

Abstract Book

Conference on

INNOVATIONS IN AGRICULTURE

THEME: Nourishing Pakistan in Changing Climate



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February 13-15, 2019



Institute of Soil & Environmental Sciences
University of Agriculture Faisalabad, Pakistan
&
Pakistan Agricultural Scientists
Forum (PAS Forum)



ABSTRACTS

Conference

INNOVATIONS IN AGRICULTURE *NOURISHING PAKISTAN IN CHANGING CLIMATE*

February 13-15, 2019

**Muhammad Sanaullah
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ORGANIZED BY

**UNIVERSITY OF AGRICULTURE, FAISALABAD
PAKISTAN AGRICULTURAL SCIENTIST FORUM**

ISBN: 978-969-8237-83-7

Edited by: Muhammad Sanaullah
Muhammad Usman
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Conference
Innovations in Agriculture: Nourishing Pakistan in Changing Climate

Published by
UNIVERSITY OF AGRICULTURE, FAISALABAD
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Designed by Rizwan Shafiq
Printed at Rizi Press, Faisalabad

February, 2019

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Oral Presentations

EXPLORING NEXUS BETWEEN AGRICULTURAL PRODUCTIVITY AND FARM CREDIT DISBURSEMENT IN PAKISTAN: DOES POLICY MATTER?

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Developing countries' agriculture including that of Pakistan substantially relies on external financial resources due to the prevalence of poor and subsistence farming community. A range of farm operations need sufficient and timely availability of funds to realize optimum yields which mostly ends up with the failure of farmer in the face of guarantee, collateral and other bureaucratic hurdles in Pakistan and rest of the developing world for effectively financing operations starting from field preparation to harvesting endeavors. Credit insufficiency remains to be the major constraint for the majority of small farmers in Pakistan who are more than 90 percent of the total. Pakistan has a well-established agricultural credit system with sufficiently long history with mixed results. Despite the availability of agricultural credit both from commercial and specified banking institutions, agricultural production has faced an unsustainable path that may be attributed to range of factors. However, it remains unclear how agricultural credit played its role in agricultural performance overtime. Although credit disbursement has picked up in last few decades but the relevant policies such as disbursement criteria, interest rate, collateral requirements and repayment conditions have caused skepticism among farmers. The misuse of credit by farmers and relatively smaller amount of credit are linked with its inefficiency thus warranting proper policy intervention and institutional framework.

Key Words: Productivity; Disbursement; Wheat; Grains; Efficiency

MANAGEMENT OF AMERICAN BOLLWORM (*HELICOVERPA ARMIGERA*) USING NATIVE ISOLATED SLITNPV NUCLOEOPOLYHYDROVIRUSES

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S. litura and *H. armigera* (Lepidoptera, Noctuidae) are polyphagous insect pests of many economically important crops. In present research, native Nucleopolyhedroses virus (SlitNPV) were isolated from cotton field and observed under microscope through Geimsa Stain and identified by polymerase chain reaction (PCR) using NPV specific primers based on late expression factor (Lef-8) gene. In order to evaluate the efficacy of Nucleopolyhedroses virus (NPV) and Spinosad, various doses of sub-lethal and lethal (1 x 10²- 1x 10⁸ POB mL⁻¹) were applied alone and in combination with Spinosad spinosad (0.01 ppm) against different instars larvae of *H. armigera*. The biological activities of native NPV isolate and its interaction were investigated under laboratory condition. The highest mortality of *H. armigera* was observed at early instars as compared to last larval instars. This study provides an opportunity to cut down the use of synthetic chemicals and encourages developing safe biological insecticides from NPV isolates, which may effectively control as well other different targeted insect pests of different crops. The result from this study indicated that *S. litNPV* was equally affective against *S. litura* and *H. armigera* and can easily be used to manage these pests successfully confirming an alternative strategy than commercial based insecticide.

Key Words: Nucleopolyhydroviruses; NPV; Insect pest management; PCR; Microbial insecticides

EFFECT OF HERBAL MINERAL VITAMIN BLEND ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF BROILERS

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This experiment was conducted to investigate the effect of supplementation of herbal, mineral and vitamin mixture on growth performance and nutrient digestibility of boilers. One hundred and eight birds were randomly distributed into 6 experimental units of 3 replicates (6 birds/replicate) as: negative control (basal diet), positive control (Lincomycin at the rate of 5g/bag), commercially available herbal mineral vitamin product (Legmin Fort™) at the rate of 50g/bag and 100g/bag, and herbal-mineral viamin mixture at the rate of 150g/bag and at the rate of 300g/bag of feed. The data regarding weekly feed intake, body weight gain and feed conversion ratio were recorded, and fecal samples were collected at the end of starter and finisher phase for nutrient digestibility trial. The results of body weight gain in starter phase indicated significant ($P < 0.05$) differences among all treatments groups in body weight gain (902.2g), feed intake (1843.9g) and feed conversion ratio (1.78). In case of nutrient digestibility, results showed significant ($P < 0.05$) values of dry matter, crude protein, and crude fat in starter phase as 77.74%, 69.37%, and 61.18%, respectively and 77.65%, 68.79% and 61.03%, respectively in finisher phase. Based on overall results, it was concluded that the dietary inclusion of combination of herbs along with minerals and vitamins can increase the production performance and nutrient digestibility in broilers.

Key Words: herbal-mineral-vitamin blend; growth performance; fecal samples; nutrient digestibility; broiler

ARABIDOPSIS THIONIN-LIKE FAMILY GENES ARE INVOLVED IN RESISTANCE AGAINST BEET-CYST NEMATODE (*HETERODERA SCHACHTII*)

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Thionins are one of the important AMPs expressed by several plants including *Arabidopsis thaliana* to combat multiple pathogen infections. Inspection of the *Arabidopsis* genome sequence revealed that it contains in addition to 4 thionin genes a large number of 67 so-called thionin-like (ThiL) genes. Out of 67, we selected 10 ThiL genes to study their expression and possible function in the *Arabidopsis* plant against beet cyst nematode *Heterodera schachtii*. RT-PCR and promoter:GUS fusions showed that most genes were expressed at a very low level but in several organs and different developmental stages. Some genes were also expressed in syncytia induced by the beet cyst nematode *Heterodera schachtii* in roots while others were downregulated in syncytia. Some overexpression lines had a lower number of nematodes that developed on the roots after inoculation. Two of the genes resulted in a strong HR if infiltrated into leaves of *Nicotiana benthamiana*. These results indicate that thionin-like genes might be involved in the response to biotic stress. These genes, many of which are only expressed at a very low level, might be a reservoir from which evolution could select genes for protection against biotic or abiotic stresses.

Key Words: Thionin-like; *Arabidopsis*; Antimicrobial activity; nematode resistance; beet cyst nematode

CONTROLS ON SOIL ORGANIC MATTER CYCLING FROM VARYING CLIMATES OF PAKISTAN

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Soil organic carbon sequestration is the key function of soil and considered as finest mitigation strategy to combat climate change and food security challenges. However, this is controversial in terms underlaying mechanisms. This is due to lack of data and knowledge gaps regarding stocks and flows of organic carbon and its controls. Inspite of a huge research on this topic worldwide, soils of Pakistan, an agriculture-based economy, are still uninvestigated. Our main objective was to find climatic and edaphic controls of soil carbon content and to estimate significance of their effect on organic matter dynamics in soils of different climatic zones of Pakistan. We, therefore selected 33 sites for soil (0-90cm) sampling across latitude gradient including major land uses of Pakistan. Analytical data from these sites demonstrated that land use type ($r= 0.61$) and depth ($r=0.94$) are the major controlling factors of soil organic carbon content. It is noted that though forests are higher in carbon stocks but soil under crop cultivation especially in surface layer is high in easily oxidizable carbon as compared to forests. Additionally, a strong positive correlation was found between mean annual temperature ($r=0.24$), weathering status ($r=0.66$), soil texture ($r=0.44$), Ca ($r=0.69$) and Mg ($r=0.58$) ions with passive pool of soil carbon.

Key Words: SOM; Edaphic factors; Soil type; SOM fractions; climate

IMPROVED CROP PRODUCTION THROUGH FARMERS' CAPACITY BUILDING IN KHYBER PAKHTUNKHWA, PAKISTAN

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Farmer Field School (FFS) is an educational approach, which provides opportunities of learning various agricultural practices by doing in the field. Keeping the importance of this approach in mind, a study was conducted to analyze farmers' capacity building in terms of improved crop production in Khyber Pakhtunkhwa. For this purpose, seven districts from the central region of Khyber Pakhtunkhwa including Peshawar, Charsadda, Nowshera, Mardan, Swabi, Kohat and Hangu were selected. Data were collected on various aspects of learning from 280 randomly selected FFS farmers. The data were collected with a pre tested interview schedule using survey method. The data collected were analyzed with the help of computer software statistical package for social sciences (SPSS). The results show that the production technologies including nursery raising techniques, use of high yielding varieties, timely & balanced use of fertilizers, using recommended seed rate, insect/ pests' control by local recipes, seed treatment with proper fungicides, cultural and chemical weed control measures were improved as a result of FFS activities in the study area.

Key Words: FFS; Capacity building; agriculture; approach; cultural control

MUTATION BREEDING IN SUNFLOWER; NATURE'S FINEST APOCALYPSE PREPPERS

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Since the beginning of this century, the world has experienced rapid climate changes in terms of drought, floods and earthquakes that have posed a serious threat to global biological systems by influencing the production of safe, healthy, and affordable food, fiber and fuel. Crop production is a major determinant of food production. To cope with the challenges of climate change, crop production must adapt and become resilient to changes. It can contribute to mitigate the climate change, for example by reducing the use of inorganic fertilizers, avoiding soil compaction or flooding to reduce methane emissions. It is recommended that more work on abiotic stresses should be done to develop the diverse germplasm. There is need to focus on the diverse food and miracle crop like sunflower. In addition, sunflower crop could participate to the mitigation solution as a low greenhouse gas emitter compared to cereals and oilseed rape. Its oil consists of polyunsaturated fatty acids, vitamin A, D, E, K and phosphorus.

In present studies, sunflower inbred lines were collected, and two different mutagens (UV Rays and Colchicine) were used to induce the mutation. Mutated seeds were sown in field for the evaluation with the comparison of non-mutated seeds. Data were recorded, and mutated library was developed. Selection of promising accessions were done on the base of statistical analysis and recommended for the variety development in future.

Key Words: Climate change; Crop production; Sunflower; Colchicine; UV Rays

CHEMICAL COMPOSITION OF ESSENTIAL OILS OF NATIVE PLANTS AND EVALUATION OF THEIR POTENTIAL AGAINST *AEDES AEGYPTI*

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Aedes aegypti L. (Diptera: Culicidae) mosquito is an important vector of chikungunya, dengue and yellow fever. (DEET) is commonly used for personal protection against mosquito bites. Fresh aerial parts of *Erigeron canadensis*, *Conyza sumatrensis*, *Chenopodium ambrosioides*, *Eucalyptus camaldulensis*, *Parthenium hysterophorus*, *Mentha spicata* and *Tagetes minuta* were used to extract essential oils through steam distillation. The essential oils were screened for their repellent potential against Ae. aegypti. Chemical constituents of essential oils were accomplished by gas chromatography-mass spectrometry (GC-MS). The essential oil of *M. spicata*, *E. canadensis*, *P. hysterophorus*, *C. sumatrensis*, *T. minuta*, *C. ambrosioides*, and *E. camaldulensis* exhibited 100%, 80%, 63.9%, 51.4%, 50.2%, 39.7%, and 13.7% mosquito repellent activity, respectively, at a concentration of 0.03 mg/cm². Limonene (23.2%, 41.3%), and cis-lachnolphyllum ester (33.3%, 6.5%), were present as major compounds in both *C. sumatrensis* and *E. Canadensis*, respectively. *M. spicata*, *P. hystrophorous* and *T. minuta* essential oils contained germacrene D (36.6%), dihydrotagetone (20.9%) and piperitenone oxide (47%). This study suggests that the essential oil of *M. spicata*, *E. canadensis* and *P. hysterophorus* have the potential to be used as alternatives to synthetic mosquito repellent.

Key Words: *Aedes aegypti*; Essential oil; DEET; Repellent; Chemical composition

EFFECTS OF LONG-TERM CARNITINE SUPPLEMENTATION ON GENES INVOLVED IN FATTY ACID METABOLISM AND CHOLESTEROL SYNTHESIS IN AGED ANIMALS

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Fatty acid disorders and metabolic diseases are the major hindrance in aged animals, which even leads to the death. Owing to limited scientific understanding on this concern, to see the effect of carnitine on different metabolic pathways. Therefore, we used the dietary L-carnitine in the diet of mice for 21 months. The dietary L-carnitine is a metabolite which is important for the energy production from free fatty acid through β -oxidation in the mitochondria and is essential for the transportation of fatty acids. There is reduction of energy production in the liver of animal during aging process. Carnitine palmitoyl transferase 1 (CPT-1A) causes the production of acyl-carnitine in a combination of L-carnitine and acyl-CoA, which transports into the mitochondria for β -oxidation. Based on these facts, the main aim of present study was, to investigate the effect of dietary L-carnitine administration on metabolism in the liver of aged mice.

Key Words: Carnitine; Fatty acid; Mice

IMPACT OF COMBINED APPLICATION OF RHIZOBIA AND BIOCHAR ON THE PRODUCTIVITY OF SUNFLOWER UNDER DROUGHT STRESS

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Drought stress hampers the productivity of field crops in arid and semi-arid regions of the world. The present experiment was conducted to evaluate the synergistic effect of rhizobia and biochar for improving the productivity of sunflower under drought stress. The study indicated that drought stress negatively affected the growth and yield attributes of sunflower. Drought stress reduced the yield of sunflower up to 25%. However, rhizobial inoculation and biochar significantly improved plant height, stem diameter, root length, shoot length, dry weight of shoots/roots, relative water contents, head diameter, seeds per head, 1000-seed weight and yield. Moreover, combined application of biochar and rhizobia performed was better than their sole application. In conclusion, combined application of biochar and rhizobial consortium improved the growth and yield of sunflower under drought stress conditions. However, site specific evaluation of these findings is needed to confirm the potential of selected strain to verify these results.

Key Words: oilseeds; biochar; rhizobia; sunflower; seed yield

FOLIAR APPLIED LEAD CHLORIDE AND LEAD NITRATE INDUCED GROWTH, PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN RICE

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Lead (Pb) is one of the heavy metals which can severely affect plant growth and development. In urban and peri-urban agricultural areas, the valid assessment of low Pb accumulation by plant species/genotypes is necessary for the successful production of Pb safe food crops. Therefore, a pot study was conducted to evaluate the effect of foliar application of Pb salts on growth, physiological processes and tissue concentration of Pb in rice. The present study was comprised of two factors: a) foliar application of Pb as lead chloride ($PbCl_2$) and lead nitrate i.e., $Pb(NO_3)_2$, along with an uncontaminated control and b) fourteen rice genotypes, arranged in completely randomized block design each with three replications. The results showed a devastating nature of $Pb(NO_3)_2$ treatment than $PbCl_2$ on growth such as plant height, straw dry matter and yield, and physiological attributes like photosynthetic rate, transpiration rate, stomatal conductance of rice genotypes. Among rice genotypes, with foliar Pb application, Shaheen Basmati and KS-282 showed better growth, yield and physiological attributes, low Pb concentration in rice straw and paddy. These both rice genotypes were identified as a valuable resource that can be used by farmers or in advance rice breeding programs targeted to increased Pb tolerance.

Key Words: Pb pollution; Accompanying anion effect; $PbCl_2$; $Pb(NO_3)_2$; Rice growth

EVALUATION OF ANTIFUNGAL POTENTIAL OF LEAF EXTRACT OF *CHENOPODIUM MURALE* AGAINST *FUSARIUM OXYSPORUM F. SP. LYCOPERSICI*

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The present study was performed to evaluate antifungal activity and GC-MS analysis of leaf extract of *Chenopodium mural* against *Fusarium oxysporum f. sp. lycopersici* (FOL), a highly problematic soil-borne pathogen of tomato. Dried leaves of *C. murale* were extracted with methanol for 2 weeks and after evaporating the solvent on a rotary evaporator, antifungal bioassay was carried out against FOL. All concentrations (1% to 5%) significantly reduced FOL biomass by 14–45%. The remaining methanolic extract was fractioned with n-hexane, chloroform and ethyl acetate and all these fractions were assayed for their antifungal potential. A 200 mg mL⁻¹ concentration of various sub-fractions reduced fungal biomass significantly by 94-98% over control. All the sub-fractions were subjected to GC-MS analysis that revealed presence of 32 compounds in n-hexane, 2 compounds in chloroform and 13 compounds in ethyl acetate sub-fraction. The predominant compounds in n-hexane sub-fraction were hexadecanoic acid, methyl ester (14.64%), methyl linolenate (16.61%) and γ -sitosterol (13.53%). In chloroform sub-fraction, bis (2-ethylhexyl) phthalate (92.31% and in ethyl-acetate sub-fraction, ethyl butyrate (19.57%), dihexyl phthalate (11.19%) and dioctyl phthalate (12.16%) were present in higher concentration.

Key Words: Antifungal; *Chenopodium mural*; *Fusarium oxysporum*; GC-MS analysis; Leaf extract

ENGINEERING THERMOTOLERANT RUBISCO ACTIVASE: TOWARDS EFFICIENT PHOTOSYNTHESIS IN CHANGING CLIMATE

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More than 90% of crop biomass is product of photosynthesis. Therefore, many crop scientists believe that enhancing photosynthesis would increase crop yield. However, photosynthetic efficiency is limited by RuBisCO catalysed CO₂ fixation through Calvin Cycle. RuBisCO 'the most abundant protein on earth' is synthesized in an inactive form and gets activated to become catalytically competent by another enzyme called RuBisCO activase (RCA). RCA is a nuclear encoded, cytosolic synthesized, plastid protein which is very sensitive to increasing climatic temperatures. In earlier studies, ectopic overexpression of barley and maize RCA in rice proved to be ineffective in increasing photosynthetic rate. In another study, it was proved that decreased RCA activity brought about thermo-sensitivity in *Arabidopsis thaliana*. By analyzing various studies critically, it has been demonstrated that engineering thermo-tolerant species-specific RCA would improve photosynthetic efficiency and subsequent productivity of important crops under current climate change scenario.

Key Words: Photosynthetic rate; Heat Tolerance; Engineering; RuBisCO; RuBisCO activase

INVESTIGATIONS ON INTERNAL MORPHOLOGICAL AND ENZYMATIC MODIFICATIONS IN THERMO-VULNERABLE AND THERMO-TOLERANT GENOTYPES OF OKRA EXPOSED TO HEAT STRESS

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Changing climate is increasing the threat of heat stress in plants due to their sessile nature. In this study behavior of thermo-tolerant (Sabaz pari and Green wonder) and thermo-vulnerable (Click-5769 and MF-03) okra genotypes was observed under heat stress (45 °C). The results revealed a significant reduction in plant growth (root length, shoot length, plant fresh weight, plant dry weight and leaf area), leaf water relations (leaf osmotic potential, relative water contents, turgor pressure and water potential) and physiological activities (photosynthesis rate, stomatal conductance, transpiration rate and water use efficiency) under high temperature stress. Whereas, increase in antioxidant enzymes such as ascorbate peroxidase, glutathione peroxidase, catalase, peroxidase and super oxide dismutase was observed in tested okra genotypes to mild the adverse effects of heat stress. Overall, high temperature badly influenced different morphological, physiological and water relations of plants and reduced number of pods per plant, pod weight and number of viable seeds in pods more in thermo-vulnerable genotypes as compared to thermo-tolerant genotypes of okra.

Key Words: heat stress; okra; morphology; physiology; water relations; antioxidant

EFFECT OF WEATHER SHIFT ON PLANT DISEASE DISTRIBUTION IN PUNJAB, PAKISTAN

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In Pakistan weather shift has emerged as a serious concern for agriculture especially for vegetable and ornamental plant. Investigations conducted against regular field crops like sunflower, sesame, maize and perishable crops Gladiolus, Tomato, Bitter Gourd and onion against most commonly occurring pathogens viz Macrophomina phaseolina, Alternaria alternata and A porri spp, Fusarium spp and Myrothecium roridum from 2007-2016 on disease distribution pattern of Root rot of Peanut, Stalk rot of maize, Myrothecium leaf spot of Bitter Gourd, Charcoal rot of Sesame and Purple Blotch of Onion. Comprehensive surveys were conducted to identify changes in the distribution pattern of major diseases in relation to different geographical zones. Main objective of these studies was to acquire knowledge about the variation in terms of prevalence, The climate change also affected on Sporulation, morphology and adaptability physiology. The severity was measured on a 0-5 visual rating scale. Some of the studies for post harvest quality deterioration in fruit and vegetable markets were also co related with weather shift. Data was collected from five Agro ecological zones in Punjab province. In these zone farmers concern was noted as Change in inputs requirement: especially irrigation, pesticides and fertilizers, Marketing instability, Post harvest processing, Crop phenology. There is need for regular monitoring of the cropping systems and isolates of the most commonly occurring pathogens.

Key Words: Climate change; plant pathogenic fungi; weather shift; plant diseases; field and perishable crops

COMPARISON OF AGRICULTURE ENERGY USE FROM DIFFERENT SOURCES FOR AN IMPROVED ENERGY EFFICIENCY AND FARM PRODUCTIVITY

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The energy consumption in different sectors and their share in economic activity show that rate of return in agriculture is higher than industrial and services sector, but energy consumption in agriculture is decreasing continuously. This study compares agriculture energy use in the form of diesel, electric and biogas tube well and its impact on wheat output to ensure the efficient energy system as well as improving productivity of the fields. In this regard, data is collected from 45 wheat farmers of Lahore district by face to face interview in which we take 15 observations of each type of Tube well. Descriptive analysis of tube wells under study was rendered on the basis of farmers' land attributes, operation and maintenance of tube wells, input output analysis of farm fields and satisfaction level of farmers related to their target energy source. The results witnessed highest (2.97) input to output ratio followed by electric (1.93) and diesel (1.83) tube well respectively. It was also observed that farmer using biogas tube wells were highly satisfied as compare to electric and diesel tube well respectively. Therefore, it is strongly recommended that policy makers must take necessary step to shift farmers from conventional energy source to cheap and efficient energy source of farming that significantly improve the productivity and income of the farmers.

Key Words: Agriculture; Energy; Biogas; Productivity; Economics

BIOFORTIFIED HIGH ZINC WHEAT: AN INNOVATIVE INTERVENTION TO NUTRITION SECURITY IN CHANGING CLIMATE

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The climate is an essential input in agricultural production to sustain natural resources, biodiversity, and human and livestock population. However, a change in climate tolls heavily on productivity and quality of agricultural crops. Reduction in nutrient minerals (zinc, iron, iodine) and vitamins (A&D) is affecting 100 million inhabitants in Pakistan. Resultantly, about 44% children under 5 years are stunted, 32% underweight and 15% wasted, while, 54%, 40% and 39% are at risk of deficiency of vitamins (A&D) and zinc nutrient, respectively. Furthermore, the footprints of malnutrition also tolls to US\$ 7.6 billion annually (equals to 3% of GDP). The intensive farming has resorted to the depletion of nutrients, i.e., nitrogen, -54; phosphorus, -281; potassium, -185; zinc, -0.9 and boron, -0.7 (000 tons per year). The endemic deficiency syndrome could be addressed by consumption of biofortified high zinc wheat. Recently, Pakistan Agricultural Research Council under National Agricultural Research System has recently released biofortified high zinc wheat variety “Zincol-2016” has released for general cultivation. It contains more than 37 microgram zinc per gram (+12 over baseline, in conventional varieties), highly competitive in yield, resistant to diseases including stem rust Ug99. This variety can be cultivated over years and specifically suitable for small farming households in rural areas.

Key words: Biofortified wheat; Variety Zincol-2016; Zinc malnutrition; Climate smart agriculture

CHARACTERIZATION OF RALSTONIA SOLANACEARUM STRAINS FROM DIFFERENT AGRO-ECOLOGICAL ZONES OF PAKISTAN AND STUDYING THEIR VARIABILITY

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Bacterial wilt caused by *Ralstonia solanacearum* is one of the major constraints in the production of chilies in Pakistan. In the present studies, 114 strains of *R. solanacearum* collected from different agro ecological zones were characterized and variations were studied among them. Of all the 114 strains, 88 with positive hypersensitive response (HR) showed mucoid growth while 26 strains having negative HR were found non mucoid and avirulent. All the 114 strains showed positive responses to all the biochemical tests used for confirmation of the bacterium. All the strains gave bands at 750 bp with egl gene, at 400 bp with flic gene and at 281 bp using the universal primers 759/760 which confirmed that all the strains were *R. solanacearum*. Out of 114 *R. solanacearum* strains, 92 (81%) were identified as Biovar 3, while the remaining 22 (19%) were recognized as Biovar 4. Biovar 3 was recorded from all the four provinces while Biovar 4 was found in the Punjab and Sindh provinces only. Of all the 114 strains of *R. solanacearum* consisting of biovar 3 and 4, 22.8% were found avirulent, 25% weakly virulent, 29.3% virulent and the remaining 21.9% were highly virulent. Among 92 *R. solanacearum* biovar 3 strains, 21.7 % were identified as avirulent, 25% weakly virulent, 34.4% virulent and 22.8% were highly virulent in the eight agro ecological zones of the country. Similarly, out of 22 *R. solanacearum* biovar 4 strains, 27.3% each were detected as avirulent, weakly virulent and virulent wh

Key Words: biovar; agro-ecological; distributive variations; bacterial wilt; strains

ASSESSING THE VULNERABILITIES OF CURRENT AND FUTURE PRODUCTION SYSTEMS: A CASE STUDY OF RAIN FED REGION OF PUNJAB

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Mankind has been put in peril and there are many reasons for it, but Climate change precedes other reasons. Problems of poor farming communities have been augmented due to the menace of climate change. This study endeavors to find out the effect on farming communities of both climate change and without climate change. To carry out the study three different districts were selected (Rawalpindi, Chakwal, Layyah). Impact of the climate vagaries on per capita income, farm returns and poverty of the respondents were taken into consideration. To pull through pathways analysis Regional Representative Agricultural Pathways had been put to use. Trade off Analysis Model for Multidimensional Impact Assessment (TOA-MD) model was used for economic analysis. Results lends credence to the aforementioned nuisance of climate change as the findings which came through were negatively effecting farm returns, per capita income and poverty of the farmers. The negative impact is for current and for future production system as well. Farmers are up against the wall because of climate change and they will have to adopt new innovations to raise their productivity.

Key Words: Climate change; Punjab; adaptations; income; wheat

CHALLENGES AND OPPORTUNITIES FOR SUSTAINABLE WEED MANAGEMENT IN PAKISTAN UNDER CHANGING CLIMATE: LESSON LEARNED FROM AUSTRALIA

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Despite other abiotic and biotic obstacles, weeds are among the major biological threats towards the productivity and sustainability of crop production systems in Pakistan. It is predicted that extreme weed infestation can cause 36 million tonnes yield losses, accounting for 3 billion USD annually in Pakistan. Numerous agronomic, climatic, institutional, and socio-economic constraints are highlighted as a major hindrance toward achieving the goal of long-term weed management in various cropping systems. Limited farm mechanization, non-judicious herbicide use, evolutionary herbicide-resistant, weed population shifts, invasive weed pressure, and poor farmer's education, are potential challenges to exert detrimental impact of agricultural growth in Pakistan. Focusing the productive dimension of food security, studies need to understand the substantial impact of predicted climate change on the biology and management of weed species, particularly their invasion and herbicide-resistant weeds. Based on cropping systems, understanding the eco-biological and physiological aspects of weed management would also helpful in designing strategic tillage options for specific weed species or populations. Rapid technological innovations, long-term and reliable institutional policies, improved research standards, and advance farmer's education and/or extension activities will contribute significantly in mitigating the adverse impacts of climate change on weed management in cropping systems.

Key Words: climate change; weed management; invasion; competition; herbicide efficacy

EFFECT OF DROUGHT STRESS ON SOIL ORGANIC MATTER DYNAMICS AND SOIL HEALTH OF NORMAL AND SALINE SOIL

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Due to anthropogenic activities, greenhouse gases (GHGs) emissions, especially CO₂ emissions have increased alarmingly, leading to climate change. These climatic changes result in uncertain rainfall causing drought stress and elevated global temperature which have direct impacts on soil health and its functioning. Soil salinity is also increasing because of climate change. The aim of this research was to elucidate the effects of drought stress on soil organic matter dynamics and health of normal and saline soils. An incubation experiment was carried out in controlled conditions where 50 g soil was used. Three different moisture levels optimum conditions, moderate drought and severe drought stress were maintained in normal and saline soils. Microbial biomass C as well as cumulative C-CO₂ emissions were significantly higher in saline soils at optimum conditions compared with normal soil. While under drought stress, it was reverse than optimum conditions. Enzymatic analyses revealed that soil extracellular enzymes activities i.e. glucosidase, Phosphatase, Leucine amino peptidase activity was significantly high at optimum conditions in saline soil while chitinase activity was also increased in saline soil but at moderate drought stress. It was concluded that saline soils showed microbial activities which decreased with increased drought stress.

Key Words: Drought Stress; Saline Soil; CO₂ emission; Extracellular enzyme activities; Soil Health

ENTREPRENEURIAL MINDSET FOR AGRI-BASED BUSINESS

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Entrepreneurship is defined as pursuing an opportunity, irrespective of the ownership and availability of resources. An entrepreneurial mindset leads to a world view which is very different than the traditional world view. The traditional world view emphasizes on strategy, planning, resources and formal systems. This approach is time consuming and most of the time does not work as resources have to be arranged before the beginning of the task. The entrepreneurial mindset approach (effectual approach) works the other way around. In this world view, the entrepreneur looks at who he is, what he knows, and whom he knows. In this approach it is implied that there is significant amount of resources surrounding the entrepreneur. The entrepreneur uses these resources in a wise manner based on a principle called "Affordable loss" leading to a low risk proposition. This world view emphasizes on calculated risk taking, collaboration and action orientation. The subject paper describes the entrepreneurial mindset and discusses its application in the agriculture sector. A few case studies are discussed to explain its application.

Key Words: entrepreneurial mindset; Affordable loss; agriculture sector; Planning; Resources

WOMEN PARTICIPATION LEVEL IN AGRICULTURE ACTIVITIES FOR SOCIO ECONOMIC-DEVELOPMENT

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Women in Pakistan are playing an important role in the society, with the majority living in rural areas. The status, employment and work performed by women in society are instrumental for economic growth of a nation. Agriculture is the predominant source of livelihood for almost 60% of the population and a major source of poverty reduction in rural area. Women are as important labor force of agriculture sector as men but still their contribution is not visible, though they are actively undertaking all the agricultural related activities from household to farm level. Current study was designed to examine their participation level in different agricultural activities, information sources and problems faced in performing these activities. The study was conducted in District Faisalabad. A sample size of 120 respondents was taken during purposive sampling. Interview schedules were designed keeping in view the guideline developed by FAO for data collection. It was concluded that women played a very important role in all the activities related to agriculture. Household activities, picking of cotton, crop production and vegetable production were major activities performed by rural women. TV, agriculture help line, mobile phone and radio were information sources related to agriculture. It was recommended that extension organization must arrange capacity building trainings by involving female extension workers for rural women.

Key Words: Rural; Women; Agriculture; Crop production; Information sources

BIOCHAR AND CHEMICAL FERTILIZER ENHANCED RADDISH (*RAPHANUS RAPHANISTRUM*) GROWTH AND BIOMASS PRODUCTION BY IMPROVING SOIL AVAILABLE NUTRIENTS AND ORGANIC CARBON IN ALKALINE SOIL

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Biochar is recalcitrant carbon (C) rich material developed from pyrolysing the biomass waste under no or limited supply of oxygen. Biochar generally imparts multiple benefits to soil-plant systems; however, these benefits vary across soils and climatic conditions, and depends on feedstock type and pyrolysis conditions. In the light of this discussion, a pot experiment was used to investigate the effects of corncob-derived biochar on raddish (*Raphanus raphanistrum*) biomass production and soil biochemical properties in the presence of chemical fertilizer in nutrient poor alkaline aridisol. Biochar was applied at 0, 1.5 and 3% w/w basis whereas recommended chemical fertilizer (RCF) was applied at 0, 50 and 100% RCF rates following completely randomized design (CRD) using three replicates per treatment. Experiment was conducted for 12 weeks and changes in plant parameters and soil biochemical properties were recorded. Biochar and mineral fertilizer enhanced raddish biomass and significantly improved soil biochemical and nutrient properties including soil mineral N, phosphorus and potassium contents whereas mineralizable C was the lowest at higher biochar application rates. The results also demonstrated that biochar increased nutrient use efficiency of chemical fertilizer. We concluded that biochar has the potential of increasing soil fertility, organic C contents and plant biomass in organic matter deficient alkaline soils of arid and semi-arid regions.

Key Words: Biochar; Raddish; Mineral fertilizer; Soil organic matter; Arid agriculture

SUBSTITUTION OF VEGETABLE PROTEIN INGREDIENTS WITH HI-PRO FISH MEAL AND ITS EFFECT ON WHOLE BODY COMPOSITION AND PROTEIN QUALITY IN ROSS-308 BROILERS FROM DAY 1-21

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A study was envisaged to evaluate the effect of gradually adding up protein share from fish meal replacing vegetable protein ingredients in semi-purified broiler starting diets. Four hundred and twenty-five (n=425) 1-day-old broiler chicks (Ross-308) were randomly distributed to 5 dietary treatments. Each treatment had 5 replicates (17 birds/ replicate). Five iso-proteinic (CP 18%) and iso-caloric (ME 2950 Kcal/ Kg) broiler starting diets (day 1-21) with 0, 25, 50, 75 and 100% fish meal substituting soybean meal, canola meal and sunflower meal on protein equivalent basis were formulated. Feed intake and body weight was recorded weekly to determine protein intake and protein efficiency ratio. On day 1st, four day old chicks were randomly selected and killed by cervical dislocation to determine the baseline whole body composition. On day 7th, 14th, and 21st, two birds from each replicate were randomly selected and fasted for four hours with free access to water. Birds were weighed, killed and whole bodies of the birds including digestive tract and feathers were dried in hot air oven at 65°C. Nitrogen retention was calculated by difference between the whole-body nitrogen (N) on day 7th, 14th, and 21st day and the corresponding whole body baseline N. Data were analyzed using GLM procedure under CRD. Means were compared using Tukey's test. Significantly higher protein intake ($p=0.003$) and improved protein efficiency ratio ($p=0.048$) were observed by birds fed on diets containing 50%

Key Words: Fish meal; vegetable protein; protein utilization; protein Intake; protein efficiency ratio

CAPACITY BUILDING OF SMALLHOLDER RICE GROWERS: IMPLICATIONS FOR OUTREACH ORGANIZATIONS

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Rice (*Oryza sativa* L.) is feeding more than half of the world's population. It is cultivated in almost 114 developing countries for food, income and employment generation. Ninety percent share of rice production is contributed by the Asian countries. Like other Asian states, it is also the staple food in Pakistan. Ironically, rice production is continuously dwindling due to many factors including less effective performance of public and private agricultural extension organizations in capacity building of rice growers. Therefore, the present study "Outreach Organizations' Consequences & Implications about Capacity Building of Rice Growers" was designed to improve effectiveness of extension work in the provinces. Gujranwala was selected as the study area because it was the largest rice producing district in the Punjab province. A sample of 342 drawn from the list of 2,365 rice growers registered by public and private sectors in Gujranwala, were interviewed. Data were collected through a well prepared, reliable and validated interview schedule along with observations and focus group discussions. The data were analyzed with Statistical Package for Social Sciences (SPSS). It was found that rice growers were more aware about comparatively old rice varieties. Rice growers were mostly relied on chemical management of rice nursery and almost not using biological management. The authors conclude by suggesting that both sectors should inculcate climate friendly technologies to growers.

Key Words: outreach ; capacity building; smallholder ; organizations; rice growers

SUSTAINABLE DAIRY PRODUCTION THROUGH FEEDING AND NUTRITIONAL MANAGEMENT

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Buffalo and cattle are our main dairy animals making 30% of the total livestock. These dairy animals mostly strive on low-quality feed stuffs including roughages and crop-residues with poor nutritive value resulting in poor production and reproduction performance. Recent investigations show that there is also issue of unjustified feeding without considering the production and physiological stages of dairy animals resulting in overfeeding of non-productive and under-feeding of productive-animals leading to poor feed use efficiency. Furthermore, for the growing heifers do not have any efficient feeding system keeping in view their feeding requirements that could reduce their age at puberty with significant reduction in the cost of feeding. Similarly, early weaning of calves is very effective way without any adverse effects on growth when given free access to good quality calf starter and it could add to dairy economics. Fodder scarcity during certain time of the year in Pakistan is another constraint toward sustainable dairying. Developing innovative approaches and solutions (hay and silage making) to these scarcity periods and developments in dairy nutrition; like establishment of nutrient requirements for dairy animals, adopting group feeding practices of dairy animals according to stage of lactation and production status, proper feeding systems for growing heifers and effective milk replacer feeding for calves could effectively lead to sustained dairy production in Pakistan.

