmental factors leading to slow down the growth and development of field crops. Under drought stress, plant start the production of reactive oxygen species (ROS) which disrupts the cell homeostasis. In addition to conventional plant breeding methods, use of genetic engineering and biotechnological based techniques has got popular during the last two decades. Markers assisted Breeding (MAB) is a way of classifying plants based on traits of interest in early generations and useful for producing successful plants. Other way is the utilization of quantitative trait loci, and molecular markers involved in the inheritance of drought tolerance. Several reports are available in literature from other field crops against biotic and abiotic stresses, where the incidence of these stresses has been increasing due to global warming around the globe. These changes provide the opportunity to the plant researcher for the development of new accessions of field crops suitable to grow in water deficit areas of the country.

Keywords: Cotton, Drought tolerant genotypes, Marker assisted breeding, Textile industry

GENETIC IMPROVEMENT OF COMMON BEAN (*PHASEOLUS VULGARIS* L.) GENOTYPES FROM AZAD JAMMU AND KASHMIR USING MARKER ASSISTED BREEDING FOR CLIMATE RESILIENT CULTIVAR

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Distant areas of Azad Jammu and Kashmir, Baluchistan, KPK, and Gilgit Baltistan show distinct signs of unsustainability, decrease in soil fertility and considerable degree of instability due to steep slopes and abrupt climatic changes. The rapid rate of growth in population increased the food demand on limited productive land, thus becoming a challenge to food security. One of the options to overcome these problems is to explore the hidden potentials of Gilgit-Baltistan and Azad Jammu and Kashmir so that the conventional agricultural system can be diversified and more economic opportunities are created. Common bean (*Phaseolus vulgaris*) is very popular edible legume crop in Pakistan but its production is insufficient to meet the domestic requirements; therefore it is being imported. Considering the nutritional importance of Common bean, a comprehensive research project funded by HEC, Pakistan has been initiated at University of Kotli Azad Jammu and Kashmir to evaluate the existing germplasm of crop from Pakistan and select the appropriate climate smart genotypes for cultivar development. There were 166 genotypes selected from mountain areas of KPK, Gilgit Baltistan and Azad Jammu and Kashmir and were grown under the agro climatic conditions of District Kotli Azad Jammu and Kashmir. The research has been based on morphological, biochemical and molecular markers for evolving the appropriate genotypes for hybridization and selection. Thirty (30) genotypes were selected on the basis of agronomic and nutritional performance and five (5) were crossed for the development of hybrids. The F1 produced at Kotli were subjected to Nakyal area to produce F2 plants. The hybrids have been developed and maintained at University of Kotli AJ&K for further analysis. The gene pool has been evaluated using SSR markers to confirm the genetic diversity. The biochemical and molecular variations have provided cushion to breed and developm climate resilient and high yielding Common bean cultivar/cultivars for Azad Kashmir and Pakistan.

Key Words: Genetic improvement, Common bean, Marker assisted breeding, Climate change, Nutrition.

MICRO-CLIMATIC EFFECTS ON COTTON YIELD, QUALITY AND GENE EXPRESSION

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Abrupt change in climatic conditions cause decline in quality and yield of major crops. Plant growth is directly affected if temperature, rainfall or humidity are not optimum. A multi location and multi season evaluation of climatic effects on quality and yield may produce a reliable data for future breeding. A set of 39 upcoming varieties of cotton were evaluated on six different micro-climatic locations of Punjab i.e. Multan, Bahawalpur, Sahiwal, Rahimyar khan, Vehari and Faisalabad in a triplicated trial. The experiment was repeated next year on same locations. Data for three key environmental factors such as Temperature, rainfall and humidity was recorded from each station. The crop was analyzed for fibre length, fibre strength, fibre finnes, yield, Bt expression and Glyphosate tolerance gene (GTG). The analysis revealed that higher temperature has positive effect on fibre length and strength, whereas, had negative effect on yield, Bt expression, fineness, uniformity and GTG. Precipitation and humidity had positive effect on fibre fineness and uniformity, whereas, negative effect of both environmental factors were recorded for fibre length and strength. Increase in precipitation was associated with increase in yield whereas higher humidity has negative impact on yield. Cotton crop growth is more sensitive to high temperature as compared to precipitation and relative humidity. Therefore, the trait high temperature tolerance in cotton should be improved for better yield.

Key Words: Cotton, Gene expression, Abiotic stress, Fiber length, Genetic improvement

GBS BASED GENOME-WIDE ASSOCIATION MAPPING OF SALINITY TOLERANCE IN BREAD WHEAT (*TRITICUM AESTIVUM* L.) AT SEEDLING STAGE

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Salinization is a serious threat of wheat crop production. Twenty percent cultivated area and 9-34% of irrigated agricultural land of world is affected due to high salinity which ultimately leads to yield losses in crops. Wheat production in Pakistan has frequently been decline in recent years. Sixty five percent average yield losses of wheat have been observed in moderately saline areas of Pakistan Even though salinity tolerance is important for plant establishment at seedling stage but its genetic architecture remains unclear. The aim of present study was to evaluate138 wheat lines against different levels of salt stress (0,150 & 250mM NaCl) and identification of the loci linked to salt tolerance by Genome-Wide Association Study (GWAS) using 6,887 high quality single Nucleotide Polymorphism (SNPs) markers. Total 195 marker trait associations were identified for all the traits including 63 highly significant markers. Highest numbers of associations were present at chromosome 3B. Total eleven best performing genotypes were identified using Multi-Trait Genotype-Ideotype Distance Index (MGIDI). Further, twelve candidate genes were identified of which many are involved in various stress conditions in plants. SNPs identified in this study and the genotypes with more favorable alleles could be further used in wheat breeding programme.

Keywords: Abiotic stress, *Triticum aestivum* L., GWAS, SNPs, Candidate genes, MGIDI

GENOMIC ANALYSES PROVIDE INSIGHT INTO THE GENETIC SIGNATURES OF SELECTION IN SHAPING THE GRAIN IRON AND ZINC CONCENTRATION IN WHEAT

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Bread wheat is important source of human nutrition. Increasing problem of malnutrition also referred as hidden hunger, especially in developing countries urges scientists to improve the nutritional status of wheat crop. Elucidation of the genomic variations and the impact of selection pressure on shaping the Fe and Zn concentration in wheat are remained elusive. Here, we report a comprehensive genomic assessment based on Wheat660k SNP array of 365 landraces and modern cultivars association panel. We uncover in total 117 unique genetic variations by conducting the genome-wide association study of Fe and Zn concentration. Investigation of the genomic analyses capture the 30 genomic region for selection sweeps that are overlapped with association signal of Fe and Zn concentration. This provides the evidence supporting the negative selection of alleles favoring Fe and Zn concentration as yield-directional selection pressure decreased the frequency of elite alleles during breeding. Of these genomic regions, three stable loci of selective regions were selected for further candidate gene identification and validate their role in Fe and Zn accumulation in wheat grains. Moreover, the validation of three stable genomic regions through near isogenic lines (NILs) will provide the genetic basis of Fe and Zn accumulation in wheat grains. We reveal the significance impact of selection on shaping the mineral quality of bread wheat, led the foundation for molecular selection and genetic improvement of grain minerals in wheat.

Keywords: Wheat, Genome-wide analysis, Iron, Zinc, Molecular breeding

ISOLATION, MOLECULAR CLONING AND TRANSCRIPT PROFILING OF SUGARCANE HIGH TILLERING DWARF 2 GENE (*SCHTD2)* FROM DIFFERENT TISSUES OF SUGARCANE

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Tillering in sugarcane increases the number of productive stalks, provides ideal plant architecture and is mandatory for high cane yield. Strigolactone is a carotenoid derived phytohormone regulating the tillering through signal transduction. It has already been established that α/β hydrolases encoded by different orthologs in many plant species hydrolyse and convert strigolactone into its active form to initiate the signal transduction, regulate many downstream processing including tillering. α/β hydrolase is also found in sugarcane and is expected to be encoded by Sugarcane High Tillering Dwarf 2 gene (*ScHTD2*) as it is important ortholog of *Arabidopsis thaliana* Dwarf 14 gene (*At D14*). *ScHTD2* was isolated from bud tissue of ROC22 hybrid. Sequence analysis indicated frequent existence of Single Nucleotide Polymorphism (SNP) in this gene and maximum six (06) SNPs were found in single allele. Nineteen (19) different nucleotides alleles were explored for this gene and fifteen (15) different protein alleles were found with maximum three amino acid variability for single allele (Sequences available at NCBI). The quantitative expression of *ScHTD2* was measured in leaf, bud and shoot apical meristem (SAM) of sugarcane ROC22 hybrid. Expression of *ScHTD2* was found 4.94 and 4.24 times higher in bud and leaf tissues respectively compared to SAM tissues.

Keywords: Sugarcane, Strigolactone responses, High tillering

AGROBACTERIUM MEDIATED TRANSFORMATION OF COLD TOLERANT GENE (*DREB1A*) IN TOMATO

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Chilling tolerance is controlled by multiple genes and it is difficult to engineer multi-genic traits for resistance in tomato like that of monogenic traits of resistance for herbicides and pests. Therefore, the transformation of transcriptional regulatory genes in place of one or a few genes has been well-liked among researchers. It has been documented that the capability to cold acclimatize is associated with definite signal transduction pathways ensuring in the commencement of numerous cold-regulated (COR) genes that develop tolerance in plants. Chilling stress can disturb tomato growth and productivity due to their cold sensitive nature. *CBF3/DREB1A* plays a key role in generating cold tolerance in tomato by regulating the response of multiple genes under chilling stress. In the current research, we have optimized various steps of agrobacterium method to transform cold tolerant gene (*DREB1A*) driven by Lip9 promoter in 03 tomato cultivars. For successful transformation of cold tolerant gene in tomato, various steps like explant age, inoculation time period, bacterial density, infection time period, co-cultivation time, antibiotic dose pre-selection time were optimized. Transgenic tomato genotypes was further tested through molecular techniques i.e. PCR, Southern blotting and Reverse transcriptase PCR for their presence, integration and expression of *DREB1A* gene. At T2 generation, physiological and biochemical analyses of transgenic tomato plants showed that under various chilling stresses they were higher than control plants. From this study, cold tolerant transgenic tomato plants were produced for the first time in the country and hopefully the output of these findings will positively influence the economy of Pakistan.

Keywords: Tomato, *Agrobacterium* mediated transformation, Cold tolerant gene (*DREB1A*)

WHEAT BREEDING IN CHANGING CLIMATE

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Climate change is a major threat to food security in a world of rising crop demand. Climate change is now unequivocal, particularly in terms of increasing temperature, increasing CO_2 concentration, widespread melting of snow and ice, and rising global average sea level and increase in the frequency of drought. The climate change has an adverse effect on food production and food quality especially with the poorest farmers and the poorest countries most at risk. The adverse effect is either a consequence of the expected or likely increased frequency of some abiotic and biotic stresses. Climate change is also expected to cause losses of biodiversity, mainly in the more marginal environments. Plant breeding has always addressed both abiotic and biotic stresses and strategies of adaptation to climate changes. It includes more accurate matching of phenology to moisture availability, varieties with different duration to escape or avoid predictable occurrences of stress, improved water use efficiency, and re-emphasize population breeding to provide a buffer against increased unpredictability. Furthermore, recent advances in genomics are laying the foundations for sustainable intensification of agriculture and heightened resilience of crops to climate change. The number of available high-quality reference genomes has been constantly growing due to the widespread application of genome sequencing technology. Advances in population-level genotyping have further contributed to a more comprehensive understanding of genomic variation. These increasing volumes of genomic data provide deeper insights into the diversity available for crop improvement and breeding of new cultivars. Genomics-assisted breeding is benefiting from these advances, allowing rapid identification of genes implicated in climate related agronomic traits, for breeding of crops adapted to a changing climate.

Keywords: Wheat; Breeding; Marker assisted selection; Climate change

MOLECULAR CHARACTERIZATION OF EARLY MATURITY RELATED GENE FAMILIES IN PEANUT (*ARACHIS HYPOGAEA*)

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Climate changes including seasonal shifts and rain pattern change highly influence the cropping pattern and productivity in agriculture. Peanut (*Arachis hypogaea*), is the one of world's most important legume and oilseed crop. It is one of the most important cash crop in the rain fed areas of Pakistan. Its production, under changing climatic conditions, can be improved by development and characterization of short duration varieties. The present study involved genomic analysis based on the *in silico* study of important gene families for early maturity associated attributes like flowering time, their pattern, duration and photoperiodism was done for a comprehensive mapping of maturity related genes. Phytochromes genes *Phy A, Phy B* and *Phy E* and flowering genes *FT2a, FT5a* and *COL2* were selected for in silico characterization for protein based analysis including Multiple Sequence Alignment (MSA), and Neighbor Joining (NJ) tree. MSA and NJ trees of the peanut with *Arabidopsis thaliana* and *Glycine max* showed a clear picture of the phylogenetic relationship on the basis of selected gene proteins. Expression profile of phytochrome and flowering genes revealed that short and long days have great influence on the *Phy A, Phy B* and *Phy E, FT2a, FT5a* and *COL2* gene expression. The relative expression was higher in short day light condition than in the long light day condition with exception of *COL2* gene protein. The molecular characterization and qPCR based gene expression profiling of the selected genes provided an evidence of the role of these genes and their comparative analysis under two photoperiodic conditions.

Key words: Cropping pattern; short duration; phylogenetic relationship; gene expression.

SELECTION OF MAIZE GENOTYPES AGAINST DROUGHT STRESS THROUGH PRINCIPAL COMPONENT ANALYSIS

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Globally, climate change is a major threat to the agricultural sector. Drought stress is very crucial and limiting factor which affects the growth and development of crops ultimately decreasing the food production. The objectives of this study were to investigate the drought responsive maize genotypes through Principal Component Analysis (PCA) and to assess the relationship among grain yield and its related traits. Responses of 60 maize genotypes in a randomized complete block design with three replications under two different irrigation levels (normal and limited water) were examined. Principal component analysis and level of association among studied traits were computed to mark drought tolerant and sensitive standards. On the basis of different evaluation standards, genotypes 19203, 19191, 15334 and 19191 were observed as drought tolerant while the genotypes 15091, 15066, 15268 and 15064 were identified as drought sensitive. Selected maize genotypes may be used in the next breeding program for the development of drought tolerant maize hybrids. Attention should be given to plant height, kernels per row and kernels per cob in the improvement of maize by breeder linked to drought stress and these traits showed positive correlation with grain yield. This study is helpful for the identification of selection criteria linked to drought tolerance in maize to be used in future breeding program.

Keywords: Maize, PCA, Drought tolerant genotypes, Selection, Breeding

GHS101 AND *GHSP26* IMPROVES BOLL RETENTION IN UPLAND COTTON GROWN UNDER HIGH TEMPERATURE OF SEMI-ARID SUBTROPICAL CLIMATE

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Cotton is a natural fibre producing crop grown worldwide where agro climatic conditions match with its growth and reproduction. High temperature is a major environmental factor affecting cotton production due to climate change. Only way to cope with high temperature is to breed for the tolerance. High temperature tolerance is a complex mechanism that includes many genes by which cotton responds to stress. Genes conferring heat stress can be best studied in segregating population like F_2 grown under stressed environment. Based on contrasting traits (boll retention percentage), two cotton cultivars i.e. FH-Lalazar (High temperature susceptible) and CRIS-9 (High temperature tolerant) were evaluated for eight heat stress related genes. Out of eight, two genes (i.e. *GHS101* and *GHSP26*) were present only in tolerant genotype i.e. CRIS-9 and these two were selected for further analyses. After development of F_2, the morphological and yield data from parental as well as F_2 population was recorded under natural high temperature conditions. The data for boll retention percentage under high temperature was recorded as an indicator of high temperature tolerance. These two genes were surveyed in 129 plants of F_2 population. Most of the plants, containing both genes showed up to 81% boll retention, but some exceptions were there. Most of the phenotypic traits showed skewed variation on histogram depicting metric nature of genes. Results demonstrated that co-segregation of boll retention property along with heat tolerant genes in F_2 population is important in reproductive development of cotton under high temperature conditions. Thus, it is necessary to identify, and pyramid other genes related to high temperature tolerance at reproductive stage.

Keywords: *GHS101*, *GHSP26,* Boll retention, Upland cotton, Semi-arid-subtropical climate

GENETIC VARIATION IN LEAF PHYSIOLOGY, ROOT MORPHOLOGY AND FIBER QUALITY AGAINST DIFFERENT NITROGEN LEVELS

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Nitrogen (N) is vital for cotton's morphological and physiological processes; however, its contribution to fiber quality is still unclear. The goal of this study was to look at the interaction between root shape, leaf physiology, and fiber quality in response to Nitrogen in different N-efficient cotton genotypes. Under control (2.5 mmolL-1) and high N (5 mmolL-11) environments, the aforementioned attributes of SLH-Chandi (N-efficient) and SLH-55 (N-inefficient) were investigated. The results revealed that under control settings, root morphological features were higher in SLH-Chandi than under high N conditions. When comparing high N to the control, leaf shape, chlorophyll and carotenoid content, and soluble proteins were all greater. However, under control circumstances, soluble sugars, fructose, sucrose content, and sucrose phosphate synthase were all greater than high N across all development stages. All morphological and physiological features of cotton leaf were greater in SLH-Chandi than SLH-55, regardless of N circumstances. Fiber quality parameters such as fiber length, strength, micronaire, and elongation were all enhanced under control circumstances compared to high N. These data imply that under low Nitrogen conditions, SLH-Chandi performed better in terms of growth and fiber quality, which might assist to minimize fertilizer consumption, production costs, and pollution.

Keywords: Root morphology, Leaf physiology, Fiber quality, Nitrogen levels

PHENOTYPIC AND GENETIC EVALUATION OF GRAPE GENOTYPES AGAINST ANTHRACNOSE

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Grape is one of the most important fruit crop in the world. It is used for eating raw as well as for wine making in different countries of the world. In countries where consumer prefer seedless grape, there is more trend for growing table grapes. Seedless grapes are highly susceptible to fungal diseases so the study was conducted to screen different grape genotypes against anthracnose. Screening of different local and exotic germplasm was done by applying pathogenicity test as well as by using molecular markers. Morphological and molecular characterization was done for identification of pathogen causing anthracnose. For morphological characterization slides from culture was prepared and Koch's postulate was full filled by inoculating healthy susceptible detached leaves. For molecular characterization fungal DNA was amplified by using ITS and specie specific primers. Samples were Sanger sequenced and were identified by doing BLAST search. For pathogenicity assay, inoculum was prepared form pure culture of identified pathogen, and spore concentrations of 105 was applied on one year old plants of different grape genotypes. Detached leaf method was used for inoculation of healthy leaves. Four days after inoculation disease symptoms were observed and disease intensity was measured by using disease scoring scale. Genotypes were characterized as highly resistant, moderately resistant and susceptible. For molecular screening DNA was extracted by using CTAB method and PCR reaction was performed by using SCAR markers linked to disease resistant gene. These screened disease resistant genotypes can be used for introgression of resistant gene into susceptible cultivars.

Key words: Grape, Anthracnose, Koch's postulate, SCAR

ASSESSMENT OF SPRING WHEAT GENOTYPES UNDER SIMULATED ACID RAIN STRESS IDENTIFIES GENETIC SOURCES FOR FUTURE WHEAT BREEDING

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Acidification of rainwater is one of the serious environmental concerns. Acid rain is mainly produced by the emissions of sulphur and nitrogen oxides. These oxides react in atmosphere with water to produce acids and wash down to earth when it rains or snows. The acids may settle down at the same area or travel to other regions and deposit as dry depositions and damage plants. Therefore, it is necessary to understand the effect of acids on crops and the crop response to acid rain stress. The aim of this research was to understand the effects of artificially induced acid rain stress on seedling vigour of wheat and to identify the genetic sources for acid rain tolerance for future wheat breeding. So, the seedlings of 20 spring wheat genotypes were sown in pots using a 2-factorial completely randomized design with 3 replications. One week old seedlings were exposed to a simulated acid rain stress using 4 sulphuric acid solutions of pH 2, 3, 4 and 5. Analysis of variance for seedling and biochemical traits indicated that effect of different pH levels on varieties was highly significant for most of the traits. Discriminant analysis was performed to classify the varieties into various categories based on their response to simulated acid rain stress. The tests of equality of group means, structure matrix for three discriminant functions and standardized canonical discriminant function coefficients provided strong evidence for significant differences among the varietal groups for survival percentage, shoot length, shoot and root fresh and dry weights, vigour index as well as other seedlings traits. Variation was also observed in different acid treatments with respect to three functions (1, 2 and 3) in group centroids. Mean values showed that under simulated acid rain stress the seedling of Inqilab 91, Bhakar 2002, and Miraj 2008 were more vigorous, therefore can be the potential source of novel alleles for resistance for apple breeding.

Key words: Wheat, Acid rain, Simulation, Genetic sources, Breeding

GENETIC DIVERSITY OF CHILI (*CAPSICUM ANNUM* L.) GENOTYPES BASED ON MORPHO-PHYSIOLOGICAL AND YIELD CONTRIBUTING PARAMETERS

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Chili (*Capsicum annum* L.) is one the most essential spice crop grown all over the world. The lack of improved genotypes is one of the major constrain of low yield. The logical way to start any breeding program is to estimate the genetic diversity that would help the plant breeder in choosing the right type of parents for purposeful breeding procedure. Therefore, genetic divergence of 23 chili genotypes was studied based on various morpho-physiological and yield contributing parameters at Department of Plant Breeding and Genetics in Lasbela University of Agriculture, Water and Marine Sciences (LUAWMS), Uthal, Balochistan. Results revealed broad spectrum of variation among the genotypes. Mean square of ANOVA showed significant difference ($p< 0.01$) for most of the parameters under study. Genotypic correlations exhibited high association (>0.90) of yield plant^{-1} with number of branches, number of fruits plant^{-1}, fresh fruit weight and fruit width. The PC_1 contributed (33.72%) followed by PC_2 (20.66%), PC_3 (12.96%), and PC_4 (11.10%) share in total variation. The yield contributing parameters including fruit length, width, fresh and dry fruit weight, and number of fruits plant^{-1} exhibited maximum contribution in PC_1 to PC_3. Similarly, DG-1, Super sky, Talhar, and Green fire-113 performed well in above mentioned principal components. Therefore, these genotypes are suggested to be used in further breeding programs, with more focus on the selected parameters.

Keywords: Chilli, Genetic diversity, Principal components and LUAWMS

INTEGRATING THE PLANT METABOLOMICS WITH PROTEOMICS AND TRANSCRIPTOMICS: A NEW DIRECTION FOR BREEDING PLANTS FOR BIOFUNCTION DEVELOPMENT UNDER CHANGING GLOBAL CLIMATES

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Global climatic change is the biggest challenge for plant biologists in general and plant breeders in special. Plants have conspicuous potential to adapt in response to both abiotic and biotic stress environments. Plants manifest these adaptations at transcriptome level, changing the proteome and subsequently express in the shape of metabolome. Such responses to any unwanted external stress involve complex metabolic processes and communication leading to the production of desired metabolites for adaptation. These responses can be quantified at molecular levels due to the development of the next generation sequencing and broad sense use of metabolic profiling techniques such as, whole genome sequencing, and comparative genomic, transcriptomic and metabolomic analysis, giving rise to the "omic platform". Integrated use of genomic, transcriptomic, proteomic and metabolomic is the novel and evolving approach to tackle a diversity of challenges faced during plant improvement for biotic and abiotic stress resistance. Additionally, it offers new tools and technologies to develop metabolic markers for the selection of superior plants, biofortification of plants with desirable nutrients genes and to understand the molecular mechanism of various physiological processes and metabolic pathways for biofunction development. The techniques used in omics involve; integrated-data-mining accompanied with computational tools in order to link the diverse nature of omic data. The recent findings have showed that these novel tools and techniques have been very effective for the data integration of plant transcriptomics, proteomics and metabolomics for the development of new varieties of crop plants through molecular plant breeding and metabolic pathway engineering. It is concluded that the omic tools and techniques combined with the biometric approaches simplified the analysis of the omic data and offers huge scope for molecular plant biologists and the plant breeders.

Keywords: Omics, Next generation sequencing, Molecular breeding, Metabolic-pathway engineering, Biofunction development.

ISOLATION AND BIOCHEMICAL CHARACTERIZATION OF SALT TOLERANT BACTERIA FROM SEA WATER FOR RECLAMATION OF SALINE SOILS

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Salinity is a major issue all around the world but in Pakistan saline soils are very common. The objective of the study was to isolate the halo-tolerant bacteria from sea water to reclaim the salt affected soils. Three samples of sea water were collected from three different locations from Golden beach, Ormarha and Gwadar, respectively and brought to lab. Physico-chemical (pH, electrical conductivity, sodium, potassium and calcium) analysis of the samples were conducted. Bacterial isolates were obtained from sea water using the serial dilution approach. The isolated bacterial colonies were purified using streak plate method and saved for future processing. Phosphate (P) solubilization and indole-3-acetic acid (IAA) production by the bacterial isolates were measured by growing the bacteria in specific medium i.e., Pikovskaya broth (for P solubilization) and LB medium (for IAA production) each supplemented with different NaCl concentrations i.e., 0%, 0.5%, 1%, 2%. Total 18 pure colonies of bacteria were obtained from the three samples of sea water. The isolates produced IAA ranging from 27-107 µg mL^{-1}, 6.8-107 µg mL^{-1}, 3-104 µg mL^{-1} and 0.2-27.1 µg mL^{-1} at 0.5%, 1%, 2% and 4% NaCl concentration, respectively. The bacterial isolates solubilized phosphate ranging from 19-112 µg mL^{-1}, 11-121 µg mL^{-1}, 60-121 µg mL^{-1}, and 7-95 µg mL^{-1} at 0.5%, 1%, 2%, and 4% NaCl concentrations, respectively. Bacterial isolate SW3-3/1 showed best results in terms of highest IAA production and P solubilization at all NaCl concentrations. In IAA test, the isolate SW3-3/1 produced 99.8, 48.1,65.1 and 10.0 µg mL^{-1} at 0.5, 1, 2, and 4% NaCl concentrations, respectively. Phosphate solubilization by the isolate SW3-3/1 was 83, 84, 120.4, and 63.8 µg mL^{-1} at 0.5, 1, 2 and 4% NaCl concentrations, respectively. Bacterial isolate SW3-3/1 performed well at all concentration of NaCl. Our isolates can survive and tolerate high salt environment. These isolates have the potential to help in restoration of salt-affected soils.

Keywords: Salt tolerant bacteria, Sea water, Saline soils reclamation.

PHYLOGENETICS AND EXPRESSION DYNAMICS OF TOMATO CLPB/ HSP 100 GENE UNDER ELEVATED TEMPERATURE

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Heat shock proteins (Hsps) are stress-responsive molecular chaperones uphold proper protein folding in response to external and internal stresses. Hsp100 family molecular chaperones playing substantial role in plant thermotolerance. In this study we investigated ClpB/Hsp100 gene family members and studied their evolutionary relationship and expression in tomato in response to heat stress**.** Using bioinformatic tools, 6 SlHsp100 genes were identified. Insilico sub cellular localization indicated that of these 6 ClpB/Hsp 100 members, 4 members are in chloroplast, 1 in mitochondria and 1 in the cytoplasm. For evolutionary relationship study, a total of 36 *Hsp100* genes were included in the phylogenetic tree showing a hierarchical ancestral relationship of the *Hsp100* genes shared by the members of the kingdom plantae, archea, chromista, Fungai and bacteria. A total of 4 pairs of orthologous and 5 pairs of paralogous genes were identified. Type - I (θ_1) functional divergence between different Hsp100 clusters showed considerable functional homology. Thermotolerance measured in different tomato genotypes in terms of cell viability, cell membrane stability and pollen viability were paralleled by the thermal resistance of the heat shock protein synthesis. Reverse transcriptase polymerase chain reaction was used to analyze gene expression in leaves of five- week - old tomato seedlings following heat stress treatment (45**°C**) and control condition (25**°C**). Expression of chloroplastic LeHSP110/ClpB genes was upregulated in all tomato genotypes after heat stress highlighting the crucial role of this gene family in acquired thermotolerance.

Keywords: Tomato, ClpB/ Hsp, Thermotolerance, Phylogenetics, Exprssion dynamics

TEMPORAL AND INTRA-PLANT EXPRESSION VARIABILITY OF CRY1AC ENDOTOXIN IN COTTON GENOTYPES OF CENTRAL PUNJAB

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Cotton is widely cultivated in Punjab province of Pakistan. Development of transgenic cotton has considerably boosted the production in the area. The gene producing δ-endotoxin has excellently controlled the heavy bollworm infestation in cotton crop. But the progressive development of insect pests resistance against this toxin has produced an alarming situation. The temporal and intra-plant expression variability of the transgene is considered as one of the reason for resistant pests. Therefore, the research was planned to look at the basis of variable expression of *Bt* gene in the genetic background of indigenous cotton genotypes. A set of 6 *Bt* genotypes (i.e. IUB-18, FH-142, FH-152, CIM-678, SLH-Chandi and SLH-8) were used to study the temporal and intra-plant expression of the gene. The plants were sampled at two different growth stages (i.e. 80 and 120 days after sowing - DAS) for temporal studies. Intra-plant expression variability was also assessed from upper, middle and lower canopy leaves. The results obtained from ELISA revealed that SLH-Chandi (4.78 µg/g) had the highest toxin level as compared to other genotypes at 80 DAS, while at 120 DAS the toxin level decreased significantly in all the genotypes except SLH-Chandi (3.93 µg/g). The toxin level in SLH-Chandi remained consistent throughout the growing season as compared to other genotypes. The genotypes upper canopy leaves had considerable amount of δ-endotoxin protein whereas, middle canopy and lower canopy leaves showed a lower level of toxin. The genotypes FH-152 (5.105 µg/g) and SLH-Chandi (4.880 µg/g) have the highest toxin level in upper canopy as compared to other genotypes and canopy areas. The study provided guide lines for the development of better performing *Bt* cotton genotypes with standard toxin expression in central Punjab region. It is concluded that cultivated genotypes don't have stable expression under local climatic conditions, which demands the development of high expressing *Cry1Ac* genotypes to maximize the benefit of this technology.

Keywords: *Bacillus thuringiensis*, Bollworms, δ-endotoxin, *Cry1Ac*, culti

IDENTIFICATION, CHARACTERIZATION, HOMOLOGY MODELING AND PROTEIN-PROTEIN INTERACTIONS OF COTTON (*GOSSYPIUM ARBOREUM*) DREB GENE

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Drought is one of the important factors, reducing the yield in cotton. Among drought responsive genes, genes encoding for dehydration-responsive element binding (DREB) proteins play a major role in overcoming various types of stresses. The genome of *Gossypium arboreum* L. contains many important genes combating biotic and abiotic stresses that can be explored to identify these genes. For amplification of DREB gene from *G. arboreum*, primers were designed based on the conserved regions of GhDREB. For the development of cDNA libraries, RNA was isolated from cotton leaves after giving water stress treatment for 0, 30, 60, 90, 120 and 150 min. Results indicated that the expression of DREB gene was maximum after 90 min of water stress. The DREB gene amplified in *G. arboreum* was cloned, sequenced and designated as GaDREB. Phylogenetic analysis of GaDREB using twenty previously reported DREB gene sequences showed its highest homology with *Salicornia bigelivoii* DREB gene. Conserved domain analysis of the GaDREB explicated a single AP2 domain in it. Protein 3D models were determined using MODELLER 9.10 and Ramachandran plot indicated that 98% of the residues were found in the favored region. Furthermore, the protein-protein interactions showed that DREB interacted with the NAC, MYB, AREB, ABRE and DRE/CRT, which are involved in various drought stress responses via ABA independent pathway. Present study validated the involvement of the gene in conferring the drought tolerance and its interaction with the other drought responsive genes. This study will further facilitate the utilization of GaDREB gene for improving the drought tolerance in tetraploid cultivated cotton species.

Keywords: ABA independent pathway, Computational tools, Cotton, Drought stress, Improved crops

MOLECULAR IDENTIFICATION OF IMPORTANT PATHOGENS INFECTING MUNG BEAN CROP FROM PAKISTAN

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Mungbean (*Vigna radiata*) is an important pulse crop of Pakistan. It is a good source of dietary protein and unlike other pulses is easily digestible. Average mungbean yield in Pakistan is much lower than many other countries due to the cultivation on marginal lands, low inputs and diseases attack. Among different pathogens of mungbean plant the diseases caused by fungal pathogens are more prominent. In this study the characterization of the fungal pathogens infecting the mungbean crop was done on morphological basis and molecular level. The mungbean field areas of Faisalabad were surveyed during the cropping season in year 2021. The leaf samples from the symptomatic plant with leaf spot disease symptoms were collected. After surface sterilization with 15% sodium hypochlorite the infected leaf discs were grown on potato dextrose agar (PDA) media at 28°C for five to seven days. Sporulation pattern, morphology of colony and characteristics of conidiophores and conidia were studied under light microscope. One of the isolate SH1-MB was identified as a member of *Alternaria* species and the other isolate SH2-MB was belonged to *Curvularia* species on the basis of morphological and culture characteristics. For molecular characterization, the internal transcribed spacer (ITS) region for both isolates was amplified using ITS1 and ITS4 primers. BLAST analysis performed on the sequences revealed that ITS region from SH1-MB strain is 99% identical to *A. alternata* and *A. tenuissima* (*Alternaria* section *Alternaria*) whereas the isolate SH2-MB is 100% identical to *Culvularia* species. Based on these finding it was concluded that the pathogens involved in leaf spots symptoms are the species of *Alternaria* and *Curvularia*. This is the first report about the infection and molecular characterization of *Alternaria* and *Curvularia* species on the mungbean plants from Pakistan.

Keywords: Mungbean (*Vigna radiata*), Pathogens, *Alternaria, Curvularia*.

TARGETING GRAIN SIZE RELATED GENES (GSRGs) THROUGH TRANSLATIONAL RESEARCH IN WHEAT

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Wheat (*Triticum aestivum*) is Pakistan's major grain crop that fulfils approximately 70% of daily caloric demands of the nation. Current yield potential of Pakistani wheat is considerably low primarily due to narrow genetic background of existing breeding material which is why conventional breeding methods have become less efficient in bringing dramatic yield increases per unit area. In addition, climate change further destabilizes regional wheat productions. Therefore, the development of quicker and innovative approaches to accelerate the wheat crop improvement work is crucial to achieve food security at national level. As a prerequisite of gene cloning by next generation sequencing approaches, sequence information regarding genes and associated homoeologs in local wheat is essential for translational research. Grain size is a key agronomic component of yield, however, functional studies addressing genes that modulate final grain size are limited merely to diploid model plants like *Arabidopsis* and rice. Although most of the yield related traits are quantitatively controlled, each gene in growth related signaling pathways drive absolute influence on final organ size. Present research aims to find and annotate organ growth related gene orthologs in local wheat varieties that can influence wheat grain size. We screened local wheat germplasm for seed size and seed weight and selected one small seeded (SS) and one large seeded (LS) genotype. The two genotypes were tested for possible single nucleotide polymorphism (SNPs) in genomic sequence of grain size related gene 1 (*GSRG1*). The sequence data revealed the presence of SNPs in *GSRG1*. The cellular examination of SS and LS seeds indicated the differences in nuclear contents and cell size in seed coat. Overall, our data suggest that the molecular evaluation of wheat germplasm for SNPs in GSRGs and exploitation through genome editing and targeted mutagenesis approaches would be helpful for smart breeding to increase wheat yields.

Keywords: Wheat, NGS, SNPs, GSRG1, Mutagenesis, Smart breeding

CALLOGENESIS, REGENERATION AND RED ROT POTENTIAL OF SUGARCANE SOMACLONES AT PUNJAB, PAKISTAN

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Sugarcane is an important cash crop and has vibrant role in nation's economy. Climate change, genetic behavior, pathogen attack and sugarcane growing pattern in different locations of Pakistan have a great impact on cane yield. Use of smart biotechnological tools i.e. somaclonal variation, marker assistant breeding, genetic transformation etc. have been used to improve yield with desirable traits under biotic and abiotic stresses. This study was conducted to examine the ability of callus induction, shooting percentage, shoot numbers, shooting and rooting length in four sugarcane varieties (CPF-248, CPF-249, CPF-250 and CPF-251). Moreover, red rot incidence was also noted on developed somaclones at various climatic areas (Rahim Yar Khan, Faisalabad and Sargodha) during year 2020-21. Meristem of studied genotypes were cultured at various levels (0, 2, 4, 6 and 8mg/L) 2, 4-dichlorophenoxy acetic acid (2,4-D) for callus induction after sterilization. Maximum callus induction was observed in CPF-249 after 28 days at 4mg/L 2, 4-D. Highest shoots percentage (95%) was also recorded in CPF-249 after 21 days followed by CPF-251 (90%) on Murashige and Skoog (MS) medium having 1mg/L kinetin while shoot length (11cm) and shoot number (25) were also recorded highest in CPF-249 after 40 days whereas maximum root length (3cm) was observed in CPF-248 after 35 days on MS+1mg/L NAA medium. Highest red rot tolerance appeared in somaclones CPF-251 while CPF-249 was found most susceptible at all three sites. CPF-248, CPF-249, CPF-251 showed moderately resistance reaction at three locations while CPF-249 showed moderately susceptible response at all places.

Key words: 2, 4-D, kinetin, MS medium, Somaclonal variation,

THE IMPORTANCE OF DOUBLED HAPLOID FOR SMART BREEDING AND ITS APPLICATION

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Holistic smart breeding approaches can be promising way out to tackle climate change and develop better adapted crop varieties. In conventional plant breeding, development of a new cultivar take around 10–12 years and may even exceed this period based on the plant habit, reproductive cycle and complexity of traits involved. The concept of smart breeding is an integration of conventional breeding strategies with advanced molecular, genomic and phenomics tools for efficiently and effectively breed the resilient crop cultivars with enhanced yield potential. New breeding approaches such as rapid generation advancement, doubled haploid (DH), marker assisted back crossing (MABC), marker assisted recurrent selection (MARS), genomic selection (GS) etc. have been used to help shorten the breeding cycle along with efficient screening for specific biotic and abiotic stresses. Biotechnology based breeding technologies (marker-assisted breeding and genetic modifications) will be essential to assist and accelerate genetic gain but their application requires additional investment. Double haploid technology ensures the production of complete homozygous wheat lines in one year helping the selection process efficient in plant breeding program. Doubled haploid not only to shorten the time to reach the homozygozity and release a variety but also used for various aspects of genetic studies such as molecular marker and genetic transformation. Recent studies indicate that wheat x maize hybridization is most effective method for haploid production in wheat because of its higher efficacy, simplicity, less genotypic specificity, less somaclonal variation and less time consumption. Moreover, doubled haloid lines have applications in basic and applied research. DH lines are the ideal material for genetic studies. The aim of this study was to investigate effect of 2, 4-D alone or combination with sucrose for haploid seeds formation. Time is also crucial factor after pollination for haploid seed. So, best day after pollination was also studied for maximum haploid seeds under various treatments of 2, 4-D and sucrose.

Keywords: Growth media, Pollinated media, Wheat x maize crossing system, Haploid seeds, 2, 4-D.

DELINEATION OF G X E INTERACTION OF LENTIL GENOTYPES UNDER RAINFED CONDITIONS

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Lentils are the 2nd most important legume crop after chickpea in Pakistan. Being enriched with 25% protein, lentils are excellent source of essential vitamins, minerals, soluble and insoluble dietary fiber. Genotype × Environment interaction makes the procedure of selecting genotypes having the best performance more complicated. It is necessary to exploit the genotype x environment interaction in order to identify the stable varieties. The current experiment was conducted to study the genotype X environment interaction (GEI) and stability analysis of lentil genotypes under different environment conditions. The experiment was conducted at two different locations of Punjab Province, i.e., Barani Agricultural Research Institute (BARI), Chakwal and Barani Agricultural Research Station (BARS) Fateh Jang during Rabi season in 2020. In this study, eleven lentil genotypes were selected for Genotype X Environment interaction (GEI) including one Standard Check. Evaluation of genotypes through yield related attributes was done. Mean sum of squares for genotype X environment interaction (GEI) and genotypes showed highly significant results among all the attributes. Under environment 1 (BARI) the genotype 17CL-309 performed better for plant height (37.633), Hundred grain weight (2.4067), pod shattering percentage (2.633) and pod length (1.2067). Genotype 17CL-304 performed better for number of primary branches (3.0333) whereas, genotype 17CL-305 gave best results for number of pods per plant (108.33). Under environment 2 (BARS) it was observed that the genotype 17CL-309 performed better for plant height (38.833) and number of pods per plant (110). Genotype 17CL-306 performed well for hundred grain weight (2.4133 and genotype Punjab Mansoor gave best results for pod length (1.23). It was further revealed that genotype 17CL-307 was stable for number of pods per plant (14.7), pod length (5.55) and seed yield (5.58) across both environments. These genotypes can be used in further breeding programs to develop high yielding varieties of lentil under diverse environments.

Keywords: G X E interaction, Lentil genotypes, rainfed conditions.

HIGH-THROUGHPUT PHENOMIC CHARACTERIZATION OF WHEAT GRAIN ARCHITECTURE AND DIVERSITY FOR CONVENTIONAL MORPHO-PHYSIOLOGICAL TRAITS

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Grain morphology affects the weight of grain which ultimately affects grain yield in wheat. Several morpho-physiological traits influence grain morphology. To assess the diversity for morpho-physiological traits and to characterize wheat for grain morphology, a collection comprising of 60 wheat varieties were explored. The ANOVA showed significant differences between varieties for all the parameters except grain thickness, peduncle length, and plant height. Descriptive statistics indicated that the collection of germplasm contained enough variability for the traits under consideration. Grain architectural traits showed positive significant correlations with most of the metric traits suggesting several criteria for indirect selection of traits like grain yield. A positive significant correlation of WUE was observed with grain morphology traits viz: grain width, grain size, grain thickness and grain volume. While 1000 grain weight, water use efficiency, grain length, grain width, grain size, grain thickness and grain volume showed positive significant correlation with grain yield. Principal component analysis extracted seven significant PCs having a cumulative variance of 78.87%. This variation was quite encouraging to initiate a breeding program to improve grain morphology and morpho-physiological traits. The PC1 indicted that grain width, unproductive water use, grain area size, and grain volume were the most diverse traits. In PC2, the maximum positive contribution towards variation was shown by the grain area, grain length and grain volume. The cluster analysis grouped varieties into seven clusters of high, medium, and low performance based on morphology and grain architecture traits. This classification might help in the selection of high and low performing varieties and could be used as parents in hybridization program.

Keywords: Genepool: Grain morphology, Varieties, Wheat, WUE

ESTIMATION OF GRAIN QUALITY THROUGH PHYTOCHEMICAL ANALYSIS AND GLUTEN CONTENT IN WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES

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Wheat (*Triticum aestivum* L.) relates to Poaceae family. In many nations around the world, including Pakistan, it is renowned as the king of cereals. To screen genotypes of wheat based on biochemical traits, an experiment was done at the Department of Plant Breeding and Molecular Genetics, University of Poonch Rawalakot. The experimentation was done in a completely randomized design (CRD) with three repetitions. The research material was comprised of grains of 50 wheat genotypes. The aim of the study was to compare phytochemical constituents, their antioxidant activity and to determine the gluten content in grains of 50 wheat genotypes. The analysis of variance (ANOVA) was carried out for biochemical traits which showed highly significant results for grain quality on the trait studied except for phenolic contents. The genotype Pak-81 showed highest mean values for gluten content, tannins and non-reducing sugars. Whereas NIA-Barsat-2010, C-273, Local white, Fareed-2006 and Pirsabak-2013 showed highest mean values for alkaloids, flavonoids, phenolic content, total soluble sugars and reducing sugars respectively. Path coefficient analysis was carried out to examine the direct and indirect effects of traits on grain quality. Gluten content, tannins, saponins, steroids, flavonoids and reducing sugars exerted positive and direct effect on grain quality. Whereas, alkaloids, terpenoids, phenolic contents, total soluble sugars and non-reducing sugars showed negative and indirect effect on grain quality. Genotypes like Pak-2013, Pak-81, NIA-Barsat-2010, C-273, Local white, Fraeed-2006 and Pirsabak-2013 showed better performance in terms of grain quality and its related traits. Hence, these genotypes could be further used for the quality improvement in wheat genotypes.

Keywords: Wheat, Grain quality, Gluten, Tannin, Saponin, Alkaloids, Terpenoids

GENETIC DIVERSITY ASSESSMENT OF SOYBEAN GENEPOOL USING SIMPLE SEQUENCE REPEAT (SSR) MARKERS

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Existence of genetic diversity in any gene pool provides breeders an insight into the genetic structure of the population and to develop climate resilient genotypes. Genetic diversity was assessed using morphological markers however different molecular markers system are now available which are not affected by the environment. Oilseed Research Institute has a gene pool of 100 different genotypes of soybean however their genetic architecture was not known. Therefore, in this study genetic diversity was assessed in 100 soybean accession using thirty two SSR markers. DNA extraction was performed using standard CTAB method and was quantified using Nanodrop spectrophotometer. PCR reaction was conducted in thermal cycler with total reaction volume of 25 µl including 20 ng/µl genomic DNA, 0.6 µM of each forward and reverse primers and 12 µl of green master mix for 35 SSR markers. The PCR reaction was set for; initial denaturation 94ºC for 5 minutes, 50 cycles of denaturation 94 ºC for 1 minute, annealing at variable temperatures according to primers for 1 minute, extension at 72 ºC for 1 minute. Final extension at 72 ºC for 7 minutes. Among these SSR markers highest number of alleles were amplified by Satt-411 (19) all of which were polymorphic similarly other discriminating markers were BE806308, Satt-163, Satt-184, Satt-687, Satt-126, Satt-310 with 18, 17, 17, 17, 15 and 15 alleles respectively. All of these alleles were polymorphic. Only one SSR marker Sat-320 amplified 08 alleles among which 06 were monomorphic and 02 were polymorphic. UPGMA (Unweighted Pair Group of Arithmetic Averages) based cluster analysis was conducted based on genomic-SSR data. Similarity matrix was first generated according to SHAN similarity index, followed by the dendrogram construction. The population was broken in to seven major groups representing strong clustering patterns with similarity co-efficient ranging from 0.61 to 0.90. Maximum 28 genotypes were found in Cluster IV followed by Cluster V with 25 genotypes, Clsuter I with 24 genotypes, Cluster II with 13 genotypes and Cluster VI with 6 genotypes. Minimum genotypes were found in cluster III with 4 genotypes i.e. ESSEA, E-1216, Adams and Chasie. Further genetic similarity coefficients of genotypes are given in excel file for more detailed information about the genetic relatedness of genotypes.

Keywords: Genetic diversity, Soybean genepool, SSR markers, Cluster analysis

GENETIC DIVERSITY ASSESSMENT OF MAIZE GENEPOOL USING SIMPLE SEQUENCE REPEAT (SSR) MARKERS

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Molecular marker-based genetic distances can be used for identifying heterotic patterns of inbred lines and for assessing their genetic diversity with high precision and less cost. Simple sequence repeats (SSRs) have been extensively used for diversity assessment in maize because they provide high level of polymorphism and are helpful in more effective and efficient use of resources for crop improvement programs. So, this research was conducted in order to assess the extent of genetic diversity among 200 maize inbred lines (100 from Maize & Millet Research Institute, Sahiwal and 100 inbred lines from Maize Research Station Faisalabad) using 101 Simple Sequence Repeat Markers that were evenly distributed on the short as well as long arms of 10 maize chromosomes. Among 101 markers 07 SSRs belonged to BNLG series, 40 were from PHI series, 08 belonged to PNC series and 46 were from UMC series. Markers belonging to PNC series proved to be more useful in studying genetic diversity among maize genotypes, as these showed highest alleles per SSR (12.50) and also higher PIC value (0.92) and lowest PIC value in this primer series was also relatively on the upper side (0.78). UMC markers seem to be least effective in study of genetic diversity as it has least number of alleles per marker (7.22). However maximum PIC value in UMC series was also 0.92 and lowest PIC value was 0.158. All the 101 SSRs were found polymorphic amplifying a total of 828 alleles with an average of 8.28 alleles per primer. Over all Maximum number of alleles (20) and maximum number of polymorphic alleles (19) were amplified by a marker (SSR-40). Similarly lowest number of alleles (1) was 1 amplified by SSR-13 marker and lowest number of polymorphic alleles was also 1 observed in SSR-85. The UPGMA tree was generated from genetic similarity coefficients which clustered two hundred maize genotypes into 07 groups (A to G) which were further divided into subgroups. Inbred lines of MRS showed relatively high genetic diversity in comparison to MMRI inbred lines. It is suggested that future breeding programs may involve crossing of such highly diverse genotypes to exploit maximum genetic diversity and hybrid vigour and to combat biotic and abiotic stresses.

Keywords: Genetic diversity, Maize genepool, SSR markers, Cluster analysis

ORAL

THEME 6

CLIMATE SMART NATURAL RESOURCES MANAGEMENT

CLIMATE CHANGE IMPACTS ON COMMUNITY STRUCTURE AND FUNCTIONING IN TEMPERATE FORESTS

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Understanding the effects of multiple climatic and edaphic factors on plant functional traits is critical to predict how plants will react to global climate change. Here, we addressed the response of eleven leaf functional traits to temperature, water, and soil-related factors in a heterogeneous environment. We hypothesize that leaf functional traits differ in adaptability and are predicted to be differentially affected by climatic and edaphic factors. We developed multiple linear mixed-effect models for each response variable by assuming environmental factors as fixed effects and sites as a random effect variable. Leaf thickness, stomatal density, and spongy tissue ratio declined with annual mean temperature. Stomatal density, spongy tissue ratio and abaxial thickness increased with mean annual precipitation but decreased with mean annual temperature. Leaf thickness stomatal density, and abaxial thickness increased along altitude gradient but others decreased. Soil carbon declined specific leaf area, dry matter, cell tense ratio, stomatal length and pore index. Soil nitrogen and phosphorus had positive impact on most of the leaf traits except few i.e., leaf thickness, spongy tissue ratio. The correlation between leaf attributes was not generally recognized and some interactions existed only in certain plant functional groups. The phylogenetic independence analysis confirmed the coevolution of different functional traits and their dependence on the other plant traits. Overall, these results suggest that climatic factors are the major drivers of leaf trait variations in temperate forest however soil factors played an additional role in shaping leaf trait diversity and forest structure.

