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# ABSTRACTS BOOK OF NATIONAL CONFERENCE on Beneficial Microbes & Sustainable Crop Production

*Organized By*

Department of Agronomy
The University of Agriculture Peshawar - Pakistan

AMERICAN SOCIETY FOR MICROBIOLOGY


**Editors:**

① **DR. AMANULLAH**
Associate Professor (Agronomy)

② **Mr. Shah Khalid**
Ph.D Scholar (Agronomy)


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# BENEFICIAL MICROBES IN FIELD CROPS PRODUCTION: SYMBIOSIS FOR SUSTAINABLE AGRICULTURE IN CHANGING CLIMATE

Amanullah and Shah Khalid

Department of Agronomy, The University of Agriculture, Peshawar, Pakistan
***Email: amanullah@aup.edu.pk**

## ABSTRACT

Soil fertility and health is continuously declining due to removal of essential plant nutrients from the soils in the current changing climate scenario. Integrated nutrients management (INM) in arid and semiarid climates increase soil fertility and health, increase crop productivity and grower's income. INM refers to the maintenance of soil fertility and improvement in crop productivity with application of plant nutrients through combined application of organic manures, chemical fertilizers and bio-fertilizers (beneficial microbes). Bio-fertilizers are the products containing living cells of different types of beneficial microbes (bacteria, fungi, protozoa, algae and viruses). Some of the commonly used beneficial microbes in agriculture include Rhizobia, Mycorrhizae, Azospirillum, Bacillus, Pseudomonas, Trichoderma, Streptomyces species etc. Beneficial microbes are essential for decomposing organic matter in the soil and increase essential macro-nutrients (nitrogen, phosphorus, potassium, sulfur, calcium and magnesium) and micro-nutrients (boron, copper, chlorine, iron, manganese, molybdenum and zinc) availability to crop plants. Beneficial microbes also play significant role in solid wastes and sewage management. Beneficial microbes increase plants tolerance to different environmental stresses (drought, heat, cold, salinity etc.) and increase plant resistance to insects and diseases attacks. Beneficial microbes not only improve crop growth and productivity by increasing photosynthesis and producing hormones and enzymes, but also improve crop quality by controlling different insects and various plant diseases. Beneficial microbes reduce the use of chemical fertilizers and thereby reduce environmental pollution caused by chemical fertilizers. Beneficial microbes reduce cost of production and so increase grower's income and profitability. Beneficial microbes are therefore very important for increasing crop productivity, profitability and sustainability. Applications of organic manures such as crop residues, animal manures, chicken manures, green manures, composts, farm yard manure, biochar, ash etc. increases the beneficial microbes in the soil and improves soil health and sustainability. Our long-term field experiments on field crops e.g. cereals crops (rice, wheat & maize), oilseed crops (canola, sunflower & soybean) and grain legumes/pulses (chickpea, mungbean & mashbean) confirmed a significant increase in yield per unit area with integrated nutrients management under semiarid climate in Peshawar Valley. The combined application of plant nutrients especially major nutrients (nitrogen, phosphorus and potash) along with different organic sources (farmyard manure; animal manures: poultry manure, cattle manure, sheep manure, goat manure etc.; plant residues: onion residues, garlic residues, wheat residues, rice residues, chickpea residues, fababean residues, canola residues, peach residues, paper mulberry residues etc.) into the soil plus application of beneficial microbes had significantly improved crop growth and increased productivity and growers income.

# NATIONAL MICROBIAL CULTURE COLLECTION ACTIVITIES OF PARC, PAKISTAN AND THE DESCRIPTION OF SEVERAL NOVEL SPECIES OF BACTERIA FROM PAKISTANI ECOLOGY

Iftikhar Ahmed[1*], Ahmad Ali[1], Saira Abbas[2]

[1] National Culture Collection of Pakistan (NCCP), Bio-resources Conservation Institute (BCI), National Agricultural Research Center (NARC) Islamabad, Pakistan,
[2] Department of Zoology, University of Science and Technology, Bannu, Pakistan.
* Email: i f t i k h a r n a r c @ h o t m a i l . c o m

**ABSTRACT**

The importance of microbes in biotechnological, agricultural and industrial applications has pushed many Institutes to collect the indigenous beneficial microbes from various ecological zones of Pakistan. Among these, the most common examples are the strains with plant growth promoting activity to be used as biofertilizer; strains for bio-remediation of heavy-metals polluted soils/water systems; pathogenic strains of bacterial blight from rice ecology and citrus canker; and other extremophilic (i.e. NaCl tolerant) strains for biotechnology. However, very few of these microbes have been truly identified at species level based upon 16S rRNA gene sequence. Most of the strains collected by various labs were either stocked in glycerol as un-identified strains or abolished with time due to contamination or loss of interest of researchers at end of the project. In spite of untiring efforts by researchers at various Pakistani Institutes, there is rare example of new species of bacteria published from the rich ecology of Pakistan since long. There was a big challenge to validate any novel species from Pakistani ecology because the systematic efforts have not been made to recognize the strains at national and/or international level based upon scientific background and molecular tagging (gene sequence). Major reasons include lack of specialized equipments for chemotaxonomic analyses as well as expertise required for validation of any novel species. Under the prevailing regime of Nagoya Protocol, identification of own validated microbes in any country is direly needed to meet the demand of their researchers, students, industry and farmers. However, in Pakistan, long term preservation of microbes is a neglected subject. Recently, Pakistan Agricultural Research Council (PARC) took an initiative to start working on identification and preservation of economically important bacterial strains from Pakistani ecology. In this regard, PARC established microbial bio-resources repository: National Culture Collection of Pakistan (NCCP) for preservation of this bio-asset of Pakistan. Microbial Culture Collection Centre is essential to harness the benefits of preserved microbial resources for basic and applied microbiology and biotechnology research. During our studies for collection and preservation of indigenous beneficial strains from Pakistani ecology, many promising novel candidate strains were identified based upon 16S rRNA gene sequencing, which can be delineated as novel species. However, many chemotaxonomic experiments need specialized equipments. Unfortunately, such modern techniques/equipments were not present in any lab in Pakistan. Under the scenario, collaboration linkages were developed with JCM, Riken, Japan, CAS, China and KCTC, KRIBB, Korea to delineate our candidate strains as novel species. It is first time in the history of Pakistan, that a productive collaboration made it possible to validate the following several novel species of bacteria from Pakistani ecology:

- **Cellulomonas pakistanensis sp. nov., (validated – 2014);**
- **Sphingobacterium pakistanensis sp. nov., (validated – 2014);**
- **Bacillus pakistanensis sp. nov., (validated – 2014);**
- **Lysinibacillus pakistanensis sp. nov., (validated – 2014);**
- **Lysinibacillus composti sp. nov., (validated – 2014);**
- **Deinococcus citri sp. nov., (validated – 2014);**
- **Acinetobacter pakistanensis sp. nov., (validated – 2015);**
- **Kushneria pakistanensis sp. nov., (validated – 2015);**
- **Alcaligenes pakistanensis sp. nov., (validated – 2016);**
- **Bacillus malikii sp. nov. (validated – 2016)**
- **Nocardioides pakistanensis sp. nov., (validated – 2016);**
- **Microvirga pakistanensis sp. nov., (published – 2016, validated – 2017);**
- **Streptomyces caldifontis sp. nov., (validated – 2017);**
- **Thermus caldifontis sp. nov., (validated – 2017);**
- **Nocardioides thalensis sp. nov., (validated – 2017);**
- **Phenylobacterium deserti sp. nov., (validated – 2017)**
- Novel genus **Caldovatus sediminis gen. nov., sp. nov. (validated – 2017)**
- **Tepidimonas sediminis sp. nov. (published – 2017 and validated – 2018)**
- **Tepidimonas alkaliphilus sp. nov., (published – 2017 and validated – 2018)**
- **Phenylobacterium tarrae sp. nov., (published and validated – 2018)**
- **Arthrobacter zafarii sp. nov. (under review process – 2019)**

Our goal is to collect many more strains from various Institutes for identification and preservation in NCCP. Since, identification and systematics of bacteria have not been extensively included in the main applied microbiological research work in Pakistan, therefore, this rich bio-asset offers an opportunity to explore many novel species of bacteria by identification, poly-phasic characterization and thus to preserve in National Culture Collection of Pakistan (NCCP), which is the ultimate goal of PARC project. This Centre will provide the biological cultures, technical services and guidance to the benefit of its partners and clients in food and agriculture, scientific and industrial communities such as farmers, private industry and researchers.

# ROLE OF RHIZOBIUM STRAINS FOR SUSTAINABLE CROP PRODUCTION

Shazia Erum[1], Arifa khan[2], Asghari Bano[3] and Sadar uddin Siddiqui[1]

[1]Bio Resources Conservation Institute, National Agriculture Research Center, Islamabad
[2] International Islamic University, Islamabad,
[3]University of Wah BioSciences, Wah Cant, Pakistan
**Email: serum2011@gmail.com**

**ABSTRACT**

Biotic and abiotic stresses are the major threats for agricultural production. To overcome these challenges microbes are an efficient tool for sustainable crop production and to scrap with future challenges. In the present study beneficial microbial strains was isolated from diverse ecological zones of northern areas of Pakistan. Phenotypic and biochemical characterization of isolates were carried out by quick (QTS-24 test) miniatured testing system after purification of bacterial colonies on yeast mannitol agar medium. Phytohormone production ability of the selected strains was also examined. Our results showed that highest level of phytohormone production was observed in the isolates from Naran, showing the pattern of QTS-24 test different from other isolates. A significant constructive correlation was established between altitude and growth hormone ($GA_3$) vs. indole acetic acid ratio (GA/IAA). Promising effects of Rhizobium inoculation were obtained on soybean (Glycine max) plants grown in sterilized soil. The maximum increase in biomass and the greater number of nodules were obtained in the Rhizobium isolates from Shinkyari as compared to that of higher altitudes. It is concluded that strain isolated from Naran was most effective strains and can be used as a bio-fertilizer for sustainable agricultural production.

# MICROBIOME A POTENTIAL BARRIER AGAINST VARIOUS HEALTH DISORDERS

Muhammad Suhail Ibrahim*[1], Asif Ahmad[1], Asma Sohail[1], Muhammad Javaid Asad[2], Amer mumtaz[3], Muhammad Nadeem[4]

[1.] Institute of Food and Nutritional Sciences PMAS- Arid Agriculture University Rawalpindi, Pakistan
[2.] University Institute of Biochemistry and biotechnology PMAS- Arid Agriculture University Rawalpindi, Pakistan
[3.] Food Science Research Institute NARC, Islamabad
[4.] Institute of Food Science and Nutrition University of Sargodha
**Email: Choudhary.mohammad@hotmail.com**

**ABSTRACT**

Fructose lysine millard reaction product formed in processed food. When ingested in larger quantities impart hazardous effects on human health in term of immunity disorder, inflammation, aging ultimately carcinogenicity. But nature has equipped the life with some minute entities naturally present in gastrointestinal tract to eradicate these hazardous toxin produced during food processing. Bacteria are the most prominent organism work for eradication of these toxins from body by metabolizing this toxin into non harmful eradicateable compounds. These microbes encode about 3 million genes producing various metabolites regulates various body functions and ultimately affect host phenotype health and fitness. These beneficial microorganisms are termed as probiotics. Bafidiobacterium and bacteria from lactobacillus species when included in the diet impart potential health benefits by immunomodulation and bioactive production. Emerging trend is to use these beneficial microbes individually or in combination producing synergistic effect. Non digestible carbohydrate referred as prebiotic improve the growth and efficacy of Bifidobacterium adolescentis, Ruminococcus bromii, and Eubacterium rectale. Low fiber diet cause microbial encroachment by degrading colonial mucous barrier. This increase pathogenic susceptibility and inflammation providing a potential mechanism for development of chronic disorders. Probiotic prevents Clostridium difficile associated diarrhoea in adults and children, Necrotising enterocolitis cause mortality in infants, antibiotic associated diarrhea, eczema in infants and children, nosocomial infections, Crohn's disease and ulcerative colitis, Pulmonary exacerbations in children with cystic fibrosis, Necrotising enterocolitis in pre-term neonates, Reduction of serum concentration of C reactive protein, Cardiovascular risk factors in patients with type 2 diabetes, Reduction of total cholesterol and low density lipoprotein cholesterol, anxiety, Vulvovaginal candidiasis in non-pregnant women and Chronic periodontitis. Modification of health through intake is the modern innovation in human nutrition. Gut microbiota interaction with drug and food highly emphasized in term of eradication of toxins and unnecessary metabolites that affect the health adversely. Randomized controlled studies are needed to study the clinical effect of the gut beneficial microbiota and fecal transplanted microbiomes.

# VERMIWASH: PHYSIOCHEMICAL AND MICROBIOLOGICAL APPROACH AS ECOFRIENDLY SOIL CONDITIONER

Mukhtiar Ali[1], Sidra Safdar[1]*, and Roshan Ali[2]

[1]Department of Wildlife & Ecology University of Veterinary & Animal Sciences Lahore
[2]Agriculture Research Institute Swat Pakistan
Email: **roshan311@yahoo.com**

**ABSTRACT**

The continuous use of chemical fertilizer is leading to contamination of soil and adversely affect the flora and fauna. Look out for natural forms of fertilizer is unceasing. The use of organic manures and fertilizers which are of biological origin is one of the important practices in agriculture. One among them is vermiwash which is liquid plant growth promoter that is known to bring about growth enhancement in a wide variety of plants. Vermiwash is a brown coloured, odorless, liquid bio fertilizer, which is collected after passes via column of worm culture. It is considered as storehouse of nutrients and microorganisms, used as foliar spray for crops. The present work was carried out to study the microbiological and physico-chemical analysis of vermiwash of Eisenia foetida. The vermiwash set up is made in a pot. Pre-decomposed municipal wastes along with cow dung (1:1 ratio) are filled in pot and composted with E. foetida. The vermiwash is collected at every 5 days intervals upto 15 days and it is subjected to various assays. Microbiological studies of vermiwash revealed the presence of higher number of bacteria, actinomycetes and fungus such as Acromobacter (1.023×103), Azatobacter (1.04×103 ) Bacillus baccilli (1×103 ), Bacillus subtillus (1.05×103), Micrococcus sp (1.02×103), Pseudomonas sp (2×103),Actinomycetes(1.24×103) and Fungus (1.8×103) CFU/ml. Nutrients such as nitrogen, phosphorous, potassium, sodium, iron, zinc and manganese were found in significant amount due to the earthworm activity.