Key Words: dairying; feeding management; resource use efficiency; feeding system; nutrition

GROUNDWATER GOVERNANCE IN PAKISTAN: COMMON PERSPECTIVES AND NARRATIVES

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Groundwater resources are playing an increasingly important role in sustaining agro-ecosystems and ensuring food security. However, the sustainability of groundwater resources in many parts of the world is subject to a number of challenges, including over-extraction, deterioration in quality, and vulnerability to the impacts of climate change and population growth etc. Given the current state of groundwater resources in Pakistan, it is of great concern to the policymakers to manage groundwater resources by changing the “rules of the game” i.e., limiting the groundwater extractions and putting a stop on polluting groundwater aquifers by formulating and implementing groundwater governance laws. It is being argued that governing the commons through commons is the right approach in common-pool resource management. Within this context, understanding and valuing the immediate stakeholders’ (groundwater user farmers) narrative and their perceptions about groundwater resources can help in resource conservation. This study is based on a cross-sectional survey data of 200 randomly selected small-scale farmers from the semi-arid agricultural plains of the Indus River Basin, Pakistan. The study results indicate that a vast majority (68%) of the respondents believes that groundwater belongs to God whereas 21% respondents believe that it is an individual's property. Only 10% respondents think that groundwater is an open access common-pool resource and only 1% respondents reckon groundwater.

Key Words: Groundwater governance; Groundwater depletion; Sustainable groundwater management; Indus Basin; Pakistan

INNOVATION IN COMMERCIAL PHOSPHATIC FERTILIZER FOR ENHANCING PHOSPHORUS USE EFFICIENCY AND YIELD OF WHEAT UNDER CLIMATE CHANGE SCENARIO OF PAKISTAN

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Wheat is facing issue of availability of phosphorus (P) on alkaline and calcareous soils. It is depicted from phosphatic fertilizer use efficiency which is seldom increased to 10% on farmer's fields and 25% in research experiments. This low efficiency of P seriously affects grain yield. To resolve this problem, HEC has granted project to improve P use efficiency. Among different possible solutions one is to avoid precipitation and fixation of P coming from added phosphatic fertilizers. This can be done by coating phosphatic fertilizers with appropriate organic polymer. Different experiments were conducted to investigate the effect of coated Diammonium phosphate (DAP), Triple super phosphate (TSP), Single super phosphate (SSP) and Nitrophos (NP) on P release in soil over different time intervals. Results revealed consistent release of Olsen's P in soil till the end of experiment in soil treated with coated phosphatic fertilizers. This P release pattern was also consistent in soil kept at different moisture levels of 25, 50, 75 and 100% of field capacity as compared to uncoated P fertilizers treatments. The application of polymer coated phosphatic fertilizers at recommended as well as reduced rates increased wheat plant height (12-20%), grain yield (15- 24%), P uptake (20-34%) and P use efficiency (30-53%) under field conditions over control. The overall results indicated maintenance of prolonged P availability in the soil treated with polymer coated phosphatic fertilizers

Key Words: Coated phosphatic fertilizer; moisture level; Wheat yield; phosphorus use efficiency; reduced rates

Poster Presentations

FARM HOUSEHOLDS MITIGATION OF CLIMATE CHANGE INDUCED FLOOD RISKS: ROLE OF PUBLIC-PRIVATE AND COMMUNITY INTERVENTIONS

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This research aims to evaluate the existing practices, roles and interventions directed to minimize flooding impacts either ex-ante or ex-post while keeping in view the prevailing institutional support mechanism. Using data from household survey of 250 farmers, the study explores roles of households' voluntary contribution through labor in flood risk mitigating activities under the auspices of local public or private community organizations. An account of the impact of public compensation in a previous event is also provided in order to ascertain the effectiveness of such intervention. Using bivariate and multivariate analysis of the data including Chi square and regression analysis, results are indicative of mixed roles of aforementioned interventions. It revealed that flood affected community offered with labor-based interventions for flood-protection schemes are relatively better placed in terms of saving their belongings and family members. On the other hand, vast majority of respondents rely on private risk-mitigating measures ex-ante but rely mostly on institutions and community organizations in the aftermath of the event. Private coping and mitigation measures are also influenced by previous flood experience. On the contrary, less than 20 percent households report that they do not rely or expect public compensation at the expense of the loss of their assets, however, the amount of public compensation significantly impacts flood management options.

Key Words: Charity hazard; Value; Willingness; Adaptation; Management

IMPACT ASSESSMENT OF SMOG ON HUMAN HEALTH

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Smog is the combination of different type of gases and particulates. Smog is caused by the coal burning, crop residual burning, and industrial smoke directly released into the atmosphere without any treatment. It results in a variety of illness especially respiratory and cardiovascular sickness diseases. Smog has negative effect on crop growth as well. The study was planned to monitor the effect of smog on crop growth and human health. The data regarding different diseases such as respiratory tract infection, asthma, heart disease, stroke and allergic conjunctivitis were collected from patients both out-patients departments (OPD) as well as emergency wards from Allied hospital, Faisalabad during smog days in 2016 and 2017. A proforma was developed and filled from urban and peri-urban areas of Faisalabad to assess the effect of smog on human health in which eye irritation problem, allergic problem, breathing problem and accidents due to low visibility were reported. The results showed that the impact of smog on human health was greater in urban areas as compared to rural areas of Faisalabad and the effect of smog on human health was more in 2016 as compared to 2017.

Key Words: crop residue burning ; industrial smoke; human health; irritation; respiratory infection

DIETARY INCLUSION EFFECTS OF CITRUS PULP ON NUTRIENT INTAKE, RUMINAL CHARACTERISTICS AND ECONOMICS OF FEEDING IN BUFFALO BULLS

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The study was conducted to evaluate the effects of dietary inclusion of dried citrus pulp (DCP) on nutrient intake, digestion kinetics and economics of feeding in cannulated Nili Ravi buffalo bulls. Four iso-caloric diets and iso-nitrogenous diets were formulated containing 5, 10, 15 and 20% DCP and represented as LDCP (low dried citrus pulp), MDCP (medium dried citrus pulp), HDCP (high dried citrus pulp) and VHDPC (very high dried citrus pulp), respectively. Cannulated bulls were fed these diets in 4x4 latin square design. The experiment was continued for 84 days. Each experimental period was of 21 days. Chemical composition of DCP revealed it an excellent ingredient for ruminant animals. Bulls fed HDCP and VHDPC diets showed higher nutrient intakes than those fed LDCP and MDCP diets. An increasing trend was observed in rumen pH and rumen ammonia nitrogen with the increasing levels of DCP in the diets. Similar trend was followed in dry matter and neutral detergent fiber degradability and extent of digestion with increased levels of DCP in the diet. There was linear reduction in price/kg feed as the level of DCP was increased. Feed intake, ruminal characteristics and extent of digestion were higher while price/kg feed was lower in buffalo bulls fed HDCP and VHDPC diets.

Key Words: Citrus pulp; Feed ingredient; Buffalo bull; Rumen characteristics ; Economics

ENDOPHYTES AND PHOSPHORUS APPLICATION IMPROVED MAIZE GROWTH IN LEAD CONTAMINATED SOIL

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Lead (Pb) is considered as an important environmental contaminant coming from different natural and anthropogenic sources. Pb is also toxic to all living organisms and enters plants tissues from contaminated agricultural land and suppresses plant growth. A pot experiment was conducted to evaluate the combined effect of plant endophytes (*Bacillus* spp. MN-54) and phosphorus (P) on maize growth in a Pb contaminated soil. Pb was applied at 250 and 500 mg/kg dry soil using lead sulphate (PbSO₄). P was also applied at 100% of recommended dose in some combinations. Endophytes treated maize (DK-6714) seeds were sown in 30 days aged soil. Results showed that Pb negatively affected the plant growth and significantly reduced the seed germination, root and shoot lengths, fresh/dry root and shoot weights. The current fluorescence yield (F_t), photosynthetic electron transport rate (ETR), effective PSII quantum yield (Y_{II}), chlorophyll content, rate of photosynthesis (A) and stomatal conductance (G_s) were also negatively correlated with Pb concentrations. However, the combined application of endophytes and P proved to be effective in mitigating Pb stress and improving maize growth. Our findings have important implications in improving crop yield in Pb contaminated soil.

Key Words: Lead; Phosphorus; Endophytes; Maize; Crop production

MORPHO-PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES IN POTATO CULTIVARS TO SALINITY STRESS

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Soil salinity is considered as one of the major consequences of global climate change which negatively affects the agricultural yields worldwide. The situation has led to elucidate the mechanisms in plants enabling to respond different abiotic stresses and develop stress tolerance strategies in crop plants. Therefore, an attempt was made to determine the salt tolerance potential in two cultivars, three exotic and two native accessions of potato to varied levels of NaCl (0, 20, 40, 60, 80, 100, 120 mM) in vitro, based on morphological, biochemical and physiological parameters. Results indicated that Kashito, Diamant and SWP had more shoot length, fresh and dry weights at higher level of salinity than all the other cultivars assessed. These cultivars also performed better for membrane stability index, relative water content and total chlorophyll contents. These cultivars also regulated their scavenging system against ROS by accumulation of K⁺ ions, proline contents and through enzymatic antioxidant defense system (CAT, SOD, POD) to reduce cellular damage and maintain plant growth. However, physiological and biochemical processes in Amarin were badly affected under salinity stress while NS, MS and Yublo responded moderately to the salinity. It may be concluded that the consequent information may contribute towards a broader understanding of salinity tolerance in potato cultivars and will be helpful for future potato breeding program.

Key Words: NaCl; Potato cultivars; Antioxidant enzymes system; Salt tolerance

KINETICS OF ZN ADSORPTION-DESORPTION UNDER SALINE-SODIC SOILS

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Due to arid and semiarid climate, Pakistani soils are deficient in nutrients reducing plants growth in salt-affected soils. Salt stress reduces nutrient uptake and poor nutrient use efficiency, hence, requires higher amount of nutrients. Zinc (Zn) is an essential micronutrient for plant and human, many enzymatic activities are mediated by Zn in plants. Adsorption and desorption of Zn was investigated in saline-sodic soils in a pot experiment. Zinc sulfate ($ZnSO_4$) was used as source to study Zn availability in soil under saline-sodic conditions. Different Zn concentrations viz. 0, 4, 8, 16 and 32 mg kg^{-1} were applied in normal and saline-sodic soil to study adsorption-desorption behavior using freundlich isotherm Model. It was observed that maximum adsorption of Zn was found with 16 mg/kg Zn application and minimum Zn concentration was found in control. Based on isotherm, it was concluded that Zn application can ameliorate plants with nutrients under saline-sodic soils.

Key Words: Nutrients; Saline-sodic soils; Freundlich isotherm Model; Zinc; Abiotic stress

EVALUATING THE EFFECTS OF SOWING DATES AND SEED SIZE ON THE GROWTH AND YIELD OF WHEAT

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Sowing time is one of important factors affecting yield of wheat in cotton-wheat and rice-wheat cropping systems of Pakistan. However, selection of optimum seed size may have the ability to cope the problem of low yield affected by delayed sowing. An experiment was performed to assess the effects of sowing dates and seed size on the growth and yield of wheat during 2017-18. Treatments were different sowing dates (20th November, 10th December and 30th December) kept in main plots and seed sizes (bold seed > 2.7 mm, medium seed < 2.7 mm, small seed < 2.3 mm) in the sub plots. Maximum stand establishment, grain yield, 1000 grain weight, biological yield and harvest index are observed with sowing bold seed on 20th November followed by 10th December with similar seed size. Thus, seed size should be considered in agronomic studies to achieve optimum planting density under different sowing regimes.

Key Words: Wheat; *Triticum aestivum*; Sowing Date; Seed Size; Sowing Time

MICROBE-INDUCED REMEDIATION POTENTIAL IN *SPINACIA OLERACEA* IN CADMIUM CONTAMINATED SOILS

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Spinach (*Spinacia oleracea*) is a green-leafy vegetable and recognized as one of the functional foods for its wholesome nutritional, antioxidants and anti-cancer composition. Heavy metals are toxic to environment and contaminating the food chain and human health. In phytoextraction plants uptake the contaminants from the soil and translocate them to upper edible plant parts. Spinach is considered hyperaccumulator of cadmium (Cd) than common vegetable crops. A pot experiment was conducted to evaluate the potential of acidified animal manure and *Enterobacter* sp. MN 17 for enhancing spinach growth in Cd contaminated soil. The soil was spiked with three levels of Cd i.e. 0, 50 and 100 ppm as CdCl₂ two weeks before planting seeds. Acidified manure was used at the rate of 2.5% (w/v). The physiological, agronomic and chemical parameters were recorded and analyzed. The result revealed that the spinach growth in Cd contaminated soil was increased by adding bacteria (*Enterobacter* sp. MN 17) and acidified manure at the rate 2.5%. Cd up take by bacteria and slurry 2.5% was more than control but it was more in bacteria+slurry 2.5%. It was concluded that spinach potential to accumulate Cd can be improved by adding endophytic bacteria (*Enterobacter* sp. MN 17) and acidified manure (Slurry 2.5%).

Key Words: Cadmium; *Enterobacter* ; Phytoremediation; vegetables; accumulation

MOLECULAR IDENTIFICATION AND PHYLOGENETIC RELATIONSHIPS OF COTTON WHITEFLY ASSOCIATED WITH CLCV VIRUS FROM COTTON FIELDS OF PUNJAB, PAKISTAN

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Morphological characterization for identification of insect induced damage needs tedious procedure of the microscopic examination. Molecular identification and characterization based on mitochondrial cytochrome c oxidase 1 (CO1) for the invasive pest is very important for correct identification. *B. tabaci* is an important pest of cotton and its mtCO1 based identification and characterization is very important because of its high polymorphism and presence of different *B. tabaci* species. In this study, whiteflies and CLCV infected symptomatic plants were collected from cotton fields of DG Khan division, Punjab. The DNA was extracted from insect and plant samples. The genetic DNA amplification of *B. tabaci* and CLCVs with CP gene was carried out through PCR. The amplified PCR products from insects and plants were sequenced. Genetic analysis of various sequences of *B. tabaci* and associated CLCVs revealed 99-100% similarity with cotton white fly, *B. tabaci* and CLCVs reported from India. This study will help us to develop species specific *B. tabaci* control measures.

Key Words: Cotton white fly; Clcv; Molecular identification; ELISA; Phylogeny

EVALUATION OF CRY1AC EXPRESSION IN COMMERCIAL BT COTTON (*GOSSYPIUM HIRSUTUM L.*) FOR THE MANAGEMENT OF AMERICAN BOLLWORM (*HELICOVERPA ARMIGERA*) IN PAKISTAN

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Helicoverpa armigera is the most dangerous insect pest of cotton and has ability to resist the toxin produced by transgenic cotton (Bt. Cotton). The study was conducted on 11 local Bt. cotton genotypes to investigate the expression of Cry1Ac and their efficacy against *H. armigera*. Leaf samples from different positions of each genotype were taken at the age of 60 DAS to check the expression of Cry1Ac endotoxin protein via quantitative ELISA and PCR. The insect bioassays against 2nd instar larvae of *H. armigera* were used to determine the lethality of Cry1Ac endotoxin under controlled conditions. Results on protein expression and larval mortality before and after bioassays showed highly variable expression of Cry1Ac within and between the genotypes. Intra-plant variation in the expression of Cry1Ac was also significant. Through ELISA and PCR, maximum quantity and expression of Cry1Ac protein was observed in upper canopy leaves of Bt cotton plants followed by middle and lower canopy leaves. Larval mortality was maximum on the upper leaves and with minimum larval mortality on the lower leaves. The genotypes of Bt cotton having LC50 (0.79 µg/g) was found better to grow under field condition to control 50% control of *H. armigera*. The study would be highly significant for farmers and cotton breeders to develop new Bt cotton varieties for sustainable insect pest management.

Key Words: American bollworm; transgenic cotton; Cry1Ac gene expression; ELISA; PCR

ANALYSIS OF GENETIC DIVERSITY FOR SEEDLING TRAITS IN WHEAT GERMPLASM UNDER WATER STRESS CONDITION

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Exploration of genetic diversity in wheat germplasm under water stress condition has great importance for plant breeders. The study was accomplished to evaluate the effects of drought stress on wheat genotypes (22) at seedling and maturity stage during 2017-18. The data was recorded for germination %age, root length, shoot length, coleoptile length, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight and relative water content, and yield contributing traits. For seedling traits, drought was induced using polyglycol-8000 (PEG-8000) and under field conditions was developed by withholding irrigation after 1st irrigation. Analysis of variance revealed significant differences for the studied traits except germination %age. Principal component analysis accounted more variation under normal conditions (81%) as compared to drought (79%) for seedling traits. Biplot analysis revealed high genetic variation among the genotypes under investigation. The presence of high genetic diversity for seedling traits among genotypes suggest for their use in breeding programs related to drought stress tolerance.

Key Words: drought; principal component analysis; PEG-8000; varaiation; water stress

SOIL APPLIED BORON EFFECTS ON GROWTH, YIELD AND QUALITY OF WHEAT (*TRITICUM AESTIVUM L.*)

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An experiment was carried out to evaluate the response of soil applied boron (B) on growth, yield and quality of wheat at Agronomy research area, University of Agriculture Faisalabad during 2017-18. Randomized Complete Block Design was used having three replications. Size of each plot was 6.0 m × 2.25 m. The treatments were different levels of B (0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, and 4 Kg ha⁻¹). Source of B was boric acid. Boron was applied at sowing time. All other agronomic practices were kept identical except the factor under study. Results showed a significant increase in number of productive tillers, grains per spike, 1000 grain weight, grain and straw yield, biological yield and harvest index. Maximum grain yield was obtained for B applied @ 2kg/ha suggesting B application at sowing time.

Key Words: Wheat; Soil Application; Boric Acid; Boron Levels; Boron Response

NITROGEN-POTASSIUM INTERCATION EFFECTS ON ROOT NUTRIENT ABSORPTION IN MAIZE (*ZEA MAYS L.*) HYBRIDS

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The present study evaluated the role of potassium and nitrogen interaction on nutrient absorption and cation exchange capacity (CEC) of roots. Two maize hybrids (Pioneer-32 F 10) and (Hycorn-8288) were grown under different nitrogen (225, 250, 300 kg/ha) and potassium (150, 175, 200 kg/ha) levels. Various biochemical, ionic, growth and physiological parameters were recorded during the research at various crop growth stages. Results showed that maize hybrid Hycorn-8288 showed more growth than the Pioneer-32 F 10. Considering different levels of nitrogen and potassium, results showed that increase in fertilizer application rate of both the nutrients caused a gradual increase in the plant growth, root CEC, nitrogen and potassium in the plant. Thus, nitrogen-potassium interaction have positive implication for root nutrient absorption by affecting rhizosphere properties.

Key Words: Nitrogen; Potassium; CEC; rhizosphere; root growth

IMPACT OF NITROGEN ENRICHED BIOCHAR ON SOIL WATER RETENTION AND PHOTOSYNTHETIC PERFORMANCE OF MAIZE UNDER SEMIARID CONDITION

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Continuous decline in soil organic matter and intensive cultivation are progressively reducing the resilience and the water holding capacity of soil leading to poor aggregate stability, decline in soil fertility ultimately restricting the growth and yield of crop. Maize is an important staple food and used as feed for livestock. Under semi-arid climate with sandy loam texture, low organic matter and poor inherent soil fertility are one of the major causes for low yield of maize. Application of organic sources is an effective way to restore soil organic C levels and overall fertility status of soil, improving structural stability and water-holding capacity. A pot trial was conducted to observe the influence of nitrogen (N) enriched biochar on water content of soil, growth and yield of maize. Treatments were control; N + biochar@ 5% and 10% per 10 kg soil; straw + N @ 5% and 10% per 10 kg soil. Results showed that N enriched biochar improved the soil water retention to depth of 0-30 cm by 30, 21 and 50% at anthesis, milking and maturity stages respectively. While photosynthesis rate and stomatal conductance also significantly increased by 30 to 40% as compared to control at respective crop stages. It was concluded that N enriched biochar seems to be effective amendment in semiarid environment for improving plant performance.

Key Words: Fertility Decline; Biochar; crop productivity; Structural stability; Nitrogen Fertilizer

BIOLOGICALLY TREATED ELEMENTAL SULPHUR; AN INNOVATIVE APPROACH FOR RECLAMATION OF SALINE-SODIC SOILS

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Soil salinity and sodicity is escalating problem in most parts of the world especially in arid and semi-arid regions. An incubation study was conducted using soil column to investigate the leaching of soluble cations during reclamation process of a calcareous saline- sodic soil with calcium carbonate (CaCO_3) = 23.19%, electrical conductivity (EC) of 17.64 (dS m⁻¹), sodium adsorption ratio (SAR) of 28.8 (meq L⁻¹), exchangeable sodium percentage (ESP) of 29% and pH of 9.4. Treatments were control and biologically treated elemental sulphur (5%, 10%, 15% and 20%) thoroughly mixed with soil. During incubation period, an intermittent irrigation method was used to imitate natural conditions using distilled water. The results showed that calcareousness, EC, SAR, and ESP of treated soil decreased by 50%, 45%, 30% and 28%, respectively at 20% level of biologically treated elemental sulphur than other subsequent levels including control. The soil pH also decreased to 8.2 after incubation. Thus, it can be concluded that biologically treated sulphur can be an effective approach for reclaiming the saline sodic calcareous soils.

Key Words: Leachate; Salinity; Sodicity; Calcareousness; Bio-sulphur

INTEGRATED EFFECT OF COMPOST AND GYPSUM ON GROWTH AND YIELD OF RICE (*ORYZA SATIVA L.*) IN SALINE SOIL

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Rice (*Oryza sativa L.*) is an important cereal crop consumed as energy source and more than 40 percent population of world is dependent on this staple. Salinity concerns are increasing day by day in rice producing areas. Growth of rice seedlings is adversely affected by salinity and eventually decreasing the final seed yield. A pot experiment was designed to observe the response of compost along with gypsum in saline soils on growth and yield of rice. Rice plants were grown under 6 and 12 dS m⁻¹ NaCl with 0 dS m⁻¹ as control each applied with compost, gypsum and compost + gypsum at rate of 1% for each treatment under pots conditions. Recommended dose of NPK fertilizer for rice were also applied. Results showed that integrated application of compost + gypsum performed much better than all other treatments at each salinity level. Integrated treatment not only enhanced plant growth and increased grain yield but also improved the soil properties significantly. It was concluded that using compost along with gypsum can be an effective approach to improve rice performance under saline conditions.

Key Words: compost; gypsum; salinity; growth; yield

ADSORPTION OF HEAVY METALS FROM AQUEOUS SOLUTION BY DIFFERENT KINDS OF MAGNETITE: DYNAMICS OF ADSORPTION, DESORPTION AND REGENERATION

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Mobility of heavy metals is strongly influenced by their adsorption onto iron minerals in environment. Here, we report the adsorption of lead (Pb) and cadmium (Cd) from aqueous solution by using three kinds of magnetite (M1, M2 and M3), a mixed-valent Fe mineral. M1 and M2 exhibited nanometric particles (30 nm and 60 nm respectively), while particle size of M3 is in micrometric range (1.5 μ m). A reverse order was, however, noted for BET surface area (M1 (103±2) > M2 (25±1) > M3 (1.7±0.1)). Adsorption performance such as (type of magnetite, reaction time, pH, metal concentration, temperature and competitive sorption behavior) were investigated in batch experiments. Based on kinetic and equilibrium adsorption data modeling, the isotherm edges data was better fitted to Freundlich and Langmuir models (≥ 0.95), while adsorption process was better simulated via pseudo-second-order model (≥ 0.95). The optimum monolayer adsorption of (Pb²⁺ & Cd²⁺) (119, 117, 71 and 70, 56, 53 mg/g), for all tested adsorbents was in a sequence of (M1 > M2 > M3). Thermodynamically, spontaneous and endothermic ($\Delta G < 0$, $\Delta H > 0$, $\Delta S > 0$), metal ions sorption was closely associated to dipole-dipole and hydrogen bonding forces. Electrostatic attraction and surface precipitation interaction via external mass transfer between bulk liquid to solid surface interface were found to be a key pathways.

Key Words: Wastewater; Contamination; Environment; Magnetite; Adsorption

ANTIFUNGAL ACTIVITY OF *GANODERMA LUCIDUM* AGAINST PLANT PATHOGENIC FUNGI

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The antifungal activity of *Ganoderma lucidum* was investigated against plant pathogenic fungi, viz. *Aspergillus flavus*, *Macrophomina phaseolina*, *Alternaria alternata*, *Drechslera australiensis* and *Fusarium oxysporum*. Organic solvent extracts were prepared using N-hexane, chloroform and ethyl acetate. Antifungal activity was investigated by utilizing 5, 10, 15, 20 and 25 mg mL⁻¹ extract concentration. The N-hexane showed 19.67, 22.67, 42.79, 19.67 and 18.52 %, chloroform with 31.15, 40.00, 30.34, 36.07 and 38.89 % while ethyl acetate extract with 45.9, 44.78, 45.9, 45.9 and 48.15 % antifungal activity. Ethyl acetate extract showed higher antifungal activity against all fungal species as compared to n-hexane and chloroform extracts. The most susceptible fungus recorded in the present investigation was *F. oxysporum*. Gas Chromatography Mass Spectrometry (GCMS) analysis was performed on ethyl acetate extract depicting the presence of 19 compounds. Of these 19 compounds, one compound identified as 1,2- Benzenedicarboxylic acid, mono (2-ethylhexyl) ester, exhibited maximum peak area as 39.8 % followed by another compound named as Diphenylamine showing peak area 16.7 %. It was concluded that the antifungal activity observed during the present investigation was due to these compounds that can be exploited as natural antifungal compounds by pesticide industries.

Key Words: Antifungal; *Ganoderma*; GCMS; Benzenedicarboxylic acid; Fungi

FARMERS' GOAL IS A KEY FACTOR TO ADOPT ORGANIC AGRICULTURE: A SURVIVAL ANALYSIS

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The purpose of current study was to evaluate the adoption decisions of organic farming. This method was introduced in EU countries to minimize the environmental impacts; which reported earlier due to intensive use of synthetic fertilizers and pesticides to enhance production yield. Organic farming is suggested as environmentally sound methodologies for crop production but Asian farmers were found reluctant to adopt these modern methods. In this study we employed the survival analysis (SA) to conclude the reasons and time taken by farmers to adopt organic agriculture. Research encompassed by using farmers' goals, agricultural policies and attitude toward risk as covariates in survival analysis. A multiple criteria decision-making method was used to evaluate the farmers' goals in analytical hierarchy process. Data was collected from main agricultural farms of three districts of Punjab Pakistan by using questionnaire to find empirical evidence. The study found that the farmers' goals were the key point to accept organic farming; furthermore young and risk inclined attitudes added excellence in order to achieve the target. The study also distinguished the arrangement changes that have been progressively applicable in spurring appropriation of organic methods.

Key Words: Organic ; Farming; Analytical hierarchy; Farmer's goal; Agriculture

THE IMPACT OF INFRASTRUCTURAL AVAILABILITY ON WOMEN HEADED HOUSEHOLD'S INCOME AND POVERTY

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Women are playing crucial role in society and contributing in every field of life. They have been struggling to become economically independent since decades in Pakistan. They are not succeeding in their efforts because of inadequate infrastructure availability. Transportation, banking system, educational institutions, hospitals and safe drinking water constrain their uplift one way or the other. In spite of their utmost economic contribution and significance in the society, they are facing lot of difficulties in their daily life. The aim of this study is to investigate the impact of infrastructure availability on the economic situation of women-headed households in Faisalabad District. Stratified random sampling technique was used for data collection. Data were collected from one fifty (150) women headed households. Poverty line was determined at Rs. 2794.044 per person per month. Poverty among women-headed household was very high as in rural areas 70 percent respondent were poor while in urban areas, 75 percent respondent are poor. Binary logistic regression was used to evaluate the impact of different variables on poverty estimates. Results showed that the education, job experience, and secondary source of income positively affect incomes of the respondent, while access to infrastructure negatively affects respondents' income/poverty level. The study recommends that government should improve the condition of existing infrastructure to uplift the household women condition.

Key Words: Women headed-households; Infrastructure; Poverty; Stratified Random Sampling; Multiple Linear Regression

CLASSICAL AND MODERN APPROACHES FOR INCREASING RESISTANCE TO CEREAL CYST NEMATODES IN WHEAT AND BARLEY

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Cereal cyst nematodes (CCNs) are among the most important nematodal pests that limit production of small grain cereals like wheat and barley. These nematodes alone are estimated to reduce production of crops by 10% globally. This emphasizes for the enhancement of nematode resistance in cereal crops against CCNs. The improvements for nematode resistance in wheat and barley coupled with higher yields are preferential research area for cereal nematologists. This usually involved the targeted genetic exploitations through natural means of classical selection breeding of resistant genotypes and finding out QTLs associated with resistance genes. These improvements were based on available genetic diversity among the crop plants. Recently, genome-wide association studies have widely been exploited to associate nematode resistance or susceptibility with particular regions of the genome. Use of biotechnological tools through the application of various transgenic strategies for enhancement of nematode resistance in various crop plants including wheat and barley had also been an important area of research. These modern approaches primarily include the use of gene silencing, exploitation of nematode effector genes, proteinase inhibitors, chemodisruptive peptides and a combination of one or more of these approaches. Furthermore, the perspective of genome editing technologies including CRISPR-Cas9 could also be a handful for improving CCN resistance in wheat and barley.

Key Words: cereal cyst nematodes resistance; wheat and barely; biotechnology; breeding; genome editing

DYNAMICS OF ENDO AND RHIZOSPHERE MICROBIOMES FOR PLANT DISEASE RESISTANCE

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A huge number of microbes are the resident in the endosphere of the plants and prevail in the rhizospheric vicinity of the roots. Most of these microbial communities are beneficial for the plants to carry out various physiological processes. In addition to growth promotion, these microbes also help the plants to cope with the biotic stresses and harsh environmental conditions. The microbes from endosphere and rhizosphere employ different strategies to enable the plants to fight with the invading pathogens. For instance, these microbes facilitate disease resistance in plants directly and indirectly. For instance, they assist the plants through the induction of systemic resistance against pathogens by various stimuli. Similarly, synthesis of siderophores, secondary metabolites and antimicrobial compounds are very important tools used by the endophytes to suppress plant pathogens. Moreover, the rhizosphere microbiomes contain a lot of microbial species which support the plants to resist pathogen entry and establishment on the plants. The rhizospheric microbes also exploit different direct and indirect strategies to contribute towards plant resistance against diseases. In this work, we cover the dynamics of endosphere and rhizosphere microbiomes to enhance disease resistance in plants.

Key Words: Endosphere; Rhizosphere; Microbiome; endophytes; disease resistance

COMPARATIVE IMPACT OF RICE-WHEAT STRAW AND THEIR BIOCHAR ON SOIL ORGANIC MATTER STOCKS AND CO₂ EMISSION

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Increased concentrations of greenhouse gases (GHGs) in earth's atmosphere are linked with global warming and climate change. Agricultural practices especially burning of crop residues and removing plant biomass contribute towards GHGs accumulation in the atmosphere and depletion of soil organic matter (SOM) respectively. It is important to elucidate the comparative role of crop residues and their biochars on SOM decomposition and contribution towards GHGs emissions. An incubation experiment was conducted by incorporating the rice and wheat residues and their biochars at two different levels i.e. 1 % and 2 % (w/w) in jars containing 50 g soil for 55 days. The results revealed that CO₂ emissions increased with the addition of rice residues with highest emissions observed at higher level of residues. Microbial biomass carbon (MBC) increased with both residues and biochar addition at lower dose, however, biochar incorporation showed increased MBC when applied at the higher level. Glucosidase and leucine-aminopeptidase showed higher activities where a higher dose of residues was applied. Chitinase activity was increased with both biochar levels and application of residues with lower level showed increased activity of acid phosphatase. It was concluded that wheat residues and its biochar have greater potential to store soil organic carbon than rice residues and its biochar.

Key Words: Rice Straw; Biochar; SOM Stocks; CO₂ Emissions; Extracellular enzyme activities

PHYTOREMEDIATION OF SELECTIVE HEAVY METALS BY WATER HYACINTH

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Heavy metal (HMs) pollution of soil and water is a major environmental issue in recent time, and most of the physico-chemical approaches are not the acceptable solution of this problem. Phytoremediation is a cost-effective technique and have more public acceptance than chemical and physical approaches. Water hyacinth (*Eichhornia crassipes*) is a phenomenal plant to uptake these traces and accumulate them in their tissue, so it is widely used to clean wastewaters. It is fast growing plant with extensive root system and have a potential to double its population within weeks. The aim of this study was to evaluate the phytoremediation potential of *E. crassipes* for Pb and Cd. Plants were cultured in tap-water (nutrient solution was applied) and added with 2 and 4 ppm Pb and Cd, respectively. Mother plants were harvested after 25 days and the study was repeated again for same number of days. Statistical analysis expressed that increasing concentration of Cd and Pb significantly reduced the plants dry biomass as compared to control treatment. When the heavy metal concentration increased in medium, plant roots absorb more amount of HMs than stem and leaves. Cd absorption in plant parts was slightly more than Pb. Our findings suggest that *E. crassipes* plants are effective and can be used in natural and artificial wetlands for the removal of Pb and Cd.

Key Words: Contaminants; Water hyacinth; Heavy metals; Wetlands; Hyperaccumulator

EVALUATING SALT RESISTANCE IN MAIZE (*ZEA MAYS L.*) GENOTYPES

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Saline agriculture is a major problem of crop production in arid to semi-arid climate. Changing K+/Na+ ratio in leaf changes the salt tolerance level of plant and ultimately affects the yield and total plant biomass. To evaluate the effect of salts on different maize (*Zea mays L.*) genotypes a hydroponic experiment was conducted under greenhouse conditions. Experiment was conducted in randomized complete design (CRD) with different salinity levels (control, 50 mM and 100 mM NaCl) and each treatment repeated three times. A half strength Hoagland solution was used for nutrition purpose. The results showed that genotype UAF DH 32/1, UAF DH 40/3 and UAF DH 18/21 performed better at different salt levels while genotypes UAF DH 12/11, ICI 8288 and KALAK 6525 showed sensitivity against different salt concentrations.

Key Words: salinity; climate; maize; K+; Na+

PHENOTYPIC PLASTICITY OF SORGHUM (*SORGHUM BICOLOR L.*) GENOTYPES FOR SALINITY TOLERANCE

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Soil salinity is a major abiotic stress continuously increasing every day and affecting the crop growth and yield. In Pakistan, 6.67 mha agricultural land is affected by salinity and increasing day by day. Sorghum (*Sorghum bicolor L.*) is used as fodder and raw material for edible oil, alcohols, sweetening agent and wax. To study the response of twenty sorghum genotypes under salinity, a hydroponic experiment was conducted comprising three salinity levels (20, 70, 150 mM NaCl) and twenty genotypes of sorghum. The seedlings were transplanted into hydroponics maintained with desired NaCl levels and nutrient solution. At 150 mM NaCl, whole seedlings were died after one week of salinity imposition. Plants were harvested after 5 weeks of salt stress for growth assays and Na⁺, K⁺ concentrations and K⁺/Na⁺ ratio determination. The results showed that the genotypes (YSS-14 and YSS-02) produced more fresh and dry weights, less uptake of Na⁺ and more inclusion of K⁺ and performed better as compared to other genotypes under salinity. But genotype YSS-08 had very low fresh and dry biomass and also very low K⁺/Na⁺ ratio and reported as more sensitive as compared to other genotypes.

Key Words: Salinity; Genotype; Sodium; Potassium; Seedlings

GROWTH POTENTIAL AND GENETIC VARIABILITY IN PEARL MILLET (*PENNISETUM GLAUCUM*) UNDER SALT STRESS

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Pearl millet is a nutritious fodder mostly liked by the livestock breeders for grazing green-chops, herbage and silage purpose. It has good tolerance for drought and salinity, however, its growth and development is affected by salinity. A solution culture experiment was conducted in wire house by using twenty cultivars/lines of millet to evaluate genetic potential and variability among cultivars and lines against different salinity levels (20 mM, 70 mM, 150 mM NaCl). The physiological attributes including like shoot and root fresh weights, shoot and root dry weights, shoot length (SL) and root length (RL) and ionic parameters like Na⁺ and K⁺ were analysed. A significant reduction in the growth of the cultivars was observed with an increase in salinity levels i.e YBS-95 elucidated around 50 percent reduction in growth at 70 mM NaCl, While FB-803 depicted about 70 percent deduction at same salinity level. On the other hand, YBS-92 displayed 90 percent reduction in growth. It is concluded that YBS-95 is highly tolerant with highest SFW, RFW, SDW and K⁺/Na⁺ following FB-80.