Keywords: Plant functional traits, Mixed effect model, Climatic change, Soil factors, Temperate forests

SMART INTEGRATED APPROACH FOR TEXTILE EFFLUENT TREATMENT AND THE POTENTIAL REUSE OF TREATED WATER (AS NATURAL RESOURCE) FOR IRRIGATION PURPOSE

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The textile industry of Pakistan is one of the main consumers of the freshwater resources; it consumes massive amount of water for fabric processing, dyeing and printing. About 90% of this water re-emerges with the chemical contaminants in the form of wastewater and then affects the flora and fauna of aquatic ecosystems that receive this wastewater during discharge. In the present study, pollution parameters, such as pH, EC, COD, BOD, TDS, TSS and particular heavy metals were significantly reduced by smart integrated treatment technology (INTG). The overall INTG-treatment system (at pilot-scale) promoted an increase in dissolved oxygen up to 68% and, concomitantly, a substantial decrease in the chemical oxygen demand (77%), biochemical oxygen demand (63%), total dissolved solids (56%), color (84%), pH (21%), Ec (82%), Na+ (48%), K+ (42%) and heavy metals [Cr (61%), Cd (35%), Ni (67%)] was recorded. The standalone treatment options (FTWs augmented with selective bacteria and UASB) also performed well in decreasing the pollution load including heavy metals from the effluent. The highest removal in pollutant parameters was observed through integrated treatment technology (UASB-treated textile effluent was further treated with FTWs (vegetated with wetland plants) and augmented with selected bacterial strains. This combine technology found successful at lab-scale as well as for plot-scale application. It was concluded that the benefits of anaerobic treatment as well as plant-bacterial partnership (bacterial degradation of organic matter) can be achieved simultaneously in the smart INTG-treatment technology. Moreover, the treated water was less toxic than untreated water and winter/summer vegetables can easily be grown with this treated water. The major advantage of smart-INTG treatment is the low capital and energy costs, less mechanical complexity, less area requirement, simple managerial requirements as compared to other treatment process, which makes it unique to adopt for the textile industry treatment.

Keywords: Textile effluent, Smart-Intg Treatment, Irrigation

DIMENSIONS OF CLIMATE CHANGE: HORIZONTAL AND VERTICAL

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Concerns over climatic imbalances on the globe attracted number of scholars to study on the issue but unfortunately researchers only perceived this matter as 'global warming' or 'vertical climate change'. However, it was perceived that the matter of climate shifting is also raised time to time by the local people and concurrently ignored by the related researchers. Targeting the matter of climate shifting or horizontal climate change, a study was conducted using secondary data of district Hyderabad, Sindh, in which temperature and rainfall intensity of two eras (1969-1989 and 2007-2018) were measured/ compared. The results revealed that some significant changes are observed in temperature and rainfall during 2007-2018. In addition, the study also validates that the concerns of local people are very much correct that the winter season has slightly shifted towards February resulting the spring season making shrink. On the other hand, no horizontal changes were recorded in summer temperature as compare to fifty years back but slight horizontal changes were revealed in summer rainfall over time. Hence, it is strongly recommended that the future studies on climate change could be clearly investigated keeping in mind the horizontal and vertical changes. And local calendars (agriculture and vacation) need to be revised to make appropriate with local climatic changes.

Keyword: Climate change

SOLAR PUMPING POTENTIAL OF GROUNDWATER RESOURCES FOR IRRIGATING RICE UNDER THE CHANGING CLIMATE IN PAKISTAN

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Climate change is generally considered as one of the major reasons for the increasing tendency in the use of groundwater for irrigation, as surface water is emerging not a sustainable resource. The use of grid electricity (max 2300MW) for operating around 0.2 million electric tube wells reduce electricity availability for domestic use during peak summer season, thus exacerbate load shedding in Pakistan. Similarly, the use of diesel fuel for operating around 1.2 million diesel powered tube wells, not only increase oil import bill but its combustion also causes air pollution by injecting millions of tons of CO_2 to our environment. Addressing these issues, a solar powered tube well installed for irrigating rice in Sheikhupura was evaluated, as case study. Moreover, the equivalent energy consumption, both electric and diesel, for irrigating rice during the last decade (2011-20) in Pakistan were evaluated for analyzing cost, CO_2 emissions and solar conversion aspects. The results showed the 20KW, 32lit/sec, submersible solar pumping system can irrigate up to five acres area of rice crop daily using the available 10 to 14 hours daily day light hours, and is feasible for adoption. Further analysis on country scale showed a total of 21 MAF groundwater extraction in addition to utilizing almost all available canal water, during the rice season. The equivalent pumping energy shows a maximum of 560MW (PKR 6.43 billion) electrical and 11546MW (PKR 106 billion) diesel consumption during the rice season (676 hours of operation). This is accompanied with 779kg/ha CO_2 emission due to diesel combustion for pumping during the rice season. The benefit cost analysis indicated that the capital cost of converting all installed electrical 3003MW (PKR 390 billion) and diesel 11928MW (PKR 1551 billion) tube wells can be recovered with in four years and seven months. Optimized site-specific solar system designs, improving irrigation management and using high yielding rice varieties can reduce the use of conventional energy resources, overextraction of groundwater resources and reduced CO_2 emission, which may lead to increased profitability, sustainable crop production and climate change mitigation in Pakistan.

Key Words: Solar Energy, Tube wells, Climate Change, Solar conversion, CO_2 emission

MICROBIAL BIOFERTILIZER DEVELOPMENT AND THEIR QUALITY ASSURANCE FOR ARID AGRICULTURE

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Biofertilizers are natural mini fertilizers. They are living microorganisms which are when applied in soil increase soil fertility and plant growth by increasing soil nutrient like phosphorus and nitrogen by fixing nitrogen and solubilizing phosphorous through natural processes. Biofertilizers are benefit for environment. Different biofertilizers like *Rhizobium*, *Azospirilium* and *blue green algae* (BGA) are now a day used to enhance the crop growth and yield. The present study aims to develop biofertilizers for various crop plants utilizing both symbiotic and asymbiotic soil bacteria isolated particularly from arid areas and to establish their quality for long term preservation and shelf life. A total of seven(7) Plant Growth Promoting Rhizobacteria (PGPR) were isolated and purified from soil collected from Fatah Jang and Jhang Bahtar (33.7660° N, 72.3609° E) of District Attock, Punjab. PGPR isolates were characterized through colony & cell morphology using gram staining and their biochemical characterization for catalase, amylase, starch hydrolysis and plant growth promoting traits, i.e., phosphorous solubilization, indole acetic acid production, nitrogen fixation and zinc solubilization. It was found that out of initial 7, 6 isolates were nitrogen fixers, namely FSL1, FSL3, FSY1, FSY2 from Fateh Jang and JSY1 and JSY2 from Jhang Bahtar. Phosphorous solubilization activity was detected in 3 isolates FSY1, FSY2 and FSY3 from Fateh Jang area. Bacterial isolates were also tested for Zinc solubilization and all seven (7) isolates were found positive for zinc solubilization while JSY2, FSY1showed maximum zinc solubilization activity. Out of seven isolates six (6) isolates were screened positive for amylase production and five(5) isolates were found positive for Catalase activity. Moreover, all seven (7) isolates were positive for Indole Acetic Acid (IAA) production. Four bacterial isolates, FSY1, FSY2, FSL1 and FSL3, selected on the basis of their phosphorous solubilization, nitrogen fixation and IAA producing abilities were selected for quality assurance using viable cell count method. All four bacterial isolates with multi-functional characters were used in colony PCR for 16S RNA gene amplification.

In addition, growth promoting abilities of 7 isolates FSL1, FSL3, FSY1, FSY2, FSY3,JSY1, JSY2 were evaluated on Maize (*Zea maize*) crop plants for various growth parameter in a field experiment at Fateh Jang under extreme arid conditions. Plants growth parameters like height, stem thickness and the yield were determine. Reportedly all PGPR inoculations enhanced the growth of Maize. However, out of seven (7) isolates five isolates namely FSL3, FSY1, FSY2, FSY3 showed significantly higher plant growth and yield as compared with the un-inoculated control. The study concludes that significantly low cost biofertilizers can be developed and effectively utilized for enhanced crop yields using characterized plant growth promoting rhizobacteria, isolated and utilized indigenously from highly arid areas.

Keywords: PGPR, IAA, Phosphate solubilization, Biofertilizer development

EVALUATION OF SALINITY LEVELS ON THE EARLYGROWTH OF WILD RICE (*Oryza coarctata* .L)

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Oryza coaretata, a highly salt-resistant wild rice species commonly found on the coastal areas in India. The magically salt tolerance level of the species can be grown on saline water having EC level 20-40 dSm^{-1} submergence for quite a long period. It was revealed that Oryza coaretata has some special unicellular salt hairs (trichomes) on the adaxial surface of the leaves. Sodium and chloride were the dominant ions in the excreted material. The most critical stage in seedling establishment is usually considered as seed germination which consequently determines the successful crop production. Understanding the responses of plants at these stages is particularly important for elucidating the mechanisms of salt resistance or sensitivity in plants and their survival. In *invitro* condition the experiment was conducted to evaluate the salt tolerance level of species 08 Treatments were applied with saline water in ppmT1=control (No salt applied), T2= 500ppm, T3=1000ppm, T4=2000ppm, T5=4000ppm, T6=8000ppm, T7=16000ppm, T8=32000ppm. The agronomic data was recorded initially after 15 days and then second after 22 days of sowing. The positive response of wild rice specie towards salt stress was recorded because shoot length of wild rice was goes very well maximum to 8000 ppm. Plant tissue Na was analyzed using flame photometry technique.

Keywords: Salinity, Wild rice

DEVELOPING LEGUMINOUS AND NON-LEGUMINOUS CROSS-INOCULANT MICROBIAL BIOFERTILLIZERS FOR ARID AGRICULTURAL AREA

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Biofertilizers are microbial based organic fertilizers having long lasting effect on the fertility of soil. The term biofertilizer can be defined as formulations comprised of living microbial cells, either a single strain or multiple strains (consortia) that promote plant growth by increasing nutrient availability. Nonetheless, biofertilizers can also provide other direct and indirect benefits for plant growth, such as phytostimulation, abiotic stress tolerance and biocontrol. They provide pests resilience in plants. Due to development of phytohormones, biofertilizers enhance root proliferation as a result boost crop yield. In leguminous plants, (*Brady)rhizobium* is present which is a Gram negative soil bacteria that colonizes to form root nodules. These bacteria can fix nitrogen inside the root nodules. In non-leguminous plants, Plant Growth Promoting Rhizobacteria (PGPR) are free living bacteria which increase plant growth by fixing nitrogen, solubilizing phosphorus and producing phytohormones. Present study aims to study cross inoculation ability of biofertilizers for leguminous and non-leguminous crops in arid agriculture regions. Total three (3) soil bacteria were isolated and purified from root nodules of groundnut and rhizosphere of maize. Out of which two (2) were (*Brady*)*rhizobium* and one (1) was PGPR, from plant root nodules and rhizosphere samples collected from tropical rainfed arid region Fateh jang, Punjab Province of Pakistan lying between 33.5673◦ North and 72.6506◦ East. Bacterial isolates were characterized for colony and cell morphology, their biochemical characterization for catalase, starch hydrolysis and plant growth promoting traits i.e. phosphorus solubilization, indole acetic acid production, nitrogen fixation and zinc mobilization. It was found out that three (3) isolates were nitrogen fixers indicated by color change. Two (2) of them was zinc mobilizer confirmed by clear zones produced by bacteria. None of them were phosphorus sollubilizers. All isolates produced phytohormone (indole-3-acetic acid) and were positive for amylase. However, only two (2) showed catalase activity. To check the efficacy and cross inoculation ability of the microbes, pot and field experiments at village Suka, Talagang were carried on *Capsicum frutescens*, variety "Hot F-1". All bacterial isolates, 2 from groundnut root nodules and 1 from maize rhizosphere were used as inoculants with an uninoculated control and with three (3) replications. The experiment is in progress.

Keywords: Biofertilizers, Phytohormones, Phosphate solubilization

BORON COATED UREA SLOWS DOWN THE RELEASE OF NH_4-N AND ITS CONVERSION TO NO_3-N

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Urea has been widely applied to agricultural crops as a source of nitrogen, however, a large portion of applied N (about 40-60%) is lost to the environment through denitrification, volatilization, runoff, and leaching. In the present study, efficacy of boron coating on urea to slow down the release of ammonium nitrogen (NH_4-N) and its conversion to nitrate nitrogen (NO_3-N) was evaluated in a soil incubation study. Urea was coated with commercial borax at 0.5, 1 and 1.5% to get boron coated urea (BCU) using two different types of emulsifying agents (A1 and A2). The soil was incubated with recommended dose of nitrogen (150 kg ha^{-1}) using BCU along with plain urea as reference control. Results showed that BCU (coated with 1% borax using A2 as emulsifying agent performed better among all the treatments of BCU. A decrease of 18.7 and 8.4% was observed in release of NH_4-N from BCU after 24 hours and 1st week of incubation, respectively, in comparison to plain urea. No significant differences were seen in NO_3-N conversion after 24 hours, however, 8.6% decrease was observed after 1st week of incubation. Moreover, increase of 7.5, 51.9 and 19.9% for NH_4-N and 4.6, 2.7 and 7.2% for NO_3-N were observed after 2nd, 3rd and 4th week of incubation, respectively, from BCU. It may be concluded that urea coated with 1% borax using A2 as emulsifying agent is most suitable formulation for slow release of NH_4-N and its conversion to NO_3-N. However, further greenhouse and field studies are suggested to confirm the preliminary results.

Keywords: Slow release urea, Mineral nitrogen, Coating materials

MICROBIAL BIOFILMS: PLATFORM OF NOVEL MICROBIAL FUNCTIONS AND DIVERSITY

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Microbial association with solid surfaces and bio-membranes by channeled network of exo-polysaccharides synthesized and released in the surroundings for attachment with the surfaces, protection against biotic and abiotic environmental stresses and the pathogenesis of the microbes against other organisms is termed as Microbial Biofilms. All the microbial biofilm components including dwelling and resident microorganisms, microbial biopolymers and chemical and biochemical (e.g., dipeptide for quorum sensing) constituents are functionally active and keep the biofilm in a continuous and dynamic state of functionality. The microbial biofilms thus act as platform of biodegradation, biotransformation, bioremediation and removal of abnoxious toxic elements and hazardous organic compounds from the surrounding environments, initiate and trigger the immune response of the living organisms, aid in biogeochemical cycling and release of the essential and toxic elements, availability of the nutrients to plants, promote or inhibitory effects on plant growth and protect the plants against pathogen attacks and other biotic and abiotic environmental stresses. However, their role as bio-indicators of global atmospheric shifts, spread of animal and human diseases and as sink or source of green house gases to address issue of climate change is mostly unexplored and ignored. Various aspects of the microbial biofilms in bio-amelioration of the salt affected soils, microbial diversity, microbial biopolymer synthesis, microbial bioremediation, organic farming and microbial pathogenesis have been studied and explored at NIAB. The review and findings of the microbial biofilm research conducted and its possible role and contribution to address environment and bio-threats issues and mending or build up climate shifts will be presented and discussed.

Key words: Microbial diversity, Biofilms, Bioremediation, Biopolymer, Climate change

MICROBIAL DIVERSITY AND BIOFERTILLIZER DEVELOPMENT FOR LEGUMINOUS & NON-LEGUMINOUS CROPS

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Biofertilizers are the microbial inoculant consisting of living microorganisms that can enhance effectively crop production and soil fertility through nitrogen fixation, phosphorous solubilization and/or by production of plant growth hormones. (*Brady*)*rhizobium* are root nodule forming bacteria having symbiotic association with leguminous plants. However, in non-leguminous plants, Plant Growth Promoting Rhizobacteria (PGPR), with similar growth promoting properties are present in the rhizosphere. The present study was associated with the development of cost effective biofertilizers for leguminous and non-leguminous crops. Total fifteen (15) soil bacteria were isolated and purified from root nodules of groundnut and rhizosphere of groundnut, lucerne and tomato. Out of which seven (7) were (*Brady*)*rhizobium* and eight (8) were PGPRs, from plant and soil samples collected from tropical rainfed arid region of Punjab Province mainly Sukka, Talagang (32.9166° N, 72.0666° E) and temperate rainfed region of Azad Jammu & Kashmir, Rawalakot (33.8533°N, 73.7513°E). The soil texture of Talagang was determined as sandy loam, pH is 8.0 and saline in nature, while that of Rawalakot silt loam, pH 7.9 and ECe of 341µS/cm. The *Rhizobium* and PGPRS isolates were characterized for colony & cellular morphology, their biochemical characterization for catalase, starch hydrolysis and plant growth promoting traits, i.e., phosphorous solubilization, indole acetic acid production, nitrogen fixation and zinc solubilization. It was found that out of initial fifteen, eight (8) isolates from Talagang soil were nitrogen fixers, indicated by color change on nitrogen free media. Phosphorous solubilization was shown by thirteen isolates, with eleven from Talagang and two from Rawalakot. Maximum phosphorous solubilization was shown by isolate from Rawalakot, RS1 (503.1 µg mL^{-1}) and Talagang isolate TS8 (479 µg mL^{-1}). Six (6) isolates were screened positive for phytohormone (Indole acetic acid) production, with maximum indole acetic production by Rawalakot isolate, RS1 (70.14 µg mL^{1}) and Talagang isolate, TS8 (50.16 µg mL^{-1}) & TR2 (40.36 µg mL^{-1}). Zinc solubilization index were determined maximum in two isolates (RS2 & RS1) from Rawalakot and one isolate (TS7) from Talagang. The four most efficient bacterial isolates from above were selected as potential biofertilizers and applied in a field experiment to determine their efficacy as inoculum on onion and tomato plants at Sukka, Talagang site. The experiment comprised of six treatments with three replicates. The growth/ yield parameters indicated a notable performance by two isolates, TS8 from Talagang and RS1 from Rawalakot. The experimental results have established the fact that bacteria isolated from soil and plant rhizosphere of diverse climatic regions, characterized on the basis of their growth promoting attributes can best be utilized as biofertilizers for crops grown under extreme environmental conditions of abiotic stresses. The bacterial isolates that have been screened for their use as biofertilizers are required to be grown on large scale, so that inoculum could be applied on larger areas in the field.

Keywords: Microbial diversity, PGPR, Phosphate solubilization, Leguminous and non-leguminous crops

ROLE OF AGRICULTURE AND RURAL ADVISORY SERVICE PROVIDERS IN PROMOTING CLIMATE SMART AGRICULTURE OF PAKISTAN FROM THE LENS OF ACADEMIA: A QUALITATIVE ANALYSIS

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Agriculture extension educators, as producers of change agents, are expected to educate and motivate their students to promote innovations, such as climate smart agriculture. The pool of experts and their services are desperately needed time and again to promote agricultural innovations and address issues like climate change. It is an undeniable fact that role of agricultural field agents is confined to the professing production enhancement notwithstanding up taking of agricultural innovations to combat climate related and other obstacles. To this end, the present study was designed to assess and understand the role of agriculture advisors in promoting the CSA from the lens of academia who are nurturing the future green advisors. In this regard, the qualitative data were collected from faculty members of the university through focus group discussion technique. The findings exhibit that any agricultural innovations is hardly adopted or adapted by the farmers without consultation with agricultural advisors, even in the next couple of decades. The results further demonstrate that, proper scaling up of CSA at the national level required to incorporate new degree programmes and courses; equipping new extensionists with CSA knowledge and empirical execution across the country for wide dissemination, uptake and impact. Additionally, initiation of training programmes for resource poor farmers, on farm CSA experimentation and adaptation, rural youth and women led CSA programmes, research on CSA adoption and adaptation, and productive linkages development among agricultural stakeholders would surely help in triggering and realizing substantial role of agricultural advisors at local to national level.

Keywords: Agriculture and rural advisory service, Climate smart agriculture, Academia, Qualitative research, Pakistan

EFFECTS OF TRANSGENIC COTTON *EXPRESSING CRY 1AC* ON MICROBIAL POPULATIONS, ENZYMATIC ACTIVITIES AND NUTRIENT DYNAMICS

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Due to increased world population, different approaches have been used worldwide to improve the yield potential of crops in order to fulfill their food requirements. Transgenic crops are one of them which have high yield potential with comparative less input cost due to less reliance on pesticides. This technology as gained tremendous attention without exploring their after effects. Transgenic *Bt*-cotton produces *Bt*-toxins (*Cry* proteins) which may accumulate and persist in soil due to their binding ability on soil components.In order to find out the potential impacts of *Bt*-toxin on soil microbial activity, substrate use efficiency, viable microbial population counts, and nutrient dynamics, a survey study was planned at different core cotton growing districts of Punjab. Soil samples were collected from *Bt* & non-*Bt* cotton plants rhizosphere from selected fields. The results revealed that there was more bacterial population (viable counts), dehydrogenase and phosphatase activities in *Bt*-rhizosphere as compared to non-Bt. Regarding nutrient dynamics, percent nitrogen, extractable phosphorous, extractable potassium, NO3-N, Fe and Zn except bulk density were also detected high in *Bt*-cotton rhizosphere. The outcome of this survey study concluded that the cultivation of *Bt*-cotton expressing *cry1 Ac* had seemingly no adverse effect on metabolic, microbiological activities, and nutrient dynamics of soils. Further work is needed to investigate and verify the potential impacts of *Bt*-cotton on ecology of soil-dwelling insects and invertebrates before its recommendation for general cultivation

Keywords: Transgenic cotton, *cry 1ac,* Microbial populations, Enzymatic activities, Nutrient dynamics

EVALUATION OF CHICKPEA (*CICER ARIETINUM* L.) ROOT ARCHITECTURE SYSTEM UNDER DROUGHT AND SALINITY STRESS

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Root architectural traits have potential role under abiotic stresses, however genetic variability need to be explored in chickpea to determine the contribution of root system architecture (RSA) under salt and drought stress. A hydroponic experiment was conducted to explore the RSA of twenty chickpea genotypes grown under salt and drought stress. This experiment was conducted to examine the root architectural traits of chickpea under control, drought and salinity conditions. One treatment (T1) 60mMNaCl was used along with control. PEG-8000 0f (-0.9 bars) was used to create the level of drought stress. This experiment was replicated 3 times. Under salinity higher level of hydrogen peroxidase was observed in root of V19 (11030). In the biochemical parameters, higher activity of catalase (CAT), ascorbate peroxidase (APx) and monodehydroascorbate (MDA) was observed in roots in salinity and drought stress. Two weeks old seedlings grown in hydroponics were treated with above-mentioned stresses and harvested after 3 weeks. Genotype C-44 and Bhakkar-11 are salinity resistant as they showed higher plant biomass, weak RSA and higher activity of APX enzyme. Thall 2006, PB-2008, 13036 and 13012 showed higher plant biomass but reduced RSA and higher activity of enzymes. So we concluded that these genotypes are drought resistant as they use enzyme activity as defense system and showed higher plant biomass. However, 15024, paidar-91 showed low plant biomass in salinity. Paida-91 and PB-2000 showed lower plant biomass in drought.

Keywords: Chickpea, Root architecture, Drought and salinity stress

MULCHING EFFECTS ON PHOSPHORUS MANAGEMENT IN COTTON

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Phosphorus (P) plays key role in improving cotton production through regulating biochemical processes (e.g. photosynthesis). Mulching is one of the important management options for moderating hydrothermal regimes and consequently it may enhance P availability and encourage cotton growth. In view, effects of mulching on P management was studied in Randomized Complete Block Design (RCBD) involving two factors including (i) Mulching, M_1 (-mulch), M_2 (+ mulch) (ii) P levels, P_1, (control), P_2 (25% RDPF), P_3 (50%RDPF), P_4 (75%RDPF), P_5 (100%RDPF). The P was applied at the time of sowing as per treatment plan and banana waste mulching material was applied after seed germination. The results indicated that most of the measured agronomic parameters (plant height, number of branches, squares, and bolls) in this study significantly increased with increasing P levels. Further, growth parameters such as number of open bolls, flowers and shedding (%) were increased in mulched applied plots. Quality parameters (staple length, uniformity index, micronaire value) was not affected by mulching as well as P application. Mulching also altered soil temperature and soil moisture content. Further, mulching also altered P availability in soil measured as different times. The results concluded that mulching altered soil temperature as well moisture content consequently altered P availability and improved growth and seed cotton yield.

Keywords: Banana residue management, Mulching, P management, Quality of cotton

PHYSIO-CHEMICAL RESPONSES OF *SACCHARUM OFFICINARUM L.* (SUGARCANE) TO VEHICULAR POLLUTION ALONG FAISALABAD-JHANG ROAD (PAKISTAN)

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A study was performed to evaluate the physiochemical responses of *Saccharum officinarum L.* (Sugarcane) to vehicular pollution along Faisalabad-Jhang road.Three sites (New Lahore, Nawababad and Fetehbad) along this road were selected for the collection of leaf samples. Control samples were collected from 50 meters away from selected road. Physiochemical characteristics such as chlorophyll contents, total soluble protein, total soluble sugar, and total free amino acid contents were measured in these samples. The results revealed that chlorophyll content (chlorophyll a, b, total and carotenoids) were reduceddue to vehicular pollution in roadside plants as compared to control site. Total amino acid content and soluble phenolics were increased while, total soluble sugars, and total soluble proteins were reduced. The results showed that metal content released from running vehicles posed changes in physiochemical characteristics of *Saccharum officinarum* and variation was also noted at various sites.

Keywords: Sugarcane, Vehicular pollution

PERFORMANCE OF TWO HYBRIDS OF *Helianthus annuus* L. (SUNFLOWER) UNDER THE STRESS OF HEAVY METALS (ZINC AND COPPER)

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A pot experiment was conducted in University of Agriculture Faisalabad to assess the effect of Cu and Zn uptake on morphological, physiological, biochemical and yield attributes of*Helianthus annuus* L.(Sunflower). Two hybrids FH-612 and FH-621 were used during this study. The experiment was laid out in a Completely Randomized Design (CRD) with four treatments and three replicates. After 20 days of germination the plants were subjected to different levels of $ZnCl_2$, $CuSO_4$ and with their combination. Three harvests were taken at an interval of seven days each to study the growth rate, morphological, physiological and biochemical attributes. At the maturity of crops final harvest was taken and yield attributes were recorded. Data of various attributes were statistically analyzed. It was observed that both the metals caused negative effect on growth rate as well as the other parameters studied. The effect was more pronounced in the metal combination treatment. Ultimately the yield was significantly reduced due to the effect of metals in both hybrids. However hybrid FH-612 revealed slight tolerance towards Cu and Zn toxicity as compared to its counterpart. FH-621. Thus it was concluded that Cu and Zn affect the morphological, physiological and yield attributes of sunflower when applied in higher concentration.

Keywords: Sunflower, Heavy metals, Zinc and Copper

RESPONSIVE ASSESSMENT OF SELECTED WHEAT VARIETIES WITH COMBINED NITROGEN AND POTASSIUM APPLICATION UNDER WATER STRESS CONDITIONS

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Global food security is one of the key issues that world is facing today and global food supply mechanism is menacing under changing climate, shrinkage yield production and water scarcity. The nutrient management with judicious use of water resources is critical for sustaining food supply and address global food security challenges. In this recent research study, effects of combined nitrogen and potassium were assessed on selected wheat genotypes under different water stress conditions. This study was aimed to address water shortages in wheat cultivation through better nutrient management practices. Four potassium combinations were assessed (K0, K30, K50, K60 kg/ha, while nitrogen was 90 kg/ha) in all plots. The wheat varieties were included on TD1, Benazir, Galaxy, Ab Sattar and Sahar. The study revealed significant effects of combined use of nitrogen and potassium on yield production level and water stress level. The yield production increased by 30% where N90 and K50 kg/ha were applied. Similarly, other traits such as height of plant, number of tillers per plant, number of leaves, number of spikelets, grain per spike and average yield production were greatly improved with combined use of nitrogen and potassium application. Moreover, relative drought index (RDI) and stress tolerance index were observed highest when N90 and K60 kg/ha were applied. The recent study revealed that with combined application of nitrogen along with potassium in wheat crop can enhance yield production even in water scarce regions. Hence, nitrogen and potassium fertilizer if applied in combination of N90 and K60 can improve yield per acre under water stress conditions.

Keywords: Drought, Food security, Water stress, Wheat and Yield production.

TILLAGE AND NUTRIENT MANAGEMENT STRATEGIES TO IMPROVE CARBON SEQUESTRATION UNDER ARID TO SEMI-ARID REGIONS.

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Soil carbon is considered a major reservoir in the global carbon cycle, as it can store approximately three times the amount of carbon contained in the atmosphere as carbon dioxide. Global climate change as evident by rising temperature, scanty and erratic rainfall, along with less crop residue additions and frequent tillage practices are resulting in significant losses in soil organic carbon. Keeping in view the importance of SOC, the present study was planned to explore the effect of tillage operations and fertilizers applications on C storage in soil in high input crops like wheat-maize rotations. Experiment was executed in two factor factorial design with minimum (MT), conventional (CT), and deep tillage (DT) in main plots and three fertilizer treatments in subplots. The fertilizer treatments were i) 100 % commercial fertilizer (CF) ii) 75% CF +25% FM iii) 50% commercial fertilizer (CF) + 50 % FM. The results revealed that DT and CT were better than MT in terms of crop yield and improvement of soil properties. MT increased SOC pools only in surface soil, by contrast DT and CT resulted in greater SOC pools in whole soil profile. Combined use of organic and mineral N was superior to sole use of mineral N in terms of yield, soil properties and SOC pool.

Keywords: Nutrient management, Carbon sequestration

THE ROLE OF BACTERIAL INOCULATION AND ACIDIFIED ORGANIC MATTER TO ENHANCE PHYTOEXTRACTION OF HEAVY METALS BY *BRASSICA NAPUS* FROM NATURALLY CONTAMINATED SOIL

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Heavy metals (HMs) are toxic and harmful even in trace amounts, posing severe threat to ecology and human health. Heavy metal toxicity in plants is related to negative effects on photosynthesis, antioxidant enzymes and nutrients uptake. There are different methods to remediate heavy metals such as physical, chemical and biological. Among these, biological method is preferred over other methods because it is one of the safer and economical methods for heavy metals remediation. *Brassica napus* is a vegetable and used to produce oil. Plant growth-promoting rhizobacteria (PGPR) are potential microbes that facilitate plant growth either directly or indirectly by colonizing in the rhizosphere. PGPR plays an important role in the remediation of heavy metals from contaminated sites. For this purpose, a pot experiment was performed in the wire house of the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad to enhance phytoextraction potential of *Brassica napus* through bacterial inoculation under heavy metal contaminated soil amended with acidified organic matter. Soil was collected from a nearby polluted site and pre- and post-harvest analysis of the soil for physicochemical characteristics was carried out. Data regarding growth and physiological parameters were recorded. Standard statistical procedure was followed to analyze the data. Results depicted that high contamination of Pb and Cd reduced *Brassica napus* growth parameters up to plant height (26%), root length (23%), shoot fresh biomass (32%) and root fresh biomass (33%) adversely as compared to uncontaminated conditions and the combination of metal resistant bacteria (SS-16, SS-8) and acidic organic matter depicted more significant results as compared to their alone application. The combination of both PGPR+AOM improved physiological attributes of plants and increased cadmium and lead uptake in above-ground parts such as roots (30.23%) and shoots (23.81%) of the plant as compared to contaminated conditions.

ISOLATION AND CHARACTERIZATION OF SALT TOLERANT PGPR FROM WHEAT

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Wheat (*Triticum aestivum* L.) is most important crop of Pakistan which is a major source of calorific intake in its various forms. Various abiotic stress in which soil salinity is one of the most serious problems for crop yield. Most of the soil and water in Pakistan is salt affected. In this study, eleven rhizospheric bacteria were isolated from wheat rhizosphere and examined for salt tolerance ability. WGT1, WGT2, WGT3, WGT6, WGT8, WGT9 and WGT11, were able to tolerate salinity up to 2% NaCl. Salt tolerant bacterial isolates were also screened for invitro characterization of plant growth promoting ability i.e., IAA production, phosphate solubilization, nitrogen fixation, cellulase production and biofilm formation. Out of eleven, six isolates WGT1, WGT3, WGT4, WGT6, WGT8 and WGT9 showed IAA production ranging from 0.7-6.4 µg mL^{-1}. WGT8 showed highest production of IAA among all isolates. Five isolates WGT1, WGT2, WGT5, WGT10 and WGT11 indicated phosphate solubilization ranging from 1.4-12.3 µg mL^{-1}. WGT2 showed highest phosphate solubilization among all isolates. After biochemical characterization, controlled condition experiments were performed. WGT11 has highest potential to increase plant growth parameters. These salinity tolerant bacteria could be used as bioferlitizers in salt effected soil.

Keywords: Salt Tolerant PGPR, Wheat

IMPACT OF ORGANIC AND INORGANIC AMELIORANTS ON ARSENIC GEOCHEMICAL FRACTIONATION AND CO_2-CARBON EFFLUX UNDER REDUCED CONDITIONS

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Climate change is a global challenge that is accelerated by contamination with hazardous substances like arsenic (As), posing threat to the agriculture, eco-system and human health. Here, we explored the impact of various ameliorants on geochemical distribution of As in two soils with contrasting textures (sandy clay loam (Khudpur village) and clay loam (Mattital village)) under paddy soil conditions, and their influence on the CO_2-carbon efflux. The exchangeable As pool in clay loam soil increased as: lignite (0.4%) < biogas slurry (6%) < cow dung (9%), and < biochar (20%). However, in the sandy clay loam exchangeable soil As pool was found to be maximum with farmyard manure followed by biogas slurry, biochar and cow dung (17%, 14%, 13%, and 7% respectively). Interestingly, in the sandy clay loam soil, the percentage As distribution in organic fraction was: biochar (38%) > cow dung (33%) > biogas slurry (23%) > sugarcane bagasse (22%) > farmyard manure (21%), that was higher compared to the clay loam soil (< 6% for all the amendments). In addition to the highest As immobilization by biochar in sandy clay loam soil, it also led to the lowest CO_2-carbon efflux (1470 mg kg^{-1}) among all the organic/inorganic amendments. Overall, the current study advances our understanding on the pivotal role of organic amendments, notably biochar, in immobilizing. As under paddy soil conditions with low (CO_2) carbon loss, albeit it is dependent on soil and ameliorant types.

Keywords: Arsenic contamination; Biochar; Geochemical as fractionation; CO_2-C efflux; Carbon pool; Decay constant.

OPTIMIZATION OF SOIL CHEMICAL PROPERTIES IN ORGANIC AMENDED SOIL USING RESPONSE SURFACE METHODOLOGY COMPREHENDING CENTRAL COMPOSITE DESIGN

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The potential of soil to offer physicochemical and microbiological properties as per requirement of the plants for the growth and development is refer as soil quality. Soils are posing nutrients deficiency due to extensive agricultural practices and intensive cropping pattern. It ultimately affects various soil quality parameters such as drainage, structure, texture, nutrients, and water availability. Furthermore, mechanized farming and excessive use of chemical fertilizer also negatively affect soil such as compaction and loss by erosion. To cope the prevalent scenario, these effects can be reduced using organic amendments in soil for crop production and improving soil quality. This will also lead to minimize the garbage and greenhouse emissions. An incubation study was designed to evaluate the impact of compost, vermicompost on soil physicochemical properties. The pots were filled with soil amended with compost and vermicompost. Both compost and vermicompost was added into the soil at the rate of 5, 15, 25, 35, and 45 percent in each cup with three replications. Each batch was further replicated for 5 times and data was evaluated after 15 days interval. Irrigation water was applied at field capacity. Nutrient quality parameters (P, organic carbon (OC), pH and EC) were evaluated. Data obtained from the study was applied to a computerized model i.e., Response surface methodology (RSM). It was revealed that increasing amounts of compost from 5 to 45 % increased soil nutrients concentration. The data was generated based on RSM, and it was found that both composts, and vermicompost had significant impact. Phosphorus (0.024-0.167 g/kg), pH. (6.9-7.02), organic matter (0.01-0.67%) till 60-65 days.

Keywords: compost, vermicompost, organic, soil, RSM, CCD

ASSESSING RURAL HOUSEHOLDS' RESILIENCE AND ADAPTATION STRATEGIES TO CLIMATE VARIABILITY AND CHANGE IN MIXED CROPPING ZONE OF PUNJAB, PAKISTAN

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Agriculture sector is one of the vital sectors contributing towards the livelihood of more than half of Pakistani families. Climatic vulnerabilities have become one of the leading factors determining the farm productivity. Climatic vulnerabilities have significantly altered farming systems worldwide, resultantly diversification and mechanism have promoted in developed countries as well as developing countries like Pakistan. Given that climatic events are expected to become more common, it is critical to address the resilience of rural families as well as their complementing adaptation options to climate change. Despite increasing awareness about the importance of developing climate resilience among developing-country farm families, little is known about the elements that influence their resilience to climate change. Pakistan is among top ten countries projecting toward facing the impacts of climate change. Considering the need of hour, a survey research was conducted in mixed cropping zone of Punjab, Pakistan. A multistage random sampling technique was used to investigate the climate resilience of 224 farm families. Findings of the above study demonstrated low, moderate, and high degrees of climate resilience, the majority of farm households were found to be unable to withstand climatic vulnerabilities. Most farmers have used a combination of absorptive and adaptive techniques to improve climate resilience. Proactive and transformational methods were less commonly used. Age, educational level, household size, type of ownership, adaptation strategies response efficacy and financial situation of farmer were the main drivers of the resilience of farm families to climate extremes. Study findings revealed that for better rural households' knowledge and information regarding sustainable farm management and to increase rural households' resilience against climate change serious steps are to be undertaken. Brainstorming for appropriate resilience-building initiatives, designing efficient preventive, absorptive, adaptive, and transformative strategies, providing equitable technical and financial supports, increasing rural households' knowledge and information for sustainable farm management and to increase rural households' resilience against climate change is need of the hour.

Key Words: Resilience, Adaptation strategies toward climate change, Climate variability, Climatic vulnerabilities.

IMPROVING CROP YIELD AND SOIL PROPERTIES UNDER RESIDUE MANAGEMENT STRATEGIES

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Crop residue, a byproduct of harvested food and fiber is now recognized for its value in reducing soil susceptibility to wind and water erosion and contributing to soil health and soil fertility. Torrential rains in the sub-mountainous areas of Pakistan yields a tremendous amount of runoff, which is a major limiting factor to obtain maximum benefits of land use. The experiment was conducted in a research field area at the University of Poonch Rawalakot Azad Jammu and Kashmir from 2016-18 in completely randomized block design (CRBD). The residue types wheat straw and maize stalks were used at the rates of 0, 4 and 6 Mg ha^{-1} making a total of 18 treatments. Two crops, i.e., maize and wheat were sown in rotation. Crop residue incorporation improved wheat grain yield by 73.50 % and 81.82 % at 4 Mg ha^{-1} and 6 Mg ha^{-1}, respectively. However, both types of residues had statistically ($P<0.05$) similar wheat grain yield. Maize grain yield improved 25 % at both 4 Mg ha^{-1} and 6 Mg ha^{-1} with crop residues addition. Between types of residues maize residues showed higher maize grain yield 12.46 Mg ha^{-1} compare to wheat residues. The data combined over four seasons had a higher bulk density, low total nitrogen and low organic matter without residue incorporation. However, maize residue incorporation enhanced soil water contents and bulk density. The season four after harvest of two wheat and two maize crops showed higher soil water contents, higher soil organic matter and low soil bulk density. Soil residue incorporation has the potential to improve crop yield and soil health.

Keywords: Crop residues, wheat residues, maize residues, wheat and maize grain yield, soil properties

RESPONSE OF BENEFICIAL RHIZOBACTERIA THROUGH DIFFERENT INOCULATION METHODS ON CHILI (*CAPSICUM ANNUM* L.)

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The aim of the present study was to compare the effect of two microbial inoculation techniques on growth of chili plants. Two microbial inoculation methods i.e enriched vermicompost and seed coating were compared. Uninoculated vermicompost and seeds were used as control. Nine potential bacterial strains i.e PSB, phytohormones producer and PGPR isolated from chili rhizosphere were selected for evaluation. Chili variety i.e Anhiun (hybrid) was transplanted in 5 kg soil in pots. Vermicompost dose was 15g Kg^{-1} soil while recommended level of NPK was utilized in seed treatment method. Complete Randomized Design with three replications was applied. The recorded data was subjected to factor factorial analysis of variance technique, using Statistix 8.1 computer software, means were compared at 5% level of probability. All the bacterial strains presented significant positive response related to shoot height, root length, fresh and dry weight of shoot and fruit as well as phosphorus and potassium uptake of shoot and fruit. Although enriched vermicompost was found better method of inoculation for chili crop but it was significantly high only in root length and shoot P uptake. Interactive effect (Bacterial strains*inoculation methods) remained non-significantly different in all the recorded parameters. Bacterial isolates CRP9 (PGPR) and CRO19 (PSB) were found better compared to other tested strains.

Keywords: Chili plant, Rhizobacteria, Inoculation methods.

INFLUENCE OF RAINFALL CHANGE ON SOIL WATER STORAGE AND SPRING WHEAT YIELD UNDER CONSERVATION TILLAGE TECHNIQUE BY APSIM-MODEL APPROACH

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Information regarding precise quantification of the effect of rainfall change under conservation tillage on soil water storage and spring wheat yield is of vast significance to ensure the agricultural sustainability particularly on the semi-arid zones. This research evaluated the response of soil water storage (SWS) and crop yield to rainfall changed scenario under conservation tillage *viz.,* straw retention to the no tilled soil (NTS) and conventional tillage (CT) over the past 50 years, on the basis of calibration and evaluation of the Agricultural Production System (APSIM) model. The weather data investigation results depicted that precipitation pattern showed large interannual variability during 1971-2020; few years had very low rainfall being lowest than 300 mm; which was not suitable for soil water storage under spring wheat field and wheat production. Rainfall decrease was harmful to the soil water storage and spring wheat crop production. The APSIM model was successfully calibrated and evaluated by using the R^2 and root mean square error (RMSE) and agreement index values (d), demonstrating good performance on simulating the soil water in 0-40 cm soil depth and spring wheat biomass and grain productivity under both NTS and CT systems on the semi-arid climatic conditions of Dingxi of China. Moreover, simulation results showed that NTS treatment increased soil water storage by 4% average over 0-40 cm soil layer than CT system under changed precipitation climate management scenario in spring wheat field averaged across 50-yrs. In addition; compared with CT, the NTS treatment increased biological and grain yield by 5 and 8.69% respectively averaged over 50-yrs under rainfall changed scenario. Consequently, on the basis of simulation results we concluded that NTS is the best climate smart conservation tillage strategy to mitigate dry-spells in wheat mono-cropping agro-ecosystems conditions.

Keywords: APSIM-model; climate smart agriculture; climate mitigation; precipitation change; spring wheat yield; conservation tillage; semi-arid Loess Plateau; soil water

ABUNDANCE AND DIVERSITY OF EARTHWORM FROM SUBDIVISION RAWALAKOT AZAD JAMMU KASHMIR

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Earthworms are considered the most important soil-inhabitant belonging to phylum Annelida and class Oligochaeta. The present study was carried out to explore Earthworm fauna and estimates its diversity in Sub-Division Rawalakot of District Poonch, Azad Jammu and Kashmir. Earthworms were collected from five different localities by hand sorting and digging method. Soil samples (500g) were taken to measure, EC, O.M, pH, moisture content, organic carbon, P, N and K. A total 263 specimens of earthworms were collected. The collected specimens were preserved in 5% formalin. The adult specimens were recognized up to species level by using Sims and Gerard (1985) key of earthworm identification. Taxonomic characters of collected specimens were studied by using microscope. The identified specimens were reposited in the Departmental laboratory of Soil and Environmental Sciences. Nine species; *Eisenia fetida, Bimastos parvus, Eisenia andrel, Aporrectodea rosea, Perionyx excavates, Lumbricus rubellus, Allolobophora chlorotica, Aporrectodea caliginosa and Drawida pullucida* belonging to 3 families *Lumbricidae, Megascolecidae and Moniligastridae* were identified. Diversity of the earthworms was calculated by using Shennon-Wiener and Simpson's diversity index. Richness of the earthworms was calculated by using Margelf's and Menhinck index while Shennon-equatibility and Nakamura index was used to record the evenness of Earthworms. Maximum diversity of earthworms was calculated from Rawalakot while minimum from Hurnamara. The higher abundance of earthworms was noted in Tolipeer area while the lowest abundance was measured from Banjusa and the higher equitability was calculated in Tain area and lowest equitability was recorded in Tolipeer of Sub-division of Rawalakot Azad Jammu and Kashmir

Keywords: Abundance and Diversity of Earthworm

LABORATORY INCUBATION STUDY TO COMPARE THE EFFECIENCY OF NATURAL WITH SYNTHETIC NITRIFICATION INHIBITORS ON NITROGEN TRANSFORMATIONS AND INHIBITION OF NITRIFICATION

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Nitrification of applied nitrogen (N) fertilizers leads to losses of N due to leaching and denitrification, resulting 45-60% losses of applied nitrogenous fertilizers. Beside many approaches, nitrification inhibitors offer a potential way to reduce nitrification and associated losses. Among nitrification inhibitors both synthetic and organic nitrification inhibitors are reported to significantly reduces nitrogen losses. Therefore this study was designed with the objective to compare the efficiency of organic [Neem (Azadirachta indica), Mint (Mentha spicata L.) Bhung (Cannabis sativa) Karanj (Pongamia Glabra vent)] and inorganic [dicyandiamide (DCD)] nitrification inhibitors. The soil was collected from an arable field of Rawalakot, Azad Jammu & Kashmir. Urea was applied at the rate of 200µg N g-1. Organic inhibitors were applied as an aqueous extract at the rate of 30% while dicyandiamide (DCD) at the rate of 5% of applied N. Treated soils were incubated at 25°C for incubation periods of 0, 5, 10, 15, 20, 25, 30, 40, 50 and 60 days. Changes in NH4+-N and NO3-_N at different time intervals were determined by analyzing total mineral nitrogen. Results revealed that the soils where Urea-N was applied without any nitrification inhibitors showed maximum NH4+-N concentration of 136 µg g-1 soil while treatment with the addition of DCD, accumulated 151 µg NH4+ g-1 soil at day 05 and diminished sharply till to the end of incubation. In treatments where Mint, Karanj, Bhung and Neem, were added with Urea-N, maximum accumulation of NH4+-N was observed at day 05 were 145, 148, 160 and 155 µg NH4+ g-1 soil respectively. Among these organic amendments Bhung found to be more effective in accumulating ammonium. Similarly, NO3--N of 81 µg NO3--N g-1 was recorded for soil amended with Urea-N while soil with DCD accumulate 57 µg NO3--N g-1 soil. The use of Mint, Karanj, Bhung and Neem significantly suppressed NO3- formation and the accumulation was observed of 57, 58, 55 and 47 µg NO3--N g-1 soil respectively. Among organic amendments Karanj, Mint, Bhung and Neem found to be more effective to inhibit nitrification and were in order of Pongamia Glabra vent (Karanj) < Mentha spicata L. (Mint) < Cannabis sativa (Bhung) < Azadiracta indica (Neem).

Keywords: dicyandiamide, Cannabis sativa, Mentha spicata L., Azadiracta indica , Pongamia Glabra vent.

CHICKEN LITTER GENERATION AS POTENTIAL NPK-RICH FEEDSTOCK FOR HIGH QUALITY COMPOST – BASELINE DATA SURVEYS OF CHICKEN RETAIL SHOPS IN LAHORE

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The chicken consumption stands dominant in the poultry sector contributing 6.6 % in agriculture of Pakistan while generating employment for over 1.8 million people. Chicken litter (offal, carcass, feathers, and excreta) being proportional (≥ 20 %) to the rate of consumption of chicken, it is a NPK-rich feedstock for composting owing to its dominant protein-based components. To date information about chicken (Broiler) litter generation in the light of daily chicken consumption is scarce. One of the basic requirements for streamlining chicken litter feedstock supply chain for yielding high quality compost is baseline data about its generation in major cities of Pakistan. The current study was aimed at quantifying chicken litter generation in Lahore through representative sampling approaches involving systematic random considerations. The study area administratively being divided into 9 towns and 271 union councils, triplicate samples from at least 3 main markets of each union council yielded 2,439 samples in total for assessing daily per capita consumption, chicken litter generation, current disposal, price variations and usage practices through surveys and especially formulated questionnaires for data recording. The results showed that based on survey-based data, an average 12.35 tonnes per day of chicken litter is being generated in Lahore on daily basis from an average live weight of 20.6 tonnes of broiler. Based on the current circulation chain of the chicken litter in Lahore; it is being collected back at nominal price, transported, and recycled for production of chicken feed. The composition and characterization data of the collected chicken litter samples are anticipated in the near future.

Keywords: chicken offal; chicken carcass; keratin-based NPK; systematic random sampling.