# ECONOMICAL AND SUSTAINABLE UTILIZATION OF DIFFERENT AGRO-INDUSTRIAL WASTES FOR PRODUCTION OF BACTERIAL MALTASE

Muhammad Asif Nawaz[1,*], Sidra Pervez[2], Shah Ali Ul Qader[3]

[1]Department of Biotechnology, Shaheed Benazir Bhutto University, Sheringal, Dir Upper, KPK, Pakistan
[2] Department of Biotechnology, Women University Mardan, KPK, Pakistan
[3]The Karachi Institute of Biotechnology and Genetic Engineering (KIBGE), University of Karachi, Karachi-75270, Pakistan
**Corresponding author* asif_biotech33@sbbu.edu.pk**

**ABSTRACT**

The biodegradable agro-industrial wastes are mostly considered as potential sustainable source for the production of various value-added products from microbial species. Due to easy availability and economical profitability, agro-industrial wastes are preferred for large-scale production of enzymes and also to improve microbial cell growth. The hydrolytic enzymes can selectively hydrolyze the internal linkages of complex carbohydrates to release glucose moieties which can be further utilized in different industrial bioprocess. In the current study, sweet potato peel (Ipomoea batatas) was observed as the most favorable substrate for the maximum synthesis of α-1, 4-glucosidase among various agro-industrial wastes. Bacillus licheniformis KIBGE-IB4 produced maximum quantity of α-1, 4-glucosidase when growth medium was supplemented with 1% substrate. It was evident from the results that bacterial isolate secreted high titer of α-1,4-glucosidase in the presence of peptone, yeast extract and meat extract with optimum concentration of 0.4%, 0.1% and 0.4% respectively. Bacillus licheniformis KIBGE-IB4 revealed maximum enzyme productivity at 40°C and pH-7.0 after 48 hours of fermentation period. An improved and cost-effective growth medium design resulted 570.63±28.53 U $mg^{-1}$ of α-1,4-glucosidase from B. licheniformis KIBGE-IB4. This enzyme can be used to fulfill the accelerating demand of food and pharmaceutical industries.

# IDENTIFICATION AND CHARACTERIZATION OF RHIZOSPHERIC BACTERIA FROM WHEAT FIELDS UNDER DIFFERENT CROP ROTATION SYSTEM FOR THE POTENTIAL BIOFERTILIZERS, BIOINOCULANTS AND INDUSTRIALLY IMPORTANT ENZYMES PRODUCTION

Aqib Iqbal, Saqlain Jehan and Irfanullah

Institute of Biotechnology and Genetic Engineering,
The university of Agriculture Peshawar
**Email: aqib72@aup.edu.pk**

**ABSTRACT**

Exploiting Plant-microbiome interaction is increasingly considered necessary to develop a sustainable agriculture resilient to climatic changes. Selectively manipulating plant root microbiome with bacterial isolates could substantially benefit plant production and adaptation to varied environmental conditions. The bacterial isolates from wheat fields under different crop rotation systems were isolated and characterized for plant growth promotion and biofertilizer potential. The 16S ribosomal RNA sequencing showed that the isolates belonged to the genus Bacillus (B. subtilis, B. megaterium, B. methylotropicus or B. cereus), Pseudomonas, Serratia, Lelliottia or Acinetobacter. Forty-eight (48) isolates produced indole acetic acid (IAA), 23 could solubilize phosphorus, 17 could solubilize potassium and 25 isolates assimilated nitrogen. The highest IAA production (29.14µg·ml$^{-1}$), phosphorus and potassium solubilization indices (3.50 and 8.20, respectively) was obtained by the isolate SS72. These bacterial isolates also exhibited the potential of micronutrient assimilation and significantly promoted plant growth under greenhouse conditions. Furthermore, 12 isolates were able to maintain growth under heavy metal stress offering an opportunity to use them as inoculants for the bioremediation or assisted phytoremediation of contaminated soils. Similarly, the enzyme kinetics of extra-cellular amylase of these isolates was also determined which exhibited variation in $V_{max}$, $K_M$ and $K_{cat}$ values, signifying the potential of producing industrially important enzymes.

# PLANT-MICROBE INTERACTION PROMOTES GROWTH AND TOLERANCE IN BRASSICA NAPUS UNDER CADMIUM STRESS

Hala Rajab, Atta Ullah Shah, Muhammad Sayyar Khan

Institute of Biotechnology and Genetic Engineering, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan
Email: **halarajab202@gmail.com**

**ABSTRACT**

Microorganisms are abundant in the root zone (rhizosphere) as well as on and in the plant and their power of the symbiotic relation can enhance plant growth, nutrient acquisition and abiotic and biotic stress resistance via the production of plant hormones, nutrient solubilising compounds, antimicrobial or antifungal compounds. In the present study, the potential of an endophytic bacterial strain i.e., Serratia sp. IU01, in terms of cadmium detoxification and plant growth promotion was evaluated. A significant increase in the biomass of two genotypes of Brassica napus L. exposed to different concentrations of cadmium was observed after three weeks inoculation with Serratia sp. IU01 compared to sole cadmium (Cd) treated plants. The steady-state levels of the major antioxidant glutathione (GSH) increased significantly in the sole Cd treated plants compared to untreated plants. However, the inoculated plants treated with Cd showed significant reduction in GSH. This demonstrated that endophytes played a major role in reducing the oxidative stress under Cd stress. Cysteine, the GSH precursor, also showed similar levels in plants treated with Cd alone. Our results suggested that B. napus inoculated with Serratia provide physiological advantage under Cd stress in terms of promoting plant growth and reducing Cd toxicity in the plant.

# MOLECULAR AND BIOCHEMICAL CHARACTERIZATION OF BACTERIAL ISOLATES FROM RHIZOSPHERIC SOIL FOR POTASSIUM AND PHOSPHORUS SOLUBLIZATION

Mian Afaq Ahmad, Murad Ali, Bashir Ahmad and Iqbal Munir

Institute of Biotechnology and Genetic Engineering, The University of Agriculture, Peshawar.
**Email: mianafaq@aup.edu.pk**

**ABSTRACT**

The application of synthetic fertilizer in modern agriculture is a common practice; however, it has serious impact on biodiversity and surrounding environment. The current research focuses on the use of alternative and sustainable approach to improve crop productivity using non-hazardous and sustainable approach such as biofertilizer. For this, soil samples were collected from lower Dir regions and a total of 74 bacterial colonies were isolated from rhizospheric soil for its potential to K, P, and Zn solubilization. Biochemical and molecular characterization revealed 17, 22 and 24 colonies capable of solubilize potassium, phosphorus, zinc respectively. The screened bacterial colonies showed 2.9, 2.5 and 3.4 mm solubilization index for K, P and Zn respectively. In terms of IAA production, only 20 isolates showed positive results ranging from 4.74 to 23.19 µl-mg-1. The sequencing analyses of 18 top performing microbial colonies, using 16S ribosomal RNA categorized these colonies into 8 different classes i.e. 4 belong to Klebsiella pneumoniae and Pseudomonas aeruginosa. While 4 representing Acinebacter calcoaceticus, 4 belong to Pseudomonas sp along with Bacillus megaterium, 2 strain each representing Pseudomonas fluorescens, Pseudomonas lurida and 3 showed resemblance with Bacillus sp. These isolates will further be studied for its potential to be used as commercial fertilizer and improve soil and plant nutrient status for sustainable development. Moreover, these bacterial isolates may also be studied for their potential against various biotic and abiotic stresses.

# POPULATION GENETICS AND GENOMICS TOOLS FOR DECIPHERING DIVERSITY AND DIVERGENCE IN MICROORGANISMS – BOTH BENEFICIAL AND PATHOGENIC SPECIES

Sajid Ali*1, Muhammad Rameez Khan1, Aamir Iqbal1, Zia-Ur-Rehman1, Safi Shinwari1, Laila Jamshed1, Muhammad Imtiaz2 and Iqbal Munir1

1 Institute of Biotechnology and Genetic Engineering, the University of Agriculture, Peshawar, Pakistan
2 International Maize and Wheat Improvement Center (CIMMYT), Islamabad, Pakistan
***Email: bioscientist122@yahoo.com**

**ABSTRACT**

Microbial species represents a diverse niche in the global ecosystem with direct implications for human interest either in the form of pathogens of crops, livestock or humans, or being beneficial to our food production systems. Deciphering the population biology of these microorganisms is thus of utmost importance to gauge their adaptation potential and evolution, which are directly linked with their commercial exploitation and management strategies. We describe the analyses framework for population genetics and genomics tools to understand the microbial population diversity and divergence, revealing their adaptation potential. The fist step involves defining a sampling strategy to conduct surveillance in space and time, followed by molecular genotyping with various genetic and genomic tools, and finally carrying out population genetic analyses. The analyses are oriented towards the questions to be answered, but mainly involves assessment of diversity parameters, spatial population subdivision, role of host (plant, animal or human) and any other pattern of interest. Our research work on the crop pathogenic fungal microorganisms, Puccinia striiformis revealed a high diversity and lack of spatial population structuring based on a collection of more than 2000 samples. The pathogen population subdivision reflected on the spatial dispersal of the pathogen across the country. An extended study involving samples from Nepal and Bhutan revealed the existence of spatial population structure at the countries level, though with some across country migration. The analyses of role of host revealed the presence of divergent pathogen lineages on the same host variety across multiple locations, revealing a lack of host-dependent structure. This lack of host dependent structure was revealed in the citrus canker bacteria Xanthomonas citri for a small collection of isolates from district Peshawar. Our analyses framework could be extended to any microbial population, whether beneficial or crop pathogenic, while the results from our work has direct implications to crop disease management.

# APPLICATION OF MICROORGANISM FOR WEEDS CONTROL

Aman Khan and Muhammad Azim Khan

Department of Weed Science, University of Agriculture, Peshawar
**Email: itsamansafi@gmail.com**

**ABSTRACT**

The increasing of both prevalence of both herbicides resistance weeds has created a strong imputes to develop novels strategies for controlling weeds. Bacteria fungi viruses to achieving these goals have to received increasingly great attention over the last three decades. Proposed benefits to this strategy include reduced environmental impact. Increased target specificity; reduced development cost compared to conventional herbicides and the identification of novel herbicidal mechanism. Fungi the prominent genera to receive attention as bioherbicide candidates include colletotrichum. Phoma and Sclerotinia Bacteria Xanthomonas and Psedudomonas share this distinction Allelopthic bacteria encompass those rhizobacteria that colonize the surface of plant roots produce and release phytotoxic metabolized similar to allelochemicals that detrimentally affects growth of plants. This group of bacteria to agriculture could contributing to biological weed management system that we have less impact on environmental than conventional system by reducing inputs of herbicides.

# THE ROLE OF ZINC SOLUBILIZING BACTERIA IN BIOFORTIFICATION OF WHEAT

Shah Khalid and Dr. Amanullah

Department of Agronomy,
The University of Agriculture, Peshawar, Pakistan
**Email: khalidmashaal@aup.edu.pk**

**ABSTRACT**

Bioaugmentation of Zn solubilizing bacteria could be a sustainable intervention to increase bioavailability of Zn in soil which can be helpful in mitigation of yield loss and malnutrition of zinc. Zinc (Zn) is one of the most important micronutrients essential for optimum plant growth, owing to alkaline conditions, the substantial quantity of applied inorganic Zn in soil is converted into unavailable form. To overcome zinc deficiency, use of zinc solubilizing bacteria has been a promising alternative for enhancing zinc availability in soil and thereby improving zinc assimilation in seeds while maintaining crop yield. A study on Zinc solubilizing bacteria and chemical Zn fertilizer ($ZnSO_4.7H_2O$) was conducted to evaluate their potential to augment Zn nutrition. These five isolates when used individually or in combination were found effective in significantly increasing the mean dry matter yield, productive tillers$^{-1}$, number of spike m$^{-1}$, number of grains spike$^{-1}$, grain yield and straw yield over the control. Bacterial inoculations significantly enhanced the total Zn uptake as well as grain Zn concentration. This study indicated that inoculation of Zn solubilizing strains has potential to promote growth and can be the potential bio-inoculants for biofortification of wheat to overcome the problems of malnutrition.

# SOIL APPLICATION OF TRICHODERMA AND PEACH (PRUNUS PERSICA L.) RESIDUES POSSESSES BIOCONTROL POTENTIAL FOR WEEDS AND ENHANCES GROWTH AND PROFITABILITY OF SOYBEAN (GLYCINE MAX)

Imran* and Amanullah

[1]Department of Agronomy, the University of Agriculture, Peshawar
***Email: imranagrarian@aup.edu.pk**

**ABSTRACT**

Weed is a limiting factor to various economically important agricultural crops including cereal, oil seed, legumes and cash crops. Minimizing pest losses in addition to better crop management is a way toward narrowing the yield gap and ensuring food security. The present study was carried out to investigate the impact of peach (Prunus persica L.) residues and soil application of Trichoderma (soft-rot fungi) along with seed inoculation of phosphate solubilizing bacteria (PSB) (Pseudomonas) and phosphorus (P) on weeds frequency, and biomass at various growth stages of soybean and its yield contributing parameters. The consecutive field experiments for years 2016 and 2017 using randomized complete block design (RCBD) were conducted on soybean (cv. Malakand-96) crop. Experimental treatments included three organic sources, three phosphate rates and two beneficial microbes. Weeds found during the whole growing period of soybean crop were Euphorbia heterophylla L, Phyllanthus fraternus L., Portulaca oleracea L., Parthenium hysterophorus L., IPomoea nil L., Erigeron canadensis L., Echinochloa crus-galli L., Asparagus officinalis L., Cynodon dactylon L., Digera muricata L., Cyprus rotundus L. and Solanum nigrum L. The most abundant and flourished weeds were Cyprus rotundus L, and Cynodon dactylon. Results revealed that peach organic sources (biochar) and Trichoderma drastically reduced weeds frequency, weeds biomass at flowering, pods formation and physiological maturity stages. However P highest and moderate (100 and 75 kg P $ha^{-1}$) rates were remained the same for weeds biomass. When compared with the economic analysis and profitability of soybean the highest net returns (NR) in Pakistani Rupees (PKRs) (PKR 62.082 $ha^{-1}$) were noted with the biochar amendment followed by compost (PKR 60,168 $ha^{-1}$), whereas least net return NR (PKR 41,548 $ha^{-1}$) was recorded with peach residues incorporation. The value cost ratio (VCR) was highest with compost application (5.48) among the organic sources followed by biochar (5.37), while the least VCR value (4.67) was observed with peach residues. Beneficial microbe's application indicated that highest NR (PKR 67,453 $ha^{-1}$) were attained with soil application of Trichoderma followed by seed inoculation of PSB (PKR 62,695 $ha^{-1}$). When compared the average VCR of both years, greater VCR was attained by Trichoderma followed by PSB.