Key Words: Salinity; Genotype; Sodium; Potassium; Fodder

SOIL ORGANIC MATTER CYCLING AS CONTROLLED BY N, P AND LITTER AVAILABILITY

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Soil play a key role in maintaining global carbon balance and is crucial for climate change. Due to important tie-ins among C, N, and P cycling alongside anthropogenic increase in N and P availability in soil, it is very critical to study soil carbon dynamics in response to N and P addition. Therefore, an incubation study was designed for 23 days. It included seven treatments, only N (90 kg. ha⁻¹) as (NH₄)₂SO₄, only P (60 kg. ha⁻¹) as Ca(H₂PO₄)₂, Only litter (L) (1 g C kg⁻¹ soil) and in combination; N+L, N+P, P+L and N+P+L. Un-amended soil was used as control. The results showed that enhanced respiration rate in all litter amended treatments, but the relationship was negative in treatments with N, and P alone. Respiration trends across the treatments were further confirmed by corresponding trends in dehydrogenase (DHA) & β-glucosidase (BGA) activities. Low urease activity (UA) in all N amended and high UA in N deficient treatments (P and L) supports existence of N-mining theory. Same (P-mining) was true for P deficient treatments. Rise in respiration rate and qCO₂ in NP treatment then N and P alone suggest that addition of P alleviated the negative effect of N and vice versa.

Key Words: SOM; Nitrogen; Phosphorus; enzyme activity; litter

IN SILICO IDENTIFICATION AND CHARACTERIZATION OF PAPAIN-LIKE CYSTEINE PROTEASES FROM CHICKPEA GENOME

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Papain-like cysteine proteases (PLCPs), which are structurally homologous of papain have been characterized in many plant species and known to have important roles in plant defense against certain microbial pathogens. PLCPs contain a cysteine residue at the catalytic site capable of cleaving peptide bonds in target proteins. Papain-like cysteine proteases are classified as the C1A family of clan CA and hence are also named as C1A cysteine proteases. Previously on basis of phylogenetic analysis, 31 PLCPs from *Arabidopsis thaliana* were divided into nine subfamilies. In this study, we performed genome-wide analysis of PLCPs from Chickpea (*Cicer arietinum*). Overall, 29 PLCPs were identified in the genome of *Cicer arietinum* and were analyzed through different in silico techniques. Phylogenetic analysis clustered all 29 PLCPs of chickpea into 4 main groups. Members of different groups showed various similarities among themselves in terms of conserved motifs to be identified in their peptide sequences. In the same way, gene structure analysis presented several homologies in intron-exon pattern of PLCPs of different groups. Six peptide sequences of different PLCPs from different groups were selected to determine their tertiary structure. All 6 PLCPs except cam_105851510 exhibited higher percentage of Alpha helix than that of beta sheets. Our findings provide a useful reference to characterize PLCP genes in other plants.

Key Words: Genome wide analysis; phylogeny; motif analysis; Papain-like cysteine proteases; *Cicer arietinum*

EVALUATING EFFECT OF ORGANICALLY AMENDED ROCK PHOSPHATE ON GROWTH AND YIELD OF WHEAT (*TRITICUM AESTIVUM L.*)

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Phosphorus (P) is amongst the most important nutrients required for agriculture. On alkaline and calcareous soils, the phosphorus use efficiency is very low ranging from 10 to 25%. The use of rock phosphate along with organic manures as P source, particularly in compost form, has attracted attention due to high potential to cut down cost of production. But the major problem associated with the rock phosphates is their solubility. Organic fertilizers increase the phosphorous solubility in soil by covering soil surface aggregates and buffering soil pH through the release of organic acids upon decomposition of organic matter. Microorganisms, particularly, phosphate solubilizing bacteria (PSB) have potential to improve P-availability for plants from P-complexes which are generally unavailable to plants. For which, a field experiment was conducted to evaluate the effect of bio-activated rock-phosphate (B-RP), in different combinations with di-ammonium phosphate (DAP), on growth and yield of wheat. Organic sources were applied on P-equivalent basis. The results showed that all treatments had significant effect on yield and yield attributing parameters as compared to control (No P). The combination of B-RP (50 %) and DAP (50 %) showed maximum plant height (120.3 cm), fertile tillers m⁻² (480), spike length (19.7 cm), flag leaf length (29.6 cm), 1000 grain weight (55.7 g) including grain and straw yields (4380 and 5458 kg ha⁻¹ respectively).

Key Words: Rock Phosphate; organic manures ; phosphate solubilizing bacteria; wheat growth and yield; Phosphorus use efficiency

INTEGRATIVE EFFECT OF ORGANIC AMENDENTS WITH PHOSPHORUS ON NODULATION AND YIELD POTENTIAL OF SOYBEAN (*GLYCINE MAX L.*)

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Soybean (*Glycine max L.*) is a valued oil seed and protein rich crop in the world. The crop is known by its highest protein content and also by glycerol production. In arid and semi-arid regions of Pakistan, its production becomes lower due to salinity. A field experiment was conducted at the experimental Farm of the Department of Soil and Environmental Sciences, University of Poonch Rawalakot to evaluate the interactive effect of phosphorus (P) along with phosphate solubilizing bacteria (PSB) and poultry manure (PM) on the growth, yield and nutrient uptake of soybean. Three P levels (0, 50 and 100 kg P₂O₅ ha⁻¹) and two levels of poultry manure (0 and 15-t ha⁻¹) as well four PSB strains (control, S-377, S-379 and consortium S-377 + S-379 strains) were used. Data was recorded at vegetative and maturity stages. Results indicated that combined application of P+PSB+PM displayed highest increase in the growth and yield of soybean relative to their alone application and compared with control. Nitrogen, phosphorous and potassium uptake was also enhanced in the consortial application with poultry manure and phosphorous as compared to control. Results depicted that application of phosphorous along with PSB and PM can be effective enhancing overall growth, yield, nodulation and N, P, K uptake of soybean crop relative to their sole application.

Key Words: Soybean; PSB; Poultry manure; Phosphorous; Nodulation

USING BIOCHAR FOR ROOT-KNOT NEMATODES MANAGEMENT IN TOMATO

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Tomato plant is affected by a number of microbial attacks and among them, root-knot nematodes (RKN) are the most destructive pathogen which belongs to genus *Meloidogyne*. They are carrier of many pathogens and have serious socio-economical loss in tomato crop. To manage these losses new strategy are being adopted to strengthen plant instead of killing RKNs. The present study explored the potential of biochar against RKNs. For this purpose, biochar with three variations (wheat straw, sugarcane baggas and rice husk) were used at three different concentrations 2%, 3%, and 5% along with control. Structure analysis of biochar was examined through SEM and XRD analysis. Calculated amount of RKNs were inoculated. Among all concentrations, 3% of rice husk exhibited significant results in plant morphology like plant height, number of leaves, root length, shoot fresh and dry weights. Galls, egg masses and number of females were reduced as compare to control in 3% biochar amended treatments. The physiological functions like chlorophyll contents were increased in amended and reduced in control treatments while on cell membrane stability (CMS) it showed non-significant effect after biochar application. In the other part of experiment, the exudates of these three biochars at levels 0.3, 0.5, 1.2, 2.3 and 3 were directly applied on freshly hatched juveniles but results showed that there were no direct toxic effects of biochar exudates on nematodes mortality.

Key Words: Root-knot nematode; Tomato; Biochar; nematode resistance; *M. incognita*

EFFECT OF PGPR, ORGANIC AND INORGANIC AMENDMENTS ON PHOSPHORUS AVAILABILITY AND GROWTH OF CHICKPEA

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Phosphorus (P) is one of the least available macronutrients and thus limits plant growth. In calcareous, alkaline and highly withered soil, P insolubility may be due to adsorption on clayey and lime surfaces. P-solubilizing microbes have a remarkable effect on P solubilization by producing organic acids. Seed inoculation with P-solubilizing microbes may alleviate the fixation of P and enhance its solubility and thus subsequent availability to plants. In this study, effect of simple and processed manure with two different inorganic sources single super phosphate and rock phosphate on growth of chickpea in the presence or absence of PGPR was investigated in a pot trial. One percent simple and processed manure was applied to selective pots along with plant growth promoting rhizobacteria (PGPR). Results showed that combined use of PGPR, processed manure and rock phosphate had pronounced effects on fresh and dry biomass, plant height, chlorophyll contents, number of pods and number of nodules and nutrients contents. In addition, combined use of PGPR, simple manure and single super phosphate also showed significant enhancement in yield attributes and other agronomic parameters. Our findings suggest that use of PGPR, organic and inorganic amendments have important implications in improving crop productivity.

Key Words: Phosphorus; Organic; Inorganic; PGPR; Chickpea

COMBINED EFFECT OF GIBBERLIC ACID AND KINETIN ON MAIZE GROWTH UNDER SALINE CONDITIONS

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Salinity is the severe ecological hazard, induced by anthropogenic activities resulting in soil erosion and low fertility. Salinity harmfully affects seedlings and significantly contributes in establishment of poor stand and ultimately causing poor production of crops. In this study, effect of gibberellic acid (GA3) in combination with kinetin (Kn) was examined on maize (*Zea mays*) growth under saline conditions. For this purpose pot experiment was conducted under artificially developed salinity (EC 7 dS m⁻¹). GA3, Kn and their combinations were used for pre-soaking of maize. Results showed that salts stress delayed the germination and reduced the total dry matter, chlorophyll content, and relative water content (RWC), but increased electrolyte leakage in maize plant. Application of GA3 and Kn significantly reduced the adverse effects of salt stress on the physiological parameters. However, combination of GA3 and Kn further enhanced their positive effects on plants under salinity. Results suggest that application of GA3 with Kn could be a better option for improving crop productivity and alleviating the negative effects of salinity on plants.

Key Words: Maize; Salinity; Gibberlic acid; Kinetin; Growth

PHOSPHORUS SOLUBILIZING BACTERIA TO IMPROVE PHOSPHORUS UPTAKE AND PERFORMANCE OF MAIZE HYBRIDS

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Under finite Phosphorus (P) resources, the future of crop production would only be survived under the proper management of P resources. Maize is from the major food crops of Pakistan and its production is limited by P unavailability due to its precipitation with calcium in the soil. The usage of P efficient strains of phosphorus solubilizing bacteria (PSB) is very economical and conservational approach in crop production system and root exudation is also an active plant approach to uptake P. The study was conducted to check the P uptake efficiency, soil P availability and yield of different maize hybrids through the mechanism of root exudation and bacterial soil phosphorus solubilization. In this study, the seeds of five maize hybrids (FH-988, FH-1012, FH-1046, DK-6714, AGI-797) were inoculated with the P efficient strain of PSB from *pseudomonas* sp. The experiment was conducted in both pot and field conditions without P fertilization. In response to inoculation soil available P, plant shoot P, plant height, plant biomass, shoot fresh and dry weights, root density and grain yield were significantly increased and plants without inoculation showed significant increase in the root length as compared to control treatment. There was no significant difference recorded in root fresh and dry weights in both inoculated and control treatments. Overall, PSB improved the performance of hybrids as followed by DK-6714, AGI-797, FH-1012, FH-1046 and FH-988.

Key Words: Phosphorus solubilizing bacteria; Maize; Phosphorus; Precipitation; Solubilization

EFFECTS OF MATERNAL DIETARY SELENIUM SOURCES ON CARCASS AND MEAT QUALITY PARAMETERS OF SUBSEQUENT BROILER PROGENY

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This study was conducted to investigate the effects of different maternal selenium sources on carcass and meat quality parameters of broiler offspring. A total of 600 female and 180 male 50-wk-old Ross-308 broiler breeders were randomly distributed into 4 treatments, each of which was replicated 5 times with 30 females and 9 male birds per replicate, with a 14-d pretreatment and 49-d trial period. One group of birds was fed a basal diet supplemented with inorganic (Sodium Selenite) and other three groups were fed diet supplemented with one of organic selenium sources (Selenium enriched yeast, L-Seleno-methionine or Seleno-hydroxy-methionine). Three hundred and fifty eggs from each dietary treatment were collected during seventh week of treatment. These eggs were incubated using standard conditions. After incubation for 21 days, 250 healthy chicks from the same parental treatment group were divided into five replicates, with 50 birds each. All the offspring were fed the same basal diet containing 0.15 mg selenium/kg. Dressing percentage, thigh and breast meat yields were not influenced by different maternal selenium sources in broiler offsprings. The maternal organic selenium treatment had significantly reduced the drip and cooking losses of breast meat of broiler progeny as compared to maternal inorganic treatment. The results suggest that maternal organic selenium diets are superior to maternal inorganic diet in improving meat quality of broiler offsprings.

Key Words: Maternal selenium sources; carcass characteristics; meat quality; broiler offsprings; broiler breeders

INTERACTIVE EFFECT OF ELEVATED CARBON DIOXIDE AND NITROGEN SOURCES ON WHEAT PLANTS

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Elevated carbon dioxide (e-CO₂) levels from ambient (a-CO₂) enhances plant biomass and yield due to increased carboxylase activity of Rubisco. However, this response might vary with nitrogen (N) form due to split up of energy at e-CO₂ among CO₂ and nitrate assimilation. This study was designed to investigate the shifts in energy under e-CO₂ and thus plant growth performance as affected by N form. Wheat plants were grown in nutrient solution prepared with NH₄⁺, NO₃⁻, NH₄⁺ and NO₃⁻ or urea under a-CO₂ and e-CO₂. Changes in photosynthetic parameters, biomass and concentrations of N, soluble carbohydrates and free amino acids in shoots and roots were determined. Plants supplied with NH₄NO₃ performed better in terms of biomass and biological enhancement ratio by e-CO₂. e-CO₂ significantly enhanced CO₂ assimilation (A) but at highly variable rates depending on the N source. Under e-CO₂, A was in the order of NO₃⁻ > NH₄NO₃ > NH₄⁺ > urea. Compared to other N sources, plants supplied with NH₄NO₃ had lower intercellular CO₂ along with higher photoassimilate translocation to roots and low accumulation of free amino acids, indicating better exploitation of the e-CO₂. We conclude that photosynthesis, protein and carbohydrate metabolism are differentially influenced by e-CO₂ depending on the N-source. Management of N fertilization towards a balanced supply of NO₃⁻ and NH₄⁺ to plants is the key for harnessing e-CO₂, while minimizing its adverse effects on the quality of the grains.

Key Words: amino acids; carbohydrate metabolism; elevated CO₂; nitrogen form; *Triticum aestivum*

IMPACT ASSESSMENT OF TEMPERATURE CHANGES AND IRRIGATION ON GROWTH OF MAIZE (ZEA MAYS L.)

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Climate change is a great challenge for the scientists to adopt and mitigate its impact on agricultural systems. The higher rate of temperature and decline in rainfall are the major constraints of climate change which adversely affect the agricultural productivity and leads towards food security. Due to these circumstances, a pot experiment was conducted to examine the interactive effects of temperature and various irrigation levels on the growth of maize and development in the green house. The maize variety (Pioneer 31-R-88) was grown and five different level of irrigation according to field capacity were tested. The crop was harvested after 60 days of sowing at vegetative growth stage. At harvesting, shoot and root lengths, fresh and dry weights of shoot and roots, Na⁺/K⁺ in shoots and roots and evapotranspiration rate was observed. Results showed that the maize can be grown in field by getting higher fresh weight per unit quantity of water and maximum growth was recorded at 100% field capacity.

Key Words: Climate; Maize; Field Capacity; Irrigation; Vegetative Growth

MICRO-MORPHOLOGICAL STUDIES OF GENUS CYPERUS FROM THE PUNJAB REGION

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The Cyperaceae is the third biggest monocotyledonous family and contain largest group of sedges. This family comprises up to 400 species and 70 genera. The distribution of Cyperaceae was cosmopolitan in nature. In Pakistan, 179 species and 22 genera are mostly recognized. The samples were collected from different sites of the Punjab. The study of micro-morphological characters during research work was very much valuable systematically for the identification of species of Cyperus genera. The species was preserved in alcohol. Photographs were taken by using digital camera. Data obtained from the qualitative and quantitative characteristics were statistically analyzed using ANOVA and multivariate analysis. The dendrogram graphs showed that similarity and dissimilarity among species by cluster formation. The qualitative characters of genus Cyperus varies species to species on the basis of different floral characters. In quantitative characters the glumes length was higher in Cyperus distans and lower in Cyperus effuses.

Key Words: Genus; Cyperus; Morphology; Qualitative; Quantative

REMOVAL OF PHENANTHRENE FROM CONTAMINATED WATER USING PLANT BACTERIA SYNERGISM IN FLOATING WETLANDS

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Water crisis is getting worse day by day and polluted water is one of the major environmental problems in the world especially in the developing countries fighting with the crisis of good quality water. Polycyclic aromatic hydrocarbons (PAHs) are generated in the environment, where biofuel is used and burning process is not completed. PAHs are toxic to all living organisms and one of the biggest challenges to treat the water containing PAHs in cost-effective and efficient way. Use of floating treatment wetlands (FTWs), augmented with specific bacteria, is an innovative approach for the remediation of water contaminated with hydrocarbons. The major objective of this study was the remediation of water contaminated with phenanthrene using plant-bacteria synergism in FTWs. The residual amount of phenanthrene in water was analyzed by FTIR. The results showed that the FTWs efficiently removed the phenanthrene from the water and its maximum (80%) removal was observed by the plant-bacteria synergism in FTWs. Similarly, more COD, BOD and TOC was removed from the water by the plant-bacteria synergism in FTWs. Inoculated bacteria showed not only persistence but also hydrocarbons degradation potential. This study revealed that the partnership of plant and bacteria in FTWs is potent to degrade phenanthrene in more effective and efficient way than the treatment had only plants.

Key Words: Floating treatment wetlands; plant-bacteria synergism; phenanthrene; hydrocarbons; contaminated water

ASSESSMENT OF THE HEAVY METALS ACCUMULATION IN SOIL, PLANTS AND WATER IN FAISALABAD

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Heavy metals from vehicular emissions pose a serious threat to human health. Present study was conducted to assess the heavy metals effects on soil, water and plants along different roads of Faisalabad. Samples were taken from 2 m and 60 m away from roads and analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS). Spatial distribution of heavy metals was taken by ArcGIS V10. Results showed that maximum zinc (Zn), copper (Cu) and lead (Pb) were found in soils at Hari Singh Road, Katcha pakka raiya 262 RB, and Dalowal 253 RB, respectively at 2 m distance from road. Maximum metals in plant samples were found in Jalandar 267 RB, Katcha pakka raiya 262 RB and Dalowal 253 RB respectively. Maximum concentration of heavy metals in water were found at Dalowal 253 RB, Katcha pakka raiya 262 RB and Jalandar 267 RB respectively. It was observed that maximum concentrations of heavy metals were found in soil, plant and water samples in 2 m vicinity of the roads as compared to the 60 m distance. It can be concluded that these high concentrations are due to the higher deposition of metals from vehicular emissions.

Key Words: Heavy metals; Vehicular emissions; Human health; GIS; Road-side pollution

EFFECTS OF MATERNAL DIETARY SELENIUM SOURCES ON CARCASS AND MEAT QUALITY PARAMETERS OF SUBSEQUENT BROILER PROGENY

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This study investigated the effects of different maternal selenium sources on carcass and meat quality parameters of broiler offspring. A total of 600 female and 180 male 50-wk-old Ross-308 broiler breeders were randomly distributed into 4 treatments, each of which was replicated 5 times with 30 females and 9 male birds per replicate, with a 14-d pretreatment and 49-d trial period. One group of birds was fed a basal diet supplemented with inorganic (Sodium Selenite) and other three groups were fed diet supplemented with one of organic selenium sources (Selenium enriched yeast, L-Seleno-methionine or Seleno-hydroxy-methionine). Three hundred and fifty eggs from each dietary treatment were collected during seventh week of treatment. These eggs were incubated using standard conditions. After incubation for 21 days, 250 healthy chicks from the same parental treatment group were divided into five replicates, with 50 birds each. All the offspring were fed with the same basal diet containing 0.15 mg selenium/kg. Dressing percentage, thigh and breast meat yields were not influenced by different maternal selenium sources in broiler offsprings. The maternal organic selenium treatment significantly reduced the drip and cooking losses of breast meat of broiler progeny as compared to maternal inorganic treatment. The results suggest that maternal organic selenium diets are superior to maternal inorganic diet in improving meat quality of broiler offsprings.

Key Words: Maternal selenium sources; carcass characteristics; meat quality; broiler offsprings; broiler breeders

IRON BIOFORTIFICATION IN RICE BY INTEGRATED USE OF BIOCHAR AND OTHER ORGANIC AMENDMENTS IN ALKALINE CALCAREOUS SOILS

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Rice (*Oryza sativa* L.) used as staple food in many countries but inherently low in iron and causes severe problems in rice dependents. Iron deficiency causes many disorders in humans like anemia, reduced growth and physical activities, infant morbidity, pneumonia, diarrhea, skin problems and memory and hair loss. In alkaline calcareous soils of Pakistan, iron is readily converted from Fe²⁺ to Fe³⁺ form and become bioavailable to plants causing malnutrition in rice consumers. Biofortification is the possible solution of malnutrition which focuses on increasing the nutritional value of food when the plants are growing. A pot experiment was conducted to evaluate the effect of iron Biofortification to combat the malnutrition on rice with different organic amendments and biochar at the rate of 1% kg⁻¹ of soil. The treatments including biochar, compost, sulphur treated animal manure, biochar + compost, biochar +sulphur treated animal manure including control were used to increase the availability of iron. FeSO₄ was used as source of iron. Results revealed that dry weight of root, shoot and grains; rate of photosynthesis, transpiration and conductance of stomata and iron grain contents increased significantly in all treatments except control. It is concluded that iron fertilization with organic amendments is an effective approach for biofortification of iron in cereals to eliminate malnutrition possessions.

Key Words: Malnutrition; Biofortification; Biochar; Organic amendments; Anemia

FONFIRST REPORT OF DETECTION, CHARACTERIZATION AND TRANSMISSION STUDY OF 16SR-II-D SUNFLOWER PHYLLODY PHYTOPLASMA AND INSECT VECTORS IN PUNJAB PROVINCE, PAKISTAN

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The study was conducted to identify the phytoplasmas associated with sunflower and different insect vectors responsible for phytoplasma transmission. The detection of phytoplasma in infected samples was carried out through staining and electron microscope. It was confirmed by PCR amplification of 16SrDNA using the primer pairs P1/P7 and RI6F2n/R2 and sequencing. RFLP analysis also showed that sunflower phyllody phytoplasmal had similar pattern of bands formation associating with 16S ribosomal-DNA of 16SrII-D subgroup linked with sesame phyllody. DNA sequencing and phylogenetic analysis exhibited >99% homology of studied isolates with already submitted phytoplasma strain "Ca. P. australasia" of 16SrII-D subgroup. The possible insect vectors Orosius orientalis, Empoasca decipiens, Amrasca biguttula and L striatellus, C. tenellus captured from infected plants and surroundings were detected positive for phytoplasma presence through PCR. Transmission study confirmed the vector status of O. orientalis and C. tenellus for sunflower phyllody diseases transmission. To our information, this is first detection of phytoplasma infestation and its insect vectors associated with sunflower in Pakistan.

Key Words: Sunflower; Phytoplasma; Insect vectors; 16SrII-D; PCR

TESTING OF NEW HERBICIDES FOR WEEDS MANAGEMENT IN COTTON UNDER CHANGING CLIMATE

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The climate change causing high temperature in Pakistan. Weeds grow very well under high temperature or adverse conditions being C4 plants. Cotton is very vulnerable to early season weed competition because of its slow emergence and growth. The present study was conducted to find out new chemistry of herbicides for effective weed control in cotton variety FH-142. Seven treatments i.e. Relax 50 EC @ 1250 mL ha⁻¹, Caster gold 50 EC@ 1250 mL ha⁻¹, Stomp 33 EC @ 2500 mL ha⁻¹, Dual gold 960 EC @ 2000 mL ha⁻¹, Percept 10.8 EC @ 875 mL ha⁻¹, G-Max Lite 15 EC@ 625 mL ha⁻¹ and control (weedy check) were included in the study. Pre-emergence herbicides were sprayed just after sowing and post emergence herbicides were sprayed after 20 days of sowing. The data regarding weed density (m⁻²), dry weed biomass (gm-2), fresh weed biomass (gm-2), narrow leaf weeds, broad leaf weeds were recorded and statistically analyzed. It was concluded that Caster gold 50 EC@ 1250 mL ha⁻¹ was the best option to attain acceptable weeds control for broad leaves weeds and G-Max Lite 15 EC@ 625 mL ha⁻¹ as best herbicide to control the narrow leaves weeds and gave satisfactory results.

Key Words: Cotton; Weeds; Herbicides; Biomass; Climate Change

BIOFUEL EXTRACTION FROM JATROPHA CURCAS SEED OIL BY TRANSESTERIFICATION METHOD

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Currently 95% biodiesel is produced from edible oil sources including palm oil, rapeseed, niger, soyabean, linseed, sesame and sunflower oil. Being expensive, these sources also compete with human diet. Hence, non-edible seeds are required to produce biofuels and biodiesel on commercial level. The researchers are trying their best to find non-edible oils as alternative sources to produce biodiesel i.e. jatropha, microalgae and castor oil due to rich in high oil content. In this study, Jatropha carcus (non-edible seeds) was used for biodiesel production. The biodiesel is extracted from Jatropha carcus seeds by using soxhlet apparatus and rotary evaporator using the process of transesterification, as an enzymatic catalyst NaOH and KOH. Different tests were carried out to examine obtained biodiesel and compared with the actual results of diesel fuel to explore cheap and available new renewable sources to produce biodiesel with substitute of petrodiesel and cover all the possible qualities of other fuels. For the betterment, it is suggested that government should design “biodiesel production policies” and develop biodiesel industries as well as promote companies because of this being environmental friendly causing less pollution.

Key Words: Biodiesel; Jatropha carcus; soxhlet apparatus; transesterification; enzymatic catalyst

PHOSPHORUS ACQUISITION IN MUNGBEAN (*VIGNA RADIATA L.*) UNDER LEAD STRESS

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Mungbean is most important leguminous crop. Phosphorus (P) is the major constituent of fertilizer (NPK) and beneficial for plant growth. Lead (Pb) is one of the most toxic heavy metal having a density of 11 g cm⁻³. This study determined the impact of Pb stress on P acquisition in mung bean (*Vigna radiata L.*) under wire house condition using mungbean variety i.e. AZRI 09008. The experiment was comprised of two levels of each P and Pb as 50, 100 mg P per kg of soil and 10, 20 mg Pb per kg of soil with 0 mg of P or Pb as control. Source of P and Pb was KH₂PO₄ and PbCl₂. Maximum weight of shoot, highest number of nodules and plant height were recorded at 50 mg of P with 10 mg of Pb stress. while highest evapotranspiration rate (ETR) was recorded at 100 mg of P with 20 mg Pb stress. Nonetheless, soil P application at 50 mg can improve mungbean performance under Pb stress.

Key Words: Phosphorus; Lead; Mungbean; Pulse; P-Acquisition

NEEM LEAF EXTRACT TO IMPROVE THE POSTHARVEST STORAGE OF PEACH

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Peach (*Prunus persica* L) is considered one of the most popular and common fruits in the world due to its nutrition value. During postharvest storage, due to internal and external factors, chemical and physical changes occur in peach fruit resulting losses in nutritional quality. To prevent these adverse effects, use of environmentally friendly technologies such as neem leaf extract (NLE) is safe signaling molecule used for post-harvest quality preservation of horticultural crops. The aim of this research was to find out the effects of various concentrations of neem leaf extract NLE (10%, 20%, 30%) on the quality and shelf life of peach fruit. Different physiochemical and biochemical parameters were analyzed in fruit stored at ambient temperature for 12 days. Lower concentration of NLE showed less significant impact on quality parameters of peach fruit during storage. While, NLE @ 30% significantly revealed less weight loss, higher sugars, TSS, TA and ascorbic acid, higher total phenolics, protein contents and increased activities of antioxidant enzymes as compared with other treatments including control. These results suggested that NLE (30%) treatment could be a powerful approach to extend quality and shelf life of peach fruit during storage conditions.

Key Words: Peach; Neem Leaf Extract; Biochemical properties; Antioxidant enzymes; Shelf life

BIOEFFICACY OF TANK MIXED POST-EMERGENCE HERBICIDES TO CONTROL WEEDS IN FORAGE MAIZE

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The bio-efficacy of tank mixed post-emergence herbicides was tested to control weeds in maize forage (*Zea mays L.*) under field conditions. The treatments were different herbicides helosulfuron @ 40 g a.i. ha-1, tank mixed with carfentrazone-ethyle @ 10 g a.i. ha-1, atrazine @ 296 g a.i. ha-1 and bromoxynil + MCPA @ 750 g a.i. ha-1. Weedy check as control and hand weeding were included for comparison. The lowest total weed density (25.50 m⁻² 15 DAT and 22.00 m⁻² at harvest) was recorded in plots where helosulfuron was tank mixed with bromoxynil + MCPA @ 750 g a.i ha-1. Tank mixed application of helosulfuron with carfentrazone-ethyl @ 10 g a.i ha-1 provided maximum (74.47%) control of *C. arvensis* at harvest. While the minimum density (9.5 m⁻²) of *E. crusgalli* was noted in plots where foliar application of helosulfuron @ 40 g a.i ha-1. + atrazine @ 296g a.i ha-1 was done. The highest values of plant population (22.00 m⁻²), plant height (230.00 cm), stem diameter (1.4 cm), number of green leaves (11.70) per plant and forage yield (80.06 t ha-1) of maize were observed. It was concluded that tanx mixing of post-emergence applied helosulfuron @ 40 g a.i ha-1+ bromoxynil MCPA @750 g a.i ha-1 provided maximum control of weeds and increased forage yield of maize.

Key Words: Post-emergence; Forage Maiz; Weed; Herbicides; Bioefficacy

IMPACT OF MOBILE ENABLED ADVISORY SERVICES IN AGRICULTURAL DEVELOPMENT: JAZZ BAKHABAR KISSAN PERSPECTIVE

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The livelihood of rural domain largely depends on agriculture. A push towards higher productivity require an information-based agricultural system. Use of mobile technology can be a major intervention for progressive farming. Rapid growth of mobile-enabled services has overcome the information asymmetry existing among farmers. The reach of smartphone in rural areas has extended the ICT beyond simple voice or text messages. About 1.5 million farmers in Pakistan are engaged with Jazz Bakhabar Kissan advisory service including SMS and IVR for legacy phone users and Android App for smart phone users, available in five regional languages, basically designed to deliver the precise information in most appropriate manner. The objective of the study was to evaluate how the service has impacted the farmers. An impact analysis was carried out based on randomised survey data and deep interviews with farmers. The study showed that 95% farmers successfully eliminated potential losses by reacting quickly to information about weather, market rate and cultivation practices through BKK service. They reported higher yields by adopting BKK advisory regarding new seed varieties with best cultivation practices. As mobile penetration continues to increase, the scope exists for a much greater rural productivity in the future.

Key Words: Information and Communication Technologies ; Jazz Bakhabar Kissan; Agriculture; Mobile Technology; SMS

WOOL PRODUCTION PERFORMANCE OF HARNAI SHEEP, BALOCHISTAN

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Sheep rearing is very common and serves as main source of income in rural areas of Balochistan. The meat and wool are the main products of sheep. This study aimed to document the wool production performance of Harnai sheep. Data of 3524 sheep regarding wool production was collected and analyzed. The animals included in this study were kept by 26 different sheep farmers of Asghara, Marati, Arbosi and Kharawa areas of District Ziarat. The wool samples were collected from 165 (4.682%) male, 1438 (40.806%) female, 771 (21.879%) male and 1150 (32.633%) female young stocks. The average wool sheared from adult male was highest (1.90 kg), followed by adult female (1.80 kg) and male young stock (1.60 kg); while the lowest (1.55 kg) was sheared from female young stock. The overall mean yield of white and mixed wool from an adult sheep was 1.75 and 0.10 kg from young sheep was 1.58 and 0.10 kg respectively. Most of the sheared wool from sheep (70%) was marketed; while 30% reported to be consumed locally for multiple purposes. At farmers' level, the price of one kg wool was Rs. 24/-, while the price of white and mix wool was Rs. 28.50 and 19.75 at retail level and Rs. 31.25 and 23.75/kg at wholesale level. These results depict the low quality and quantity of wool production. Therefore, farmers were trained to use new tools of shearing and adopt new technologies to enhance the production.

Key Words: Wool Production; Sheep farming; Animal Production; Balochistan; consumption

FATTENING POTENTIAL OF HARNAI LAMBS

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Animal fattening has been practiced long ago, achieved the maximum weight at desired time. However, the fattening potential of Harnai lambs was never evaluated before. In this study, 165 Harnai breed lambs were divided into three groups (A, B and C, 55 lambs in each group) for the fattening program. Group A and B lambs were fed with commercial fattening ration for three months. While the group C was kept as control and nourished as per routine. The results demonstrated that group A and B lambs weight gain was 13.65 kg and 12.19 kg respectively after three months. However, the control lambs group achieved only 2.91 kg. Importantly, the last two months of fattening were the successful ones as during first month of trial no significant difference in weight gains among all three groups was observed. The poor weight gain by the control group was mainly because of draught which leads to non-availability of bio-mass in the rangeland. These results conclude that fattening of these lambs lead to maximum weight gain which will maximize the profit of the farmer.

Key Words: Fattening; Lambs; Sheep; Bio-mass; Balochistan

EVALUATION OF DIFFERENT PLANT ESSENTIAL OILS AS REPELLENT AGAINST DENGUE VECTOR, *AEDES AEGYPTI*

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Mosquitoes are primary vectors for many dreadful and fatal diseases such as dengue, malaria, yellow fever, filariasis and West Nile virus. The repellency of essential oils against dengue vector was evaluated using the human bait technique. Extract of 100 µl was applied on about an area of 30 cm² of the hand. Hand of human subject was exposed for 5 minutes and numbers of landing were counted, and control was treated with ethanol each treatment repeated 3 times. The percentage of repellency was calculated on different plant essential oils by using percentage formula. *Euclyptus melanopholia* essential oil proved the most effective repellent against Ae. aegypti followed by *Oreganum vulgare*. *Nigella sativa*, *Oreganum majrona*, *Syzygium aromaticum*, *Cuminum cyminum*, *Cymbopogan citratus*, *Amomum subulatum*, *Curcuma longa*, *Ocimum basilicum*, *Euclyptus pillata* and *Euclyptus globulus* respectively. Identification of antennal active volatile compounds from essential oils is under progress using gas-chromatography coupled electroantennographic detection (GC-EAD) technique and followed by GC-MS analysis of respective essential oils.

Key Words: Dengue; Essential oil; GC-MS; Mosquito repellent; Aedes

IDENTIFICATION OF GUAVA FRUIT VOLATILES AND THEIR ROLE IN ATTRACTION AND OVIPOSITION BEHAVIORS OF PEACH FRUIT FLY, BACTROCERA ZONATA (SAUNDERS)

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In the present study, *B. zonata* female flies' attraction was observed in a Y-tube olfactometer using fruits of three locally grown guava varieties; Gola, Larkana Large Surahi (LLS) and Larkana Small Surahi (LSS). Female flies showed significantly higher levels of attraction to both un-infested and infested guava fruit odors compared to control (blank). In pairwise comparisons between different fruit varieties, females *B. zonata* showed significantly greater levels of attraction towards un-infested Gola compared to un-infested LSS, while in the case of the same variety, significantly more flies were attracted to un-infested compared to infested fruit in all three tested varieties. In two-choice oviposition bioassays, *B. zonata* females made significantly more visits, greater numbers of ovipositions spent a significantly longer time, and larger numbers of pupae and adults developed on Gola fruits compared to LSS fruits. However, in no-choice bioassays, females made more visits and spent a significantly greater amount of time on LSS compared to Gola and LLS. GC-MS analysis of guava headspace revealed presence of aliphatic and aromatic esters as a dominant group of compounds in both un-infested and fruit-fly-infested guava fruits, with a higher quantity mostly occurring in fruit-fly-infested fruits. Role of guava volatiles is discussed in an ecological context of attraction and oviposition behaviors of adult females and fitness of their offspring.