SUSTAINABLE MANAGEMENT OF RICE RESIDUES FOR PROMOTING REGENERATIVE PRODUCTIVITY OF WHEAT CROP

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Rice-wheat (RW) is the major cropping system in South Asia and practiced on about 13.5 million hectares in the Indo-Gangetic Plains (IGP). In Pakistan, this system is practiced over 2.2 million hectares and produces 10-14 Mg ha−1 crop residues. However, sustainability of this essential cropping system is at risk due to poor soil health, mounting pressure on natural resources and emerging challenges of climate change. Innovations in crop residues management to avoid straw burning should assist in achieving sustainable productivity, good soil health and reduced risk due to climate change. Rice residues are important natural resources, and recycling of these residues improves the soil physical, chemical and biological properties. Wheat Straw is an important fodder for the cattle. On contrary, the rice Straw is least preferable food for cattle due to high silica content. Common practice to get rid of rice straw is through its on field burning is causing nutrient loss and emitting greenhouse gases (GHGs) contributing to the global warming affecting climate and human health. The present study was aimed to study the effect of different management option of rice straw on the productivity of wheat and which option prove to sustainable for cropping system and soil health . The methodogly was based on two techniques for rice residues management: infield management and off field management of rice straw. The levels of infield management was no retention(RS.), stubble only(RS_1), straw+stubble(RS_2) and burnt straw(RS_3) and the off field management consisted of biochar(B) and composting(C) of rice straw and combination of both B+C with different rates of recommended fertilizers (F(0%).,F_1(50%) and F_2(100%). For this purpose the mesocosmic experiment was carried out with three replicates of each treatment combination. Galaxy 2013 wheat variety was selected. The treatment combination C+F1 significantly increased the tillers, plant height, No of spikes/m_2, no of spikelet's per spikes , 1000 grain weight and yield of wheat over control. The grain yield of wheat (4.36 t ha-^{1}) increased significantly with 50%F+rice residues compost) over 100%F +B,B+C (3.88 t ha1) and 100%F + rice residue retention (4.12 t ha1). The off field options proved to be eco friendly with least emission of green house gases. SPAD value show signifance result at P=0.05 in off field management options with 100% Fertilizers. Our study revealed that off field techniques proved to be promising option for rice straw management as compared to in field methods both for wheat growth and soil health.

OPTIMIZATION OF AEROBIC COMPOSTING IN UNDISTURBED STATIC PILES THROUGH MODIFIED AERATION SYSTEM

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One of the major problems of the world specifically in developing countries like Pakistan is the management of municipal solid waste (MSW), mostly being rid of through waste burning and landfilling which not only causing waste of resources but also intensifying environmental issues like air pollution and soil pollution. One useful way to get the biodegradable components with low labor and mechanical mixing is through static pile composting. However, this method facilitates only anaerobic decomposition of the feedstock which renders compost of poor quality. The current study was aimed at optimizing aerobic composing in undisturbed static piles by introducing four different designs of modified aeration systems. The aerobic decomposition optimization was assessed on the basis of duration and quality of derived composts. The results showed that the aeration designs that facilitated ≥ 60 % aeration mixing in the composting feedstock resulted in production of high-quality composts. The aeration systems with deficient aeration mixing ratio had more pockets of anaerobic decomposition. Hence, the composts derived from such assemblies were of poor quality

ISOLATION AND CHARACTERIZATION OF HYDROLYTIC ENZYMES FROM THE ROOT NODULES OF GLYCINE MAX L.

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Soybean or *Glycine max* is an oilseed crop containing 18-22% oil. It is highly rich in protein containing 40-42% protein. It has many nutritional contents including fat, minerals, moisture, carbohydrate, etc. annual world production of this crop is 347.4 million metric tons. It is mostly cultivated in Argentina, China, USA. In Pakistan, it is mostly cultivated in Azadkashmir, Lahore, Peshawar, etc. Beneficial bacteria live in the rhizosphere and inside the plant, and they improve the plant's development in a variety of ways, both directly and indirectly. Bacteria found in soybean plants can be studied to discover if they can boost soybean development. This work aims to extract endophytic bacteria from soybean (Glycine max L.) root nodules and evaluate their ability to boost plant growth. A total of 8 bacteria were isolated from soybean root nodules and examined in vitro for their ability to promote plant growth. The capacity of these bacterial isolates to enhance growth is assessed using several assays such as cellulase, pectinase, and chitinase. The majority of the isolates were able to grow on pectinase and cellulose media, but few of the isolates were positive for chitinase production.

ROLE OF BIOCHAR IN CONSERVATION OF SOIL NUTRIENTS DURING CULTIVATION OF VEGETABLE CROPS

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Biochar is a pyrolyzed derivative of biomass while agribiochar or agrichar is a pyrolyzed outcome derived from agricultural wastes arising from different cropping systems and livestock management businesses. As biochar can have very high surface area to volume ratio compared to its source material, can be engineering to alter surface charge properties, and can stay in the soil for decades to centuries; the current study was aimed at assessing role of biochar in conservation of soil nutrients during cultivation of vegetable crops based on its physical, chemical, and biological sorption performance. Through multiple vegetable experimental trials at greenhouse and filed level, it has been observed that soil nutrient conservation was proportionate to the quality of biochar applied in the soil. However, a biochar obtained at high temperatures with complete omission of air showed very high stability and retention time in soil, but its surface charge affinity was very poor, dropped very quickly over time, and showed exchange of nutrients with soil solution mainly through physical sorption and desorption process. However, biochar derived form feedstock with high volatile contents showed very active surface with noticeable values of cation exchange capacity during earlier years of application which started dropping over time due to biodegradation of volatiles retained on its surface. The engineered (chemically, physically and/or biologically pre-treated) biochar showed more longevity of the surface charge than respective type of non-engineering biochar. Overall, biochar application in soil reduced up to ≥ 50 % of the application of chemical fertilizers in the soil without comprising quality and yield of the derived vegetables.

Keywords: active biochar surface; engineered biochar; nutrient sorption; nutrient desorption; agricultural waste feedstock.

DERIVING BIOCHAR COMPOSITE FROM RICE STRAW AND ANIMAL BONES AS SLOW-RELEASE FERTILIZER FOR THE GROWTH OF SUNFLOWER

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Populous countries such as Pakistan with its increasing demand for chicken and meat results in the production of millions of tons of bio waste including rice straw and bones. Such kind of waste rich in nutrients are being discarded without a sufficient return at the cost of environmental deterioration. Charring this waste not only reduces its volume but offers an amendment that has potential for improving soil fertility due to its high content of K, Ca, Mg, and P. Properties of biochar on the basis of their physical and chemical parameters showed the diverse range of functionality, porosity and macro and micronutrients. Findings of applying each prepared biochar in potted soil alone and in mixture as biochar composite at 2, 4 and 6% (w/w) and CF revealed insignificantly different growth results of sunflower. Biochar composite at the rate of 6% (w/w) revealed good potential as slow release organic fertilizer applicable in soil to improve soil properties and agricultural commodities. Moreover this study could lead to a possible sustainable solution for reducing the environmental risks associated with the overuse of commercial fertilizers.

ROLE OF COMPOSTING IN RENDERING SUSTAINABLE SERVICES IN AGRICULTURAL ECOSYSTEM – CONSERVING RESOURCES WHILE REDUCING CARON FOOTPRINTS AND WATER BUDGET

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Sustainable agricultural systems (SAS) essentially rely upon practices that render least possible or no generation of agricultural wastes, hence strongly depends upon regenerative agricultural practices that convert wastes into resources. Agriculture in Pakistan generates huge bulk of wastes almost in all types of cropping and animal livestock management systems being practiced at large scale. The unhealthy disposal practices of agricultural wastes create huge environmental challenges in the form of pollution of air, land, and water resources. The generation of wastes reciprocates wastage of agricultural resources and ever-increasing input cost, so conserving wastes can reduce input cost of the agricultural interventions along with reduction of environmental footprints. As most of the agricultural wastes are biodegradable, the current study was aimed at assessing potential role of composting of such biodegradable waste in rendering multiple sustainable services in the diverse types of agricultural ecosystems while conserving resources and reducing environmental footprints. The study compares pros and cons of on-field retention of crop residues with its soil health and crop productivity challenges due to low organic matter in the soil. Great emphasis has been made on off-field composting-based management of crop and livestock wastes. A holistic overview of sustainability of composting-based management of biodegradable agricultural wastes is provided by enlisting potential services in the social, economic, cultural, and environmental sectors of the agriculture of Pakistan.

Keywords: regenerative agriculture; agricultural wastes; livestock wastes; biodegradable agricultural wastes; crop residue management; resource conservation practices.

APPRAISAL OF ENDOPHYTIC BACTERIA AGAINST SUGARCANE SMUT CAUSED BY *SPORISORIUM SCITAMINEUM* UNDER GREEN HOUSE

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Sugarcane is 2nd largest cash crop of Pakistan. Smut is most devastating disease and emerging threat to sugarcane industry. This pathogen is transmitted through setts. Smut disease significantly decrease yield and sugarcane recovery. In ratoon crop disease incidence increase as compared to newly transplanted. In green house assessing of five endophytic bacteria against *S. scitamineum* was carried out. Endophytic bacteria strains EPB 42, EPB 55, EPB 13, EPB 94 and EPB 36 were taken from Plant Pathology laboratory. Endophytes were applied on moderately susceptible sugarcane buds and artificial inoculum was applied on them. Pots were arranged under CRD with three replications in greenhouse conditions. It was observed that they reduced disease severity; enhance the germination and quality of cane. Minimum smut disease severity (12.5 %) was recorded in EPB 94 treated plants followed by EPB 55 (18.2%), EPB 36 (23.1%), EPB 13 (29%) and EPB 42 (45%).

Keywords: Sugarcane, *Sporisorium scitamineum*, management, entophytic bacteria

EFFECT OF CADMIUM-RESISTANT RHIZOBACTERIA ON THE GROWTH OF ARABIDOPSIS SEEDLINGS UNDER CADMIUM TOXICITY

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Cadmium (Cd) is one of the highly toxic environmental contaminants and causes a significant reduction in growth and yield due to its toxicity. Plant growth-promoting rhizobacteria (PGPR) possess the potential to immobilize heavy metals and decrease their translocation within plants through adsorption precipitation, and complex formation. Therefore, the present study was designed to determine the role of *Morganella morganii* in alleviating Cd stress in Arabidopsis seedlings. Both *M. morganii* strains (ABT3 and ABT 9) were highly resistant to Cd and showed positive results for the nitrogen fixation, indole acetic acid (IAA), ammonia, and phosphate solubilization, catalase, gelatinase and protease enzyme production. Pot experiment under controlled conditions showed that Cd significantly reduced Arabidopsis growth, quantum yield and chlorophyll content. Cd toxicity also triggered different associations between lipid peroxidation and enzymatic antioxidant mechanisms. However, when both strains were applied to the Arabidopsis seedlings, the shoot and root length and fresh and dry weights were improved in the control and Cd-stressed plants. Moreover, both strains enhanced the resistance against Cd stress by increasing antioxidant enzyme activities (catalase and peroxidase) that ultimately cause a substantial reduction in lipid peroxidation. Both strains also showed positive results in improving quantum yield and chlorophyll content, thus increasing the growth of Arabidopsis seedlings. These results elucidated the mitigating role of PGPR in effectively protecting Arabidopsis plants against Cd toxicity. Thus, the application of Cd-tolerant rhizobacterial strains might remediate heavy metal polluted sites by mitigating Cd-induced toxicity and improving the growth of different plants and crops.

COMPARISON OF HEAVY METALS IN LOCALLY GROWN LEAFY VEGETABLES WITH COMMERCIALLY AVAILABLE IN RAWALAKOT MARKET

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Ingestion of vegetables containing heavy metals is one of the main routes through which these metals enter into the human body. The current research was conducted to quantify the accumulation of heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) in vegetables collected from local farmers as well as commercially available in Rawalakot. Most frequently consumed leafy vegetables including spinach (*Spinacia oleracea* L.), coriander (*Coriandrum sativum* L.), mint (*Mentha arvensis* L.), fenugreek (*Trigonella foenum-graecum* L.), dill (*Anethum graveolens* L.) and kale (*Brassica oleracea* L.) were selected to analyze their heavy metal contents by atomic absorption spectrophotometer. The risk associated with consumption of these vegetables was also assessed by calculating daily intake of metal (DIM) and Health risk index (HRI). The average concentrations of heavy metals detected in locally grown leafy vegetables ranged for Cd (0.40-0.54), Cr (0.33-9.61), Cu (1.22-2.90), Ni (1.39-8.43), Pb (0.11-0.85) and Zn (0.06-3.95) mg kg^{-1}. Whereas in commercially available vegetables the concentration of heavy metals was found in the range for Cd (0.37-0.72), Cr (4.78-15.70), Cu (2.05-3.40), Ni (2.27-25.92), Pb (1.27-32.85) and Zn (2.31-6.75) mg kg^{-1}. On average only Zn and Cu level was found within the safe limits, while Cr, Pb, Ni and Cd level in the vegetables across both locations was above the safe limits set by WHO/FAO. The DIM for Cu and Zn were lower than recommended daily intake (DI) levels across both locations. The HRI values for Cd, Cu, Ni and Pb in the vegetables of both locations were > 1 whereas for Cr the HRI < 1. It can be concluded that marketed leafy vegetables contained greater concentration of heavy metals as compared to locally grown.

Keywords: Heavy Metals, Leafy Vegetables

COMBINED FERTILIZATION OF NITROGEN AND PHOSPHORUS TO SUNFLOWER IMPROVED CROP YIELD AND NUTRIENT USE EFFICIENCY

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Optimum use of applied inputs is prerequisite in modern agriculture and scientists are working hard in this regard. It is necessary to apply précised amounts of nitrogen and phosphorus to obtain maximum crop yield. The aim of the present study was to examine the effects of different application rates of nitrogen and phosphorus on growth, yield and nutrient uptake of sunflower under rainfed conditions of Rawalakot, Azad Jammu and Kashmir. There were four levels of nitrogen application i.e. 0, 75, 120 and 180 kg N ha^{-1} while phosphorus was applied at three levels i.e. 0 60 and 90 kg ha^{-1}. The combination of these application levels give rise to twelve treatments i.e. T_1: control, T_2:N_0P_{60}, T_3:N_0P_{90}, T_4:$N_{75}P_0$, T_5:$N_{75}P_{60}$, T_6:$N_{75}P_{90}$, T_7:$N_{120}P_0$, T_8:$_{120}P_{60}$, T_9:$N_{120}P_{90}$, T_{10}:$N_{180}P_0$, T_{11}:$N_{180}P_{60}$, T_{12}:$N_{180}P_{90.}$ Sunflower hybrid "NARC HMH 0907" was used as the test crop. The results of the study showed that application of different combinations of nitrogen and phosphorus but in general application of $N_{120}P_{90}$ produced better results for most of the parameters. In terms of yield it was observed that N_{120} produced maximum results in terms of head diameter, number of seeds per head and ultimately the grain yield. The grain yield produced by N_{120} was 3019 kg ha^{-1} while N_{180} showed seed yield of 2373 kg^{-1}. On the other hand P_{90} produced higher results for both morphological and yield attributes as compared to P_{60}. Seed yield in P_{90} was 2389 kg ha^{-1} while P_{60} gives yield of 2304 kg ha^{-1}, respectively. Application of different fertilizer rates also significantly enhances nutrient uptake and use efficiency. Total and straw N uptake was higher in N_{180} but in case of seed N uptake N_{120} produced better results. N_{120} also produced better results for nitrogen use efficiency with a value of 141% while in case of N_{180} it was 114%. On the other hand P_{90} produced better results both in case of uptake and phosphorus use efficiency. The total P uptake in P_{90} was 17.1 kg ha^{-1} while for P_{60} its value was 9.66 kg ha^{-1}. For phosphorus use efficiency P_{90} gives a value of 19% that was significantly higher as compared to 16% PUE observed for P_{60}. The study revealed the importance of rational use of nitrogen and phosphorus either alone or in combination to get highest possible yield of sunflower without causing environmental problems due to over application of both nutrients.

Keywords: Nitrogen, Phosphorus, Sunflower, Nutrient Use Efficiency

USE OF CLIMATE SMART SOIL AMENDMENTS FOR THE RESTORATION OF COPPER POLLUTED SOIL AND CANOLA GROWTH IN WASTEWATER ALKALINE SOIL

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Wastewater irrigation is becoming a massive challenge for sustainable agriculture. Particularly, copper (Cu) presence in wastewater poses a great threat to the food chain quality. Thus, scientists need to address this issue by using chemical and organic soil amendments to restore the soil ecosystem. Therefore, this study aims to examine the efficacy of elemental sulphur, vegetables waste byproduct (compost) and animal manure for Cd immobilization, and Canola growth in wastewater irrigated soil. The current findings presented that all the soil amendments prominently improved Canola yield and significantly minimized the Cd uptake by Canola shoots and roots in compost amended soil by (43% and 32%). Similarly, addition of soil amendments showed the significant reduction in bioavailable potion of Cd in soil with the increasing application rate. The maximum reduction was observed by 29.21%, 19.5% and 45.8% when acidified manure, elemental sulphur and vegetable compost was applied at 5% application rate. The incorporation of organic soil amendments showed the prominent improvement in soil available nutrients and soil organic matter contents with the increasing application rate from 2% to 5%. Overall, among all the soil amendments organic waste byproducts compost is considered the suitable candidates for wastewater treatment and alkaline nature polluted soil restoration.

Keywords: Copper; Canola; Compost; Elemental Sulphur; Remediation

PSEUDOMONAS SP. AF-54 CONTAINING MULTIPLE PLANT BENEFICIAL TRAITS ACTS AS GROWTH ENHANCER OF HELIANTHUS ANNUUS L. UNDER REDUCED FERTILIZER INPUT

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Plant growth promoting rhizobacteria (PGPR) are capable to increase the growth and yield of crops in ecofriendly and sustainable manner. To evaluate the response of sunflower towards inoculation with PGPR, a sunflower root associated bacterium AF-54 isolated from Diyar Gali Himalayan Mountain region, Azad Jammu and Kashmir (AJK), identified as Pseudomonas sp. by *16S rRNA* sequence analysis and was characterized using polyphasic approach. The bacterium produced 23.9 µgmL^{-1} indole-3-acetic acid in tryptophan-supplemented medium, showed 44.3 nmoles mg-1 protein h−1 nitrogenase activity through acetylene reduction assay and released 48.8 µgmL^{-1} insoluble phosphorus in Pikovskaya's broth. During P-solubilization, the pH of the Pikovskaya's medium decreased from 7 to 3.04 due to the production of acetic acid, malic acid and gluconic acid. Pseudomonas sp. AF-54 showed metabolic versatility by utilizing 79 carbon sources from BIOLOG GN2 plates and resistance to many antibiotics. Furthermore, it inhibited the growth of *Fusarium oxysporum* in dual culture assay. To evaluate the plant-inoculation response, series of experiments conducted in hydroponic, sterilized soil and fields at AJK, and Faisalabad where inoculated plants with reduced fertilizer showed a significant increase in growth, yield, oil contents and achene NP uptake as compared to non-inoculated control. AF-54 showed extensive root colonization in sterilized and non-sterile conditions documented through yfp-labeling and fluorescent *in situ* hybridization coupled with confocal laser scanning microscopy. This study concludes that the Pseudomonas sp. strain AF-54 containing multiple plant growth promoting traits can be a potential candidate for biofertilizer production to enhance sunflower crop yield with reduced application of chemical (NP) fertilizers

Keywords: PGPR, *Pseudomonas*, CLSM, Colonization studies, FISH, Plant inoculation

CROPLAND SOILS AND CARBON SEQUESTRATION: ROLE OF ROOT *VS* SHOOT RESIDUE IN MITIGATING GREEN HOUSE EFFECT AND CLIMATE CHANGE

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The quality of plant residues predicts their decay in soil. However, it remains unclear that how quality and location of the plant residues affect carbon (C) retention in soil. Better understanding of soil C dynamics under actual agricultural conditions is important for predicting impact of climate change on soil C sequestration and mitigating green house effect. The objective of this research was to track the relative contribution of root *vs* shoot derived C (C_{new}) in soil aggregate as a function of their quality and location in soil. Wheat, pea and vetch plants were pulse labeled with $^{13}CO_2$ in the field and "paired treatments" were made by combining ^{13}C labeled shoots with unlabeled roots (LS) and unlabeled shoots with ^{13}C labeled roots (LR) (root+soil) to track shoot *vs* root residues C in whole soil and in different aggregate size classes. Soil aggregates were separated by wet sieving. A great proportion of the shoot and root derived C_{new} of three crops was associated with large macroaggregates (LMa, >2000 µm) in 0-5 cm soil depth while small macroaggregates (SMa, 250–200 µm) held major proportion of root and shoot derived C_{new} in 5-15 and 15 -30 cm soil depths. The C_{new} in SMa and microaggregates (Mi, 53-250 µm) increased with time in all soil depths. The shoot derived C_{new} retained in soil was in order of vetch > pea > wheat while it was in order of vetch > wheat > pea for root residues. After 24 months, 25% of the root derived C_{new} was present in soil compared to 3% (average of three crops) of the shoot derived C_{new}. The mean relative contribution of root *vs* shoot derived C_{new} was 2.8 ranging from 2.14 (pea) to 3.23 (vetch). Our results show that quality of residues impact C stabilization only when residues are decomposing in similar environmental conditions whereas, location of the residues prevail on quality under contrasted decomposition conditions and impact C stabilization in soil.

Keywords: C distribution, No tillage, Roots, Shoots, Soil aggregates, C Sequesteration

INTERVENTION AND INNOVATION IN FERTILIZER REDUCE LOSSES OF NUTRIENTS AND IMPROVE CROP YIELD UNDER CHANGING CLIMATE SCENARIO OF PAKISTAN

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Synthesis of various types of fertilizers (organic, synthetic, quick release, slow release, solid, liquid or gaseous) and evaluation of their efficiency have been quite intensively researched. Since existing efficiencies are very low at farmer's fields like N ≤ 30%, P 5-15%, K ≤ 50% and micronutrients < 10% which emphases to introduce some intervention for improving use efficiency of applied nutrients. The knowledge of chemistry and functionality of fertilizers, their agronomic roles and factors affecting their functions is continuously improving. As fertilizers are one of the most important elements of modern agriculture, therefore their definite role in crop production have been acknowledged when applied in balance amount. However, a significant portion of nutrients applied in the field is not taken up by plants and is lost through leaching, volatilization, nitrification, fixation, or other means and thus decrease their use efficiencies. Such a loss increases the cost of fertilizer and severely pollutes the environment. To alleviate these problems, enhanced efficiency fertilizers (EEFs) could be used in the form of slow/controlled release fertilizers and nitrification/ urease inhibitors. These type of interventions have become need of time due to shortage during peak requirement time and high escalation in the prices of fertilizers. The application of polymer for coating in EEFs tailoring the release pattern of nutrients to closely match the growth requirement of plants is an innovative technique. This technique can improve nutrient use efficiency with both less loss and cost. This technology has been successfully used and renovated according to Pakistan's soil and climate needs and obtained encouraging results in research trials and farmers' fields.

Keywords: Nutrient losses, Crop yield

EQUILIBRIUM KINETICS AND THERMODYNAMIC STUDIES ON BIOSORPTION OF HEAVY METALS BY METAL RESISTANT STRAINS OF *TRICHODERMA* ISOLATED FROM TANNERY SOLID WASTE

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One of the eco-friendly strategies to clean-up the heavy metal polluted environment is the use of indigenous microorganisms. This study was aimed at determining the metal sorption potential, equilibrium kinetics, thermodynamic studies, and thermo-kinetics of indigenous *Trichoderma* strains. The effect of various biosorption parameters was observed on the biosorption potential of isolated strains. Results revealed that metal uptake capacity and removal efficiency for Cr, and Pb have increased with an increase the initial metal concentration (50-800 mgg^{-1}), temperature 25-30 ^{o}C. Among the thermodynamic modals, maximum correlation coefficient values (R^2) of 1 were found for the Langmuir model, representing a better-fitted model for biosorption of *Trichoderma* strains. Equilibrium kinetic analysis showed that data of metal biosorption was best fitted with Pseudo kinetic second-order (PSII). The results of thermodynamic studies indicated that heavy metal biosorption by *Trichoderma* species was an endothermic and spontaneous reaction. Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM-EDX) analysis indicated significant changes in different active functional sites and also surface morphology of mycelium. The high metal tolerance potential exhibited by *Trichoderma* strains could make them an efficacious bioremediation mediator for heavy metal polluted environments.

Keywords: Tannery solid waste, Autochthonous fungi, Biosorption, Isotherm, FTIR

CHARACTERIZATION OF HALOPHYTES TO REMEDIATE THE SALT AFFECTED SOIL

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Soil salinity is becoming a major constraint to agricultural production. Therefore, the plant especially the crops possessing capacities of salt tolerance will be of great economic significance. The adaptation or tolerance of plants to salinity stress involves a series of physiological, metabolic and molecular mechanisms. Halophytes have demonstrated their capability to thrive under extremely saline conditions and thus considered as one of the best germplasms for saline agriculture. To fulfill the globally increasing demand for food for humans and livestock, the selection of salt-tolerant genotypes to get production from salt affected soils is imperative. In the present experiment, four halophyte species were evaluated against four salt levels (Control, 10 dSm^{-1}, 20 dSm^{-1}, and 30dSm^{-1} NaCl) using different agronomic, physiological and quality indices. Significant variations regarding growth were observed in all halophyte species. Results depict that *Boerhavia diffusa* exhibited higher salt tolerance by conferring higher plant biomass, chlorophyll, and water contents, membrane stability along with K^+/Na^+ ratio while *Chenopodium album* depicts lower plant growth and inferior K^+/Na^+ ratio among all species. Our results can be a potential source for plant breeders and crop physiologists due to their genetic variability and responsiveness to salinity and provide a good starting material for the breeding of salt tolerant species with high nutritional value that are able to grow and make possible the utilization of saline lands.

Keywords: Phytoremediation, Halophytes, Salt affected Soil.

IRON AND ZINC OXIDE NANOPARTICLES REDUCE SOIL MICROBIAL ACTIVITIES AND NITROGEN UTILIZATION FROM MANURE BUT DO NOT POSE RISKS ASSOCIATED TO HUMAN HEALTH

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Soil contamination with metallic nanoparticles (NPs) is increasing owning to their extensive use in agriculture, industrial products, soil remediation, and wastewater treatments. These NPs can be toxic to soil microbes and can affect their associated functions like decomposition and nitrogen (N) mineralization of added organic material and thereby affect the plant yield and N recovery. Once take up by plants, these metallic NPs may pose health risks to humans via dietary intake of vegetables grown in NPs receiving soil. This study aimed to examine and compare the effects of zinc oxide (ZONPs) and iron oxide (IONPs) nanoparticles on (i) soil microbial activities, reddish yield and plant N recovery after soil application of poultry manure (PM) and (ii) associated health risks via dietary intake of reddish. Soil application of ZONPs and IONPs significantly ($P<0.05$) increased the microbial biomass Zn/Fe content indicating their absorption by the soil microbes. This has decreased the colony forming units of bacteria by 32 and 19% from PM applied with ZONPs and IONPs, respectively. The respective decrement in case of fungal colony forming units were 23 and 28%. Consequently, N mineralization of the added organic N significantly decreased by 62 and 29% due to the addition of ZONPs and IONPs, respectively. As a result, total reddish dry matter yield from PM decreased by 22 and 12% after addition of ZONPs and IONPs. The respective decrement in case of ANR were 65 and 39%. Between the two NPs, ZONPs proved to be more toxic for soil microbes as compared to the IONPs. Health risk assessment indicated that DIM and HRI were not significantly ($P>0.05$) different with or without addition of both these metallic NPs.

Keywords: Nanoparticle toxicity**,** Health risk assessment, Poultry manure, Microbial biomass, Fertilizer value, Mineralization

EFFECT OF MAGNETIC BIOCHAR ON IMMOBILIZATION OF HEAVY METALS IN TOMATO CROP IRRIGATED WITH WASTEWATER

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Use of untreated municipal wastewater (WW) contains toxic trace elements that pose a serious threat to the soil-plant-human continuum. The use of biochar (BC) is a promising approach to minimize trace element induced toxicity in the ecosystem. Therefore, the present study aims to evaluate the efficacy of BC derived from wheat straw and Magnetic biochar (MBC) to reduce trace element buildup in soil and plants that consequently affect tomato plant growth and physiological response under WW irrigation. The BC and MBC was applied at four levels (0, 0.5, 1, and 1.5%) in WW irrigated soils. The results indicated that the addition of BC and MBC resulted in significant reduction in trace element mobility in soil. Interestingly, the application of WW+MBC (1.5%) was more effective in reducing trace element mobility and bioavailability in soil by 78% (As), 58% (Cr), 46% (Pb) and 50% (Cd) compared to WW irrigation, and thus reduced trace element accumulation and toxicity in plants. Results revealed that WW irrigation negatively affected tomato growth, fruit yield, physiology and antioxidative response. Addition of BC and MBC ameliorated the oxidative stress (up to 65% and 58% reduction in H_2O_2 and MDA) and increased plant tolerance (up to 49% increase in POD and APX activity). The risk indices also showed minimum human health risk (H1 < 1) from tomato fruit after the addition of BC or MBC in WW irrigated soils. It was concluded that MBC addition in WW irrigated soil could assist in reducing trace elements accumulation and toxicity in tomato and associated human health risks.

Keywords: Magnetic biochar; tomato; wastewater irrigation; biomass; yield; antioxidants; risk assessment

ALLEVIATING CHROMIUM (VI) STRESS IN CONTAMINATED SOIL BY CR-TOLERANT RHIZOBACTERIA

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Chromium especially hexavalent specie, is one of the supreme contaminated toxin that enter the soil through numerous humaninduced activities. It not only has many negative effects on plants, but also has different negative effects on favorable soil microbes. Chromium pollution of agricultural landhas become a severe worldwide issue.This studyaims to determine the influence of Cr- resistant rhizobacteria *(Bacillus xiamenensis*PM14*)* on *Helianthus annuus* growth and HM absorption beneath chromium pollution conditionsi.e. 25, 35 and 45 ppm. A pot experiment was designed to examine the results of Cr-resistant rhizosphere bacteria and the ability of sunflowers to absorb chromium.It is found that inoculum with Cr-resistance bacteriareduced the Cr concentration and support crop growth by improvingthe absorbance of Cr in sunflowers. Under different Cr concentrations, rhizosphere bacteria increased the Cr absorption in theplant.Although the difference was not significant, when the Cr content doubled; the percentage of increase was halved. Rhizobacter inoculation ($P < 0.05$) significantly,impacted the physical and etymological appearances of crop and augmented agronomic tallness, physical aspects (chlorophyll a, chlorophyll b), carotenoids, antioxidant accomplishments, relative water contents, boosted total Cr accumulation, condensed proline and electrolyte leakage in *Helianthus annuus*.

Keywords: *Bacillus Xiamenensis,* Bioremediation, Chromium, Heavy metal, PGPR, Sunflower

MITIGATING THE EFFECTS OF CLIMATIC VARIABILITY THROUGH THE PILLARS OF CLIMATE-SMART AGRICULTURE: A WAY FORWARD

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At present billions of mouths go to bed hungry. According to an estimation, the global population will almost double by 2050. On the globe in many countries agriculture is a single sector that plays a vital role in the economic development of a country and trying to reduce poverty, while this sector is under various threats, among these threats climatic variability or climate change is the major threat for this sector. In recent years that has increased consequent of climate variability. Results of many studies highlighted that climate change is reducing crop production, particularly in developing countries. It not only reduces the crop yield but is also responsible for food insecurity in the country. Therefore, in the world, various national and international bodies and groups are working together to devise a farming system that boosts food production to fulfill the food requirements at the local and global levels. In this context, Climate Smart Agriculture (CSA) is a way to face the climatic variability. CSA is a good opportunity to improve the food and livelihood security in the region. It is an innovative approach for mitigating climatic variability. The Food and Agriculture Organization of the United Nations (FAO) defined climate-smart agriculture as having three pillars, food security, adoption, and mitigation. According to these pillars, food security means sustainably increasing agricultural production and income, Adoption deals with developing the resilience against the climate change and reducing the causes of climate change like greenhouse gas emissions according to the possibility. These three pillars of CSA have the potential to face the climatic variability and mitigate its effects on the globe. These are the best strategies if we need to overcome the effects of climate change. In this scenario educating and promoting these strategies in the community is an important step in ensuring the minimal effects of climate change and food security.

Keywords: Climate change, Climate-smart agriculture, Food security, Pillars of CSA

GEOCHEMICAL ANALYSIS OF GROUNDWATER QUALITY AND HEALTH RISK ASSESSMENT IN PUNJAB, PAKISTAN

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Understanding groundwater quality and hydrogeochemical behavior is important because consumption of the potentially toxic elements (PTEs)-contaminated drinking water may induce several health problems for humans and animals. In the current study, we examined the potential groundwater contamination with various PTEs (arsenic, As; cadmium, Cd; copper, Cu; manganese; Mn) and the PTEs-induced health risk. Groundwater (n = 111) was characterized for total As, Cd, Cu, and Mn concentrations and other water quality attributes along the River Sutlej floodplain of Punjab, Pakistan. Results revealed that groundwater, which is used for drinking purpose, contained high concentrations of As and Cd (mean As: 33 µg/L, mean Cd: 3 µg/L), exceeding 100% and 32% than the World Health Organization's safe limits (10 and 3 µg/L, respectively) in drinking water. The other water quality attributes (i.e., EC, HCO_3, Cl and SO_4) were also found above their safe limits in most of the wells. Hydrogeochemical data showed that groundwater was dominated with Na–SO_4, Na–Cl, Ca/Mg–CO_3 type saline water. The hazard quotient and cancer risk indices values calculated for As and Cd indicated potential threat (carcinogenic risk > 0.0001 and non-carcinogenic risk > 1.0) of drinking groundwater in the study area. This study shows that the groundwater along River Sutlej floodplain poses a health threat to the communities relying on it for drinking and irrigation due to high concentrations of As and Cd in water. Moreover, it is important to monitor groundwater quality in the adjacent areas along River Sutlej floodplain and initiate suitable mitigation and remediation programs for the safety of people's health in Punjab, Pakistan.

Keywords: Groundwater quality, Health risk Assessment, PTEs, Floodplains

SILICON APPLICATION IMPROVES Fe AND Zn USE EFFICIENCY AND GROWTH OF MAIZE GENOTYPES UNDER SALINE CONDITIONS

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Salinity causes decrease in maize growth and production. Maize occupies an important position in fodder and food crops of Pakistan. Recently, maize has been designated as silicon (Si) accumulator which can alleviate the salinity damage, a major constraint to agricultural crop production. With the objective to combat salinity stress in maize by Si applications using silicic acid $Si(OH)_4$, an experiments was conducted on two contrasting maize genotypes (salt sensitive; Pak-Afgoee and salt tolerant; Ev-5098), under normal and saline conditions. Three different levels of Si (0, 1 and 3 mM) were optimized for salinity tolerance on the basis of plant morphological characters especially dry weight in hydroponics. These Si-level was further used to investigate its effect on maize in hydroponic (0 mM NaCl) and saline (100 mM NaCl). The evaluation was done on the basis of various morphological, physiological, biochemical and growth traits during the experiments. Silicon supplementation into the solution culture significantly improved the K+: Na+ with reduced Na+ and increased K+ uptake. Plant water relations with higher water potential, increase in chlorophyll fractions and its ratios, enhanced stomatal conductance. It was concluded that Ev-5098 is better than Pak-Afgoee under salt stress and silicon inclusion into the any growth medium is beneficial for maize and can improve crop growth by maintaining plant water status, better K+: Na+ and recovering the plant defense system adversely influenced by salt stress.

Keywords: Salinity, maize, silicic acid, morphological, physiological, biochemical

EFFECT OF BLACK SOLDIER FLY LARVAE AND GARBAGE ENZYME IN RAPID COMPOSTING OF FOOD WASTE

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The application of food waste to the composting process is made unfavorable by the high moisture content, higher oil and fats content and low C/N ratio. In this study we focused on providing the favorable conditions for rapid composting of food waste using a novel combination of Garbage enzyme and Black soldier fly larvae (BSF) on food waste and rice husk. Different level of garbage enzyme and BSF larvae were applied both combine and separately to examine the best possible combination. Treatments includes control (food waste alone), 2nd, 3rd and 4th treatment includes 5%,10%, and 15 % garbage enzyme respectively, however; 5th treatment has BSF larvae, 6th, 7th, and 8th treatment contains 5%, 10%, 15% garbage enzyme together with BSF larvae (0.04 g /1 gram of waste) were used in combination. The composting of food waste was done in just 30 days using these combination and comparative analysis was done. The maximum pH 5.31 was recorded in T4 followed by T5 and T3. A significant reduction in heavy metals content was recorded and high bio accumulation factor in larvae body was detected. It is perceived that specific combination of BSF larvae and garbage enzyme can prove to be viable solution for effective and rapid composting of food waste.

Keywords: Garbage Enzyme (GE), Black soldier fly larvae (BSF), Food waste (FW)

EFFECTS OF SALINITY ON SEEDS GERMINATION AND MORPHOLOGICAL CHARACTERISTICS OF ALFALFA *(MEDICAGO SATIVA)*

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Salinity, drought, cold, and heat are all abiotic stresses that damage crop survival, biomass production, and yield. Soil salinity is a major worldwide issue around 20% of irrigated land and limits production considerably.Salt stress is one of the most serious limiting factors for crop growth and production through the water-deficit effect of salinity and injury to cells in the transpiring leaves. *Medicago sativa*of the family Fabaceae is one of the naturally growing seasonal wild leguminous shrubs having high potential as a cover crop to improve the soil fertility, mulch, green manure, and forage for livestock. The present work was conducted to assess the toxic effect of sodium carbonateon seeds germination and the morphological characteristics of *Medicago sativa.* Seeds of *Sesbaniabispinosa* were grown in the pots for 3 months. Three treatments were employed such as T0 (0mM), T1(50mM), and T2(100mM) to evaluate *Medicago sativa*performance in terms of growth for seven days. Morphological characters were noted after the completion of the experiment. Results showed that germination rate was not much affected by sodium carbonate stress under any treatment. Moreover, root length, shoot length, leaf length, and leaf number were morphologically the same under all levels of stress.Further biochemical analysis (photosynthetic pigments, phenolic content) was also determined in the laboratory to understand the changes that occur due to sodium carbonate stress. It was proposed that *Medicago sativa*could survive in the saline environment and had some potential against salt stress.

Keywords: Alfalfa, Biochemical analysis, Morphological characters, Salinity

ISOLATION AND CHARACTERIZATION OF ARBUSCULAR MYCORRHIZAL FUNGI FROM ONION PLANTS

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Arbuscular mycorrhizal fungi (AMF) plays a vital role in plant water, soil structure and nutrient uptake particularly in poor soils. This study aims to determine the spore density and morphological characteristics of AM fungi in the rhizosphere of onion collected from four different sites in District Mirpur Khas, Sindh and two sites in District Haripur, Khyber Pakhtunkhwa. Isolation of AMF spores was done with wet sieving and decanting technique and sucrose density centrifugation technique. Enumeration of AMF spores isolated from rhizosphere was done under stereoscope and their morphological characteristics was observed under compound microscope. Results showed that highest AMF spores' density was observed in soil of Goth Bitharo which was 1166 spores per kg of soil. The density of AMF spores was lowest in Goth Ghulam Rasool, District Mirpur Khas which was 26 per 30 g soil. The morphological characteristics of AMF spores isolated from sampled sites was different. Some spores were globose in shape and others were sub globose and circular. Similarly, other spores' morphological characteristics was also different like color of wall layer, number of layers, inner content. AMF spores isolated from sampled sites had smooth, granulated, hyaline inner content and color of wall layer of mostly spores was brown to black. Overall, AMF spores' density was lowest in soil of Noor Colony and Naseem Town of District Haripur due to higher nutrient content and organic matter compared to other sampled sites of District Mirpur Khas, Sindh. Future study should concentrate on this AMF spore morphology analysis at the molecular level with their genus or species.

Keywords: Mycorrhizae, Biofertilizers, Bio stimulants, AMF Spores, Nutrients uptake, P uptake

REMOTE SENSING APPROACH FOR EARLY DETECTION OF INVASIVE SPECIES IN PROTECTED AREAS OF PAKISTAN

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Globally, biological invasions are considered as one of the major contributing factors for the loss of indigenous biological diversity. Remote sensing plays an important role in the unbiased detection and delineation of invasive weeds to support ecological restoration and conservation and agriculture management. The main objective was to study the potential use of hyperspectral remote sensing to discriminate the invasive species in two Protected areas, Lehri Reserve forest and Jindi Reserve Forest in Punjab Pakistan. Spectral measurements were collected from the field using ASD field spectroradiometer and discrimination between plant species was evaluated statistically using spectral indices and leaf wavelength spectra. Spectral separability was also calculated using JM distance index. Results showed that there were statistically significant differences ($p<0.05$) in reflectance between the spectral indices of the most plant species of the forests. However, red edge parameters showed the highest potential ($p<0.001$) to discriminate between pairs of plant species. With leaf spectra, 562 wavebands (75%) were able to discriminate spectrally ($p<0.05$) with all plant species and NIR region contributed best (96%) for the significant differences found between plant species. Overall, the study concluded that it is possible to identify invasive weeds spatially, through hyperspectral sensors for long-term monitoring. However, upscaling of hyperspectral measurements to airborne and satellite sensors can provide a reliable estimation of invasion inside protected areas and can help to save biodiversity, agriculture and environmental ecosystem in future.

Keywords: Reserve forest; Hyperspectral sensors; Spectral signatures

ISOLATION AND CHARACTERIZATION OF POTENTIALLY HALO-TOLERANT BACTERIA FOR THE GROWTH OF TOMATO (*SOLANUM LYCOPERSICUM* L.)

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Soil salinization has become sever risk to food security and climate change through deterioration of soil and decline in crop production. In this study, we isolated salt-tolerant bacteria from the rhizosphere of wild plants grown on saline area of Khewra salt mines to test these bacteria's efficiency in alleviating salt stress in tomato. Initially ten bacterial strains (S1–8) were isolated and two were found to be tolerant at high salinity. Selected tolerant isolates (S2-S6) were further characterized for salinity tolerance and useful traits by a sequence of quantitative tests. Biochemical characterization showed that bacterial survivability declines slowly with increasing level of NaCl salt stress. Selected bacterial strains were further tested on tomato in a soil pot experiment under saline conditions. Various physiological, biochemical, and ionic attributes were measured from plants at vegetative stage. Based on obtained results, both superior strains were effective to ameliorate the adverse effect of induce salt stress on tomato seedlings. Our results demonstrated that salt-tolerant bacteria isolated from the rhizosphere of wild plants grown on saline area of Khewra mine could be used for alleviating salt stress in crop plants.

Keywords: salt stress; plant growth; rhizosphere bacteria; wild halophytes.

L-PROLINE INDUCED MORPHO-PHYSIOLOGICAL CHANGES IN BARLEY (*HORDEUM VULGARE* L.) GROWN UNDER CADMIUM STRESS

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Barley, due to innate behavior to grow under different environmental conditions is used to cultivate on small as well as large agricultural practices. Among heavy metals, cadmium is measured as poisonous heavy metal which harmfully distresses the ability of plants. An experiment was carried out in sand-filled pots at Old Botanical Garden, University of Agriculture Faisalabad to assess the role of exogenously applied L-Proline in alleviating the effect of cadmium (Cd) stress on two barley genotypes Jao-17 and Sultan-17. The experiment was arranged in a completely randomized design (CRD) in a factorial arrangement with three replicates. After germination, seedlings were exposed to Cadmium stress (120µM) along with L-proline (1mM) and grown for 40 days. Crop was harvested after 45 days of germination, different morphological parameters were measured immediately after harvesting. Enzymatic and non-enzymatic antioxidants, inorganic ions, MDA and H_2O_2 level were also determined after harvesting using standard protocols. The results suggested that cadmium stress reduced many morphological parameters (weight of plant, height of plant, shoot fresh weight, root fresh weight, number of tillers per plant) when compared with control. Physiological parameters were also reduced under cadmium stress. Cadmium stress also decreased the activity of antioxidant enzyme (CAT) while increased the activity of SOD and POD, MDA and H_2O_2 level relative to control. On the contrary, foliar application of proline was effective in reducing the toxicity of cadmium, and also showed partial reversal of Cd stress effects by improving the growth attributes in barley. These findings indicated that higher K^+, Ca^{+2}, protein, could be the key factors, which offer advantage to barley over other crops for superior performance under heavy metal stress conditions.

Keywords: Barley, Heavy metal stress, L-Proline, Antioxidant activity

IMPROVING RESOURCE USE EFFICIENCY AND SOIL HEALTH BY INTEGRATING RICE CROP IN COTTON

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Cotton is an industrial as well as cash crop for the farmers in Pakistan. The area and production of cotton in the country are lower to fulfill annual industrial demand. Cotton cultivated area has shifted to other season crops like rice, maize and sugarcane due to economic factors. One of the options to meet the country's lint demand is the vertical expansion of cotton plant to gain better yields per unit area. The other viable options adopted by different countries to increase the farm income are to intercrop other crops along with cotton. Intercropping is the proven option of vertical expansion of cotton that can help to ensure both subsistence and disposable income to the farmers. The experiment consisted of the following treatments e.g. T-Sole cotton, T2-Cotton (plant space 1 ft) + Rice, T3-Cotton row skip + Rice, T4-Cotton (plant space 1.25 ft) + Rice, and T5-Cotton (plant space 1.5ft) + , was initiated to grow cotton on ridges and rice crop in furrows with the objectives to increase the farm income per unit land area and for making efficient utilization of available resources. Results revealed that in treatment, one row skipped in cotton + rice in furrows, plant height, bolls per plant and boll weight remained maximum while in sole cotton treatment plant height and number of bolls per plant remained minimum. Although, in sole cotton treatment maximum seed cotton yield was obtained while in row skip in cotton + rice in furrows minimum seed cotton yield was observed but paddy rice yield remained maximum in row skip in cotton + rice in furrows. In the treatment T2, cotton (plant space 1ft) + rice in furrows, the soil parameters such as moisture content, bulk density and soil temperature remained much promising as compared to other treatments. Similarly in T2 treatment the parameters of economic analysis such as land equivalent ratio, area time equivalent ratio and cotton yield equivalent ratio also remained higher as compared to other treatments. Furthermore, in the treatments T3, T4 and T5, the seed cotton yield and other parameters remained lower than sole cotton treatment, which indicated less profitable for intercropping. From the study it is concluded that the treatment "cotton (plant space 1ft) + rice in furrows" is more resource efficient and economical inter cropping configuration for farmers.

Key words: Intercropping, sustainable, cotton, rice, resource efficient

DOES PHOSPHORUS APPLICATION TIME AFFECTGROWTH, DEVELOPMENT AND PRODUCTIVITY IN COTTON?

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Crop growth requires nutrients' availability and constant supply throughout the growing season. Cotton yield responds positively to application time of each nutrient, especially P. The time of fertilizer application in the soil affects the nutrients uptake by plant and dry matter accumulation in the cotton plant parts. The P application time is crucial as it influences earliness, root development, accumulation of other nutrient and plant biomass with greater tendency towards the vegetative and reproductive organs. Crops respond differently to the P application time. Due to present hike in phosphatic fertilizers, the P fertilizer use strategy needs a careful revision, considering its low recovery in the cotton belt. Conclusive experimental data regarding critical P application time are still lacking.Keeping in view the significance, experiments were conducted, in the cropping seasons 2020-21, on two cotton cultivars e.g. Cyto-537 and Cyto-535 to evaluate the response of applied P_2O_5@50 kg ha^{-1} at sowing, 25 days after planting (DAP), and in two equal splits at 25& 50 DAP. Applied P_2O_5 @50 at 25 DAP improved main stem height, number nodes on main stem and intermodal length in both cotton genotypes as compared to full P at sowing and control treatments. Similarly in the treatment where full P was applied at 25 DAP, the fresh biomass of leaf, stalk and root portions increased by 59% & 45%, 53% &37%, 44%& 38% in Cyto-511 and 17% &22%, 12%& 8%, and 37% &27% in Cyto-535 during 2020 and 2021, respectively, as compared to full P at sowing. Furthermore, in the treatment where full P was applied at 25 DAP, the nutrients uptake such as N, P and K was also higher in both genotypes as compared to full P at sowing and control treatments. Moreover, in treatment where full P was applied at 25 DAP, the seed cotton yield, number of bolls and boll weight increased by 17% &13%, 20% & 14% and 7% &5% in Cyto-511 and 12% & 30%, 19% & 31% and 3% & 3% in Cyto-535 during 2020 and 2021, respectively as compared to treatment with P applied in full at sowing. In the treatment where P applied in two equal splits such as 25 & 50 DAP the seed cotton yield and other parameters remained higher as compared to full P at sowing and control while remained at par with P at 25 DAP. In conclusion, the experiment provides the evidence that delayed application of P in cotton is more beneficial as indicated by improved plant structure, increased biomass, seed cotton yield and yield attributing factors in both cotton genotypes.