# INOCULATION WITH PGPB PROTEOBACTERIA BUKHOLADERIA PHYTOFIRMANS MITIGATES NEGATIVE CONSEQUENCES OF DROUGHT IN WHEAT (TRITICUM AESTIVUM L.) BY IMPROVING PHYSIOLOGICAL AND BIOCHEMICAL ASPECTS

[1]Malik Ghulam Asghar*, [2]Ayesha Ifitikhar, [1]Muhammad Jahanzaib Shafi, [1]Muhammad Nadeem Shah and [3]Ahmad Raza.

[1]Department of Agronomy, Bahauddin Zakariya University Multan, Pakistan
[2]Department of Soil Science, Bahauddin Zakariya University Multan, Pakistan
[3]Department of Agronomy, University of Agriculture, Pakistan
***Email: gh.asghar@hotmail.com**

**ABSTRACT**

Pakistan ranks seventh among the most susceptible states to the climatic variations. Due to climate change, incidences of weather extremes have increased like drought and temperature stress in terms of duration, frequency and extent. Drought stress greatly inhibits physiological processes of plants. Wheat is grown as staple crop; its yield fluctuates due to abiotic stresses. The adaptation of conservational techniques like inoculation of grains with plant growth promoting bacteria (PGPB) can be among one of the climate change mitigation approaches. To investigate the effectiveness of PGPB Burkholderia phytofirmans in drought stress amelioration of wheat, a field experiment was designed at Department of Soil Science, Bahauddin Zakariya University Multan Pakistan, during two consecutive years, 2017-18 and 2018-19. The experiment was arranged in RCBD split-plot having main factor uninoculated and inoculated grains, while sub-plot factor was three irrigation regimes that were normal irrigations, drought stress at vegetative stage and drought stress at reproductive stage. The wheat variety Galaxy-2013 was used as test crop. The pooled data of both years represented significant variations among treatments. Drought stress at reproductive stage severely affected morpho-physiological and biochemical aspects of wheat. Inoculation of wheat grains with PGPB mitigated negative drought consequences by improving stomatal conductance, transpiration rate, relative water contents (RWC), chlorophyll a and b and water use efficiency (WUE). The enzymatic antioxidants, catalase (CAT), peroxidase (POD) and superoxide dismutase (SOD) as well as non-enzymatic antioxidants, total phenolic content (TPC) and ascorbic acid (AsA) were also improved in drought stress under inoculated treatment. The data during both years showed improvement in wheat grain yield by 23 and 18%. The results suggested that inoculation of wheat with Burkholderia phytofirmans could be used successfully to enhance grain yield under normal as well as drought stress conditions.

# RESPONSE OF SOIL MICROBIAL BIODIVERSITY TO ENVIRONMENTAL STRESSES AND ITS IMPLICATIONS IN SUSTAINABLE AGRICULTURE

Dr. Noshin Ilyas

Assistant Professor, Department of Botany
PMAS Arid Agriculture University Rawalpindi
**Email:** noshinilyas@uaar.edu.pk

**ABSTRACT**

Soil microbial diversity is a key indicator of soil health and fertility. The main drivers of soil ecosystems include plant and soil type and all factors are governed by environmental conditions. There is a dire need to explore beneficial microbial responses for managing the risks to sustainable agriculture in an environment threatened by climate change. Soil is a limited resource and environmental stresses are decreasing agricultural productivity day by day. To check the effect of environmental stresses like drought, salinity, and heavy metal on soil microbial biodiversity and testing the efficacy of tolerant Plant growth Promoting Rhizobacteria alone and in combination with effective soil amendment techniques for improving plants growth under predicted abiotic stresses of climatic change. Experiments were conducted to isolate and characterize stress tolerant Rhizobacteria, and to check their stress mitigation potential. Modified plant biomasses like compost, biochar, and bio-organic fertilizer were used as soil amendments techniques. Various morphological, physiological, biochemical, growth and productivity parameters were studied. Microbial strains were isolated from the stressed region. The identification of isolated microbial strains was carried out by physiochemical and 16s rDNA sequencing and phylogenetic analysis. Stress tolerance and different plant growth-promoting traits of isolated strains were evaluated under normal as well as in stress condition. Inoculation of seeds with PGPR along with compost, biochar and bio-organic fertilizer improved all growth and productivity parameters, increased nutrient status and improved osmolyte production and hence helped the survival and growth under stress conditions. Microorganisms have a variety of evolutionary adaptations and physiological acclimation mechanisms that allow them to survive and remain active in the face of environmental stress. Building our understanding of the interdependence of micro-organism communities, environmental stresses and plant responses will be important for understanding climatic effects on soil health and plant growth. Our new understanding of microbial diversity in response to environmental stresses will allow us to cure and conserve our environment and grow more food.

# MICROBIAL INTERACTION WITH EDIBLE AND NON-EDIBLE PLANTS AND ITS ROLE IN PHYTOREMEDIATION OF METAL CONTAMINATED SOILS

Rizwan Ahmad*, Matiullah Khan, Muhammad Mahmood-ul-Hassan and Taqi Raza

Land Resources Research Institute, Islamabad, Pakistan
**Email: rizwan_narc@yahoo.co.in**

**ABSTRACT**

Heavy metal accumulation in environment due to different anthropogenic processes is a global concern. Phytoremediation: use of plants and associated microbes to clean the environment is getting tremendous importance. A series of pot experiments was conducted on maize, sunflower rapeseed crops and floricultural plants to evaluate phytoremediation potential of bacterial inoculation. Heavy metal tolerant bacteria isolated from metal contaminated sites and screened against Cr, Cd and Cu were used for inoculation and all plants were grown in metal contaminated soil under green house conditions. Results showed that bacterial inoculation enhanced uptake of Cr, Cd and Cu from 30-130% in maize, 60-80% in rapeseed and 90-120% in sunflower compared to un-inoculated treatments. Crop growth was also improved over un-inoculated control by metal tolerant bacteria possessing plant growth promoting ability. Similar results were also obtained on non-eatable floricultural plants. It was concluded that bacterial inoculation can effectively be used for phytoremediation of contaminated soil as well as crop improvement. Moreover, growing of non-edible floricultural plants during phytoremediation process is a best alternate approach with additional monetary and aesthetic advantages. It is suggested that understanding suitable plant–microbe interaction will further improve phytoremediation for sustainable agriculture and environment. Further exploration of suitable plant–microbe interaction and alternate non-edible crops is the dire need of the day for better phytoremediation and sustainable environment.

# APPRAISAL OF PHOSPHORUS COMPETENCES AND SOIL PHOSPHORUS IN SOYBEAN VS MAIZE CROPS UNDER THE COMBINATION OF PEACH (PRUNUS PERSICA L) CARBON SOURCES, BENEFICIAL MICROBES AND INORGANIC PHOSPHORUS

Imran[1, 2] and Amanullah[1],

[1]Department of Agronomy, the University of Agriculture Peshawar, Pakistan
[2]Department of Agriculture, Hazara University Mansehra KP, Pakistan
*Email: **imranagrarian@aup.edu.pk**

**ABSTRACT**

For sustainability, use of different sources and forms of organic sources with inorganic P and beneficial microbes improve soil productivity. Separate experiments (maize and soybean) were conducted for the first time to utilize peach leftovers and biomass (leaves, twigs, fruits, stones and barks partially decomposed, its compost and biochar) along with three phosphorus (P) levels (50, 75, 100 kg P $ha^{-1}$) and two beneficial microbes (PSB and Trichoderma) to enhance soil sustainability and P use efficiency of soybean and maize. PUE in both crops (soybean and maize) was maximum (25.6 & 28.4%) with peach biochar than compost and residues along with Trichoderma (21.7 & 27.8%). Highest PUE in soybean was recorded with 75 kg P $ha^{-1}$(22.2%) however in maize maximum PUE was noted with 50 kg P $ha^{-1}$(33.5%). In soybean experiment, peach residues increased soil P (12.0 mg $kg^{-1}$) as compared to peach compost and biochar (8.6 & 11.7 mg $kg^{-1}$). Soil P concentration was maximum (12.1 mg $kg^{-1}$) with PSB than Trichoderma (9.5 mg $kg^{-1}$). Application of P at 100 kg $ha^{-1}$increased soil P contents (16.9 mg $kg^{-1}$) as compared to 50 and 75 kg P $ha^{-1}$ (5.9 & 9.6 mg $kg^{-1}$) respectively. P concentration was increased drastically in year 2 (12.4 mg $kg^{-1}$) than year one (9.1 mg $kg^{-1}$). Conclusively soybean and maize PAE, PFPp and PUE was higher with biochar, soil incorporation of Trichoderma and P at the rate of 75 kg $ha^{-1}$ and can improve soybean and maize yield and soil productivity on sustainable basis.

# BIOSYNTHESIS AND BIOLOGICAL EFFECTS OF ZANTHOXYLUM ARMATUM DC FRUIT NANOPARTICLES

Sumira Yasmin[1], Muhammad Ibrar[1] and Muhammad Adnan[1]

[1]Department of Botany University of Peshawar, Peshawar, Khyber Pakhtunkhwa, Pakistan
[1]Department of Botanical and Environmental sciences, Kohat University of Science & Technology Kohat-26000, Khyber pakhtunkhwa, Pakistan
**Email: sumirakhan11bot@gmail.com**

**ABSTRACT**

Present study is about Zanthoxylum armatum belonging to family Rutaceae and comprises biosynthesis and biological effects of nanoparticles of fruit of this plant. Results of phytochemical screening of Z.armatum fruit showed presence of carbohydrates, proteins, alkaloids, volatile oils, fixed oils .The crude ethanolic extract of the fruit was evaluated for the formation and characterization of nanoparticles. The characterization techniques such as UV Spectrophotometry, Scanning Electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR), confirmed the presence of stable Au nanoparticles in the fruit of Z. armatum.This study further showed that Z.armatum is a valuable medicinal plant due the presence of nanoparticles which have lots of biological applications. Biological activities of the plant such are phytotoxic, cytotoxic and antioxidant activities were also carried out. Fruit Ethanolic extract and Au nanoparticles showed highly significant cytotoxic, phytotoxic and antioxidant activities. Z.armatum fruit have lesser LD50 values suggesting that some active cytotoxic constituents might be present in this valuable plant. The ZFE scavenging values are greater than the scavenging values of ZFN. These results suggest that ZFE is more antioxidant than ZFN. Both ZFE and ZFN showed excellent percent inhibition 1000µg/ml dose with $FI_{50}$ values of 4.67 and 11.72 µg/ml respectively. These results suggest that the fruit of Z.armatum have some active principles with phytotoxic potential and Z. armatum can be a good herbicides or weedicides.

# BIOCONTROL ACTIVITIES OF SACCHAROTHRIX ALGERIENSIS NRRL B-24137 TOWARDS FUSARIUM OXYSPORUM A CAUSATIVE AGENT OF COTTON WILT DISEASE

Rizwan Asif[1] Saima Muzammil[1], Muhammad Hussnain Siddique[1], Muhammad Hidayat Rasool[1], Muhammad Waseem[1]

Department of Microbiology, Government College University Faisalabad, Pakistan
**Email: asifrizwan429@yahoo.com**

**ABSTRACT**

Cotton, (Gossypium hirsutum) is one of the most important crops for human being and playing a major role in the world's economy. Several diseases of cotton are well recognized but fusarium wilt is one of most devastating disease of cotton. Cotton wilt caused by Fusarium oxysporum f. sp. visinfectum leads to severe economic losses. Various chemicals are used to control the wilt disease. But, it may danger to nature and humans. Because of recent community fear, the use of plant growth promoting rhizobacteria is a better substitute to resolve this problem. In the present research, the potential of Saccharothrix algeriensis NRRL B-24137 PGPR isolated from Saharan soils in Algeria has been evaluated as a biocontrol agent against F. oxysporum in the laboratory and field conditions. In-vitro dual culture method was used for the screening of antagonistic activities of Saccharothrix algeriensis against pathogenic fungus. As well as in-vivo experiments were also conducted for evaluation of anti-fusarium activities of Saccharothrix algeriensis. For in-vivo study, pre-sowing cotton seed treated with bacterial suspension and control seed with CMC solution were implant in pots. The Results indicates that the Saccharothrix algeriensis showed significant antagonistic activity against pathogenic fungi both in the laboratory and field conditions. Saccharothrix algeriensis strain enhance the growth parameter of cotton plants under greenhouse conditions in comparison with non-inoculated control plants. Notably, cotton seeds pre-treatment with Saccharothrix algerensis strain significantally reduced the disease incidence of Fusarium oxysporum by above 75% and significant correlation between the antagonistic properties of Saccharothrix algeriensis and its capacity to reduce the disease occurrence ($P \leq 0.01$) has been highlighted.

# HALOTOLERANT RHIZOBACTERIA PSEUDOMONAS PSEUDOALCALIGENES AND BACILLUS SUBTILIS MEDIATE SYSTEMIC TOLERANCE IN SOYBEAN (GLYCINE MAX L.) AGAINST SALINITY STRESS

Humaira Yasmin

Department of Biosciences, COMSATS University Islamabad (CUI), Islamabad Campus
**Email**: **humaira.yasmin@comsats.edu.pk**

**ABSTRACT**

Salt stress is one of the devastating factors that hampers growth and productivity of soybean. In soybean, the use of Pseudomonas pseudoalcaligenes to improve salt tolerance has not been thoroughly explored. Therefore, we observed the response of hydroponically grown soybean plants, inoculated with halotolerant P. pseudoalcaligenes and Bacillus subtilis under salt stress in a pot experiment. In vitro testing of 44 bacterial isolates revealed high salt tolerance by four isolates. Among them, B. subtilis and P. pseudoalcaligenes showed ACC deaminase activity, siderophore formation and indole acetic acid (IAA) production. We determined that $10^6$ cells/ml of B. subtilis and P. pseudoalcaligenes was sufficient to protect soybean against salinity stress (100 mM NaCl) in hydroponics by enhancing plant biomass, relative water content and osmolytes. Upon exposure of salinity stress, P. pseudoalcaligenes inoculated soybean plants were protected by the increased activities of defense related system such as ion transport, antioxidant enzymes, proline and MDA content in shoots and roots. The $Na^+$ concentration in the soybean plants was increased in the salt stress; while, bacterial priming significantly reduced the $Na^+$ concentration in the salt stressed soybean plants. However, the antagonistic results were observed for $K^+$ concentration. Additionally, soybean primed with P. pseudoalcaligenes and exposed to 100 mM NaCl showed a new protein band of 38 kDa suggesting that P. pseudoalcaligenes effectively reduced salt stress. Thus, B. subtilis and P. pseudoalcaligenes halotolerant PGPR could be effective bio-source for the protection of soybean plant under salinity stress. Our results showed that salinity tolerance is more pronounced in P. pseudoalcaligenes as compared to B. subtilis. However, a detailed study at molecular level to interpret the mechanism by which PGPR alleviate salt stress in soybean plants is still needed.