Key Words: Headspace; Gas chromatography-mass spectrometry; Plant volatiles; Oviposition; Y-tube olfactometer

IMPACT OF DIFFERENT PHOSPHORUS SOURCES AND BANANA COMPOST ON GROWTH AND YIELD PERFORMANCE OF SUNFLOWER

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Phosphorous (P) is 2nd most essential nutrient after nitrogen (N). It is a major growth limiting nutrient. Mostly P is provided to the deficient soils through the use of synthetic fertilizers. However, very often P availability to plants becomes limited due to its strong adsorption to organic matter and soil particles. The P availability can be improved by improving different properties of soil through organic manuring along with the use of synthetic fertilizers. In this study, a pot experiment was conducted to evaluate the impact of different P sources and banana compost (BC) on P availability and growth of sunflower (*Helianthus annuus L.*). For this purpose, 1% BC and different P sources (i.e. DAP, SSP & rock phosphate) were compared. At the sowing, different P fertilizers, recommended doses of potassium and N were applied. Crop was harvested after 60 days and seed germination, shoot and root length, dry and fresh biomass of shoot and root were recorded and analyzed. Results showed that BC and DAP significantly increased the plant height, stem diameter, head diameter, No. of achene per head, 1000-achene weight, and achene yield as compared to control. In summary, BC and DAP application was very effective in improving sunflower yield and related parameters.

Key Words: Phosphorus; Banana compost; DAP; Synthetic fertilizers; Sunflower

EVALUATING HARVESTING LOSSES OF MECHANICAL RICE HARVESTERS FOR REDUCING GHG'S EMISSIONS

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Rice being one of the most revenue earning and staple food for Pakistan, sown on around 2.7 million hectares producing nearly 6.5 million tons accounts for about three percent value added in agriculture and 0.6 percent of the country's GDP. Harvesting of paddy is generally carried out using machines, usually with combine harvesters followed by burning of straw thus creating smog hazards. During couple of years, Kubota, a especially designed harvester for rice, is also in the business. This study was carried out to test the efficiency of machine harvesting by identifying harvesting losses by conventional wheat combine (Full feeding-combine harvester) and rice specific (head feeding-Kubota) harvesters. The harvesting losses data (including scattering, shattering and threshing) of 20 machines (10 of each type) were collected at different paddy moisture levels. Kubota harvester was found efficient at moisture contents 21-24% with harvesting losses estimated at 1.0 – 2.5 pounds per acre as compared to conventional wheat combine harvester that ranged between 3.5 – 7.0 pounds per acre. The trash contents and broken grains were minimum i.e. <1% and 40 – 50 grains/100 g, respectively as well as higher head rice recovery. The cutting height of Kubota was 4 – 6 inches as compared to combine that worked at greater than 12 inches from ground surface thus helped to retain straw and reduce risk of burning.

Key Words: Smog; Kubota harvester; harvesting losses; GHG emissions; Optimal moisture content

AUTO STEERING TECHNOLOGY FOR ENHANCING WHEAT CROP YIELD

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Autonyms driving of tractor offer many potential advantages over human control; however, traditional agricultural farming practices leads wastage of agricultural resources, e.g. seed, fertilizer, water and harvesting losses. Wheat is being sown using rabi drills however there is always capacity of improvement. To explore these possibilities, we tested auto steering technology (AST) fitted on local tractor system for its adoptability in Pakistani Farm settings. The technology was tested at University of Agriculture, Faisalabad in wheat crop during the year 2017-18 using rabi drill. 1.5 acres were sown with and 1.5 acres without auto steering technology. Irrigation and fertilizer for both plots were kept same. The yield was measured using square meter method as well as yield of entire plots. Experimental results depicted that increase in plant papulation and yield was estimated at 8.7% and 9.8 – 10.5% higher, respectively. Yield of entire plot (1.5 acres) was 10 mounds more than normal drill sowing. Moreover, AST on board local tractor provided 24 hour working efficiency with centimeter level accuracy and fuel efficiency was increased by 6% as compared to conventional drill sowing. More experiments need to be performed to confirm these findings.

Key Words: Auto steering technology; Precision agriculture; Crop yield; Technology; Wheat yield

ASSESSMENT OF ALGAE SLUDGE FOR TEXTILE WASTEWATER TREATMENT

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Industrial effluents have been documented as a potential threat to the sustainable environment globally. Treatment and safe disposal of industrial waste water is very challenging process before its disposal to the aquatic channel by textile processing and other printing units. A lot of physio-chemical methods have been introduced to reduce the reactive organic load. Most of the reported methods are economically impracticable, incapable of eliminating reactive effluents and produce an immense quantity of slurry which may cause irreversible environmental damages. Hence, a study was planned to degrade textile effluents by using two strains of micro algae and one bacterial strain. Waste water was collected from inlet points of textile effluents. After 15 days, sludge volume index of 30 minutes settling was 35%. Results revealed that combined effect of algal and bacterial sludge was highly effective. Sludge removes 95% of contaminants within 8 hours leading to possibility of recycling wastewater for irrigation purposes. It was concluded that algae sludge is effective in degrading industrial pollutants.

Key Words: effluents; algae; sludge; textile; wastewater

PHOSPHORUS ACQUISITION IN MUNG BEAN (*VIGNA RADIATA L.*) UNDER CADMIUM STRESS

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Pulses are important to fulfill protein requirements of tremendously increasing world population. Human interventions are major cause of heavy metal deposition and reduction in pulses yields all around the world. A pot experiment was carried out to investigate the extent of Cd stress on acquisition of P in mungbean by applying three levels of Cd (0, 10 and 20 mg Cd kg/soil) with P (0, 50 and 100 mg P kg/soil). The results indicated that no. of nodules/plant increased with the application of 50 mg P at 20 mg Cd and 100 mg P at 10 mg Cd was also effective in this regard. Reduction in number of nodules were observed in nutrient deficit (control) soil. Shoot biomass increased under 50 mg P with 10 mg Cd up to 7.8 mg in weight and decrease in shoot fresh weight was observed 0.7 mg at 100 mg P with 20 mg Cd treatment/kg soil. Highest shoot length was observed at 100 mg P in absence of Cd stress and lowest shoot length in control. Root biomass elevated with the application of 50 mg P+10 mg Cd. In excess of both nutrients, root fresh weight was reduced. Highest root length was observed for 20 mg P in absence of Cd and lowest in the absence of P application. In conclusion, application of 10 mg Cd/kg soil significantly enhances the P acquisition in mungbean. Application of 50 mg-100 mg P/ kg soil with 10 mg Cd can be opted to get maximum growth and yield of mungbean under semiarid conditions.

Key Words: Mungbean; Phosphorus; Cadmium stress

FOLIAR APPLICATION OF NITROGEN AND BORON IMPROVES PRODUCTIVITY OF WHEAT (*TRITICUM AESTIVUM L.*) CROP

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The experiment was conducted to determine the effect of foliar application of nitrogen and boron at different growth stages on growth, yield and quality of wheat during rabi season, 2017-18. The experiment was comprised of 16 treatments including different levels of nitrogen (N0 control=0%, N1=4%, N2=8% and N3=12%) and boron (B0 control=0%, B1=1%, B2=2% and B3=3%) applied to plant foliage. The source of nitrogen was urea (46% N) and boric acid (17% B). Agronomic practices and recommended fertilizer dose (N: P: K) was applied during crop period. Foliar application of nitrogen and boron was applied at tillering and booting stages respectively. Foliar applied nitrogen and boron were significantly different from each other with highest number of productive tillers, spike length, grains per spike, 1000-grain weight and grain yield. Foliar application of nitrogen and boron proved to be an effective method to increase the grain yield up to desirable level.

Key Words: Nitrogen; Boron; Wheat; Foliar application; *Triticum aestivum L.*

ASSESSMENT OF NOISE POLLUTION AND ITS EFFECTS ON HUMAN HEALTH AT INDUSTRIAL HUB OF PAKISTAN

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Faisalabad is the third largest city and industrial hub of Pakistan, which may cause noise pollution to the local residents. This study aimed at i) map the level of noise pollution at various locations of Faisalabad city, ii) assessment of comparative level of noise pollution at morning, noon and evening hours, and iii) its non-auditory effects on human health. Two industries and 44 famous/busy locations were selected to study noise pollution using sound level meter for 24 h. A questionnaire-based survey was also conducted to get the public perception about health impact of noise pollution. The equivalent sound pressure level (SPLeq) was found higher than the permissible limits at all the sampling locations during morning, noon and evening hours. The maximum SPLmax was found 102 dB inside production unit in noon of Mian Muhammad Siddiq Textile Loom industry. The average SPL was found at State Bank road (102 dB), Children's Hospital (101 dB), Jhang Bazar (100 dB) in noon and at Punjab Medical College in evening (97 dB). Based on survey, 94% respondents reported headache, 76% sleeplessness, 74% hypertension, 74% physiological stress, 64% high blood pressure and 60% dizziness due to noise. Noise pollution was well above the standard limits which causes non-auditory effects on human health. Thus, it can be concluded that there should be the proper maintenance of the vehicles and industrial machinery along with the provision of the personal protective equipment to the workers.

Key Words: Annoyance; Non-auditory effects; Occupational health; Community Survey; Noise pollution

IMPACT OF SALT STRESS ON THE UPTAKE OF PHOSPHORUS IN MUNG BEAN (*VIGNA RADIATA L.*)

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Mung bean (*Vigna radiata L.*) is a kharif season short duration crop. Mung bean is nutritionally very important and improves soil fertility by fixing the atmospheric nitrogen. However, its growth and yield is affected by many factors such as salinity. Salt stress affects the uptake of phosphorus and other minerals. The impact of salinity stress on the acquisition of phosphorus in mung bean was investigated in a pot experiment. Phosphorus was applied as 50 and 100 mg P/kg soil including no P as control. Salt stress was imposed as control (2 dS m⁻¹), 4 dS m⁻¹ and 6 dS m⁻¹. The mung bean cultivar (AZRI) was used. Results indicated that total number of plants, leaves, nodules, plant height and test weight were reduced due to salinity as compared to control treatments. Major impact of salinity was observed on roots as compared to shoots and leaves. Phosphorus at (100 mg P/kg soil) enhanced the growth and yield of mung bean when applied alone as a fertilizer but under salt stress its acquisition was suppressed which strongly affected mung bean growth and yield.

Key Words: Mung bean; Salinity stress; Phosphorus; germination; Pulse

IMPACT OF NITROGEN AND MAIZE LITTER ON SOIL ORGANIC CARBON DYNAMICS

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Agricultural practices particularly nitrogen (N) fertilization has significant impacts on plant growth and soil organic carbon (SOC) contents. Excessive N fertilization could also pose adverse effects on environment probably due to release of nitrous oxides (N₂O) into atmosphere. It can stimulate the decomposition of plant residues and can contribute to emission of other greenhouse gases (GHGs) besides N₂O emission. Fifty grams (g) of soil was taken in incubation jars to which maize residues (10 g kg⁻¹ soil) were added. Control was maintained without addition of maize residues. Nitrogen (132 mg kg⁻¹ of soil) was added at the start and after 15 days of onset of experiment. The results showed that cumulative C-CO₂ emission significantly increased by applying the maize litter, but there was no significant effect of N fertilization. Microbial biomass carbon (MBC) significantly increased in the absence of litter at second application of N after 15 days. Enzymes (glucosidase, acid phosphatase and Leucine aminopeptidase) activities significantly increased by applying residues in case of N exclusion. However, chitinase activity was found to be significantly increased after 15 days with and without maize residues. It is concluded that N being applied to partially decomposed maize residues significantly increased the enzymes activities as well as MBC which consequently improved the soil health attributes and native SOM decomposition as well.

Key Words: Nitrogen; Maize Litter; SOC Dynamics; GHGs; Extracellular Enzyme Activities

SOIL APPLICATION OF COAL FLY ASH DECREASES GRAIN CD CONCENTRATION IN ZN BIOFORTIFIED WHEAT UNDER CD STRESS

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To overcome the micronutrient malnutrition, development of Zinc (Zn) biofortified cultivars offers a sustainable approach. In this experiment, standard (Galaxy-2013) and Zn-biofortified (Zincol-2016) wheat cultivars were grown in the cadmium (Cd) contaminated soil and treated it with different levels of coal fly ash. The fly ash (FA) is considered a waste product of thermal power station, but it has significant potential for uses in Agriculture, and comprises of almost all macro- and micronutrients. The FA application increased the nutrient availability, decreased the bioavailability of Cd and improved the general health of soil. The growth and yield responses and distribution of Cd and Zn was observed in roots and shoots of both cultivars. The uptake of Cd was increased in both wheat cultivars and decreased plant growth in Cd contaminated soil. But the FA amended soil the uptake of heavy metal was decreased, and plant growth was improved. The Zincol-2016 wheat grown under Cd contaminated soil significantly decreased the Cd uptake. Concentration of Cd was higher in shoot of both cultivars but lower in grains of Zincol-2016 while high In Galaxy-2013. Thus, it can be concluded that CFA application in soil decreases grain Cd content in Zn biofortified wheat.

Key Words: Cadmium ; Heavy metal; Fly Ash; Wheat; Biofortification

ROLE OF BIOCHAR IN ALLEVIATING Cd STRESS IN WHEAT

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Cadmium (Cd) is very toxic heavy metal and it does not have any major function in plants. However, Cd generates reactive oxygen species (ROS) in plants and disturb plants major metabolic functions including structure of chloroplasts. Biochar (BC) application has been known to protect the plant against heavy metal stress. In this experiment, wheat was grown under Cd contaminated soil and treated with different levels of biochar. The application of BC decreased the heavy metal stress in wheat and improved the plant growth and reduced the Cd uptake in wheat. In conclusion, application of BC reduced the oxidative stress in plants and decreased the bioavailability of Cd.

Key Words: Cadmium ; Heavy metal; Biochar; Wheat

OSTRICH FARMING INNOVATIVE TREND: A SUSTAINABILITY CONCERN

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Ostriches are raised commercially for its meat, leather, feathers, oil and medicinal use. Its meat is delicious and better for health. Ostrich farming is environmentally friendly and sustainable. Ostrich is considered as a bird for the future which can help to ensure food and meat security in globe. Ostrich farming is currently being done all over the world and it also have great scope especially in Pakistan. In this perspective, it was necessary to conduct a research survey to find out the farmers' perceptions. Survey was conducted in districts Faisalabad and Lahore. As district Faisalabad is prominent for Ostrich farming and district Lahore is prominent for end users. Thus, the sample was all registered Ostrich farmers of district Faisalabad (21 farms) while 89 end-users from district Lahore was selected by snow ball sampling technique including total 110 respondents. The collected data were analyzed by using Statistical Package for Social Sciences (SPSS). It was concluded that the ostrich farming has great potential in Pakistan and it can help to meet the future need of the meat. The study recommends that the government should provide trainings to the veterinary doctors.

Key Words: Ostrich farming; Sustainability; Meat

MITIGATION OF SALT STRESS IN WHEAT BY EXOGENEOUS APPLICATION OF MORINGA LEAF EXTRACT

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Salt tolerance could be induced by environmentally safe and economical application of moringa leaf extract (MLE). A field experiment was conducted under natural saline conditions during 2016-17 to evaluate the bio-stimulant potential of foliar applied distilled water, MLE obtained from fresh leaves (MLEF; 3%), MLE obtained from dry leaves MLED (5%) and MLED (10%) while non-treated plots were considered as control. Salt sensitive and tolerant wheat cultivars (Galaxy-2013 and Pasban-90 respectively) were grown on salt-affected soil (ECe; 12-14 dS m⁻¹). Extracts were applied at tillering and booting stages to induce salt tolerance. The experiment was laid out in a randomized complete block design (RCBD) with factorial arrangement having three replications. All MLE treatments significantly improved growth and yield of both wheat cultivars, however, MLED (10%) and fresh MLE were found most effective due to 33% more grain yield (Galaxy-2013) than control. These improvements may be due to maintenance of stay green character as depicted by increased leaf chlorophyll contents. Furthermore, yield of Pasban-90 was also improved by 23% as compared to control and attributed to enhanced activities of antioxidant enzymes (superoxide dismutase, catalase, peroxidases) in leaf. Results showed that efficacy of dry and fresh MLE should be evaluated in other crops for abiotic stress mitigation.

Key Words: Wheat; Moringa; Salt Tolerance; Antioxidants; Yield

WEED RELATED YIELD LOSSES IN IRRIGATED CHICKPEA

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Studies to appraise critical period of weed competition in desi and kabuli chickpea genotypes were undertaken during rabi season, 2017-18. Desi (Punjab-2008) and Kabuli (Noor-2009) genotypes of chickpea were sown during mid-November 2017 in 45 cm spaced crop rows using a seed rate of 75 kg ha⁻¹. Chickpea crop was subjected to different durations of weed competition [competition for 20 days after sowing (DAS), 40, 60 and 80 DAS] as well as weed free periods [weed-free till 20, 40, 60 and 80 DAS]. Season-long weed check and weed-free plots were also maintained for both chickpea genotypes. Chickpea crop was infested by diverse weed flora comprising of field bindweed, common lambs quarters, fathen, blue pimpernel, broadleaf dock (broad-leaved weeds), wild oat and canary grass (grassy weeds) under irrigated conditions. Increasing period of weed competitions (20 to 80 DAS) had a diminishing effect on dry matter accumulation and crop growth rate of chickpea. Weed competition reduced chickpea yield regardless of genotype by reducing number of branches per plant, number of pods per plant, number of seeds per pod and 100-seed weight. Weed competition up to 80 DAS caused 56 and 60% reduction in chickpea dry biomass and seed yield regardless of genotype.

Key Words: Chickpea; Genotypes; Weed competition; Weed dynamics; Yield loss

BIOLOGICAL ACTIVITIES OF TRADITIONAL MEDICINAL PLANTS EXTRACTS FROM HARIPUR

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Many medicinal plants are available worldwide that are used for the treatment of various diseases. They produce bio active compounds include alkaloids, essential oils, terpenoids and flavonoids. About 80% of rural household population of Pakistan utilized the medicinal plants. Depending upon their treatment properties, many medicinal plants have been used for the therapeutic purposes in the treatment of various diseases. The aim of present study is to check the biological activity of locally available medicinal plants in district Haripur. A total of fifteen medicinal plants were collected and check the biological activity against bacterial species including *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Propionibacterium acne*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Klebsiella pneumoniae* and *Acinetobacter baumannii*. The leaves extract of *Eucalyptus globulus* showed highest activity against *Propionibacterium acne*, *Listeria monocytogenes* and *Pseudomonas aeruginosa* with the zone of inhibition is 18mm. The leaves extract of *Acacia nilotica* and *Melia azedarach* showed no activity against *B. subtilis* and *Klebsiella pneumoniae* while the extract of *Melia azedarach* showed low activity against *Acinetobacter baumannii* with zone of inhibition is 4mm. Our result show great activity against some bacterial species so we use some locally available medicinal plants for treatment of bacterial diseases.

Key Words: Alkaloids; Terpenoids; Flavonoids; Bioactive compounds ; Zone of inhibition

VEGETABLE PRODUCTION IN PERI-URBAN AREAS

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Horticulture sector plays 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 pre-requisite for health, and vegetables supply the food nutrients needed for the balanced human diet. More than thirty six varieties of vegetables are grown on large scale in Pakistan. Among different provinces of Pakistan, Punjab holds the largest share of 63 and 74% in vegetables' area and production, respectively. On one hand, the country is earning foreign exchange from export of vegetables and on the other hand, the country is spending a tremendous amount on import of vegetables. In past decades, vegetable production has remained very low in Pakistan because the research institutes and researchers have not given due priority and inadequately addressed. Moreover, the extension organizations are not giving due importance to vegetable production. The present study was conducted in peri-urban areas of Faisalabad, Pakistan. The study revealed that majority of the farmers were deficient in information regarding fertilizer and irrigation application methods. After analyzing the results, it was suggested that farmers need training in irrigation methods and fertilizer application.

Key Words: Vegetables; Training; Punjab; Extension; Need assessment

EFFECT OF HIGH ZINC LEVELS ON GROWTH, CARCASS CHARACTERISTICS AND IMMUNE FUNCTIONS IN BROILERS

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The effect of higher Zn levels than recommended by National Research Council (NRC) of USA (40 ppm) was tested on growth performance, carcass characteristics and immune response in broilers. A basal iso-nitrogenous (CP: 19.7%) and iso-caloric (ME: 2930 kcal/kg) diet was formulated to contain zinc 40 (Zn-40), 80 (Zn-80), 120 (Zn-120) and 160 ppm (Zn-160). Each diet was fed to 50 broiler birds, from post hatching to day 35, divided into 5 replicates of 10 birds each. When diets were analyzed, CP, ME and Zn concentrations were found 16.6%, 3220 k cal/kg and 35, 45, 55 and 70 ppm, respectively. Thus, results are described keeping in view the analyzed values of Zn. Body weight gain was higher in birds receiving 45 ppm Zn than other concentrations. Carcass percentage was better in birds receiving 45 ppm Zn. Weights of bursa and thymus were improved in broilers fed diet containing 70 ppm Zn concentration than lower levels. Feed intake and FCR was not influenced by varying levels of Zn. Antibody titers against Newcastle disease virus were not affected by Zn concentrations. Relative gibblet organ percentages were not influenced by dietary treatments, but relative abdominal fat percentage was decreased as Zn concentration increased in the diets. Based on the results of the study, it was concluded that adding more Zn than recommended by NRC did not improve growth performance or immune function and thus recommendations of National Research Council for Zn in broilers diet

Key Words: Zinc; broiler; immune organs; humoral immunity; growth performance

A SURVEY OF ARABIDOPSIS GENOME FOR THE IDENTIFICATION AND CHARACTERIZATION OF NON-SPECIFIC LIPID TRANSFER PROTEINS

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Plant non-specific lipid transfer proteins (nsLTPs) are widely distributed in the plant kingdom and form multigenic families of related proteins. These nsLTPs are important antimicrobial peptides. Additionally, plant nsLTPs perform numerous physiological functions like involvement in plant pathogen interactions and could be associated with disease resistance response. In this study, we identified and characterized 49 non-specific lipid transfer proteins in the Arabidopsis genome. Phylogenetic analysis clustered all 49 nsLTPs genes into two main groups namely as G1 and G2. Conserved motif analysis found 10 conserved motifs in all 49 nsLTPs peptide sequences. We found 4 motifs with highly conserved cysteine residues at specific positions in the peptide sequences. Chromosomal positioning revealed that maximum 17 nsLTPs are located on chromosome 5 whereas 10, 7, 9 and 5 nsLTPs are present on chromosome 1,2,3 and 4 respectively. Gene structure analysis indicated several similarities in intron-exon pattern of nsLTP genes among the members of the same group. This identification and characterization of nsLTPs can help the researchers for the analysis of this gene family in other plant species in future. Moreover, it will be good information to study the role of these proteins in plant pathogen-interaction.

Key Words: Arabidopsis; non-specific lipid transfer proteins; motif analysis; phylogeny; disease resistance

INTERACTIVE EFFECT OF NITROGEN SOURCE AND WEEDICIDE ON THE PRODUCTIVITY OF WHEAT (*TRITICUM AESTIVUM L.*)

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Weedicides are important component of production technology to improve yield. This possibility is only suitable, where main crop has minimum stress effect of weedicide application. The main problems due to weedicide application involve environmental pollution and soil plant nutrient interaction. This interaction minimizes the nutrients uptake by plant and ultimately target yield decreases. To tackle these problems, there is need to manage the source of nitrogen and weedicide for effective control of weeds with improvement in main crop yield. A field trial was conducted to evaluate the interaction between weedicide and nitrogen fertilizer sources on the wheat yield. The research plan was comprised of two nitrogen fertilizers sources combinations viz.[Urea+DAP+SOP] and [CAN+NP+SoP] along with weedicide "Atlantis" applied with respect to different timing (before, during and after irrigation). Recommended dose of N-P-K 120-80-60 kg ha⁻¹ respectively and weedicide at the rate of 150 g per acre was applied. Experimental results showed that first combination improved wheat productivity associated with increased number of fertile tillers (10-18%), plant height (11-19%), chlorophyll contents (19-33%), grain yield (10-17%) and nutrients uptake (15-24%) as compared to before and during weedicide application with second combination. This combination also decreased the negative impacts of weedicide on the quality and yield.

Key Words: Weedicide; Nitrogen source fertilizer; Wheat; Timing; Production

EVALUATING PRODUCTIVITY AND GRAIN BIO-FORTIFICATION OF MAIZE (*ZEA MAYS L.*) THROUGH INTEGRATED NUTRIENT MANAGEMENT UNDER DROUGHT STRESS

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Lack of water availability and malnutrition are serious threats to world food security and survival of the living organisms. To address and overcome these issues a pot experiment was designed to improve the productivity and grain bio-fortification of spring maize (*Zea mays L.*) through zinc nutrition under limited moisture supply. Thirty two pots were placed in rainout sheltered under net house under the Faisalabad, Punjab, Pakistan climatic conditions during spring 2014. The treatments were two drought levels i.e. well watered (70% water holding capacity), and drought stress (35% water holding capacity), while factor B contains two maize hybrids DK-6525 (Monsanto), high corn-8288 (ICI) and two levels of zinc (Zn) 0, 10 mg kg⁻¹ of soil. The results revealed that zinc treated pots with 10 mg kg⁻¹ soil had significant ($P<0.05$) effects on root fresh weight plant-1, leaf length, leaf water potential, and grain zinc contents over control. Among genotypes, DK-6525 performed better as compared to high corn 8288 at 10 mg kg⁻¹ Zn application with respect to morphological and physiological traits. It was concluded that soil application of Zn @ 10.0 mg kg⁻¹ under well-watered conditions improved growth, productivity and grain zinc contents as compared to water stress condition.

Key Words: zinc; nutriton; cultivars; biofortification; maize

ACCUMULATION AND BIOGEOCHEMICAL BEHAVIOUR OF ARSENIC IN PADDY SOIL-RICE SYSTEM UNDER THE INFLUENCE OF VARIOUS AMENDMENTS

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Arsenic contamination of groundwater is threat to over 200 million people globally. Arsenic becomes more mobile and bioavailable under reduced paddy soil conditions. The objectives of the present study were to explore the accumulation of As in different parts of rice plants of the two contrasting rice genotypes (Kainat and KSK-385); and evaluate the effect of As on morphological and biochemical parameters of rice plants. Six types of organic (farm yard manure (FYM), cow dung (CD), biogas slurry (BGS), mixed biomaterials waste (MBW)) and inorganic (gypsum, lignite) were applied to determine their impact on As availability and uptake by two different rice genotypes. Arsenic-contaminated irrigation water was applied to rice plants after 15 days of transplantation, and each irrigation was applied at three equal intervals – each irrigation contained 15 mg As/L (400 mL per 2 kg soil). It was found that the percentage increase in number of tillers ranged from 28–51% and tiller length spanned 28–50% with the maximum values obtained for FYM over their respective control for KSK-385 genotype. In case of Kainat genotype, number of tillers and tiller length ranged from 41–50% and 18–33%, respectively, with the maximum values attained for CD treatment compared to control. This study shows that organic amendments, particularly FYM and CD, could possibly enhance the growth and yield of the two rice genotypes under irrigation with As contaminated water.

Key Words: Arsenic; rice; genotype; amendments ; organic, inorganic

OSMOREGULATES AND ANTIOXIDANTS PRODUCING IN THREE FOREST SPECIES UNDER HEAVY METAL STRESS OF CADMIUM AND ARSENIC

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A pot experiment was conducted to identify the effect of heavy metal on growth, morphological, osmoregulation and antioxidants changes in three forest species (*Conocarpus erutus*, *Dalbergia sissoo*, *salix tetrasperma*). Sodium Arsenate (300 µM) and cadmium chloride (200 µM) were applied in aqueous solution to all pots. All the growth parameters and dry biomass significantly decreased under heavy metal stress. R:S ratio of *C. erutus* species increased under cadmium stress and minimum decreased under arsenic stress and willow species R:S ratio was similar under both stress levels. *D. sissoo* species produced more R:S ratio under arsenic stress. Activities of antioxidant (SOD, POD, CAT, APX) of all the three species were enhanced under heavy metal stress with maximum values obtained in *C. erutus* species as compared with other two species. Proline content also enhanced in all the species under stresses but maximum production was noticed in *C. erutus* and *D. sissoo*. Maximum hydrogen peroxide was produced in *D. sissoo* under both arsenic and cadmium stress as compared to other species. Osmolytes accumulation production was higher in *C. erutus* and *D. sissoo*. Among species, *C. erutus* and *D. sissoo* was better able to neglect the heavy metal included oxidative damage, which was associated with higher antioxidant activities, greater osmolytes accumulation, and lower ROS production in this cultivar.

Keywords: antioxidant defense; drought; proline; *Conocarpus erutus*; *Dalbergia sissoo*

PHYSIOCHEMICAL ANALYSIS AND QUALITY PARAMETERS OF ALLIGATOR WEED COMPOST

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Composting the weeds and their utilization as an organic fertilizer is an economically beneficial practice. A laboratory trial was carried out to analyse the physiochemical and quality parameters of alligator weed compost. Alligator weed biomass was harvested from four different places i.e maize field, biogass plant, fallow land and water channel. Collected biomass was well dried and chopped into smaller particles (1-2 inches). Finally, chopped material was composted under anaerobic conditions. After composting, the alligator weed biomass, physiochemical and quality analysis of composted material was carried out to evaluate nutritional values and quality of compost. Highest pH and organic matter was observed in compost from slurry (near biogas plant) while highest moisture contents were observed in compost from water channel.

Key Words: Alligator Weed; Analysis; Compost; Compost Quality; *Alternanthera philoxeroides*

ESTIMATION OF INTER- AND INTRA-FIELD SPATIAL VARIABILITY IN ISOPROTURON DISSIPATION IN VARYING AGRICULTURAL FIELDS

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Isoproturon [3-(4-isopropylphenyl)-1,1-dimethylurea (IPU)], one of the phenylurea herbicides, is extensively used across the globe in agricultural fields to overcome the pre- and post-emergence of broad leaf weeds in cereal cultures. Intensive use of IPU is becoming a source of ground and surface water contamination. Several problems including cancer, endocrine disruption and inhibition of growth in humans, animals and plants are related to IPU toxicity. Keeping in view the environmental concerns associated with IPU, there is a need to develop the strategies for removal of IPU from our environment. In this regard, the present study was conducted to estimate the potential of natural adapted microbial communities for biodegradation of IPU within the agricultural fields of Shorkot, Faisalabad and Sahiwal repeatedly exposed with this herbicide. The in-field spatial variability in IPU degradation within the field was correlated with the prevailing physicochemical properties of the respective soils and was found positively correlated with the organic matter content, total organic carbon as well as the abundance of culturable heterotrophic microorganisms and negatively correlated with the pH. Based on the findings of this study, it might be concluded that the isoproturon dissipation in the agricultural fields is variable not only from field to field but also at different points within the same field thanks to the prevailing physicochemical biological properties of the soils.

Key Words: Isoproturon; Dissipation; Soils; Physicochemical properties; Microbial communities

INTEGRATIVE EFFECT OF POTASSIUM HUMATE AND PHOSPHORIC ACID ON NUTRIENT AVAILABILITY AND CHEMICAL PROPERTIES UNDER SALINE CONDITIONS

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Soil salinity is one of the major factors degrading soil fertility, hence reducing the growth and plant yield. Several strategies have been introduced to counteract this affect. It has been reported that addition of humic acid as a chemical fertilizer played a vital role in the development of soil structure and increasing plant yield. Application of humic acid in combination with phosphoric acid had been found to show great impact on both saline and non-saline soils. In this perspective, a pot experiment was conducted to evaluate the response of potassium humate in combination with phosphoric acid (50%) on soil chemical properties and nutrient availability under non-saline and saline conditions. Parameters including pH, salinity (EC), cation exchange capacity (CEC), organic matter, NPK, C: N ratio, lime contents and total organic carbon were determined. A significant development was observed in all the treated units compared with the controlled units. Maximum improvement was observed with phosphoric acid 0.35 ml kg⁻¹ + potassium humate 37.5 mg kg⁻¹ (Urea =130 mg kg⁻¹, SOP = 72 mg kg⁻¹) for all the studied parameters. It was concluded that the combined response of potassium humate and phosphoric acid increased the nutrient availability.

Key Words: salinity; humic acid; sodicity; phosphoric acid; fertility

BIOAVAILABILITY OF FOLATE NUTRIENT IN BIOFORTIFIED WHEAT GRAINS THROUGH GENOME EDITING TECHNOLOGY

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Malnutrition is the form of iron deficiency and other important micronutrients in the diet is the main cause of abnormal brain development and anemia in poor population across the globe. Cereals are deficient in micronutrients, particularly folate. Implication of modern breeding technologies can help genetically improving the cereal grains with folate through biofortification for destitute in the world. Recently, genome editing has emerged as environment friendly biotechnological tool that mimics the conventional breeding in nature. Phytic acid is a main anti-nutrient that makes the minerals such as iron unavailable for absorption by forming strong complexes with minerals. We have embarked on CRISPR-Cas9 genome editing system that can disrupt the IPK gene codes for an enzyme involved with the final step of phytate biosynthesis. Two guide RNA for each IPK gene/genome of wheat were successfully annealed in CRISPR vector that was shuttled to Cas9 vector through gateway recombination. In planta, transformation in wheat was successfully achieved and alleles carrying mutations ranging from single base insertion, substitution and deletions of 4 to 180bp were screened through mismatch cleavage assay followed by Sangar sequencing. Research work on validation of genome editing in wheat plants as well as isolation, cloning and analysis of other vitamin related genes and nutraceutical plant such as Seabukthorn has also been carried out.

Key Words: Folate; Biofortification; Genome Editing; Wheat; CRISPR-Cas9

COMPARING FATTY ACIDS COMPOSITION AND AMINO ACIDS PROFILE OF DIFFERENT FLAX GENOTYPES UNDER ARID ENVIRONMENT

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This study evaluated seven flax genotypes from different geographical regions concerning their composition from oil and protein contents, fatty acids and amino acids, besides to calculate the correlation coefficients between the fatty acids and also between the amino acids under arid land conditions of Saudi Arabia. The main results showed that verum cv. had the highest oil content and linolenic acid (Omega-3) while Hiera cv. was the highest in meal protein content and most amino acids. The highest amino acid concentration, proline ranged from 27.15% to 30.21%. Lysine amino acid concentrations ranged from 1.35% to 1.67%. Linolenic acid (Omega-3) negatively and significantly correlated with oleic and linoleic (Omega-6) fatty acids. Lysine amino acid positively and significantly correlated with the amino acids of glutamine, aspartic, leucine, serine and isoleucine.

Key Words: Arid Environment; *Linum usitatissimum*; Proline; Grain analysis ; Oil Seed

GENOTYPIC VARIABILITY IN WHEAT FOR EFFICIENT PHOSPHORUS ADAPTATION

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Phosphorus (P) is an essential macro nutrient for plant growth and productivity and its low availability causes growth deficient condition in cereals particularly in wheat. Phosphorous requires rational management for enhancing the production of cereals. The experiment was executed to evaluate the effect of P on wheat genotypes Shafaq 2006, Faisalabad 2008, Lasani 2008, AARI 2011, Millet 2011, Punjab 2011, Galaxy 2013 and Ujala 2016 when grown under three P levels i.e (0 kg ha⁻¹, 50 kg ha⁻¹, 100 kg ha⁻¹). Standard procedures were used for recording data on different growth, yield and quality parameters. Maximum plant height, total number of fertile tillers m⁻², spike length, number of grains per spike, 1000 grain weight, grain yield, total dry matter, biological yield, harvest index, protein contents and phosphorus contents in grains were observed at 50 kg P ha⁻¹ than all other combinations and minimum in control. Biplot analysis also showed that the variability in performance of different wheat genotypes at different P levels.

Key Words: Phosphorus; wheat; genotypes; dry matter; biological yield

CHALLENGES, OPPORTUNITIES FOR CROP PRODUCTION AND ADAPTATION TO CLIMATE CHANGE IN PAKISTAN: AN OVERVIEW

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Climate change is one of the most complex challenges that humanity possibly will face in the coming decades. However, the threat of climate change is in fact a reality that puts our food and fiber resources at risk. Pakistan is highly vulnerable to climate change, with the Global Climate Risk Index (GCRI) ranked 21st in extreme weather conditions from 1993 to 2012. The World Bank also enlisted Pakistan as 12th most highly exposed country to climatic changes. Potential consequences, such as declining agricultural production due to climate change and the displacement of traditional crops, have forced producers to change their crop production systems to adapt to climate change. Major challenges to sustainable crop production under climate change include rising temperature, variations in precipitation patterns, weather shifting, drought, flash floods and pests invasion. However, adaptation strategies, such as the use of drought-resistant or excessively hydrated species, modifying crop rotation, using cover crops and the installation of controlled drainage/irrigation systems, will help to increase our crop productivity in challenging climate conditions. Therefore, this paper summarizes some of the climate-related challenges faced by crop production systems, and then proposes some steps to mitigate and adapt to these challenges.