Key words: Phosphorous, plant structure, Seed cotton yield, nutrient uptake

CHANGES IN PHOSPHORUS FRACTIONATION WITH ANAEROBIC CO-DIGESTION OF BANANA PEEL AND INTESTINAL FLUID BY USING LATRITE AND ROCK PHOSPHATE AS ACCELERANT

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Pakistani soils are deficient in various macro and micronutrients especially nitrogen and phosphorus. In-order to combat the prevalent soil nutrient deficiencies, different organic amendments have great potential to improve nutrient availability and soil health. Precipitation of phosphorus in the form of di-calcium phosphate is the major cause of phosphorus deficit in Pakistani soils. The goal of this study was to examine how anaerobic digestion of banana peels affects soil P fractions. The phosphorus proportion in organic fertilizer digestate changed due to laterite. While phosphorus from rich phosphate redistributed as a different percentage in the digestate, this might affect the digestate's long-term phosphorus supply. Different soil parameters such as: total nitrogen, oxygen demand, C:N ratio, available phosphorus, potassium were analyzed in current study. Using laterite and rock phosphate, anaerobic digestion protected nutrients throughout the process, converting complex, biologically bound phosphorus into a more physiologically accessible form. It substitute phosphorus-rich organic fertilizer for chemical fertilizers (phosphate fertilizer).

Keywords: phosphate fertilizer, phosphorus fractionation, organic fertilizer, Food waste (FW), Anaerobic co-digestion

MONITORING OF SELECTED HEAVY METALS TOXICITY IN FRESH WATER AND SEDIMENT OF RIVER AND ITS BIO-ACCUMULATION IN MALLARD (*ANAS PLATRHYNCHOS*) IN THE VICINITY OF RIVER HARO

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Heavy Metal (HMs) is one of the great health concerns that pollute the aquatic life. Heavy metal circulates into the food cycle and damage the quality of environment. Heavy Metals can be assessed by the bird's feathers' and eggshell that is used as a bioindicator and biomonitoring tool. Our experiment was conducted to study the level of cadmium (Cd), copper (Cu) and zinc (Zn) by bioindication of feathers and eggshell of *Anus platrhynchos* in water and sediments in selected locations of River Haro District Haripur, KPK, Pakistan. Samples were collected from feathers (Body, wing, and tail), eggshell, water sample along various location of river Haro. Samples were then analyzed for Cd, Cu and Zn amount by the help of atomic absorption spectrophotometer. Level of Cu, Cd and Zn in various sample can best represented the order wing feathers>tail feathers>body feathers>eggshell, respectively. Elevated amount of heavy metals may affect *A. platrhhynhos* life, and reduce this species. In conclusion the chemical contaminations of heavy metal from domestic and industrial waste are damaging the quality of life.

Keywords: Heavy Metals **(**HMs), Copper (Cu), Cadmium (Cd), Zinc (Zn), Feather, *A. platrhynchos,* chemicals.

BIORESOURCE NUTRIENT RECYCLING: A STEP TOWARDS SUSTAINABLE AGRICULTURE

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The improvement and maintenance of soil health by the addition of bioresources is considered a cornerstone of organic agriculture. Present study was designed to evaluate the impact of conventional practices (fertilizer alone) and diverse farming approaches (such as green manuring, farmyard manure application, rice residues incorporation, residues mulching, residues removing and residues burning) on the physico-chemical, biological and enzymatic attributes of soil in rice-wheat cropping system. Initially a field survey (100 farmers) was conducted to observe the farming approaches of the residents that were practicing on regular basis in the last three years in their field areas. Total thirty-five study sites were selected with five sites (replicates) from each farming approach system. Thirty-five sites were selected on the basis of seven treatments along with five replicates. These thirty-five sites were selected both as pre as well as post farming approaches for various physio-chemical, biological and enzymatic activities of soil. Characterization of rice residues of all cultivars, green manure crop (sesbenia) and decomposed farmyard manure samples showed differential behavior for macronutrients, micronutrients and trace elements. Higher doses of inorganic fertilizers significantly influenced soil attributes especially electrical conductivity, nutrient contents, bacterial and fungal population and soil enzymatic attributes. The crop residue treatments favorably influenced the soil parameters over the control. Crop residues incorporation or burning increased soil available K, microbial biomass, enzymatic activities and organic carbon significantly over fertilizer application alone, while total N content was increased by residue incorporation. Soil bulk density was decreased with residue incorporation as compared to fertilizer application and burning treatments. However, green manuring and farmyard manure applications showed inferior response as compared with residue management treatments. It is therefore recommended that bioresources should be managed properly to warrant the improvements in soil properties, nutrient recycling and the sustainability for crop productivity in intensive rice–wheat cropping system.

Keywords: Soil health; Residues: Burning; Fertilizer; Green manure

SCREENING OF LIPASE-PRODUCING BACTERIA FROM OIL CONTAMINATED SOIL AND OPTIMIZATION OF LIPASE-MEDIATED BIODIESEL PRODUCTION

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Lipases are important hydrolytic enzyme having application in production of biodiesel. The aim of this study was the production of biodiesel by using lipase enzyme as a catalyst obtained from bacterial strains. From soil contaminated with cooking oil, six lipase producing bacteria were isolated using the method of serial dilution. Rhodamine olive oil agar medium containing olive oil as substrate was utilized for screening, in result, the orange zone of detection for lipase producing bacterial strains were obtained. They exhibited catalytic lipase activities recording 120U/mL, 101U/mL, 89U/mL, 85U/mL, 78U/mL and 58U/ml. Biodiesel was produced from the identified strains by taking waste cooking oil and methanol in 1:2 M ratios with lipase supernatant and HCL buffer solution 1 mL each, given incubation at 60 ○C for 5 h, then 900 µL of n-hexane to collect top desired layer. Fourier transform infrared spectroscopy confirmed the presence of fatty acid methyl esters. The infrared spectra within the range of 1735–1750 at cm−1 and 1300–1000 cm−1 matches to C=O and C-O functional groups, respectively. Consequently, isolated bacterial strains may provide promising bacterial lipases, which can enhance the economic feasibility and biotechnology of enzyme bio-catalysis for the synthesis of valuable green chemicals.

Keywords: Bacteria, Lipase-Mediated Biodiesel Production

BLOOMS OF *NOCTILUCA SCINTILLANS* INDUCED BY CLIMATE CHANGE THREATEN THE DIVERSITY OF MARINE LIFE IN NORTHERN ARABIAN SEA

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The *Noctiluca scintillans* is a dinoflagellate of marine environment can form bloom and generates substances that are noxious to marine organisms. An intense bloom of the *N. scintillans* in Baluchistan coast along Northern Arabian Sea is reported in the current study. Sea water was collected using Niskin water sampler from three locations for water quality and nutrient analysis. Among toxic species of dinoflagellates, *Alexandrium tamaresence, Ceratium fusus, Dinophysis caudate, Gyrodinium spirale, Prorocentrum micans, Prorocentrum arcuratum* and *Scrippsiella trochoidea* were observed. The *Noctiluca scintillans* can transfer toxins to higher trophic levels by grazing these toxic dinoflagellates. It is itself not toxic but the blooms can accumulate high amount of ammonia, which may prove deadly when released into the water. This ammonia makes *N. scintillans* unpalatable for marine organisms. Only jellyfish and salps are known to prey on it. The increase in intensity of algal blooms occurrence in marine waters cause detrimental effects include bio toxins, physical damage and the anoxia caused massive fish mortality, affect fishery resources, biodiversity and vulnerable to the aquatic ecosystem.

Keywords: *Noctiluca*, Dinoflagellate, Algal bloom, Diatoms, Microalgae.

SMARTPHONES: AN ANALYTICAL TOOL FOR DETECTION OF WATER POLLUTANTS

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With the advancement in technology, smartphones are becoming a basic need of our society. In recent years, smartphones have made their way as an analytical tool to several multidisciplinary fields, including health sciences and analytical sciences for data collection, smart transportation systems, virtual reality, and global environmental monitoring. Industrialization and heavy traffic have raised the production of pollutants, resulting in a higher risk of environmental contamination. Long-term exposure to these pollutants gives rise to various human diseases and makes environment unfit for the healthy survival of plants and animals. Water pollutants like heavy metals can directly affect agricultural plants which ultimately effects the yield of crops. For easy and continuous assessment of these heavy metals in water bodies, smartphones that are modified as analytical tools are being introduced. Suitable smartphone applications are designed to work with appropriate built in mobile software. By merging different technologies with smartphones, scientists have developed a cost-effective and efficient monitoring system for observing the real-time concentration of contaminants in the environment that can directly affect agricultural system.

Keywords: Smartphones, analytical, environment, water, contaminants, agriculture

THEORETICAL CALCULATION OF SELENIUM *N*-HETEROCYCLIC CARBENE COMPOUNDS THROUGH DFT STUDIES: SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL POTENTIAL

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N-heterocyclic carbene (NHC) is one of the significant class of compounds in the organometallic chemistry. Strong sigma donating property and weak pi-accepting property of NHC makes it prominent, so that they can interact with metals to form the stable organometallic complex. These ligand compounds have capability to release the metal in the form of ion slowly and sustainable rate at any site in the biological system. Selenium is also very active element having highly demanding applications like antioxidant agent and is necessary trace element for human body. In the current research work two new imidazolium salts (as pre ligands) and respective selenium-NHC compounds have been designed and computed theoretically before the synthesis of active compounds among the designed compounds. Compounds, namely ML1, ML2, MC1 and MC2, on the basis of imidazole unit were designed and computed for different properties, absorption spectra, dipole moment, theoretically estimated biological potentials, and frontier molecular orbitals, by calculating the HOMO/LUMO energy orbitals via Density functional theory method. Density functional method was applied using Gaussian 09 software and Gauss view 5.0 program. Analysis of compounds were done at B3LYP level by using 6-31G (d) level of DFT (Density Functional Theory). Theoretical calculation showed that compounds are highly biologically active, as their synthesis is exigency of the time so these compounds were synthesized. Synthesized compounds were characterized by UV-visible, FT-IR, carbon and proton NMR spectroscopies. Antioxidant and anticancer properties of compounds were calculated and their characteristics were compared with the characteristics of imidazole present in the literature and results were the almost same as calculated by theoretical method.

Keywords: *N*-heterocyclic, Sigma donation, Dipole moment, Exigency

BIOCOMPOSITES OF POLYPYRROLE, POLYANILINE AND SODIUM ALGINATE WITH CELLULOSIC BIOMASS: ADSORPTION-DESORPTION, KINETICS AND THERMODYNAMIC STUDIES FOR THE REMOVAL OF 2,4-DICHLOROPHENOL

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The biocomposites of polypyrrole (PPY), polyaniline (PANI) and sodiumalginate (NaAlg) with cellulosic biomass barley husk (BH) were prepared and employed for the removal of 2,4-dichlorophenol (2,4-DCP) form aqueous media. The sorption of 2,4-DCP was studied using native and biocomposites (PPY/BH, PANI/BH and NaAlg/BH) as function of various process variables. The maximum sorption (q_e, 7.55–24.57 mg/g) of 2,4-DCP was achieved in the range of 7–10 pH, 0.05 g composite dose, 25mg/L initial concentration of 2,4-DCP and 120 min contact time at 30 °C. The FTIR analysis revealed the involvement of amino, hydroxyl and carboxylic groups for the binding of 2,4-DCP on the surface of biocomposites. The Freundlich and pseudo second order kinetics models best explained the 2,4-DCP adsorption on to the biocomposites. The ΔG, ΔH and ΔS parameters were also computed, which revealed the favorable and exothermic adsorption nature of 2,4-DCP. Presence of salts affected the 2,4-DCP adsorption negatively. HCl found to be efficient desorbing agent for 2,4-DCP from composites and up to 65.12% was eluted using 0.5 N solution. In view of promising efficiency, the biocomposites have potential to remove 2,4-DCP form industrial effluents.

Keywords: 2,4-Dichlorophenol, polypyrrole (PPY), polyaniline (PANI), sodiumalginate (NaAlg), Thermodynamics, Kinetics, desorption

VISUALIZATION OF SOIL COLLECTED FROM WHEAT GROWING AREA OF DISTRICT MARDAN BY R STUDIO PLATFORM

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R studio is an Independent Development Environment (IDE) aimed at data analysis, visualization and computation of big data. Soils samples of wheat growing areas were collected at two depth such as 0-15 cm and 15-30 cm and two number in each union council of Mardan district, Khyber Pukthun Kha province. Data were visualized by ggplot2 is an R package developed by Hadley Wickham and colleagues that is based on Leland Wilkinson's "Grammar of Graphics". Different plotting techniques such as boxplot, scatter plot, frequency table, and interaction matrix were run on different soil parameters to see spread, central tendency and relative interaction among soil parameters and soil depth etc.

Key words: R studio, soil, wheat, visualization

SULFUR OXIDIZING BACTERIA FROM HOT SPRINGS OF AZAD JAMMU & KASHMIR AND GILGIT BALTISTAN: AN ENVIRONMENTAL FRIENDLY APPROACH

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Sulfur is an important nutrient, but its high concentrations can adversely affect the human and environment health in the form of sulfur dioxide ($SO_{2)}$, acid rain, hydrogen sulfide (H_2S) gas etc. Use of sulfur oxidizing bacteria to reduce sulfur pollution has drawn much attention due to its cost-effectiveness, high sulfur pollution removal efficiency and environmental friendly behavior. This study was aimed at the isolation and characterization of sulfur oxidizing bacteria from hot springs of Pakistan. The study comprised of 3 experiments. In the first experiment, Isolation and screening of bacteria was done from the hot springs of Tatta Pani (Azad Jammu & Kahmir) and Kundus (Gilgit Baltistan). In the second experiment, the effects of various sodium thiosulfate concentrations (4-100 mM) were evaluated on bacterial growth for 7 days. Third experiment was done for molecular identification of efficient SOB strains, using 16srRNA gene sequence analysis. The isolation was carried out on LB and Nutrient agar media. A total number of 74 isolates were obtained, all the strains showed variation in colony morphology. All the isolated strains were screened on thiosulfate mineral media using sodium thiosulfate as a sole energy source. A total number of 39 potential sulfur oxidizing bacterial isolates were screened on the basis of their abilities for using thiosulfate as their energy source. Spectrophotometric method was used to quantify the amount of sulfur oxidized by these isolates. HST7P, HST11P, HST12P, HS12G, HS16G, HS18G, HS21G, HS4B, HS12B were selected based on their abilities to grow faster on TSM media, produced the higher sulfate ion and reduced the pH in the growth medium. Phenotypic and biochemical characterization showed that among all the isolates tested 22% of the strains were oxidase positive while 77% of the strains were oxidase negative, 88% isolates were catalase positive while 11.11% were catalase negative. Gram positive result was shown by 44% of the strains while 55% of the strains were gram negative. The shape of 22% cells was cocci and 77% cells were rod shaped. The maximum concentration of sulfur was oxidized by HS21G, HS4B and HS12B with 69.27%, 69.21% and 69.21% as compared to the control. These strains can be used to remove the toxic forms of sulfur compounds to reduce their adverse effects.

Keywords: Sulfur Oxidizing Bacteria, Hot Springs

SALT-AFFECTED SOILS: RECLAMATION TRENDS, CARBON SEQUESTRATION AND CROP PRODUCTION

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Salt-affected soils, after reclamation can play an important role in the soil carbon cycle and by acting as a sink for carbon storage. The reclamation of salt-affected soils and their exploration as carbon sinks and their use as crop lands comes with multiple benefits, including increased area for food crop production, improved food security, reduction in atmospheric carbon concentrations, and mitigation of global climatic changes. Salt-affected soils cover almost 7% of the world's total area and 20% of irrigated area. Their reclamation has an important implication in improving food security and mitigating climate change. This paper explores the total salt-affected area around the world along with the causes and reclamation options under different environments. This paper considers different well-established salt-affected soil's reclamation and management strategies (including use of organic and in-organic amendments) for crop cultivation and carbon sequestration.

Keywords: Salt-Affected Soils, Reclamation Trends, Carbon Sequestration.

HEAVY METAL POLLUTION AND CLIMATE CHANGE IN FISHES FROM MARINE COASTAL AREA

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Marine pollution of heavy metals is increasing and has become of great concern due to the adverse effects on marine organisms. The industrial and domestic waste is continuously discharge into the marine environment causing heavy metals pollution in fishes. The period of exposure and other factors are responsible for the lethality of metals and it relies on its type and quantity. The water and fishes samples were collected from the Sindh coast of Pakistan. Heavy metals such as Cr, Cd, Co, Ni, Cu, Pb, Mn, Fe and Zn concentrations were analyzed by atomic absorption spectrophotometer. We examined the high concentration of metals in fishes from the Sindh coast of Pakistan. The concentrations of metals in water were in the following order Ni> Fe> Mn> Cr> Co> Zn> Cd> and Pb>Cu. Heavy metals accumulate in marine organisms. The exposure and persistence of heavy metals is a threat to fishes and humans. Fishes are also adversely affected by lower availability of oxygen due to a rise in surface air temperatures due to climate change. Changes in ocean currents, sea level rise temperature and predator response to climate change will significantly alter fish breeding grounds, food supply for fish and finally the profusion of fish populations.

Keywords: Heavy metal pollution, Fishes, Marine coastal area

DESIGNING BIOSTIMULANTS FOR SUSTAINABLE WHEAT PRODUCTION

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Phosphorous deficiency is a major challenge faced by global agriculture. Applying phosphate solubilizing bacteria (PSB) as bio-fertilizers has enormous potential for sustainable agriculture. Despite this, there is still a lack of information regarding efficient formulation strategies. In the present study, well-characterized PSB, *Ochrobactrum* sp. SSR (DSM 109610), *Enterobacter* spp. DSM 109592 and DSM 109593 along with four organic amendments, biochar, compost, filter mud and humic acid were used to design bioformulations. All four carrier materials maintained adequate survival and inoculum shelf life of the bacterium, indicated by field emission scanning electron microscopy analysis. Filter mud (FM) based bio-formulation was most efficacious and enhanced not only wheat grain yield (4-9%) but also seed P (9%). Moreover, FM based bio-formulation enhanced soil available P (8.5-11%) and phosphatase activity (4-5%). The present study provides a valuable groundwork to design field scale formulations that can maintain inoculum dynamics and increase its shelf life. This may constitute a step-change in the sustainable cultivation of wheat under P-deficient soil conditions.

Keywords: Biostimulants, Wheat production

SOIL AMENDMENTS TO IMPROVE SOIL FERTILITY AND RECLAMATION OF AGRICULTURE SUSTAINABILITY

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Phosphorous (P) deficiency is a major challenge confronted by worldwide agriculture. Phosphate solubilizing bacteria (PSB) offer a sustainable approach to supply available phosphates to plants with enhanced crop productivity through harmonious interaction with plant roots. The present study demonstrates an insight into this cooperative P-solubilizing mechanism of PSB isolated from rhizosphere soils of different agro-ecological zones of Pakistan. Five efficient strains were selected based on P-solubilizing activity (233-365 µg ml^{-1}) with concomitant decrease in pH (up to 4.13) due to production of organic acids, mainly acetic acid (~182 µg ml^{-1}) and gluconic acid (~117 µg $^{ml-1}$). These isolates have other plant growth promoting traits i.e., Indole acetic acid (1.7–14 µg mL^{-1}), nitrogenase activity and siderophores. The inoculation response of these PSB on wheat varieties grown under net house and field conditions was positively correlated with improved plant growth and soil P contents. Additionally, application of these microbes as seed pelleting and fertigation showed significant increase in grain yield (14.28%) and seed P content (14%) with 10% reduced application of diammonium phosphate (DAP) and Urea fertilizer. Additionally, these bacteria can solubilize rock phosphate (RP). The use of RP solubilizing bacteria can provide an alternate to Phosphatic fertilizers for low-cost sustainable wheat production.

Keywords: Phosphate solubilizing bacteria, soil amendments, reclamation.

COATED UREA AND UREASE INHIBITOR FOR RICE PRODUCTION AND IMPROVED NITROGEN USE EFFICIENCY UNDER CLIMATE CHANGE SCENARIO

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Urea is widely used fertilizer in agriculture but most of the nitrogen (N) is lost through volatilization and leaching which not only contaminate the environment but decreases the nitrogen use efficiency (NUE). Controlled-release urea (CRU) and urease inhibitors (UI) are being recommended over conventional urea to minimize N-losses and enhance NUE. This study was carried out to understand the impact of CRU and UI on the morpho-physiological, biochemical and yield traits of rice. CRU slowly release the N while UI delays the hydrolysis of urea. The differences in nitrogen (N) accumulation, translocation, dry matter and yield formation with different N fertilizer doses were analyzed. Rice plants were grown in pots till maturity and fertilized with different doses of CRU and UI i.e., boric acid (BA). Coated calcium ammonium nitrate (CAN) was obtained from a commercial company and applied at different levels (60, 84, and 108 kg N ha^{-1}) as split application (40% at transplanting, 30% at tillering and 30% at the panicle stages). Each treatment was replicated three times. Control pots with full Urea (120 kg N ha^{-1}) were also cultivated. Results show that the CRU was more effective as compared to UI. Urease enzyme activity was much lower in UI then CRU that delay the urea hydrolysis which decreases the loss of ammonia. The N recovery efficiency and N agronomic efficiency for CRU were significantly higher than UI and control. CRU significantly increased the rice yield as compared with UI and control, respectively. Relative to UI, CRU have higher flag leaf SPAD and photosynthetic rate, as well as higher ROS, enzymatic activity and N uptake during grain filling.

Keywords: controlled releasing urea; urease inhibitor; nitrogen use efficiency; boric acid; rice

MORPHO-PHYSIOLOGICAL ANALYSIS OF OSMOTIC STRESS RESPONSES UNDER HYDROPONICS FOR SELECTION OF RESILIENT RICE

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In the current scenario of climatic shift water scarcity is one of the most common abiotic stress that hinders rice growth through alteration in many morphological and physiological responses. To sustain crop production under water deficit condition the need of the hour is to select drought tolerant rice variety. Therefore, in the present study morpho-physiological responses of rice genotypes were evaluated for polyethylene glycol (20%) induced osmotic stress under hydroponic system. The experiment was carried out in a growth room and to decipher the variation in genotypes for drought tolerance, 8 DPT (days post transplantation) rice seedlings were then subjected to the drought stress. Drought stress was imposed by elevating the osmotic potential (PEG-simulated drought) from 5%-20% PEG gradually.

Rice genotype NIBGE-DT-02 showed tolerance to PEG-induced osmotic stress as indicated by minimum reduction in seedling length and biomass. Higher chlorophyll content with less percent reduction was observed in tolerant check variety (IR-55419-04) followed by NIBGE-DT-02 under osmotic stress. Significant percent decrease in chlorophyll a was observed in SB (78.7%) followed by NIBE-DT-11 (76.9%). While increased leaf proline content (20 $\mu molg^{-1}$ fresh weight) was observed in NIBGE-DT-02 as compared to susceptible variety. All these responses collectively validated the adaptive response of selected genotype under osmotic stress. The results obtained from the present study will be employed for the improvement of the rice crop in future breeding programs to address the food security issues in this alarming situation of climate change.

Keywords: Osmotic stress, Hydroponics, Selection, Resilient Rice

MICROBIAL BASED SOLUTION TO INDUCE THERMOTOLERANCE IN PLANTS UNDER GLOBAL WARMING COURSE OF EVENTS

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Global warming and emission of exogenous gases have caused an erratic rise in temperature, posing a major challenge to agricultural production and food security. In agricultural environment, heat stress is usually temporary and persistent but may progressively become sever with time. Plants require a specific temperature at the appropriate time for proper development. A temperature above their optimal has adversely affects on overall plant phenology, development, cellular activities, gene expression, anatomical characteristics, and the functional and structural orientation of roots, shoots, twigs, and leaves which ultimately diminish final yield. Plants have built-in systems to deal with many stressors, including heat, which varies from plant species, duration, and severity of the heat stress. In current study, we have isolated heat-resilient beneficial bacteria from the Cholistan Desert, south Punjab of Pakistan that were able to grow at 50°C±2 and showed PGP (IAA production, Zn, P, Ca. solubilization, Nitrogen fixer) traits and upregulate the heat shock protein up to 45°C±2. Root colonization was observed under a confocal laser scanning microscope (CLSM). Plant-heat-resilient PGPR (HR-PGPR) inoculation experiments showed, there was a significant difference between HR-PGPR inoculated and non-inoculated maize and wheat plants. Plant enzymes and gene expression analysis showed that in HR-PGPR treated plants, there was high regulation of antioxidant and heat shock protein as compared with non-treated ones. Results suggest that HT-PGPR could be used to induce heat tolerance and improve the quality and yield in grain and cereals as well as for crops grown under high temperature and nutrient-deficient soils.

Keywords: Climate Smart Agriculture, Heat Stress, Heat stress effect on plants, Mechanism of Heat tolerant PGPRs, Food Security

PRUNUS ARMENIACA EXTRACT MEDIATED SYNTHESIS OF ZINC BASED NANOPARTICLES AND EVALUATION OF THEIR BIOLOGICAL ACTIVITIES

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Nanotechnology is well known area of research since last century. There have been made various revolutionary developments in the field of nanotechnology. Nanotechnology produced materials of various types at nano scale level. Nanoparticles (NPs) are wide class of materials that include particulate substances, which have one dimension less than 100 nm at least. The importance of these materials realized when researchers found that size can influence the physiochemical properties of a substance. This study was undertaken to determine the synthesis and characterization of metal based nanoparticles using extract of *Prunus armeniaca.* To evaluate the enzyme inhibition activities of extracts of metal based Nanoparticles using *Prunus armeniaca* extract and to interpret the antimicrobial activities of extracts of metal based nanoparticles using *Prunus armeniaca* extract against selected microbes. Disc diffusion assay was used for in vitro antibacterial and antifungal screening. The antimicrobial activities of the extracts were determined by measuring the respective zone of growth inhibition in MIC. Enzyme inhibition activities were determined by using in vitro AChE, BChE and Urease inhibitory assay. The current study revealed that water extracts of apricot possess potent antibacterial activity. Water showed maximum activity against *Escherichia coli* and *P. multocida.* Results suggested that the highest antimicrobial activity was showed by the root extracts of apricot. The present study revealed that highest antifungal activity was showed against *Fusarium solani.* Experimental results indicate that Zn nanoparticles exhibited maximum antibacterial activity against *S. aureus* and as for as activity of plant part is concerned nanoparticles of apricot root showed higher antibacterial activity and maximum antifungal activity was showed by Zn nanoparticles against *A. parasiticus.* In case of enzyme inhibition studies generally the maximum enzyme inhibition activity was recorded against BChE. It can be concluded from results that extracts of different parts of *Prunus armeniaca* showed significant antibacterial and antifungal activity against selected microbes. While in case of enzyme inhibition studies extracts exhibited good activity against BChE.

Key Words: Nanoparticles, *Prunus armeniaca*, Plant extract, Antimicrobial activity

GREEN ZINC OXIDE AND SILVER NANOPARTICLES AS ANTIMICROBIALS AGAINST MAJOR RICE PATHOGENS: CASE STUDIES

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Xanthomonas oryzae pv. *oryzae* (*Xoo*), *Bipolaris oryzae* and *Sphaerulina oryzina* are the major rice pathogens causing a huge damage to rice growth and yield in Pakistan and around the world. Namely, bacterial leaf blight, brown leaf spot and narrow brown leaf spot are the rice diseases caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*), *Bipolaris oryzae* and *Sphaerulina oryzina*, respectively. Amid the scenario of pesticide toxicity, cost of pesticide chemicals, and reportedly negative consequences of extensive pesticide application on living ecosystems and human health, green nanomaterials have started to draw attention by scientists and other stakeholders. We tested green zinc oxide nanoparticles (ZnONPs) and silver nanoparticles (AgNPs) against above-mentioned rice pathogens in-vitro and in pots. The ZnONPs and AgNPs were synthesized by using a non-pathogenic bacterial strains. Standard material characterization techniques like UV-Vis spectrophotometry, FTIR, TEM, SEM, and XRD were used to characterize NPs. Antibacterial activity results of ZnONPs at different concentrations (5, 10, 15 and 20 µg/ml) against *Xoo* showed clear inhibition zones as compared to control. Maximum inhibition was demonstrated at 20 *µg/ml NPs concentration. Similarly, antifungal activity in terms of inhibition of mycelial growth was measured at different concentrations of ZnONPs (5, 10, 15 µg/mL). The inhibition percentage was 40.9%, 46.6% and 63.3% for fungus Sphaerulina oryzina* and 27.6%, 46.5% and 59.8% for *Bipolaris oryzae* at the above-mentioned NPs concentrations, respectively. Moreover, AgNPs were able to decrease the disease lesion length and diameter on rice leaves in symptomatic plants. There results promising to be reproduced in large field trials.

Keywords: Antimicrobial activity**,** Biosynthesis, pathogens, rice, green nanomaterials

ISOLATION AND CHARACTERIZATION OF RHIZOBACTERIA FROM WATER LOGGED AND SALINE VEGETATION

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Waterlogging and salinity are the major issues which causes the physiological stress which decrease the crop yield and quality. PGPR are useful bacteria that can help plants respond better to biotic and abiotic challenges. The aim of research was to isolate halo-tolerant bacteria with PGPR characteristics. 21 bacterial isolates were isolated from samples collected from waterlogged and saline soils with varying colony morphology. The isolated bacteria were screened for halo-tolerance potential and PGPR traits (P-solubilization, IAA and ACC deaminase potential). Among all the bacterial isolates W_1I_3, S_1I_1, W_2I_4, and S_2I_3 were able to grow at high salt (25%) concentration. Phosphate solubilization was also tested in bacterial isolates, and 14 of them showed clear halo zone formation on Pikovskaya's agar medium. When the isolated bacteria were tested for IAA activity with Salkowski's reagent, 13 out of 21 isolates showed pink color (varying from light to dark pink), indicating IAA producing potential. In a biochemical experiment, among the all bacterial isolates tested for ACC deaminase activity, 5 isolates shows the positive activity. The S_1I_1 isolate had the greatest level of ACC deaminase activity, while the other isolates W_1I_3 and $S_2I_{2(b)}$,W_1I_5 and W_2I_2 had minimal activity. Potential microbes with different PGPR characteristics will be used as bio inoculants/ biofertilizers to raise the crops productivity under stress conditions after *in-vivo* studies.

Keywords: Water logging, salinity, halo-tolerant bacteria, ACC deaminase

INSIGHTS INTO MITIGATIVE ROLE OF SILICON DIOXIDE NANOPARTICLES IN *OCIMUM BASILICUM* UNDER LEAD STRESS

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Lead (Pb) accumulation, even in minute quantities, has adverse effects on the morphology, physiology, and biochemistry of almost all plants, resulting in various abnormalities. Silicon dioxide nanoparticles (SiO_2-NPs) are used excessively to reduce abiotic stresses in a large variety of plant species. The present research work was designed to explore the role of SiO_2-NPs in the mitigation of Pb toxicity in *Ocimum basilicum*. SiO_2-NPs were green-synthesized from *Arando donax* plant extract. Characterization of green synthesized SiO_2-NPs was assessed with UV-vs, XRD, FTIR, and SEM-EDS. To analyze the morphology and antioxidant enzymes activities in *O. basilicum*, 8 days old plants were subjected to 3 different concentrations of Pb and SiO_2-NPs (50, 500, and 1000ppm). Results of UV-vs, XRD, FTIR, and SEM-EDS showed the capping of SiO_2-NPs by different functional groups (Si $(CH_3)_3$, and Si-O-Si) together with its crystalline structure. The average size of the nanoparticles was 26 nm which was confirmed by XRD analysis. Morphological analysis revealed that treatment with 500 ppm concentration of Pb resulted in a significant decrease in the length of root, shoot, and weight, in the ratio of 19, 14, and 10%, respectively. But treatment with 500ppm (SiO_2- NPs) significantly promoted root, shoot length, and weight of the plant, at the rate of 13, 22, and 7%, respectively. When the ameliorative effect of SiO_2-NPs was confirmed, a combined application of Pb + SiO_2-NPs was tested. Root damage and Pb concentration in all the plant parts were much reduced. It was revealed that antioxidant activities of POD and APX were markedly decreased while those of the CAT and SOD increased. The results revealed that SiO_2-NPs is an anti-stressor, that remove Pb from *O. basilicum*, by enhancing its antioxidant activity.

Keywords: Pb; SiO_2 -NPs; Antioxidants Enzymes; *Ocimum basilicum*; Stress

PHOSPHORUS DISTRIBUTION ALONG AN ALTITUDINAL GRADIENT IN DIFFERENT LAND-USE CATEGORIES OF DISTRICT MUZAFFARABAD, AZAD JAMMU AND KASHMIR

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To understand the distribution of major soil phosphorus forms is a prerequisite to interpret and predict the effects of tree litter type as well as climate change on P dynamics and its labiality in mountainous regions. The current investigation zone lies in lesser Himalayan lower regions of Azad Jammu and Kashmir in District Muzaffarabad, AJ&K and sampling was carried during 2019. Five sites were chosen in the investigation region varying in elevation gradient from 900 to 2900 m distributed in four height ranges. In first site three woods patches were chosen going in height from 900 to 1400 m. These were (I) Closed shade woods (ii) Open backwoods (iii) Disturbed woodland. Three soil tests from the depth of 0–5, 05-15 and 15–30 cm was taken at each plot. Similar, sampling was done in other selected heights (for example 1400–1900, 1900–2400, and 2400–2900m or more). We sampled plant roots (up to 40 cm depth) and soils (100cm depth) in grasslands along a 2300 m altitude gradient (1286–3589m above sea level) between alpine steppes. A modified Hedley P fractionation in combination with root and microbial P, alongside phosphatase activity, was used to characterize P transformations depending on climate. Both the roots and microorganisms stored more P and produced higher phosphatase activity in cold meadow than in warm steppe soils. The results indicated that bioavailable P (Resin P) values showed variability both along altitude gradient and land use land cover (LULC) types. The highest concentration of bioavailable P 60.2 mg kg^{-1} was at L10 (close canopy forest) and lowest concentration 11.4 mg $kg^{-1}$was reported at L1 (arable land). Both Labile inorganic P and labile organic ($NaHCO_3$ P) showed highest values of NaHCO3 P at high altitude 2150m in L10 (close canopy forest) and lowest was reported at L1 (arable land) which were 62.5 mg kg^{-1} and 10.2 mg kg^{-1} respectively. Values of $NaHCO_3$ P follow the pattern L10 > L3 > L5 > L11 > L9 > L8 > L2 > L4 > L6 > L7 > L1 which indicates that highest concentrations in close canopy forest followed by open forest and lowest concentration is in arable land. Concentration of sodium hydroxide extractable P (0.1M NaOH P) was highest in L6 (open forest) followed by L10 (close canopy forest) and L11 (grass land), respectively. The altitudinal gradient exhibited that highest concentration was 450 mg kg^{-1} in L6 and lowest concentration was 190 mg kg^{-1}. While along with depth highest concentration of moderately labile P was reported in depth (5-15 cm) and lowest was reported in (15-30cm). Highest P (HCl 0.1M) was found in interval from 1900 m to 2400 m altitude while comparing the P fractions in depths a slight incline can be observed from L8 (grass land) to L10 (Close Forest – pine trees), the highest P values were in 0–5 cm depth (310 to 320 mg kg^{-1}). Overall, the highest TP across all LULC types and altitudinal gradients was recorded

at location 3 (close canopy forest) at all depths ranging from 800 mg kg^{-1} (15–30 cm) to 967 mg kg^{-1} (0–5 cm). Minimum overall TP were found at location 7 (220 mg kg^{-1}) at depth 15–30 cm and 257 mg kg^{-1} at depth 0–5 cm. The overall TP varied along with different altitudes and the overall deviation in TP could be associated to the land used types. The least disturbed areas having high values of TP and on other hand, disturbed and open areas show less P as compared to close canopy forest indicating the worst impact of anthropogenic factors on P bioavailability.

Keywords: Phosphorus pools, Gradient, Azad Kashmir, Land-use change

DEVELOPMENT OF SALINE SOIL SPECIFIC BIOFERTILIZER

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Salinity is one of the major stress factors affecting agricultural production throughout the world. One of the upcoming management strategies is the use of microbial inoculants containing beneficial microbes, capable of improving plant growth, quality, and fertility of the soil. This green agriculture approach was adopted in the reported study to combat the detrimental effects of salinity and to reduce hazardous agrochemicals. This research was planned to investigate the role of salt-tolerant PGPR-based bioformulations as an eco-friendly, low-cost biofertilizer that can improve plant growth under salt stress. The promising strains with PGP traits were used for the bio priming of wheat seeds (PUNJAB-11 and FSD-08), to see the impact germination under controlled conditions in growth room and the growth parameters in hydroponic system under different salinity levels. It was observed that germination rate and seedling growth parameters of wheat were recorded better in bio-primed seeds as compared to control. Experiments were also conducted for the selection of suitable carrier material and sugar mill waste press mud was selected for the survival of inoculated strains among press mud, cow dung, cow compost, and plant compost. The impact of the bioformulation application on the growth and yield of wheat was estimated by conducting pot and field experiments under normal and salt stress conditions and data showed that inoculated plants showed better root and shoot growth, plant weight, and yield as compared to control. All the data recorded during the research suggests the use of halotolerant bacteria to improve salt stress tolerance in wheat under saline conditions.

Key Words: Salinity, Wheat, Bioformulations, Hydroponic, Halotolerant PGPR

SOIL FERTILITY AND WHEAT PRODUCTIVITY AS AFFECTED BY ORGANIC AND INORGANIC FERTILIZERS

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The maintenance of soil fertility and crop productivity to meet the global food requirement with a sustainable approach is an important approach. For this purpose, a field-based study was steered by using different types of organic and inorganic sources of fertilizers to explore its effect on soil fertility and wheat productivity**.** Different sources of organic fertilizers like farm yard manure and poultry manure plus inorganic sources like NPK were also used, The source used for nitrogen was urea while for phosphorous and potassium was SSP and SOP, respectively. Throughout the growing season of wheat crop, all other agronomic practices were followed. The results indicated that integrated use of inorganic with organic source of fertilizers significantly escalated the yield and yield components of wheat and also improved nutrient status of the soil. Plant height of 96 cm, biological yield of 9981 kg ha^{-1}, thousand grain yield of 51.64 g and grain yield (4251 kg ha^{-1}) were recorded when 20t FYM+NPK was applied. Soil pH and Electrical conductivity were also significantly improved**.** Soil organic matter (%) was 1.69 % by applying 20t FYM+NPK. Soil Total N was recorded with 0.144%, extractable P was (9.95 mg kg^{-1}) recorded and extractable K content (0.144 mg kg^{-1}), was recorded in the plots when 20t FYM+NPK was applied. The results concluded that the application of organic fertilizers along with inorganic fertilizers can play vital role for nutrient turnover and long-term productivity of the soil.

ASSESSMENT OF SOIL CONTAMINATION AND ORGANIC CARBON DYNAMICS UNDER VARIOUS LAND USES ALONG CHINA PAKISTAN ECONOMIC CORRIDOR (CPEC) WESTERN ROUTE

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This study was carried out to assess the contamination status of soil and Organic Carbon dynamics under different land uses in selected areas of the western route of China Pakistan Economic Corridor (CPEC). Key objectives of this study were to measure soil changes in physical parameters, changes in Organic Carbon (OC) content of soil and assessment of soil contamination due to construction activities along the CPEC western route. The nature of the study demanded intensive sampling and so the study area was divided into ten different zones based on soil texture and other properties. A total of 120 soil cores from three depth i.e.0-20, 20-40 and 40-60 were collected via random sampling using standard soil sampling procedures from 20 locations of the study area. Each location was further classified as Controlled and Exposed. Soil samples were analyzed for various physical and chemical characteristics including; Texture (sand, silt, clay content), porosity, bulk density, Particle Density, pH, Organic matter, % OC content, phosphorous, potassium, Sulphur and heavy metals availability. Variations in average pH and EC values were small and inconsistent except some locations. Exposed soil samples of 0-20 cm, 20-40 cm and 40-60 cm depths exhibited pH values of 8.07 ±0.45, 8.05 ±0.34 and 8.05 ±0.40 respectively while Controlled samples showed pH values of 7.75 ±0.46, 7.82 ±0.47, 7.92 ±0.30 for the same depths. Electric Conductivity of the exposed samples was 315 ±0.62, 286.38 ±0.67 and 351.75 ±0.71 in relation to the controlled values of 271 ±0.58, 295 ±0.74 and 312 ±0.79 for the predefined depths of the selected locations. Total organic matter of the exposed samples was 5.05% ±1.83, 5.43 ±1.99 and 4.16 ±1.04 in relation to the controlled values of 4.41 ±1.09, 4.09 ±1.09 and 5.75 ±1.51 for three depths respectively. However, among controlled locations maximum OM were recorded for Batal, Burhan, Haripur, PanjBorrh followed by Nowshera, Ichriyan, Toran while among exposed sites Ichriyan, Kotlein Payein, PanjBorrh and Shennai Bala showed maximum values. Bulk Density of the exposed samples was 1.07 ±0.18, 1.01 ±0.11 and 1.05 ±0.13 while that of controlled samples the recorded values were 1.01 ±0.11, 1.02 ±0.12 and 1.03 ±0.11 respectively. Particle density the of the exposed locations was 1.24 ±0.24, 1.46 ±0.22 and 1.44 ±0.22 as compared to 1.41 ±0.27, 1.33 ±0.30 and 1.39 ±0.13 for controlled samples. Average values for porosity of exposed samples were 24.42 ±12.02, 29.81 ±15.38 and 25.75 ±13.73 as compared to 29.39 ±18.93, 25.25 ±14.35 and 28.06 ±09.29 respectively. Phosphorus content (mg/Kg) was 3.70 ±2.45, 3.92 ±2.25 and 4.14 ±1.94 for controlled while exposed locations showed 3.89 ±1.86, 4.10 ±1.58 and 3.19 ±1.19 for all depths ranging from surface to 60 cm respectively. Among locations Qalandar Abad was observed to be the most deficient

in P followed by Haripur, Battagram, PanjhBorrh, Jharikas and Hainra. Potassium content (mg/Kg) from surface to 60 cm depth was 112 ±8.47, 112.91 ±4.68 and 113.82 ±5.58 for controlled locations as compared to 113.76 ±10.62, 111.96 ±6.01 and 113.31 ±5.34 for exposed areas. Overall low Sulphur content (mg/Kg) was measured i.e. 1.51±0.62, 1.46 ±0.50 and 1.48 ±0.50 for controlled while exposed locations showed 1.57 ±0.50, 1.55 ±0.51 and 1.78 ±0.47 for all depths ranging from surface to 60 cm respectively. CPEC is a key to the development of Pakistan, but so far, no environmental study is carried out to assess its negative socio-economic impacts on the lives of the local communities especially farmers. This study has recorded and compared controlled and exposed soil samples for the mentioned parameters that can be used as a baseline in future research studies and policy making process.

Keywords: Organic Matter, Soil Texture, Porosity, CPEC, Soil Contamination

SYNTHESIS OF LOW BAND GAP PEROVSKITE FOR THE HARVESTING OF SOLAR LIGHT FOR PHOTOCATALYTIC APPLICATIONS

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Perovskite nanoparticles were fabrication via facile microemulsion route and effect of dopants on the basis of structural, electrical and optical properties was evaluated. The X-ray diffraction pattern confirmed the distorted rhombohedral symmetry with particle in 76-92 nm range. Dielectric parameters showed high dispersion at low frequency, while remained constant at low values. The AC conductivity showed increasing trend with doping in association with enhanced polarization. Band gap was tuned from 3.1eV for pure to 2.55eV for doped material in association with decline in PL intensity for improved catalytic response. The doped material showed superior RhB degradation efficacy of 91% versus 63% for undoped material in 2 h. In view of promising photo-activity, it has potential application for the removal of dyes from effluents under visible light irradiation, which will make the process economical feasible.

Keywords: Perovskite; Doping; Micro-emulsion; Photocatalysis; Visible light

600 KEV AG IONS IRRADIATION EFFECT ON THE STRUCTURAL, OPTICAL AND PHOTOVOLTAIC PROPERTIES OF MAPBBR$_3$ FILMS FOR SOLAR CELLS APPLICATIONS

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Organ metallic halide perovskite solar cells have become one of the most aggressive emerging technology because of their low fabrication cost, having large functioning area, long lifetime, and considerable high energy, power conversion efficiency (PCE). Spin coating technique is utilized for the fabrication of pure $CH_3NH_3PbBr_3$ ($MAPbBr_3$) thin films. 600 keV Silver (Ag) ions are implanted on these films at the fluency rate of $4x10^{14}$ and $6x10^{14}$ ions/cm^2. XRD confirmed the cubic structure of $MAPbBr_3$. The high grain size is observed at the flouency rate of $4x10^{14}$ ions/cm^2. UV-Vis spectroscopic technique has been used to calculate the optical properties like bandgap, refractive index, extinction coefficients, and dielectric constant. A direct band gap of 2.44 eV is measured for pristine film sample whereas 2.32 eV and 2.36 eV are measured for Ag ions implanted films having $4x10^{14}$ and $6x10^{14}$ ions/cm^2 fluence rate, respectively. Solar cells of these films are fabricated. The J_{sc} (6.69 mA-cm^{-2}), FF (0.80), V_{oc} (1.1 V), and efficiency of pristine $MAPbBr_3$ based cell. All of these parameters are improved by Ag ions implantations. The maximum values are observed at the fluency rate of $4\square10^{14}$ ions/cm^2 where V_{oc} is 1.13 V, Fill-Factor is 0.75, short-circuit current density is 8.18 mA/cm^2, and efficiency is 7.01%. This efficiency is 84% higher than pristine film based solar cell.

Key Words: Ion implantation; Ag; perovskite solar cells; $MAPbBr_3$

ISOLATION AND CHARACTERIZATION OF FREE AND CONJUGATED PHENOLIC ACIDS IN FRUITS OF SELECTED WILD PLANTS

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A gas chromatography–mass spectrometric (GC–MS) method was utilized for the separation, and systematic characterization of phenolic compounds as trimethylsilyl derivatives in fruits of wild plants including Olive, Jujube and Common Fig. Both the free and conjugate phenolic acids (rarely determined before and several are reported first time here), extracted by acid and ultrasonic hydrolysis, were characterized. A baseline separation of the 20 phenolic acid was achieved in 25 min with standard calibration curves linear over the concentration range from the detection limits to 20 µg/mL. Total of fourteen phenolic acids were identified in wild Olive fruit, eight in wild Jujube fruit and ten in wild Common Fig fruit, out of which 2,4-dihydroxybenzoic acid and trans-cinnamic acid were dominant in these fruits with concentration of 87.02, 5.25 and 14.16 mg/kg and 32.43, 5.77 and 11.70 mg/kg (dry weight), respectively. The results of this study support the utilization of the tested wild fruits as a potential source of valuable phenolics for functional food and nutra-pharmaceutical applications.

Keywords: Wild plants, Phenolic acids, Antioxidant, Acid hydrolysis, Ultrasonic Hydrolysis

POSTERS

THEME 1

CLIMATE SMART CROP PRODUCTION TECHNOLOGIES

INTERACTION OF PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) AND SALICYLIC ACID TO AMELIORATE SALINITY STRESS IN WHEAT

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Wheat is world's leading crop and source of staple food for more than half of the world's population. It provides more than 20% of daily fats and protein to its consumers. Pakistan is an agricultural country and wheat is the staple crop of Pakistan. However, the national wheat yield has fluctuated significantly in last decade. Low productivity of the wheat is linked with the soil salinity. In this scenario, the transformation of uncultivable saline soils into productive agricultural land can offer a suitable option for expanding the wheat cultivated land. Plant growth promoting rhizobacteria (PGPR) are the microbial species which helps in alleviating biotic and abiotic stresses through production of different phytohormones like auxins, gibberellins, cytokinins and secondary compounds like exopolysaccharides. Salicylic acid (SA) has been proved to lower the impact of salinity due to its various stress tolerance mechanisms such as increased antioxidants, synthesis of stress tolerant proteins and activation of stress tolerant genes. Inoculation of plant growth promoting bacteria to soil and SA application to the plant offer cost-effective solution for ameliorating the effect of salt stress on the growth and yield of wheat. This study was conducted to check the effect of plant growth promoting rhizobacteria (PGPR) and different levels of SA alone, and in combination with PGPR and SA on plant growth under salinity stress. Salinity was developed by dissolving sodium chloride (NaCl) in distilled water and subsequent addition to soil. The study was carried out in pots and the seeds were sown in saline soil inoculated with pre-isolated salt tolerant PGPR strain. SA was sprayed after 60 and 90 days of crop growth. Different growth (plant height, root, shoot fresh and dry weights, no. of tillers and spikes), physiological (chlorophyll contents), yield (100 grains weight) and chemical parameters such as nitrogen and phosphorus in root, shoot and grains were recorded. It was revealed that significant increase in plant height, root and shoot fresh weight, maximum no. of tiller and maximum grain yield per pot were found in treatment, where PGPR+SA @1.50 was applied. In case of nitrogen and phosphorus, PGPR+SA @1.50 showed significant results as compared to control. Based on the results, it was concluded that salicylic acid application in combination with PGPR proves to be a good option for alleviating salinity stress and increasing plant growth and yield.

CONCEPT OF CLIMATE SMART AGRICULTURE

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Agriculture continues to be Pakistan's second-largest economic sector accounting for more than 25% of the country's GDP (GDP). Climate-smart agriculture (CSA) is a term that expresses a desire to better integrate agricultural climate resiliency and developmental goals. It is challenging to achieve comprehensive developmental objectives and to secure the food products in the scenario of climate change and increased food demand. In order to sustainably enhance productivity, resilient crops, and decrease greenhouse emissions, CSA initiatives must plan to handle interchanges and collaborations across these three pillars: mitigation, production, and adaptation (GHGs). In the contrast of climate changes, it is necessary to develop more effective, equitable, and efficient agriculture system that will be benefitted environmentally, socially, and economically and problem solving across productive landscapes and this smart system attracting the attention of various governments and stakeholders. However, the idea of smart agriculture is an initiative while many of the CSA tactics are already being used by farmers all over the world to address a variety of production concerns. A detailed study of present and potential approaches, as well as institutional and financial enablers for CSA adoption, is required to mainstream CSA.