# MODERATION OF SODIUM CHLORIDE INDUCED DAMAGES BY THE APPLICATION OF PLANT GROWTH PROMOTING RHIZOBACTERIA AND BIOCHAR IN CICER ARIETINUM L.

Athar Javaid and Sami Ullah

Department of Botany, University of Peshawar, Pakistan
**Email: atharjavaid999@gmail.com**

**ABSTRACT**

Changes in climatic and environmental conditions are causing various abiotic stresses such as salinity that have the ability to induce the expression or repression of hundreds of genes in plants that can lead to the decline of agricultural production. Therefore the current study was carried out to determine the effect of plant growth promoting rhizobacteria (PGPRs) and biochar on Cicer aeritinum L. under induced stress of 40mM NaCl. The experiment was carried out in green house of Botany Department, University of Peshawar in 2019. Seeds obtained from the seed bank located in Hashtnagri, Peshawar were inoculated with both species of PGPR i.e NCCP 98 and NCCP 100 (collected from NARC, Islamabad) separately, prior to sowing. Biochar was prepared from the wood of Morus alba by the method of pyrolysis and was mixed with the soil. The seeds were then sowed in triplicate in specific diameter clay pots filled with soil and sand (3:1). Significant reduction was observed by the induction of salinity stress in agronomical and physiological attributes including leaf size, root-shoot length and their ratio, chlorophyll contents and carotenoids, which were positively ameliorated by biochar and PGPR. Proline and glycine betaine were regulated by the combine application of biochar and PGPR along with antioxidant enzymes such as catalase (CAT), superoxide dismutase (SOD), peroxidase (POD), ascorbate peroxidase (APOX) and glutathione peroxidase (GPX). Hereby it can be concluded that application of biochar and PGPR may play a vital role in our agricultural production under saline conditions.

# EFFECT OF HUMIC ACID COATED PHOSPHATIC FERTILIZERS INOCULATED WITH ARBUSCULAR MYCORRHIZAL FUNGI ON YIELD AND PHOSPHORUS UPTAKE OF WHEAT CROP

Muhammad Sharif and Muhammad Izhar Shafi

Dept. of Soil and Environ. Sciences, The University of Agriculture Peshawar
**Email: msharif645@aup.edu.pk**

**ABSTRACT**

Phosphorus availability to crop is one of the major causes of poor crop production worldwide. Effect of inorganic phosphorus (P) fertilizer sources, i.e., nitro phosphate (NP), di-ammonium phosphate (DAP) and single superphosphate (SSP) coated with different humic acid levels inoculated with arbuscular mycorrhiza on crop production and P uptake by wheat plants was investigated. All P sources at a recommended rate of 90 kg $P_2O_5$ $ha^{-1}$ coated with humic acids levels (0, 5 and 10 kg $ha^{-1}$) inoculated with micorrhiza were arranged in Randomized Complete Block (RCB) design with three replicates. Results showed that all P sources coated with HA inoculated with AMF significantly increased plant height, thousand grains weight, wheat grain and straw yield, plant and soil P concentration and P uptake. Phosphorus utilization efficiency (PUE) of inorganic P was increased with HA coating and AMF inoculation, and the highest PUE was recorded by DAP coated with 10 kg HA $ha^{-1}$. Results indicate that coated P fertilizers inoculated with AMF has potential to further improve yield and plants P uptake.

# ISOLATION, CHARACTERIZATION OF SOIL MICROBES AND THEIR EFFECTS ON YIELD AND PHOSPHORUS UPTAKE OF CROP

Sadiq Hussain[1]*, Muhammad Sharif[1]

[1]Department of Soil and Environmental Sciences, The University of Agriculture- Peshawar, Khyber Pakhtunkhwa- Pakistan
**Email: sadiqhussain@aup.edu.pk**

**ABSTRACT**

An experiment was carried out to study the characterization of arbuscular mycorrhiza fungi as well as phosphate solubilizing bacteria and their effects on yield and phosphorus of crop. The experiment was carried out in completely randomized design replicated three times during season 2017-18. The recommended dose of N @ 120 kg $ha^{-1}$ was applied in the form of urea, while K was applied in the form of sulphate of potash. Spores of mycorrhiza were isolated from fresh growing crop of berseem at The University research farm and used as inoculums in this experiment. Phosphate solubilizing bacteria was isolated from the same soil and characterized into their respective species like Bacillus, Strepto bacillus, Sprilla and coccus. Arbuscular mycorrhiza fungi was classified into different species such Mossai and Sclerosistis. Results showed the maximum grain yield of 15.09 and 14.7 g $pot^{-1}$, highest total dry matter yield of 36.3 g and 36 g $pot^{-1}$, maximum roots dry weight of 5.6 and 5.41g $pot^{-1}$, hundred grains weight of 4.64 g and 4.6 g were observed for the mycorrhiza inoculated with phosphate solubilizing bacteria treatments. Highest straw yield of 21.5 g and 21.2 g $pot^{-1}$, maximum plant N uptake of 0.71 g and 0.68 g $pot^{-1}$ were obtained by mycorrhiza inoculated with half and full doses of vermicompost treatments. Plants P uptake of 0.09 g were found in mycorrhizal inoculated along with phosphate solubilizing bacteria. Maximum spores density of 58 were recorded by mycorrhiza fungi inoculated with phosphate solubilizing bacteria, while root colonization of 57.8% was maximum by the treatment of mycorrhiza inculcation alone. Results suggested that inoculation of mycorrhiza with phosphate solubilizing bacteria has potential to improve yield, yield component and phosphorus uptake of crop under prevailing soil and environmental conditions.

# EFFECT OF MYCORRHIZA WITH DIFFERENT PHOSPHORUS LEVELS ON PRODUCTIVITY AND ROOT INFECTION INTENSITY OF WHEAT CROP

Jawad Ul Haq and Muhammad Sharif

Department of Soil and Environmental Sciences, The University of Agriculture Peshawar, Pakistan

**Email: jawadulhaqsgr@gmail.com**

**ABSTRACT**

A field experiment was conducted to determine the effect of Arbuscular mycorrhiza fungi (AMF) inoculation with different levels of phosphorus (P) on productivity and roots infection intensity of wheat at research farm of the University of Agriculture, Peshawar in 2018-2019. The wheat variety Pirsabaq 2013 with recommended seed rate of 120 kg $ha^{-1}$ was grown in randomized complete block design (RCBD) with two factors arrangement having three replications. Fertilizers urea and sulphate of potassium were applied as a source of N @ 120 kg $ha^{-1}$ and K @ 60 kg $ha^{-1}$ respectively. Single super phosphate was used as a source of P. All phosphorus and potassium were applied at sowing time, while N was added in two splits. The P was applied at the rate of 0,30, 60, 90 and 120 kg $ha^{-1}$ with and without AMF inoculation the AMF infected soil and root of maze were used as AMF inoculum @ 1.5 kg uniformly in all corresponding treatments. Results indicated that inoculation of AMF with different levels of P improved yield and yield components of wheat significantly ($P< 0.05$) over control. Maximum grain yield of 3340.1 kg $ha^{-1}$ with 21% increase and total dry matter yield of 8350 kg $ha^{-1}$ with 41% increase over control were recorded by the inoculation of AMF with 90 kg P $ha^{-1}$Plant height, straw yield and thousand grains weight of wheat improved significantly ($P<0.05$) by the inoculation of AMF with 90 kg P $ha^{-1}$ over control. · Maximum and significantly ($P<0.05$) improved concentration of plant N and P and their uptake of 98 kg $ha^{-1}$ and 22 kg $ha^{-1}$ were recorded by the inoculation of AMF with 90 kg P $ha^{-1}$ application. Postharvest soil pH and organic matter content were affected non significantly by the inoculation of AMF with different P levels. Soil spore density of AMF and their root infection intensity in wheat increased significantly ($P<0.05$) by AMF inoculation with different P levels. Results suggest that inoculation of AMF with different P levels has the potential to further improve wheat yield, yield components and plant nutrients uptake in field conditions.

# EFFECT OF BIOCHAR AND PLANT GROWTH PROMOTING RHIZOBACTERIA ON AGRONOMIC, PHYSIOLOGICAL AND BIOCHEMICAL ATTRIBUTES OF VICIA FABA L. UNDER INDUCED DROUGHT STRESS

Muhammad Nafees and Sami Ullah

Department of Botany, University of Peshawar, KPK, Pakistan
Email: **nafeesafridia@gmail.com**

**ABSTRACT**

Drought is a persistent and intricate natural vulnerability whose rate of recurrence and enormity is expected to increase with climate change. Regardless of progress in response and adaptation to water scarcity (with the development of new policies), drought continues to cause severe impacts and afflictions. Therefore, the present study has been carried out to investigate the effect of biochar and plant growth promoting rhizobacteria (PGPR) on Vicia faba under induced water deficit stress with 15 and 30 days. The experiment has been carried out in the green house of Department of Botany, University of Peshawar in 2019. Seeds were obtained from the Seed Bank located at Hashtnagri, Peshawar. Biochar were prepared from the wood of Morus alba by pyrolysis. Two species of PGPR Cellulomonas pakistanensis and Sphingobacterium pakistanensis were obtained from NARC, Islamabad. Seeds were inoculated with both species of PGPR separately prior to sowing. Clay pots were used for sowing filled with soil and sand (3:1) in triplicate. The induced drought stress significantly reduced the agronomical and physiological attributes including the leaf size, root and shoot length and their ratio, chlorophyll contents and carotenoids, which were positively ameliorated by biochar and PGPR. Furthermore, proline and glycine betaine contents were regulated by the combined application of biochar and PGPR along with antioxidant enzyme activities including catalase, superoxide dismutase, peroxidase and ascorbate peroxidase. From the present study it has been concluded that application of biochar and PGPR may be significant in agriculture practices carried out at water deficit regions.

# DROUGHT STRESS ALLEVIATION BY THE APPLICATION OF BIOCHAR AND PLANT GROWTH PROMOTING RHIZOBACTERIA IN BRASSICA NAPUS L.

Gul-Lalay and Sami Ullah

Department of Botany, University of Peshawar, KPK, Pakistan
**Email: gullalay573@gmail.com**

**ABSTRACT**

Drought is a soil water deficit condition which effect plants growth and development in all parts of the world. With growing water scarcity and climate change the effect of drought are expected to increase. Currently and in future water is an increasingly scarce for human population and societal needs, putting an emphasis on sustainable water use. Pakistan is susceptible more to climate change including drought and salinity because of global warming, due to its geographical position. Hence the present study has been carried out to evaluate the effect of plant growth promoting rhizobacteria (PGPR) and biochar on Brassica napus L. under induced drought stress with 20 and 40 days. The experiment has been conducted in the green house of Botany department, University of Peshawar in 2019. Seeds were obtained from National Agriculture Research Center (NARC) Islamabad. Through pyrolysis, biochar was prepared from the wood of Morus alba. Two species of PGPR, NCCP 493 and NCCP 494 were obtained from NARC, Islamabad. In broth culture of PGPRs strains, seeds were inoculated before sowing. Pots (in triplicate) were filled with soil and sand (3:1). The induced drought stress significantly reduced the physiological and agronomical features including leaf area, plant height, total biomass, root shoot ratio and carotenoid and chlorophyll content which were significantly enhanced by biochar and PGPRs strains. Moreover, antioxidant enzyme activities including peroxidase, catalase, ascorbate peroxidase and superoxide dismutase were regulated by biochar and PGPRs along with proline, sugar and glycine betaine. It has been concluded from the present study that the application of biochar and PGPRs may be significant in agriculture practice carried out under drought condition.

# INFLUENCE OF SEASONAL DISPARITIES ON POLYPHENOLICS CONTENT AND ANTIMICROBIAL ACTIVITY OF BERBERIS LYCIUM R.

Zainab Bibi1, Arshid Pervez1, Arshad Mehmood Abbasi1*

Department of Environmental Sciences, COMSATS University Islamabad, Abbottabad Campus 22060, Pakistan
***Email: amabbasi@cuiatd.edu.pk**

**ABSTRACT**

Seasonal variations viz. temperature, sun light duration, rainfall, UV radiations and humidity impose significant impact on the therapeutic efficacy of medicinal plants, particularly on the production of secondary metabolites and their bioactivities. Present study was focused to assess the impact of seasonal variations on polyphenolic contents and antimicrobial activities of B lycium, which have rarely been explored yet in this perspective. Total phenolics and flavonoid contents were determined using standard analytical methods in the methanolic extracts of root and stem bark collected from January to December. And antibacterial activities of the extracts were performed against E. coli and Staphylococcus aureus by well diffusion method. Overall results predicted that more polyphenolics compounds production and more inhibition of bacterial strains were shown in winter samples under stress conditions. Maximum levels of total phenolic contents in root and stem bark were estimated in the samples of April followed by September and October, while total flavonoids were maximum in December and April. These values were significantly different at $p<0.05$. Likewise, root bark collected in November exhibited maximum of E. coli and S. aureus. However, stem bark collected in October and December had elevated levels of inhibition against test strains. Our findings revealed that bark samples collected in winter season and early spring is rich in polyphenolics and possess highly significant antibacterial activities. Therefore, we suggest that to get maximum health benefits from the bark of B. lycium, it should be harvested in the peak season i.e. November to April.

# EFFECT OF ORGANIC P FERTILIZATION, BACTERIAL CONSORTIA AND THEIR GRAZER NEMATODES APPLICATION ON PLANT P UPTAKE AND SOIL P POOLS

Saba Ahmed, Nadeem Iqbal, Moniba Zahid and Usman Irshad

Department of Environmental Sciences, COMSATS University Islamabad, Abbottabad Campus
**Email: rashidnazir@cuiatd.edu.pk**

**ABSTRACT**

Phosphorus is an important but limiting macronutrient for plant growth and development. In agriculture, to sustain good crop yield phosphorus management is done by frequent application of animal manure and synthetic phosphorus fertilizer leading to accumulation of excess phosphorus in organic and inorganic phosphorus compounds. Soil biodiversity can play an important role in environmental and economic management of phosphorus. The completely randomized pot experiment consisted of four treatments, sterile control unamended, sterile control amended (poultry, cow manure and vegetable waste) plant and soil, plant, soil and bacteria and soil+bacteria+nematodes was set. Bacterial strains (phosphorus solubilizers) and their grazer nematodes were used in a pot experiment owing to their trophic level interactions. Quadruple consortia comprising Rhodococcus boritolerans, Bacillus cereus, Salmonella enterica and Bacillus subtilis were inoculated with and without nematodes in wheat rhizosphere. Interactions between the bacteria and nematodes showed considerable increase in the phosphours level and plant biomass ( Triticum Sativum) when compared with the control. All treatments containing nematodes and bacteria had higher bacterial densities than similar treatments without nematodes. Plants growing in soil with bacteria and bacterial-feeding nematodes grew faster. Similar results were obtained from both the unamended and the organic residue-amended experiments. Results from application different combinations of biological treatment; bacterial consortia and their grazer nemtodes and biowaste in wheat rhizosphere in pot experiment suggested that there is an optimal point for biological composition and organic amendment which can benefit phosphorus management. In general, application of biowaste in combination with biological treatment had the enhanced effect on yield, P uptake, and soil P status.