Key Words: Adaptation; Climate change; Crop production; Mitigation approaches; Pakistan

EFFECT OF SEED SIZE ON THE PERFORMANCE OF WHEAT UNDER DIFFERENT SOWING METHODS

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Appropriate seed size and sowing method play a significant role in resource conservation and overall performance of wheat. To establish the relationship between sowing methods and seed size, two years field study was conducted. The experiment was comprised of three seed size classes having different 1000-grain weight, bold grain (39.8 and 39 g first and second year respectively) medium grain (31.8 and 33 g first and second year respectively) and small grain (23.4 and 23 g first and second year respectively) and five sowing methods i.e. broadcast, line sowing, zero till sowing, bed planting and broadcast augmented with furrows. The results indicated that sowing methods and seed size classes had significant impact on weed dynamics, crop growth, stand establishment and grain yield. The minimum weeds fresh weight (5.68 g, 2.40 g) and dry weight (1.24 g, 1.09 g) and, weed density (10.3, 6.8) was recorded in bed planting. Moreover, the maximum grain yield (4.08 t ha⁻¹) and biological yield was obtained in bed planting as compared to other sowing methods. Amongst the seed sizes, minimum weed fresh weight, dry weight, weed density and maximum grain yield and biological yield was recorded with bold seed. In conclusion bed planting with bold seeds may be opted to get maximum yield of wheat under Faisalabad conditions.

Key Words: Wheat; Seed size; sowing method; growth; productivity

PHOSPHORUS ENRICHED POULTRY COMPOST INCREASES WHEAT (*TRITICUM AESTIVUM L.*) YIELD

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Low phosphorus use efficiency is a major cause of low wheat yield in Pakistan. Yield potential of wheat is high, yield per hectare is extremely high in other countries as compared to Pakistan. This experiment was conducted to evaluate the effects of different phosphorus sources on grain yield in wheat (*Triticum aestivum L.*). Wheat variety Fsd-2008 was grown and experiment was consisted of four sources of inorganic phosphorus, single super phosphate (SSP), diammonium phosphate (DAP) and rock phosphate compared to control and two levels of poultry compost, control and recommended poultry compost @1.875 t ha⁻¹. Total Phosphorus contents was same in each plot (80 kg P₂O₅ ha⁻¹). Spike length, plant height, number of fertile tillers m⁻², number of grains per spike, 1000 grain weight, total biomass and grain yield of wheat increased significantly when compost was applied with DAP and SSP respectively. Wheat yield was significantly increased with application of phosphorus enriched poultry compost due to reduced P fixation in soil.

Key Words: Compost; DAP; SSP; Rock phosphate; P Fixation

APPRAISAL OF GEOTECHNICAL CHARACTERISTICS IN ALLUVIAL PLAINS OF DISTRICT CHINIOT

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A proper evaluation of the soil fertility before planting a crop helps in adopting appropriate measures to make up nutrient requirements and ensuring a good crop production. Therefore, total of 6808 advisory soil samples were collected during 2016-2018 from the farmers' field alongwith GPS co-ordinates from district Chiniot. The results showed that 92.3% soil samples had pH ranged from 7.5 to 8.5, while 7.6% samples had pH >8.5. However, 91.2% samples were within defined normal salts critical limits, while 4.5% saline, 2.07% saline-sodic and 2.18% sodic of the total collected samples. Likewise, 2.6% soil samples were found light textured, 94.9% had medium and 2.4% were found heavy textured. Furthermore, 55.5% soil samples were poor (<0.86%), while 37.7% medium (0.87 - 1.29%) ranged and 6.6% had adequate (>1.29%) OM. Likely, 54.1% soil samples were poor in available P (<7.0 mg kg⁻¹), 43.1% medium (7.1 - 14.0 mg kg⁻¹) and 2.7% had adequate (> 14.0 mg kg⁻¹) soil P. Moreover, 19.9% soil samples were poor (<80 mg kg⁻¹) in available K, 69.5% medium (81-180 mg kg⁻¹) and 10.5% had adequate (>180 mg kg⁻¹) soil K. Site specific fertilizers recommendations using soil test-based fertilizer prediction model were given to farmers, by the expert scientists of Soil and Water Testing Laboratory Chiniot operative under SFRI, AARI, Department of Agriculture, Government of Punjab.

Key Words: Advisory Service; Chiniot; Characterization; Soil Fertility; GIS.

WEED MANAGEMENT STRATEGIES IN SPRING PLANTED MUNGBEAN UNDER DIFFERENT SOWING METHODS

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Mung bean growth and yield are significantly reduced by inappropriate weed control measures and planting patterns. Therefore, field experiment was conducted during 2018 to determine the impact of sowing methods and weed management strategies on performance of mungbean. The experiment was composed of different sowing methods i.e, zero tillage, broadcast and line sowing and different weed control measures i.e, Pendimethalin 800 ml/L (pre-emergence), Pendimethalin 800 ml/L (pre-emergence) + Lactofen @ 200 ml (post emergence), Lactofen @ 200 ml (post emergence). The results indicated that sowing methods and weed management strategies had significant effect on the performance of mungbean. The maximum number of grains per pod and grain yield (1235.23 kg ha⁻¹) was recorded with line sowing method. In case of weed management strategies, maximum number of grains per pod (10) and grain yield (1088 kg ha⁻¹) was recorded with Pendimethalin 800 ml/L (pre-emergence) + Lactofen @ 200 ml (post emergence) in interaction effects maximum number of grains per pod (11) and grain yield (1233.3 kg ha⁻¹) was recorded in line sowing with Pendimethalin 800 ml/L (pre-emergence) + Lactofen @ 200 ml (post emergence). In conclusion, line sowing method and Pendimethalin 800 ml/L (pre-emergence) + Lactofen @ 200ml (post emergence) can be used to get maximum yield.

Key Words: sowing methods; weed control measures; number of grains per pod; yield; mungbean

SALICYLIC ACID IMPROVES MORPHO-PHYSIOLOGICAL AND BIOCHEMICAL ATTRIBUTES IN MUNG BEAN AGAINST CADMIUM STRESS

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This study was conducted to explore the mediatory role of salicylic acid to accelerate the biosynthetic machinery of mung bean against cadmium (Cd) stress. A pot experiment was conducted under wire house condition. Mung bean plants were exposed to 0, 5, 10 and 15 mg Cd per kg of soil. Foliar application of salicylic acid at 0, 10-6, 10-3 M was done before flowering stage. The reduction was observed in plant height, dry weight, chlorophyll contents and total soluble proteins while an increasing trend was observed in H₂O₂, MDA and enzymatic antioxidants including POD and APX under increasing Cd concentration. Results showed that foliar application of salicylic acid with 10-3 M significantly increase shoot length, shoot dry weight, chlorophyll, total soluble protein, POD and APX activity by 14.5%, 32.6%, 5.6%, 63.1%, 47.7% and 22.12% respectively under 15 mg Cd/kg of soil. Moreover, it reduced the H₂O₂ and MDA contents by 23% and 29.2% respectively under 15 Cd/kg of soil. In crux, foliar application of salicylic acid at 10-3 M efficiently improved the growth, physiology and antioxidant mechanism of mung bean under Cd stress.

Key Words: Mung bean; Cadmium; Salicylic Acid; Antioxidants

EVALUATING THE IMPACT OF DIFFERENT PELLETING AGENTS ON STAND ESTABLISHMENT, VIGOUR AND PHYSICAL PROPERTIES OF TOBACCO SEEDS

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Seed quality is of prime importance for the assessment of satisfactory yield thus providing monetary benefits. In order to attain the improved germination, stand establishment, precision in plantability of tobacco, seed pelleting was performed. Ultimately seed quality was improved by improvement in the size and shape of seeds and provision of growth promoting agents in pelleting. In Pakistan, almost all the pelleted seeds are imported and till now no seed pelleting is performed that results in expenditure of huge amount on import of pelleted seeds. Thus, in order to mitigate the above stated problem an experiment was conducted having calcium oxide, titanium dioxide, bentonite, talcum and china powder as seed pelleting agents. 25 combinations were evaluated having different properties. A significant improvement in final emergence percentage was obtained in experimental units having a combination of calcium oxide:talcum (1:2) followed by calcium oxide:titanium dioxide (1:1) as compared to non-pelleted seeds taken as control. Due to less time taken for emergence pelleting combinations calcium oxide:talcum (1:2) followed by calcium oxide:titanium dioxide (1:1) also showed a significant improvement in seedlings length, fresh weight and dry weight as compared to control. Highest values for seed to pellet ratio was linked with calcium oxide:bentonite (2:1). Hence seed pelleting could be better adaptive approach for improving the tobacco seed quality.

Key Words: pelleting; seed quality; tobacco; calcium oxide; emergence

MASH-97 PERFORMS BETTER UNDER PHOSPHORUS STRESS

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A pot experiment was carried out to study the effect of various levels of phosphorus (P) on the performance of different genotypes of mash bean. Three levels of P viz. 5, 20 and 40 mg P kg⁻¹ of sand. Pots were filled with 3 kg sand and two varieties of mash bean (Mash Arooj and M-97) were compared. Nutrient solutions containing different P levels of all macro and micro nutrients were applied in split doses after their dilution. Distilled water was applied to maintain 60% water holding capacity. The experiment was done in sand culture because sand has less holding capacity so that root exudates were properly determined. It greatly enhanced the plant height, root length, formation of root nodules, number of leaves, lateral root formation, total and extractable P content, root and shoot P content, dry and fresh weight of shoot and root and germination rate. The treatments with high P concentration performed better to growth, germination, root and shoot lengths, chlorophyll contents, total and extractable P. Mash-97 performed better than Mash Arooj with the application of 40 mg P kg⁻¹ of sand.

Key Words: Phosphorus; Mash; Sand culture; Extractable P; Shoot P content

ROLE OF INFORMATION SOURCES IN IMPROVING FARMER'S KNOWLEDGE FOR HEALTH HAZARDS PERTINENT TO WASTE WATER IRRIGATION IN VEGETABLES

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About 90% of wastewater formed universally remains unprocessed, causing widespread of water contamination. Farmers generally rely on wastewater because of unavailability of other cheap and reliable sources of irrigation water. Wastewater is considered as beneficial for plant growth, hence extensively used for irrigation of crops. With increase in demand, farmers are trying to get more yield to earn more profit and to use sewage or industrial waste water in vegetable production as cost effective and easily available all the time source. The study was conducted in 4 towns of Faisalabad (Jinnah town, Madina town, Lyallpur town, Iqbal town) selected purposively to access the role of information sources in improving farmer's knowledge regarding health hazards pertinent to waste water irrigation in vegetables. 30 respondents were selected using simple random sampling technique for interview from each town. Result showed that excess amount of toxic matters found in waste water can make soil unfertile and cause metabolic problems to humans and plants as well. Training and awareness to build skills and knowledge on using raw sewage for irrigation should be considered in planning process of re-use projects to protect all risk groups. Awareness campaigns and trainings on precautions of raw effluent use is required to educate and orient farmers .

Key Words: Water Effluents; Vegetables; Health hazards; Farmer Perception; Peri-Urban Areas

STUDYING THE EFFECT OF SOWING DATES AND VARIETIES ON GROWTH AND YIELD OF WHEAT

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Wheat is the most important cereal in Pakistan. But its average yield is much lower than the potential yield. Late sowing and less use of approved wheat varieties are the main reasons for low yield in Pakistan. Therefore, an experiment was carried out to evaluate the growth and yield response of different wheat varieties to different sowing dates. Experiment was carried out during rabi 2017-18. Experiment was laid out in randomized complete block design (RCBD) with split plot arrangement. Treatment included different wheat varieties (Faisalabad-2008, Punjab-2011 and Ujala-2016) and sowing dates (3rd week of Nov, 2nd week of December and 4th week of December). Results revealed that Ujhala-2016 significantly performed better than other varieties when sown in 3rd week of November.

Key Words: Wheat; Triticum aestivum; Sowing Date; Variety; Sowing Time

CROP PRODUCTION AND CLIMATE CHANGE: CHALLENGES AND SOLUTIONS

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Climate change arises due to emissions of greenhouse gases from different anthropogenic activities including fuel combustion, deforestation, urbanization and industrialization. Pakistan lies in arid and semiarid region contributing less to greenhouse gases emission but highly vulnerable towards the disrupted weather patterns. According to the 2018 Global Climate Risk Index, Pakistan is among 10 most affected countries. The key effects of climate change include unusual rainfall patterns, extreme temperature fluctuations, soil erosion and drought stress which are liable for agricultural crop production. Almost 25 % reduction in wheat yield is expected due to climate change towards the end of the ongoing century and has given rise to food inflation. Yield of sugarcane and rice is expected to decrease by 10% and 16-18% by 2080 respectively. Average increase in temperature results almost 6% and 28% drop in maize and cotton production till 2030 respectively. This will ultimately result in food insecurity, socioeconomic imbalance, economic crisis and trade distortion. Dissemination of new adaptive crop farming techniques, water conservation management, integrated fertilizer management, drought and heat resistant seeds would be appropriate derivatives to compete with adverse climatic challenges across the agro climatic zones of Pakistan to achieve sustainable development goals (SDGS).

Key Words: global warming; ; Pakistan; sustainable agriculture; rainfall patterns; temperature rise

EFFECT OF PLANTING METHODS AND CULTIVARS ON BIOMASS PRODUCTION AND METHANE YIELD OF SORGHUM

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Bio-fuels produced from plant biomass are considered to be cheap, sustainable and more environmental friendly. Management considerations including sowing method and suitable cultivar have considerable effect on the dry matter yield which in turns influenced the bio-fuel yield. Field experiment was conducted during 2016 and 2017 to determine the influence of sowing methods and cultivars on biomass production, chemical composition and methane yield of sorghum bicolor. The results revealed ridge sowing performed better and resulted in more plant height (229 cm, 225 cm), stem diameter (1.48 cm, 1.43 cm), leaves per plant, (13.88, 13.88) dry matter yield (16.43 t ha⁻¹, 16.10 t ha⁻¹) and methane yield ha⁻¹ (3904 m3N ha⁻¹, 3853 m3N ha⁻¹). Moreover, the sowing methods had non-significant effect on protein, sugar, ash, acid detergent fiber, neutral detergent fiber, lignin concentration and specific methane yield. In case of cultivars Jawar-2011 performed significantly better with maximum plant height (223 cm, 217 cm), leaves per plant (13.09, 12.92), stem diameter (1.35 cm, 1.32 cm), dry matter yield (15.42 t ha⁻¹, 15.09 t ha⁻¹), protein (10.6%, 10.5%) and sugar concentration (11.28%, 11.17%) and methane ha⁻¹ (3622 m3N ha⁻¹, 3604 m3N ha⁻¹) as compared to other cultivars. In conclusion, ridge sowing and cultivar Jawar-2011 may be opted owing to higher dry matter yield for maximizing the methane yield ha⁻¹.

Key Words: Sowing methods; Dry matter yield; Biomass composition; Methane production; Cultivars

BIOLOGICAL ALTERNATIVES TO CONTROL CROP PARASITES

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More than 4,100 species of nematode have been reported which lead to destruction or at least limit the production of crops. Approximately \$US173 billion loss is caused by these parasites each year around the globe. These crop losses in term of parasitic invasion would be even higher since data is not available from several countries. Some of these nematodes colonize around the plant roots from where they cause damage or transmit viruses. However, most important damage in crops is attributed to sedentary endo-parasites which belongs to the family of Heteroderidae. Sedentary nematodes have been managed by using nematicides since the 1950s'. Due to environmental and health concerns led to the development of antagonistic micro-organisms as biological control agents to these pests. Several soil-residing bacteria with bio-control abilities, such as *P. chlororaphis*, *P. putida* and *P. fluorescens* are the members of *Pseudomonas* genus. In this study, these beneficial *Pseudomonas* bacteria were inoculated at seeding time and wheat plant performance in term of growth and productivity were monitored. The preliminary results of first have demonstrated that these soil micro-organisms propagated successfully in soil and significantly reduced the burden of nematode. Importantly, the plant heath and production of these treatments groups were significantly higher when compared to control group. In vitro, employed *Pseudomonas* spp. contained the nematodes growth significantly.

Key Words: Biological parsitic control; Nematodes; *Pseudomonas*; Crops

EVALUATION OF INSECTICIDES RESISTANCE DEVELOPMENT IN BEMISIA TABACI GENN. (HOMOPTERA ALEYRODIDAE) UNDER FIELD CONDITIONS AT FAISALABAD

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In the present studies, evaluation of development of resistance in *Bemisia tabaci* Genn. against various insecticide groups including insect growth regulator will be worked out. Serial concentration of each insecticide will be prepared and leaf-dip bioassay will be followed for organophosphate, neonicotinoids, pyrethroids and chlormfenapyr. For insect growth regulators, whitefly will be confined inside the clip cage on cotton leaf treated with the insecticide concentrations. Twenty adults of whitefly will be transferred per each concentration for each insecticide. Five replications will be prepared for each concentration. A control will be set up by spraying with water only. LC₅₀ of each insecticide will be calculated on the basis of mortality percentage of field collected population and reference population (non selected) of whitefly. Adult survivor of each concentration of each insecticide will be pooled and allowed to lay eggs on cotton plant in separate iron cages covered with net for next generation under field conditions. F₂ population will be tested in above mentioned manner and these tests and subsequent generation production will continue upto 5th generation of survivors of each insecticide. At the end of each test, LC₅₀ for each insecticide will be calculated and overall development of resistance level upto five generations will be presented and compared statistically, in context of the reference strain. Toxicological inference will be recorded by using Polo PC.

Key Words: *Bemisia tabaci*; Insecticides; Resistance; Leaf-dip bioassay; LC₅₀

COMPARATIVE EFFICIENCY OF BIOGAS PRODUCTION THROUGH ANAEROBIC DIGESTION USING ANIMAL DUNG AND DIFFERENT DUNG MIXTURES

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The study was planned to evaluate comparative efficiency of biogas production from animal dung with and without different mixtures (wheat straw, goat manure and poultry droppings). Wheat straw, goat manure and poultry droppings were added in dung in three different ratios i.e. 10, 20 and 30% each. Study was designed with ten treatment plans. In T1 only animal dung was used (control) while in T2, T3 and T4, dung-wheat straw mixtures were used in the ratio of 90:10, 80:20 and 70:30, respectively. In T5, T6 and T7 treatments, dung-goat manure mixtures were used in the ratio of 90:10, 80:20 and 70:30, respectively while in T8, T9 and T10 treatments, dung-poultry droppings mixture were used in the ratio of 90:10, 80:20 and 70:30, respectively. It was observed that co-digestion of cattle/buffalo dung with different organic substances like wheat straw and poultry droppings not only increased biogas production but also enhanced nitrogen, phosphorus and potassium (NPK) value of bio-slurry. Study indicated that dung-goat manure mixture is not a good combination for biogas production as its concentration was not influenced by this mixture. The best combination for improvement of biogas yield was dung-wheat straw mixture. The NPK value of all the treatments revealed that dung-poultry droppings mixture produced best bio-slurry.

Key Words: Comparative efficiency; anaerobic digester; biogas; slurry; NPK value

BIOFORTIFICATION OF WHEAT WITH FE AND ZN THROUGH FERTIGATION AND FOLIAR APPLICATION

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Zinc (Zn) and iron (Fe) deficiencies are now considered as vital malnutrition problem worldwide and in developing countries specifically, where cereals are being used as staple food. Biofortification of wheat through fertilizers is a valid strategy to mitigate micronutrient malnutrition. To investigate the impact of Zn and Fe fertilization on wheat through fertigation and foliar application, the experiments were carried out at PCSIR Laboratories Lahore during 2016-2017. Morphological and physiological traits of four wheat cultivars (Sehar 2006, Faisalabad 2008, Lasani 2008, Punjab 2011). The experiments were laid separately for both mineral applications in a randomized complete block design with three replicates. Foliar application of both mineral nutrients increased the growth, yield, leaf area index, chlorophyll content and quality of grains, as compared to fertigation and control conditions. Foliar application of Fe and Zn enhanced the crop growth rate, number of tillers, productive tillers, spike length, spikelets per spike, grain per spike and 1000 grain weight. Moreover, foliar application increased the concentration of Zn and Fe up to 51.28 mg kg⁻¹ and 33.76 mg kg⁻¹ grain dry weight, respectively. Cryo-sectioning analysis of grain revealed that more Fe was accumulated in aleurone and endosperm region, while Zn was more concentrated in endospermic regions. Foliar application of Zn and Fe is an effective strategy to mitigate micronutrient malnutrition in humans.

Key Words: Triticum aestivum; Fe and Zn ; biofortification; soil application; foliar spray

IMPACT OF PHOSPHORUS ON NITROGEN FIXING BACTERIA IN MUNG BEAN (*VIGNA RADIATA L.*)

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Mung bean (*Vigna radiate L.*) is an important pulse crop. P application with optimum levels increase yield and yield contributing parameters in mung bean. A field experiment was conducted at Agronomic Research Area, University of Agriculture Faisalabad to evaluate impact of phosphorus on nitrogen fixing bacteria in mung bean. The treatments were comprised of two levels of inoculation; No rhizobium (control) (I1), ii) rhizobium phesiolie @ 100 g kg-1 seed (I2) along with three phosphorus levels i.e. (control) (P1), 40 kg ha-1 (P2), 80 kg ha-1 (P3). The yield and yield parameters i.e. plant height, pod length, 1000 grain weight was taken. Maximum plant height (47.4) cm was observed using Rhizobium with P 80 kg ha-1. In case of pod length maximum pod length (7.7) cm was observed by using P 40 kg ha-1 while maximum 1000 grain weight (68.5) g was observed using rhizobium + P, and maximum yield (448.1) kg ha-1 was observed using P 80 kg ha-1. Phosphorus nutrition significantly affected the activity of Nitrogen fixing bacteria and the yield of mung bean.

Key Words: Pulses; Mung bean ; Rhizobium; Phosphorus; Inoculation

CHALLENGES AND PROSPECTS FOR WEED MANAGEMENT IN PAKISTAN

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Weed management has become increasingly important in the backdrop of sustainable crop production, uncertain climatic patterns and food security concerns in Pakistan. Due to diverse agro-climatic conditions, 267 weed species have been identified to cause monetary loss worth 3 billion USD annually. Weed competition for resources, interference with crops, weed-related increased incidence of pests and diseases in different crops, and high management costs incurred in controlling weeds make weed management a critical task for the farmers. Moreover, herbicide resistant weeds, labor shortage, higher wages, weed population shifts, changing climatic optima, unavailability of proper and timely inputs, ever increasing threats of invasive weeds, lack of knowledge and training regarding herbicides, and the poor financial resources of the small land holders are major hurdles towards effective weed management in Pakistan. These multi-dimensional problems need holistic line of action with multi-disciplinary collaboration. Improved knowledge of weed ecology, biology, genetics and molecular biology is essential for developing sustainable weed management practices. Here, we have presented a broad review to summarize the current state of knowledge about the problems and prospects of sustainable weed management approaches in Pakistan. Advanced weed management approaches keeping in view the local agro-ecological conditions have also been discussed.

Key Words: Climate change; Yield loss; Herbicide resistance; Invasive weeds; Weed research and education

ESTIMATION OF PHOSPHOROUS USE EFFICIENCY OF MUNG BEAN CULTIVARS UNDER DIFFERENT PHOSPHOROUS REGIMES

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Phosphorus deficiency is one of the major production limiting factors in mung bean. Development of phosphorus efficient genotypes of mung bean which perform well under phosphorus deficit conditions is key strategy to overcome this problem. A trials was conducted following factorial completely randomized design with five mung bean genotypes i.e. NM2010, AZRI, 8009, NM-2011 and NM-2016, three phosphorus levels i.e. P1 5 mg /kg sand (control), P2 20mg /kg sand and P3 40 mg/kg sand and four replications in sand filled pots. Data was recorded for various morphological and physiological parameters. Significant differences were observed for Shoot length, root length, number of lateral roots, number of nodules, shoot and root phosphorous contents at different phosphorus levels. Moreover, different genotypes exhibited statistically significant interaction with phosphorus levels for various morphological and physiological parameters. Variety NM-2010 gave the highest value for shoot length and root length at minimum phosphorus application. Likewise, highest level of available phosphorus in growing media was observed for variety 8009 with minimum application of phosphorus. These observations indicate that considerable genetic variation is present in available mung bean genotypes for phosphorus use efficiency and this variation may be used to select suitable genotype for evolving phosphorus efficient cultivars.

Key Words: Mung bean; Phosphorus use efficiency; Genetic variability; Phosphorus deficiency

IMPACT OF M-AGRICULTURE TECHNOLOGY FOR IMPROVING SUSTAINABLE AGRICULTURE IN PAKISTAN

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Telecommunication and specifically mobile phones have the potential to provide solution to the existing scattered information for agriculture sector. Improving information services through telecommunication technology has a proven positive impact on rural incomes. Mobile phone helps farmers to get accurate information at different growing stages of crop. It is also helpful in arrangement of transportation for products to various markets by getting information through mobile phone for good market price. This research was designed to check the result of well-timed information availability with mobile on crop productivity. The information was accumulated through well-structured customer survey by interviewing 100 farmers through BKK service from five districts i.e., Attock, HariPur, Sawabi, Chakwal and Sarghoda. Twenty farmers were selected from each district that used mobile phones to get alerts regarding agriculture. It concluded that less communication cost and ease use of information regarding wholesale market prices through SMS and IVR service help farmers in increasing crop production and market agents in marketing.

Key Words: SMS; IVR; Mobile Technology; Agriculture; BKK

EFFECT OF SUPPLEMENTATION OF CA AND VITAMIN D3 ON THE PERFORMANCE AND EGG SHELL QUALITY IN LAYER JAPANESE QUAILS (*COTURNIXCOTURNIX JAPONICA*)

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The study was carried out to determine the effect of varying dietary levels of vitamin D3 and calcium on performance and egg production parameters of Japanese quail layers (*Coturnixcoturnix japonica*). Two hundred and sixteen mature Japanese quails were divided into six groups, each group was contained 36 birds with three replicates. Six iso-caloric and iso-nitrogenous (CP 22%, ME 2850 kcal/kg) diets were formulated containing 3% Ca+ 2000 IU/kg vitamin D3, 3% Ca+ 3000 IU/kg vitamin D3, 3.5% Ca+ 2000 IU/kg vitamin D3, 3.5% Ca+ 3000 IU/kg vitamin D3, 4% Ca+ 2000 IU/kg vitamin D3, 4% Ca+ 3000 IU/kg vitamin D3, respectively. The results showed that supplementation of vitamin D3 (2000IU, 3000IU) in diet significantly affected the egg weight ($P<0.05$) whereas there was no significant difference on body weight, feed intake, laying percentage and egg shell quality. It was concluded that the best combinations of vitamin D3 and calcium were 3000 IU/kg and 4% and 2000 IU/kg and 4% in diet for egg weight and egg shell weight respectively.

Key Words: Vitamin D3; Egg shell; Calcium; Quail

EFFECT OF FOLIAR APPLICATION OF BORON ON WHEAT GROWTH UNDER WATER STRESS

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Drought is a major abiotic stress to reduce crop growth and yield. Rational use of micronutrients may help the crops to withstand under drought stress. A pot experiment was carried out to evaluate the role of foliar applied boron on wheat (*Triticum aestivum L.*) growth under drought stress at wire house agronomic research area, University of Agriculture, Faisalabad. Experiment was comprised of three replications and the treatments were: boric acid as boron (control, 10mg/L at booting and 20mg/L at flowering stage) and drought stress (control and 40% field capacity). During study, data on growth and yield parameters were recorded by following standard procedures. Obtained results have shown that drought has suppressed the growth and yield of wheat. However, boron foliar spray @ 10mg/L at booting and 20mg/L at flowering stage has significantly improved the tolerance of wheat plants against drought stress as shown by significant improvement in plant height (24.25 cm), leaf area (7.89 cm²), spike length 13.62 (cm) , number of spikelets per spike (326.35), number of grains (321.79), biological yield (19.94 t/ha), straw yield (37.2t/ha) and harvest index (35.32%). From these results we can conclude that if we are facing water shortage conditions then micronutrients like boron could be applied to get optimum yield of wheat under drought stress.

Key Words: Water Deficit; Boron Foliar Spray; Yield Parameters; Booting; Flowering

EFFICACY OF SEED SIZE FOR MANAGING EARLY DROUGHT IN WHEAT (*TRITICUM AESTIVUM L.*)

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A research was conducted to minimize the effects of early drought on wheat crop through different seed size classes of wheat, in Faisalabad during 2017-18. This trial was laid out in Randomized Complete Block Design by split plot arrangements with three replications. Irrigation treatments such as I0 (first irrigation 25 days after sowing than normal irrigations), I1 (first irrigation 40 days after sowing than normal irrigations) and I2 (first irrigation 55 days after sowing than normal irrigations) were in main plots while different seed sizes i.e. bold ($> 2.7\text{mm}$), medium ($> 2.3 \text{ mm to } 2.7 \text{ mm}$) and small ($\leq 2.3 \text{ mm}$) were placed in sub plots. Drought stress and seed size both significantly affected the number of productive tillers m⁻², biological yield and grain yield. Among water stress treatments maximum mean productive tillers (377) and grain yield (4.3 t ha⁻¹) were recorded in I0 ((first irrigation 25 days after sowing) while minimum mean productive tillers (276) and grain yield (2.7 t ha⁻¹) were recorded in I2 (first irrigation 55 days after sowing). Among seed sizes maximum mean productive tillers (357) and grain yield (3.8 t ha⁻¹) were recorded in bold seeds while minimum mean productive tillers (310) and grain yield (3.2 t ha⁻¹) were observed in small seeds. The results showed that bold seeds produce vigorous seedlings, increase tillering and ultimately improve grain yield. Therefore, seed size can play a significant role to overcome the effects of early drought in wheat.

Key Words: drought; seed size; growth; yield; wheat.

ISOLATION AND SCREENING OF DROUGHT-TOLERANT PHOSPHATE-SOLUBILIZING PLANT GROWTH PROMOTING RHIZOBACTERIA

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Drought is one of the major factors that limit the production of crops. By 2050, it is estimated that most of arable land will seriously come under drought stress. Therefore, there is need to resolve the drought response of plants under changing climate. Plant growth promoting rhizobacteria (PGPR) have potential for improving plant growth in extreme environments i.e. water shortage. One of the traits of PGPR is phosphate-solubilization. Phosphorus is the essential element for plant growth and development. PGPR have the capability to solubilize insoluble phosphorus (P) under drought stress and make it available for plant utilization. Herein, we isolated one hundred and forty four bacterial strains from root rhizosphere of Barley (*Hordeum vulgare*), Gram (*Cicer arietinum*) drought tolerant crops and C colocynth (*Citrullus colocynthis*) and Castor (*Ricinus communis*) grown in arid and semi-arid regions of Punjab Pakistan (Thal, Layyah and Bhakkar). These strains of bacteria were tested for their survivability (Optical density at 600nm) and phosphate solubilization under different water stress conditions (0%, 3%, 5%, 10% and 20% PEG 6000). Sixteen isolates were initially selected for their ability to solubilize phosphorus as well as drought tolerance. All of these drought-tolerant isolates were able to solubilize phosphorus at pikovskaya agar with two levels 3% and 5% of PEG 6000. C27 showed the highest level of PSI (Phosphorus solubilizing index) 8.5 and 6 at 3% and 5% PEG6000.

Key Words: Drought; PGPR; PEG600; Phosphate solubilization; PSI

STUDYING THE ANTIOXIDNT POTENTIAL OF PERSIMMON (DIOSPYROS KAKI) FRUITS HARVESTED FROM DIFFERENT LOCALITIES OF RAWALAKOT, AZAD JAMMU AND KASHMIR

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Persimmon is a fleshy fruit belonging to family Ebenaceae. It is grown wild in few selected areas of Azad Jammu and Kashmir and Rawalakot has been found the most suitable area for its cultivation. However, due to lack of awareness, attention towards its proper harvesting, storage and utilization, most of the fruit is wasted every year. Therefore, this study was designed to evaluate the antioxidant potential of persimmon fruits collected from five different localities (Drake, Jhiri, Rawalakot city, Dhamni, Khaigala) of Rawalakot on the basis of elevations (3378 ft, 4358 ft, 5374 ft, 5431 ft, 6628 ft), respectively. Persimmon fruits were collected and analysed for antioxidant properties including (vitamin C, total phenols, total antioxidants and total flavonoids). Results showed that persimmon fruits collected from different localities had different antioxidant values. Fruits collected from Khaigala (6628 ft) showed the highest amount of vitamin C (0.83 mg/100ml), total phenols (0.45 mg gallic acid per 100 g), total antioxidants (1.02 µg/100mg FW) and total flavonoids (4.21 mg per 100 g FW) as compared to fruits collected from other four locations. Thus, based on results obtained, it could be concluded that Khaigala is the most suitable locality for growing persimmon fruits as compared to other localities. However, detailed studies are needed to establish its supply chain system and storage conditions for its marketing at domestic and international level.

Key Words: Indigenous fruits; Elevations; Postharvest quality; Antioxidant properties; Supply chain system

Biomass and Biogas Yield Potential of Maize Cultivars

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Present study was conducted to evaluate difference among cultivars of maize (*Zea mays L.*), for their biomass, chemical composition and biogas yield. Maximum leaf area was produced by DTC and Pakafgoi and minimum value was exhibited with cv. Yousafwala. DTC and MMRI yellow produced clearly higher chlorophyll content which is 0.0344 mg/cm² and 0.0342 mg/cm² respectively. On the contrary, minimum chlorophyll content was recorded in EV-77 which is 0.0293 mg/cm². Regarding biomass production, DTC gave higher DM yield in comparison with all other tested cultivars while minimum yield was observed with Yousafwala hybrid. Among the cultivar, markedly higher protein contents were determined with cv. Sahiwal. Maximum crude fiber was exhibited by Cv. DK6789 and the minimum was given by Yousafwala hybrid in comparison with other cultivars. For the comparison of NDF contents in forage maize we found that the maximum neutral detergent fiber was recorded in DTC and MMRI Yellow and minimum value was determined with Yousafwala hybrid. the lowest lignin contents were exhibited by Yousafwala hybrid in comparison with all other tested cultivars. Yousafwala hybrid produced highest biogas yield per kg DM yield followed by Cv. Pakafgoi. However, DTC produced significantly higher biogas yield on hectare basis due to higher DM per ha.

Key Words: Maize Cultivar; Biomass Yield; Protein Content; Lignin Content; Biogas Yield

INTERACTIVE EFFECT OF RATES AND METHODS OF IRON SULPHATE APPLICATION ON PRODUCTIVITY AND IRON GRAIN BIOFORTIFICATION OF MUNGBEAN

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Malnutrition is the biggest threat now a day throughout worldwide. Moreover, Pakistani pulses also lack micronutrients, (iron) contents in their grain. Lack of micronutrient iron (Fe) causes blood diseases including anemia- world's growing problem. Mungbean (*Vigna radiata*) is a highly nutritive crop and contains large amount of protein contents which fulfill the protein need of great population. To solve this problem, a field study was conducted at Research Farm, Department of Agronomy, BZU Multan during spring season 2017. Mungbean variety Azri 2006 variety was sown under four levels of Fe viz. 0, 5, 10 and 15 kg Fe ha⁻¹ using FeSO₄ as source. Iron was applied as basal application (whole at sowing), side dressing (whole at 1st irrigation) and 50% as basal application + 50% side dressing. The results of study showed that Fe application has significant effect on mung bean allometry traits as well as yield related traits. Fe application at rate of 15 kg ha⁻¹ with basal + side dressing application produced maximum chlorophyll content, leaf area index, number of branches, number of pods per plant, number of seeds per pod, grain Fe content and grain yield against control. In conclusion, FeSO₄ at 15 kg-ha⁻¹ with basal + side dressing improved the mung bean productivity and enhanced mungbean Fe content which may lead towards resolving the issue of malnutrition.

Key Words: mungbean; grain biofortification; malnutrition; seed yield; iron

SYNERGISTIC EFFECT OF PLUTELLA XYLOSTELLA GRANULOVIRUS AND AZADIRACHTA INDICA ON DIAMONDBACK MOTH

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Diamond back moth (DBM) *Plutella xylostella* (L.) is a cosmopolitan and destructive insect pest of cruciferous crops worldwide. DBM has developed resistance against conventional chemical insecticides. To overcome this problem there is dire need to explore alternative control measures which are safer to environment and compatible to human health. The study was conducted to investigate the insecticidal properties of native isolated *Plutella xylostella* granulovirus (PxGV) and *Azadirachta indica* (AZA) on mortality and development of *P. xylostella* under laboratory conditions. Both PxGV and AZA either applied alone and in integrated manners at LC50 and LC 20 dose rates. The interaction of PxGV with high dose rate of AZA, resulted in antagonistic effects after 2 and 4 days post application while additive effects was observed after 6 and 8 days post treatment. Moreover, combined application of PxGV and AZA at sub-lethal dose rates exhibited increased larval, pupal and pre-pupal duration and decreased larval, pupal and adult weight. In conclusion, combination of PxGV and AZA at low dose rate is viable option to control diamond back moth. .