CLIMATE SMART CROP PRODUCTION TECHNOLOGIES

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Long term changes in weather patterns are termed as climate change. Change in climate impacts all living and non-living things. Agriculture production is particularly dependent on the climate. Different climate factors: temperature, water, light intensity, precipitation changes, and wind impact crop production. Change in climate can destroy food production, availability and quality of crops. Developing countries are more prone to climate change because they lack social and financial resources. Climate smart agriculture (CSA) techniques are those that improve crop production by adopting different methodologies. Good quality seeds are very important for high crop yield. Make sure that farmers use sterilized seeds. In developing countries, farmers obtain seeds from different unregulated sources. For example: purchasing local seeds, saving seed from their own pluck. Irrigation is another way of achieving a high yield. Improved water usage can increase crop production instantly. This can be done by following a water balance assessment. Water quality and quantity are major issues for poor farmers. Polluted water can kill nutrients in soil as well as cause gradual death in plants. Irrigation often involves extra energy costs, which need to be accompanied by relevant energy technologies (solar-powered pumps). A sustainable use of genetic resources (genetic engineering, mutation, and biotechnological application) for climate change adaption has been improving crop yield. Farmers grow plants which have desired traits. For example, plants have the ability to bear high temperatures and humidity changes. Application of pesticides and herbicides is a widely useful approach. Change in climate also influences the growth of various pests and other unwanted weed species. Integrated pest management (IPM) is a technique used for crop protection and crop production. CSA aims to increase crop production and incomes, adapting soil to tolerate adverse climate changes and mitigation of green-house gas emission.

PHENOTYPING OF RSAs OF WHEAT (*Triticum aestivum*) UNDER VARYING IRON AND ZINC AVAILABILITY

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RSA is important for crop nutrient uptake, water acquisition, and grain production, and variations in RSA have been connected to previous increases in wheat productivity. Root phenotyping approaches now in use have mostly focused on root features in young plants in controlled conditions. Genetic changes in root system architecture (RSA) are an unappreciated path to more productive and efficient wheat crops. This experiment was conducted in the growth room of the Science block at the University of Agriculture Faisalabad. The experiment was arranged in a Completely Randomized Design with two-factor factorial arrangements. 12 verities of Wheat Dharabi-11 ,Punjab-11,Faisalabad-2008,BARS-2009,NARC-2009,Jauhar-78, Pir Sabak 2013 ,Pakistan-2013 ,NARC-2011,Miraj-08 ,Lasani-08,Ujala-1 used in this study. Treatments were replicated four times. Treatments of Zinc and Iron were applied, T_0 is the control treatment without iron and zinc, T_1 contains Zn and Iron is absent, T_2 contains Iron and Zn is absent, and T_3 contains both Zn and Iron. This experiment was conducted to observe the Root System Architecture (RSA) of wheat and also examine the influence of different treatments of iron and zinc on RSA. Combine Zn and Fe deficiency reduced shoot growth similarly but root growth was only reduced under Fe deficiency, whereas under Zn deficiency root growth was even enhanced compared to the control.

EFFECT OF BALANCE NUTRITION ON COTTON PESTS AND SEED COTTON YIELD

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Sucking insect pests are most important biotic factor that affect the photosynthetic activity of plants and also act as a vector of the disease-causing pathogen. However, balanced nutrition could be helpful in altering host plant susceptibility to sucking insect-pests. Therefore, an experiment was conducted to evaluate the effect of balance nutrition on cotton pests and seedcotton yield. There were six treatments viz. T_1= No fertilizer, T_2= RDF (N+P+K+Zn+B), T_3= 75% RDF, T_4= 50% RDF, T_5= 25% RDF and T6= 125% RDF. Our results showed the significant effect of balance nutrition on the thrips, jassid and whitefly. With the increasing dose of fertilizers, the thrips and jassid were increased, whereas the population of whitefly was fluctuated at different doses. Highest thrips 6.8 was observed in T6 followed by 4.84 in T2, while the lowest population was 3.12 in T1 followed by 3.83 in T5. Similarly, the maximum of jassid was recorded 0.50 in T6 followed by 0.28 in T2, while the lowest population was 0.14 followed by 0.16 observed in T1 & T5, respectively. Whenever, the trend of whitefly observed as T1>T5>T3>T4>T2>T6, the highest population (0.36) in T1 and lowest (0.16) in T6 respectively. Our findings also revealed that there was significant effect of balance nutrition on plant height, sympodial branches per plant, boll per plant, shedding of fruiting structures per plant, boll weight, seed index over the control. Significant effects of balance nutrition on cotton yield were also observed. The highest seedcotton yield (2635 kg per hectare) was recorded at 125% RDF followed by 2607 kg per hectare at RDF (N+P+K+Zn+B). The yield of seedcotton decreased as the dose of balance nutrition decreased and yield increased as the dose increased over recommended dose. Although, the population of insects increased with the increased dose of fertilizers, however, we obtained a satisfactory seedcotton yield on balance nutrition. The application of recommended balance nutrition could be an effective approach for better production of cotton. Consequently, excessive, injudicious and unscientific use of fertilizers can result in nutrient imbalance and finally into increased attack of insect-pests.

Keywords: Balance nutrition, cotton, insect pests, seedcotton yield

SILICON AND SALICYLIC ACID APPLICATION ALLEVIATES NEGATIVE IMPACTS OF SALINITY ON MAIZE GROWTH

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Soil salinity is one of the most important abiotic stresses inhibiting crop growth all over the world. Plant responses to salt stress can be very different due to the soil factors in the root zone such as salt distribution. Salt stress severely affects the crop growth, development, and yield. Maize is considered as an essential crop of Pakistan. Its importance cannot be ignored because it is useful as staple food in Pakistan. To investigate the impact of application of Si and SA on maize growth under saline conditions, an experiment was carried out in wire house of Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad. Maize growth was studied in normal (control) and saline (EC 9 dS m^{-1}) soils. The Si was applied at two levels (i.e., 100 and 200 mg kg^{-1}) in soil while Salicylic acid was applied as foliar spray (0.5 and 1.0 mM), along with control. The treatments consisted of T_1 = Control, T_2 = salinity (EC 9 dS m^{-1}), T_3 = Silicon at 100 mg kg^{-1}, T_4 = Silicon at 200 mg kg^{-1}, T_5 = Salicylic acid 0.5 mM, T_6 = Salicylic acid at 1.0 mM, T_7 = Si at 100 mg kg^{-1} + SA at 1.0 mM, T_8 = salinity + Silicon at 100 mg kg^{-1}, T_9 = salinity + Silicon at 200 mg kg^{-1}, T_{10} = salinity + SA at 0.5 mM, T_{11} = salinity + SA 1.0 mM, T_{12} = salinity + Si at 100 mg kg^{-1} + SA at 1.0 mM. A factorial completely randomized designed was followed with three replications for each treatment. Crop was harvested at maturity. The results showed a significant reduction in growth and physiological parameters of maize grown in saline conditions. However, silicon and SA inclusion in growth medium had significant positive effect on maize height, membrane stability index, shoot K concentration and fresh and dry weight. Therefore, it can be concluded that Si and SA played a progressive role in improving overall health of maize particularly under salt stressed conditions and found effective in the augmentation of salinity tolerance in maize.

ALLEVIATION OF NEGATIVE EFFECTS OF DROUGHT BY PRE-SOWING GAMMA TREATED MAIZE SEEDS

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Drought is a major constrains to the growth and production of several crops especially maize globally. It negatively affects maize morphology and physiology. Its negative effects can be mitigated by various mitigants like gamma radiations. Therefore, a pot experiment was design with pre-sowing gamma irradiated maize seeds under control (normal condition) and drought conditions. Results indicated that water stress significantly reduced almost all morphological, biochemical characters with ionic imbalance because of shortage of water in stressed plants. However, gamma irradiated plants showed improvement in all morphological and biochemical parameters except shoot length and root fresh weight. It also increased the absorption of K^+ and Ca^+ ions in root and shoot.

MAGNESIUM ENABLED HUMATE COMPLEX IN ENHANCING SOIL-CROP HEALTH

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Humic acids are complex large carbon molecules that exist naturally in soils, peats, oceans and fresh waters. The major source of humic acids are the sedimentation layers referred to as Leonardite. These layers were originally deep in the earth's crust, but over many years have been exhumed to near-surface location. On the other hand, magnesium (Mg) is the central core of the chlorophyll molecule in plant tissue. Thus, if Mg is deficient, the shortage of chlorophyll results in poor and stunted plant growth. Magnesium also helps to activate specific enzyme systems. Enzymes are complex substances that build, modify, or break down compounds as part of a plant's normal metabolism. Magnesium becomes available for plant use as these minerals weather or break down. For the acid soils of the eastern counties, the addition of dolomitic limestone in the crop rotation, when needed, should supply adequate Mg for crop growth. Magnesium is held on the surface of clay and organic matter particles. Although this exchangeable form of Mg is available to plants, this nutrient will not readily leach from soils. It was hypothesized that combined application of the Mg and humate together can enhance the soil-crop health along with the enhanced microbial growth. Furthermore, these complexes can also be useful in the remediation of the contaminated soils and can be used for water remediation purposes.

EFFECT OF CHELATORS AND BIOCHARS ON GROWTH OF *Abelmoschus esculentus* L. EXPOSED TO HEAVY METAL STRESS

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Heavy metal contamination of ecosystem is reaching global dilemma because of the notable harms to mankind, biodiversity, and environment stability. To evaluate the heavy metal uptake from soil, a pot experiment using high biomass plants (*Abelmoschus esculentus* L.) was conducted for 60 days. In this study, four distinct types of biomasses (Rice husk, Peanut shell, *Asphodelus tenuifolius*, *Pseuda fruticosa)* were selected for the preparation of biochar in locally fabricated pyrolyzing unit at 500-550 ºC under the oxygen limited conditions and applied at rate of 20% to soil. EDTA and citric acid were used as chelating agents (1 and 5mM kg^{-1}). Synthetic heavy metals solutions of cadmium, chromium and lead (50ppm) were added to the soil. The results revealed that biochars and chelating agents synergistically increase the absorption of heavy metals. In comparison to the control, biochars and chelating agents increased uptake of heavy metals from soil and translocation to various plant parts. The root to shoot translocation factor was found to be greater than 1 in all treatments except control in the current investigation. The findings also revealed a substantial increase in plant height, fresh/dry plant biomass and chlorophyll content in comparison to untreated control. Hence the application of chelating agents along with biochars can be a useful strategy for the phytoextraction of heavy metals by *Abelmoschus esculentus* L. as well as management of wastes in form of biochars.

Keywords: Heavy metal, Biochar, EDTA, Citric Acid, *Abelmoschus esculentus* L.

COUMARIN TREATMENT IMPROVES SALINITY TOLERANCE OF *SORGHUM BICOLOR* BY REMOVING OXIDATIVE STRESS AND PROTECTING PHOTOSYNTHETIC MACHINERY

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Phenolic compounds play an important role in alleviating salt-induced negative effects in plants. Present study focused on seed priming and foliar application of coumarin- a potent phenolic compound, to improve salt tolerance of *Sorghum bicolor* var. SS-77. Based on pilot experiment, 100 ppm concentration of coumarin was applied to the plants grown at 0, 100 and 200 mM NaCl in 4 different ways (i) non-primed control (NP), (ii) seed priming (COP), (iii) foliar application (COF) and (iv) a combination of seed priming and foliar application (COPF). Plants were grown under netted greenhouse conditions and salt treatment was applied for 4 weeks. Salt stress significantly reduced the plant growth, biochemical attributes, and photosynthetic efficiency of Sorghum whereas, coumarin application (COP, COF and COPF) showed a significant increase ($P< 0.01$) in above mentioned parameters at all salinities. Among all, the combined treatment (COPF) showed maximum increase in growth, photosynthetic pigments (chlorophylls and carotenoids), photosynthetic efficiency parameters (Fv/Fm, qn, qP, qI, NPQ and ETR), and osmolytes. It also significantly reduced the oxidative stress markers (H_2O_2 and MDA) by improving enzymatic (SOD, CAT, APX and GPX) and non-enzymatic (polyphenols and flavonoids) antioxidant defense system. Therefore, it is suggested that a combination of seed priming and foliar spray of 100 ppm coumarin is more suitable than their individual applications. It is an environment friendly and economically feasible approach that will be used to improve salt tolerance of Sorghum and helpful to get considerable biomass from saline degraded lands to fulfill food, fodder and energy demands of the ever-growing population.

MITIGATING CLIMATIC RISK FACTOR FOR SUSTAINABLE CHICKPEA PRODUCTION THROUGH FOLIAR FEEDING OF MAJOR NUTRIENTS UNDER POTHOWAR CONDITIONS

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Being mainly a rainfed crop of major chickpea growing areas of the country and due to changing climatic scenarios the non-availability of proper moisture at the time of sowing which resultantly causes poor germination and early crop growth make farmers often feel reluctant to apply basal dose of fertilizers for chickpea production that leads to compromise the yield. To overcome the problem foliar feeding of nutrients could be an effective way for sustainable chickpea production. Therefore a field study was performed for mitigation of climatic risk factor and to assess the impact of sole and combine application of macronutrients as basal dose and foliar feeding of major nutrients for sustainable chickpea production. Experiment was conducted at pulses research field, NARC, Islamabad during Rabi 2020-21 using RCBD with three replications and eight treatments i.e (T_1= No DAP or foliar spray, T_2 = DAP as basal application only, T_3 = Dap as basal dose + One foliar spray of NPK, T_4 = DAP as basal dose + Two foliar sprays of NPK, T_5 = DAP as basal dose + Three foliar sprays of NPK, T_6 = One foliar spray of NPK without DAP basal dose, T_7 = Two foliar sprays of NPK without DAP basal dose, T_8 = Three foliar sprays of NPK without DAP basal dose). Results showed that all foliar spray treatments either used alone or in combination with basal dose of DAP fertilizer had a positive influence and an increasing trend on different growth and yield traits. The best results for most of the studied traits including grain yield (1131 kg/ha) was obtained when crop was treated with three foliar appliactions of NPK in combination with basal dose of DAP and it was followed by DAP+ two foliar appliactions and DAP + one foliar application by producing yield 1089 kg/ha and 1062 kg/ha respectively. However two foliar sprays with out DAP application produced the yield (1022 kg/ha) comparable to the treatment where only DAP was used (1010 kg/ha) without any foliar application. So the study suggested that if due to certain reasons farmers are unable to apply DAP fertilizer as basal dose, two foliar sprays of NPK may compensate this deficiency without compromising yield.

ALLELOPATHIC EFFECT OF (*Calotropis procera*) ON GERMINATION, GROWTH, CHLOROPHYLL CONTENT AND MINERAL UPTAKE OF FIVE AGRONOMIC CROPS

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The present research was conducted to find out the allelopathic capability of Calotropis procera (C.P) on germination indices, growth and mineral uptake of five cultivated crops, namely Tomato (Solanum lycopersicum), Gram (Cicer arietinum), Mung Bean (Vigna radiata), Fenugreek (Trigonella foenum-graecum), and Lettuce (Lactuca sativa). The selected species were grown in petri dishes for germination indices and in pots to examine growth potential and mineral uptake under four different Calotropis procera aqueous extracts (CPAE) (0% Control, 10% T1, 20% T2, and 30% T3) for 30 days after germination in pots. The data revealed significant reduction ($p<0.05$) in Germination indices i.e. germination percentage (GP%), germination rate (GR), germination index (GI), coefficient of velocity of germination (CVG) under increasing extract concentration whereas mean germination time (MGT) significantly ($P<0.05$) increased with increasing extract concentration. The data obtained from pot seedling revealed significant reduction in root shoot length, fresh and dry weight of seedling in all studied species. Allelopathic stress also induced the inhibition in mineral uptake and reduction of chlorophyll content in all species with increasing plant extract.

Keywords: "allelochemicals; weeds; crops; chlorophyll; agro-ecosystems"

APPLICATIONS OF FERTILIZERS THROUGH FERTIGATION TECHNIQUE TO IMPROVE THE FERTILIZER USE EFFICIENCY OF MAIZE CROP

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A field investigation on applications of fertilizers through fertigation technique to improve the fertilizer use efficiency of Maize crop was carried out at Ayub Agricultural Research Institute, Faisalabad. Eight different fertilizer combinations were applied at different times using Randomized Complete Block Design (RCBD) with three replications. The soil analysis of the experimental site showed that pH was 7.75, EC 1.31 dSm^{-1}, available phosphorus 8.1 ppm, extractable potash 186 ppm and OM 0.75%. The growth and yield parameters were recorded at the time of harvest. Furthermore, maize grains were analyzed for mineral contents. The results revealed that maximum grain yield (5.53 t ha^{-1}) was observed in treatment where N, P, K was applied by fertigation in two splits (sowing + 1st irrigation) while lowest grain yield (2.31 t ha^{-1}) was observed in control (without fertilizer). In this treatment, N-P-K:17-17-17, Nitrophos and Urea were used as a source of fertilizer. Moreover, the maximum phosphorus and potash use efficiencies were observed in the same treatment. Therefore, it is concluded that fertigation improved yield and fertilizer use efficiency due to more efficient utilization of applied fertilizer.

POSTERS

THEME 2

CLIMATE RESILIENT PLANT PROTECTION STRATEGIES

EVALUATION OF SELECTED INDIGENOUS *TRICHODERMA HARZIANUM* ISOLATES FOR THEIR BIOCONTROL POTENTIAL AGAINST PANAMA WILT PATHOGEN, *FUSARIUM OXYSPORUM* F. SP. *CUBENSE*

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There is no workable method to control Panama wilt (banana disease) which is a serious threat to the banana industry for the last 20 years. This study was designed to analyze biocontrol efficacy of *Trichoderma harzianum* isolates against Panama wilt pathogen, *Fusarium oxysprum* f. sp. *cubense* (Foc), under *in-vitro* and greenhouse conditions. Three *T. harzianum* isolates TS1, T2R1, and T4R1 and 28 Foc isolates were collected from Fungal Pathology Laboratory, Crop Disease Research Institute. The biotype profiling of *T. harzianum* isolates clustered together with the Th1 BCA biotype. A significant inhibition in growth was noted in all pathogen isolates in dual culture test with TS1 showing highest inhibition while least inhibition was recorded for T4R1 strain. The research trial in greenhouse showed that wilt attack reduced significantly in biocontrol treated plants compared to pathogen only control plants. Maximum reduction in disease severity was noted in TS1 and T2R1 strain whereas minimum reduction in disease severity was observed with T4R1 strain. Reduction in disease severity was linked with improvement in agronomic characters like plant height and leaf area index. It was concluded that the recovered *T. harzianum* TS1 and T2R1 isolates can be promising biocontrol candidates in future field research studies.

Keywords: Panama wilt disease, *Fusarium oxysprum* f. sp. *cubense*, *Trichoderma spp.*, Biological control, Disease severity.

INVESTIGATION OF BIOTYPE AND CYTOCHROME P450 INSECTICIDE RESISTANCE DETOXIFICATION GENES OF COTTON WHITEFLY, *BEMISIA TABACI*

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Despite being an important cotton pest in Pakistan, whiteflies (the *Bemisia tabaci* complex) remain imperfectly understood. For resolving species complexes and studying species distributions, DNA barcoding is a useful tool. The genetic diversity of *B. tabaci* lineages was determined using DNA barcoding, and the distribution of these lineages was mapped in cotton-growing regions in Pakistan's South Punjab. Based on *mtCOI*, *Asia II-1* is present in the South Punjab regions, including Multan, DG Khan, Bahawalpur, and Vehari. *B. tabaci* management strategies are largely dependent on the application of insecticides. Insecticide resistance is high among field populations. Utilizing molecular and gene sequence data obtained from resistant and susceptible *B. tabaci* populations collected in the field has led to a better knowledge of resistance mechanisms in this pest. Two cytochrome P450s, *CYP6CM1* and *CYP4C64* are known to be insecticide resistance detoxification genes that contribute to increased resistance. The moderate to high levels of *CYP6CM1* and *CYP4C64* genes were detected in field-collected populations to investigate resistance mechanisms. The above findings offered useful information on the status of biotypes and associated metabolic insecticide resistance, which might be used to help develop management measures for *B. tabaci*.

Keywords: DNA barcoding, Whitefly, Insecticide resistance, Detoxification genes, South Punjab

AN INSIGHT OF QUINCLORAC RESISTANCE MECHANISM IN EARLY WATER GRASS (*ECHINOCHLOA ORYZOIDES*)

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Quinclorac- main herbicides targeting to barnyard grass has been used for decades in rice fields. *Echinochloa* species have been reported evolving into quinclorac resistance. Quinclorac resistance and its mechanism remain undisclosed in *Echinochloa oryzoides* (Ard.) Fritsch that needs to be uncovered. Dose-response assays were performed followed by ethylene synthesis and related enzyme activities along with gene transcription were studied. β-CAS activity and its molecular docking were investigated. *E. oryzoides* evolved into 21 times resistance to quinclorac from Jiangsu province of China. The increment in ethylene levels in this biotype was correlated negatively with the level of resistance and positively with quinclorac induced growth inhibition. Ethylene response pathway determination showed that resistant biotype decreased 1-aminocyclopropane-1-carboxylic acid (ACC) contents, related enzyme activities and transcription of *ACS* and *ACO* genes. These results indicated that ethylene biosynthesis inhibition and quinclorac resistance possessed a positive correlation. Resistant biotype exhibited ~ 2-fold more β-CAS activity than susceptible ones. Resistant *EcCAS* gene depicted nucleotide changes as compared to susceptible ones, which resulted in two amino acid substitutions (Met-287-Lys and Thr-352-Ala). Consequently, resistant β-CAS enzyme exhibited binding residue increment in active site (simulation modelling); that can be the probable reason for higher enzyme activity in the resistant biotype. The study concludes that variation in response pathway of auxin or alteration in related enzyme activities due to a decreased transcription of *ACS* and *ACO* genes, improved activity of β-CAS, and amplified transcription of *EcCAS* gene were plausible mechanisms endowing quinclorac resistance in *E. oryzoides*.

Keywords: Inhibition of ethylene biosynthesis; Auxin response pathway; β-cyanoalanine synthase

FUNCTION AND SUBCELLULAR LOCALIZATION OF PLASMOPARA VITICOLA PUTATIVE RXLR EFFECTORS

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Grapevine downy mildew, caused by oomycete fungus *Plasmopara viticola*, is one of the most devastating diseases of grapes across the major production regions of the world. Although many putative effector molecules have been identified from this pathogen, the functions of the majority of these are still unknown. In this study, we analyzed the potential function of 26 *P. viticola* effectors from the highly virulent strain YL. Using transient expression in leaf cells of the tobacco *Nicotiana benthamiana*, we found that the majority of the effectors could suppress cell death triggered by BAX and INF1, while seven could induce cell death. The sub-cellular localization of effectors in *N. benthamiana* was consistent with their localization in cells of Vitis vinifera. Those effectors that localized to the nucleus (17/26) showed a variety of subnuclear localization. Ten of the effectors localized predominantly to the nucleolus, whereas the remaining seven localized to nucleoplasm. Interestingly, five of the effectors were strongly related in sequence and showed identical subcellular localization, but had different functions in *N. benthamiana* leaves and expression patterns in grapevine in response to *P. viticola*. This study highlights the potential functional diversity of *P. viticola* effectors.

Keywords: Grapevine, RxLR effectors, Expression patterns, Subnuclear localization, Biological activities

COMPARATIVE EFFICACY OF NEONICOTINOIDS AND CONVENTIONAL INSECTICIDES AGAINST WHITEFLY *BEMISIA TABACI* (GENNADIUS) ON COTTON

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Cotton whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is most destructive pest of many ornamentals, vegetables and field crops in the tropical and subtropical areas worldwide. Both adult and immature damage the plants by desaping the plants, honey dew excretion and owing to its ability to transfer major plant viruses. Management of whitefly becomes a challenge for researchers and farmers because of development of resistance to major insecticide group. Current study was done to compare the efficacy of selected neonicotinoides and conventional insecticides against adult whitefly on cotton during 2021. The study was laid out in a Randomized Complete Block Design having 11 treatments and 3 replication along with control. Population of adult whitefly was estimated one day before and 24, 48, 72 and 68hrs after the spray of selected insecticides. All the insecticides applied gave significant mortality of adult whitefly up to 168hrs of application. However, flunicamide, thiacloprid and bifenthrin resulted in significantly higher mortality of adult whitefly (60.98±2.60, 51.06±2.60, 47.64±2.60) and (79.78±1.99, 61.67±1.99, 62.84±1.99) at 24 and 48hrs of application, respectively. After 72 hr of the spray flunicamide found to be most toxic (82.81±3.88) followed by thiacloprid (64.85±3.88) which is overlapped by profenofos, bifenthrin and thiamethoxam (62.89±3.88, 61.49±3.88, 58.94±3.88), respectively. Same trend in population of whitefly was observed for all insecticides except for acetamiprid (63.03±2.09) which gave satisfactory control only after 168 hrs of application. Effectiveness of insecticides within the plant canopy showed that tested insecticides exerted effective control of whitefly on upper leaves when compared with middle and lower leaves of cotton 24, 48, 72 and 168hr after application. It may be due to that upper leaves may receive maximum spray particles as compared to middle and lower canopy of cotton plant.

Keywords: *Bemisia tabaci*, Neonicotinoids, Conventional insecticides, Toxicity

PREVALENCE OF POWDERY MILDEW OF MANGO IN HYDERABAD AND ITS CORRELATION WITH TEMPERATURE AND HUMIDITY

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Powdery mildew of mango was found to perpetuate through older infected mango leaves and inflorescence in the form of mycelium and conidia or dormant mycelium. Maximum infection in the host occurred at range temperature (15-30 ^{0}C) and relative humidity (60-85%). The Losses caused by powdery mildew have been estimated 20% to 90% per cent of mango crop in Pakistan. A field study was carried out to record the prevalence of powdery mildew of mango and its correlation with temperature and humidity in the surroundings of Hyderabad. For this purpose, 04 mango varieties such as Siroli, Almas, Dusheri and Sindhri have selected three mature trees from each variety were included in the study at Tandojam. Hyderabad to observe the incidence of powdery mildew at different temperature and humidity regimes. Meteorological data was collected from agro-meteorological data regional omit Centre Tandojam and data were statistically analysed by using statistical software. All the mango varieties showed positive and negative correlation for the incidence of powdery mildew with temperature and relative humidity correlation. However, peak incidence of powdery mildew was observed for 'Siroli' at temperature of 28.2 ^{0}C and 49% humidity and whereas, comparably lower disease incidence was recorded at temperature of 34.4 ^{0}C and 47% humidity and while, Minimum incidence of powdery mildew was recorded for mango variety 'Sindhri' at 40 ^{0}C and 42% humidity. It was concluded that Dusheri and Sindhri mango varieties are late varieties and lowest possible infestation of powdery mildew takes place on them. The finding of the present study concluded that there was a positive and negative relationship between the temperature, relative humidity and disease incidence of powdery mildew in all cultivars of mango.

Keywords: Powdery Mildew, Mango, Correlation, Temperature, Humidity

MYCOFLORAL STUDY OF CULTIVATED MAIZE SEED IN DISTRICT POONCH AZAD JAMMU AND KASHMIR

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The current study was carried out on the prevalence of mycoflora associated with maize seeds using blotter paper method. Maize seed samples were collected from six different locations of district Poonch, Azad Jammu and Kashmir. Objective of this study was to determine the fungi associated with maize seeds. A total of seven species of fungi were isolated. *Penicillium* spp., *Fusarium* spp., *Aspergillus niger, A. flavus*, *Fusarium* spp., *Fusarium oxysporum* and *Pythium* spp., were identified. Davigali had the infection percentage of 72 % in all locations. Occurrence frequency and type of fungi isolated varied with location. Prevalence of pathogenic fungi with maize seeds of district Poonch was found variable. Resistant varieties of maize, maintaining temperature, relative humidity and their treatment is suggested to reduce disease and increase yield.

Keywords: Maize, Mycoflora, Blotter test, Pathogenic fungi

FIRST REPORT OF BOTRYTIS CINEREA CAUSING GRAY MOLD DISEASE ON PEACH FROM PAKISTAN

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Gray mold caused by *Botrytis cinerea* is an important disease that attacks fruits, leaves and twigs of peach. Peach is grown on an area of 18,008 ha with an average production of 72,085 tons per year in Pakistan (FAO, 2017). During May 2017, brown spots on 33% of the peach fruits examined were observed in Swat district of KPK province of Pakistan. Infected fruits were incubated at 25±2 °C in a humid chamber resulted in greyish mycelial growth with light brown lesions. Hyphal growths on infected fruits were cultured on PDA media and purified by hyphal tip method. Morphologically whitish grey growth was observed on PDA and later on dark sclerotia were observed after 6-7 days of incubation. Hyphae were found septate with branched hyaline conidiophores having a bunch of ovoid conidia at their tips. Further confirmations were done by amplifying internal transcribed spacer regions (Andrew *et al.*, 2009) and glyceraldehyde-3-phosphate dehydrogenase (G3PDH) region of the isolates (Li *et al.*, 2012). Amplicons sequenced from Macrogen Korea were blasted and submitted in NCBI showed that ITS sequences (Accessions MH049690 and MH049691) were 99% identical with already reported (MG878388 and MG654661) sequences and the G3PDH gene sequences (Accessions MH560352 and MH560353) were 99 % identical with already reported (Accessions MG204876) sequences of *B. cinerea*. Pathogenicity was confirmed on healthy peach fruits disinfected with 50% ethanol, inoculated by placing a plug of about 1cm2 taken from the edge of actively growing *B. cinerea* isolate (BTS-16). Fruits were incubated at 25±2 °C in a humid chamber (Abata *et al.*, 2016). A set of healthy fruits mock-inoculated with a plug of agar medium were used as control. Three days after inoculation, inoculated fruits showed sunken lesions with cottony greyish mycelial growth on their surface. Fungus isolated from these infections was re-confirmed as *B. cinerea*. Conducive environment for the disease progression in nearby areas can result into a huge loss in peach produce so there is a need to devise management strategies to cope with the pathogen. This is the first report of gray mold disease of peach caused by *B. cinerea* from Pakistan.

Keywords: Gray mold; Peach; *Botrytis cinerea*; G3PDH; ITS

DISTRIBUTION AND VIRULENCE OF ROOT-KNOT NEMATODES ON SUMMER VEGETABLES IN SUDHNUTI DISTRICT OF AZAD JAMMU AND KASHMIR

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Root-knot nematodes (RKN) are root pathogens of important vegetable crops belong to genus *Meloidogyne* with worldwide distribution resulting in responsible for huge yield losses. Tropical species cause severe yield losses on vegetable crops in Azad Jammu and Kashmir. A detailed field survey was conducted in vegetable producing areas of the district Sudhnuti for the estimation of incidence and collection of the RKN targeting variety of vegetables. A total of 65 sites were visited during the survey, 47 sites found with 72 percent incidence and severity galling index range 2-8. Eggplant, tomato, cucumber, okra, beans, cucurbits, and chilies observed as the most frequently cultivated vegetables in the area. Host plants harboring RKN were enlisted along with non-host plants on positive sites. The altitude, longitude, latitude, and other related data of the surveyed sites were documented and a distribution map was prepared. The cucumber was found most frequently infested crop with 11 infested fields followed by okra and other cucurbits with 9 fields and tomato with least field infestation 07 fields. RKN was not infesting chilies crop in the area. The study elaborates a detailed comprehensive picture of incidence, prevalence and virulence potential of RKN in the Sudhnuti district, Azad Jammu and Kashmir, Pakistan on vegetable crops.

Keywords: Root-knot nematodes, Eggplant, *Meloidogyne* spp., Vegetables, Incidence

CYLINDRICAL INCLUSION PROTEIN BASED CHARACTERIZATION OF ZUCCHINI YELLOW MOSAIC VIRUS (ZYMV) INFECTING RIDGE GOURD (*Luffa acutangula* L.) IN PUNJAB, PAKISTAN

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Zucchini yellow mosaic (ZYMV) included in the genus Potyvirus is one of the most destructive pathogens of cucurbits, including ridge gourd (*Luffa acutangula* L.) which is widely grown in Indo-Pak subcontinent and can cause significant yield losses worldwide. In the present study, a total of 300 leaf and fruit samples of ridge gourd with virus-like symptoms were collected from 03 districts of Punjab, Pakistan. To perform an initial screening of ZYMV these samples were subjected to Plate Trap Antigen-Enzyme Linked Immunosorbent Assay (PTA-ELISA) using monoclonal antibodies. Overall disease incidence during 2018-2019 was 28.33%. The prevalence of ZYMV was confirmed in all ridge gourd sampling sites. ELISA-positive samples were further confirmed through RT-PCR and sequence analysis. Comparison of sequences with those available in Genbank showed 91-98% nucleotide and 98%-100% amino acid-based homology. Phylogenetic tree analysis revealed that Pakistani ZYMV ridge gourd isolates (MN897100, and MN897101) have close relationship with South Korean, Chinese and Turkish ZYMV isolates, and strengthened the belief that ZYMV Pakistani isolates reported in this study has Asian origin. Identification of new ZYMV isolates strengthen the breeding programs for the development of resistance genotypes to manage this notorious virus.

Keywords: Ridge gourd, ZYMV, PTA-ELISA, RT-PCR, GenBank

EFFECT OF EGG PARASITOIDS TRICHOGRAMA CHILONIS AGAINST MAIZE STEM BORER (*CHILO PARTELLUS*) (LEPIDOPTERA: PYRALIDAE)

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Maize (*Zea mays*) is considered an important major cereal crop used as food and several other products. Additionally it has been consumed by livestock and poultry productions. However, the crop productivity has been lagging behind due to several biotic and abiotic factors. Among these, maize stem borer (*Chilo partellus*) causes severe economic losses to maize crop. The use of synthetic chemicals for the management of this pest has resulted in pest resurgence, resistance to pesticides and harmful effects against natural enemies. Keeping in view as an alternate to synthetic pesticides use of *Trichogramma chilonis* can be a potential bio-control and climatic adoptive agent against maize stem borer. Hybrid maize was planted in the research area Youngwala Department of Entomology, University of Agriculture, Faisalabad. The field was divided in to blocks with different treatments using RCBD layout. The *Trichogramma* cards were prepared in the Biological Control Lab. Department of Entomology, University of Agriculture, Faisalabad. Different treatment means has been separated by using LSD test at 5% probability level. Results showed that, after 3rd day of 1st treatment revealed that *C. partellus* larval population at highest concentration of egg (500) was 0.25 and at lowest egg amount (100) were 6.5. After 3rd day of 2nd treatment revealed that at maximum *Trichogramma* egg concentration (500) the *C. partellus* larvae were 6.7 and at lowest (100) were 18.2. After the 3rd day of 3rd treatment results revealed that at maximum egg concentration (500) the amount of larvae was 7.2 and that at lowest (100) was 6.25. After the study of 3rd day of 4th treatment results showed that at maximum amount of egg (500) the larvae amount was 7.5 and that at lowest (100) was 30.2. Tricho-cards were stapled and interaction was recorded on pest on regular basis divided in to treated and control blocks. Study was recorded with the interval of 3 days in four treatments. Study revealed that with the card installation amount of parasite decrease with the time of intervals. The study will be useful for the future sustainable management of maize stem borer using bio control agents and can be interacted in to other IPM strategies.

Keywords: Maize, *Trichogramma chilonis*, *Chilo partellus*

EVALUATION OF TRAPPING EFFICIENCY OF SOME SLOW- RELEASED FORMULATIONS OF CUE-LURE IN ORCHARDS AGAINST FRUIT FLIES

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Fruit flies (Diptera: Tephritidae) are the major quarantine pest in Pakistan as well as of whole world. The experiment was designed to assess the efficiency of five biodegradable waxes i.e. Candellila wax, Paraffin wax, Carnauba wax, Lanoline wax and Bees wax to make slow release formulations with cue-lure (Butanone Acetate). Waxes and pheromone were mixed in different formulations, each wax in 9 different formulation (10:90, 20:80, 30.70, 40:60, 50:50, 60:40, 70:30, 80:20 and 90:10) along with standard formulation and installed in traps. The formulation (wax 10%+90% cue lure) of three waxes Paraffin wax, Carnauba wax, and Lanoline wax showed maximum attraction 23.42, 19.82 and 35.3 male flies/day/trap, respectively as compared to standard formulation 5.19 male flies/day/trap. The other two waxes Candellila wax and Bees wax showed maximum attraction 25.3 and 24.3 male flies/day/trap, respectively as compared to their standard formulation 5.7 male flies/day/trap. The Paraffin wax, Carnauba wax and Bees wax found highly attractive 71.42%, 80.64% and 77.78%, respectively according to attractive index (AI) and was categorized in class-III (AI>50%). The results revealed that the yellow sticky trap was more attractive in attraction of male *B. cucurbits* and it was more effective to be used with Slow released formulations that capture 32 male flies/day/trap which showed higher attractancy than Standard (8.14 male flies/day/trap) application techniques. According to this research study it was concluded that slow released formulations of pheromones have great potential for the management of fruit flies population under field conditions.

Keywords: Pheromone (Cue- Lure), Butanone acetate, Biodegradable waxes, Slow-Released formulations, Yellow sticky traps, Attractancy, Fruit fly

TOXICITY IMPACTS OF SOME NEW CHEMISTRY INSECTICIDES ON *T. CHILONIS* AND *CHRYSOPERLA CARNEA*

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Trichogramma chilonis as an egg parasitoid and *Chrysoperla carnea* as voracious predator are playing an important role in integrated pest management (IPM) program of insect pest. In IPM program, biological control is supplemented with insecticides which may have toxic effects on natural enemies. The aim of this study was to determine the toxicity impact of IGR insecticides buprofezin (Chitin synthesis inhibitor), lufenuron, pyriproxyfen (juvenile hormone mimics), methoxyfenozide and tebufenozide (moulting hormone agonists) on the *T. chilonis* and *C. carnea* under the laboratory conditions. Different serial concentrations of buprofezin (2%, 1.0%, 0.5%, 0.25%, 0.125%), lufenuron (0.8%, 0.4%, 0.2%, 0.1% and 0.05%), pyriproxyfen (1.0%, 0.5%, 0.25%, 0.125%, 0.06%), methoxyfenozide (1.0%, 0.5%, 0.25%, 0.125%, 0.06%) and tebufenozide (0.8%, 0.4%, 0.2%, 0.1%, 0.05%) were prepared and adults as well as their immature stages were exposed to these concentration. The mortality data of adults and immature stages were recorded after 24 hours of exposure. Results indicated that all insecticides at their higher concentrations caused maximum mortality to the adults as well as immature stages of *C. carnea* and *T. chilonis*. Lufenuron exhibited lower LC_{50} value for eggs (0.07%), larvae (0.08%) and pupae (0.05%) of *C. carnea* and proved more toxic to these three stages of *C. carnea.* However pyriproxyfen explained lower LC_{50} value (0.09%) for adult of *C. carnea* and proved more toxic to this stage. Lufenuron caused 95% for eggs, larvae and pupae of *C. carnea*. For *T. chilonis*, lufenuron caused 95% and 98% mortality of eggs and adults, respectively.

Keywords: Insecticides (IGR, MHA, CSI and JHM), Toxicity, *Trichogramma chilonis*, *Chrysoperla carnea*

MORPHOMETRIC, DISTRIBUTION, MAPPING AND MOLECULAR ANALYSIS OF TERMITES IN THE SELECTED AGRO-ECOLOGICAL ZONES OF KHYBER PAKHTUNKHWA

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The current study area is of oriental region and comprise of Northern mountainous (Buner); Eastern Wet Mountainous (Haripur) and Central Valley plains (Swabi). To report and study the economically important species of termites in the area, a collection survey was carried out either by direct collection or installing traps at the selected sites during summer of 2016-19. Collected specimens were stored in vails containing ethanol (80% and 96%) which were later used for morphometric identification and DNA isolation. GPS coordinates with host and feeding types were also noted for distribution and mapping in ArcGIS (10.04). Collected soldiers were identified on the basis of the available litratrue by measuring various characters/parameters followed by images capturing and processing via Helicon Focus (6.0) and Adobe Photo shop (CS6). Key to the identified termites was made for the studied area along with the combined distribution map and host; and species presence records in the studied area. Identified representative specimen's DNA was extracted followed by PCR amplification, Gel images, cleaning, and sequencing of mtDNA COII. Sequences were trimmed and pairwise alignment was done by using BLASTn search tool for % query covered, % identity, higher bit cover and relevant taxon match with NCBI curated reference sequences (Refseq). Trees were made with retrieved sequences for the studied termites by employing Neighbor-Joining (NJ) and maximum likelihood (ML) methods in MEGA 6.0. Made trees helped in understanding the variation/similarity among the species which is also supported by morphometric variation noted for the under-observation species, thus novel sequence of COII region was uploaded to NCBI GenBank. Species diversity resulted that Genus *Odontoteremes* is more strengthened in terms of number of species in the studied area as compared to other genera with total of 16 and 17 hosts for district Haripur: and Buner and Swabi respectively with some new host records. Percent host preference revealed that in district Buner, wood and Pinus was most preferred while wood followed by grasses and acacia are most preferred in district Haripur and district Swabi, respectively. Upon the investigation of the preferred habitat, it resulted to almost similar number of percent attacks for forest in Haripur (46.15%) and Buner (47.92%) with lower number of attacks in

Swabi (34.21%) while in structures 34.21% and 35.42% attack is recorded for districts Swabi and Buner and lower number of percent attack on structure in Haripur (30.77%). But in agriculture, Swabi was maximum percent attacked (31.58%) as compared to Haripur (23.08%) and Buner (16.67%). Forest and structure in the Buner are more diverse in number of species (05 sp.; 05 sp.) than Swabi (04sp.; 04sp.) and Haripur (04sp. ;03sp.) respectively. But in agriculture, Haripur is more diverse in the number of species (05 sp.) than Swabi and Buner (03 sp. each).

Keywords: Termites, Swabi, Haripur, Buner, Forest

ANTIFUNGAL ACTIVITY OF MEDICINAL AND AROMATIC PLANT EXTRACTS AGAINST *RHIZOCTONIA SOLANI* CAUSING ROOT ROT DISEASE OF CHILLI

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Chilli (*Capsicum annum* L.) is cultivated throughout the world as spice crop. Pakistan is the fifth largest producer of chilli crop throughout the world. Chilli is mostly cultivated in the province of Sindh and Punjab. It is attacked by several biotic disorders and abiotic stresses. The significance of this study was to control the *Rhizoctonia solani* by medicinal and aromatic plant extracts. Three medicinal and aromatic plant extracts of *Azadirichta indica*, *Ferula oopoda* and *Cuminum cyminum* including their crude and oil extracts were tested against pathogen (*Rhizoctonia solani*) and they exhibited the anti-fungal properties against *R. solani* and also reduce the mycelial growth of fungus as compared to control (un-inoculated soil). Among the tested three medicinal and aromatic plants the oil extract of *A. indica* reduced the fungal mycelium by 86 % having mycelium growth of (1.22mm) at 1.0 % concentration. The crude extract of *A. indica* reduce the fungal mycelium growth by 70 % having mycelial growth of (2.59mm) at 1.0 % dose. Whereas the fungal mycelium growth was (3.65mm) and mycelial colony was retarded 58 % at 0.1 % dose and (3.14mm) hyphal growth was observed at 0.5 % dose with reduction of colonial growth by 63 % correspondingly. The total mycelial growth of *R. solani* was (2.15mm) recorded at the dose of 1.0 % and reduced the mycelial growth by 75 %, treated with *Cuminum cyminum* (zeera) oil extract. The 0.1 % & 0.5 % concentrations were also effective and reduced the mycelial growth by 4.55mm (52 %) and 5.55mm (62 %) respectively. The maximum mycelial growth of *R. solani* was (3.14mm) recorded at 1.0% crude extract of *C. cyminum* and reduced the mycelial growth by 63%. The 0.1 & 0.5 % doses were also effective and reduced the mycelial growth by 39 % (5.25mm) and 48 % (4.45mm) respectively. Ferula oopoda (Hing) oil extract reduced the fungal mycelium by 62% (3.28mm) at 1.0 % dose. The crude extract of Ferula oopoda (Hing) reduce the fungal mycelial growth by 53% (4.85mm) at 1.0 % dose. On the other hand, fungicide comparison test was also done with standard fungicide (Antracol) where mycelial growth was 0.64 mm and reduction percentage was 92% of the target pathogen. It is stated that the oil extracts were more effective against the targeted pathogen *R. solani* as compared with crude extracts of *Azadirichta indica*, *Ferula oopoda* and *Cuminum cyminum*.

Keywords: *Azadirichta indica, Ferula oopoda*, *Cuminum cyminum*

IN VITRO EVALUATION OF AQUEOUS EXTRACT OF DIFFERENT PLANTS AND EXTRACTION METHODS ON THE MYCELIAL GROWTH OF SOIL-BORNE PATHOGENS

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Soil-borne Plant Pathogens are widely distributed, they have a wide host range and can cause economic losses in crop yield. Plant extracts can be used as an alternative source of chemical control for controlling soil-borne disease. Aqueous extracts of five different plants i.e., Neem (*Azadirachta indica*), Sufaida (*Eucalyptus* sp.), Drumstick Tree (*Moringa* sp.), Conocarpus (*Conocarpus erectus*), Curry Tree (*Murraya koenigii*) were investigated for their inhibitory effect on mycelial growth of *Sclerotium* sp., *Rhizoctonia* sp., *Macrophomina* sp. Two different methods were used to prepare the aqueous extract of plant i.e., Boiling method and non-boiling method. In boiling method, among the tested organisms Sufaida showed highest inhibition 48.52% followed by Neem 20%, Conocarpus 8.15% on the growth of *Sclerotium* sp. Drumstick tree and curry tree showed no inhibition against *Sclertotium* sp. Only Conocarpus showed inhibition 7.41% against *Macrophomina* sp. None of the plant extract showed inhibition against *Rhizoctonia* sp. In Non boiling method, among the tested organisms Neem showed highest inhibition 100% followed by Sufaida 54.81%, Conocarpus 47.78%, Drumstick tree 28.15% and Curry tree 15.19% on the growth of *Sclerotium* sp. Neem showed highest inhibition 100% followed by Conocarpus 40%, Drumstick tree 18.89%, Curry tree 4.07% and Sufaida showed no inhibition on the growth of *Rhizoctonia* sp. Only Sufaida showed inhibition 57.04% against *Macrophomina* sp.

Keywords: *Azadirachta indica,* Sufaida, Curry tree, Conocarpus

CLIMATE CHANGE AND ITS IMPACT ON PLANT DISEASES

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Climate change is the biggest threat to mankind, and is the cause of nearly 0.4 million deaths a year worldwide and costing the world more than US$ 1.2 trillion. Climate change is affecting our agriculture due to 0.74 °C average global increase in temperature in the last 100 years and atmospheric CO_2 concentration increase from 280 ppm in 1750 to 400 ppm in 2013. The climate influences the incidence as well as temporal and spatial distribution of plant diseases. The main factors that control growth and development of diseases are temperature, light and water. The climate change affects the survival, vigor, rate of multiplication, sporulation, direction, and distance of dispersal of inoculums, rate of spore germination and penetration of pathogens. Climate affects all life stages of the pathogen and host and clearly poses a challenge to many pathosystems. The environmental change, especially when combined with pathogen and host introductions, may result in unprecedented effects. Such changes will have a drastic effect on the growth and cultivation of the different crops on the Earth. Simultaneously, these changes will also affect the reproduction, spread and severity of many plant pathogens, thus posing a threat to our food security. Climate change is also putting stem rust resistance due to Sr31 under threat of Ug99 race of stem rust caused by *Puccinia graminis* f. sp. *tritici.* Elevated temperature and CO_2 concentration are also posing higher threat perception of late blight (*Phytophthora infestans*) disease of potato and important diseases of rice, namely blast (*Pyricularia oryzae*) and sheath blight (*Rhizoctonia solani*). Changing disease scenario due to climate change has highlighted the need for future studies on such models which can predict the severity of important pathogens of major crops in real-field conditions. Simultaneously, disease management strategies should be reoriented in changing conditions with amalgamation of new strategies for sustainable food production.

Keywords: Climate change; Temperature; Carbon dioxide;Disease.

ANTIFUNGAL AND PHYTOCHEMICAL ANALYSIS OF SOME NON-WOODY SUB-TROPICAL PLANT SPECIES

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Plant species facing different environmental stresses required to activate different metabolic pathways for survival. Therefore, contain high amount of unique metabolites that have potential to be used for different purposes. To replace the harmful synthetic chemicals in agriculture, a new trend have been evolved for the isolation of plant active compounds which results in production of natural compounds having strong biological activity. Nineteen non-woody sub-tropical plant species were screen for antifungal and phytochemical analysis in this study. Methanolic extracts of foliar parts for antifungal activity were assessed against *Fusarium oysporum* Schlechtendal, *Aspergillus parasiticus* Speare and *Alternaria solani* Sorauer at the rate of 5 and 10 mg/mL using disk diffusion method. *Cassia fistula* and *Thespesia popunea* showed higher antifungal activities against tested fungal strains at both concentrations. Highest total phenolic content was also found in *C. fistula.* However, higher flavonoid content was recorded in *Heliotropium subulatum* while low to moderate range was showed by the extract of *Cassia fistula* and *T. populnea*, respectively. It is concluded that higher phenolic contents were responsible for antifungal activity *C. fistula.* Further studies are required to investigate the antimicrobial and phytochemical potential of non-woody plant species growing in the areas near the coast of Pakistan.