# CO-APPLICATION OF MYCORRHIZAE WITH BENEFICIAL MICROBES ENHANCED THE CROP PRODUCTIVITY UNDER ENVIRONMENTAL STRESSFUL CONDITIONS

Iqra Kanwal[1], Taqi Raza[2], Muhammad Bilal Amir[3]

[1]Department of Plant Pathology, University of Agriculture Faisalabad, Pakistan 38000
[2]Department of Agri. Soil Science, University of Agriculture Faisalabad Sub Campus Burewala, Pakistan, 61010
[3]Qingdao Agricultural University, Qingdao, Shandong, PR China
***Email: iqrakanwal520@gmail.com**

**ABSTRACT**

Increasing global demand for food to feed the increasing world population becomes a challenge for today's agriculture. Due to lack of resources, un-cultivated and multiple stressful environmental. It is hard to meet the increasing demands of food. This problem may be solved by the use of resources smartly through efficient use of agro-biosystem approaches. The rhizospheric microflora such as mycorrhizae to improve plant growth and yield attributed under stressful conditions. Many strains of mycorrhizae have to be found that competent in stress conditions when applied with beneficial soil microbes which increase the nutrient uptake of plants and also work as an effective bioinoculant. Keeping in view these objectives, a pot experiment was conducted in a greenhouse from November to May. 2018-19. Pots were filled with soil and cultures of arbuscular fungi Glomus mosseae and Glomus etunicatum were applied. Tens of seeds of wheat were sown in each pot. The experiment was arranged in a split-plot, randomized complete block design with three replicates and water regimes were the main plots with AM fungi inoculums treatments as sub-plots. The ANOVA results indicated that mycorrhizal colonization with wheat roots was higher in pot that grows under well water (WW). Biomass and grain yield increased to 38-41.4%, with 4.71% heads number, 20-26.0% grains weight and 17-21.8% grain number per head. Mycorrhizae also improved the nutrient uptake by improving the soil porosity and increasing root hair contact with soil and water under water stress. Thus, it is concluded that the application of mycorrhizae may improve crop productivity under stressful environmental conditions.

# EFFECTIVENESS OF BACTERIAL CONSORTIUM AND SORGHUM EXTRACT ON GROWTH AND YIELD ATTRIBUTES OF WHEAT

Taqi Raza[1], Muhammad Yahya Khan[2], Shakeel Imran[2], Rizwan Ahmad[1], Matiullah Khan[1], Abdul Baseer Khan[1]

[1]Land Resources Research Institute**,** NARC, Islamabad, Pakistan
[2]University of Agriculture Faisalabad Sub Campus Burewala, Pakistan, 61010.
[*]**Email: taqiraza85@gmail.com**

**ABSTRACT**

Wheat (Triticum aestivum L.) is of prime importance being staple food of many nations including Pakistan. Bacteria need adequate nutrients to express their maximum potential. Allelopathy extract of plants is the rich source of nutrients. A synergistic relationship exist between allelopathy extract and different bacteria which ultimately improve the plant growth. Thus, the application of bacterial consortium and allelopathy extract takes importance in agriculture production. Keeping in view this concept, a field study was carried out to assess the effectiveness of bacterial consortium and sorghum extract on growth and yield attributes of wheat. Five treatments were tested including T1: control T2: chemical herbicide (Atlantis), T3: sorghum extract, T4: consortium of bacteria and T5: sorghum extract + bacterial consortium. The experiment was laid out in randomized complete block design with three replicates. Results indicated that combined application of sorghum (S. bicolor L.) extract and bacterial consortium significantly improved the number of tillers (43%), number of spikelet's (49%), total biomass (73%) and grain yield (70%) as compared to the control. Economic analysis was also revealed that treatment T5 increased the net benefits with a high marginal rate of return. It can be concluded that the extract of sorghum in combination with the consortium of bacteria may result in more prominent growth and yield of wheat.

# ASSESSING THE NITRIFICATION ENZYME ACTIVITY ACROSS VARIOUS SOIL ECOSYSTEMS AT ABBOTTABAD REGION

Tahir Zaman1, Wasia Qazi1, Akhtar Iqbal1, Rashid Nazir1, Faridullah1, Muhammad Bilal1, Muhammad Irshad1, Farhan Hafeez1*

[1]Department of Environmental Sciences, COMSATS University Islamabad, Abbottabad Campus, Tobe Camp University Road Abbottabad 22060 Pakistan.
**Email: drfarhan@cuiatd.edu.pk**

**ABSTRACT**

Grassland, forest and arable soils are widespread ecosystems in Pakistan landscape however the climate change event and accelerated weather patterns have strongly influenced these ecosystems but also the associated services such as microbial community functioning. To assess these dynamics, we investigated the nitrification potential and functional stability of various soils across grassland, forest and arable ecosystems at Abbottabad region, lesser Himalaya. The soil samples incubated at lab scale for a month (under heat-drought stress) and further analyzed for microbial community functioning – nitrification enzyme activity (NEA) showed a strong variation across three soil ecosystems where upon heat-drought stress application (42C for 24h and 48h - climate change proxy), the arable soil exhibited high resistance for microbial activity-NEA for both climate change treatments. However, the resilience in these soil ecosystems measured through NEA at day 7, 14 and 28, demonstrated that in all the samples arable soil showed a higher nitrification rate with greater resilience (ability to recover once the stress is over) for the forest soil ecosystem thus highlighting that it could withhold the applied stress at all studied time intervals. The results also provide the baseline for assessing the impact of future predicted climate change events on soil functioning especially in microbial community functioning perspectives.

# CIGARETTE BUTTS DECOMPOSITION AND MICROBIAL REMEDIATION TO ALLEVIATE THE HEAVY METAL TOXICITY IN SOIL

Akhtar Iqbal[1]*, Rashid Nazir[1], Bilal Ahmad Zafar Amin[1], Farhan Hafeez[1], Faridullah[1], Hafiz Muhammad Rashad Javeed[2]

[1]COMSATS University Islamabad, Abbottabad Campus, Department of environmental sciences.
[2]COMSATS University Islamabad, Vehari Campus, Department of environmental sciences.
***Email: akhtariqbal@cuiatd.edu.pk**

**ABSTRACT**

Cigarette butts (CBs) are found as the most common type of litter on this entire planet. The leftover or residue of a cigarette after it is smoked is commonly known as cigarette butt. According to an estimate about 5.6 trillion CBs are discarded into the environment annually. There are a number of hazardous heavy metals like cadmium, chromium, lead and arsenic etc. emitted from the cigarette smoke and butt. The aim of this study was to investigate the heavy metals' toxicity induced by CBs degradation in soil. To achieve this purpose, the study was conducted at CUI, Abbottabad Campus. An incubation study was performed at 25±2 °C. The cigarette butts of two brands (Capstan and Gold leaf) were used. The treatments were as follows: Capstan (Ca), Gold leaf (Gl) and mixture of Capstan and Gold leaf (Ca+Gl). To investigate the chromium bio-sorption, two bacterial strains (Bacillus cereus and Pseudomonas japonica) were introduced along with CBs during decomposition. These microbial strains were introduced singly or in combination with all above cited treatments. During 120 days decomposition, maximum (22 %) CBs mass loss was observed for Capstan in the presence of both microbial strains. At day 120, the order of heavy metals' induced toxicity was Cr> Ni> Cd. Maximum Cr (25 mg/kg) concentration was introduced in soil during decomposition of Capstan in the presence of Bacillus cereus. In the same way, maximum Cd toxicity was introduced in soil during decomposition of Capstan in the presence of Bacillus cereus. But Highest Ni toxicity was produced by Gold leaf in the presence of Pseudomonas japonica. Microbial strains showed positive results in Cr bio-sorption whereas no significant effect was observed on Cd and Ni bio-sorption. From this study, it can be concluded that metals leaching from CBs enter into soil and can even enter into underground water affecting aquatic environment.

# SOIL MICROBIOTA PRODUCED FLAVOR AND FRAGRANT COMPOUNDS

Nabeela Daud[1], Fawad Ahmed Khan[1], Rashid Nazir[2], Usman Irshad[2], Muhammad Azeem[1]*

[1] Department of Chemistry, COMSATS University Islamabad, Abbottabad Campus, Abbottabad 22060, Pakistan
[2] Department of Environmental Sciences, COMSATS University Islamabad, Abbottabad Campus, Abbottabad 22060, Pakistan
***Email: muhazeem@cuiatd.edu.pk**

**ABSTRACT**

Aroma and flavour constitute important part of food, detergent, cosmetic and pharmaceutic industry. Flavour and aroma are generally low molecular mass esters, aldehydes, dicarbonyls, terpenes and sulphur containing compounds. Most available flavour compounds are now produced via chemical synthesis and extraction from plant sources. Drawbacks of synthetic chemicals are the formation of undesirable racemic mixtures and the growing aversion of the consumer towards chemicals added to his food, cosmetics and other household products. This has caused flavor companies to direct their attention towards flavour compounds of biological origin, so called natural or bio-flavors. Up till now plants were also an important source of natural flavor and fragrances represented by their essential oils However, active components are often present in minor quantities or in bound form which make their isolation not economic or difficult leading to expensive flavor or fragrance compounds. In current study we have evaluated different strains of bacteria and fungi from Himalaya soil to meet the healthy demands of humans through natural production of aroma and flavour by in expensive method. The bacterial and fungal strains were grown on nutrient broth and potato dextrose broth respectively. The volatile organic compounds (VOCs) produced by bacterial and fungal strains were collected from the headspace of grown microbes by solid phase micro extraction (SPME) and solvent extraction method. The identification and quantification of microbial VOCs was conducted gas chromatography coupled with mass spectrometry (GC-MS).The major compounds identified from various bacterial and fungal strains were ethanol, isobutyl alcohol, isopentyl alcohol, butyric acid, isovaleric acid, benzaldehyde, phenyl ethyl alcohol, nerolidol, hexanoic acid, and methyl mercaptopropyl alcohol. The Himalayan soil microbes are rich source of aroma compounds those could be used industrially.

# LOWER HIMALAYAN LIGNOCELLULOLYTIC MICROBIAL CONSORTIA AND THEIR USE FOR ETHANOL PRODUCTION FROM LOCALLY ACCUMULATED SOLID WASTE

Faheem Jadoon, Rashid Nazir and Bilal Ahmad Zafar Amin

Department of Environmental Sciences, COMSATS University Islamabad (CUI), Abbottabad Campus
**Email: rashidnazir@cuiatd.edu.pk**

**ABSTRACT**

The growing concerns regarding the solid waste management, depletion of fossil fuel reservoirs and subsequent environmental pollution throughout the globe, has led to look for the sustainable waste management and alternative means to produce energy. In this regard, solid waste is needed to be managed with its reuse to produce biofuel and other important chemicals; has gained special interest. Several approaches have been adopted for efficient degradation of solid waste in minimum time; to yield the sugars which can be further used for bioethanol production. The solid wastes from different sources were characterized and fractioned for cellulose, hemicellulose and lignin content analysis. After initial characterization, quantitative analysis was done to degrade the cellulose and xylan substrates and was analysed via DNS (Dinitro Salicylic Acid) method, while lignin degrading strains were analysed using ABTS method. The degradation capability and substrate functionality were assessed by application of three different consortia (C1, C2 and C3) on four wastes including kitchen waste (KW), municipal waste (MSW), fruit and vegetable waste (FVW) and paper industry waste (PW). Weight loss was found to have an important factor to study other enzyme's activities. The consortia C1was found efficient degrader for all wastes. Due to high degradation ability C1 was applied on all four wastes to release sugars for further fermentation. After saccharification, Saccharomyces cerevisiae was applied and its ethanol yielding potential was assessed. Ethanol production by KW, MSW, FVW and PW was recorded as 18.4 gm/L, 21.6 gm/ L, 16.9 gm/L and 28.2 gm/L respectively. The maximum 65.3% conversion of available glucose to ethanol is achieved for PW.

# IN VITRO AND IN PLANTA NEMATICIDAL ACTIVITY OF ASPERGILLUS SPP. (TRICHOCOMACEAE) AGAINST THE SOUTHERN ROOT KNOT NEMATODE, MELOIDOGYNE INCOGNITA IN TOMATO (SOLANUM LYCOPERSICUM L.)

Shamsulhaq[1], Ishrat Naz[1], Shaukat Hussain[1], Maria Musarrat[2], Ifra Siddique[1] and Fazli Kabir[1]

[1]Department of Plant Pathology, Faculty of Crop Protection Sciences, The University of Agriculture, Peshawar-Pakistan, P.O.Box. 25130, Khyber Pakhtunkhwa, Pakistan
[2]Department of Soil and Environmental Sciences, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar-Pakistan, P.O.Box. 25130, Khyber Pakhtunkhwa, Pakistan
**Email: ishratro@hotmail.com**

**ABSTRACT**

Root knot nematodes, (Meloidogyne spp.) are polyphagous pests causing losses in a wide range of vegetable hosts. Due to the negative toxic effects of chemical nematicides, the search for novel and eco-friendly microbial strains for nematode control is relevant. A study was conducted to evaluate the nematicidal potential of Aspergillus spp., in vitro and in vivo against the southern root knot nematode, M. incognita (Kofoid and White) Chitwood in tomato (Solanum lycopersicum) L. cv. Royal. Efficacy of different cultural filtrates of Aspergillus spp.,on egg hatch inhibition and juvenile's mortality were assessed in vitro after three exposure periods (24, 48 and 72 hours) and at three concentrations (10, 20 and 30%) of Aspergillus spp. Maximum juvenile's mortality (81.25%) and inhibition of egg hatching (78.75%) were found for culture filtrate of Aspergillus spp., when applied @30% and at 72 hours of exposure period. In vivo results showed that nematode parameters such as galling index (2.50), number of galls (8.25), number of egg masses (5.75), number of adult females (5.75) and reproduction factor (0.34) were substantially reduced when culture filtrate of Aspergillus spp.,was applied @ 30% as compared to control treatments. Plant growth parameters such as shoot and root lengths (35.6cm and 12.30 cm), fresh shoot and root weights (14.59g and 4.46g), dry shoot weight (4.58g), number of leaves (33.20) and flowers (11.0) were increased significantly with the application of culture filtrates of Aspergillus spp., @30%. These results indicated that Aspergillus spp., possessed strongest nematicidal activities against RKNs and enhanced plant growth parameters in tomato. These antagonistic fungi could be utilized as effective biocontrol agents against root knot nematodes as part of integrated disease management in an organic vegetable production.