Key Words: *Plutella xylostella* ; granulovirus; *Azadirachta indica*; diamondback moth; Interaction study

EFFECT OF MORINGA OLEIFERA ON FEED INTAKE, NITROGEN BALANCE, MILK YIELD AND ITS COMPOSITION IN NILI RAVI BUFFALOES

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The study was conducted to evaluate Moringa oleifera hay (MOH) as an alternate feedstuff and its effect on feed intake, digestibility, nitrogen balance, milk yield and its composition. Eight early lactating Nili Ravi buffaloes, four in each group, were used in complete randomized block design. Medicago sativa hay (MSH) was provided to one group (control) while other group was offered MOH ad libitum. Concentrate was also formulated and offered in equal quantity to the animals. It was observed that feed intake was higher in buffaloes which were offered MOH based diet compared to those animals receiving MSH diet. Nutrient digestibility was also higher in buffaloes receiving MOH based diet than the animals of other group. There was a linear increasing trend of nitrogen balance in buffaloes receiving MOH diet compared to those fed MSH based diet. Milk yield and its composition were also improved by feeding MOH based diet. In conclusion, feeding MOH based diet to lactating buffaloes resulted in improved nutrients intake, digestibility, nitrogen balance, milk yield and its composition.

Key Words: Moringa oleifera; buffaloes; feed intake; nitrogen balance; milk yield

RHIZOBIAL INOCULATION TO IMPROVE THE GROWTH OF CAULIFLOWER IN CHROMIUM CONTAMINATED SOIL

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Chromium is one of the potential heavy metal contaminants causing major health issues at global level. It has no essential role as micronutrient in the metabolism of plants. There are various physicochemical approaches used for remediation of heavy metal contaminated soil, but most of them are not eco-friendly. However, bioremediation is cost effective and environmental friendly approach for remediation of heavy metal contaminated soil. Therefore, study was planned to evaluate the efficacy of two rhizobium isolates individually and in combination on growth of cauliflower under chromium contaminated soil. For this purpose, a pot experiment was carried out under completely randomized design (CRD) with factorial arrangements. Two pre-isolated rhizobial inoculants were applied according to the treatment plan. Recommended dose of NPK were applied @ 120:80:40 kg ha⁻¹. The results of the pot study revealed that the use of rhizobial inoculants improved the growth of cauliflower in chromium contaminated soil. Plant growth was significantly increased by the combined application of both rhizobial inoculants in chromium contaminated soil as compared to control. Combined application of rhizobial inoculants significantly decreased the chromium concentration in cauliflower fruit as compared to control and their sole application. The study concluded that combined use of both rhizobial inoculants improve cauliflower growth in chromium contaminated soil as compared to individual strain.

Key Words: Rhizobium; Remediation; Contamination; Chromium; Cauliflower

EFFECT OF DEAD BIRD'S COMPOST ON THE YIELD, TUBER QUALITY AND NUTRIENTS UPTAKE OF POTATO

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Potato (*Solanum tuberosum* L.) is among the most important vegetable that meets basic human nutritional requirements. Organic compost has variously been reported as a soil amendment and supply sufficient amount of essential plant nutrients. Dead poultry birds along with poultry litter compost is not only rich source of macronutrients, but also contains a sufficient amount of iron (Fe), zinc (Zn) and manganese (Mn). These micronutrients are essential for plant growth and also have significance for human health. A field experiment was conducted to investigate the effects of poultry litter and dead birds' compost on the yield, quality and mineral contents in potato at research farm of University of Agriculture, Faisalabad. Poultry litter and dead bird's compost was applied at the rate of 0, 1250 and 1850 kg compost ha⁻¹ with three replications. Recommended dose of N, P and K were applied as urea, diammonium phosphate and potassium sulfate, respectively. Plant growth and yield responded parameters (No of potato, diameter of potato and potato yield) were followed. It was found that dead bird's compost application at the rate of 1850 kg ha⁻¹ significantly increased 12% tuber yield as compared to control. Furthermore, dead birds' compost improves the potato quality by improving Zn and Fe content which are very important to combat micronutrient malnutrition of people of Pakistan, where a huge population is anemic and micronutrient deficient especially Zn and Fe.

Key Words: Dead bird's ; compost; potato; yield; micronutrients

SCREENING OF MAIZE (*ZEA MAYS L.*) GENOTYPES FOR SALINITY AND ION DISTRIBUTION AT SEEDLING STAGE

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Soil salinity is a major problem of crop production in all over the world. In Pakistan 6.67 million hectare land is salt affected. Salts cause the osmotic stress and ionic imbalance in plants which ultimately reduced the plant growth. Maize (*Zea mays L.*) is a sensitive crop to salinity and in Pakistan maize is grown as a fodder and cereal crop. A hydroponic experiment was carried out to screen the maize genotypes against different salt levels. This experiment was carried out using three levels of salt (control, 50 mM and 100 mM NaCl) under completely randomized design (CRD) with factorial arrangement. Two leaf stage old seedlings were used in 200-liter tubs and half strength Hoagland solution was used to fulfill the nutrition of plants. Significant variations were observed in all morphophysiological attributes and ionic contents. The maize genotypes FH 1471, UAF DH 32/1 and Monsanto 661 perform better against different salt concentration and the genotypes Kalak 6525, Malka and ICI 8288 show the sensitive behavior against salinity. The results show that salt resistant genotypes could be a better source for breeders for further evaluation on salt affected soils.

Key Words: salinity; maize; yield; genotype; osmotic stress

IMPACT OF BIOCHAR AND CHARCOAL AMENDMENT ON CARBON DIOXIDE EMISSIONS FROM SOIL UNDER DIFFERENT WATER REGIMES

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Unprecedented emission of greenhouse gases into atmosphere that climate is considered as major threatening issue on earth. Globally, increased interest in using biochar and charcoal in agriculture to help mitigate global warming and improve crop productivity. Carbon Dioxide (CO₂) is one of the major greenhouse gas that causes global warming worldwide. The main aim of this study is to determine the impact of biochar and charcoal on amount of carbon dioxide (CO₂) emitting from soil and also evaluate the water levels in soil on carbon sequestration and CO₂ emission under controlled conditions. Due to this reason intensive research on carbon dioxide (CO₂) emission under different agricultural practices is being conducted in many parts of the world. In this present study, a pot experiment was conducted in the chemistry lab of Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad using 0.5 g C in 100 g-1 soil by using rice husk and charcoal at 50 and 100 field capacity and kept in incubator at 28°C for three month and readings were taken once a week in every month. The experiment was arranged in completely randomized design (CRD) having factorial arrangement with 3 replications. The results showed that the application of biochar increased the residual carbon in soil. Among the biochar type charcoal performed best and retain maximum residual C in soil. It was observed that minimum residual carbon was observed in control.

Key Words: Biochar; Greenhouse Gases; Ricehusk; Carbon Sequestration ; Global warming

SCREENING OF MAIZE (ZEA MAYS L.) GENOTYPES AT DIFFERENT SALT CONCENTRATIONS

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Saline agriculture is a major problem of crop production in arid to semi-arid climate. Changing K+/Na+ ratio in leaf changes the salt tolerance level of plant and ultimately affects the yield and total plant biomass. To evaluate the effect of salts on different maize (*Zea mays L.*) genotypes a hydroponic experiment was conducted in green house of University of Agriculture Faisalabad. Experiment was conducted in randomized complete design (CRD) with different salinity levels of (control, 50 mM and 100 mM NaCl) and each treatment repeat three times. A half strength Hoagland solution was used for nutrition purpose. The results showed that genotype UAF DH 32/1, UAF DH 40/3 and UAF DH 18/21 perform better at different salt levels and genotype UAF DH 12/11, ICI 8288 and KALAK 6525 shows sensitivity against different salt concentrations.

Key Words: salinity; climate; maize; K+; Na+

INFLUENCE OF ZINC AND BORON APPLICATION ON WEED DYNAMICS IN NO TILL AND PLOUGH TILL WHEAT

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Tillage practices have strong impact on the weed infestation and weed dynamics in field crops. In this study, consisted of two independent experiments, influence of zinc (Zn) and boron (B) application on weed dynamics in wheat planted in long-term (maintained for the last seven years) no tillage (NT) and plough tillage (PT) systems was evaluated. In the first experiment, Zn was applied as foliar spray (0.025 M), soil application (10 kg ha⁻¹) and seed priming (0.5 M); while in second experiment, B was delivered as soil (1 kg ha⁻¹) and foliar applications (0.01 M) and seed priming (0.01 M). No Zn and B application were taken as control in first and second experiment, respectively. In both experiments, the most important weeds identified were sweet clover (*Melilotus indica* L.) and little seed canary grass (*Phalaris minor* L.). Application of Zn and B did not have significant effect on the weed infestation. In first experiment, NT wheat had less total weed density (40% and 48%) than PT wheat during 2016-2017 and 2017-2018, respectively. No tillage reduced the density of sweet clover by 54% and 29% and density of little seed canary grass by 22% and 30% during first and second years, respectively compared with PT system. In second experiment, density of total weeds was higher (30%) in PT than NT wheat during both years. Zero tillage had lower density of sweet clover (47 and 33%) and little seed canary grass (28 and 40%) during 2016-2017 and 2017-2018, respectively.

Key Words: Conservation tillage; Little seed canary grass; Micronutrients; Sweet clover

EFFECT OF MORINGA OLEIFERA LEAVES ON NUTRIENTS INTAKE, NITROGEN BALANCE AND IN SITU DIGESTIBILITY IN NILI RAVI BUFFALO BULLS

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This study was conducted to observe the effect of Moringa oleifera leaves on nutrients intake, ruminal parameters (pH, ammonia), nitrogen balance and in situ digestion kinetics. Three Nili Ravi buffalo bulls were used in 3x3 Latin Square Design. Three iso-caloric and iso-nitrogenous diets containing 0, 5, and 10% moringa leaves were formulated and represented as T1, T2 and T3, respectively. All the animals were fed on 50% maize fodder and 50% concentrate. In each period of the experiment, first 10 days were for adaptation period and last 5 days for data collection. For in situ digestibility duplicate samples in nylon bags were incubated in rumen of fistulated bulls for 0, 2, 4, 6, 12, 24, 36, 48, 72 and 96 h in reverse order. Results showed moringa leaves an excellent source of protein. It was observed that 5% supplementation of moringa leaves in animal diet increased the nutrients intake. Nitrogen balance was highest at 5% inclusion level of moringa leaves. Feeding of moringa leaves had non-significant effects on ruminal parameters (pH, ammonia). There were no differences in dry matter and neutral detergent fiber in situ digestibility kinetics in all treatments. A reduction in price was recorded as the level of moringa leaves was increased in the diet. The experiment revealed that moringa leaves can be used as cheaper protein source in animal diet.

Key Words: Buffalo bulls; moringa; intake; nitrogen balance; economics

TOTAL FACTOR PRODUCTIVITY GROWTH AND PERFORMANCE OF LIVESTOCK SECTOR IN PUNJAB, PAKISTAN

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In this study, total factor productivity (TFP) performance of livestock sub-sector in Punjab, Pakistan was estimated for the time period of 1970 to 2009. The objective was to analyze the effect of government policy changes on livestock sector performance. For this purpose, index number approach namely Tornqvist Theil approximation to divisia index was employed. Results revealed that overall average annual growth rate of livestock TFP index in Punjab remained 1.54 percent. The contribution of TFP towards output growth stood at 42.66 percent during the study period. The output and input growth remained as 3.61 and 2.03 percent, respectively. The results further indicated that productivity growth has been a significant factor in the performance of livestock sub-sector in Punjab over 39 years. The analysis also disclosed that TFP remained negative during no plan period (1970-78) due to neglect of this sector. Then it started increasing and reached to the level of 2.63 with 56.53 percent contribution of TFP towards output growth of the sector. This is the maximum growth of TFP which has been observed during 1983-1988 due to change in government policy in favour of livestock sub-sector.

Key Words: Livestock; Performance; Productivity; Punjab; Pakistan

ALGAL BIOMASS AS A THIRD GENERATION FEEDSTOCK FOR BIOETHANOL PRODUCTION

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The mounting social and industrial awareness of the environmental impacts such as global warming and climate change associated with the use of fossil fuels has created the need for more sustainable fuel options like Biofuel. Among Biofuel, bioethanol is considered as one of the most important renewable energy sources in order to reduce greenhouse gases and global warming. This study aimed to evaluate the potential of algal biomass collected from various water bodies as feedstock for bioethanol production via hydrolysis and yeast (*Saccharomyces cerevisiae*) fermentation. Results demonstrated that carbohydrates present in solution were fermented by *Saccharomyces cerevisiae* into bioethanol. Ethanol percentage varied with the variation of hydrolysis time, concentration of sulfuric acid and fermentation time. Although the percentage of ethanol produced is not economical but the main task of establishing the process of biofuel production from algae comes to a successful end. These findings indicate carbohydrate-producing algae as a promising third generation feedstock for fermentativebioethanol production.

Key Words: Bioethanol; algal biomass; fermentation; *Saccharomyces*; Global warming

MICROBIAL CONSORTIUM AND COMPOST ADDITION ALLEVIATED THE TOXIC EFFECTS OF PETROLEUM HYDROCARBONS ON MAIZE

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Petroleum hydrocarbons (PHs) are the most ubiquitous organic pollutants and problems related to petroleum products are major environmental issues all over the world. Accidental oil spills are one of the major sources of PHs contamination. Petroleum products contain hazardous compounds thus their removal from the environment is essential. PHs are known to be very toxic to plants. In this study, a pot experiment was conducted to examine the effects of a microbial consortium and compost addition on growth of maize in artificially diesel-contaminated soil. Compost and microbial consortium were applied to the selective pots. Maize (DK-6714) seeds were sown and recommended doses of NPK were applied. Results showed that PHs decreased the germination of maize and negatively affected the growth parameters (i.e. root and shoot length, fresh/dry root and shoot biomasses). In addition, physiological parameters such as chlorophyll content, stomatal conductance, current fluorescence yield (F_t), electron transport rate (ETR), effective PSII quantum yield (YII) and rate of photosynthesis (A) were negatively affected by PHs. However, combined use of compost and microbial consortium significantly reduced the negative effects of PHs on maize and improved the plant growth under PHs stress. Our results suggest that microbes and compost addition could be useful in improving crop productivity in PHs-contaminated soil.

Key Words: Crop production; Compost; Microbial consortium; Diesel; Maize

DETERMINATION OF LOSS IN COTTON SEED QUALITY DURING SEED DEVELOPMENT AT DIFFERENT SOWING DATES

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Cotton seed quality is drastically affected by poor management practices during seed development. Proper picking time is crucial for maintaining good seed quality. Physical and physiological quality seed quality of cotton is highly dependent on picking time during seed development as in early stages seed is not properly developed causing deterioration and in later stages it may be susceptible to diseases and insect attack. This study was conducted to elucidate the effect of different picking time on cotton seed quality. Cotton was sown fortnightly from 1st April to 15th May in Faisalabad. White flowers from each sowing date were tagged and picked 10, 20, 30 and 40 days after flowering (DAF). Collected bolls were dissected to isolate the developing seeds. Results revealed that cotton seeds isolated 30 DAF for the crop planted on 1st May had significantly ($p<0.05$) higher germination percentage relative to other picking time and sowing dates. Decrease in seed vigor was observed with the 1st and 15th April sowing dates and picking time of 10, 20 and 30 DAF. Increase in electrolyte leakage and free fatty acid contents was observed in under developed seeds. It can be concluded that 30 DAF is the best time for picking cotton sown from 1st to 15th May.

Key Words: Cotton seed; Seed development; Sowing date; Picking time; Seed quality

FOLIAR APPLICATION OF LEAD OXIDE NANOPARTICLES TO ASSESS THE ACCUMULATION, TOXICITY, AND RISKS ASSOCIATED WITH AN INFERENCE OF HUMAN HEALTH

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There is scarcity of data about foliar-applied heavy metals as well as the associated bio-physio-chemical changes inside plants and health hazards. we therefore, evaluated the effect of foliar-applied lead nanoparticles (Pb-NPs) on their phytoaccumulation, physiological and biochemical changes inside plants and associated health risks. For this purpose, we used a green method to synthesize Pb-NPs. SEM analysis showed preparation of smooth, unwrinkled, granular and spherical. Foliar-applied Pb-NPs resulted in significant accumulation of Pb in leaves, with limited translocation to root tissues. Results showed a significant decrease in pigment contents (38%) and dry weight (67%). After foliar uptake, Pb caused several fold increase in the activities of antioxidative enzymes. However, foliar Pb-NPs did not induce significant changes in ROS production and lipid peroxidation. The highest level of Pb-NPs showed possible human health risks due to consumption of Pb-contaminated leaves of spinach. Therefore, based on the results of current study, it is submitted that atmospheric contamination and foliar deposition of metal-PM can seriously affect vegetable growth and can induce human health risk from the consumption of contaminated plants.

Key Words: Pb nanoparticles; foliar uptake; bio-physio-chemical changes; risk assessment; human health

GROWTH YIELD AND QUALITY RESPONCES OF THREE WHEAT VARITIES TO FOLIAR SPRAY OF MICRONUTRIENTS

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A field experiment was carried out to test the foliar application of micronutrients on growth, quality and yield of three wheat cultivars. The trial was performed at Agronomic Research Area, University of Agriculture Faisalabad during 2016-17. Randomized complete block design (RCDB) with three replications was used. Treatments were Wheat varieties (Jouhar-2016, Ujala-2015 and Gold-2016) and micronutrient spray (Zn 2%, B 0.5%, Fe 1%, Mn 1%, and Cu 0.5%) with different volume (1000 ml ha⁻¹, 1250 ml ha⁻¹ and 1500 ml ha⁻¹). Micronutrient spray was applied at booting stage. Wheat variety Ujhala-2016 showed significant result over others, it produced maximum plant height, grain yield, 1000 grain weight, biological yield and harvest index when micronutrients were applied @1250 ml ha⁻¹.

Key Words: Wheat; Micronutrients; Foliar spray; Foliar application; Booting

BIOLOGICAL EVALUATION OF NAOH TREATED AND UN-TREATED FEATHER MEAL IN BROILER CHICKS

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The experiment was conducted to determine the biological evaluation of NaOH treated and untreated feather meal in broiler chicks. Four different rations (A, B, C and D) were formulated in such a way that ration A was nitrogen free, ration B was casein based that served as a standard. In ration C NaOH treated feather meal was used as a sole source of protein, ration D was based on untreated feather meal which served as a control. All the rations were isonitrogenous containing 10% crude protein except ration A that was nitrogen free and all the rations were isocaloric containing 3100 kcal/kg of metabolisable energy. During first week of experiment commercial ration were fed to the chicks then eighty day-old Hubbard broiler chicks were divided into twenty experimental units. Each experimental unit was subdivided into five replicates of four birds each. Separate cages were used for each replicate. At the end of the experiment the chicks were killed by chloroform, body cavities were opened and dried in hot air oven at 70°F. Results of this experiment showed that overall broiler performance was significantly higher for ration B which contained casein as sole source of protein as compared to other rations. The net protein ratio and net protein utilization per broiler chick were higher in treatment B than other treatments. In conclusion, birds fed diet containing casein as sole source of protein showed better performance compared to other rations.

Key Words: feather meal; biological evaluation ; broilers; growth performance; net protein ratio

WASTEWATER INDUCED MANGANESE TOXICITY AFFECTS GROWTH AND BIO-AVAILABILITY IN SPINACH (*SPINACIA OLERACEA L.*)

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The different types of sewage sludge generated from different urban sources are commonly used for irrigation in agriculture and contain heavy metals (as manganese, cadmium, lead and zinc). This sewage water is mostly used for vegetable production in peri-urban areas and is a source of heavy metals. Therefore, this study was conducted to evaluate the effects of wastewater with different toxicity levels of manganese (Mn) on growth and bio-availability of Mn in spinach. The sewage water with two levels of Mn was applied exogenously as i) 150 mg L⁻¹ sewage water (moderately toxic), ii) 350 mg L⁻¹ sewage water (toxic level) and no Mn as control; (only sewage water). Two cuttings of spinach were taken after 45 and 90 days of germination. There was significant accumulation of Mn in leaves. The maximum concentration of Mn (11.13 and 12.67 mg L⁻¹) was recorded with 350 mg L⁻¹ Mn in sewage water at both cuttings, respectively. Minimum number of leaves with decrease of 43% and 25% were recorded with Mn 350 mg L⁻¹ (toxic) and 150 mg L⁻¹ (moderate) respectively. Plant biomass and dry weight showed negative behavior in second cutting as compared to first. The results showed that long-term application of Mn contaminated wastewater decreases the growth rate and yield of spinach by increasing its accumulation in leaves up to toxic levels. In conclusion, the application of sewage water to vegetables (especially spinach) should be avoided to prevent human life from health disorders.

Key Words: Wastewater; Heavy metals; Accumulation; Bioavailability; Human health

IMPACT OF VARYING ENVIRONMENTAL CONDITIONS ON KINNOW FRUIT QUALITY IN CLIMATE CHANGE SCENARIO UNDER PREVAILING CULTURAL PRACTICES

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Varying environmental conditions under climate change scenario has adversely affected physiology and fruit quality of Kinnow fruit. The study was conducted in the three main citrus growing regions namely Sargodha, Toba Tek Singh (TTS) and Vehari districts of the Punjab province, Pakistan to asses fruit quality under prevailing cultural practices. High temperature during March-April has increased thrips and mites infestation and heat stress in May-June and smog/fog in November-December resulted higher fruit drop in Vehari and TTS than Sargodha while prolonged summer has increased fruit fly damage. Citrus scab and melanose diseases were more observed in Sargodha whereas stem-end rot incidence was found higher in Vehari and TTS under changing climate. Varying environmental conditions under climate change has not only deteriorated fruit physical quality but also affected biochemical properties. Higher temperature and prolonged summer resulted imbalance in acid and sugar ratio with low polyphenols, flavonoids, flavonols and antioxidants contents in Vehari and TTS than Sargodha. Late fruit colour development and maturity index due to high temperature has shortened market duration and affected fruit supply chain mechanism. In conclusion, climate change has more deteriorated fruit quality in Vehari and TTS than Sargodha. The experiment was laid out in factorial (RCBD) with three replications (3 plants/replication) and collected data on monthly basis.

Key Words: climate change; Kinnow fruit ; quality; environmental condition; prevailing practices

SCREENING OF WHEAT GENOTYPES FOR EFFICIENT ZINC AND IRON UPTAKE UNDER SALINE CONDITIONS

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Salinity is a major problem in arid and semi arid regions of the world that is deteriorating soil fertility and reducing essential nutrients uptake by plants. The plants grown on high pH, low organic matter and calcareous soils suffer from Zn and Fe deficiencies. Among staple food, wheat grains are the primary source of micronutrients like Zn and Fe. Majority of Pakistani saline/saline-sodic and calcareous soils are deficient in these micronutrients. The aim of present study was to screen out wheat genotypes which can efficiently uptake Zn and Fe saline conditions. Therefore, ten wheat genotypes were exposed to varying rates of Zn and Fe under normal as well as saline conditions in a solution culture experiment. Salinity was developed by using NaCl salt, while the sources of Zn and Fe were ZnSO₄.7H₂O and FeSO₄.7H₂O respectively. The data of various wheat growth and ionic parameters including root and shoot length, root/shoot fresh and dry weights, chlorophyll contents, Zn, Fe, K, Na and Cl were recorded using standard procedure. The results showed that Zn and Fe application significantly ($p \leq 0.05$) increased wheat plant growth under salt stress. Among tested genotypes, FSD 2008 performed better under saline conditions with maximum biomass production, Zn, Fe and K uptake. Therefore, this genotype was found to be a good source for future wheat breeding programs or can be grown by farmers owing to efficient Zn and Fe uptake wheat production under saline conditions.

Key Words: Salinity; Wheat; Zn; Fe; Uptake

MORPHO-PHYSIOLOGICAL RESPONSE AND LEAF RUST RESISTANCE OF WHEAT CULTIVARS INOCULATED WITH BACTERIAL AND FUNGAL ENDOPHYTES AT DIFFERENT GROWTH PHASES

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Wheat (*Triticum aestivum L.*) is the most important cereal crop and also known as a staple food of many countries all over the world including Pakistan. But the present condition of wheat is threatened by various biotic and abiotic factors. Among these leaf rust of wheat is one of the most abundant and infinite disease in Pakistan which causes both quality and yield decline. The rapid increase in population inserts pressure on Agriculture. Now, twice increase is require in wheat production to feed this ever increasing population. In this state, for the enhancement of growth and yield attributes and to overcome the wheat leaf rust disease is the application of antagonistic fungal and bacterial endophytes are attractive approaches. Furthermore, the bacterial and fungal endophytes also act as biofertilizer and play a vital role in the stimulation of morpho-physiological parameters. In present study, I focused on the response of endophytic bacteria, fungi and their consortium on the morpho-physiology, growth and yield of four different varieties of wheat at different growth stages. In results, it was observed that the application of consortia of fungi and bacteria showed significant effect on the promotion of growth and yield parameters; however, disease severity was reduced in all three treatments as compare to control condition.

Key Words: wheat; endophytes; grain yield; rust resistance; morpho-physiology

ADAPTABILITY OF NEWLY INTRODUCED AMARANTH GERMPLASM UNDER AGRO-ECOLOGICAL CONDITION OF FAISALABAD.

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Amaranth being a naturally resilient crop can be an alternative to conventional food crops. An experiment was conducted at Agronomic Research Area, University of Agriculture, Faisalabad to evaluate 200 accessions from USDA. Plant biomass and seed yield produced by many accessions was reasonable. In this study ten accessions (3, 4, 6, 48, 58, 62, 66, 67, 125 and 163) appeared to be high yielder. Almost 150 mounds per ha yield can be estimated. Seed yield was linked to morphological and yield related traits. Accessions having medium crop duration (48, 62 and 67) almost produced more seed yield. Furthermore, short stature accessions, having lengthy compact main panicles were also high yielder. More plant height (89, 16, 107 and 113) seems to be negative character for seed yield. Huge diversity observed in amaranth germplasm introduced in agro ecological zones of Pakistan.

Key Words: Amaranth; Accessions; Morphology; Yield; Diversity

ASSESSMENT OF THE ALLELOPATHIC POTENTIAL OF PARTHENIUM HYSTEROphorus L. ON GERMINATION AND SPECIES COMPOSITION OF THREE PROMISING SPECIES OF RANGELANDS OF PAKISTAN.

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Invasive weed species have the detrimental potential to damage crops, grasslands, environment and human health. Studies were carried out in the field and laboratory to investigate the phytotoxic effect of Parthenium hysterophorus against *Panicum turgidum*, *Sorghum halepense* and *Cenchrus ciliaris*. Seeds of tested species were grown in pots having control 1%, 2% and 4% residues incorporated. After decomposition seeds were grown in the same pots and on harvesting different parameters were taken. Aqueous extract of Parthenium hysterophorus was prepared and applied at various concentrations i.e. 2.5% , 5% and 10% to the seeds of these grasses. Seed biomass was significantly reduced at higher concentrations in selected species. Mean germination time was increased at higher water extract concentrations in all species. The total germination was 96.25% in *Sorghum halepense*, 75% and 80% in *Panicum turgidum* and 76% and 78% in *Cenchrus ciliaris* at control and 2.5% aqueous extract while the germination decreased at 5% and 10% of aqueous extract in all species. Higher chlorophyll contents were observed in *Sorghum halepense* i.e. 5.54 mg/g FGW in control treatment as compared to *Panicum turgidum* and *Cenchrus ciliaris*.The results prevailed that the overall impact of allelochemicals was significant in all experimented grasses. However, it was found that the *Panicum turgidum* was more susceptible to the allelochemicals of Parthenium as compared to the other experimented grasses.

Key Words: Invasive; Parthenium; , decomposition; chlorophyll; allelochemicals

GENOTYPIC VARIATION IN MAIZE FOR ROOT ARCHITECTURAL TRAITS UNDER SALT STRESS

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Maize (*Zea mays L.*) is the third major cereal crop in Pakistan after rice and wheat. Soil salinity is the most significant stress issue which limits plant development and production. A rhizobox experiment was carried out to investigate the genotypic variation and modification in root architecture for salt uptake by maize. The research was laid out in completely randomized design CRD with two treatments T1(no NaCl) and T2(with 100 mM NaCl) with four replications. Maize genotypes name FH-949, FH-1137, FH-1046, FH-988, FH-985, and Malka-2016 were sown in rhizobox. Seven days after sowing, plants were harvested and plant fresh weight and dry weight of shoot and root will be measured. Maize roots were scanned and the primary length of roots, lateral root number, lateral root length and density of roots of each plant was measured by using the software Image J under normal and saline stress. Under 100mM level of sodium chloride the number of lateral roots, lateral root length, lateral root density showed differential response among various genotypes and were increased in some genotypes. The primary root length decreased at recommended level of NaCl. Lateral root growth increased under salinity condition may be due to search for nutrients. Root architectural variation in response to salinity level varies among maize genotypes where FH-1046 and FH-988 were found to be salt resistant genotypes with reference to root architectural characteristics.

Key Words: Maize; Salinity; Root Architecture; Genotypes

COMPARATIVE EFFECT OF COATING STRENGTH AND NUMBER OF COATINGS OF POLYMER ON DIFFERENT PHOSPHATIC FERTILIZERS TO PROLONG PHOSPHORUS AVAILABILITY IN SOIL

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Limited availability of phosphorus (P) in our soils is one of the major factors for poor yield. The recovery of P in calcareous soils varies from 5 to 20% on single crop bases. Renewal of P is a serious issue in our agriculture system. In Pakistan little attention has been given to the use of organic polymers to increase the P accessibility to plant roots by ensuring controlled release of P. By controlling the concentration and number of layers of polymer on phosphatic fertilizers the release of P can be controlled and the efficiency of phosphatic fertilizers can be enhanced. So, the concentrations and number of layers of polymer on the grains of phosphatic fertilizers are of great concern to improve the P use efficiency. In these laboratory studies 0 (control), 0.5, 1 and 1.5% polymer concentrations were used to check the release of P on Di-ammonium phosphate (DAP), Single super phosphate (SSP), Nitro-phos (NP), Rock phosphate (RP) and the best selected concentration was coated in one, two and three layers on phosphatic fertilizer sources to check the release of P in soil over different time intervals i.e. 15, 30, 45 and 60 days of incubation. Uncoated fertilizers were also included as control to compare the release pattern with coated fertilizers. In these studies RP coated with any concentration and number of coating layer remained at bottom. Among the phosphatic fertilizer sources, DAP coated with two layers of 1% polymer performed the best in these studies.

Key Words: Coating; Control release; Fertilizer; Polymer; P use efficiency

INFLUENCE OF DIFFERENT POTASH FERTILIZERS USING AT DIFFERENT LEVELS ON THE MAIZE GROWTH AND YIELD

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Maize (*Zea mays L.*) is one of the most cultivated grain in the world due to its high nutritional status. However, inadequate nutrient management particularly potassium negatively affects the maize growth resulting in losses in grain yield. Efficient use of potassium fertilizers with right source and balanced quantity is the key factor for improving the growth, yield and performance of maize. Therefore, the present study was carried out to investigate the role of different potassium fertilizers on the growth, yield and performance of maize crop. Potassium was applied as sulfate of potash (SOP; 70% and 100%), murate of potash (MOP; 70% and 100%). The plots received no fertilizers were taken as control. Soil used for experimental purpose was analyzed for different physiochemical properties such as pH, EC and potassium concentration. The results indicated SOP 70% significantly improved the shoot fresh weight, shoot dry weight, plant height; while roots dry weight was maximum with SOP 100%. Whereas, MOP application improved the yield and yield related components of maize and the maximum 1000-grain weight, number of rows per cob and grain yield was recorded with MOP 70%. In conclusion, potassium application using SOP significantly enhanced the plant biomass. Whereas, MOP application (70%) as potassium source was best in improving the yield components and grain yield of maize.

Key Words: Maize; Potassium fertilizer; Plant biomass; Grain yield

ROLE OF ZINC FOLIAR SPRAY IN IMPROVING GROWTH, YIELD AND QUALITY OF WHEAT (*TRITICUM AESTIVUM*) UNDER DROUGHT STRESS

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Drought is a critical threat to world food security especially for cereal-based food. Micronutrients foliar application such as zinc is one of the solutions to mitigate this problem. A pot experiment was carried out to explore the role of zinc foliar spray in reducing the drought stress on wheat. Design used to conduct the experiment was Completely Randomize Design (CRD) having factorial arrangements with three replications. Seeds of (drought tolerant) wheat variety Faisalabad-2008 were sown in pots. The sources of fertilizer applications were NPK, that was given as per need of crop. Two factors were maintained: drought (Control- full water and 50% field capacity) and foliar application of zinc as zinc sulfate having three treatments (Control-no foliar spray, 0.5% Zn at booting and 1% Zn at heading stages). Plants with control treatment were grown with normal water requirement, whereas 50% field capacity was maintained from booting to heading for remaining. Result has shown significant reduction in quality, quantity, growth as well as yield parameters of wheat crop. Zinc application in foliar form has mitigated the drought stress by ameliorating the physiological as well as yield parameters. Our findings of this experiment reveal that the application of zinc as foliar improve all parameters of wheat at (0.5%) as compared to (1%) at booting and heading stage.

Key Words: Drought Stress; Zinc Foliar Spray; Yield Parameters; Booting; Heading

EFFECT OF CLIMATIC VARIATIONS ON AUTUMN PHENOLOGY OF GRAPEVINE

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Environmental variations have affected the crop production around the world. Rising temperature, shortening of growth season, earlier flowering and harvesting have been reported as common phenomenon associated with climate change. These events have a significant impact on crop yield and productivity potential. Viticulture i.e. production as fresh grapes, wine grapes, raisins, fermentation for vinegar and other value added products make it the largest fruit industry globally. However, changing environmental conditions have affected the phenological behaviour of this crop. Phenological shifts have been reported around the world e.g. earlier bud burst, flowering, and fruiting and earlier disease incidence. Phenological studies are mostly focused on spring phenology, however record of autumn phenology is completely missing except some studies on deciduous forest species. Global climate change phenomenon is expected to make many regions of world un-suitable for viticulture as chilling requirements of high chill requiring may not be met in future. There is a need to identify low chill grape genotypes in the wake of climate change for sustainable production. The current study was designed to explore the diversity in autumn phenology of different grape cultivars under the agro-climatic conditions of Pothwar. Our results revealed that there exists a wide diversity among different grape cultivars with respect to leaf fall timing, pattern, autumn coloration and dormancy period.

Key Words: grapevine; climate change; dormancy; fall phenology; Pothwar

FOLIAR AND SOIL SUPPLEMENTATION OF FE AND ZN IMPROVES YIELD AND MICRONUTRIENTS IN BREAD WHEAT GRAIN

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Zinc and Iron malnutrition (hidden hunger) are major health problems in Pakistan and over two billion people in the world are facing serious diseases due to low concentration of micronutrients in their daily intake. Agronomic biofortification by soil and foliar application in wheat staple may be helpful to overcome this problem. Therefore, an experiment was conducted consecutively two-years (2016-2017) at Wheat Research Institute, AARI, Faisalabad to evaluate the enhanced Zn and Fe supplementation treatments by foliar application of ZnSO₄, FeSO₄ @0.5% and 1% and by soil application of Zn and Fe @ 10 and 12 kg ha⁻¹ in sole and combinations on yield and concentration of Zn and Fe in bread wheat grains. The experiment was laid out in randomized complete block design (RCBD) with factorial arrangements having three replications. All micronutrient treatments significantly improved growth and yield during both years. Yield of wheat increased 24% as compared to control by Fe supplementation in soil @ 12 kg ha⁻¹ that was linked to more number of tillers, spike length, number of spikelet's per spike, number of grains per spike, 1000-grain weight. Furthermore, micronutrient was also increased in grain 42% Zinc and 112% Fe due to combined Foliar application of 0.5% ZnSO₄ and 1% FeSO₄ as compared to control. Results of this study suggests this easy strategy can be adopted to overcome problem of "hidden hunger".

Key Words: Bread Wheat; Agronomic Biofortification; Zinc; Iron; Malnutrition

RABBIT FARMING; A MISSING INTEREST OF PUBLIC AND PRIVATE SECTOR TO COMBAT THE NUTRITIONAL DEFICIENCY IN RURAL AREAS OF PAKISTAN

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To fulfill the food demand for growing population, we have to find out different ways of food production. The rabbit known as “Micro-Livestock” can be a great source of food production. There is a great opportunity of rabbit farming, and commercial production can be a great source of income and employment. They may be raised for commercial purposes, including meat consumption, as pets and for laboratory use. Rabbits need small place for living and less food for surviving. Rabbit meat contains high ratio of protein, energy, calcium and vitamin than any other types of animal meat. The amount of cholesterol, fat and sodium is also less than other meat. Their meat is very tasty, nutritious and easily digestible for all aged people. Rabbits grow very fast and the female rabbit produce 2 to 8 kids every time. They can consume very low quality food and turn this foods to high quality meat, skin or fiber of all the meat-producing livestock, rabbits have the best feed conversion ratios: They consume forages rather than grains and convert that food source into meat efficiently. By comparison, grain-fed livestock including beef and poultry, require a much higher amount of food in the form of grains so by comparison have a larger carbon footprint than rabbits. Raising rabbit can be a great income source to the unemployed educated people and landless farmers. So commercial rabbit farming business can be a great source to meet-up the food or protein demand and a great source of employment.