Keywords: Plant extracts, Phenolic contents, Flavonoid contents, Paper disc method

NEONICOTINOIDS INSECTICIDES IMPAIRS CROP POLLINATION; CONSEQUENCES TO PRODUCE THE SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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Pesticides are considered a risk to pollinators; however, little is known about the possible effects of their injudicious use on pollinators, including the ecosystem services provided to crops and wildflowers. Recently, great attention has been paid to the effects of neonicotinoid pesticides on pollinators and their potential role in harming the health of bees all over the world. Cross-pollinated crops such as sunflowers, primarily mediated by bees, essentially need heavy pesticide use against pest attacks for increased production of seeds. To reveal such potential impacts of neonicotinoids, we undergone a current study that aimed to estimate flower visitation and pollination in sunflower crop by applying three neonicotinoid insecticides i.e., Imidacloprid, clothianidin, and thiamethoxam, including the control group. In all experimental plots, we quantified floral visitors for fourteen days at three different times (8 am, 12 pm, and 5 pm). Floral visitors were divided into three groups, Apis bees, carpenter bees, and butterflies. After the maturation period, the achenes from each capitulum were separated and brought for weight. We observed significant differences in the yield between the neonicotinoids treated and control group. The average was approximately (M = 1.34, SD = 46.3), (M = 1.21, SD = 58.4) and (M = 1.17, SD = 99.0) higher in control group as compared to imidacloprid, clothianidin and thiamethoxam respectively. Hence, this study confirmed the adverse effects of neonicotinoids on sunflower production. Moreover, the abundance of floral visitors, the mass of fruits, and the quantity of oil in the seeds were significantly lower after treatment with neonicotinoid pesticides, thus proving its negative effect on sunflower productivity.

Keywords: Pollinators, Neonicotinoids, Abundance, Sunflower, Pesticide toxicity, Productivity

POSTERS

THEME 3

NOVEL FOODS AND FOOD SECURITY

PRODUCTION INTERVENTION TO ENHANCE BUCKWHEAT YIELD FOR FOOD AND NUTRITIONAL SECURITY

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Food and nutritional security is an essential element of the International Development Agenda. However, development priorities and challenges have changed over time, and the required investment has not been sustained. Food insecurity has become a significant challenge in food chain supply, and there is an urgency to address the issue. Food and nutritional security are becoming a severe concern for the growing populations in the mountainous regions, especially Gilgit Baltistan (GB). The fast-growing health issues have attracted the attention of researchers and consumers toward traditional foods. Buckwheat is a traditional cereal crop of GB. The buckwheat production has declined over time due to the introduction of early maturing and high-yielding wheat varieties in the area that have replaced the traditional crops. Similarly, buckwheat production is low, and the conversion of buckwheat into value-added products is left in negligence. Buckwheat has many health benefits and great potential to be used as a health food. Many gastrointestinal problems and diabetics are attributed to imbalanced diets. Thus, healthy human life depends on a balanced diet containing protein, lipids, carbohydrates, and regulatory nutrients, i.e., vitamins and minerals. Buckwheat had prevalent uses in the old culture of GB, and people still insist on the increasing use of buckwheat in typical diets to improve health & combat fast-growing health issues and chronic diseases. There is a need to promote buckwheat productivity in the area since there is a greater demand for ready-to-eat foods and local products with high nutritional content that appeal to many consumers. The growing domestic tourism, mountaineering, and China-Pakistan Economic Corridor (CPEC) necessitate using local food sources for value-added products to create maximum earning opportunities for the local communities. Thus, the current study will help increase buckwheat's productivity in the hilly areas of GB and utilize different products like biscuits, cakes, cookies, and porridge; therefore, the main aim is to establish the value chain of buckwheat from production to product development. This endeavor will help the household to ensure food and nutritional security. The product development technology will be commercialized for food entrepreneurs to establish viable.

CLIMATE IMPACTS FOOD SAFETY AND FOOD SECURITY

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Livestock production is the world's dominant land use, covering about 45% of the Earth's land surface. Climate change (CC) can impact the amount and quality of products, reliability of production, and the natural resource base on which livestock production depends. Climate is an important factor of agricultural productivity and CC is expected to severely impact livestock production systems. Animal production plays (and will continue to do so) a key role in the food supply chain. While the increasing demand for livestock products, it offers market opportunities and income for small, marginal, and landless farmers. Livestock production globally faces increasing pressure because of negative environmental implications, particularly because of greenhouse gas (GHG) emissions. Agriculture is one sector which is important to consider as it both impacts CC as well as is influenced by CC. Higher temperatures, potentially caused by GHGs (Nitrous oxide, Carbon, and Methane), are expected to decline in dairy production, reduced animal weight gain, reproduction, and lower feed-conversion efficiency in warm regions. Incidence of diseases among livestock and other animals are likely to be affected by CC, since most diseases are transmitted by vectors (arthropods) such as ticks and flies (development stages of ticks and flies are often dependent on ambient temperature). Cattle, goat, horses, and sheep are also vulnerable to an extensive range of nematode worm infections, most of which have their development stages influenced by climatic conditions Although the direct effects of CC on animals are likely to be small (as long as temperature increases do not exceed 3°C), CC will affect animals indirectly through physiological stress and thermoregulatory control, nutrition, and disease stress. While the livestock products are an incredibly important human food, and animal farming is a significant source of income for millions of farmers, it is immensely needed the early risk assessment, adaptation and mitigation strategies to ensure the food safety and security.

Keywords: Food safety, Food security, Climate Change, Greenhouse gases (GHGs), Ticks

COOKING QUALITY CHARACTERISTICS OF EXTRA- LONG GRAIN RICE OF PUNJAB, PAKISTAN

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Rice is one of the primary grown cereal of universe and is eaten by 60% of the world population as staple food. Three indigenous extra-long grain rice varieties grown in Punjab, Pakistan were analyzed for their cooking quality characteristic. Comparison of newly developed varieties was done with existing Basmati 515 and Super Basmati. The varieties differ significantly at $P > 0.001$ for volume expansion ratio, water uptake, Gel consistency, elongation ratio, Amylose content, alkaline spread value, gelatinization temperature and aroma. The gelatinization temperature (GT) was determined based on alkaline spreading score. Volume expansion ratio varied from 4.5 to 5.5. Kissan Basmati had higher volume expansion ratio than the other varieties. Grain elongation during cooking ranged between 14.7 to 16.6mm. The values for the amylose ranged between 22.50 to 24.0 % and amylopectin ranged between 76-77.5%. The range of AGL of extra-long grain ranged from 8.10 to 8.23mm, L/B ratio from 4.47 to 5.47. The characteristics of the various varieties make them suitable to meet the preferences of majority of exporters as their quality traits are close to traditional Basmati varieties.

Keywords: Rice, Cooking, Long grain varieties, Basmati, Amylose, ASV, Yield

KSK111H: FIRST EVER BASMATI RICE HYBRID, A FINE GRAIN HIGH YIELDING, EARLY MATURING AROMATIC RICE *(ORYZA SATIVA)* HYBRID IN PAKISTAN FOR TOMORROW'S FOOD SECURITY

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Basmati rice hybrid KSK111H is first ever approved rice hybrid from Punjab in Pakistan's rice history. "KSK111H" a high yielding aromatic rice hybrid with tolerance to moderate salinity levels in soil. It will be auctioned to private companies during 2021-22 for seed production and then for general cultivation to farmers in next consecutive years. This hybrid was developed by Rice Research Institute, Kala Shah Kaku by using its germplasm including KSK1301A and KSK1301R lines through hybridization. This rice hybrid was developed to break the yield barriers of basmati rice cultivated by the local farmers of southern Punjab. KSK111H was fine grain rice hybrid which has good cooking quality with mild aroma and expected to fetches good market price in future. The paddy yield of KSK111H was 51% higher as compare to Super Basmati. KSK111H was an early maturing (almost 3 weeks earlier than Super Basmati).Tolerant to salinity upto EC 5. It has aroma like other basmati varieties. Rice hybrid provide good results when sowing and transplanting time is as other basmati varieties mid June to mid July. Its yield potential is 11.5 t/ha and average yield is 7.2 t/ha.

Keywords: Rice (*Oryza sativa*); Basmati hybrid; Punjab; Pakistan;High Yielding; Early maturing

NOVEL FOODS AND FOOD SECURITY

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Foods that humans have rarely consumed are called novel foods. Innovative food technologies have derived all these foods from plants, mineral resources, animals, and microorganisms—for example, chia seeds and noni fruit juice. However, in the past, novel foods were represented by intensive extraction of natural ingredients, for instance, phytosterols, oil rich in DHA, and lycopene. Currently, some advanced resources and techniques are used for novel food manufacturing to avoid using raw materials of conventional origin. Advanced sources are fungi and algae cell culture, insects, oilseed, duck seed, and nanomaterials. Novel foods have essential ingredients that address the different issues of chronic diseases (diabetes, heart diseases, cancer, e.g.). On the other hand, security is essential in the novel food market. Novel foods need to be appropriately labeled to avoid the chances of being misleading and safe for consumers. It must be ensured that there are no side effects to consuming novel foods. And provide evidence for novel foods' kinetics, toxigenicity, allergenicity, and nutritional status. The Supplemental Assistance Nutritional Program (SNAP) plays a fundamental role in novel food security. There is a need for the reliability of food consumption that compels the search for unique food resources with aspects of affordability that help to maximize the use of resources.

Keywords: Duckseed, Phytosterols, Lycopene, SNAP

GLOBAL AQUACULTURE PRODUCTIVITY IN THE SCENARIO OF CHANGING CLIMATE!

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Aquaculture plays an important role in meeting the demand for food in many developing countries of the globe (80 million tons in 2016), but aquaculture production is under great threat as fisheries capture has stagnated. Though there is an increase observed in aquaculture further increase in its production has raised environmental concerns with widespread challenges faced by the community. Environmental concerns affecting aquaculture are resource decline, habitat destruction, eutrophication, biotic depletion, ecological effects, fish disease, and greenhouse gas (GHG) emissions. The effects of changing climate pose a global threat to aquaculture production. Aquaculture can be affected by a combination of climatic events such as global warming, extreme heat, cyclones, ocean acidification, drought and flooding, rainfall variation, rise in sea level, and increased salinity. For sustainable growth of aquacultures such as fishes, crabs, shrimps, and other seafood, environmental impacts must be reduced significantly. Adaptation to the changing climate is needed to produce more fish without environmental impacts. Adaptation strategies include the expansion of seafood (coastal aquaculture, mariculture, mollusks, and seaweed farming), cohesive and integrated aquaculture (rice-fish farming, pond-based rearing of aquaculture, and mangrove-shrimp culture), and recirculating aquaculture system (RAS) including aquaponics and biofiltration system. These adaptive approaches could help in increasing aquaculture production with a projected 140 million tons in 2050 meeting global food security, with sustainable environment and climate change adaptability.

Keywords: aquaculture, climate change adaptability, environmental sustainability

DETERMINATION OF NUTRITIONAL PROFILE OF NOVEL FOOD AND ITS INCORPORATION AS FUNCTIONAL FOOD PRODUCT

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Novel foods are foods that have not had enough exposure to be considered safe, and may include, depending on national regulations. While security is a key entrance element in the novel foods industry, a growing demand for food sustainability is driving the quest for new food sources with low-cost characteristics that optimize the utility of the resources at our disposal. Novel food like Sesame oilseed meal *(Sesamum Indicum)* keeps on getting affirmation in the field of functional food as it contains phytoestrogens, alpha linolenic acid and lignins. The seed oilseed contains high quality dietary fibers. The seeds give digestible proteins, calcium and omega-3 fatty acids. The two major nutrients of sesame meal which are center of attention in functional food world are protein and dietary fiber appeared to prevent abdominal disorders and protein-energy malnutrition in children. An adequate intake of sesame oilseed meal or sesame oilseed meal fortified food products have shown to decrease postprandial glucose absorption, low density lipoprotein cholesterol, low inflammatory markers and raise serum level of ALA eicosapentanoic acid and omega-3 unsaturated fatty acids. The aim of this study was to evaluate the nutritional profile of sesame oilseed meal and sensory properties of sesame seed oil meal fortified cookies. The results of proximate analysis showed 52% protein, 23% NFE, 1% crude fat, 6% crude fiber, 10% ash and 9% moisture content. Parameters for sensory evaluation were taste, texture, color, aroma, flavor, mouth fullness and overall acceptability. Results of sensory evaluation showed high acceptance of sesame oilseed meal cookies and supports sustainability as well as security as a food product.

DEVELOPMENT OF WALNUT (*Juglans regia L.)* MILK AND ITS NUTRITIONAL ASSESSMENT DURING STORAGE

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Walnut (*Juglans regia* L.) belongs to the family *Juglandacae* . Walnuts have proven health benefits as it contain essential fatty acids (omega 3, omega 6, PUFA), high biological proteins carbohydrates, minerals, fat soluble vitamins and functional components. it also rich in HDL antioxidant, phenolic compounds, antioxidant and fat soluble vitamins,(vitamin E) which helps in fighting against heart disease, hypercholesterolemia. Objectives of the study were development of walnut milk, application of preservation technique to increase its shelf life and quality evaluation of developed product during storage. Walnuts were collected from district Shigar, Gilgit Baltistan for development of walnut milk. Product was developed in laboratory of Food Science and Technology University of Poonch Rawalakot. Walnut kernel was soaked in luke warm water for 6 hour and then its thin skin was removed. grinded by using grinder add water 20:80 kernel water ratio the obtained product was pasteurized at 65˚C for 15 minutes and applied preservative . T_{o-} Walnut milk without preservative at room temperature, T_{1-} Walnut milk at refrigeration temperature, T_{2-} Walnut milk with 0.08% sodium benzoate at room temperature, T_{3-} Walnut milk with 0.08% sodium benzoate at refrigeration temperature, T_{4-} Walnut milk with 0.02% sodium azide at room temperature, T_{5-} Walnut milk with 0.02% sodium azide refrigeration temperature, T_{6-} Walnut milk with 0.04% sodium benzoate with 0.01% sodium azide at room temperature, T_{7-} Walnut milk with 0.04% sodium benzoate with 0.01% sodium azide at refrigration temperature and stored at room temperature and room temperature. The effect of treatment and storage was checked after every 5 days intervals. The physicochemical (pH, acidity, fat, protein, ash, total solids), total phenols and antioxidant, sensory (taste, color, flavor and overall acceptability) and microbiological (TPC, TFC) were assessed every 5 days of storage. The results were statistically analyzed using complete randomized design at 5% level of significance and treatments were compered at Tukey HSD value. The results of the study demonstrated that application of sodium azide 0.02% at refrigeration temperature was best in sensory and organoleptic properties shelf life was improved up to 25 days of storage.

ANTI-HYPERLIPIDEMIC AND ANTI-HYPERGLYCEMIC EFFECTS OF BUCKWHEAT EXTRACT ON DIABETIC RATS

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The study was conducted to assess the anti-hyperlipidemic and anti-hyperglycemic effects of buckwheat husk extract on diabetic Albino Sprague Dawley rats. In addition, the protein quality of buckwheat was also evaluated during the study period. The results regarding bioactive compounds indicated that the Tartary buckwheat contained higher quantity of bioactive compounds as compared to common buckwheat. Significantly highest rutin (32.98 mg/100g), D-Chiro inositol (DCI) (141.93mg/100g), and quercetin (1.64mg/100g) was observed in husk part of Tartary buckwheat while lowest rutin (10.94 mg/100g), DCI (14.66 mg/100g), and quercetin (0.52 mg/100g) was found in fine flour of Tartary buckwheat. Likewise highest Rutin (22.65 mg/100g), DCI (112.62 mg/100g), and quercetin (1.23 mg/100g) was noted in husk part while lowest rutin (6.71 mg/100g), DCI (12.39 mg/100g) and quercetin (0.34 mg/100g) was found in fine flour of common buckwheat, respectively. The results regarding the nutritional evaluation revealed that the supplementation of buckwheat flour significantly increased the food intake, weight gain, protein efficiency ratio, true digestibility, net protein utilization, and biological value. It is evidenced from the results that nutritional value was improved by the supplementation of buckwheat in experimental diet. The buckwheat extract significantly reduced the total cholesterol, triglycerides and low density lipoproteins while high density lipoproteins level increased. The fasting blood glucose level of group I increased while it decreased in group II and group IV over time. Group II and group IV had more glucose tolerance as compared to group I.

Keywords: Buckwheat, Extraction, Nutritional evaluation, Hperlipidemia, Hyperglycemia

COMPARISONS OF PHYSICO-CHEMICAL AND FUNCTIONAL PROPERTIES OF DIFFERENT BUCKWHEAT VARIETIES

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Buckwheat is an important pseudo-cereal rich in nutrients like protein, minerals, phenolics, antioxidants and bioactive compounds. To harvest its potential a study was designed to evaluate the physicochemical and functional characteristics of different indigenous buckwheat varieties grown in Gilgit Baltistan, Pakistan. The physical characteristics showed that the thousand-grain weight, length, width, thickness, arithmetic mean diameter and geometric mean diameter was found highest in common buckwheat whereas the highest mean values for bulk density and sphericity was observed in Tartary buckwheat. The water absorption capacity, oil absorption capacity, swelling capacity, foaming, and foaming stability were noticed high in common buckwheat as compared to Tartary buckwheat. The results regarding chemical properties revealed that common buckwheat contained a higher quantity of protein (14.67%), fat (3.86%), fiber (1.38%), ash (2.24%), and total carbohydrate content (65.8%) while Tartary buckwheat contained moisture (13.31%), protein (11.9%), fiber (1.38%) fat (3.57%), ash (2.69%) and total carbohydrate content (68.8%). It was exhibited that the Tartary buckwheat contained a higher quantity of total phenolic, total flavonoid and antioxidants. The data regarding minerals profile also revealed that the highest mean values for zinc, copper, manganese, iron, magnesium, and calcium content in Tartary buckwheat while in contrast greater mean value for total dietary fiber content was recorded in common buckwheat. During the comparison of milling factions, it was found that buckwheat husk contains the highest quantity of Cu (6.78 ppm) and manganese (32.79 ppm) while fine flour proved to be a rich source of magnesium. Likewise, the highest amount of iron and zinc was found in bran flour and coarse flour. Milling of common buckwheat yielded 33% fine flour, 29% coarse flour, 8.87% bran flour, and 27% husk while Tartary buckwheat yielded 31% fine flour, 27 % coarse flour, 12.4 % bran flour and 26% husk respectively. The present research work identified variability among buckwheat varieties and milling fractions for physicochemical and nutritional traits that can be used in the supplementation of various food products.

Keywords: Buckwheat, Physicochemical characteristics, Functional properties, Grain milling fractions

HYPOGLYCEMIC ROLE OF CORN SILK

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Hyperglycemia is a condition of high blood sugars levels in body, mostly seen in diabetic patients. Diabetes is the leading cause of death & other health related issues during these days, Various studies are done to reduce the effect of elevated sugar levels in body, One of them is use of corn silk , Corn silk has the ability to reduce blood sugar levels in body. It has the potential to mitigate the hyperglycemia and effects on serum electrolytes. Corn silk is used in various forms either in form of capsule, powder to add in various food products & to evaluate its hypoglycemia effects, studies show corn silk is added in wheat flour to make a bread/Roti it can be added in Naan in different ratios. Corn silk is added in whole wheat bread /Roti & Naan which improves sensory parameters significantly. Color taste, texture, flavour and overall acceptability enhances by addition of corn silk. Corn silk addition in the wheat bread/roti/naan enhances the nutritional value of this will provide additional health benefits & improves the blood sugar as well as cholesterol levels. More over fiber addition will make the more complex grain & improves insulin resistance. Fibers will reduce the insulin spikes that why more complex carbohydrates are beneficial for health status of an adult.

Keywords: Corn Silk, High Blood Glucose, Nutrition, Insulin Resistance

THERAPEUTIC POTENTIAL OF MULBERRY LEAVES

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Mulberry leaves are used as a food source for silkworms. It belongs to the family "*Moraceae*". Mulberry leaves are a rich source of vitamins, phytosterols, minerals, flavonoids, and many other functional components mainly deoxynojirimycin, which is a potent α-glucosidase inhibitor and thus act as an anti-diabetic drug. In China and Japan, the leaves of the mulberry plant have been used to treat different diseases such as blood pressure, cough, and blood sugar as it helps to boost immunity. The leaves are used in different food products such as yogurt, herbal tea, salads, dry powder, smoothie, oil, etc. The extract of mulberry leaves consists of anti-glycation and hyperglycemic components, which can be used for the treatment of "hyperglycemia". It acts as an anticancer as it is also a good source of natural antioxidants such as flavonoids and phenols. "Resveratrol" a flavonoid present in the leaves of mulberry increases the production of nitric oxide, which acts as a vasodilator. It also helps to remove any blockage in blood vessels, thus lowering heart attack problems. Thus, mulberry leaves have shown huge therapeutic potential and can be used in daily diet to treat different diseases.

Keywords: Natural Antioxidant, Anticancer, Immunity Boost, Therapeutic Role

POSTERS

THEME 4

CLIMATE ADAPTIVE MARKETABLE HORTICULTURE

GEOSTATISTICAL MAPPING OF POSTHARVEST STRUCTURE DAMAGE, TREND ANALYSIS AND FUNGAL BIODETERIORATION MANAGEMENT OF PEAR FRUITS

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Fresh fruits are extremely vulnerable to structural damage during harvesting, to transportation. In this study, spatial data of pear fruit structure damage from two districts were analyzed, using Geostatistics and Geographic Information System (GIS) to map the variation of damage. The structural damage in terms of incidence %, damage length (cm), and damage depth (cm), the histogram results indicated that district Gilgit had more structural damage than district Nagar. Nugget/sill ratios of 0.164, 0.219, and 0.476 in Gilgit district suggest high to moderate spatial dependence, whereas 0.88, 0.19, and 0.05 in Nagar district indicate moderate to severe spatial dependence. The interpolation maps and color shades helped us to visualize the geographical distribution pattern of structural damage at the study site. On the maps, high damage incidence, length, and depth were represented by red tones, followed by yellow tones, while low damage incidence, length, and depth were represented by deep green tones. In both districts, a separate damage trend was detected in the trend analysis graph. Pear fruits were dropped from a height of (140 cm) onto various surfaces, with the results indicating that the metal surface, followed by wood, imposed the largest impact of structural damage. Four fungus species and two plant extracts were used to assess in vitro biodeterioration of healthy pear fruit. Artemisia absinthium designated high efficacy and statistically significant difference in mycelia reduction at P< 0.01). The information can be used in the packing of fresh pear fruit to prevent structural damage, damage impact, and biodeterioration.

Keywords: Geostatistical Analysis: Pear fruit; Fungal contamination; trend analysis

DOMESTICATION OF WIDELY GROWN BLACK RASPBERRIES (*Rubus Occidentalis* L.) FOR NUTRITION AND INCOME GENERATION

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Raspberries are the third most popular berry with consumers in the United States, after strawberries and blueberries, and the U.S. is the third largest producer in the world Black raspberry (*Rubus occidentalis*) is a deciduous shrub of temperate region and closely related to rose, they grow especially well as cool climate plants. Due to the ideal climatic conditions for its growth, black raspberry plants have been found wild under Rawalakot conditions. Therefore, a huge plantation could be found in wild. Raspberry is a rich source of food components; vitamins, minerals and bioactive compounds like phenolics, anthocyanins, organic acids etc. The wild fruit species chosen for their high vitamin C content, mineral elements and medicinal value could be of interest for fruit processing industries. For their economic potential, wild fruits, semi domesticated and less utilized fruits provide better economic return by making a variety of edible products such as jam, jelly, juice, squash and sauce. Moreover, berry extracts are commonly used in botanical dietary supplement forms for their possible health benefits. Extensive research, using laboratory animals, has found that berries have anticancer properties. The biological activities of berries are partially described to their high content of a wide range of phytochemicals such as flavonoids (anthocyanins, flavonols, and flavanols), tannins (proanthocyanidins, ellagitannins, and gallotannins), stilbenoids (e.g., resveratrol), phenolic acids (hydroxybenzoic and hydroxycinnamic acid derivatives), and lignans.

EFFECT OF DIFFERENT MICRONUTRIENTS ON PRE-MATURE APPLE (*Malus domestica)* FRUIT DROP

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Boran is an essential micronutrient. When it is not present in sufficient quantity, apple and pear profit are reduced. A major effect of B nutrition in fruit trees is its role in fruit set (Faust, 1989). Early research indicated that B is necessary for flower bud formation. Foliar fertilization with micronutrients is generally successful because deliverable amounts are enough to meet most tree requirements. At present, most growers apply foliar B. Because transitory low B status may limit fruit set, the goal of foliar B programs is to increase B in flower buds. Boran sprays often are applied in early fall after harvest or during the prepink blossom stage. Magnesium has an important role primarily as a constituent of chlorophyll, when it is deficient, photosynthetic activity is reduced. In addition, it has a significant effect on phosphorilation and carbon-dioxide assimilation as an enzyme activator, it participates in the process of glycolysis, citric acid cycle and nitrogen metabolism.

EFFECT OF DIFFERENT PLANT GROWTH REGULATOR ON PRE-MATURE APPLE (*Malus domestica)* FRUIT DROP

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Boron is an essential micronutrient. When it is not present in sufficient quantity, apple and pear profit are reduced. A major effect of B nutrition in fruit trees is its role in fruit set (Faust, 1989). Early research indicated that B is necessary for flower bud formation. Foliar fertilization with micronutrients is generally successful because deliverable amounts are enough to meet most tree requirements. At present, most growers apply foliar B. Because transitory low B status may limit fruit set, the goal of foliar B programs is to increase B in flower buds. Boron sprays often are applied in early fall after harvest or during the prepink blossom stage. Magnesium has an important role primarily as a constituent of chlorophyll, when it is deficient, photosynthetic activity is reduced. In addition, it has a significant effect on phosphorilation and carbon-dioxide assimilation as an enzyme activator, it participates in the process of glycolysis, citric acid cycle and nitrogen metabolism.

EFFECT OF CLIMATE CHANGE ON GLOBAL FOOD AND CROP PRODUCTION

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Climate change is making the world's weather unpredictable, and its wreaking havoc on agriculture. Extreme meteorological and climatic occurrences are being caused by warm atmospheres, decreased snowfall, increasing sea levels, unpredicted changes in precipitation, and greenhouse gas emissions. The temperature rise is the primary cause of these changes. Climate change and extreme weather events pose serious risks to agriculture all around the world. Due to the vagaries of weather and other natural disasters such as extreme temperatures, extremely erratic rainfall, floods and droughts, dust cyclones, pest infestations, and crop diseases, coupled with low adoption rates of new technologies, countries face challenges in achieving food security, poverty reduction, and rural development. Climate change has a big influence on water resources, agriculture production, food supply, farmer well-being, fisheries and livestock, and the global economy. Agriculture production level is low and it's an alarming situation for every country, in this time we should make a smart and innovative plan for increasing agriculture yield and grip on climate for solving the issues. Introduce some technologies that enhance agriculture production as well as livestock management. Climate-smart agriculture responds to climate change while also improving farmers' livelihoods. At the farm level, climate-smart agricultural technological developments have the potential to address climate-related issues. Climate-smart agriculture (CSA) has emerged as a framework for developing and implementing a robust agriculture system. Which improve the living condition in rural areas, improve food security, and facilitate adaptation to climate change. Various strategies and policies are being implemented at the local, national, and regional levels to lead activities and investments toward climate-smart agriculture on a global scale. However, large expenditures and coordination are necessary for CSA to have a meaningful influence, and its principles must be broadly followed across the whole sector.

Keywords: Climate Smart Agriculture (CSA), Livestock, Sea level, Pest infestations

CLIMATE CHANGE IS ALLEVIATING COLD STRESS ON VEGETABLE CROPS

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Plant productivity is hampered by low temperatures, which are an important environmental influence. Cold stress is a severe danger to crop yields' long-term viability. Low temperatures have a significant impact on plant life and spread. It has a deleterious impact on cellular components and metabolism, and temperature extremes impose varying degrees of stress, depending on the strength and duration of the stress. Low temperature (below the minimum) causes chlorosis, necrosis, membrane damage, cytoplasm viscosity changes, and changes in enzyme activity, all of which lead to plant mortality. The integrity of intracellular organelles is disrupted by cold stress, resulting in the loss of compartmentalization. It also inhibits and reduces photosynthesis, protein synthesis, and other metabolic activities. Furthermore, flower drop is caused by cold stress during anthesis. Furthermore, cold stress during anthesis causes flower loss, pollen sterility, pollen tube distortion, ovule abortion, and impaired fruit set, all of which contribute to lower growth and yield. Plant growth regulators (salicylic acid, abscisic acid, jasmonic acid, Gibberellin, as well as unitization of genetics tools and plant breeding, are being used to mitigate the negative effects of cold stress, which threatens the successful production of vegetable crops. Plant growth regulators are more important in increasing cold stress resistance. The effects of cold stress on vegetable growth, productivity, and physiological activities were examined in this research, and several efficient approaches for cold stress mitigation that assist sustain vegetable output in a changing climate presented.

Keywords: Cold stress, Plant growth regulators, Climatic change, Vegetables, Genetic tools

EFFECT OF NaCl ON SEED GERMINATION AND MORPHOLOGICAL CHARACTERISTICS OF STOCK (*Matthiola incana* L.)

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Salinity drastically affects the productivity of horticultural crop plants. Thus, an experiment was conducted to examine the of salinity tolerance in stock (Matthiola incana L.). The response of stock (Matthiola incana L.) to NaCl at different salinity levels (0, 25, 50, 75 and 100 mM) was studied. High salinity delayed mean germination time of seeds and also decreased the morphological traits (root fresh weight, shoot fresh weight, shoot dry weight, shoot dry weight shoot length, root length, length of flower stalk and number of leaves per plant) at seedling stage. The results indicated that all morphological traits were severely affected. But it was revealed by statistical analysis that Rosy Red cultivar was minimum percentage reduction obtained while Dark Blue cultivar was maximum percentage reduction obtained sensitive to NaCl. It is concluded that different cultivar under consideration vary in their ability to tolerate salt stress.

Keywords: Salinity, Stock, Germination, Morphological, NaCl

APTNESS OF SOME ESSENTIAL OILS IN EXTENDING SHELF LIFE AND CONTROLLING *BOTRYTIS CINEREA* IN STRAWBERRY

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Strawberry (*Fragaria ananassa*) is a spoilable fruits and have a quick shelf life. The application of plant extracted oils is considered foremost appropriate strategies to extend the freshness period of strawberry through storage. The purpose of this work was to evaluate atifungal effect of plants oil obtained from orange (*citrus x sinensis*), cinnamon bark (*Cinnamomum cassia* L.) and garlic (*Allium sativum* L.) against the postharvest pathogens *Botrytis cinerea* of strawberry. The results of this investigation indicated that plant extracted oils of cinnamon bark (*Cinnamomum cassia* L.) and garlic (*Allium sativum* L.) significantly inhibit the mycelium growth of postharvest pathogens of *B. cinerea* of strawberry. The essential oil from orange (*citrus x sinensis*) were found less effective in controlling the growth of *B. cinerea* during storage at room temperature. The cinnamon bark essential oil completely suppressed the mycelial growth of *B. cinerea* at 2% and 4% concentration for the period of one week. These finding suggest that essential oils derived from cinnamon bark and garlic could be suitable for applications to control *B. cinerea* and prolong the shelf life of strawberry fruits during storage.

Keyword: Strawberry, *Botrytis cinerea*, Orange, Cinnamon bark, Garlic, essential oils, antifungal activity

EFFECT OF DIFFERENT INSECTICIDES ON PRE-MATURE APPLE (*Malus domestica)* FRUIT DROP

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Codling Moth (*Cydia pomonella* L.) is considered as the major serious insect pest in apple production throughout the world. It also damages in almost all the provinces of Pakistan including Gilgit-Baltistan and Azad Jammu and Kashmir. This codling moth causes almost 50-60% damage. It causes serious damage because of its deep feeding habit. Besides apple pest can also complete the development process in pears, walnut, quince and many other fruits causing economic losses in the production. Larvae attack the fruits and these damaged fruits dropped soon after drop occurs. The pest is very adaptable to different climatic conditions and is known for the development of resistance to several chemical groups of insecticides Thus, the present study has been designed to initially investigate the potential cause of pre-mature fruit drop and further to explore the influence of different insecticides (Cypermethrin, Biphenthrin, Acetamiprid) on pre-mature fruit drop and biochemical characteristics of selected apple varieties (Kashmiri Amri, Red Delicious, and Star Crimson) grown in Rawalakot, Dheerkot and Bagh. This study will be helpful for apple growers to reduce pre-mature fruit drop and to increase their income by reducing the losses due to pre-mature fruit drop.

POSTERS

THEME 5

EMERGING BIOTECHNOLOGICAL AND BREEDING INNOVATIONS

THE ROLE OF GOLD NANOPARTICLES FOR THE PHOTO THERMAL CANCER THERAPY

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Gold is the multifunctional material used in different drugs of medication importance, because it has a distinctive resistance to antioxidant, bacteriostatic and anti-corrosive characteristics. Now in this time, recent medications are taking shape and use of gold to create nanomedicines in numerous developments, because gold nanoparticles contain the group of amines and thiol used for the use of the medicines and antibodies. The colloidal gold has been found to be the localized Plasmon surface resonant, to absorb light in gold nanoparticles at the particular wavelengths and to show photo thermal and photo acoustic properties which make them helpful for hypothermal cancer treatment as well. Modifying shape and dimension of gold nanoparticles can alter the photochemical localized plasma resonance of the surface, and thus alter photo-caustic and photo thermal features that permit the use of different light wavelengths, such as light, in the near-infrared range. Gold nanoparticles can readily be distributed around the body to locate tumours and excrete readily through the urine system when they are produced at the nanoscale point. In this document we discuss the progress, applications, structures and future directions for the use of gold nanoparticles to treat cancer.

Keywords: Gold nanoparticles, Hyperthermia, Cancer therapeutics, Photoactive property

IN SILICO DISSECTION AND EXPRESSION ANALYSIS OF *SUCROSE SYNTHASE* GENE FAMILY IN SUGARCANE

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Sugarcane, the world's largest source of sugar and biofuel, still carries an unassembled ~10 GB poly aneuploid genome, which is a major bottleneck in studying this crop at molecular level. Sugar is mainly derived from sugarcane, hence the sucrose metabolism pathway is one of the most intriguing hotspot for sugar crop researchers. Four main gene families have been reported to be involved in sucrose metabolism including the SuSy (sucrose synthase) gene family. Sucrose synthase in plants degrades sucrose to UDP-glucose and fructose to ensure their availability for growth and developmental purposes. Here, we attempted to get deep insights into sugarcane SuSy gene family and carried out bioinformatics and expression analyses to get a high resolution holistic snapshot. Multiple stress-responsive cis motifs Abscisic acid responsive element (ABRE), Anaerobic induction responsive element (ARE), Auxin responsive element (AuxRE), Low temperature responsive (LTR), Wounding response element (WUN), WRKY transcription factors binding site (W-motif), predicted in the regulatory region showed their involvement in the stress signalling pathways, in addition to sucrose metabolism. Similarly, the protein interaction network analysis predicted an array of proteins of diverse range of functions. Moreover, the expression pattern of SuSy gene family in two varieties CPF251 (higher sugar level) and CPF252 (lower sugar level) was compared in leaf and internodes (top and bottom). qRT-PCR indicated the differential expression pattern of the SuSy genes in these two varieties. The expression of SoSuSy2 was high in leaf and top internodes while low in bottom internodes indicating its activity in this tissue. In CPF251, both SoSuSy2 and SoSuSy4 displayed higher expression level, however, only SuSy2 had higher expression in CPF252. In contrast, SoSuSy6 and SoSuSy7 were the least expressed genes followed by SoSuSy1. This study highlights the candidate genes for gene manipulation and consequent metabolic engineering of sugarcane for enhanced sucrose contents.

Keywords: *In silico* dissection, Sucrose Synthase, Gene family, Sugarcane

EFFECT OF PHYTOHORMONE AGAINST TOCOPHEROLS IN RICE CALLUS

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Rice is a staple food in many countries throughout the world and it feeds half of the world's population. Flavonoids, phenolic acids, tocopherols, sterols, and triterpenoids are bioactive components of rice. These chemicals are mostly found in the outer layer of rice. Tocopherols, a kind of vitamin E, have long been considered the most significant natural antioxidant. Tocopherols play significant role in plant growth and development, in addition to impacting yield. Tocopherol is important for helping the body to cope with a variety of environmental challenges because of its antioxidant capabilities (e.g., salinity, drought, metal toxicity, ozone, UV radiation). The levels of tocopherol in rice callus have been investigated in relation to number of phytohormones. In this study different varieties of basmati rice were quantified for different phytoharmones and their results were compared to those of rice callus. The Murashige and Skoog 1962 (MS) medium was supplemented with 0.1 mg/L 6-Benzylaminopurine (BAP) and 0.1 mg/L Thidiazuron (TDZ) to produce rice callus. The analyzed tocopherols were in much higher content in Pak basmati than the super basmati (5.63 µg/g compared with the 0.35 α-toco in rice, 47.57 µg/g compared with 18.71 µg/g γ-toco or, 5.56 µg/g compared with 1.74 µg/g β-toco). The highest content of the three analyzed tocopherols was γ -tocopherol, both in callus and rice variety. Rice callus can be a great resource of tocopherols and rice varieties have a big impact on *in vitro* callus generation and callus tocopherol concentration (p 0.05).

Keywords: Rice, Bioactive compounds, Phytohormones, Tocopherol, Antioxidant

ASSESSMENT OF GENETIC VARIABILITY IN PEPPER (*Capsicum annuum* L.) GERMPLASM FOR VARIOUS MORPHOLOGICAL TRAITS

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A field study was conducted at Vegetables Research Institute, Ayub Agricultural Research Institute, Faisalabad to investigate the variability parameters in pepper germplasm. Twenty five genotypes of hot pepper (*Capsicum annuum* L.) were assessed for means, components of variability, phenotypic and genotypic interrelationships for yield and yield components. The experiment was conducted with three replications in Randomized Complete Block Design (RCBD). The data for yield and its various components viz; plant height, number of primary branches, inter nodal length, leaf area, peduncle length, fruit width, fruit length, pericarp thickness, seeds per fruit, fresh red fruit weight, dry red fruit weight, seed index (1000 seed weight) and yield was recorded using standard procedures and statistically analyzed for the estimation of genetic variability, direct and indirect contribution of various yield components to overall yield. Morphological data were subjected to principal components analysis followed by hierarchical agglomerative clustering. There were five principle components which accounted for (77.2%) variability. Clustering provided five groups based on morphological properties. It can be concluded that there is a large variation among the different genotypes for most of the characters studied. So, this germplasm may be utilized for future breeding programme. On the basis of higher estimates of inter cluster distance (59.2612) observed between Cluster II and Cluster IV followed by (38.41) between Cluster III and Cluster II, desirable parents can be selected from the above clusters for effective crossing programme.

Keywords: Pepper, Genetic variability, Principal component analysis, Cluster analysis

MORPHOLOGICAL AND PROTEOMIC ANALYSIS OF DROUGHT TOLERANT AND SUSCEPTIBLE WHEAT GENOTYPES

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Wheat (*Triticum aestivum*) is a major crop grown in temperate regions. It is most extensively consumed food crop and is widely grown as a staple food due to its high nutritional value compared to other cereals. Wheat is referred as the "King of Cereals". A number of biotic and abiotic factors effect crop yield, drought as a major abiotic stress effects crop output and performance by slowing down its growth and development. Drought stress occurs when there is lack of water or high rate of transpiration. It influence growth, membrane integrity, osmotic adjustment, water relations, photosynthetic activity and yield. Drought causes change in physiological, morphological and biochemical characteristics in plants and also effects the productivity of crop. In the present study, ten different wheat genotypes were collected from Ayub Agricultural Research Institute Faisalabad. Only five best performing varieties showed an increase root and shoot length. For protein analysis, five varieties (Fakhre-Bhakar,Punjab-11,Akbar-19,Fareed 2008 and Anaj-17) were first grown *In Vitro* under drought stress samples were analyzed using SDS-PAGE. Results showed that two varieties (Fakhre-Bhakar and Punjab-11) has high protein expression under drought stress.

Keywords: Wheat, Drought stress, Physico-chemical changes, Proteins, SDS-PAGE

IN VITRO AND *IN VIVO* SCREENING OF MILLET GENOTYPES AGAINST SALINITY TOLERANCE

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Millet is a group of small grained, annual cereal grasses which belong to Poacea family. Millets rank fifth after rice, wheat, maize, barley and sorghum in Pakistan. Millets account less than 1% of worldwide and 3% of coarse cereal production. The current millet yield in Pakistan (315 MT) is far less than the world's average (302.45 MT). The production of crops is influenced by several abiotic stresses. The average yield losses in major crops due to salinity, stress has been documented as 15–90%. This study was carried out to screen pearl millet genotypes for salinity tolerance under field and lab conditions. A total of ten pearl millet genotypes were screened on modified MS medium containing four different treatment combinations of NaCl at germination stage. Based on *in vitro* and *in vivo* analysis varities 18-BY and YBS-98 showed best performance and highly tolerant with respect to plant height(54.25cm,79.85cm), inflorescence length (11.2cm,15.65cm), inflorescence width (2.55 cm,3.10cm), flag leaf length (16.25cm, 23.50cm) and flag leaf width (1.80cm,2.75cm) respectively.

Keywords: Millet genotypes, *In vitro-in vivo* Screening, Salinity tolerance

IMPACT OF SALT STRESS ON DIVERSE WHEAT GENOTYPES AT GERMINATION AND SEEDLING STAGE

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Wheat output has decreased due to harsh environmental conditions. Salinity is the most damaging of these stressors in wheat crop development. Although there is a large amount of wheat germplasm available, testing in saline conditions is restricted. As a result, the current study evaluated the performance of 20 wheat genotypes under saline and normal circumstances. The current study was carried out at the Department of Plant Breeding and Genetics at Ghazi University in Dera Ghazi Khan, Pakistan, in both lab and field conditions. Two studies were carried out on different seedling characteristics of wheat, such as germination %, germination rate index, chlorophyll content, leaf area. Under CRD, the research will be split into two experiments with two treatments and three replications each. Germination percentage, Germination rate index, and Coleoptile length were measured seven days after seeding (germination stage). Seedling traits were measured at three leaf stage for all genotypes in both treatments. All genotypes, treatments and interaction between genotype and environment showed significantly difference for all traits studied in analysis of variance. Genotypes A8 and A12 showed best performance for most of the traits studied. Correlation analysis indicated that positive and significant association was found between traits like germination percentage, germination rate index and coleoptile length to increase growth of the plant. So, two genotypes A8 and A12 have been identified as salt tolerant when compared with other genotypes under experiment. So, these genotypes, A8 and A12 can be used as parents for hybrid wheat program and wheat varietal development program to increase pe acre yield of the crop at maturity.

Keywords: Wheat, Genetic variability, Correlation, Germination, Seedling traits

GENETIC VARIABILITY IN RICE GERMPLASM ASSOCIATED WITH ROOT SYSTEM ARCHITECTURE

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Nitrogen is the most vital nutrient for plant growth and productivity as it involves in plethora of metabolic processes. Rice (*Oryza sativa* L.) is considered as the most significant staple food for half of the global population and has the lowest nitrogen use efficiency. For sustainable agriculture it is necessary to screen rice cultivar which makes best use of N in alleviated N supplies because in developing countries like Pakistan excessive N fertilization is a major economic cost for rice farmers. To achieve the goal present study have been designed to screen 109 genotypes collected from rice research institute, Kala Shah Kaku at growth chamber of Department of Botany, University of Agriculture, Faisalabad. Hydroponic culture media was used to evaluate the root system architectural variation. Two levels of N i.e.,100% of recommended and 50% of the recommended with two sources of N Calcium nitrate and urea were used as treatments. Treatments were replicated four times. At 19th day SPAD values were taken and at 20th day seedlings were harvested R software was used to generate biplots relating Root system architecture with SPAD values and total biomass production. Different genotypes showed diverse response in terms of length of primary root and lateral root density under nitrate and ammoniacal sources however the selection was performed by attributing the highly efficient and inefficient genotypes as having vigorous and weak root system architecture positively associated with higher and lower SPAD value and Biomass. Out of 109 genotypes the efficient genotypes selected for future experiments were Shua 92, KSK 133, 98PP-7, IR-30, DR-82.BAS 5854 and PKBB1 Whereas Inefficient genotypes were TKM 6, Hansrajj-1, PGRI_NARC_Rice_7692 and RC-82.

Keywords: Genetic variability, Root system architecture, Nitrogen, PCA, Rice

GENOME AND TRANSCRIPTOME WIDE ANALYSES OF FAMILY-1 UDP GLYCOSYLTRANSFERASES IN POPULUS TRICHOCARPA INDICATES DROUGHT RESPONSIVE GLYCOSYLATION

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Populus trichocarpa (Black cottonwood) is a dominant timber-yielding tree that has become a notable model plant for genome-level insights in forest trees. The efficient transport and solubility of various glycoside-associated compounds is linked to Family-1 UDP-glycosyltransferase (EC 2.4.1.x; UGTs) enzymes. These glycosyltransferase enzymes play a vital role in diverse plant functions, such as regulation of hormonal homeostasis, growth and development (seed, flower, fiber, root, etc.), xenobiotic detoxification, stress response (salt, drought, and oxidative), and biosynthesis of secondary metabolites. Here, we report a genome-wide analysis of the *P. trichocarpa* genome that identified 191 putative UGTs distributed across all chromosomes (with the exception of chromosome 20) based on 44 conserved plant secondary product glycosyltransferase (PSPG) motif amino acid sequences. Phylogenetic analysis of the 191 *Populus* UGTs together with 22 referenced UGTs from *Arabidopsis* and maize clustered the putative UGTs into 16 major groups (A–P). Whole-genome duplication events were the dominant pattern of duplication among UGTs. A well-conserved intron insertion was detected in most intron-containing UGTs across eight examined eudicots, including *Populus*. Regulation of putative UGTs expression in response to water deficit conditions was observed based on microarray and RNA sequencing datasets in *Populus euphratica* (a desert poplar tree). Up- and down-regulated UGT expression models were designed, based on transcripts per kilobase million values, and confirmed their maximally varied expression under drought conditions. Co-expression networking of putative UGTs indicated their maximum co-expression with cytochrome P450 genes. Our results provide an important resource for the identification of functional UGT genes to manipulate drought-responsive glycosylation in *Populus*.

Keywords: Populus, UGTs, Gene structure, Drought, Gene co-expression.

WATER-SOLUBLE POLYMERS IN AGRICULTURE: XANTHAN PRODUCTION BY SOME LOCALLY ISOLATED XANTHOMONAS SPECIES

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In the agriculture of the 21st century one of the means of increased productivity is the use of novel and high-performance materials. These are employed to constructively modify the properties of soil, water, fertilizers and plant protection products. Among other materials, water soluble polymers (WSPs) have wide applications in agriculture for instance to alter water retention capacity, to improve soil structure or physical characteristics, as a controlled release system for fertilizers or phytochemicals, in soil remediation for removal of heavy metals and oil contamination or as a biocide. Xanthan gum is the most important microbial polysaccharide in terms of production volume and diversity of applications. In agriculture it is used for soil improvement, encapsulation, to control drift and in geotechnical engineering. For the use of xanthan in local industries, Pakistan imports xanthan due to a lack of indigenous production. A protocol optimized for local production is needed, which will cut down the price of imports and help in earning foreign exchange. This study focuses on the isolation of Xanthomonas sp. from infected plant samples for xanthan production. Following the isolation, strains were characterized and the selected strains were subjected to produce xanthan. Further studies are on way to optimized parameters for production. Xanthan produced indigenously will be used in diverse agricultural applications and thus will provide sustainable solutions.

Keywords: Water soluble polymers (WSPs), Xanthomonas sp., Xanthan gum, Industry

CLONING AND SEQUENCING OF INTERNAL TRANSCRIBED SPACER (ITS) REGION FORM CHICKPEA *RHIZOBIUM*

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Sustainable crop production is the major issue faced by all countries of the world. Unpredictable climate and soil conditions causes severe losses by affecting the yield and production of crops. Researchers are trying to make plants climate resilient by inserting some tolerant genes using transgenic technology. Crop yield and production is improved by various methods, most important one is nitrogen fixation by *rhizobium* bacteria, where yield of legume crops is enhanced by inoculation of *rhizobium* bacteria. Importance of chickpea crop as a nutritive food cannot be ignored and its production is affected by *rhizobium* inoculation. In this study, sequence variation in the Internal Transcribed Spacer (ITS) region was used to genetically identify closely related rhizobial strain. ITS region is commonly used as an important marker for the establishment of phylogenetic relationship among rhizobial strains. This ITS region was isolated from the *rhizobium* bacteria by isolating DNA from the nodules that adhere with the roots of legume plants. ITS region was amplified using forward (ITS450) and reverse (ITS1440) primer to differentiate the species. Colony PCR was performed to verify presence of DNA. Precise sequence of nucleotide was determined using nucleic acid hybridization technique. Sequence analysis was performed using bioinformatics tools such as NCBI and Clustal W, where correct information about nucleotide arrangement was determined. Phylogenetic analysis revealed that ITS region has high homology with *Mesorhizobium ciceri* and *Bradyrhizobium* gene.