# ISOLATION OF ENTOMOPATHOGENIC NEMATODES FROM MALAKAND DIVISION AND THEIR EFFICACY ON THE MANAGEMENT OF ROOT KNOT NEMATODE (Meloidogyne spp.) IN TOMATO

Fazli Kabir, Saifullah, Ishrat Naz, Muhammad Awais and Shamsul Haq

Department of Plant Pathology, Faculty of Crop Protection Sciences, The University of Agriculture, Peshawar-Pakistan, P.O.Box. 25130, Khyber Pakhtunkhwa, Pakistan
**Email: ishratro@hotmail.com**

**ABSTRACT**

The study was conducted to evaluate the effect of Entomopathogenic nematodes (EPNs) on the management of root knot nematode (Meloidogyne incognita) in tomato (Lycopersicun esculentum L.). A survey was conducted to screen out the EPNs in different localities of Malakand division. The total 135 samples were collected from 15 different localities and then were test for the presence of EPNs in the laboratory. Among total samples (135), 99 samples were positive for the presence of EPNs. The overall percent isolation range of EPNs from the Malakand division was 0-73%. Then EPNs were isolated and reared using baiting and white trap method. In-vitro study revealed that EPNs have a significant effect onegg hatch inhibition (88.5) and mortality of juveniles of RKNs (53.7) on tomato. Study conducted at green house revealed that the EPNs had a significant effect on controlling root knot nematodes when applied at three different concentrations i.e (1000, 2000, and 3000) EPNs per pot. Results showed that EPNs concentration (@ 3000) significantly reduced number of galls (13), galling index (2.75), number of eggs (11), number of females (12.25) of RKNs in tomato roots when applied 7 days before nursery transplantation. The RKNs were also inoculated to the plants in the nursery in the same pattern. The plants treated with high concentration of EPNs (@ 3000) showed improvement in plant growth parameters (height of plant, shoot length, root length, fresh and dry root weight) as compared to the minimum concentration of EPNs. This study suggests that EPNs could be used for successful management of RKNs.

# INVITRO EFFECTS OF SILVER NANO PARTICLE AND ANTIBIOTICS ON PLANT PATHOGENIC BACTERIA (ERWINIA carotovora) AND FUNGI (FUSARIUM solani)

Ifra siddique, Isharat Naz, Haleema bibi, Rifat ali, Ghafoor

Department of Plant Pathology, Faculty of Crop Protection Sciences, The University of Agriculture, Peshawar-Pakistan, P.O.Box. 25130, Khyber Pakhtunkhwa, Pakistan
**Email: ishratro@hotmail.com**

**ABSTRACT**

In the current research antimicrobial activity of silver nano-particle i.e Ag, Agp, AgAe, AgIB and AgBE and antibiotics (Nystatin and streptomycin) were evaluated against plant pathogens,Fusarium solani and Erwinia carotovora.The experiment was carried in completely randomized design(CRD) with three replications.The antibiotic Nystatin was used as a standard antibiotic reference against antifungal activity while streptomycin against antibacterial activity for antifungal and antibacterial activity different concentrations (150ppm,200ppm and 250ppm) and zone of inhibition (mm)for all AgNps and antibiotics were prepared and inhibition zone wsa measured in millimeter (mm).The result revealed that AgBE Agp showed the largest inhibition zone with the tested Erwinia carotovora where the activity was15.34mm and 14.13mm,respectivily followed by AgAE (9.40mm),AgIB(10.34) and Ag (7mm) while the referernce antibiotic streptomycine produced the lowest inhibition zones (5.44mm). In case of Fusarium solani maximum inhibition zones were acheived from AgIB and AgAE where the fungal activity was 27mm and 26mm followed by AgBE(23.32mm),AgP(20.mm)and Ag(18.66) while the reference antibiotic Nystatin produced minimum inhibition zone (4mm). It was concluded that increasing the concentraion of AgNps significantly ($p<0.05$) increased the inhibition zones of the test pathogen and higher concentration (250ppm) possesses strong antimicrobial activity. It is concluded that AgNps had maximum inhibitory effect against Erwinia and Fusarium solani as compared with the antibiotics.

# FRIST REPORT OF THE PHYTOPATHOGENS ASSOCIATED WITH PEACH LEAF CURL DISEASE IN PAKISTAN

Fazal Akbar[*1], Atta Ur Rehman[1,2], Haji Khan[1], Akhtar Rasool[1], Muhammad Israr[3],Nisar Ahmad[1], Mohammad Ali[1], Nasib Zaman[1], Muhammad Rizwan[1], Zahid Hussain[1],

[1]Center for Biotechnology and Microbiology, University of Swat, KP, Pakistan.
[2]Department of Botany, Hazara University Mansehra, KP, Pakistan.
[3]Department of Forensic Sciences, University of Swat, KP, Pakistan
**Email: fazalakbar@uswat.edu.pk**

**ABSTRACT**

Peach leaf curl disease (PLCuD) is one of the most important biotic limitations for peach production in the world. Taphrina deformans is the most prominent fungal species that cause PLCuD in the world. PLCuD has also greatly damaged the fruit industry in Pakistan, but none gave serious attention to the problem and the agents that cause the disease still remain unknown. Therefore, this was very important to identify the causative agents involved in the disease. Disease symptoms similar to those caused by T. deformans were observed on the leaves of peach plant in District Swat, Pakistan. The fungi were isolated from infected peach plant via spore-fall method and cultured on Potato Dextrose Agar (PDA) medium. The isolates recovered from infected leaves had white, cream to pinkish, circular, shiny, convex and pasty appearance on PDA. The PCR displayed amplification of ~700 base pair fragments using fungi universal primers. Molecular characterization of the ITS region confirmed that the sequences obtained has 99% sequence similarity with Tephrina deformans. In addition, some of the sequences obtained have sequence similarity with the uncultured fungi and other fungi Naganishia uzbekistanensis and Cryptococcus adeliensis. This study suggests that diverse fungal species may be associated with PLCuD in Pakistan to support the primary infection caused by T. deformans.

# ROLE OF MOLYBDENUM, BACTERIUM INOCULATION METHODS AND CHICKPEA VARIETIES ON NODULATION EFFICIENCY UNDER IRRIGATED AND RAINFED CONDITIONS

Asim Muhammad*, Kabir Khan and Sarmad Iqbal

Department of Agronomy, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan

***Email: asimmuh@aup.edu.pk**

**ABSTRACT**

Lack of Molybdenum (Mo) in soil affecting nodule formation and its efficiency in legume. To investigate the role of Mo in chickpea for nodulation efficiency along with rhizobium inoculations under irrigated and rainfed conditions. Experiments were conducted at two different locations of Khyber Pakhtunkhwa province of Pakistan (Agronomy Research Farm, The University of Agriculture Peshawar as irrigated and Farmer's field at Karak as rainfed) with the objectives to find out appropriate level of molybdenum and bacterium application method on different chickpea varieties (Chattan and Lawaghar) in order to exploit the nodulation efficiency under agro-climatic condition of Peshawar (irrigated) and Karak (rainfed). The study was carried out in randomized complete block design with three replicates. Analysis of the data showed that application of molybdenum @ 0.3 kg $ha^{-1}$ showed highest number of nodules, active nodules and nodules weight $Pant^{-1}$. Bacteria inoculated with soil have maximum number of nodules, active nodules and fresh weight of nodules as compared to seed treated bacteria. Among chickpea varieties Lawaghar achieved higher number of nodules and active nodules than Chattan vareity. While highest nodule weight was observed in Chattan. Chickpea sown in rainfed region of Karak had highest number of nodules, active nodules and nodule fresh weight as compared to irrigated condition of Peshawar. It is concluded that for achievement of higher number of nodules, active nodules $plant^{-1}$ Lawaghar may be sown at Karak.

# COMPARATIVE ANTIBIOTIC RESISTANCE PROFILE OF ACINETOBACTER SPP. ISOLATED FROM FISH, CHICKEN AND BEEF MEAT

Uzma Ayaz, Fareeha Akhtar,Muhammad Ilyas Khan, Hameed Ur Rehman, Syeda Alia Gerdazi, Uzma Ghani, Muhammad Hanzalah Khan, Aftab Ahmad, Hira Mushtaq,Nausheen Abdul Malik,Nasir Mahmood, Matiullah, Wahid Shah,Malik Nawaz Shuja

Department of Plant Breeding and Molecular Genetics University of Poonch Rawalakot Azad Jammu & Kashmir
Department of Animal Sciences, Quaid-i-Azam University, Islamabad, Pakistan
Department of Zoology, Kohat University of Science & Technology, Kust, Kohat, KP, Pakistan
Department of Biotechnology, Women University of Azad Jammu & Kashmir, Bagh, AJK
Faculty of Veterinary Sciences Gomal University Dera Ismail Khan, KP, Pakistan1Department of Microbiology, University of Veterinary and Animal Sciences Lahore, Pakistan
Center of Biotechnology and Microbiology University of Peshawar
College of Biological Sciences Northeast Forestry University, No.26 Hexing Road Xiangfang District Harbin Heilongjiang Province, China
Department of Microbiology, Quaid-i-Azam University, Islamabad, Pakistan.
PhD Scholar Hebei Medical University, China
Department of Microbiology, Kohat University of Science & Technology, KUST-26000, KP, Pakistan
**Email: uzma_ayaz89@hotmail.com**

**ABSTRACT**

Acinetobacter is a gram-negative bacterium which is found to be involved in serious health implications due to consumption of contaminated food. In present study different markets of Lahore were selected to collect fish, beef and chicken meat samples. Identification was performed by using microscopic, morphological, biochemical and molecular analysis of all the samples. Samples were subjected to antibiotic resistance to create a comparative profile for antibiotic resistance for fish, beef and chicken meat. In the present study the molecular identification was used for carbapenem resistance gene (SPM-1). The results indicated that 24 (26.6%) of total samples were positive for Acinetobacter species. The prevalence of the Acinetobacterspecies was (30%) (26.6%) and (23.3%) in fish meat, chicken meat and beef, respectively. Ampicillin and trimethoprim showed highest resistance 100% followed by tetracycline 100%, 75% and 66.6% in beef, chicken and fish isolates respectively. Only 17 of 24 isolates were confirmed as targeted bacterium for the SPM-1 gene by PCR. Acinetobacter species had low percentage in beef meat than in fish meat and chicken meat. The chicken meat is contaminated with antibiotics resistance Acinetobacter species; they can cause serious diseases in future in poultry, animals and human. The risk concern with antibiotics resistance Acinetobacter species cannot be ignored because, they resist to currently using potential antibiotics.

# APPLICATION OF BENEFICIAL MIROBES IN SUSTAINABLE FISH PRODUCTION IN INTENSIFIED AQUACULTURE THROUGH BIOFLOC TECHNOLOGY (BFT): CASE STUDIES OF TILAPIA FISH RAISED UNDER BFT TANKS AT BISMILLAH FISH FARM FAISALABAD, PAKISTAN

Muhammad Shah Sawar Khan*, Syeda Kokab Shah**, Syeda Faryal Israr**

*Patron, FnK Organics Bannu. **Graduate students, Department of Environmental Sciences, Peshawar university and owners of FnK Organics, Bannu
**Email: gssp07@gmail.com**

**ABSTRACT**

Bioflocs are clumps of bacteria, algae, protozoans, zooplankton, nematodes and various particles of organic matter like feces and uneaten feed. In water tank/column, each floc is held together in a loose medium of mucus which is secreted by bacteria and bounded by threadlike microorganisms. Biofloc technology (BFT) is as an environment friendly aquaculture technique which is based on in situ microorganism production. It is also known as “blue revolution” because the available nutrients are continuously recycled and reused in the culture medium with minimum or zero-water exchange. In BFT, Fish and shrimp are grown in an intensive way (minimum of 300 g of biomass per square meter) with zero or minimum water exchange. Continuous movement of water in the water reservoirs is required to induce the biofloc formation. **CnF Organics** is a private company promoting the use of beneficial microbes in BFT for aquaculture, decomposition of organic matter and manufacturing organic pesticides and tonics utilizing natural microbes, red wiggler earth worm and black soldier larvae to decompose organic waste. Moreover, it is striving to replace the plant proteins (from pulses and cereals) by animal proteins (from insect larvae) in feeds of poultry and fish. The company, in association with other sister units is promoting BFT in aquaculture for raising tilapia fish and shrimp in above ground water tanks, specially designed for this purpose. It has been experienced that in a tank with 10,000 liter water capacity, 820 tilapia fingerlings are retained for seven months (March – October). During 2019-20, 625 kg fish was harvested with average individual weight of 700 grams and sold at Rs. 300 per kilogram, generating a gross income of Rs. 187,500. It is worth mentioning that feed cost over the period was Rs.51660.00 (630 kg @ Rs.82.00 per kilogram)

# CHARACTERIZATION OF LOCAL ISOLATES OF CLOSTRIDIUM PERFRINGENS TYPE D FROM SHEEP IN DISTRICT PESHAWAR

Saqib Nawaz, Sher Bahadar Khan and Umar Siddique

Department of Animal Health, Faculty of Animal Husbandry &Veterinary Sciences
The University of Agriculture, Peshawar Khyber Pakhtunkhwa-Pakistan
**Email: sbvetdr@yahoo.com**

**ABSTRACT**

Pulpy kidney disease caused by Clostridium perfringens type D (CPD) is a deadly disease of small ruminants particularly sheep. Despite vaccination and treatment the disease is quiet prevalent in Pakistan; thus an investigative study was conducted to characterize the CPD from local isolate of sheep for effective diagnostic measures. A total of 271 fecal swabs were collected from sheep and lambs during the period of March to July from four different regions of District Peshawar. Isolates were morphologically, biochemically and molecularly confirmed through gram staining, Gelatin Liquefaction test (GLT) and Polymerase chain reaction (PCR) respectively. Out of total, 85 (31.3%) were positive for CPD on PCR. The results shown that significantly ($P<0.006$) higher prevalence rate of CPD was recorded in region 3 (34%) followed by region 4 (28%), region 2 (24%) and region 1 (6%). Similarly, significantly ($P<0.001$) higher prevalence was observed in lambs (55%) as compared to sheep (23%). Gross lesions revealed that out of total 50 necropsied animals, 43 (86%) sheep were recorded showing hemorrhages on serosa of intestine followed by gas filled small intestine in 41 sheep (82%), lesions in ileum and colon in 39 sheep (78%), soft kidney 27 (54%), dark congested liver 26 (52%), nephritis 23 (46%) and Spleenitis 13 (26%). Microscopic lesions revealed that out of total lesion scoring of 18 of Kidney tissue the sheep present a score of 10 while the lesion score of intestinerevealed 08 out of total lesion score of 15. The result revealed that kidney are more severely infected as compared to intestine in sheep.