Key Words: rabbit farming; rabbit meat; forage; grain; livestock

ENHANCEMENT OF SALINITY TOLERANCE IN MAIZE THROUGH COATING OF BACTERIAL STRAINS.

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Maize is affected by many stresses which caused the stunted plant growth and reduces the yield. Salt effected soils are major problem for maize production in many arid and semi-arid areas of Pakistan. Plant growth promoting rhizobacteria may be used to enhance tolerance in maize in salt effected soils. Experiment was conducted in wire house of department of Plant breeding and genetics, University of Agriculture Faisalabad to observe the performance of bacterial strains for improving the growth and physiological aspects of maize crop under salt effected soil. The experiment was consisted of three salt stress levels control, 6 dSm-1, 12 dSm-1 and priming of halo-tolerant bacterial strains i.e. Enterobacter sp. MN17 and Bacillus sp. MN54. The experiment was laid in Complete Randomized Design (CRD) with factorial arrangement. All the data regarding growth, physiological and biochemical parameters was collected and analyzed statistically. The results indicate that growth related parameters total free amino acids and enzymatic activity decrease under high salinity concentration while increasing trend was observed in reactive oxygen species. Results reveled that seed coating with MN-54 significantly increased growth and anti oxidant of maize while reduces activity of Reactive oxygen species under salt stress. So, coating with MN-54 perfomes best against salinity stress.

Key Words: Coating; Salt stress; PGPR; Maize; MN-17

COPING STRATEGIES AGAINST SUGARCANE INSECT PEST WITH SPECIAL REFERENCE TO INTEGRATED PEST MANAGEMENT IN PUNJAB, PAKISTAN

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Integrated pest management (IPM) is a suitable technique used to control insect pest and to protect the environment for the betterment of human health. The purpose of the study was to identify coping strategies against sugarcane insect pest with special reference to integrated pest management that imparts proper awareness training programs for sugarcane growers. The study was conducted in District Rahim Yar Khan and Chiniot from the Punjab. From each of the selected Districts, two Tehsils namely Sadiqabad and Chiniot were selected. From each selected Tehsil two villages were selected, involving 140 sugarcane farmers from four villages. The Districts, Tehsils and villages were selected randomly. A pre-tested and well-structured interview schedule was developed for the collection of information from sugarcane farmers. Data were analyzed using both descriptive and inferential statistics through the Statistical Package for Social Sciences. Results indicated that there was a significant difference between the two groups, adopters and non-adopters, regarding cultural, mechanical and biological control. The results revealed that the majority of the respondents (75%) were unable to practice IPM due to lack of technical knowledge, practical skills and awareness related to the identification of sugarcane pest and their management. The study recommended that awareness regarding integrated pest management should be promoted through proper campaigns to mitigate insect pest of sugarcane.

Key Words: Sugarcane; Integrated Pest Management; Awareness Campaigns; Technical Knowledge; Punjab

CADMIUM TOXICITY ALLEVATION BY APPLICATION OF ZINC CONTAINING FERTILIZERS

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Cadmium is a toxic heavy metal and considered as toxic metal to plants even at very low concentration. Zinc is an essential micronutrient for plant as well as for animals. Among micronutrients Zn deficiency is a major health problem around the globe that affects one third population worldwide. In soil Zn and Cd can interact with each other, their uptake by wheat crop roots and translocation to upper edible parts of crop is same because both Zn and Cd exhibit common geochemical mechanism to acquire nutrient from soil. This study was designed to explore the uptake of a toxic heavy metal cadmium (Cd) by a Zn biofortified wheat cultivar (Zincol-2016) and was compared with Zn-inefficient (Galaxy-2016) a research was conducted at agronomic research area University of Agriculture Faisalabad. Two wheat cultivars including Zincol-2016 (biofortified cultivar) and Galaxy-2016 (standard cultivar) was grown in soil filled pots and treated with different levels of Cd and Zn. In conclusion, Zincol not only produces higher amount of Zn in wheat grains but it also accumulates Cd in root and shoot leading to decrease its accumulation in grain. In present scenario, this research was conducted to demonstrating the role of zinc is alleviating heavy metal stress and beneficial dietary role of Zn in wheat grains. However Zn at lower concentration increases Cd toxicity in wheat plants. On the other hand, during wheat growth parameters higher level of Zn decreases the Cd toxicity.

Key Words: Cadmium; Heavy metal; Zinc; Wheat; Biofortification

UTILIZING WHEAT (TRITICUM AESTIVUM. L.) AS DUAL-PURPOSE (FODDER AND GRAIN) FOR COMPENSATING THE WINTER FODDER DEFICIT

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Livestock sector contributes much in agriculture, as it provided 58.3% to agriculture share that added 11.4% to country GDP in Pakistan during 2016-17. Livestock sector for undisturbed and increasing production depends upon continued fodder. Fodder deficiency during the winter and summer season hinders livestock productivity. For winter season, the deficiency can be compensated by winter cereals as for the ability of rabi cereals to regrow if clipped at early vegetative stages. Among all other cereals grown in winter, wheat is most suitable as the area under wheat cultivation is more than any other cereal. Wheat can be used for dual-purpose as the clipping before the hollow stem formation increases the tiller formation. For intention to grow wheat as dual-purpose and to observe its yield responses with control (No cut), a study was conducted at Agronomic Research Area, University of Agriculture, Faisalabad using four wheat varieties and three cutting intervals (40, 50 and 60 DAS) as compared to control. The results of the study supported the fact that early cutting does not affect the yield as compared to late cut. In all cutting treatments the fodder produced adds to the net farm income, but late cutting reduces the yield. In early cut wheat treatments the net farm income was even more than the control treatment as the fodder obtained added to the net farm gain. Thus, cultivation of wheat as dual-purpose can be promoted.

Key Words: Fodder; Dual-purpose wheat; Net farm income ; Sustained Livestock Production

ALLEVIATION OF SALINITY STRESS BY APPLICATION OF SILICON IN MAIZE GENOTYPES

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Salinity is a global problem which adversely affects the plant growth and yield. Improving salinity tolerance in plants is an important strategy for sustainable agriculture. Silicon (Si) is known to alleviate biotic and abiotic stresses which ultimately improve plant fitness. So Si was applied in the form of silicic acid to determine its possible role in mitigation the negative effects of salinity in two genotypes of maize at vegetative stages. There were two salinity levels (0 and 60mM) with and without addition of silicic acid (0 and 2mM). Sodium chloride (NaCl) was applied in two splits; first half dose along with full dose of silicon at sowing time and second half dose of NaCl after 14 days of germination. The effects of Si, Na⁺ and K⁺ concentration in root and shoot were estimated on the basis of variation in growth of different cultivars. From results it cleared that Si application improves plant fresh and dry weight significantly with and without salt stress. Uptake and concentration of K⁺ in shoot was increased with Si application and decreased with salt stress due to Na⁺ concentration in shoot. By Si application increasing K⁺ concentration and decreasing Na⁺ concentration in root and shoot is a possible mechanism to increase salinity tolerance in plants. Our, these results showed the beneficial effects of Si on salt stress but additional studies are needed on the rate and onset of salinity to examine the interrelating factors and better understanding the mechanisms.

Key Words: salinity; silicon; maize; stress; growth

CONSEQUENCES OF HYDROGENATED VEGETABLE FAT SUBSTITUTION WITH PHOENIX DACTYLIFERA SEED OIL ON PHYSICO-CHEMICAL AND FUNCTIONAL ASPECTS OF FUNCTIONAL COOKIES

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Fats are an essential component of taste and texture of food as well as to stimulate neurological sensory signals of "fullness" after consumption. Some oils are rich in antioxidants, which may decrease harmful inflammatory conditions resulting from oxidative stress and increase the shelf life of food products by reducing rancidity. Date (*Phoenix dactylifera L.*) seed oil holds significant antioxidant potential owing to its phenolics and flavonoids. In the present research project, two types of functional cookies were prepared, the first (T1) containing date seed oil having (dietary supplement i.e., rutin, catechin and caffeic acid) to evaluate their synergistic effect along with control (T0) with normal shortenings based on hydrogenated vegetable fat. The results described that energy and fat percentage were considerably greater in date seed oil than hydrogenated vegetable fat cookies. The moisture, peroxide value, and acidity were significantly higher ($P < 0.05$) in hydrogenated vegetable fat cookies after 60th day of incubation. Over time protein and fiber percentage declined in both cookies but remained superior in date seed oil at 60th day of inundation. Date seed oil cookies had longer shelf life, better palatability, enhanced physical properties and higher antioxidants. Therefore, the present study results showed that date seed oil can be utilized further as a substitute for partially hydrogenated vegetable fat in the preparation of diverse functional cookies.

Key Words: Antioxidant activity; Cookies development; Ionic composition; Date seed oil; Hydrogenated Vegetable Fat.

A GLANCE AT SUGARCANE GENOME TO REPORT THE PREVALENCE AND CHARACTERISTICS OF WRKY TRANSCRIPTION FACTORS GENE FAMILY

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Papain-like cysteine proteases (PLCPs), which are structurally homologous of papain have been characterized in many plant species and known to have important roles in plant defence against certain microbial pathogens. PLCPs contain a cysteine residue at the catalytic site capable of cleaving peptide bonds in target proteins. Papain-like cysteine proteases are classified as the C1A family of clan CA and hence are also named as C1A cysteine proteases. Previously on basis of phylogenetic analysis, 31 PLCPs from *Arabidopsis thaliana* were divided into nine subfamilies. In this study, we performed genome-wide analysis of PLCPs from Chickpea (*Cicer arietinum*). Overall, 29 PLCPs were identified in the genome of *Cicer arietinum* and were analyzed through different in silico techniques. Phylogenetic analysis clustered all 29 PLCPs of chickpea into 4 main groups. Members of different groups showed various similarities among themselves in terms of conserved motifs to be identified in their peptide sequences. In the same way, gene structure analysis presented several homologies in intron-exon pattern of PLCPs of different groups. Six peptide sequences of different PLCPs from different groups were selected to determine their tertiary structure. All 6 PLCPs except cam_105851510 exhibited higher percentage of Alpha helix than that of beta sheets. Our findings provide a useful reference to characterize PLCP genes in other plants.

Key Words: Genome wide analysis; phylogeny; motif analysis; Papain-like cysteine proteases; *Cicer arietinum*

IRRIGATION QUALITY STATUS OF TUBE-WELL WATERS. A CASE STUDY OF TEHSIL YAZMAN

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Water shortage is currently considered as a major problem for both human and agriculture. To ensure food security and increasing crop yield this growth has also led to problems of overdraft, falling water tables and degradation of groundwater quality, and yields generally remain well below potential levels. In this study qualitative assessment of groundwater was done and a ground water quality index criterion was used to understand the suitability of groundwater for irrigation purpose in the of different areas of tehsil Yazman district Bahawalpur. Total 1126 samples were collected from different sites of tehsil Yazman District Bahawalpur with the help of Global Positioning System. According to the results of all analysis out of 1126 samples only 12% water samples were fit, 12% water samples was marginal fit and 76% samples were found unfit for irrigation purpose with respect to the EC and SAR. There is a great need for the assessment and monitoring of quality and quantity of groundwater resource required at local level to develop an exact scenario of watershed.

Key Words: Ground water quality; EC; pH; Yazman; Irrigation

ESTIMATION OF THE CARBON FOOTPRINTS OF WHEAT CROP IN FAISALABAD, PAKISTAN

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Climate change is a global phenomenon, which refers to increase in the earth's temperature due to anthropogenic activities. In Pakistan, agricultural sector is the most sensitive to climate change, but at the same time this sector has huge contribution towards CO₂ emissions. It is very challenging to become a food secure nation as well as handle the rising climate risks. This study aims to estimate the carbon footprints (on-farm production-base emission of GHGs) of wheat crop in district Faisalabad, Pakistan. Primary data were collected through face to face interviews with 200 farmers. The wheat crop produced total 0.31 kg CO_{2eq} / kg-1 and 532.17 kg CO_{2eq} / acre-1, inorganic fertilizers are the largest contributor with 59% of the total emissions. Other operations like ploughing, rotavator, harvester, transport, irrigation with diesel, irrigation with electricity pesticides and herbicides are contributing about 7%, 5%, 10%, 3%, 4%, 3%, 1% and 1%, respectively. To mitigate unfavorable impacts of crop cultivation it is recommended the use of green manure as organic fertilizers should be promoted, agricultural and animal waste should be used to produce biogas to use in various farm operations, improving irrigation system and crop diversification may also help reduce the emissions.

Key Words: Carbon footprints; Agriculture inputs; GHGs emission; Climate change; Fertilizers

PRE HARVEST SPRAYS OF ZINC SULPHATE AND BORIC ACID TO IMPROVE THE YIELD AND QUALITY ATTRIBUTES OF GUAVA FRUIT (C.V.GOLA)

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Guava (*Psidium guajava*) is the Apple of the poor man. Guava have a rich source of vitamin C, have high nutritional value. Comparison of different fruits of the country guava have fourth position in term of production. Summer and winter season guava give low quality of fruit and short shelf life due to fruit fly attack and disease Anthracnose. Winter season guava give high quality of yield and better shelf life. A field experiment was carried out in 9 square garden at the Horticultural Research of University of Agriculture Faisalabad. The experiment was laid out in Randomized Block Design with 4 treatments, replicated thrice and two branches was taken as a unit .There were four treatments T1 (Boric acid 0.6%), T2 (Zinc Sulphate 0.6%) , T3(Zinc Sulphate + Boric Acid 0.6%) , T4(Zinc Sulphate + Boric Acid 0.3%) and one control treatment with water spray. Observations were recorded on yield, Physical and quality characters of guava. Foliar application of zinc sulphate 0.6% give maximum size of fruit, weight, diameter, yield and quality attributes. Combined effects of Zinc Sulphate and Boric acid 0.6% recorded maximum pulp weight, TAA, TSS, Ascorbic acid contents, reducing and non-reducing sugar. Seed to Pulp ratio was recorded minimum at the combined effects of sprays.

Key Words: guava; winter season; Zinc Sulphate, Boric Acid ; fruit chracter; yield

ASSESSMENT OF GENETIC DIVERSITY FOR RUST RESISTANCE AND GRAIN YIELD IN PAKISTANI WHEAT CULTIVARS

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In the present study, screening was done for the inherited resistance against stripe and leaf rust in historical wheat germplasm developed or introduced in Pakistan. Data about disease severity and disease incidence of leaf and stripe rust was recorded on weekly basis in order to find the source of resistance from the historical germplasm. The results showed that 88 varieties are resistant and moderately resistant to rusts. Data was assembled on disease severity, interaction of different environmental factor for disease development and different yield attributes from the field and was analyzed using statistic software under RCBD. Analysis showed that all the varieties have highly significant difference for all the traits that were taken in our study. Cluster analysis classified the 133 genotypes into five different groups. The members of 2nd and 3rd clusters showed the adequate degree of diversity with cluster one. On the other hand, the members of cluster 4 have maximum diversity with cluster 3. The D^2 statistics showed the highest distance between 3rd and 4th clusters, while the 1st and 2nd clusters showed the maximum similarities. Scatter plot showed the adequate diversity among the wheat accessions for various characters. The results showed that the morpho-physiological assortment in the studied material is controlled by genotypes and this diversity can be used for breeding programs aimed at improved wheat germplasm.

Key Words: historical wheat germplasm; diversity; grain yield; rust resistance; breeding

EVALUATING THE EFFECT OF DIFFERENT LEVELS OF SALINITY ON GROWTH AND PHYSIOLOGY OF DIFFERENT CULTIVARS OF CHICKPEA

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Soil salinity is a rigorous abiotic factor which restrict the growth of plants and affect their physiology. The experiment was conducted at Wire House Agronomy, University of Agriculture, Faisalabad. The experiment was consisted of two factors (chickpea cultivars and salinity levels) and all the treatments were arranged in Randomized Complete Block Design with three replications. The study was conducted to evaluate the growth and physiology of three different chickpea cultivars (Bittle-98, Bittle-2016 and Bhakkar-2009) under non-saline (control) and saline (8 and 16 d Sm-1) conditions. Increasing the salinity level viciously affected the emergence, number of leaves, root fresh weight, shoot fresh weight, shoot dry weight, shoot length and root length of plants. Lowest emergence rate was noted in the cultivar Bittle-98 at salinity level of 16 d Sm-1 and highest in Bhakkar-2009 in control conditions. Highest number of leaves, root fresh weight, shoot fresh weight, shoot dry weight, shoot length and root length were observed in the cultivar Bhakkar-2009 and lowest in the cultivar Bittle-98. The highest salinity level resulted in the reduced emergence, number of leaves, root fresh weight, shoot fresh weight, shoot dry weight, shoot length and root length of plants in all cultivars. Results revealed that cultivar Bhakkar-2009 performed better in all growth attributes than the cultivars Bittle-98 and Bittle-2016 in saline conditions.

Key Words: salinity levels; growth; physiology; cultivar; chickpea

EVALUATION OF EFFICACY OF PROSOPIS CINERARIA WOOD EXTRACTIVES ON SUBTERRANEAN TERMITES

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In this study, choice and no choice tests were carried out to determine natural resistance of *Prosopis cineraria* against subterranean termites. Poplar wooden stakes were treated with the *P. cineraria* wood extractives to test the termitecidal activity. Cold extraction method was followed to prepare *P. cineraria* wood extractives in ethanol, ethyl acetate, petroleum ether and water. Three different concentrations (10%, 20% and 30%) were prepared by diluting the obtained extractives in the respective solvents. Poplar wooden stakes were checked for combined efficacy of extractives by dipping for 36 and 72 hours in respective solvents. Stakes were exposed in soil to check termitecidal activity and the data was recorded after 2 months. *P. deltoides* stakes were oven dried at 80°C, 100°C and 150°C for 7 days and data was calculated after 24 hour interval. Weight loss of wooden stakes in each experiment were recorded after 60 days exposure to the termites. Field experiments were performed in accordance with Complete Randomized Design (CRD) with three replications. Minitab (statistical techniques) was used to analyze experimental data. In the experiment No. 1 the minimum weight loss was observed when ethanol was used in 30% concentration and showing results 23.10%. Maximum weight loss (40.23%) were observed in untreated (control) groups. In 2nd experiment combination of ethyl acetate and ethanol showed significant Results with minimum weight loss of 18.31%.

Key Words: *Prosopis cineraria*; Termitecidal activity; Extractives; Weightloss; Results

EFFECT OF SOWING METHOD AND WEED MANAGEMENT STRATEGIES ON WEED DYNAMICS AND PRODUCTIVITY OF SPRING PLANTED MASH BEAN

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Pulses are important crops due to their high nutritional value and are cheap source of vegetable protein. The management practices particularly planting and weed control methods can play vital role in improving the final production of mash bean crop. A field experiment was conducted to find the best sowing method and weed management strategy for mash bean crop. The experiment was comprised of three sowing methods (broadcast, drill sowing and zero tillage) and five weed control methods (control, hand weeding, S-Metolachlor 960 EC g L-1 as a Pre-emergence, Lactofen 24 EC @ 200 ml as a Post-emergence and S-Metolachlor 960 EC g L-1 as a Pre-emergence + Lactofen 24 EC @ 200 ml as a Post-emergence). The experiment was conducted in randomized complete block design (RCBD) with split plot arrangement having three replications. During entire crop development observations were recorded on crop growth, weed biomass, agronomic and yield related parameters by following standards procedures. The collected data was analyzed statistically. The results showed that weeds were best managed in plots where combination of pre and post emergence were used against hand weeding. Weed density and weed biomass were recorded minimum where combination of herbicides were applied. Agronomic and yield related parameters were obtained maximum in line sowing method with treatments where combination of pre and post emergence herbicide were applied.

Key Words: weed dynamics; herbicide; sowing method; weed control; weed biomass

EVALUATING THE EFFECT OF DIFFERENT LEVELS OF SALINITY ON GROWTH AND PHYSIOLOGY OF DIFFERENT CULTIVARS OF CHICKPEA

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Soil salinity is a rigorous abiotic factor which restrict the growth of plants and affect their physiology. The experiment was conducted at Wire House Agronomy, University of Agriculture, Faisalabad. The experiment was consisted of two factors (chickpea cultivars and salinity levels) and all the treatments were arranged in Randomized Complete Block Design with three replications. The study was conducted to evaluate the growth and physiology of three different chickpea cultivars (Bittle-98, Bittle-2016 and Bhakkar-2009) under non-saline (control) and saline (8 and 16 d Sm-1) conditions. Increasing the salinity level viciously affected the emergence, number of leaves, shoot fresh weight, shoot dry weight, shoot length, root length and plant height. Lowest emergence rate (8.33) was noted in the cultivar Bittle-98 at salinity level of 16 d Sm-1 and highest (10.67) in Bhakkar-2009 in control conditions. Highest shoot dry weight (1.5 g), shoot length (17.7 cm) and plant height (76.3 cm) was recorded in the cultivar Bhakkar-2009 and lowest shoot dry weight (1.04 g), shoot length (12.6 cm) and plant height (50.0 cm) was recorded in cultivar Bittle-98. Results revealed that cultivar Bhakkar-2009 performed better in all growth and physiological attributes than the cultivars Bittle-98 and Bittle-2016 in saline conditions. Moreover Bhakkar-2009 proved more salinity stress tolerable than other cultivars of chickpea.

Key Words: salinity levels; growth; physiology; cultivar; salinity stress

INVESTIGATION OF CLIMATE CHANGE ADAPTATION STRATEGIES AGAINST HEAT WAVE FOR HUMAN HEALTH

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It is univocal that human health is affecting badly due to climatic variation. Impacts of climate change on human health are triggered by industrial revolution due to the emission of greenhouse gases and deforestation to acquire land for commercialization. As a result, frequency and intensity of heat waves and cold spells increased. Temperature has been increased that is stimulating pathogens, vector ecology, human behaviors, population displacement, and public health problems. This study was conducted in District Muzaffargarh with the help of well-structured questionnaire about human perception, impacts, and adaptations against heat wave. 150 respondents which were dissimilar in education as well as socio-economic status were selected. Results showed that young, educated and high-income respondents had better adopt the adaptation strategies against climate change. In addition, regardless of the aforementioned factors, the respondents, having more awareness about the effects of the heat wave, had more adaptation strategies against heat wave as compared to those respondents having less awareness. It was suggested that the early warning system of the heat wave, awareness, and public education should be used to reduce the health impacts of the heat wave. Mortality rates during extreme heat vary with age, sex, housing, clothing and race. Moreover, urban population is most vulnerable to heat wave as a result of urban heat island effect and lack of open space.

Key Words: Heat Wave; Human Health; Adaptation; Perception; Impacts

IMPACT OF FLUCTUATING CLIMATIC CONDITIONS IN PERFORMANCE OF INSECT PATHOGENS AS BIOLOGICAL CONTROL

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In Pakistan, biological control is the most suitable and environment friendly techniques more the management of insect pests because several kinds of hazardous insecticides generate sociological problems for humans. Different entomopathogens such as bacteria, viruses, protozoa and nematodes are successively used in biological control. Bio-control agents are affected with the gradual fluctuation in climate conditions. For this purpose, the experiment was conducted to control the lepidopteron insect pests through entomopathogens including Beauveria bassiana, Bacillus thuringiensis and Deladenus siricidicola and also estimate their pathogen performance speed of infection and pathogen virulence were checked under challenging environmental conditions (low and high range of temperature and humidity) in the department of entomology, BZU, Multan. The experiment was done in glass square cages in which microbial agents were applied at controlled conditions by maintaining the temperature and humidity in growth chamber. Results indicate that the B.thuringiensis was found to persist and have efficient pathogen performance, speed of infection, pathogen virulence under drought and cool lab environments conditions and its virulence and persistence were somewhat decreased but remain effective, while microbes Beauveria bassiana and Deladenus siricidicola their performance was slow for the management of lepidopteron inset pests in challenging environmental conditions .

Key Words: Biological control ; entomopathogens; lepidopteron; challenging; environmental conditions

ROLE OF FLUCTUATING CLIMATIC CONDITIONS IN THE DEVELOPMENT OF INSECTICIDE RESISTANCE IN MITE *TETRANYCUS UTRICAE*

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Agriculture faces a lot of biotic, abiotic and different legislative challenges with the change of climate. Due to injudicious and continuous use of different chemistry insecticides for the management of insect pests that play a most important role in climate change, while. Among these pests, mites are considered very important pest of different agriculture crops. But ignored due to small in size. The nymphs of mites have been developed the resistance against different acaricides and insecticides but did not reported in adult stage. In the present study, spiromesifen, spirotetramat, chlorpyrifos and chlorgfenapyr were used to check the resistance in adults of mite *Tetranychus urticae*. Mites were reared in laboratory at standard conditions 27 ± 2 oC, 60 ± 5 oC relative humidity and photoperiod of 14:10 h (L:D) Select the homogeneous adults nine generations for bioassay and exposed on leafs that were dipped for 10 seconds in insecticides at room temperature. Usually 5 adults were released on each leaf with 5 replications. Mortality was recorded 72 hours after exposed to insecticides. A preliminary bioassay of siromesifen, spirotetramate, chlorpyrifos and chlorgfenapyr were done to find out the concentration for selection and level of resistance. Results indicate that about 30 fold resistances have been recorded in adults against selected insecticides, but highest resistance was found against spirotetramate and lowest has been observed against chlorpyrifos under laboratory conditions.

Key Words: Climate; challenges; Insecticides; Resistance; *Tetranychus urticae*

QUANTIFICATION AND RISK ASSESSMENT OF HEAVY METALS BUILDUP IN SOIL-PLANT SYSTEM AFTER IRRIGATION WITH UNTREATED CITY WASTEWATER IN VEHARI, PAKISTAN

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In peri-urban areas of district Vehari, farmers are using untreated city wastewater for crop irrigation owing to the shortage of good quality water. This practice may pose severe environmental and health issues to local habitants attributed to the high concentration of potentially toxic metals (PTMs) in wastewater. The present study evaluated the potential impacts of wastewater irrigation on metals (such as Pb, Cd, Ni, Cu, Cr, Mn, Zn and Fe) buildup in the soil-plant continuum. we collected 17 wastewater 108 soil and 65 plant samples from 15 peri-urban sites of three tehsils of district Vehari. Results showed that the mean concentration (mg/L) of Cd (0.02), Mn (0.25) and Fe (1.57) in wastewater samples was higher than their respective threshold values. Similarly, Cd, Mn and Fe concentration in soil were beyond the permissible limits of agricultural soil after wastewater irrigation. However, plants showed high accumulation of Pb, Cr and Fe than their respective limits depending on the vegetable/crop species. The health risk parameters showed that Pb and Cd are major toxic chemical substance to human health and the daily intake of crop plants can pose a potential health threat due to wastewater irrigated crop consumption. Our results emphasized the need for pretreatment of wastewater to avoid the soil and vegetable contamination by wastewater irrigation system and furthermore to reduce the associated health risks.

Key Words: Wastewater irrigation; potential toxic metals; crops; vegetables; human health risk

RISK ASSESSMENT AND HEAVY METALS EXPOSURE VIA DRINKING GROUNDWATER IN VEHARI, PAKISTAN

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Heavy metals are categorized as the highly toxic environmental pollutants by several world organizations and are capable to exert many injurious health effects by intake of metal-contaminated water. In current study, we planned to estimate the heavy metal concentration in groundwater used for drinking purpose in peri-urban areas of District Vehari. We collected about 129 groundwater samples and subjected to analyze heavy metal concentrations (Pb, Cd, Ni, Cu, Cr, Mn, Zn, Fe). Moreover, temperature, electrical conductivity, pH, total dissolved solids, anions (chloride, carbonates, and bicarbonates) and cations (sodium, potassium, lithium, calcium and barium) contents of groundwater were also determined. Results indicated that the values of several groundwater physicochemical parameters were above the limit values recommended by different health organizations (e.g., world health organization). Groundwater parameters such as cation contents, alkalinity, chloride concentration and especially the levels of heavy metals such as Pb (93%), Cd (68%) and Fe (100%) were higher than their threshold given by WHO. The risk assessment parameters also showed possible carcinogenic risks associated with the ingestion of metal-contaminated groundwater at peri-urban areas of District Vehari, predominantly with Pb (0.002-2.04). The HQ values for all the metals was < 1, while Pb showed HQ > 1 showing non-carcinogenic risk with the consumption of groundwater of District Vehari.

Key Words: Heavy metals; drinking water; groundwater; peri-urban areas; human health risk

WHEAT (TRITICUM AESTIVUM L.) PRODUCTION AND PRODUCTIVITY IN IRRIGATED SEMI-ARID CONDITIONS OF FAISALABAD UNDER DIFFERENT CLIMATE CHANGE SCENARIOS

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Crop production are affected by the changing climatic conditions, in some regions it may negatively affect by decreasing yield or by deteriorating the quality of the crops. Field trials were conducted at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad on wheat to assess nutrient and water productivity in irrigated semi-arid conditions of Faisalabad under changing climatic conditions. The treatments were six dates of sowing (DOS) (20th Oct., 30th Oct., 10th Nov., 20th Nov., 30th Nov. and 10th Dec.) with five nitrogen levels (N-levels) i.e. (0, 60, 120, 180 and 240 kg ha⁻¹). Results show that biological and grain yield were increased up to sowing date 10th November and then a decreasing trend was started up to 10th December sowing date. CSM-CERES-Wheat model were used for climate change impact assessment and the results show that N-levels have not much significant effect on wheat yield. However, date of sowing show more significant results in irrigated conditions of Faisalabad by the years 2030, 2050 and 2090 depending upon Intergovernmental Panel on Climate Change (IPCC), representative concentration pathways (RCPs). Model predicts that the date of sowing 30th November with 180 kg N ha⁻¹ performs better than other dates of sowing under these changing climate scenarios (RCPs) by the years 2030, 2050 and 2090.

Key Words: Wheat; Climate Change; Nitrogen; CSM-CERES Model; RCPs

IMPROVING THE PRODUCTIVITY AND GRAIN BIOFORTIFICATION OF MUNG BEAN (*VIGNA RADIATA L.*) THROUGH ZINC NUTRITION

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The productivity of mung bean is low in arid and semi-arid soils owing to little or no application of fertilizers. The majority of mung bean growing regions of Pakistan are low in zinc (Zn) contents. According to the World Health Organization, more than 2 billion people worldwide, including women, children and the middle-aged are suffering from vitamin and mineral deficiencies, primarily iodine, iron, vitamin A and Zn. To resolve the problem, this study was conducted at Department of Agronomy, Bahauddin Zakariya University Multan, Pakistan during the years 2017. Mung bean variety "Azri 2006" was sown under Zn level of 10 kg ha⁻¹ with different sources (ZnSO₄, Zn EDDHA and 50 % ZnSO₄ + 50% Zn EDDHA). Zn was applied as soil application, foliar application and 50 % soil + 50 % foliar application. The result of this field study showed that Zn application improved the allometric and yield related traits of mungbean . Zn as a ZnSO₄ with soil application produced maximum chlorophyll content, leaf area index, sympodial and monopodial branches, number of pods per plant, 1000 seeds weight (g), grain yield and biological yield against control. In conclusion, ZnSO₄ 10 kg ha⁻¹ with soil application improved mung bean productivity and enhanced mung bean Zn content which may lead towards resolving the malnutrition problem.

Key Words: mungbean; zinc; biofortification; seed yield; soil application

IMPACT OF INDUSTRIAL WASTEWATER ON GREENHOUSE GAS EMISSION AND SOIL HEALTH

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Increasing greenhouse gases (GHGs) emission due to anthropogenic sources is the most potent driver behind global warming. Due to unprecedented climatic changes, the availability of fresh water is reducing drastically throughout the year and farmers are using wastewater as irrigation source which could also be a potential source of GHGs emission. Incubation study of 55 days was conducted to determine the impact of industrial wastewater on CO₂ emission and soil health. In 200 mL incubation jars 50 g soil and wastewater from dying, textile and leather industries applied. Control was maintained by applying distilled water. Results manifested that cumulative C-CO₂ emission significantly decreased by application of dying industrial wastewater. Microbial biomass C contents increased by applying the leather and dying industrial wastewater, but it decreased by applying the chemical industrial wastewater. Enzymatic analyses revealed that Chitinase activity increased in control condition. However, it was found to be decreased in case of dying and chemical industry wastewater. Acid phosphatase activity increased in case of leather industry wastewater. Enzymes i.e. Chitinase and Leucine amino peptidase activity increased by applying the dying industry wastewater. It was concluded that the emission of CO₂ drastically varies in response to the use of wastewater of different industries which pose variable impacts on soil health attributes i.e. enzymatic activities and MBC contents in soil.

Key Words: Industrial Wastewater; GHG emission; Soil Health; Microbial biomass; Enzyme Activities

IDENTIFICATION AND COMPUTATIONAL CHARACTERIZATION OF DISEASE RESISTANCE-RESPONSIVE (DRR) GENES FAMILY IN ARABIDOPSIS THALIANA

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Disease resistance responsive (DRR) proteins which are also known as dirigent-like proteins are important mediators of defence responses in plants. They are mostly involved in the biosynthesis of biologically active molecules such as lignin which have a significant role in disease resistance. In this study, we performed a genome-wide study of disease resistance responsive genes family from *Arabidopsis thaliana*. Overall, 26 disease resistance responsive genes were identified in the *Arabidopsis* genome. There were 5 genes on chromosome 1, 5 genes on chromosome 2, 6 genes on chromosome 3, 6 genes on chromosome 4 and 4 genes on chromosome 5. On basis of proteins sequence similarities, phylogenetic analysis clustered all 26-disease resistance responsive genes of *Arabidopsis* into 4 main groups. Members of different groups showed various similarities among themselves in terms of conserved motifs identified in their peptide sequences. In the same way, gene structure analysis revealed several homologies in intron-exon pattern of DRR genes within the members of same groups. Out of 26 genes introns were only present in two DRR genes namely as At2g21100 and At3g58090. This may be due to the horizontal transfer of the members of this gene family from prokaryotes into the *Arabidopsis thaliana*. Our findings provide a useful reference for the identification as well as characterization of DRR genes in other plant species by using various bioinformatics tools.

Key Words: Disease resistance responsive gene; phylogeny; motif analysis; gene structure analysis; disease resistance

EFFECT OF SOIL APPLIED ZINC AND BORON ON SPRING PLANTED MAIZE

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A field trial was carried out to evaluate the effectiveness of zinc and boron fertilizers on maize (*Zea mays L.*). Proposed experiment was carried out at Agronomy Research Farm, University of Agriculture Faisalabad during spring 2018. Research comprised 36 plots having 4 ridges in each. Crop was sown on one side of ridges. Randomized Complete Block Design with factorial arrangement was used for the allocation of treatments with three replications. The treatments were different levels of zinc (4, 6, 8 kg/ha) and boron (0.75, 1 kg/ha) along with control. Zinc sulfate (ZnSO_4) and borax ($\text{Na}_2\text{B}_4\text{O}_7$) will be used as a source for Zn and B, respectively. Interactive effect of zinc and boron resulted significant. B 1 kg/ha and Zn 8kg/ha when applied in combination resulted in maximum plant height, cob girth, cob length, lines per cob, 1000 grain weight, grain yield, biological yield and harvest index.

Key Words: Maize; Zinc; Boron; ZnSO_4 ; Boric acid

EFFECT OF SEED SIZE AND SEEDING DENSITY ON PRODUCTIVITY OF WHEAT (*TRITICUM AESTIVUM L.*)

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Optimum seeding density and seed size considered as important management factors for improving the yield of wheat. Therefore, field experiment was conducted in 2017-18 at Research Area of Agronomy, UAF to determine the impacts of seed rates and seed sizes on performance of wheat crop. The experiment was laid out in Randomized Complete Block Design with the factorial arrangement. The experiment was composed of different seed rates i.e, 00, 125 and 150 kg ha⁻¹ and different seed sizes i.e., bold seed more than 2.7 mm, medium seed less than 2.7 mm and small seed less than 2.3 mm. The results indicated that seed sizes and rates had significant on the performance of wheat crop. The maximum plant height (96 cm) productive tillers (368 m⁻²) and grain yield (421.58 kg ha⁻¹) was recorded with seed rate of 150 kg ha⁻¹. In case of seed size maximum plant height (102 cm) productive tillers (349) and grain yield (443.22 kg ha⁻¹) was recorded with bold seed (more than 2.7 mm) and minimum productive tillers (294) and grain yield (344.20 kg ha⁻¹) was obtained from small seed size (less than 2.3 mm). In interaction effects maximum productive tillers (384) and grain yield (459.33 kg ha⁻¹) was recorded in bold seed with 150 kg ha⁻¹ seed rate and less productive tillers (258) and grain yield (315.67 kg ha⁻¹) was noticed in small seed with 100 kg ha⁻¹ seed rate. In conclusion, 150 kg ha⁻¹ and bold seed size can be used under Faisalabad conditions to get the maximum wheat production.