Keywords: Chickpea, *rhizobium,* Internal transcribed spacer (ITS) region, Cloning, Sequencing

ASSESSMENT OF HERITABILITY OF GRAIN IRON AND ZINC CONTENTS UNDER RAINFED CONDITIONS IN WHEAT THROUGH PHYSIOLOGICAL BREEDING

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Wheat is the most significant grain crop in the world, supplying more than one third of the global population. It requires specific attention for raising productivity in order to ensure food security. Malnutrition is among the most serious global threats to human health, notably between those living in developing countries. Nutritional deficiency in iron and zinc is ubiquitous and worldwide, impacting more than half of the global total. Non-diversified cereal and plant based diets which are poor in micronutrients are main reason for micronutrient deficiency in the populations. The research was conducted at research area of Pir Mehr Ali Shah Arid Agriculture University Rawalpindi. The data was analyze in line into tester design. The grain yield mean was higher in Glaxy x 11280, faisalabad08 x11280, and Ass11 x 11280. For grain per spike, Glaxy was a good combiner. Glaxy x 11280 demonstrated the highest grain iron and zinc content. Glaxy x 11280 had the highest grain yield heterosis, as well as positive heterosis for the number of fertile tillers and spike length, as well as negative heterosis for 1000-kernel weight and days to heading. The presence of both additive and nonadditive gene effects was supported by σ2 gca/σ2sca, (σ2 A σ2D)$^{1/2}$ low ratios, and low to intermediate estimates of h2 ns.

Keywords: Malnutrition, Micronutrient Deficiency, Physiological Breeding

DECIPHERING OF GENOTYPE × ENVIRONMENT INTERACTION TO IDENTIFY STABLE HEAT TOLERANT MUNGBEAN GENOTYPES BY GGE BIPLOT ANALYSIS

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Heat stress due to climate change is the major determinant for low grain yield in top five mungbean producing countries in Asia. The present study was designed to identify the stable heat tolerant genotypes for grain yield from a panel of 80 advanced lines of mungbean including three checks under normal and heat stress conditionsat three locations (Chakwal, Piplan and Bhakkar) in Pakistan. Correlation and principal component analysis revealed the positive interaction of grain yield with pods per plant, seed per pod, 100-grian weight, and harvest index, while days to flowering and maturity had the negative association under normal and heat stressed conditions. The GGE biplot analysis efficiently explained 85.1% of the total variation and demonstrated that among eight vertexed genotypes of polygone biplot, the G14 and G38 were heat tolerant as these genotypes outclassed others in all the heat stressed environments. In contrast, the genotype G51 and G74 produced maximum yield under normal conditions (E3 and E5). The ranking biplot partitioned 83 genotypes into low yielding (38) and high yielding genotypes (47) among which G38 produced the highest average grain yield followed by G51, G34 and G14. The GGE biplot based on environment scaling revealed that the heat stress condition of Piplan (E4) was found very close to ideal environment for the evaluation of mungbean genotypes. The environmental conditions of Chakwal (E1 and E2) and Bhakkar (E6, heat stress) clustered together to form the first mega environment while the environmental conditions of Piplan (E3 and E4) and Bhakkar (E5, Normal) constituted the second mega-environment. Taken together, these findings provide the baseline to utilize these genotypes as parents to pyramid the heat tolerant attributes with the biotic resistance for further improvement in mungbean.

Keywords: Mungbean; heat stress; genotype × environment interaction; GGE biplot analysis

GENETICS OF YIELD INDICES IN SPRING WHEAT UNDER WATER DEFICIT CONDITIONS

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Wheat (*Triticum aestivum* L.) as a king of cereals is among world top cereals feeding almost 36% of the world population due to its vast production, consumption, massive cultivation area and distinctive features among other cereals. Objective of study was to selection of parents for yield parameters and to select best parents to use in future wheat breeding programs. This research work was conducted in the fields of Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad during the cropping season 2016-2017. Data will be recorded for tillers per plant, grain yield per spike (g), spikelets per spike, 1000 grain weight (g) and grain yield per plant (g). Results revealed that all the genotypes were depicted highly significant differences for all characters under study. Peduncle length among parents was maximum recorded for genotype XJ-18 (16.5 cm) followed by Aas-2011 (13.93 cm), LU-26 (13.33 cm) and XJ-20 (12.83 cm). For number of grains per spike Aas-2011 (75.44) followed by XJ-18 (69.77) showed maximum vales. 1000-grain weight was maximum for XJ-18 (38.04 g) followed by 20 (35.04 g), XJ-19 (35.84 g) and XJ-17 (33.75 g). Results suggested that XJ-18 was good performer and was recommended for further breeding plans to develop water tolerant lines/ varieties.

Keywords: Wheat, Drought, Peduncle length

PHYSIOLOGICAL AND GENETIC EVALUATION OF WHEAT (*TRITICUM AESTIVUM* L.) ROOT ARCHITECTURE FOR CHANGING CLIMATIC CONDITIONS IN PAKISTAN

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Wheat is abundantly grown in rainfed areas worldwide and 50% decline in wheat productivity in these areas is due to abiotic and biotic stresses govern by climate change. Drought and heat are considered as the most detrimental climatic disasters for wheat production in Pakistan. During drought stress conditions, wheat roots continuously grow in search of water; even so, the airy organs are confined to develop. Root architecture, physiological and genetics is of key importance to be taken under consideration, to understand the root's response under drought condition. The present study is aimed to evaluate the root architecture based on high-throughput platform and selection of best root architecture genotypes. Expression pattern of PIN gene family members among the selected genotypes was performed under control and drought conditions. Statistical analysis was carried-out using SPSS and R software. The genotypes revealed non-significant ($p \geq 0.05$) results for all traits except root length which demonstrated significant results ($p \leq 0.05$). Mean square values of treatments into genotypes interaction revealed highly significant results showed by root length, surface area and total chlorophyll content. Based on root related traits, selected two long and short root genotypes. Expression pattern of PIN gene family members revealed significant expression level among the selected genotypes. These best performing genotypes under drought will be helpful in breeding new cultivars with favorable root architecture system. Furthermore, implementation of advanced technologies i.e., high-throughput phenotyping and next-generation sequencing will be helpful for wheat improvement in term of drought tolerance and grain yield.

Keywords: Drought, Wheat, Root architecture, High-throughput phenomics, PIN gene, Expression profiling

GENOME-WIDE SURVEY OF HMA GENE FAMILY AND IDENTIFICATION OF ITS FUNCTION DURING DROUGHT STRESS TOLERANCE IN WHEAT (*TRITICUM AESTIVUM*)

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Abiotic stress, which includes drought and heavy metal toxicity, has presented a significant risk to long-term agricultural output around the world. Although the HMA (heavy-metal-associated domain) gene family has been widely explored in Arabidopsis, it has not been thoroughly studied in *Triticum aestivum*. The purpose of this study was to investigate the effect of wheat HMA genes under water deficit. To analyze the phylogenetic relationships, gene structure, gene ontology, and conserved motifs, a comparative study of wheat HMA genes with the Arabidopsis genome was performed. A total of 27 *Triticum aestivum* proteins belonging to the HMA gene family were discovered in this investigation, with amino acid counts ranging from 262 to 1071. HMA proteins were found to be divided into three subgroups in a phylogenetic tree, and closely related proteins in the tree showed the same expression pattern as motifs found in distinct subgroups. Gene structural study found that intron and exon arrangement differed by family. As a result, the current work offered important information regarding HMA family genes in the *Triticum aestivum* genome under drought stress, which will be valuable in understanding their putative functions in other wheat species.

Keywords: HMA (heavy-metal-associated domain), Drought-stress, Wheat (*Triticum aestivum*), Phylogenetic analysis

POSTERS

THEME 6

CLIMATE SMART NATURAL RESOURCES MANAGEMENT

CO-INOCULATION OF *RHIZOBIUM* SP AND PGPR FOR GROWTH PROMOTION OF CLIMATE RESILIENT CROP

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Legume inoculation has been carried out to favour nitrogen fixation before the onset of green revolution. *Rhizobium* species have outstanding ability to colonize roots of legumes to promote nitrogen fixation and ultimately yields of legumes. Isolates of *Rhizobium* sp and PGPR (five of each type) have been characterized for the biosynthesis of IAA, P-solubilization, siderophore production and other biochemical tests. Isolates showed higher values of IAA equivalents, solubilization index, siderophore unit and on the basis of other biochemical tests were selected for enhancing nodulation, growth parameters of mung bean in a field study at graded N levels i.e., 12 and 25 kg ha^{-1}. Results clearly demonstrated the effect of bacterial inoculation at both N levels as compared to uninoculated ones. Co-inoculation effect on yield and nodulation parameters was significantly higher than the separate application of isolates. Co-inoculation improved the grain and biomass yield of mung bean i.e., 984 and 2049 kg ha^{-1}, respectively. Co-inoculation also enhanced nodule number and mass (45 and 0.080 g $plant^{-1}$) as compared to the rest of inoculation levels and control at 25 kg N ha^{-1}. Similarly, co-inoculation also enhanced the grain and plant N&P content in comparison to remaining treatments. Moreover, soil analysis at harvest also showed higher soil N and available P i.e., 0.053% and 10.15 mg kg^{-1}, respectively at higher N level. This field study suggested that interactive effect of symbiont and rhizobacteria could be used after thorough screening and valuable approach as compared to their individual application. However, there should be comprehensive strategy to use free living microbes in combination with their symbionts to promote quality foods and efficient nitrogen utilization in agricultural systems and exploring the hidden potential of rhizobacteria in field studies to produce climate resilient crops.

Keywords: Co-inoculation, N Levels, *Rhizobium* sp, PGPR, resilient.

ECOFRIENDLY BIOMASS STOVE FOR RURAL AREAS: A SOLUTION FOR CLIMATE CHANGE AND NATURAL RESOURCE MANAGEMENT

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In developing countries like Pakistan, energy demand particularly for the domestic application is continuously increasing due to rapid increase in population. Mostly, this requirement is met by using the depleting resources, i.e., fossil fuels at high costs which also contribute to the greenhouse emission. However, in rural areas, the daily life energy requirement is accomplished by using the wood obtained from the local forests or common trees sheds. This is resulting in massive deforestation leading to the depletion of precious resource at earth putting additional pressure on the already stressed natural resources as well as the climate which is reducing the resilience for the agro-ecosystem. One primary drive to mitigate the green house emission is the use of the renewable biomass fuel. The most common and high energy consuming practice in rural areas is cooking which is conventionally executed by burning the raw biomass in a simple three stone stove. However, it has been observed that biomass fuel is difficult to burn completely in the traditional stove whereas the (nearly) complete combustion is needed to reduce the household air pollution. In this research study, a low-cost ecofriendly biomass cooking stove has been designed based on the reverse engineering practice of the existing stoves. Biomass (crop residue and leftovers) is used as fuel in this stove. This ecofriendly biomass stove has components, i.e., fuel inlet, combustion chamber, air inlet, cooking plate and exhaust gas outlet. The stove allows complete combustion of the fuel and reduce the amount of fuel as compared to the traditional cooking stove. Optimized operating conditions for the newly designed ecofriendly biomass stove has also been discussed in this study.

Keywords: Biomass, Resource conservation, Energy, Ecofriendly

GLOBAL SIGNIFICANCE OF MANGROVES BLUE CARBON IN MITIGATING CLIMATE CHANGE

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Mangrove forests store and separate a large amount of blue carbon. Normal solutions differ in method, scale and scope but mostly comprise the restoration, protection or enhanced management of normal and human-modified biomes such as marshes, croplands and forests. Mangroves isolate 4% of the CO_2 that is separated by groundwater ecosystems, indicating that mangroves are a minor partner in global CO_2 storage and seizure. Overall, natural environment solutions have the prospective to provide significant climate change mitigation benefits while delivering co-benefits such as ensuring water, clean air, and food security, protecting livelihoods and preserving biodiversity. The mangrove ecosystem role in mitigating climate change is small globally but is more important in the tropical coast and is effective nationally and regionally, especially in areas with high deforestation and deforestation rates. A review of literature accumulating carbon capture rates in key ecologies confirms that blue carbon ecosystems are the furthermost efficient natural carbon sinks at the plot scale, although approximately overlooked biogeochemical processes may lead to overestimation. While forests have historically been the primary focus of such efforts, coastal wetlands—especially seagrass, tidal marshes, and mangroves—are now recognized as important and efficient long-term carbon sinks.The present review discusses and summarizes about the role of mangroves in the context of carbon sequestration as well as climate change mitigation.

Keywords: Blue Carbon, Carbon Sequestration, CO_2 Emission, Climate Change, Mitigation

EFFECT OF BACTERIAL INOCULATION ON THE GROWTH PATTERN OF SPINACH UNDER LEAD CONTAMINATED SOIL

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To feed the ever-increasing population of the world, the production of vegetables is of prime importance. Among vegetables, spinach is widely consumed and it has a number of beneficial effects on human health. Almost all vegetables in the periphery of the main cities are irrigated with wastewater that results in the entering of heavy metals in the agricultural lands, ultimately entering the food chain. The accumulation of heavy metals in plants causes a variety of metabolic, physiological, and systemic disturbances, which inhibit plant development and ultimately cause the death of plants. For the healthy and safe production of vegetables, heavy metal entry must be restricted. Among different heavy metals lead (Pb) is a major heavy metal that particularly affects plant growth. Soil microbial populations and plants are negatively affected by high Pb concentrations. Heavy metals such as Pb, when present in high concentrations, can cause a variety of toxic symptoms in plants, including growth retardation, negative effects on photosynthesis, blackening of roots, and a variety of other symptoms. Several techniques are used to reclaim the Pb contaminated soil. The biological remediation of Pb through the use of rhizobacteria and plants was the primary focus of this study. Pb tolerant plant growth promoting bacteria are environmentally acceptable alternative for metal-contaminated soil reclamation and heavy metal stress mitigation, to form the agriculture sustainable. A pot experiment was conducted in wire-house by using spinach as a fast growing crop. Battery waste was used as a source of Pb. The experimental plan had 8 treatments and three replications. Different physiological parameters (SPAD value, chl 'a', 'b' and carotenoid contents) were measured in standing crop, data regarding growth, yield, and nutrients such as nitrogen, phosphorus, potassium uptake, and Pb concentration in different plant parts were measured at harvest. PGPR improved the plant growth parameters significantly when compared with control. Plant height was increased, significantly, by the combined application of PGPR and Pb battery waste @ 0.2%. Based on results, PGPR can be best used for bioremediation and growth increase of spinach under lead contaminated soil.

Keywords: PGPR, heavy metals, lead contaminated soil, bioremediation, Spinach, plant growth

CAUSES AND MITIGATION OF CLIMATE CHANGE

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Climate change is a biggest problem of many countries now a days. Developed, under developed and developing countries facing the problem of climate change. Greenhouse gas emission is main cause of global warming and climate change. Pakistan contribution in total greenhouse gas emission is very low i.e. < 1% which is among the lowest in the world. Greenhouse gas mostly composed of CO_2, other gases are CH_4 & NO. CO_2 is mostly created by burning fuels like oil, diesel, petrol, ethanol, organic petrol, organic diesel and Natural gas. CH_4 mostly emitted from burning of natural gas and also from Livestock and poultry manure. During last 50 years the emission of carbon dioxide increased dramatically and is still going on increasing by 3% each year. If we talk about the causes than different sectors are contributing which includes Transport, Agriculture, Population, industrialization and urbanization. Transportation is involved in the emission of gases by burning fuels, some agricultural practices like use of fertilizers and irrigation systems are also involved in the emission of gases. Due to increased population and urbanization the emission of gases from different sources is also enhanced. So, it is the need of time to control the emission of these gases. Climate change mitigation refers to efforts to decrease emission of greenhouse gases. Mitigation means using new technologies and renewable energies. It can be as complex as a plan for a new city, or as simple as improvements to a cook stove design. To control emission of greenhouse gases transportation strategies should be re planned and use these fertilizers in the agriculture which emit less amount of NO and proper management of poultry and Livestock manure by feed them with such feed which emit less amount of Methane in manure.

Key words: Climate change, Greenhouse gases, Global warming, Mitigation

CLIMATE CHANGE AND AN INCREASED RISK OF TICKS AND TICK-BORNE DISEASES

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Long-term climate change and other environmental changes have led to the expansion of a wide range of ticks and tick-borne diseases (TBDs). As ticks transmit a wide range of protozoan, bacterial, and viral diseases in many temperate, tropical and sub-tropical regions of the world like Asia, Africa, Europe, Canada, and America. With the temperature rise, the fecundity of ticks also increases, and so does the TBDs prevalence around the globe. Along with Lyme disease, new TBDs like Anaplasmosis, Babesiosis, Powassan virus, and Borrelia miyamotoi, have also emerged with an increasing ratio in different regions of the world. Increased temperature favors the survivability, prevalence, range, and activity of ticks, and increases the range of tick hosts and reservoirs (mice, deer, and other ruminants). It also increases the duration and behavior of the human population affected by the ticks. An increase in temperature and humidity has improved the survival conditions for ticks' reproduction and development and an accelerated lifecycle of ticks that contributes to ticks' abundance where tick population already occurs, the spread of ticks to higher latitudes, and increased tick activity and questing behavior. As the graph of climate change and prevalence of ticks and tick-borne pathogens is at its peak provokes the various disease control organizations (CDC, WHO) for the control of ticks and TBDs. These public health policies to mitigate the impact of TBDs on public and animal health include early detection and surveillance of emerging TBDs and public health actions to prevent infections by the modification of environmental and social risk factors through public awareness. Clinical care approaches include early detection, laboratory testing and investigation, treatment, and the education of the patient for future control.

Keywords: Climate change, ticks, TBDs, mitigation strategies

CLIMATE CHANGE AND SUSTAINABILITY OF FOOD ANIMALS

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Climate variability influences the course of food safety hazards at different stages of the food supply, from primary production to consumption. Sustainability in livestock production system is mostly affected by climate change. Climate change affects various factors associated with production, reproduction, health, and adaptability of the animals. Dairy sector is more susceptible to climate change. The temperature humidity index (THI) is the widely used as index for the measurement of thermal stress in animals. Environmental stress has adverse effects on health status of dairy animals and decreases the milk production and reproductive performance of dairy cows resulting in huge economic losses. Global climate change is expected to alter temperature, humidity, rainfall, atmospheric carbon dioxide. The dairy sector is more vulnerable to climate change and global warming where it is mostly affected by the temperature and humidity such as temperature humidity index (THI). Combined effect of high ambient temperature and high humidity results adverse effect on reproductive performance of farm animals. The management strategies viz., microclimatic modification, nutritional management, feeding strategies and artificial insemination protocols are to be strictly followed to ameliorate the adverse effects of heat stress in dairy animals. This will be helpful to gain a better insight into the current food safety situation, as well as to create and implement adaptation measures to address rising climate change threats to food animals.

Keywords: Artificial Insemination, Microclimate, Food, Temperature humidity Index, Food safety

CLIMATE IMPACT ON VECTOR AND VECTOR-BORNE DISEASES (VBDS)

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Currently, forecasting the future in the presence of changing climatic conditions is one of the biggest challenges on this globe. Climate change is any short or long-term momentous change in parameters of climate such as temperature, precipitation, wind, rainfall along with weather intensity. These changes are indicated by an increase in temperature above ground and sea level, humidity, and ocean heat content. All these affect animals and human health in many ways such as malnutrition, diarrheal diseases, and diseases outbreaks especially due to increases in vectors of different pathogens (parasites) such as rodents, ticks, mosquitoes, bugs, flies, mites, and other different parasites, that flourish in changing ecology. Climate change affects the temperature of latitudes and boundaries, biology, physiology, life cycle, and genetic composition of vectors they flourish more to cause more outbreaks related to animals and public health importance such as the brain-eating amoeba outbreak occur in Karachi in 2017, an epidemic of Crimean Congo hemorrhagic fever (CCHF) reported in Punjab and Dengue outbreak occur in Pakistan with 16,500 cases and in November 2016, chikungunya virus outbreak leads to 400 confirmed cases. Globally parasitic diseases such as amebiasis, giardiasis, is, cyclosporiasis, chagas diseases, and taeniasis kill 900,000 people (about half the population of Idaho) annually. Climate change leads to the emergence and re-emergence of these parasitic outbreaks. Changes in climatic conditions such as deforestation, increase in industrialization, and increased travel of peoples, animals, and goods cause an increase in vector prevalence in that area so in turn increase in vector-borne diseases.

Keywords: Ecology, Interventions, Adaptations, Malnutrition, Emergence, Flourish, Industrialization, Life cycle, Humidity, Outbreaks, Vector, Chagas disease, Pathogens

EFFICIENCY OF INDIGENOUSLY ISOLATED BACTERIAL STRAINS TO REMOVE LEAD AND CADMIUM FROM INDUSTRIAL EFFLUENTS

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Heavy metal toxicity is a global problem for the mankind and has major threat to human health and the environment. Among these heavy metals lead and cadmium are considered as widespread environmental contaminants. The aim of this study was to isolate bacterial strains which can remove or reduce the heavy metal toxicity from the contaminated water bodies. The bacteria were isolated from the heavy metal contaminated sites and were characterized morphologically and biochemically. The bacterial isolates were characterized positive for the bioremediation from different biochemical tests. B1CD showed positive result for catalase, oxidase and carbohydrate and negative for oxidase and citrate test. B2Cd showed positive for catalase and citrate but negative for oxidase and carbohydrate. B1Pb and B2Pb showed positive for all the tests instead of citrate. The growth curve was variable for all the bacteria and showed resistant with the metals. The B1Cd and B2Cd showed maximum removal efficiency 97% and 90% against 2 ppm Cd and 5 ppm Cd respectively. B1Pb and B2Pb showed maximum removal efficiency of 98% and 94% at 10 and 50 ppm lead concentration. The B1Cd showed about least removal efficiency (28.3%) at 5 ppm cadmium These bacterial strains possess excellent potential and capability to biodegrade the heavy metal and to utilize this research in future for the waste and pollution treatment with reference to Pakistan. In addition, there is an ongoing work on phytoremediation, where various indigenous plant species have been collected to calibrate their bioremediation efficiency.

Keywords: Biodegradation lead, Cadmium, Industrial effluents

EVALUATION OF CHICKPEA (*CICER ARIETINUM* L.) ROOT ARCHITECTURE SYSTEM UNDER DROUGHT AND SALINITY STRESS

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Root architectural traits have potential role under abiotic stresses, however genetic variability need to be explored in chickpea to determine the contribution of root system architecture (RSA) under salt and drought stress. A hydroponic experiment was conducted to explore the RSA of twenty chickpea genotypes grown under salt and drought stress. This experiment was conducted to examine the root architectural traits of chickpea under control, drought and salinity conditions. One treatment (T1) 60mMNaCl was used along with control. PEG-8000 0f (-0.9 bars) was used to create the level of drought stress. This experiment was replicated 3 times. Under salinity higher level of hydrogen peroxidase was observed in root of V19 (11030). In the biochemical parameters, higher activity of catalase (CAT), ascorbate peroxidase (APx) and monodehydroascorbate (MDA) was observed in roots in salinity and drought stress. Two weeks old seedlings grown in hydroponics were treated with above-mentioned stresses and harvested after 3 weeks. Genotype C-44 and Bhakkar-11 are salinity resistant as they showed higher plant biomass, weak RSA and higher activity of APX enzyme. Thall 2006, PB-2008, 13036 and 13012 showed higher plant biomass but reduced RSA and higher activity of enzymes. So we concluded that these genotypes are drought resistant as they use enzyme activity as defense system and showed higher plant biomass. However, 15024, paidar-91 showed low plant biomass in salinity. Paida-91 and PB-2000 showed lower plant biomass in drought.

Keywords: Chickpea, Root architecture, Drought and salinity stress

ASSESSING SALT RESISTANCE OF SUGAR BEET CULTIVAR BASED ON GROWTH ATTRIBUTES AND METABOLIC CHANGES AT SEEDLING STAGE

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Salt stress is a major problem at global level and it is very important to utilize salt-affected soils using appropriate techniques. Growing of halophytes on saline-sodic soil is a win-win strategy getting economic crop production and conserving soil resources. An experiment was conducted to screen out the salt-resistance sugar beet cultivar at seedling based on growth, physiological and biochemical parameters under different levels of salt stress. A hydroponic experiment was conducted using eight sugar beet cultivars and two salt stress levels (60 and 120 mM NaCl) along with a control. The plants were harvested ten days after giving salt stress. Cluster dendrogram and principal component analysis were the most appropriate methods for screening the suitable cultivar. Most of the sugar beet cultivars responded resistance against salt stress, however, VEDA cultivar performed better against salt stress. Thus, VEDA cultivar acquired highest position at 60 mM NaCl showing the highest growth attributes, antioxidant activity with higher K^+/Na^+ ratio, hydrogen peroxide, phenolic and melandialdehyde content, indicating strong defense mechanism against salt induced oxidative and osmotic stress mainly owing to the best K^+ and Na^+ balance. Therefore, VEDA cultivar is considered as the best salt-resistant cultivar with great potential to be grown on salt-affected soils and further characterizing of this cultivar can lead to develop further salt-resistant cultivars as well.

Keywords: salt resistance, sugar beet, growth attributes metabolic changes

THERMO-CHEMICAL PYROLYSIS OF SAW DUST TO PRODUCE GASEOUS FUEL USING FLUIDIZED BED GASIFICATION TECHNIQUE TO COMBAT CLIMATE CHANGE AND GLOBAL WARMING

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Energy production and environmental protection both are considered as the major challenges in today's world. Short-term power outages increase rapidly due to quick depletion of fossil fuels. This also leads to a sharp increase in fuel prices that threatens industrial growth, especially in developing countries. On the other hand, the use of fossil fuels to produce energy causes environmental degradation creating severe changes in the local climate. The burning of fossil fuels releases harmful gases into the atmosphere causing environment and global warming issues. There is a need to introduce alternatives energy production with little impact in a sustainable environment economic growth. Energy production from biomass and agricultural residues are one of the Waste-to-Energy methods in which agricultural residues are processed to extract energetic content for a useful purpose. There are several ways to extract energy from biomass, however the use of either method depends on the available biomass and the type of energy required. Biomas gasification is one of such approaches for those agricultural wastes which are generated in fine powdered material. For example, saw dust is produced at a very high quantity as a by product at the wood and furniture processing units. Such materials being already in particulate in nature can be thermochemically treated to produce gaseous under controlled operating conditions. However, the optimization of the operating parameters and the reactor design is very important in this regard. Under this concept, the current research has been conducted to produce gaseous fuel from saw dust with the help of a pilot scale fluidized bed gasification (FBG) reactor. The study come up with the optimized operating conditions for the production of gaseous fuel under variable raw material feedstock.

Keywords: Biomass, Sawdust, Energy, Gasification, Climate Change, Global Warming

ALLEVIATION OF HARMFUL EFFECTS OF SALINITY ON THE GROWTH AND YIELD OF OKRA THROUGH SILICON AND POTASSIUM APPLICATION

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Salinity is the primary issue that Pakistan is facing these days. It inhibits plant growth and decreases the crop yield. Potassium (K) is a vital macronutrient that plays a major role in plants, including osmotic balance, opening and closure of stomata, enzyme activation and nutrition balance. Salinity has an influence on plant K availability, which can be enhanced with K^+ foliar treatment. Foliar application of K can help lessen the harmful effects of extreme salt stress. Many studies have provided useful insights into the functions of Silicon (Si) and its dissolution mechanisms. Plants are protected by Si against a variety of abiotic stresses. Silicon has been identified as a useful fundamental nourishing component for many crops and has already been appeared to moderate abiotic stresses in numerous plant species. The aim of this research is to reveal the interactive effects of Si and K on the growth and yield of okra under saline conditions. A pot experiment was conducted in the wire house of the Institute of Soil and Environmental Sciences (ISES), University of Agriculture Faisalabad (UAF). Okra variety sabz pari was examined under normal conditions as well as under salt stress (EC 8 dS m^{-1}). The Si was applied at two different levels (100 and 300 mg kg^{-1}) and 2% K^+ foliar was applied at the vegetative stage of okra. Completely Randomized Design (CRD) with factorial arrangements and three replications was used. The growth, yield, Physiological and ionic parameters were recorded by standard methods. The results showed that salinity negatively affected the growth and yield of okra while Si and K application alleviated the harmful effects of salinity and improved okra growth and yield in normal as well as saline conditions.

Keywords: Salinity, Silicon, Potassium, Foliar Spray, Okra

IMPACT OF SOIL AND FOLIAR APPLICATION OF Zn FOR IMPROVING THE GROWTH AND YIELD OF MAIZE UNDER SALINE CONDITION

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Salinity and water deficit are major abiotic stresses restricting the crop production globally owing to their harmful impacts on plant growth, physiological processes and yield. In Pakistan, sustainable agriculture is persistently at risk due to several factors including soil salinity. However, salinity is most imperative amongst all, in causing soil degradation. Maize (*Zea mays* L.) is an important staple cereal that comes among top three cereals in country; cultivated in two seasons for food and forage purposes. In addition to human consumption, maize is also utilized to feed animals. Soil salinity is amongst the stern extortions to viable maize production, as maize is a sensitive glycophytic plant. Under saline stress uptake of Zinc (Zn) is also decreases. The Zn is necessary ingredient for plants' natural and healthy growth and development. Zn utilized by plant in a variety of an essential procedures, like membrane structure and function, protein synthesis, oxidative stress tolerance, and gene expression. To investigate the interactive influence of soil and foliar application of Zn on maize growth and yield under saline conditions, a pot experiment with eight treatments was conducted in the green house of ISES, UAF. The Zn was applied at two levels (50 and 100 mg kg^{-1}) in soil and foliar spray (1% Zn solution) along with control, under Completely Randomized Design (CRD) with factorial arrangements and three replications of each treatment. The results of this study showed that salt stress caused significant reduction in chlorophyll contents, relative water contents, membrane stability index, plant height, shoot fresh and dry weight and grain yield. However, the application of Zn proved effective in improving maize growth and yield under salt stress condition. It was observed that combined application of Zn in soil at 100 mg kg^{-1} along with 1% foliar Zn spray was more effective in mitigating the harmful effects of salinity and for improving the growth and yield of maize grown under saline conditions.

Keywords: Zn application methods, Maiz, Saline soils

COMPARATIVE EFFECTIVENESS OF IRRIGATION METHODS IN ENHANCING WATER AND NUTRIENT USE EFFICIENCY, AND WHEAT YIELD UNDER CLIMATE CHANGE SCENARIO

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Climate change is one of the serious challenges of sustainable crop production especially in semi-arid and arid regions of the world. Owing to climate change, these regions will be facing limited availability of fresh waters to support livelihood. Further, conventional methods of irrigation like flooding will not only aggravate the problems of water and nutrient use efficiency. Nitrate leaching to lower soil depths is a serious problem that decreases NUE and may cause ground water pollution. In this context, a field trial was planned to compare the efficiency of three different water application methods viz., conventional method (flooding), according to soil requirement (field capacity [FC]), according to plant needs (reference evapotranspiration [ET_0]). The experiment was laid out in Randomized Complete Block design with four replications. Results showed that irrigation methods significantly influenced all of growth and yield parameters of wheat. A significant increase in plant height, spike length and no. of spikelets per spike with flood irrigation, however, grain yield and harvest index were significantly decreased with flood irrigation. Applying irrigation water based on ET_0 caused a significant increase in 1000-grain weight. More drainage was recorded in flood irrigation as compared to FC and ET_0. Maximum NO_3-N concentration was observed with flood irrigation at 0-30 cm depth while minimum NO_3-N concentration was observed with FC treatment at 0-90 cm depth. It is concluded that ET_o and FC based irrigation of wheat crop could improve crop yield, water and nutrient use efficiency and are need of the time in climate change scenario.

Keywords: Irrigation methods, Water and nutrient use efficiency, Wheat yield

THE CHANGES IN GROWTH ATTRIBUTES OF *ZEA MAYS* PLANT UNDER COBALT TOXICITY IN SOIL

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Plants require many nutrients for their normal growth. These elements are considered as essential nutrients. Some of these nutrients are needed in larger amount and many are used in traces. In these chemicals many metals in lower concentrations are considered beneficial for the growth of plants. But, their elevation in soil severely influences the growth of plants by damaging their biochemical parameters. Co is a beneficial element but its higher amount in the growing medium can also be toxic for the growth of plants. Therefore, to study the toxicity of Co on maize, different levels (0, 50, 100, 150, 200, 250, & 300 µM) of this metal were applied in the soil. The morphological (Shoot and root length, shoot and root fresh weight, number of roots and leaves, leaf area, stem diameter), and photosynthetic attributes (Chl. a., Chl. b, Car.) were severely influenced by increasing the concentration of Co. The maximum disruption in all noted characteristics was calculated at 300µM while 50µM concentration was less toxic as compared to other levels.

Keywords: Cobalt, Maize, Photosynthetic, Morphological, Biochemical parameters

EVALUATION OF ROOT TO SHOOT TRANSLOCATION OF Fe IN WHEAT (*TRITICUM AESTIVUM* L.) AS AFFECTED BY SOIL APPLICATION

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Roots are considered important hidden half of plants as root architecture plays a major role in nutrient mining and absorption. A CRD (completely randomized design) based pot experiment was carried out to determine the Fe uptake, its translocation and localization of Fe along with its concentration in grains. Twelve wheat varieties Dharabi-11, Punjab-11, Faisalabad-2008, BARS-2009, NARC-2009, Jauhar-2008, Pir Sabak-2013, Pakistan-2013, NARC-2011, Miraj-08, Lasani-08, Ujala-16 were selected for this experiment. $FeSO_4.7H_2O$ was used as Fe source and applied as soil application at the rate of 20 kg ha^{-1} at the time of 1st irrigation. Two treatment Fe sufficient conditions and Fe deficient conditions were applied in four replicates. Standard crop management practices were followed during whole experiment. The growth, yield, physiological and biochemical parameters were by following standard procedures. Biochemical analysis was carried out in environmental and biogeochemistry lab and Hitech lab of University of Agriculture Faisalabad. Translocation of Fe was determined in soil, root, shoot, husk and grain. The results were analyzed by R studio R×64 3.6.1. . Statistical analysis of data explored that leaf area index (11 (45.82 cm^2) and plant height (76.73 cm), spike length (17.0 cm), Number of spikelets (20) were significantly improved in Fe sufficient conditions as compared to Fe deficient conditions. Improved correlation in physiological parameters chlorophyll, photosynthetically active radiation (PAR), fluorescent transient (FT), electron transport rate (ETR) and effective quantum yield photosystem II (YII) was also observed. Comparative analysis of uptake of Fe and translocation of Fe in shoot, husk and grain disclosed that different varieties acquired different concentration of Fe from soil with homogeneous amount of Fe. Uptake of total Fe by roots influenced the concentration of Fe to be translocate to shoot, husk and grain. Moreover, application of Fe enhanced the availability of Fe in rhizosphere and improved the uptake of Fe. Varieties with efficient uptake of Fe by roots translocate higher concentration of Fe to shoot, husk and grain. Fe amount to be translocate towards farthest sink grain from roots was found correlated with amount of Fe exist in shoot, husk and grain. Visualization of Fe localization by staining represented those grains with higher concentration of Fe appeared darker in color as compared to the grains with lower concentration of Fe. Fe appeared in aleurone layer and embryo part of seed. The varieties recognized with potential of Fe biofortification can be used for further molecular studies to find out the genes responsible for it and can be used in conventional as well as molecular marker-based breeding programs.

Keywords: Fe Translocation, Wheat, Biofortification

BIODIVERSITY AND QUALITY ASSURANCE OF DIAZOTROPHIC BACTERIA FOR SUSTAINABLE AGRICULTURE

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Diazotrophic bacteria are capable of enzymatically reducing the atmospheric N into bio-available form of nitrogen. Plant growth promoting rhizobacteria (PGPR) that can inhabit the rhizosphere of plants and are accomplished of fixing nitrogen, solubilizing inorganic phosphorus, promoting plant growth, development and yield .The present study aims to develop biodiversity of symbiotic *(Brady) rhizobium* and PGPR isolated from rainfed arid regions of Punjab Pakistan and establish their quality for long term preservation and shelf life assurance through viable dilution technique. A total four bacterial isolations from root nodules and rhizosphere of plants were collected and purified. Colony and cellular morphology and different biochemical assays were determined for all the bacterial isolates.16S rDNA gene sequencing was carried out for the identification of bacterial isolates. Two (*Brady)* rhizobial and two PGPR isolates were found positive for nitrogen fixation. The solubilization of inorganic phosphorus was revealed by two isolates. Phytohormone, indole acetic acid producing ability was observed in four isolates. zinc mobilization were observed positive for all the isolates. Overall two (Brady) rhizobium and two PGPR isolates were selected on the basis of their multifunctional properties for a field experiment to evaluate their ability to improve yield of maize crop and to find their diversity under arid climate in Fateh Jhang area.

Keywords: Diazotrophtic bacteria, Biofertilizers, PGPR, N_2-fixation

BIOFORTIFICATION OF RICE (*ORYZA SATIVA* L.) WITH IRON AND ZINC THROUGH THEIR APPLICATION TO SOIL AND FOLIAGE

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Biofortification is considered an effective process to increase the micronutrients in food crops including rice. It is also a sustainable and feasible strategy to alleviate micronutrient deficiencies for people who mainly consumed rice and have limited access to diversified food. Globally, rice is the prime crop, and it is the major cereal crop after wheat. Rice is the second cultivated crop in Pakistan. A randomized complete block design-based field experiment was conducted at Rice Research Institute Kala Shah Kaku. Fifteen rice genotypes were evaluated in the field. Four treatments (T1: control, T2: with Zinc, T3: with zinc and iron foliar applied at heading and milking stage and T4: foliar and soil application of both zinc and iron was applied at the heading stage) with three replicates. Zinc sulfate was applied at the rate of 5_kg per acre at the heading stage in soil and foliar spray of iron and zinc sulfate was applied at the milking stage. The experiment showed that the exoge application of iron and zinc improved the concentration in rice grains. Foliar and soil application of Iron and Zinc on different rice genotypes enhanced physiological and yield attributes such as plant height (153.8 cm), Panicle length (25.4 cm to 32.7 cm) number of tillers per plant (15.4 to 17), number of grains per panicle (101 to 121), grain weight per panicle (1.5 g) and grain yield after treatments. Zinc concentration ranges from 5 mg/kg to 38 mg/kg where Basmati 2000 has the highest and RC18001 showed the lowest grain Zn. The minimum concentration of iron in rice grain was observed in PK 10967 (0.28 mg/kg) and the maximum was in Basmati 370 (60.76 mg/kg). Combine foliar application of iron sulfate and zinc sulfate significantly increase the iron and zinc content in the rice grain over the control. The foliar application also improved the amount of grain iron and zinc in contrast to soil application.

Keywords: Biofortification, Iron, Rice, Zinc

FRESHLY RECLAIMED SALT-AFFECTED SOILS IN AN ARID ZONE CAN EFFECTIVELY CONTRIBUTE TO CARBON SEQUESTRATION AND FOOD GRAIN PRODUCTION: EVIDENCE FROM PAKISTAN

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The reclamation of salt-affected soils and their use for crop production and carbon sequestration can help to mitigate climate change and reduce food insecurity. A field scale fallow period and crop production experiment was conducted for a wheat-maize rotation on salt-affected soils in Pakistan. The experiment was continued for 3 years to check the effectiveness of organic amendments for reclamation of salt-affected soils, carbon sequestration and food grain production. Soil and plant samples were collected for every cropping season for the treatments; the control (no amendments), gypsum and gypsum in combination with different organic amendments (poultry manure, green manure, and farmyard manure). The treatment with gypsum in combination with farmyard manure was most effective at increasing soil carbon (+169% over the three-year period of the trial). The maximum wheat yield was also recorded with gypsum in combination with farmyard manure (51%), while the effect of green manure combined with gypsum resulted in a significant increase in maize yield in year 3 (49%). Simulations over the long-term (100 years), using a modified version of the RothC model, suggested that all treatments had a significant impact on carbon sequestration, with soil C increasing after 100 years of trial from 0.53% in the control to 0.86% with gypsum alone (due to the increase in plant productivity), 1.25% with added poultry manure, 1.69% with green manure and 2.29% with farmyard manure. Additional impacts might be expected over the long term due to improved soil structure associated with reduced salinity and increased soil organic matter conferring greater resilience of crop production to dry conditions. Based on the results, it was concluded that food crops can be produced from freshly reclaimed salt-affected soils, and this can have added long-term benefits of carbon sequestration and climate change mitigation.

Keywords: Soil degradation, Soil properties, Food security, Food crops

DEVELOPMENT OF PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPRS) AS BIOFERTILIZERS AND THEIR PRESERVATION TECHNOLOGY

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Biofertilizers are natural fertilizers which are living microbial inoculants of bacteria and they augment the availability of nutrients to the plants. The role of Biofertilizers in agriculture assumes special significance, particularly in the present context of increasing cost of chemical fertilizer and their hazardous effects on soil health. PGPR has been proven to be an environmentally sound way of increasing crop yields by facilitating plant growth through either a direct or indirect mechanism. The present study aim to develop biofertilizers for various crops utilizing symbiotic and asymbiotic soil bacteria from different areas which can be used as a cross inoculants. Six bacterial isolates were isolated from the roots or rhizosphere of pea and potato plants .all the six bacterial isolates were PGPRs and were collected from tropical region of Punjab from Gadwal Area Wah cantt (33.8003° N, 72.7531° E).The PGPR isolates were purified, identified and Characterized for their colony and cell morphology. They are also biochemically characterized for their catalytic activity, starch hydrolysis and plant growth promoting traits, i.e., phosphorous solubilization, indole acetic acid production, nitrogen fixation and zinc mobilization activity. It was found that all the bacterial isolates were test positive for nitrogen fixation estimation so they are nitrogen fixers as indicated by color change. The bacterial isolates also show positive results for zinc solubillization by the formation of halo zone. Phosphorus solubilization also give positive result by all the bacterial isolates. Six (6) bacterial isolates were also tested for their starch hydrolyzing ability. Two bacterial isolates showed positive result for amylase production ability after 24 hours. Two isolates (POGA, POGC) showed minimum amylase production ability and the other two shows maximum amylase production ability. All of the Six (6) bacterial isolates were screened positive for phytohormone (Indole acetic acid) production. In order to study different bacterial isolates the storage and preservation of bacterial cultures is necessary so establish short term storage methodology of selected microbial cultures. Pot experiment on chilli plant has been conducted in the lab complex of university of Wah and field experiment has been organized in the arid region of sukkah talagang. Different bacterial isolates were chemically tested for this purpose to be used in the field experiment and the field experiment is in progress.

INFLUENCE OF IRRIGATION WATER MANAGEMENT ON ARSENIC ACCUMULATION BY RICE

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Geogenic arsenic (As) contamination has been reported globally over 115 countries especially in South and Southeast Asia countries including India, Bangladesh and Pakistan. Worldwide rice is being used as a staple food by more than three billion people for their energy requirement. Arsenic becomes mobile and bioavailable under paddy (reduced) soil conditions due to conversion of arsenate to arsenite. This study was conducted to evaluate As accumulation by rice under alternate wetting and drying cycles (varying irrigation) in a pot experiment. Seedbed was prepared for nursery and after 25 days nursery was transplanted in pots in the wire house. The alternate wetting and drying cycle were maintained as 30, 50, 70 and 100% (IW-30, IW-50, IW-70 and IW-100) irrigation water levels. Morphological parameters including number of tillers/plant was relatively higher in IW-100 and IW-50 compared other IW levels. Plant height, shoot and root height was also found higher in IW-50 (117 and 35cm) compared to other IW levels. Shoot and root dry biomass comparatively greater in IW-50 (8.8 and 4 g) compared to control and other IW levels, number of spikelet and dry weight of grains were also higher in IW-50 (4.81g) compared to control and other IW level (3.55, 3.50, 3.66 g). SPAD values were found maximum in IW-50 compared to other levels. Arsenic concentration in root, shoot result indicated that there was significant ($p < 0.05$) difference of As concentration was relatively higher in IW-100 (108, 40 mg kg^{-1} DW) compared to other and minimum As concentration was calculate in 50 % IW level (25, 10 mg kg^{-1}). Arsenic concentration in rice grains and husk was not detected. Hazard Quotients (HQ) were calculated, and significant ($p < 0.05$) difference was observed in grain with IW-100 (0.94 mg kg^{-1} day^{-1}) compared to IW-50 (0.15 mg kg^{-1} day^{-1}). However, cancer risk assessment (ILTCR) in grains were also found higher in IW-100 (0.15) and in IW-50 was below the detection limit. Result showed that alternate wetting and drying could be efficient and cost-effective approach to minimize As translocation and bioaccumulation. Arsenic accumulation was minimum at IW-50 but IW-50 enhanced grain production compared to IW-100.

Keywords: Arsenic, Rice, Contamination, Human Health Risk, Wetting and drying cycles

PLANT COMMUNITY AND THEIR RHIZOSPHERIC BACTERIA FOR PHYTOREMEDIATION OF CONTAMINATED RIVER WATER

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Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater. Rhizosphere biodegradation is a process in which the plant releases natural substances through its roots, supplying nutrients to microorganisms in the soil. The microorganisms enhance biological degradation. PGPR has been proven to be an environmentally sound way of increasing crop yields by facilitating plant growth through either a direct or indirect mechanism. The present study aims to purify contaminated water channel using indigenous plant community and their associated PGPR. Plant samples were collected from bank of water channel of (sub-tropical region) village Karima, Attock of Pakistan(33°39'04.2"N 72°42'14.6"E). Plant species including *Xanthium orientale, Adiantum aethiopicum, Plantago lanceolata* and *Cannabis sativa* were sampled. The PGPR isolates were purified, identified and Characterized for their colony and cell morphology. They are also biochemically characterized for their catalytic activity and plant growth promoting traits, i.e., indole acetic acid production, phosphorous solubilization and nitrogen fixation. In order to study different bacterial isolates, the storage and preservation of bacterial cultures is necessary so establish short term storage methodology of selected microbial cultures. Different bacterial isolates were used in the field experiment and the field experiment is in progress.

Keywords: Phytoremediation, Contaminated soils, Rhizospheric microbes

CHARACTERIZATION OF HALOPHYTES TO REMEDIATE THE SALT AFFECTED SOIL

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Soil salinity is becoming a major constraint to agricultural production. Therefore, the plant especially the crops possessing capacities of salt tolerance will be of great economic significance. The adaptation or tolerance of plants to salinity stress involves a series of physiological, metabolic and molecular mechanisms. Halophytes have demonstrated their capability to thrive under extremely saline conditions and thus considered as one of the best germplasms for saline agriculture. To fulfill the globally increasing demand for food for humans and livestock, the selection of salt-tolerant genotypes to get production from salt affected soils is imperative. In the present experiment, four halophyte species were evaluated against four salt levels (Control, 10 dSm^{-1}, 20 dSm^{-1}, and 30dSm^{-1} NaCl) using different agronomic, physiological and quality indices. Significant variations regarding growth were observed in all halophyte species. Results depict that *Boerhavia diffusa* exhibited higher salt tolerance by conferring higher plant biomass, chlorophyll, and water contents, membrane stability along with K^+/Na^+ ratio while *Chenopodium album* depicts lower plant growth and inferior K^+/Na^+ ratio among all species. Our results can be a potential source for plant breeders and crop physiologists due to their genetic variability and responsiveness to salinity and provide a good starting material for the breeding of salt tolerant species with high nutritional value that are able to grow and make possible the utilization of saline lands.

Keywords: Phytoremediation, Halophytes, Salt affected Soil.

ROLE OF BIOFERTILIZERS FOR ALLEVATION THE IMPACT OF CLIMATE CHANGE

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In the face of global warming, agricultural production systems must become more resilient to long-term changes in temperature and precipitation, as well as to disruptive events. By the year 2100, under different scenarios, climate change is predicted to have an impact on the market (as a percent of GDP) for the entire world. Agriculture, as a climate sensitive sector, plays an important role in the economies of poor countries, where the impact is larger and the relationship between crop responses and temperature follows an inverted U-shape relationship. The resilience of agricultural production systems to climate change requires higher efficiency in the use of natural resources and inputs of agricultural production. Biofertilizers/bioinoculants have emerged as potential environment-friendly inputs that are benefited for agricultural crop production system. They hold vast prospective in fulfilling the plant nutrient requirements, which are reducing the chemical fertilizer application and minimizing environmental pollution. Bioinoculants can facilitate plant growth indirectly by reducing plant pathogens or directly by influencing phytohormone production (e.g. auxin, gibberallin or cytokinin), by facilitating the uptake of nutrients from the environment, and/or by lowering the levels of plant ethylene, nitrogen fixation, mineral phosphate solubilization (MPS), sequestration of iron by secretion of siderophores by release of volatiles. Microbial inoculants could play an important role in stress management in the edaphic stress prone areas. Thus adaptability of microbial inoculants over wide range of pH, temperature and salt concentration is crucial for their application under different agro climatic conditions. Peat is the most successively used carrier because of high surface area and high water holding capacity. The bio inoculants are used as a seed treatment or soil treatment, improving plant nutrient availability and finally crop growth and yield even under stressful environment. The adequate use of biofertilizers help in maintaining soil quality and thus provides a low-cost approach to manage crop yield along with protecting the environment.

Key words: Agriculture, Biofertilizer, Bioinoculants, Climate change

SYNTHESIS IN COMBINATION WITH BIOLOGICAL AND COMPUTATIONAL EVALUATIONS OF SELENIUM-N-HETEROCYCLIC CARBENE COMPOUNDS

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Bis-imidazolium salts and their Se-NHC adducts were designed, synthesized, and characterized by various spectroscopic techniques. Density Functional Theory (DFT) was applied on designed molecules through the basis set of hybrid functional B3LYP/6-31 G level of theory. To estimate the structural properties of tested compounds and their influence on biological applications, the HOMO and LUMO energy levels and their energy gaps were calculated. Theoretical studies were used to elaborate on the optical properties of salts and respective selenium adducts. The synthesized salts and N-Heterocyclic carbenes adducts of selenium (Se-NHCs) were tested in vitro against the Breast Adenocarcinoma cell line (MCF-7) by cell viability measurements. It was found that the N-alkylated substitutions on imidazolium salts have more significant free radical scavenging property whereas the reverse case was observed in the selenium compounds. All the compounds except M1 were not showing prominent cytotoxicity against cancerous cell lines.