# PREVAILING STATUS OF BRUCELLOSIS IN CATTLE AND HUMAN POPULATION IN DISTRICT SWAT

Salman Khan, Sher Bahadar Khan, Shah Zeb, Muhammad Nadeem

College of Veterinary Sciences, Faculty of Animal husbandry and Veterinary Sciences, The University of Agriculture, Peshawar

**Email: sbvetdr@yahoo.com**

**ABSTRACT**

Brucellosis is the second most important zoonotic disease and every year more than 500,000 brucella infections occurred around the globe. This study was therefore designed to find out the prevailing situation of brucellosis in cattle and human population in district Swat using to compare the sensitivity and specificity of Serum Plate Agglutination Test (SPAT), Rose Bengal late Test (RBPT) and indirect-ELISA. A total of 107 blood samples were collected from cattle (n=59) and human (n=48) i.e veterinary assistant (n=15), butchers (n=12) and livestock handlers (n=21) during period from May to July 2019. On SPAT the sero-prevalence was 18% (9/48) in humans and 8% (5/59) in cattle, on RBPT the sero-prevalence was 14%(7/48) in humans and 5% (3/59) in cattle while on indirect ELISA the sero-prevalence was 8.3% (4/48) in humans i.e veterinary assistant 6% (1/15) , butcher 8.3% (1/12), women 9.5% (2/21) and negative in cattle. This study indicates that bovine brucellosis is more prevalent in human than cattle in district swat. The prevalence of brucellosis was found high in older individuals as compared to young one, more in livestock handlers and those individuals who were consuming raw/unpasteurized milk.

# PREVALENCE OF CLOSTRIDIUM PERFRINGENS IN CALVES IN DISTRICT PESHAWAR

Saima Khan+, Sher Bahadar Khan*, Qasim Shah+, Saqib Nawaz*

+Kohat University of Science and Technology, Kohat
*The University of Agriculture, Peshawar
**Email**: **sbvetdr@yahoo.com**

**ABSTRACT**

Early calf mortality is a major issue in livestock raising which causes huge economic losses. Clostridial Perfringens associated diarrhea is one of the main causes of early calf mortality. In the current study our main objective was to identify the prevalence of Clostridium perfringens types in calf in district Peshawar. For this purpose, a total of 250 fecal samples were collected from calves (< 1year) of five different regions (I, II, III, IV, V) of Peshawar district between the months of October to December 2019. Fecal sampleswere processed for the isolation of different types of C. perfringens followed by their identification through colony characterization, Gram staining, and biochemical tests. The C. perfringensisolates were further examined forvarious type of toxin productionby Polymerase chain reaction (PCR). Out of 250, 53(21.2%) samples were positive for C. perfringens based on morphological and biochemical procedures. These isolates were furtherexaminedfor alpha and epsilon toxin (released by C. perfringens type D(CPD)) by using PCR assaywith an amplicon size of 247bp and 206bp respectively.PCR results showed a higher prevalence of CPD in region IV (38%) followed by region I (7.6%), region II (15%), region III (15%) andregion V (23%). Collectively our observation suggests that CPD is highly prevalence in calves compared with C. perfringens type C. For more study we should sequence the whole genome and prepare vaccine for the local isolates

# BETA-LACTAMASE PRODUCING ESCHERICHIA COLI ISOLATES IN LOCAL POULTRY MEAT OF FAISALABAD, PAKISTAN

Zia ullah[1], Amir Aslam[1]W and Waqas ahmad[2]

1. Department of Microbiology, University of Agriculture Faisalabad-38000, Pakistan
2. Department of Pathology, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan

Email: **vetahmad27@gmail.com**

**ABSTRACT**

Escherichia coli (E. coli) is the member of the family Enterobacteriaceae, which are present as normal flora in intestinal tract of warm blooded animals. E. coli mostly causes opportunistic infections transmitted through contaminated water and food in peoples whose immune system is depressed. The development of antibiotic resistance is accounting in the failure of proper treatments and due to the presence of β-lactamase enzymes. For this reason, the purpose of the proposed study was to check the presence of β-lactamase enzymes and screening antimicrobial profiling of clinical E. coli isolates. A total of 50 samples (poultry meat) were collected from different retail meat shops and local markets of Faisalabad, Pakistan. Samples were collected in polythene bags and kept in ice box and were transported to the bacteriology laboratory, Institute of Microbiology, University of Agriculture Faisalabad, Pakistan. MacConkey agar was used for cultivation of bacterial species in which 12 samples were found E. coli positive which is 24%. For the confirmation of bacteria biochemical tests were performed in which E. coli was found positive for indole and methyl red and was negative for voge-proskauer, citrate and oxidase. Antibiotics sensitivity test was performed using common antibiotics by following the guideline of clinical laboratory standard institute in which the most effective drug found against the isolated strains was Cefepime-fourth generation cephalosporin antibiotic, which was 22% susceptible and the isolated strains show most resistant to Tetracycline which was 84%. In PCR study, out of 12 E. coli positive isolated strains 4 were found β-lactamase positive which is 33%. It is concluded that β-lactamase enzymes E. coli isolates were found in locally reared broiler chickens meat, demonstrating that these isolates may be spreading through food trade, which are the potential sources for human exposure to β-lactamase enzymes E. coli.

# ECHINACEA PURPUREA (CONE FLOWER): AN IMMUNOMODULATORY AGENT IN NEWCASTLE DISEASE INFECTED BROILER CHICKS

Waqas Ahmad[1], Farzana rizvi[1], Ziaullah, Sadaf faiz

Department of Pathology, Faculty of Veterinary Science, University of Agriculture, Faisalabad, Pakistan
Email: **vetahmad27@gmail.com**

**ABSTRACT**

Vaccination nowadays is the utmost reliable approach to reduce the fatality rate due to Newcastle disease virus (NDV). In spite of vaccination and biosecurity, Newcastle disease (ND) is still prevalent globally in poultry. Various drugs shield the poultry birds for short period of time, while immune modulators work for longer duration against infection. The present study was planned to examine the immunomodulatory effects of Echinacea purpurea (E.P) dried extracts against NDV infection. For the present trial, a flock of 120 day old broiler chicks were randomly distributed into 4 equal groups A, B, C and D with 30 birds per replicate. Experimental shed was properly cleaned and disinfected with 4% formalin solution a day before the arrival of chicks. Fresh water was available for chicks ad libitum. All chicks were vaccinated against infectious bursal disease (IBD), NDV and hydropericardium syndrome (HPS) according to routine schedule. Group A served as control negative received no treatment and E.purpurea treatment was offered @2.5g/kg to group C and D in feed till 40$^{th}$ day of age. At day 19$^{th}$ of trial, the chicks of control positive group B were challenged with velogenic NDV strain. Anticoagulant added blood was collected at day 26$^{th}$, 33$^{rd}$ and 39$^{th}$ day post infection (DPI) for haemagglutination (HA) and haemaagglutination inhibition (HI) assay against NDV and sheep red blood cells (SRBCs). The Duncan multiple range test results concluded that body weight was significantly higher in group C from 3$^{rd}$ week onward as compared to control negative group. Geometric mean titers $\log_2$ against NDV was higher in control positive group B & treatment group D as compared to control groups at 26$^{th}$, 33$^{rd}$ and 39$^{th}$ DPI. Cellular immunity and phagocytic index; lymphoproliferative response (LPR) against avian tuberculin was higher significantly at 24$^{th}$ and 48$^{th}$ hour post inoculation in group D while carbon clearance assay (CCA) was higher in treatment group C at 0,3$^{rd}$ & 15$^{th}$ minute. In conclusion, the present study revealed that use of Echinacea purpurea @2.5g/kg in feed enhanced the overall performance and immune response of broiler birds against NDV.

# GC-MS ANALYSIS AND ANTI-CANCER ACTIVITY OF SALVADORA OLEOIDES ROOT EXTRACTS FROM SOUTHERN KHYBER PAKHTUNKHWA PAKISTAN

Rabia Nousin*[1] Muhammad Adnan[1], Zafar Iqbal[1], Hafiz Naveed Shahzad[2], Kalim Ullah*[3]

1. Department of Botany, Kohat University of Science and Technology, Kohat-26000, Khyber Pakhtunkhwa, Pakistan.
2. SBS, University of Punjab, Lahore, Pakistan
3. Department of Zoology, Kohat University of Science and Technology, Kohat-26000, Khyber Pakhtunkhwa, Pakistan

*Email: dr.kalim@kust.edu.pk

**ABSTRACT**

Cancer still remains a major health burden all over the world and around 18 million new cases and 9.6 million deaths occurred due to various types of cancer in 2018. Traditionally, plants and plant derived extracts have been used for the treatments of various diseases including cancer. Medicinal plants are rich sources of bioactive molecules that target multiple cellular processes and pathways involved in cancer progression. Pakistan is comprised of various climatic zones with unique biodiversity and consists of around 6000 plant species, of which approximately 400–600 species are reported to be medicinally important. There are many plants that have been used for the treatment of various cancers traditionally in Pakistan, but their anticancer potential has not been studied yet. In the present research GC-MS analysis and anticancer activity of salvadora oloid from Southern Khyber Pakhtunkhwa was determined. GC-MS analysis revealed that this plant contains different bioactive molecules. For anticancer activity different concentration of the root of this plants were used against Breast, liver and cervical cancer via MTT assay. Results showed that root extracts were more effective against breast and cervical cancer. Data obtained from the present research work could be useful for their further anti-cancer investigation.

# NODULATION AND GROWTH RESPONSE OF MASH BEAN (VIGNA MUNGO L.) TO RHIZOBIUM INOCULATION AND PHOSPHORUS UNDER CONTROLLED CONDITION IN SKARDU GILGIT BALTISTAN

Sajid Hussain[1*], Zakir Hussain[2], Javaid Hassan[3], Aziz Sheikh[3], Muhammad Abbas[4]

1. Department of Soil Science, Sindh Agriculture University Tandojam, Hyderabad, Sindh, Pakistan
2. Soil Research Laboratory, Agriculture Department, Skardu, Gilgit-Baltistan Pakistan
3. Institute of Soil Science, PMAS Arid Agriculture University Rawalpindi, Punjab, Pakistan
4. Department of Soil Science, University of Agriculture Peshawar, KPK, Pakistan

**Email: sajid14_5@yahoo.com**

**ABSTRACT**

The pot trail was conducted at Agriculture Department Skardu in May-August 2018 to investigate the effects of rhizobium inoculum and phosphorus on nodulation and growth parameters of mash bean (NARC-III). Rhizobia fix atmospheric nitrogen and thus not only improve the production of inoculated crops, but also leave a fair amount of nitrogen in the soil. Phosphorous has considered to as the master key element in crop production. The experiment was carried out in randomized complete block design with three replications and eight treatments. A soil composite was collected for analysis of chemical and physical properties of soil. The phosphorus rates were 0, 40, 60 and 80kg $P_2O_5$ $ha^{-1}$. The crop was observed in terms of nodule number, nodule fresh weight, nodule dry matter, plant height, shoot fresh weight, root fresh weight, shoot dry matter and root dry matter. It was noticed that the combined use of phosphorus and rhizobium inoculum rise the number of nodules per plant. All the characters were recorded better in treatment $T_8$ by application of (**80 kg $P_2O_5$ $ha^{-1}$ and Rhizobium**) as compared to all other treatments. The result shows that the growth of plant was related to the number of nodules on roots of plant.

# EFFECT OF BENEFICIAL MICROBES, HUMIC ACID AND FARMYARD MANURE ON YIELD AND YIELD COMPONENTS OF WHEAT

Nawab Ali, Muhammad Mehran Anjum, Muhammad Hamid and Gul Roz khan

Department of Agronomy, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar-Pakistan
**Email: nawab@aup.edu.pk**

**ABSTRACT**

An experiment was conducted at Agronomy Research Farm, the University of Agriculture Peshawar during winter 2016-17 to study the response of wheat to different levels of beneficial microbes (BM), humic acid (HA) and farmyard manure (FYM). The experiment was laid out in three factorial randomized complete block design having four replications. Two levels of beneficial microbes (0 and 50 L $ha^{-1}$) and three levels of humic acid (15, 25, and 35 kg $ha^{-1}$) and farmyard manure (10, 15, and 20 t $ha^{-1}$) were used. Each replication had one control plot with no beneficial microbes, humic acid and farmyard manure. Results showed that days to emergence and emergence $m^{-2}$ were non-significantly affected by beneficial microbes, humic acid and farmyard manure. However, physiological maturity, productive tillers $m^{-2}$, leaf area $tiller^{-1}$ ($cm^2$), spike length, spikes $m^{-2}$, plant height (cm), grains $spike^{-1}$, thousand grains weight (g), biological yield (kg $ha^{-1}$), grain yield (kg $ha^{-1}$) and harvest index (%) significantly affected by beneficial microbes, humic acid and farmyard manure. Beneficial microbes treated plots at the rate of 50 L $ha^{-1}$ produced maximum productive tillers $m^{-2}$ (262), leaf area $tiller^{-1}$ (109.62 $cm^2$), spike length (10.01 cm), spikes $m^{-2}$ (264), plant height (98.8 cm), grains $spike^{-1}$ (51), thousand grains weight (45.59 g), biological yield (10272 kg $ha^{-1}$), grain yield (3719 kg $ha^{-1}$) and harvest index (36.15 %). Similarly, humic acid treated plots at the rate of 35 kg $ha^{-1}$ revealed maximum days to physiological maturity (163 days), productive tillers $m^{-2}$ (262), leaf area $tiller^{-1}$ (111.38 $cm^2$), spike length (10.37 cm), spikes $m^{-2}$ (268), plant height (100.4 cm), grains $spike^{-1}$ (52), thousand grains weight (46.95 g), biological yield (10457 kg $ha^{-1}$), grain yield (3815 kg $ha^{-1}$) and harvest index (36.56 %). Application of farmyard manure at the rate of 20 t $ha^{-1}$ showed maximum days to physiological maturity (164 days), productive tillers $m^{-2}$ (267), leaf area $tiller^{-1}$ (111.60 $cm^2$), spike length (10.49 cm), spikes $m^{-2}$ (271), plant height (100.9 cm), grains $spike^{-1}$ (52), thousand grains weight (47.50 g), biological yield (10711 kg $ha^{-1}$), grain yield (3997 kg $ha^{-1}$) and harvest index (37.34 %). Combined application of BM and FYM had significantly affected yield and yield components of wheat. It was concluded that beneficial microbes at 50 L $ha^{-1}$, humic acid at the rate of 25 kg $ha^{-1}$ and farmyard manure at the rate of 20 t $ha^{-1}$ significantly increased yield and yield components of wheat.