Key Words: seed rate; seed size; growth; yield; wheat.

ENHANCEMENT OF ZN CONTENT IN RICE (*ORYZA SATIVA L.*) BY EXOGENOUS APPLICATION

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Zinc (Zn) plays an important role in plants as well as in human metabolic processes. Its deficiency in edible plant parts affects human health. Rice is the major crop used as a staple food world-wide. A study was conducted to enhance Zn concentration in rice-grain endosperm of five cultivars (Bas-515, KSK-434, Super Basmati, KSK-133 and Chenab) using different Zn application methods i.e. soil application, root dipping and foliar spray. Zinc sulfate ($ZnSO_4 \cdot 7H_2O$) was used as a source of Zn. Application of Zn as soil was done at the time of transplanting, for root dipping the plant-roots were dipped in $ZnSO_4$ solution before transplanting to the pots and foliar spray was done at the time of panicle initiation. It was found that in foliar spray treatment was better in for KSK-133 compare to other cultivars showing 6% increased chlorophyll contents and 32% more filled grains with reference to control. For root dipping treatment KSK-434 performed the best with a 13% increase in chlorophyll contents and 17% more filled grains compared to control treatment where no Zn was applied. Soil application did not show any significant effect with respect to control. It is concluded that foliar application and root dipping are better methds of Zn application, nevertheless varietal variation does occur, and one application strategy may not be valid for all cultivars. Regarding endosperm Zn content grain samples are being analyzed and results will be included in poster presentation.

Key Words: Zn; Zn localization rice seed; rice yield; biofortification; rice verities

ALLEVIATION OF SALT STRESS ON GROWTH AND PHYSIOLOGICAL PARAMETER OF MAIZE BY THE FOLIAR APPLICATION OF SALICYLIC ACID

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The study was conducted at Agronomy wire house, University of Agriculture, Faisalabad to evaluate the upgrading effects of foliar application of salicylic acid on maize under salt stress. The experiment was laid out in completely randomized design with two factor factorial arrangement using three replications. There were three levels of salt stress applied i.e., control, 6 dSm-1, 12 dSm-1 and three levels of salicylic acid i.e., control, 300 mM and 600 mM were foliarly sprayed after 20 days of germination. Different growth and physiological related parameters including root length, shoot length, shoot dry weight, root dry weight, chlorophyll, carotenoid and total soluble protein decreased with the increasing concentration of salt stress. Moreover, electrolyte leakage, activity of antioxidant system and reactive oxygen species (ROS) were increased under salt stress. The foliar application of salicylic acid significantly ameliorated the effect of salt stress on maize and enhanced the growth, photosynthetic pigments and biochemical parameters of maize. However, foliar applied salicylic acid with 600 mM remained at top rank with respect to improvement in growth, physiology and biochemical parameters of maize under salt stress as compared to other levels.

Key Words: Maize; Salt Stress; Salicylic Acid; Growth; Antioxidants

THE IMPACT OF SALT STRESS ON NITROGEN UPTAKE IN MUNGBEAN (VIGNA RADIATAL.)

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Mungbean (*Vigna radiata* L.) have high nutritional value and is an important pulse. It improves the soil fertility by fixing the atmospheric nitrogen. Salinity is a major factor which negatively affects the growth, development and yield of mungbean. A pot experiment was conducted to evaluate the impact of nitrogen and salinity on the mungbean (AZRI) at the Agronomic Research Area, UAF. Nitrogen (N) with different levels was applied as, i) 0 mg kg⁻¹ (N1), ii) 50 mg kg⁻¹ (N2) and iii) 100 mg kg⁻¹ soil (N3) along with three levels of salinity 2 ds m⁻¹ (S1), 4 ds m⁻¹ (S2), and 6 ds m⁻¹ (S3). Results indicates that, salinity stress decreased the number of plants, number of leaves, leaf area, plant height, number of nodules and mungbean biomass compared to control plants. Salinity stress negatively affected the mungbean roots compared to shoots and leaves. Application of nitrogen had improved the growth, but its acquisition was suppressed under salinity.

Key Words: Mung bean; Salinity; Nitrogen; Pulses; Nodulation

EFFECT OF MICROBIAL CONSORTIUM AND COMPOST ON PHYTOREMEDIATION OF PETROLEUM HYDROCARBONS AND GROWTH OF MASH BEAN

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The contamination of soil by petroleum hydrocarbons (PHCs) is a major soil ecological concern. PHCs are harmful to all living organisms including plants, animals and humans. Cleaning up of these pollutants from environment is a challenge. Many physical, chemical and biological remediation had been investigated to remove PHCs contamination. However, the use of plants in combination with microbes for phytoremediation of PHCs is believed to be an environmentally-friendly and cost-effective option. Thus the aim of this study was to assess the effects of indigenous microbial consortium and compost addition on phytoremediation of PHCs and growth of mash bean in PHCs contaminated soil. For this purpose, soil was artificially contaminated with diesel (6000 mg/kg) and used for this study. Although germination was not inhibited, significant ($P < 0.05$) reduction in root and shoot lengths, fresh/dry biomasses and other growth parameters was observed in plants grown under PHCs contamination. However, application of microbial consortium and/or compost greatly reduced the toxic effects of PHCs on plant growth. Results showed that the consortium along with banana compost can improve the tolerance of plants against PHCs stress and can assist plants in phytoremediation of PHCs contaminated soil.

Key Words: Mash bean; Banana compost; Phytoremediation; PHCs; Microbial consortium

CONSERVATION OF NATURAL RESOURCES AND SUSTAINABLE AGRICULTURE AND LIVESTOCK PRODUCTION THROUGH EXTENSION IN PAKISTAN

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Recent developments in agriculture and livestock production have resulted in growing consumption of inorganic fertilizer, pesticides, animal feed-stuffs and agricultural machinery. All this has substituted for natural processes and resources. Pesticides have replaced biological and cultural methods for controlling pests; inorganic fertilizers have substituted livestock manures, composts, and nitrogen-fixing crops with the less emphasis on the capacity building of farmers for the proper use of natural resources. On the other hand industrial-livestock production is associated with decline in a number of locally adopted breeds and has further raised the issues of animal welfare. The basic challenge for sustainable-agriculture is to make better use of regenerative and resource-conserving technologies and practices that can bring both environmental and economic benefits for farmers. This goal could effectively be achieved through extension and capacity building. Growing awareness and new knowledge of the unintended impacts associated with some agricultural practices have led us to heightened social expectations for improved environmental, community, labor, and animal welfare standards in agriculture systems. One solution to improve the sustainability of Pakistan agriculture is to focus on a system research approach. Extension has an important role to play here by making visible the interdependence between stakeholders and increasing among them the natural resource use efficiency.

Key Words: food security; capacity building; resource use efficiency; sustainability; stakeholder

IMPACT OF AUXILIARY POTASSIUM TO DIMINISH DELETERIOUS EFFECTS OF SALT STRESS IN OKRA

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Excessive accumulation of salts in soils is a potential threat for limiting crop productivity around the globe. Salinity affects potassium (K) availability to plants in the soil by disturbing ionic compartmentalization including Na⁺ K⁺ ratio. Okra is one of the most important nutritious vegetable crop having high commercial and food value. In order to check the effect of applied K on growth and yield of okra under saline conditions, a pot experiment was conducted in wire house at Institute of Soil & Environmental Sciences, University of Agriculture, Faisalabad. In present study, two salinity levels (i.e. 6 and 8 dS m⁻¹) were developed using NaCl salt along with control. Three rates of K at 60, 90 and 120 kg ha⁻¹ were used in Completely Randomized Design each with 3 replications. The variety used in the experiment was sabz pari. Standard procedures were used to record the data on physiological and yield related attributes. The results showed that application of supplementary K had significant ($p \leq 0.05$) effects on Okra growth parameters. A significant reduction in physiological and chemical parameters was observed due to salt stress. However, the application of K at 120 kg ha⁻¹ had a significant effect with increased chlorophyll contents, roots/shoot fresh and dry weights, pod length and weight, increased K⁺ concentration and decreased Na⁺ in shoots of okra plants under saline conditions.

Key Words: Okra; Salinity; Potassium; SPAD-value

ENHANCEMENT OF ALKALINITY TOLERANCE IN SPRING MAIZE BY USING PGPR

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Alkaline stress is an agricultural pollutant and has adverse effects on plant metabolic rate, mainly root structure. Plant growth promoting rhizobacteria (PGPR) can be used as bio-priming agents for initiation of alkalinity tolerance. An experiment was conducted in wire house of department of plant breeding and genetics to check the efficacy of bacterial strains under different alkalinity levels. Experiment was conducted in completely randomized design (CRD) with factorial arrangement having three replications. Three alkalinity levels such as control, 6dSm-1 and 12dSm-1 were maintained in the pots. While efficacy of primed seed of maize with bacterial strains MN-17 and MN-54 was checked under different alkalinity levels. There was maximum reduction in growth, antioxidant enzymatic activity when exposed to salinity stress. The results showed that priming with bacterial strain MN-54 significantly increase the enzymatic activity (CAT, POD and APX) and growth-related attributes. While reactive oxygen species reduces including H₂O₂ and MDA contents under NM-54.

Key Words: Bio-priming; Alkalinity stress; PGPR; Maize

REMEDIATION OF MIXED WASTEWATER OF CHOKERA DRAIN THROUGH CONSTRUCTED WETLAND USING ELEPHANT EAR PLANT (COLOCASIA ESCULENTA L.)

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The untreated wastewater from industries and domestic sectors is being disposed-off in developing countries and has adversely affected the living organisms. The amount of sewage production in Pakistan has reached 962,335 MGD (million gallons per day) while 2000 MGD of contaminated water is being released into freshwater streams every day. Keeping this in view, an experiment consisting of two setups of constructed wetlands and a control was conducted to treat the wastewater of Chokera drain by using elephant ear plant. The horizontal flow constructed wetland (HFCW) and vertical flow constructed wetland (VFCW) performed well for different water quality parameters including chemical oxygen demand (COD), biological oxygen demand (BOD), electrical conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS), cadmium (Cd), mercury (Hg) and pH. In case of HFCW, the percent decrease observed in different quality parameters including COD, BOD, TSS, Cd and Hg was 29, 61, 75, 65 and 46% while percent increase observed in pH and TDS was 20 and 35%, respectively. The main reason behind the increase of pH and TDS was the use of sand and soil in its bedding. In case of VFCW, there was a significant decrease in all aforementioned parameters. The results indicated that constructed wetland technology can achieve an appreciable level of contamination reduction and can be a viable and cost effective approach in the treatment of mixed wastewater.

Key Words: Waste water treatment; horizontal flow constructed wetlands; vertical flow constructed wetlands; Cadmium; Mercury

EFFECT OF POTASSIUM SUBSTITUTION BY SODIUM ON GROWTH AND QUALITY OF POTATO

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Potassium (K) substitution by sodium (Na) may enhance tuber production and its quality of potato due to some beneficial effect of Na. This study was planned to investigate the effect of K and Na application fertilization on yield and quality of potato. Experiment was conducted in the old Botanical garden of University of Agriculture Faisalabad. Three treatments including nitrogen (N) and phosphorus (P) (T1), N, P and K (T2), N, P and Na equivalent to K (T3) with four replications were used in plastic pots with 28 kg soil. Four seeds were sown in each pot and design (CRD). Data for average diameter of potato, tuber yield, tuber dry weight, Na and K content in tubers and carbohydrates content in tubers was recorded. Results revealed that rate of photosynthesis, rate of transpiration, substomatal CO₂, stomatal conductivity percentage increase in K treatment as compared to control. Na was more in the K treatment and in the Na treatment. Carbohydrate % was highest in Na treatment in shoots while in the tubers high percentage is observed in the control. Significant association between the uptake of sodium to the shoots of plants and the extent of substitution of potassium was found in this study. It is concluded from present study that Na can replace for K to large extent due direct involvement in non-specific functions of K. This substitution can make K available within the plant cytosol and re-translocation from older to younger leaves and from vacuole for specific function.

Key Words: Potassium; Sodium; Potato; Yield; Tuber Quality

PLANT GROWTH AND FRUIT QUALITY ESTIMATES IN GUAVA UNDER DEFICIT IRRIGATION

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Drought stress stands amongst the most serious global threats to agriculture and water scarcity is rising sharply in Pakistan. Among fruit crops, guava (*Psidium guajava L.*) stands as one of the most economical tree crops in terms of orchard establishment, management and is potentially drought tolerant crop. Bearing trees of guava cultivars Round and Pyriform were exposed to water deficit by irrigating after 15, 30 and 45 days interval and its effects on tree morphology and productivity were estimated. No genotypic differences were noted in plant morphology and fruit physio-chemical traits except fruit length which was higher in cv. Pyriform. Deficit irrigation significantly arrested plant growth and most of the fruit related parameters, however, floral bud induction was enhanced from 71% to 91% in response to stress. Fruit setting (%), harvesting (%), fruit size and quality were also reduced, however, total soluble solids (TSS) increased from 8.7 to 9.9 in response to irrigation after 45 days interval. It is concluded that fruit length was the least affected physical trait across genotypes and floral bud induction and TSS could be enhanced by mild water stress. Such studies will help in selection of potentially tolerant varieties and understanding the behaviour of mature plants under deficit irrigation conditions.

Key Words: Round; Pyriform; Morphology; Abiotic stress; Flowering

PERFORMANCE OF MAIZE HYBRIDS FOR FORAGE PRODUCTION UNDER WATER STRESS CONDITIONS IN SUBTROPICAL ARID CLIMATE

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Pakistan is an agricultural country where agriculture contribute around 20% in the national GDP. Livestock is an important sector of agriculture and has more than 50% value addition in the agriculture. In Pakistan, especially in irrigated areas, fresh green forage is major source of livestock feed, but its production does not meet the requirements. Maize is an important fodder crop in Pakistan grown in irrigated areas, but its production is affected by water shortage. To address this challenge, a pot experiment was conducted to evaluate eight maize hybrids for forage production under three levels of water stress i.e. at i) 100% field capacity ii) 70% field capacity and iii) 50% field capacity. Data were collected for dry matter yield, protein contents, acid detergent fiber and neutral detergent fiber. Results revealed that water stress significantly reduced the forage yield and effected the forage quality. Maximum effect was observed for all the traits when water stress was applied at 50% field capacity level. maize hybrid Granon showed maximum tolerance to water stress both for dry matter yield and quality traits. Variable performance of different hybrids under water stress conditions depicts that selection for water stress tolerant maize hybrids/genotype may boost forage production in water scarce areas.

Key Words: maize; water stress; forage; dry matter; quality

APPLICATION OF ZINC AND PLANT GROWTH PROMOTING BACTERIA IMPROVES SOIL HEALTH AND BIOMASS OF CHICKPEA

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Chickpea is mainly grown under rainfed and marginal soils and there is neglected use of Zn and plant growth promoting bacteria (PGPB) to improve its yield. This study was conducted to evaluate the effect of Zn application and PGPB (endophyte Enterobacter sp. MN17) on soil health and biomass of desi and kabuli chickpea. Zinc was applied as i) seed priming (0.001M) and ii) soil application (10 kg Zn ha⁻¹) with and without Enterobacter sp. MN17 application. The highest biomass (5.1 t ha⁻¹) was recorded with Zn seed priming + Enterobacter sp. MN17 in kabuli chickpea followed by Zn seed priming in desi. The application of Zn at both growth stages (vegetative and maturity) significantly increased the MBC. Among the chickpea types, the greater response was recorded in the rhizospheric soil of kabuli (795 and 731 µg C g⁻¹) compared with desi (655 and 533 µg C g⁻¹) at both growth stages respectively. The highest extra-cellular soil enzymes activities; β-glucosidase, acid phosphatase, chitinase and leucine amino-peptidase were recorded with Zn seed priming. These extra-cellular soil enzymes activities were higher at vegetative growth stage compared to maturity. Among the chickpea types, in the rhizosphere of kabuli, the response was higher compared to desi. In conclusion, the application of Zn as seed priming along with PGPB may improve soil health and biomass of chickpea in rainfed and marginal soils.

Key Words: Chickpea; Zinc; Microbial biomass; Soil health ; Extra-cellular enzyme activities

ALLELOCHEMICALS OF DIFFERENT AGRO FORESTRY PLANTS ON THE PERFORMANCE OF WHEAT (*TRITICUM AESTIVUM L.*)

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Pakistan is going to start a trillion-tree tsunami project for climate changes. In this regard, different agro-forestry models will be adopted. Despite the application of various inputs like chemical fertilizers, pesticides and irrigation, wheat yield is low yet. One of yield reducing factor is allelochemicals. These allelochemicals are present in plants that surrounds wheat field. Current field study was conducted to investigate the selection of trees for agro-forestry models. Experiment was conducted at Research Area of PARC-Arid Zone Research Centre, D. I. Khan in Rabi season 2018-2019. Six allelochemicals of different plants were isolated viz. Acacia, Moringa, Conocarpus, Eucalyptus, Sheesham and Pongamia as seed priming for 24 hours. Each treatment was replicated thrice and experiment was laid out in randomized complete block design (RCBD). The net plot size was kept 1.8 m × 5 m. Significant reduced time to start emergence, mean emergence, and time to start 50% emergence was observed in control as compared to treated with pongamia, eucalyptus, acacia and conocarpus isolated allelochemicals. However, priming with allelochemicals of moringa and sheesham at par with control. Conocarpus significantly reduces vegetative and root extension traits i.e. leaf length, chlorophyll contents, root length, root area, root diameter, root volume and root density by 11%, 16%, 20.6%, 25.89%, 1.11%, 19.32% and 18%, respectively, as compared to control.

Key Words: Allelochemicals; Climate; Crop; Tree; Wheat

EVALUATION OF THE COMPETENCE OF TRICHODERMA HARZANIUM IN COMBATING TOXIC EFFECTS OF SULPHATE ON PAKISTAN'S STAPLE FOOD CROP: TRITICUM AESTIVUM

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The current study was conducted in Nusrat Jahan College Rabwah Pakistan to examine the efficacy of Trichoderma harzanium to eradicate toxic effects of sulphate, affecting wheat. Four varieties of *T. aestivum*; Punjab, Shafaq, Ari and Millat were taken from National Agricultural Research Centre. The fungal strain *T. harzanium* was also obtained from NARC. All seeds were coated with *T. harzanium* (2×10^7 CFU) using pelgel. Seeds were taken up to seedling stage and harvested after 30 days. At two leaf stage, sulphate stress was applied (100mg/L and 300mg/L). Roots and shoots were separately preserved in phosphate buffer (50mM). Preserved samples were subjected to Biochemical tests using spectrophotometer. Trichoderma harzianum seed coating effectively increased total protein content in applied sulphate toxicity wheat seedlings, also total phenolics content was increased resulting in production of various ROS scavenging proteins, hence reducing production of hydrogen peroxide, catalase and MDA. This reduction in production of ROS prevents crop from oxidative damage. Thus, our study supports that Trichoderma use under toxic conditions is an effective approach for healthy crop growth.

Key Words: wheat; seed coating; sulphate toxicity; Trichoderma harzanium; biochemical tests

PHRAGMITES AUSTRAILS ROLE IN REMEDIATING THE LEAD CONTAMINATED SOIL

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Lead (Pb) is also a heavy metal with having the long residence time in soil. It can enter into the food chain through the various pathways and contaminate water and food which are the most important sources of all the living organisms. *Phragmites australis* (Cav.) Trin. Ex Steud. known a common reed, is a large grass grown on waste mater. This study was meant to evaluate the ability of *Phragmites australis* to remove Pb from the artificially contaminated soil. Seedlings of *Phragmites australis* (PA) were grown in the artificially contaminated soil and harvest after 60 days of sowing. Results showed that PA removed Pb from the contaminated soil and accumulated in its roots and shoots. Increase in concentration of the heavy metal Pb does not show any adverse effect on plant's body. The treatment having a maximum concentration of metals also showed maximum biomass as compared to the other treatments which had less concentration of heavy metals. The root and shoot length were also maximum in the soil containing a maximum concentration of heavy metals except for the control treatment which was free of any type of contamination in the soil. Results indicated that the *Phragmites australis* has the ability to remove Pb from contaminated soil to accumulate this in its roots and shoots. Since biomass of PA could be used in the paper industries, hence heavy metals accumulated in such plants would not pose a direct and acute risk to living organisms.

Key Words: Contamination; toxicity; remediation; lead; PHRAGMITES AUSTRAILS

ROLE OF POULTRY MANURE BIOCHAR AND METAL TOLERANT BACTERIAL STRAIN TO REDUCE METAL (CD AND PB) AVAILABILITY IN MUNICIPAL SOLID WASTE COMPOST AMENDED SOIL AND ITS EFFECT ON MAIZE (*ZEA MAYS L.*) GROWTH

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Soil application of municipal solid waste compost (MSWC) can affect soil, animal and human health due to toxic metals present in it. The use of poultry manure biochar and metal tolerant bacterial strains could be a useful strategy to decrease cadmium (Cd) and lead (Pb) in MSWC amended soil. Therefore, a study was designed to evaluate the role of poultry manure biochar and metal tolerant bacterial strain *Enterobacter* sp. MN-17 to reduce the availability of Cd and Pb in MSWC applied soils and its effect on maize (*Zea mays L.*) growth. MSWC amended soil was treated with different combinations of poultry manure biochar and metal tolerant bacterial strain *Enterobacter* sp. MN-17. Treated soil was filled in glazed pots with 3 replicates of each placed in completely randomized design. After 60 days of sowing, plant samples were evaluated for growth and chemical parameters. The post-harvest soil samples were analyzed for AB-DTPA extractable Cd and Pb. The other parameters like soil microbial biomass (SMB C and N), soil dehydrogenase activity (DHA) were also measured. The poultry manure biochar and bacterial strain *Enterobacter* sp. MN-17 decreased the mobility of Cd (53%) and Pb (71%) and enhanced growth and physiological parameters whereas their combined application was found more effective in MSWC amended soil. SMB and DHA concentrations were also increased by the addition of poultry manure biochar and metal tolerant bacterial strain *Enterobacter* sp. MN-17 with MSWC in soil.

Key Words: compost; trace metals; soil remediation; microbes; biochar

EFFECT OF DIFFERENT NITROGEN SOURCES ON POTASSIUM UPTAKE IN RICE

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Rice (*Oryza sativa L.*) is most important food crop cultivated worldwide. Nitrogen is the major nutrient for crop growth and development. Ammonia (NH₄) and nitrate (NO₃) N sources may have differential effect on K, also an important macro nutrient, uptake by plant. Therefore, present study is planned to determine the effect of NH₄ and NO₃ fertilizers on K uptake in rice. Different nitrogen sources: urea and nitrophos applied in combination with KCl and K₂SO₄. Phosphorous was applied in the form of single super phosphate. Nursery was grown for anaerobic condition and then shifted in pots after 20 days. While in aerobic condition seeds sown directly in pots. Shoot length and shoot weight was greater in Urea + K₂SO₄ in aerobic condition as compare to anaerobic condition. Root parameters were better in half Urea + SOP + half NP in aerobic condition. Potassium content decreases where ammonium and K was applied together. Chlorophylls content were higher in aerobic condition as compared to the anaerobic conditions. On the basis of results, it was concluded that urea has negative effect on K uptake by plants due to possible NH₄⁺ competition with K compared to NO₃⁻ fertilizer.

Key Words: Potassium; Nitrogen; Rice Yield; Anaerobic; Aerobic

ESTIMATION OF CARBON STOCK AND CO₂ SEQUESTRATION IN FOUR DIFFERENT AGED LINEARLY PLANTED VACHELLIA NILOTICA IN DISTRICT FAISALABAD.

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Increasing level of Carbon dioxide (CO₂) in the atmosphere is one of the recognized causes of climate change around the globe. Agroforestry trees have the ability to capture CO₂ from the atmosphere both in plant parts and soil, thus can play a vital role in mitigating climate change. Carbon stock and CO₂ sequestration along with growth and biomass were assessed in four different aged linearly planted *Vachellia nilotica* (L.) P.J.H. Hurter & Mabb. along farm crops. Nondestructive method was used to assess the tree biomass and carbon stocks in a subdivision (tehsil) of district Faisalabad (Tandlianwala) Punjab, Pakistan. Soil sampling was done at two depths: 0-15 cm and 15-30 cm to calculate the soil organic carbon (SOC). Higher growth rate of diameter at breast height (DBH) and height was observed in 3 and 6 years old *V. nilotica* trees as compared to 9 and 12 years old. Aboveground carbon stock and CO₂ sequestration increased from 9.47 t/ha & 34.71 t/ha at 3 years to 46.18 t/ha 169.15 t/ha at 12 years. The amount of SOC stock tended to be lower with depth but increased with age and ranged from 14.24 t/ha to 24.32 t/ha at 0-15 cm depth and 13.52 t/ha to 21.48 t/ha at 15-30 cm depth. The total carbon stock (plant + soil) varied from 37.23 t/ha at 3 years to 91.98 t/ha at 12 years of age. The above findings indicated that planting *V. nilotica* along field boundaries can capture significant amount of carbon to mitigate climate change.

Key Words: Agroforestry; *Vachellia nilotica*; Biomass; Carbon dioxide; Climate change

WEEDICIDE AND NITROGEN FERTILIZER SOURCES COMPATIBILITY EFFECT ON WEEDS CONTROL AND YIELD OF WHEAT

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This experiment was conducted with the collaboration of Fatima Fertilizer Limited to investigate the interactive effect of weedicide and nitrogen fertilizer on weeds control and crop production. This interaction between nutrient and weedicide restricts the uptake of nutrient. There is a need to select the appropriate time of application of weedicide and nitrogen for effective control of weeds with improvement in main crop yield. A study was conducted including N fertilizer sources DAP, NP, urea and CAN while weedicide source was Atlantis. Recommended dose of N, P and K (120- 80- 60 kg ha⁻¹, respectively) and weedicide at the rate of 100 ml acre⁻¹ was applied. The time of weedicide application was before, with and after fertilizer N application during crop growth. Two N fertilizer combinations i.e. DAP-Urea and NP-CAN were compared. Results revealed that weedicide application after fertilizer combination (NP-CAN) exhibited improvement in growth and yield parameters of wheat compared to all times of application of weedicide and fertilizer combination (DAP-Urea). This treatment also increased plant height, chlorophyll contents, grain yield and nutrients uptake compared to weedicide application before and with fertilizer combination of NP-CAN. In short this experiment provides information how to get benefit from application of weedicide and higher crop yield with least stress impact of weedicide and climate.

Key Words: Weedicide; nitrogen fertilizer sources; time of application of weedicide; wheat yield; climate stress

PATHOGENESIS AND FLOWER DEVELOPMENTAL RELATED GENES EXPRESSION IN 16SR-IX GROUP PHYTOPLASMA INFECTED BRASSICA COMPESTRISACT

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Phytoplasmas are phloem-limited, uncultivable, plant pathogenic bacteria. They are transmitted by insect vectors from infected to healthy plants. In this study, Phytoplasma belonging to 16Sr-IX-H group causes developmental abnormalities (phyllody, virescence, yellowness and stunted growth) in *Brassica campestris* affecting normal flower formation that were closely associated with changes in the expression of flower developmental genes. The alteration in the expression of developmental genes and its association with DNA methylation was investigated as a possible mechanism. *Brassica* plants were infected with phytoplasma using insect vector, *Orosios orientalis* and grafting. The study was carried out through RT-PCR, Southern blotting and Bisulfite Sequencing. Transcriptional expression of methylated genes particularly orthologous to *Arabidopsis* APETALAs involved in petal and stamen formation during flower development was found to be globally down-regulated in plants infected with phytoplasma. The DNA methylation status of flower developmental gene in phytoplasma infected plants with 5-azacytidine restored gene expression suggesting that DNA methylation was involved in down-regulation of floral development genes.

Key Words: Flower malformation; Phytoplasma; Gene expression; Insect vectors; DNA methylation

ASSESSMENT OF CHROMIUM(VI) CONTAMINATION IN TANNERY WASTEWATER OF DISTRICT KUSAR, PAKISTAN

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The leather industry is an important cause of chromium (Cr) contamination for the water and soil environments. Nearly, 70% of the contamination loads of Cr and total dissolved solids (TDS) are generated from soaking, liming/deliming, pickling and tanning processes. In tanning process, high use of Cr salts led to the discharge of wastewater having highly toxic and mobile Cr species, i.e., chromate (Cr(VI)). Therefore, the objective of this study was to determine the total Cr, as well as chromium (VI) in wastewater samples collected from several tanneries in district Kasur. All the tannery wastewater samples showed elevated Cr concentrations (range: 1-185 mg L⁻¹; mean: 16 mg L⁻¹, SD: \pm 34 mg L⁻¹). The concentrations of Cr(VI) ranged from BDL-17 mg L⁻¹. The Cr(VI) concentration in most of the wastewater samples exceeded the National Environmental Quality Standards (NEQS; 0.25 mg L⁻¹) and United States Environmental Protection Agency (USEPA; 0.1 mg L⁻¹) safe limits in wastewater. The physicochemical parameters of the tannery wastewater including pH, electrical conductivity, TDS cations and anions were found to be higher than their safe limits for wastewater. Our data indicate that the wastewater of these tanneries having toxic level of Cr(VI) that is a potential threat to the aquatic systems, and hence some suitable remediation strategies are needed to treat Cr(VI) contaminated tannery wastewater, such as employing a constructed wetland technology.

Key Words: wastewater; Chromium ; contamination; tannert; wetlands

ROLE OF ZINC IN REDUCING HEAVY METAL TOXICITY AND MALNUTRITION THROUGH BIOFORTIFIED WHEAT CULTIVAR ZINCOL

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Chromium (Cr) is very toxic heavy metal and it does not have any important metabolic function in plants. It was observed that Cr cause phytotoxicity by reducing nutrient uptake, photosynthesis plant growth and increased (ROS) in plants. Zinc (Zn) is an essential micronutrient which is necessary for plants functions, increase yield and plant growth and take part in various physiological functions in plants. Among micronutrients Zn deficiency is a major health problem around the globe that affects one third population worldwide. In Pakistan 40% of women's and 30% of children's are zinc deficient. Various techniques in the form of bio-fortification have been used to overcome Zn deficiency. To overcome this Zn deficiency a new biofortified wheat variety Zincol (zincol-2016) has been developed which contains higher amount of Zn in its grains. A research was conducted at agronomic research area University of Agriculture Faisalabad to observe the behavior of zinc biofortified wheat cultivar under Cr contamination. Two wheat cultivars including Zincol-2016 and Galaxy-2016 (standard cultivar) was grown in soil filled pots. In present scenario, this research was conducted to demonstrating the beneficial and important role of Zn in reducing the heavy metals stress in plants. Dietary Zn deficiency can be overcome by consuming Zn biofortified wheat variety Zincol which contain higher amount of Zn in its grains as well as zinc can alleviative heavy metal toxicity from plants.

Key Words: Chromium ; Heavy metal; Zinc; Wheat; Biofortification

GENOME-WIDE COMPARATIVE ANALYSIS OF PAPAIN-LIKE CYSTEINE PROTEASES FROM ARABIDOPSIS AND GLYCINE MAX

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Papain-like cysteine proteases (PLCPs) contribute a pivotal role during plant-microbe interactions like the invasion of bacteria, fungi, nematodes and oomycetes. PLCPs being a class of proteolytic enzymes are also involved in several plant physiological processes like tolerance against biotic and abiotic stress, in plant growth and development, protein storage and mobilization, organ senescence, abscission and seed germination. Papain-like cysteine proteases are classified as the C1A family of clan CA and hence are also named as C1A cysteine proteases. In this study, we perform a genome-wide study to analyzed PLCPs from both *Arabidopsis thaliana* and soybean (*Glycine max*). Overall, 46 and 22 PLCPs were identified primarily in the genome of *Glycine Max* and *Arabidopsis thaliana* respectively. Phylogenetic analysis clustered all 68 PLCPs from both plants into 4 main groups. Members of different groups showed various similarities among themselves in terms of conserved motifs identified in their peptide sequences. In the same way, gene structure analysis presented several homologies in intron-exon pattern of PLCP genes of within the members of same groups. Chromosomal positioning of all 68 PLCP genes revealed that Papain-like cysteine proteases are uniformly distributed in the genome of both *Arabidopsis* and *Glycine max*. Our findings provide a useful reference to characterize PLCP genes in other plant species by using various bioinformatics approaches.

Key Words: *Arabidopsis*; soybean; phylogenetic analysis; motif analysis; disease resistance

BORON NUTRITION HELP IMPROVES ZINC BIO-FORTIFICATION OF TOMATO-EVIDENCES FORM A FIELD STUDY

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As the Pakistani soils are deficient in plant available zinc (Zn), crop grown on these soils also have low Zn content in fruit to contribute significantly to daily human Zn intake. Owing to diverse physiological function of boron (B) in plants, it was thought to improve Zn uptake and its translocation to tomato fruit. Based upon this hypothesis, a study was planned to evaluate the effect of B on improvement of Zn content in tomato fruits. Tomato (cv. Ali Akbar) was grown in field with following treatments: T1=control, T2 = soil zinc application at the rate of 5 kg per hectare (Zn), T3 = Soil boron application at the rate of 1 kg per hectare (B), T4 = combined application of both Zn and B (Zn+B), T5 = Soil application of half of both Zn and B (1/2 Zn +1/2 B) and T6= T5+2 foliar sprays of Zn (0.2 %) and B (0.1 %). The alone application of zinc and boron in soil did not improve the quality parameters significantly. Combined as well as half of the recommended dose of Zn and B improve the quality parameters but maximum increase in fruit pulp weight, dry matter content, total soluble solid (TSS), ascorbic acid, lycopene content, chlorophyll-a, chlorophyll-b, zinc and content were 33%, 55%, 29%, 41%, 183%, 152%, 142%, 37% and 44% respectively when half dose of soil applied Zn+B was combined with foliar application of 0.2% solution of Zn and 0.1 % solution of Boron. The results revealed that the boron nutrition improve the zinc content, quality parameters and yield of tomato.

Key Words: Boron; Zinc; Foliar application; Biofortification; Nutrition

A PERCEPTION OF COTTON GROWERS ABOUT PESTICIDES USAGE AND ITS HARMFUL EFFECTS ON ENVIRONMENT

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Pesticides have a role in meeting the food, cotton fiber and control of harmful diseases. However, pesticides become circulated in the environment and affects the health of agricultural and industrial workers. However, pesticides secure some benefits for crop from problems and risks. Cotton is the supreme main cash crop of Pakistan and has quarter number in cotton production after the USA, India and China. Many developing countries issue related pesticides exposure become a major issue from the last years. Many studies were conducted by researchers on environmental related issues but there are only few studies on knowledge and behavior of applicators. The uses of these chemicals have serious effects on environment that may cause an immediate and long term effects. Exploring farmers have no awareness of agrochemicals residues and their behaviors regarding application to reduce human factors that negatively affect agricultural safety. Cotton growers have been facing various productions, protection and marketing problems due to the lack of proper policy management. Public sector is not provided the extension services due to limited infrastructure and human resources. Private sector got importance in provision of advisory services than public sector climate friendly technologies to growers.

Key Words: Pesticides ; Cotton; Environment; Extension; Services

EVALUATING OPTIMUM LIMITED IRRIGATION AND INTEGRATED NUTRIENT MANAGEMENT STRATEGIES FOR WHEAT GROWTH, QUALITY AND YIELD

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Agricultural productivity is greatly affected by restricted availability of irrigation water and poor soil health. In order to assess the influence of different potential soil moisture deficit (PSMD) regimes and integrated nutrient levels on growth, yield and quality of wheat, an experiment was carried out at research area of University of Agriculture Faisalabad during 2014-15. The experiment includes three levels of moisture deficit that are I1: 25 mm PSMD, I2: 50 mm PSMD and I3: 75 mm PSMD and four integrated nutrition levels that are N1: 50% organic manure + 50% Inorganic NPK, N2: 75% organic manure + 25% Inorganic NPK, N3: 100% application of organic manure and N4: 100% application of Inorganic NPK. Results of experiment revealed that maximum grain yield (4.78 t ha^{-1}) was obtained as a result of irrigation at 50 mm PSMD with combined use of organic and inorganic sources at equal proportion ($I2 \times N1$). In contrast minimum yield was observed at I3: 75 mm PSMD with 100% application of organic manure ($I3 \times N3$). The highest plant height (99.11 cm), fertile tillers (284.4), 1000-grain weight (44.48 g), biological yield (14.82 t ha^{-1}), radiation use efficiency for grain yield (RUEGY) (5.71 g MJ $^{-1}$) and radiation use efficiency for total dry matter (RUETDM) (2.15 g MJ $^{-1}$) were observed under N1: 50% organic manure + 50% Inorganic NPK treatment. Highest value of these parameters was also observed in I2 (50 mm PSMD).

Key Words: Grain yield; potential soil moisture deficit; radiation use efficiency; total dry matter

Conference on
**INNOVATIONS IN
AGRICULTURE**

ISBN: 978-969-8237-83-7



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