Keywords: N-Heterocyclic carbenes, Selenones, DFT, Bis-imidazolium salt, Se-NHC, Biological activity

DFT STUDIES OF OCTYL BRIDGED TERMINAL ALIPHATIC ALKYL SUBSTITUTED SELENIUM *N*-HETEROCYCLIC CARBENE COMPOUNDS

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N-heterocyclic carbene (NHCs) have made significant progress in recent decades, and they complement other organocatalysis by enabling the development of up till now unattainable activation mechanisms. Se-NHC have various application in many fields of medicine such as anti-cancer, anti-bacterial antitubercular, and anti-convulsing agent Gaussian 09 software and the Gauss View 5.0 application were used to apply the density functional technique. B3LYP analysis of compounds was carried out utilizing the 6-31G (d) level of DFT for the analysis of compounds. Various characterizations are carried out by Gaussian 09 software such as NMR, IR, Dipole moment and structural optimization of complexes

Keywords: N-heterocyclic carbine, Gaussian 09, Se-NHC

IMPROVING N-UPTAKE IN WHEAT USING BIO-NANO-FERTILIZER

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Nitrogen is the most significant yield-limiting nutrient but is also the most deficient nutrient in almost all agricultural soil. External nitrogen application is the most prevalent strategy to fulfill plant nitrogen demand, but most of the applied nitrogen is wasted either in the air or the soil/ water system, making all agriculture non-efficient and ecologically unhealthy. Nanotechnology since its inception has provided solutions to lot of agricultural problems. In this study, urea was encapsulated and applied on plants in pots in split doses and also on different varieties of wheat and measured the physiological parameters. The study concludes encapsulated urea is a good and beneficial source of nitrogen for plant growth and development. And we can use this nano fertilizer with PGPRs in the future for better growth of plants because bacteria help plants to uptake nitrogen and make nitrogen available for plants.

Keywords: N-Uptake, Wheat, Bio-Nano-Fertilizer

PHYTOCHEMICAL SCREENING AND TOXICITY ASSESMENTOF WHOLE PLANT EXTRACT OF *EUPHORBIA MILII* AND *CHENOPODIUM ALBUM*

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The importance of medicinal plant in drug development is known to us and humans have used them for different diseases from the beginning of human history. Traditional folk treatment from wild plants has always guided researchers to search for novel medications to develop healthy life for humans and animals. In addition, some medicinal plants are still obscured within the plant which need to be scientifically evaluated. *Euphorbia milii* is the subgenus of Euphorbia commonly known as crown of thorns. It is originally from Madagascar but cultivated all over the world due to having medicinal and ornamental importance. Bathua is the common name of *Chenopodium album*. It is fast growing, annual and weedy plant. It is an excellent source of purposeful nutrients and has curative characteristics. The phytochemical analysis of both plants confirmed the presence of alkaloids, flavonoids, saponins, tannins, coumarins and phenols. Dry matter percentage in the dried sample of whole plant extract of *E. milii* was 93.41%, moisture 6.2%, crude protein 6%, crude fat 2%, crude fiber 8.3% and total ash 7%. Dry matter percentage in the dried sample of whole plant extract of *C. album* was 87.4%, moisture 0.6%, crude protin 3%, crude fat also 3%, crude fiber 2.5% and total ash 1%. Both plants have cytotoxic effect. LC50 value for *C. album* was greater than *E. milii*. 44% root length inhibition of radish was recorded by *E. milii* and *C. album* extracts. Seed germination decreased by increasing concentration of plant extracts. Germination index of radish seeds decreased upto17% and 39% by *C. album* and *E. milii* extracts respectively. Overall, toxicity analysis revealed that *E. milii* is more toxic than *C. album*.

Keywords: Phytochemical Screening, Toxicity Assesmen, *Euphorbia Milii, Chenopodium Album*

DEVELOPMENT OF SALINE SOIL SPECIFIC BIOFERTILIZER

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Salinity is one of the major stress factors affecting agricultural production throughout the world. One of the upcoming management strategies is the use of microbial inoculants containing beneficial microbes, capable of improving plant growth, quality, and fertility of the soil. This green agriculture approach was adopted in the reported study to combat the detrimental effects of salinity and to reduce hazardous agrochemicals. This research was planned to investigate the role of salt-tolerant PGPR-based bioformulations as an eco-friendly, low-cost biofertilizer that can improve plant growth under salt stress. The promising strains with PGP traits were used for the bio priming of wheat seeds (PUNJAB-11 and FSD-08), to see the impact germination under controlled conditions in growth room and the growth parameters in hydroponic system under different salinity levels. It was observed that germination rate and seedling growth parameters of wheat were recorded better in bio-primed seeds as compared to control. Experiments were also conducted for the selection of suitable carrier material and sugar mill waste press mud was selected for the survival of inoculated strains among press mud, cow dung, cow compost, and plant compost. The impact of the bioformulation application on the growth and yield of wheat was estimated by conducting pot and field experiments under normal and salt stress conditions and data showed that inoculated plants showed better root and shoot growth, plant weight, and yield as compared to control. All the data recorded during the research suggests the use of halotolerant bacteria to improve salt stress tolerance in wheat under saline conditions.

Key Words: Salinity, Wheat, Bioformulations, Hydroponic, Halotolerant PGPR

SOIL FERTILITY AND WHEAT PRODUCTIVITY AS AFFECTED BY ORGANIC AND INORGANIC FERTILIZERS

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The maintenance of soil fertility and crop productivity to meet the global food requirement with a sustainable approach is an important approach. For this purpose, a field-based study was steered by using different types of organic and inorganic sources of fertilizers to explore its effect on soil fertility and wheat productivity**.** Different sources of organic fertilizers like farm yard manure and poultry manure plus inorganic sources like NPK were also used, The source used for nitrogen was urea while for phosphorous and potassium was SSP and SOP, respectively. Throughout the growing season of wheat crop, all other agronomic practices were followed. The results indicated that integrated use of inorganic with organic source of fertilizers significantly escalated the yield and yield components of wheat and also improved nutrient status of the soil. Plant height of 96 cm, biological yield of 9981 kg ha^{-1}, thousand grain yield of 51.64 g and grain yield (4251 kg ha^{-1}) were recorded when 20t FYM+NPK was applied. Soil pH and Electrical conductivity were also significantly improved**.** **S**oil organic matter (%) was 1.69 % by applying 20t FYM+NPK. Soil Total N was recorded with 0.144%, extractable P was (9.95 mg kg^{-1}) recorded and extractable K content (0.144 mg kg^{-1}), was recorded in the plots when 20t FYM+NPK was applied. The results concluded that the application of organic fertilizers along with inorganic fertilizers can play vital role for nutrient turnover and long-term productivity of the soil.

ASSESSMENT OF SOIL CONTAMINATION AND ORGANIC CARBON DYNAMICS UNDER VARIOUS LAND USES ALONG CHINA PAKISTAN ECONOMIC CORRIDOR (CPEC) WESTERN ROUTE

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This study was carried out to assess the contamination status of soil and Organic Carbon dynamics under different land uses in selected areas of the western route of China Pakistan Economic Corridor (CPEC). Key objectives of this study were to measure soil changes in physical parameters, changes in Organic Carbon (OC) content of soil and assessment of soil contamination due to construction activities along the CPEC western route. The nature of the study demanded intensive sampling and so the study area was divided into ten different zones based on soil texture and other properties. A total of 120 soil cores from three depth i.e.0-20, 20-40 and 40-60 were collected via random sampling using standard soil sampling procedures from 20 locations of the study area. Each location was further classified as Controlled and Exposed. Soil samples were analyzed for various physical and chemical characteristics including; Texture (sand, silt, clay content), porosity, bulk density, Particle Density, pH, Organic matter, % OC content, phosphorous, potassium, Sulphur and heavy metals availability. Variations in average pH and EC values were small and inconsistent except some locations. Exposed soil samples of 0-20 cm, 20-40 cm and 40-60 cm depths exhibited pH values of 8.07 ±0.45, 8.05 ±0.34 and 8.05 ±0.40 respectively while Controlled samples showed pH values of 7.75 ±0.46, 7.82 ±0.47, 7.92 ±0.30 for the same depths. Electric Conductivity of the exposed samples was 315 ±0.62, 286.38 ±0.67 and 351.75 ±0.71 in relation to the controlled values of 271 ±0.58, 295 ±0.74 and 312 ±0.79 for the predefined depths of the selected locations. Total organic matter of the exposed samples was 5.05% ±1.83, 5.43 ±1.99 and 4.16 ±1.04 in relation to the controlled values of 4.41 ±1.09, 4.09 ±1.09 and 5.75 ±1.51 for three depths respectively. However, among controlled locations maximum OM were recorded for Batal, Burhan, Haripur, PanjBorrh followed by Nowshera, Ichriyan, Toran while among exposed sites Ichriyan, Kotlein Payein, PanjBorrh and Shennai Bala showed maximum values. Bulk Density of the exposed samples was 1.07 ±0.18, 1.01 ±0.11 and 1.05 ±0.13 while that of controlled samples the recorded values were 1.01 ±0.11, 1.02 ±0.12 and 1.03 ±0.11 respectively. Particle density the of the exposed locations was 1.24 ±0.24, 1.46 ±0.22 and 1.44 ±0.22 as compared to 1.41 ±0.27, 1.33 ±0.30 and 1.39 ±0.13 for controlled samples. Average values for porosity of exposed samples were 24.42 ±12.02, 29.81 ±15.38 and 25.75 ±13.73 as compared to 29.39 ±18.93, 25.25 ±14.35 and 28.06 ±09.29 respectively. Phosphorus content (mg/Kg) was 3.70 ±2.45, 3.92 ±2.25 and 4.14 ±1.94 for controlled while exposed locations showed 3.89 ±1.86, 4.10 ±1.58 and 3.19 ±1.19 for all depths ranging from surface to 60 cm respectively. Among locations Qalandar Abad was observed to be the most deficient

in P followed by Haripur, Battagram, PanjhBorrh, Jharikas and Hainra. Potassium content (mg/Kg) from surface to 60 cm depth was 112 ±8.47, 112.91 ±4.68 and 113.82 ±5.58 for controlled locations as compared to 113.76 ±10.62, 111.96 ±6.01 and 113.31 ±5.34 for exposed areas. Overall low Sulphur content (mg/Kg) was measured i.e. 1.51±0.62, 1.46 ±0.50 and 1.48 ±0.50 for controlled while exposed locations showed 1.57 ±0.50, 1.55 ±0.51 and 1.78 ±0.47 for all depths ranging from surface to 60 cm respectively. CPEC is a key to the development of Pakistan, but so far, no environmental study is carried out to assess its negative socio-economic impacts on the lives of the local communities especially farmers. This study has recorded and compared controlled and exposed soil samples for the mentioned parameters that can be used as a baseline in future research studies and policy making process.

Keywords: Organic Matter, Soil Texture, Porosity, CPEC, Soil Contamination

SYNTHESIS OF LOW BAND GAP PEROVSKITE FOR THE HARVESTING OF SOLAR LIGHT FOR PHOTOCATALYTIC APPLICATIONS

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Perovskite nanoparticles were fabrication via facile microemulsion route and effect of dopants on the basis of structural, electrical and optical properties was evaluated. The X-ray diffraction pattern confirmed the distorted rhombohedral symmetry with particle in 76-92 nm range. Dielectric parameters showed high dispersion at low frequency, while remained constant at low values. The AC conductivity showed increasing trend with doping in association with enhanced polarization. Band gap was tuned from 3.1eV for pure to 2.55eV for doped material in association with decline in PL intensity for improved catalytic response. The doped material showed superior RhB degradation efficacy of 91% versus 63% for undoped material in 2 h. In view of promising photo-activity, it has potential application for the removal of dyes from effluents under visible light irradiation, which will make the process economical feasible.

Keywords: Perovskite; Doping; Micro-emulsion; Photocatalysis; Visible light

BIOFORTIFICATION OF MUNG BEAN (*VIGNA RADIATA* L.) WITH MICRONUTRIENTS

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Soils of arid and semi-arid regions generally have high pH and low organic matter which reduce the availability of micronutrients and led to multi-micronutrient deficiencies. Micronutrients most commonly associated with human health problems on a global scale include Zinc (Zn) and iron (Fe) and our crop products generally contain very low conc. of both these micronutrients. Zn and Fe deficiency-related health problems in humans may be solved by improving their concentration in edible grains. The previous studies conducted at Soil Chemistry Section revealed that Zn + Fe application increased the grain quality of wheat and maize crops. Now this study was planned to improve the quality of Mung bean by soil & foliar application of micronutrients (Zn and Fe). The experiment comprised of seven treatments of Zinc and Iron viz., T1: Control (Recommended dose of NPK), T2: RDF + soil application of Zn @ 5 kg ha^{-1}, T3: RDF + soil application of Fe @ 4 kg ha^{-1}, T4: RDF + 0.5% Zn foliar spray, T5: RDF + 0.2% Fe foliar spray, T6: RDF + soil application of Zn @ 5 & Fe @ 4 kg ha^{-1}, T7: RDF + Zn (0.5%) and Fe (0.2%) foliar spray. The sources used for N, P, K, Fe and Zn were urea, SSP, SOP, zinc sulphate and ferrous sulphate respectively. Soil and foliar application of $ZnSO_4$ + $FeSO_4$ at sowing and flowering stage respectively, resulted in the Zn (41 & 50 mg Zn kg^{-1} grain) and Fe (214 & 227 mg Fe kg^{-1} grain) content in grains. As compared to the sole application of Fe & Zn, the combined use of Fe and Zn improved the grain Fe and Zn contents. Grain yield (0.97 t/ha) were also increased over control (0.76 t/ha) with these treatments.

POTENTIAL ROLE OF BIOCHAR IN REDUCING LEAD AND CADMIUM TOXICITY TO WHEAT PLANTS

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Heavy metal contaminated soil, especially lead (Pb) and cadmium (Cd) deteriorate the nature of agricultural products and lead human health into danger through food chain. There is need to choose certain economic and effective rectifying techniques to manage the continuous deterioration of land quality. A research project weas initiated to estimate the potential of biochar to absorb cadmium and lead in soil while preventing their entry in plants and food chain. Contaminated soils were collected from the fields of high levels of lead and cadmium. Biochar was synthesized from sugarcane bagasse and rice husk. Soil was amended with different levels of biochars individually and in combinations. Wheat variety "Zincol" was used as test crop in biochar amended soil. Biochar application had positive effect on growth and wheat yield in metal polluted soil by adsorbing metals. Quantitative effects were monitored by measuring different agronomic and yield parameters. Plant samples were also analyzed for total N, P, K and metal contents. Soil samples were analyzed for pH, EC, NO_3-N, available P, extractable K, available Pb and Cd. Application of biochar in contaminated soil showed significant improvement in soil properties as well as plant growth as evident from the results of incubation and pot experiments. Biochar application increased availability of nutrients in both experiments while reducing the concentration of available Pb and Cd in soil as well as concentration of these metals in wheat straw and grain. Moreover, plant growth and yield were also increased with biochar application and beneficial effects increased with increasing concentration. Therefore, in light of these results it can be concluded that application of biochar, especially sugarcane bagasse biochar has the potential to improve growth and yield of wheat cultivated in contaminated soil while reducing metal uptake by plants and reducing their entry in food chain.

Key words: Lead, Cadmium, biochar, adsorption, wheat

600 KEV AG IONS IRRADIATION EFFECT ON THE STRUCTURAL, OPTICAL AND PHOTOVOLTAIC PROPERTIES OF MAPBBR$_3$ FILMS FOR SOLAR CELLS APPLICATIONS

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Organ metallic halide perovskite solar cells have become one of the most aggressive emerging technology because of their low fabrication cost, having large functioning area, long lifetime, and considerable high energy, power conversion efficiency (PCE). Spin coating technique is utilized for the fabrication of pure $CH_3NH_3PbBr_3$ ($MAPbBr_3$) thin films. 600 keV Silver (Ag) ions are implanted on these films at the fluency rate of $4x10^{14}$ and $6x10^{14}$ ions/cm^2. XRD confirmed the cubic structure of $MAPbBr_3$. The high grain size is observed at the flouency rate of $4x10^{14}$ ions/cm^2. UV-Vis spectroscopic technique has been used to calculate the optical properties like bandgap, refractive index, extinction coefficients, and dielectric constant. A direct band gap of 2.44 eV is measured for pristine film sample whereas 2.32 eV and 2.36 eV are measured for Ag ions implanted films having $4x10^{14}$ and $6x10^{14}$ ions/cm^2 fluence rate, respectively. Solar cells of these films are fabricated. The J_{sc} (6.69 mA-cm^{-2}), FF (0.80), V_{oc} (1.1 V), and efficiency of pristine $MAPbBr_3$ based cell. All of these parameters are improved by Ag ions implantations. The maximum values are observed at the fluency rate of $4\square10^{14}$ ions/cm^2 where V_{oc} is 1.13 V, Fill-Factor is 0.75, short-circuit current density is 8.18 mA/cm^2, and efficiency is 7.01%. This efficiency is 84% higher than pristine film based solar cell.

Key Words: Ion implantation; Ag; perovskite solar cells; MAPbBr

GENETICALLY ENGINEERED COTTON CROP DEVELOPMENT TO IMPROVE WHITEFLY-INDUCED BIOTIC STRESS RESISTANCE

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World has entered an era where technology is revolutionizing the agricultural production systems. Meanwhile, the global warming and climate change is affecting the crop's resistance to biotic stresses and the global spread of the plant disease carrying insect vectors. Cotton is the white gold of Pakistan's economy and is one of five major crops having a good share in GDP. However, Pakistan's cotton production has seen a decline to 0.6% from 1.2% (2015) mainly because of reduced area under cultivation, biotic stresses imposed by whitefly and pink boll worm and abiotic stresses from drought, heat, rainfall, and flooding. This study has taken the challenge of improving stress resistance from *Bemisia tabaci* damage which imparts two-way damage to cotton crop i.e., by depleting the vital nutrients by sucking cotton phloem sap leading to yellowing of cotton leaves, drying, sooty mold development and transmitting Cotton Leaf Curl Virus. In this study, the cotton was genetically engineered by overexpressing aspartate aminotransferase gene from nitrogen metabolic pathway family to increase the free aspartic acid in cotton phloem sap. Aspartic acid is the precursor to four essential amino acids in the plants and the enzyme aspartate aminotransferase serves an important role in shuttling nutrients from carbon to nitrogen cycle between different organelles in the plant. The metabolic increase of aspartic acid not only mobilizes the nitrogen transport but also acts a neurotoxin to the notorious phloem feeder whitefly and impairs it's muscoskeletal junctions. The whitefly bioassays on the genetically engineered cotton crop resulted in 95% mortality of adults of T0 generation and upto 80% decline in ethe eggs/nymph development of the T1 whitefly population. Another important finding of the study showed the healthy state of transgenic cotton crop and increase in the yield of cotton fiber.

THE KNOCKOUT OF VACUOLAR INVERTASE GENE IN POTATO TO ADDRESS COLD INDUCED SWEETENING

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CRISPR-Cas9 mediated knock out of vacuolar invertase (*VInv)* gene was carried out using two single gRNAs in potato cultivar AGB purple. The overall transformation efficiency of potatoes was found to be 11.7%. The primary transformants were screened through PCR, Sanger sequencing, Digital PCR, and ELISA. The amplicon sequencing data showed maximum indel frequency for potato plant T12 (14.3 %) While for plant B4 the maximum indel frequency of 2.0 % was found which resulted in 4.4% knock out and 4% frameshift as analyzed by geneious. qRT-PCR data revealed that mRNA expression of *VInv* gene was reduced 90-99 folds in edited potato plants when compared to the control. The results obtained from titration method determined that the tubers of B4 transgenic line had five folds fewer reducing sugars when compared to the control. The genome edited potatoes behaved like their conventional counterpart when analyzed on physiological basis. The CRISPR based constructs resulted in successful knock out of *VInv* gene and ultimately resulted in increased tolerance of potatoes against cold induced sweetening with minimum accumulation of reducing sugar.

Keywords: Genome editing, knock out, vacuolar invertase, cold induced sweetening

REGULATORY LANDSCAPE OF GENOME EDITED CROPS; WHAT'S HAPPENING

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The crop plants are constantly exposed to insect pest and disease threats from their emergence from soil to harvesting. The literature suggest that 37% overall losses are incurred to crop yield because of the insect pests and diseases. Crop protection measures needs special attentions to address the yield concerns. Classical selection breeding of the genotypes that are resistant as well as searching for the resistance genes using quantitative trait loci (QTLs) have been exploited for this purpose. Such an improvement has been possible due to the existing crops' genetic diversity. We have also witnessed the use of genetically engineered crops against insect pests and weeds at commercial levels. Besides that, the use of chemicals (insecticides, herbicides, and fungicides etc) has been used widely to control the losses from insect pests and diseases. The researchers are exploiting new crop protection technologies (like RNA interference and genome editing) for crop improvement against pests and diseases. The use of RNA interference and CRISPR (Clustered regularly interspaced short palindromic repeat)-Cas9 (Crispr associated nuclease 9) associated with bacterial immune system against viral attacks has been utilized recently in silencing and editing genes in association with the RNA-guided nucleases. I will present data on Crispr-Cas of our experiments and will talk about how these techniques can efficiently be used as modern crop protection techniques. The regulator matters of genome edited crops will also be discussed shortly.

Keywords: Gene knock outs, knock down, gene editing, regulatory affairs

TRANSFORMATION AND EXPRESSION ANALYSIS OF CEMB GLUFOSINATE GENE IN LOCAL MAIZE INBRED LINES

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Maize (*Zea mays* L.) is the principal crop of the world and stands first among the grain crops in terms of production. It belongs to the family Poaceae, genus *Zae*, with cultivation area of almost 100 million hectares worldwide. The present study was designed to produce transgenic maize inbred lines harboring herbicide resistant for glufosinate. Glufosinate resistant gene is transformed to overcome the arising problems from glyphosate herbicide which has been proved as the cancerous agent. The sequence of Glufosinate gene was retrieved from NCBI and it was codon optimized. The sequence was synthesized in pUC57 vector under restriction sites *KpnI* and *BamHI*. The gene was ligated in pCAMBIA 1300 having the Polyubiquitin promoter and NOS terminator under *SacI* and *HindIII*. The immature maize embryos obtained from CEMB-developed maize inbred lines were transformed through *Agrobacterium*-mediated transformation. These transgenic plants were then subjected to molecular analysis. The screening of successfully transformed plants was done by gene specific PCR performed with short length and full-length primer by using the genomic DNA extracted from the leaves of transgenic plants. Approximately, 450 immature embryos were transformed with CEMB Glufosinate gene, out of which 35 plants gave positive results for PCR amplification with primer designed within the sequence of CEMB Modified glufosinate gene. PCR positive plants were further confirmed by ELISA and Quickstick assays. The protein expression in transgenic plants of Plot2-Lane 2, Plot2-Lane 11 and Plot2-Lane checked in which following plants: PGL-6, PGL-8 PGL-9 and PGL-11 protein expression with OD_{650} = 1.339, 1.512, 1.405 and 1.512 respectively. The successfully transformed plants are potential candidate for further field trial of herbicide spray.

Keywords: Maize, inbred lines, glufosinate, farm productivity

CRISPR/CAS9 MULTIPLEX BASED GENOME EDITING OF COTTON LEAF CURL VIRUS (CLCUV) BY TARGETING B-SATELLITE AND DNA-A REGION

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Cotton is the largest revenue-earning non-food crop in Pakistan and worldwide. Despite its role in the economy, 40-50-% yield losses of cotton occur due to damage caused by phloem sucking insects mainly whitefly, which also acts as a carrier of notorious virus CLCuV, the culprit of two million cotton bales losses each year in Pakistan. This combination of whitefly and CLCuV results in nutrient deficiency, stunted plant growth, decreased fibre quality and yield. A powerful site-specific genome-editing tool CRISPR-Cas9 has recently been applied to many different systems with the modification of using multiplex, which eliminated the chances of mutant escape by single sgRNA. A noval approach of CRISPR/Cas9 multiplex genome editing of viral genes from CLCuV betasatellite, DNA-A regions and Cathepsin protein gene from vector whitefly simultaneously by using Gateway Cloning. Molecular biological tools like confirmation of construct through amplification, restriction digestion and sequencing confirmed the successful introduction of the cassette into the cotton plant. The knockout efficacy of the 72% for DNA-A, 90% of betasatellite was achieved. The qPCR confirmed the successful reduction of the vial titre and the feeding assay showed the 90% of mortality in the whiteflies. The study results were also validated by the change in Alpha chain, Beta Chains and loops of the 3D protein models of native and edited proteins predicted with Alpha Fold2. The knockout efficiency and the virus inoculation assay magnificently determined the faith in using this technology for plant virus control alongwith its vector.

Keywords: genome editing, cotton, Leaf curl virus, **β-Satellite, DNA-A Region**

EXPRESSION STUDIES OF *IRI3* GENE FROM *LOLIUM PERENE* IN POTATO CULTIVAR DAIMANT AGAINST LOW TEMPERATURE STRESSES

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Potato crop is grown in moderately low temperatures however, a subzero temperature reduces the tuber yield and quality significantly. Extremely low temperatures initiate ice crystallization within cells and results in freezing injury. Recrystallization of these ice crystals possesses the structural damage and cellular dehydration of potato leaves, hence drastically reducing the photosynthesis and food to be stored in the form of tubers. Ice recrystallization inhibition proteins (IRIPs) bind the ice crystals and hinder their further growth. In this study, we investigated the role of IRI3 gene derived from *Lolium perene* to combat cold stress in *Solanum tuberosum* c/v Daimant. Sub-cellular localization of IRI3 gene was studied in transgenic *Arabidopsis* seedling by Confocal Microscopy. Codon optimized IRI3 gene along with translational enhancer was introduced in potato plants through *Agrobacterium* mediated transformation. Transgene insertion was confirmed with the help of GUS assay, PCR and southern Blot analysis. Three transgenic lines were selected for cold stress and ion leakage assay. Cold stress was given at 2^{o}C for 5 days, under stress IRI3 mRNA expression up regulated with maximum increase to 20 folds at 96 h post stress. Ion leakage assay also revealed promising results as transgenic plants exhibited reduced ion leakage as 14 -22% as compared to control non-transgenic plants. This study advocates the use of transgenic technology to improve abiotic tolerance and help stabilize yields under changing climate conditions.

GENOME AND TRANSCRIPTOME WIDE ANALYSIS OF LEGUME CROP SPECIES FOR STUDIES OF PROGRAMMED CELL DEATH (PCD) INDUCING METACASPASES GENES

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Metacaspases (MCs) are subclass of caspases and functionally characterized as cysteine proteases. The MCs are known to involve in various physiological functions of plant such as development of seed to falling of leaves, various stress responses and unfavorable environmental conditions. Most importantly, upon pathogen infection, MCs contribute to establishment of induced programmed cell death (PCD) and limit pathogen further invasion. This study was primarily designed to report and characterize the MCs in eight legume crops. As result, 15 MC genes in *A. hypogea*, 9 in *C. cajan*, 9 in *C. arietinum*, 13 in *G. max*, 13 in *G. soja*, 9 in *P. vulgaris*, 10 in *M. truncutula* and 9 in *V. radiata* were identified. Phylogenetic analysis divided identified genes into two clades, MC1 (subgroup 1A, 1B and 1C) and MC2 (2A and 2B) on the basis of presence of proline rich domain at N-terminal and linker DNA domain at C-terminal respectively. Resultant grouping and subgrouping were also supported by conserved domain analysis, motif analysis and gene structure analysis. The gene structure analysis depicted the occurrence of up to eight introns in all MCs. The gene duplication analysis revealed that most of genes might evolve by segmental duplication under the influence of purifying selection in legume plant species. Similarly, promotor analysis exhibited that large number of cis-regulatory elements are present at upstream of MC genes which response to wide range of biotic and abiotic stresses responses.

INSIGHTS INTO EVOLUTIONARY AND FUNCTIONAL BIOLOGY OF PLANT CELL WALL DEGRADING PECTATE LYASES (PELS) FROM PLANT PARASITIC NEMATODES OF THE ORDER TYLENCHIDA

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Plant parasitic nematodes (PPNs) develop sophisticated feeding sites in plant roots, called nematode feeding sites (NFSs). The development of NFSs depends on the degradative role of certain cell wall degrading enzymes, namely, cellulases, xylananses, arabinases, and pectate lyases (Pels). The Pels are secreted by esophageal glands of PPNs into the cytoplasm of the host cell to invade and macerate the host root tissues. Considerable research has been conducted on exploring the Pels of pathogenic bacteria and fungi. However, a detailed Pel characterization has not yet been done for PPNs. This study was primarily intended to characterize and investigate the evolutionary and functional dynamics of Pels in PPNs of the order Tylenchida. Consequently, Tylenchida Pels were found to be evolutionary derived into two major clades. Clade-1 lineage meets with the Pels of sub-family_3, whereas the lineage of Clade-2 meets with subfamily_2 of polysaccharide lyases family 3. Structurally, Clade-1 Pels exhibit eight turns of β-strands, whereas Clade-2 comprises seven turns of β-strands. Molecular docking of Pels with the substrate molecule α-D-galacturonic acid revealed a mechanistically appealing role of Turn 1, β-strand, and Turn 3 in catalytic activity, ultimately enhancing the degradation mechanism of pectin through Pels.

OVEREXPRESSION OF TWO DISEASE RESISTANCE RESPONSIVE GENES REDUCES SUSCEPTIBILITY TO CYST AND ROOT-KNOT NEMATODES IN ARABIDOPSIS

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The plant parasitic, beet cyst nematode *Heterodera schachtii* induces specialized feeding sites in the roots of Arabidopsis which are called syncytia. The transcriptome study of these syncytia revealed significant down-regulation of various defence related genes including the genes *At4g135800* and *At3g24020* which belong to disease resistance responsive and dirigent like genes family (Szakasits et al., 2009). The objective of this study was to test if these genes play a role in the interaction with *H. schachtii* using overexpression lines and a double knock-down (KD) mutant. For overexpression and miRNAbased silencing of these genes, used pMAA-Red vector developed in our laboratory. pMAA-Red which contains a *pPdf2.1*::*DsRed* fusion as fluorescent selectable marker and a CaMV::GUS cassette within the T-DNA (Ali et al., 2012). The promoter::GUS lines for both genes we constructed by using the same plasmid vector. The promoter::GUS lines showed expression specifically in seedling roots, trichomes of young leaves, young stamens and anthers, and immature seeds in silliques which was confirmed further by Reverse transcriptase PCR. For overexpression of both the genes, we used the CaMV 35S promoter after confirming that this promoter was active in syncytia up to 10dpi (Ali and Abbas, 2016). The down-regulation of both *At4g135800* and *At3g24020* in WT syncytia and giant cells was confirmed by qRT-PCR and promoter::GUS lines. The overexpression of these genes resulted in less number of cyst (*H. schachtii*) and root-knot nematodes (*M. incognita*) and smaller syncytia as compared to wild type and while double KD mutant did not show significant difference. Expression of these genes was specifically induced in response to jasmonic acid and ethylene, hinting that this enhanced resistance against nematodes in the overexpression lines may be mediated by JA/Et dependant pathways. Moreover, overexpression lines showed lower susceptibility to *Botryis cinerea* as well. Our results indicate that these disease resistance responsive genes are is involved in resistance against *H. schachti*, *M. incognita* and *Botryis cinerea* through JA/Et dependant pathways.

EFFECT OF SOLE AND CONSORTIUM APPLICATION OF ANTAGONISTIC BACTERIA ON PLANT GROWTH PROMOTION AND INHIBITION OF *MELOIDOGYNE INCOGNITA* INFECTION IN OKRA

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Plant-parasitic nematodes (PPNs) are a serious threat to food security. Root-knot nematodes (RKNs) are important plant parasitic nematodes that affect the vegetable crops worldwide including okra. Among the RKNs, *Meloidogyne incognita* is one of the major constraints to okra production. In this study, the effect of different bacterial strains i.e., *Bacillus* sp. MN54, *Enterobacter* sp. MN17 and *B. phytofirmans* PsJN alone and in different combinations was assessed on plant growth promotion and inhibition of *M. incognita* infection on okra in a greenhouse experiment under completely randomized design (CRD). The results revealed that application of *Enterobacter* sp. MN17 significantly enhanced the root length (19.0), root weight (8.7), and shoot dry weight (19.6) as compared to other treatments. However, the combined treatment of (*Bacillus* sp. MN54 + *Enterobacter* sp. MN17 + *Burkholderia phytofirmans* PsJN) has successfully reduced the number of galls (10.5), number of females (23.2), egg masses (19.5), egg mass index (4.1), and galling index (2.1) against the RKNs. Conclusively, the combined application of all the bacterial strains was more effective in causing the suppression of RKNs and promotion of plant growth. This study illustrates the role of endophytic bacteria in controlling root knot nematode infection through the different changes in plants.

Keywords: Okra, *Meloidogyne incognita*, growth promotion, Root knot nematode, *Bacillus*, *Enterobacter*

SURVEY OF *MELOIDOGYNE GRAMINICOLA* (GOLDEN AND BIRCHFIELD) IN WHEAT-RICE CROPPING ZONE AND RESISTANCE EVALUATION OF INDIGENOUS RICE AND WHEAT GERMPLASM

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Rice and wheat are the most valuable cereal food cropping systems threatening by root-knot nematode Meloidogyne graminicola, one of the most important pests that caused significant reduction in yield. Among several management strategies used, resistance against *M. graminicola* could be the most helpful and reduce this issue in rice and wheat fields. The present research survey was conducted to determine the prevalence and identification of rice root-knot nematode *M. graminicola* (Golden & Birchfield) in rice zone II, Pakistan. Further, advanced lines/varieties of rice and wheat for resistance against *M. graminicola* were tested. The goal of this work was to screening wheat and rice cultivars in diverse conditions in Pakistan for resistance resources that could be utilized in farming and breeding for resistance against *M. graminicola*. The most rice cultivated field surveyed during September 2017 from zone II (Faisalabad, Hafiz Abad, Sheikhupura and Lahore districts) in Punjab Province of Pakistan. The survey results concluded that all districts have root-knot nematode infection which was 29% in Faisalabad, 35.71% in Hafizabad, 30.76% from Sheikhupura and 13.33% from Lahore district. 12 rice cultivars showed susceptible response with maximum number of galls and number of juveniles respectively while Basmati 385 showed highly susceptible against *M. graminicola*. Lowest grain weight was recorded from susceptible varieties (PK-386, 1.90g, Basmati 385, 2.36g) and maximum from tolerant varieties (Basmati-2000, 6.73g, NIAB IRRI-9, 7.20g, Basmati 198, 7.10g, Basmati-515, 6.80g). Most of the wheat varieties were found susceptible to partially susceptible. Dharrabi 2011, T-D-1, AS-2002, AAS-2011, Millat-2011, ARRI- 2011, C-217, Barani-83 showed susceptible response. There were only three varieties Shafaq-2006, Faisalabad-2008, Galaxy 2013 displayed a partially tolerant response to *M. graminicola*. None of the varieties under study showed resistance response. Appropriate extension programs must be established to explain and advise crop growers on proper nematode management strategies.

EXPLORING THE POTENTIAL OF HOST RESISTANCE AND DIFFERENT MANAGEMENT STRATEGIES TO CONTROL *MELOIDOGYNE GRAMINICOLA* IN *SORGHUM BICOLOR* L.

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Sorghum (*Sorghum bicolor* L. Moench) is a very important cereal crop for human beings and livestock. It is a multipurpose crop that finds its use in a variety of food and feed products globally. World sorghum production is about 60 million tons per year. In Pakistan from (2015-16) sorghum engaged (0.195 million ha) and produced (0.104 million metric tons) of sorghum that accounted for (12.16%) the fodder yield of the crop. After berseem, sorghum is the second-largest fodder crop, contributing (43.54 %) of the total. The main sorghum-producing countries are the USA, Nigeria, and India. Global sorghum production and productivity are affected by various stresses, especially by biotic factors such as diseases, weeds and insect pests. Many diseases, including fungi, bacteria, viruses, and nematodes are harmful to the crop. In Pakistan, the root-knot nematode (*Meloidogyne spp.*) could be one of the most devastating threats to crop production. *M. graminicola*, is a prevalent plant-parasitic nematode that affects Poaceae crops all over the world. Rice, wheat, barley, oat, and sorghum are prime hosts of *M. graminicola* in the Poaceae family. The purpose of the study was to evaluate host resistance germ-plasm and different management strategies against *M. graminicola* in a sorghum pot experiment. Biological control approaches, such as the application of antagonistic microorganisms and soil amendments, will be used to manage *M. graminicola* in sorghum. The data regarding plant growth traits and nematode infection parameters were assessed using standard procedures. In Pakistan, there is no information that *M. graminicola* is pathogenic to sorghum. Due to this present investigation was conducted to assess the influence of *M. graminicola* on sorghum. Jawar Sandal showed maximum resistance followed by Fakhar-E-bhakkar, Jawar Hegari, Gp-70, Gp-71, GP-72, GP-73, JS-2002, Jawar 2011 and Jawar Noor.

EVALUATION OF BIOCHAR DEVELOPED FROM DIFFERENT FEED STOCKS ON PLANT GROWTH AND RESISTANCE AGAINST ROOT-KNOT NEMATODES IN TOMATO

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In Pakistan, the tomato (*Lycopersicum esculentum Mill.*) is vulnerable to attack by various biotic and abiotic stresses. Among all pathogens, plant parasitic nematodes cause significant losses to vegetable crops including tomato. Root knot nematode (*Meloidogyne incognita*) is a serious threat to tomato production among all *Meloidogyne* spp. and it is a major pest causing serious crop losses globally. In the present study, the experiment was conducted to evaluate resistance response of tomato cultivar towards *M. incognita and t*o assess growth and yield response of tomato cultivar *by using biochars from different feed stocks (sugarcane, green waste, wheat straw, maize stalk pyrolysed at 300 and 500°C) at different concentrations like 1.0, 2.0 and 3.0% (w/w) with three replications under completely randomized design* and nematode application, biochar feedstocks, biochar concentrations and all of their interaction were studied by analyzing all the data of root weight (gm), Shoot weight(gm), growth, chlorophyll contents, plant height(cm), number of galls, egg masses and no. of females. It was cleared from the results that different temperatures used for pyrolysis performed considerably well in managing the PPNs and promoting different plant physiological parameters. Green waste, maize stalk and wheat straw perform significantly better in enhancing the yield of tomato plant. Sugarcane baggase somehow contributed in enhancing overall plant growth. In 2nd experiment impact of biochar in controlling of *M. incognita* was confirmed by substantial reduction in nematode attack in biochar amended soil. Whereas, the study revealed that the appropriate biochar is 3.0% sugarcane baggase for reducing overall nematode infection.

GENETIC DIVERSITY AMONG THE FUSARIUM ISOLATES COLLECTED FROM THAL REGION ASSOCIATED WITH CHICKPEA WILT

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Chickpea is top pulse crop in Pakistan regarding area under cultivation and total production. It is rich in protein. Mainly fungal diseases target this crop. Chickpea wilt is an important disease which incidence at seedling and mature plant phase. At seedling stage, effects of wilt disease are more drastic and effected plant dries and become source of secondary infection, while at pod formation stage, disease effects are less and Farmers has some yield at the end of the season. In the current studies, comprehensive surveys were conducted in Thal region. Fungus was isolated and identified on the basis of morphological and microscopic characteristics. Later, DNA was successfully isolated from the purified Fusarium oxysporum samples, and ITS region was amplified by using Universal primer pair. The amplified fragment was sequenced through service provider and resulting sequences were submitted to GenBank. From the results obtained, we can depict that diversity exists among various isolates of *Foc* in the thal region. Significant genetic closeness of the Foc isolates from thal region was found with the isolates/races reported from India and Iran, and phylogeny details directs towards some common ancestry among the isolates of these regions that could be further examined through whole genome sequencing technique. The isolates under study showed significant virulence as demonstrated by the pathogenicity trials. Therefore, the study of diversity in these isolates for virulence gene could be the topic of future research.

IDENTIFICATION OF ANTI-QUORUM SENSING POTENTIAL OF *REYNOUTRIA JAPONICA* WITH REFERENCE TO *STAPHYLOCOCCUS AUREUS*

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It is estimated that by the end of 2025, 226 million people worldwide will be affected with infectious diseases. Although many treatments for these bacterial infections are available in the form of antibiotics but excessive and indiscriminate use of antibiotics to treat them has led to the emergence of multiple drug resistant strains. The global rise of anti-microbial resistance combined with the rapid rate of microbial evolution and the slower development of novel antibiotics focuses the urgent need of development of innovative therapeutics and new strategies to fight emerging infections. One of these strategies is to disturb quorum sensing system which is cell density dependent communication mechanism and responsible for virulence and biofilm formation in multidrug resistant strains of bacteria such as *Staphylococcus aureus*. Efforts to disrupt biofilms have enabled the identification of natural bioactive molecules produced by different plant species. One of these is *Reynoutria japonica* which is Japanese medicinal herb. Its root contains certain bioactive compounds with a wide spectrum of pharmacological effects and has been used for treatment of inflammation, jaundice and many other diseases. The motive of the present research was to discover potential antibacterial compounds from *Reynoutria japonica*. Ten bioactive compounds from this plant i.e. 2Methoxy-6acetyl- 7- methyljuglone, emodin, emodin 8-o -b glucoside, polydatin, resveratrol, physcion, citreorosein, quercetin, hyperoside and coumarin were taken as ligands and docked with accessory gene regulator protein A, B, C and signal transduction protein TRAP. The 3D structure of the target proteins and the ligands was taken as the input for docking. The best ligand was selected on the basis of docking score ADMET properties and lipinski rule. By considering all these parameters resveratrol was seen obeying all drug-like properties with docking score 8.9 against accessory gene regulator protein C. It followed lipinski rule and toxicity and other ADME values are also in tolerable range as compared to other ligands. To check further effectiveness of resveratrol it was compared with commercially available antibiotic drug penicillin. A comparison of all drug- like characteristics showed that resveratrol is much better in many aspects over penicillin. Penicillin showed docking score - 6.7 while resveratrol has - 8.9, other pharmacokinetic properties of resveratrol are also good than penicillin. So it is concluded here that resveratrol can prove itself as drug candidate in future antibiotic therapeutics.

Keywords: *Reynoutria japonica*, *Staphylococcus aureus*, antibiotic resistance, quorum sensing, resveratrol

CARBAMOYL PHOSPHATE SYNTHASE SUBUNIT CGCPS1 IS NECESSARY FOR VIRULENCE AND TO REGULATE STRESS TOLERANCE IN *COLLETOTRICHUM GLOEOSPORIOIDES*

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Glomerella leaf spot (GLS) is a severe infectious disease of apple whose infective area is growing gradually and thus poses a huge economic threat to the world. Different species of *Colletotrichum* including *Colletotrichum gloeosporioides* are responsible for GLS. For efficient GLS control, it is important to understand the mechanism by which the cruciferous crops and *C. gloeosporioides* interact. Arginine is among one of the several types of amino acids, which plays crucial role in biochemical and physiological functions of fungi. The arginine biosynthesis pathway involved in virulence among plant pathogenic fungi is poorly understood. In this study, CgCPS1 gene encoding carbamoyl phosphate synthase involved in arginine biosynthesis has been identified and inactivated experimentally. To assess the effects of CgCPS1, we knocked out CgCPS1 in *C. gloeosporioides* and evaluated its effects on virulence and stress tolerance. The results showed that deletion of CgCPS1 resulted in loss of pathogenicity. The *Δcgcps1* mutants showed slow growth rate, defects in appressorium formation and failed to develop lesions on apple leaves and fruits leading to loss of virulence while complementation strain (CgCPS1-C) fully restored its pathogenicity. Furthermore, mutant strains showed extreme sensitivity to high osmotic stress displaying that CgCPS1 plays a vital role in stress response. These findings suggest that CgCPS1 is major factor that mediates pathogenicity in *C. gloeosporioides* by encoding carbamoyl phosphate that is involved in arginine biosynthesis and conferring virulence in *C. gloeosporioides*.

Keywords: *Colletotrichum gloeosporioides*; Glomerella leaf spot; apple; gene knockout; virulence.

CHARACTERIZATION OF 1-AMINOCYCLOPROPANE-1-CARBOXYLIC ACID (ACC) UTILIZING AND EXOPOLYSACCHARIDE (EPS)-PRODUCING PGPR AND THEIR INOCULATION RESPONSE ON WHEAT

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At the present time, food crops especially the staples are continuously exposed to the climate changes and associated factors e.g., salinity, drought etc. affecting food securityand productivity worldwide. The effect of these factors is complicatedly interrelated that influences all the essential processes of plant causing major constraints to global food security, crop productivity and economy at local, regional and global levels. Soil bacteria with plant growth promoting (PGP) traits possess the potential to ameliorate plant growth and health subjected to various stresses. The main mechanism behind thebacterial stress tolerance is their ability to utilize 1- aminocyclopropane-1-carboxylate (ACC) and produce exopolysaccharides (EPSs). The present study was designed to isolate, characterize and exploit stresstolerant PGPR to minimize the effects of salinityand drought stress on wheat. Out of 35 strains screened from different habitats, four strains showed ACC deaminase activity, four produced exopolysaccharide EPS while 7 produced IAA, 15 were able to fix nitrogen, 4 produced siderophore, 8 showed catalase activity. 15 strains solubilized insoluble P, 14 solubilized Zn while one solubilized calcium. Eight of these PGPR were identified as members of Bacillus and Pseudomonas species based on the sequence analysis of 16S rRNA gene. Selected stress-tolerant PGPR were tested for plant-inoculation response underdifferent stress-induced experiments on different varieties of wheat (Gandum-1, Punjab-2008) in vitro (lab) and (AASS and Johar) in vivo (field). Statistical analysis ofthe collected data confirms that the inoculated treatments showed significant improvement in plant morphology as well as yield compared to non-inoculated controlplants under salt and water stress both in pot and field conditions. The study conclude that stress-tolerant PGPR containing ACC & EPS traits can be used as bio formulation to improve wheat growth and productivity under salinity and drought stress. The strains may further be tested on multiple hosts and stressed environments for widespread field application.

MITIGATING THE EFFECTS OF CLIMATIC VARIABILITY THROUGH THE PILLARS OF CLIMATE-SMART AGRICULTURE: A WAY FORWARD

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At present billions of mouths go to bed hungry. According to an estimation, the global population will almost double by 2050. On the globe in many countries agriculture is a single sector that plays a vital role in the economic development of a country and trying to reduce poverty, while this sector is under various threats, among these threats climatic variability or climate change is the major threat for this sector. In recent years that has increased consequent of climate variability. Results of many studies highlighted that climate change is reducing crop production, particularly in developing countries. It not only reduces the crop yield but is also responsible for food insecurity in the country. Therefore, in the world, various national and international bodies and groups are working together to devise a farming system that boosts food production to fulfill the food requirements at the local and global levels. In this context, Climate Smart Agriculture (CSA) is a way to face the climatic variability. CSA is a good opportunity to improve the food and livelihood security in the region. It is an innovative approach for mitigating climatic variability. The Food and Agriculture Organization of the United Nations (FAO) defined climate-smart agriculture as having three pillars, food security, adoption, and mitigation. According to these pillars, food security means sustainably increasing agricultural production and income, Adoption deals with developing the resilience against the climate change and reducing the causes of climate change like greenhouse gas emissions according to the possibility. These three pillars of CSA have the potential to face the climatic variability and mitigate its effects on the globe. These are the best strategies if we need to overcome the effects of climate change. In this scenario educating and promoting these strategies in the community is an important step in ensuring the minimal effects of climate change and food security.

EFFICACY OF DIFFERENT MEDICINAL PLANT EXTRACTS AND FUNGICIDES AGAINST RHIZOCTONIA SOLANI CAUSING DAMPPING OFF TOMATO

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Tomato (*Lycopersicum esculentum*. L) Crop is main vegetable in the world, which is infected by several biotic diseases and abiotic stresses. Among them damping off is dangerous disease caused by *Rhizoctonia solani*. The objective of this research experiment was to control *Rhizoctonia solani* by application different plant extracts. Three distinct medicinal plant extracts of *Cuminum cyminum* (Zeera), *Ferula oopoda* (Hing) and *Azadirachta indica* (Neem) and fungicide are used against *Rhizoctonia solani*, Also decreased the mycelium growth of *Rhizoctonia solani* as contrasted with control. However, among the three medicinal plant. The *Cuminum cyminum* (Zeera) reduce the fungal mycelium growth by 86 %, fungal mycelium growth reduced by 77 % treat with *Azadirachta indica* (Neem) and *Ferula oopoda* (Hing) decreased the fungal mycelium growth by 59 %. The fungicide showed that high efficacy to control the *Rhizoctonia solani* and reduce the mycelium growth by 95% and the extract of *Cuminum cyminum* (Zeera) is more effective against *Rhizoctonia solani* as compared to extract of *Azadirachta indica* (Neem) and *Ferula oopodo* (Hing). The crude extract of *Cuminum cyminum* (Zeera) have ability to inhibit *Rhizoctonia solani*. It is recommended to control of *Rhizoctonia solani* causing damping off tomato seedling for future aspects with no dithering, since it is cheapest, an eco-friendly and without side effects in environment. Additional exposed to be affordable route for disease management.

Keywords: Tomato (*Lycopersicum esculentum*) crop, Mycelium growth, *Rhizoctonia solani*, Medicinal plant extracts

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