# PEHONOLGY AND MORPHOLOGICAL TRAITS OF WHEAT CROP AS AFFECTED BY APPLICATION OF HUMIC ACID, FARMYARD MANURE AND BENEFICIAL MICROBES

*Muhammad Hamid[1], Muhammad Mehran Anjum[1], Nawab Ali[1] and Gul Roz Khan

[1]Department of Agronomy, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar-Pakistan
[2]Department of Soil and Environmental Sciences, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar-Pakistan
**Email: mehrananjum503@gmail.com**

**ABSTRACT**

An experiment was conducted at Agronomy Research Farm, the University of Agriculture, Peshawar during winter 2016-17 to study the response of wheat to different levels of beneficial microbes (BM), humic acid (HA) and farmyard manure (FYM). The experiment was laid out in three factorial randomized complete block design having four replications. Two levels of beneficial microbes (0 and 50 L $ha^{-1}$) and three levels of humic acid (15, 25, and 35 kg $ha^{-1}$) and farmyard manure (10, 15, and 20 t $ha^{-1}$) were used. Each replication had one control plot with no beneficial microbes, humic acid and farmyard manure. Results showed that days to emergence and emergence $m^{-2}$ were non-significantly affected by beneficial microbes, humic acid and farmyard manure. However, physiological maturity, productive tillers $m^{-2}$, non-productive tillers, leaf area $tiller^{-1}$ ($cm^2$) and leaf area index (cm) significantly affected by beneficial microbes, humic acid and farmyard manure. Beneficial microbes treated plots at the rate of 50 L $ha^{-1}$ produced maximum days to physiological maturity (164 days), productive tillers $m^{-2}$ (262), leaf area $tiller^{-1}$ (109.62 $cm^2$),. Similarly, humic acid treated plots at the rate of 35 kg $ha^{-1}$ revealed maximum days to physiological maturity (163 days), productive tillers $m^{-2}$ (262), leaf area $tiller^{-1}$ (111.38 $cm^2$),. Application of farmyard manure at the rate of 20 t $ha^{-1}$ showed maximum days to physiological maturity (164 days), productive tillers $m^{-2}$ (267), leaf area $tiller^{-1}$ (111.60 $cm^2$). Combined application of BM and FYM had significantly affected morphological traits of components of wheat. It was concluded that beneficial microbes at 50 L $ha^{-1}$, humic acid at the rate of 25 kg $ha^{-1}$ and farmyard manure at the rate of 20 t $ha^{-1}$ significantly increased morphological and yield components of wheat.

# EFFECT OF RHIZOBIUM INOCULATION AND PHOSPHOROUS LEVELS ON YIELD OF MUNGBEAN

Maleeha Mehboob and Shazma Anwar

Faculty of Crop Production Sciences, Department of Agronomy, The University of Agriculture, Peshawar
**Email: shazma@aup.edu.pk**

**ABSTRACT**

Low productivity of grain legumes is generally associated with reduced soil fertility and limited $N_2$-fixation. In order to assess the influence of rhizobium inoculation and phosphorus levels on yield of mung bean, an experiment was conducted at Agronomy Research Farm, The University of Agriculture, Peshawar during summer 2018. Two factors i.e. seed inoculation (inoculated and un-inoculated) and phosphorus levels (0, 40, 60 and 80 kg $ha^{-1}$) were included in the experiment. The experiment was laid out in randomized complete block design with three replications. Plot size of 3m x 2m, having 6 rows with row to row distance of 30 cm was maintained. The experimental results showed that seed inoculation with rhizobium performed better than un-inoculated seed. Rhizobium inoculation significantly enhanced leaves $plant^{-1}$ (26), nodules plant (23), pods $plant^{-1}$ (26), thousand seeds weight (37 g), seed yield (558 kg $ha^{-1}$), biological yield (2241.4 kg $ha^{-1}$) and harvest index (24.8%). Regarding phosphorus application, maximum leaves $plant^{-1}$ (25), nodules $plant^{-1}$ (20), plant height (77.7 cm), pods $plant^{-1}$ (26), seeds $pod^{-1}$ (11), grain yield (618.4 kg $ha^{-1}$), thousand seeds weight (38 g), biological yield (2398.1 kg $ha^{-1}$) and harvest index (25.7%) was recorded in plants that received 80 kg P $ha^{-1}$. It is concluded from the experimental results that inoculation of mung bean seeds with rhizobium and application of phosphorus at the rate of 80 kg $ha^{-1}$ showed prominent increase in yield and thus recommended for higher production of mung bean in the agro climatic condition of Peshawar, Pakistan.

# HARNESSING THE SIGNALING EFFECTS OF PLANT CYTOKININ TWO-COMPONENT SYSTEMS INTO SUSTAINABLE CROP PRODUCTION

Dr. Muhammad Naseem [1,2]

1: College of Natural and Health Sciences, Department of Life & Environmental Sciences, Zayed University Abu Dhabi
2: Department of Bioinformatics, Biozentrum University of Wuerzburg Germany
**Email: muhammad@biozentrum.uni-wuerzburg.de**

**ABSTRACT**

Cytokinins are small molecule plant hormones that control every aspect of plant growth and development. Their function in mediating plant susceptibility to plant pathogens is well known. We studied the contrary and found that the interaction between cytokinins and salicylic acid pathways promote plant resistance to pathogen infection. We explored ways in which cytokinin signaling could crosstalk with plant immune networks. Some of these networks are modulated by pathogens to propagate disease, whereas others help the host to mitigate an infection. Besides salicylic acid, cytokinin also crosstalk with auxin and thus module immune dynamics of plants. Cytokinins are also secreted by many different type of beneficial as well as pathogenic microbes. Few of these pathogens have been shown to harbor CHASE-domain and LOG-domain proteins, which perceive and convert inactive cytokinins into active species. Besides plants, cytokinins are also shown to be involved in animal/human microbial pathogenesis and thus raise questions about food-security and cross-kingdom regulations. We also showed that spatiotemporal homeostasis of cytokinins metabolism has pertinent consequences for plant response to abiotic stresses such as prolong drought exposure. I would like to highlight these interesting developments in the field of plant cytokinin biology and discuss the overall role of cytokinins in sustainable crop production.

# THE INFLUENCE OF BIOAAB APPLICATION AS A BIO-FERTILIZER WITH DIFFERENT N SOURCES ON THE YIELD AND NUTRIENT UPTAKE OF WHEAT

Imran Azeem and Hamida Bibi

Department of Soil and Environmental Science,
Faculty of Crop Production, The University of Agriculture Peshawar
**Email: drhamida@aup.edu.pk**

**ABSTRACT**

This study evaluated the effect of nitrogen sources and Bioaab application on wheat yield, nutrients uptake and soil fertility. Experiment was conducted at Agronomic research farm, the University of Agriculture Peshawar. Design used randomized complete block (RCBD) with plan mean comparison having three replications. The experiment consisted on thirteen treatments of organic (FYM) and inorganic (urea) ratios (0:100, 20:80, 40:60, 60:40, 80:20 and 100:0) with and without Bioaab and control. Basal dose of P and K were applied @ 90 kg $ha^{-1}$ and 60 kg $ha^{-1}$ respectively at the time of sowing. Application of Bioaab significantly enhanced grain yield (3247 kg $ha^{-1}$), total dry matter (8993 kg $ha^{-1}$), plant height (92.1 cm), spike length (10.1 cm), grain $spike^{-1}$ (52), thousand grain weight (46.2 g), soil electrical conductivity (0.29 $dSm^{-1}$),soil lime (1.34 %), soil organic matter (1.34 %), soil nitrogen (2669 mg $kg^{-1}$), plant nitrogen (1.56 mg $kg^{-1}$), uptake of nitrogen (143.47 kg $ha^{-1}$), soil phosphorus (4.45 mg $kg^{-1}$), plant phosphorus (0.22 mg $kg^{-1}$), uptake of phosphorus (20.96 kg $ha^{-1}$), soil potassium (80.93 mg $kg^{-1}$), plant potassium (1.43 mg $kg^{-1}$) and uptake of potassium (131.54 kg $ha^{-1}$). Application of organic and inorganic ratio 60:40 significantly increased grain yield (3695.8 kg $ha^{-1}$), total dry matter (9806.3 kg $ha^{-1}$), plant height (97.9 cm), spike length (10.5 cm), grain $spike^{-1}$ (59.2), thousand grain weight (48.3 g), soil nitrogen (2791 mg $kg^{-1}$), plant nitrogen (1.78 %), uptake of nitrogen (174.86 kg $ha^{-1}$), plant phosphorus (0.29 mg $kg^{-1}$), uptake of phosphorus (28.96 kg $ha^{-1}$), plant potassium (1.62 mg $kg^{-1}$) and uptake of potassium (160.56 kg $ha^{-1}$) However, soil organic matter (1.45 %) and electrical conductivity (0.30 dS $m^{-1}$), soil phosphorus (5.14 mg $kg^{-1}$), soil potassium (88.02 mg $kg^{-1}$), were observed with application of N from sole organic source. From the results, it is concluded that application of Bioaab and 60:40 organic and inorganic ratios improved yield and nutrients uptake in Peshawar valley.

# RESIDUAL EFFECT OF ZINC LEVELS, COMPOST TYPES AND ZINC SOLUBILIZING BACTERIA ON GROWTH AND YIELD OF MUNGBEAN

Abdul Haseeb Khan, Maazullah, Shah Khalid and Amanullah

Department of Agronomy, Faculty of Crop Production Sciences,
The University of Agriculture, Peshawar- Pakistan
**Email: Abdulhaseebbjr@gmail.com**

**ABSTRACT**

Field experiment was conducted to study the residual effect of zinc levels and compost types and Zn solubilizing bacteria on mungbean under wheat-mungbean cropping system. The experiment was conducted during kharif season 2019 at Agronomy Research Farm, The University of Agriculture Peshawar. Randomized complete block design (RCBD) was used hiving three replications. Three types of composts (poultry, sheep, and farmyard manure) along with one control, three levels of zinc (0, 5, 10 and 15 kg Zn $ha^{-1}$) and application of Zn solubilizing bacteria (with and without) were applied to the preceding wheat crop and their residual effect was studied on the subsequent mungbean. The results revealed that composted poultry manure produced more nodules $plant^{-1}$(13), leaves $plant^{-1}$ (21), maximum plant height (72 cm), grain yield (825 kg $ha^{-1}$), biological yield (2657 kg $ha^{-1}$), and harvest index (25 %). Composted poultry manure significantly enhanced phenological parameters i.e. days to flowering, days to pod formation and days to physiological maturity. Seed treated with zinc solubilizing bacteria (+) performed better in terms of higher yield and yield components as compared to control plots (without ZSB). Application of zinc at the highest rate of 15 kg $ha^{-1}$ to the preceding wheat crop significantly increased nodules $plant^{-1}$ (14), plant height (73 cm), leaves $plant^{-1}$(22), pods $plant^{-1}$(28), seeds $plant^{-1}$(13), thousand grains weight (59 g), biological yield (2623 kg $ha^{-1}$), grain yield (825 kg $ha^{-1}$) and harvest index (23 %) of the subsequent mungbean. Based on results it was concluded that the residual effect of poultry manure compost + 15 kg Zn $ha^{-1}$ along with ZSB increased yield and yield components of mungbean under wheat-mungbean cropping system.

# EFFECT OF ZINC LEVELS AND COMPOST TYPES ON LEAF CHARACTERISTICS AND CHLOROPHYLL CONTENT OF WHEAT WITH AND WITHOUT ZINC SOLUBILIZING BACTERIA

Maazullah, Abdul Haseeb Khan, Shah Khalid and Amanullah

Department of Agronomy, Faculty of Crop Production Sciences,
The University of Agriculture, Peshawar- Pakistan
**Email: maazmohib0342@gmail.com**

**ABSTRACT**

Field experiment was conducted to study the effect of zinc levels and compost types on wheat parameters with and without Zn solubilizing bacteria at the Agronomy Research Farm of The University of Agriculture Peshawar, Pakistan during winter 2018-19. The experiment was conducted in randomized complete block design with split plot arrangement having three replications. Zinc solubilizing Bacteria (ZSB) was allotted to main plots, while combination of compost sources [control, sheep, cattle and poultry manure compost (5 t $ha^{-1}$)] and zinc levels (0, 5, 10 and15 kg $ha^{-1}$) to sub plots. A plot size of 3 x 4 $m^2$, consisting of 10 rows, 4 m long with row to row distance 30 cm was used. Experiment results showed that application of zinc at the rate of 15 kg $ha^{-1}$ produced maximum mean leaf area (33.9 $cm^2$), leaf area index (3.2), productive tillers $m^{-2}$ (240.7), chlorophyll content (50.4), spike length (17.3 cm), spikelet's per spike (21.9) and spike weight (3.9 g) except un-productive tillers $m^{-2}$ (8.6). Poultry manure compost enhanced mean leaf area (35.8 $cm^{-2}$), leaf area index (3.4), productive tillers $m^{-2}$ (245.8), chlorophyll content (53.3), spike length (18 cm), spikelet's per spike (20.8) and spike weight except un-productive tillers $m^{-2}$ (9.2). Higher mean leaf area (34.3 cm), leaf area index (3.21), productive tillers $m^{-2}$ (228.7) chlorophyll content (49.2), spike length (16.8 cm), spikelet's per spike (21.9) and spike weight (33.1 g) was observed in ZSB treated plots as compared to without ZSB. Hence for higher wheat production, application of zinc at the rate of 15 kg $ha^{-1}$ and poultry manure compost with ZSB is recommended in agro-ecological region of Peshawar.

# IMPACT OF BIOFERTILIZERS, ORGANIC AND INORGANIC PHOSPHORUS SOURCES ON YIELD AND YIELD COMPONENTS OF HYBRID MAIZE

Faiq Ahmad, Amanullah and Shah Khalid

Department of Agronomy, Faculty of Crop Production Sciences
The University of Agriculture, Peshawar-Pakistan
**Email: faiqriaz@gmail.com**

**ABSTRACT**

Field trial was conducted to investigate the impact of biofertilizers, organic and inorganic phosphorus sources on yield and yield components of hybrid maize (CS-200) with PSB and trichoderma. The research was conducted at the Agronomy Research Farm of The University of Agriculture Peshawar, during summer 2017. Experiment was laid out in randomized complete block design with split plot arrangement, using four replications. Combination of inorganic and organic sources was used as main plot factor, and biofertilizers (PSB and trichoderma) as sub plot factor. Phosphorus sources (organic and inorganic) and biofertilizers (PSB and trichoderma) significantly affected all parameters under study. The PSB had significant effects on ear length, number of grains per row, number of rows per ear, number of grains per ear, thousand grains weight, biological yield, grain yield, stover yield, harvest index and shelling percentage. Among phosphorus sources compost increased in number of ears plant$^{-1}$ (1.6), ear length (27.5 cm), number of grains row$^{-1}$ (36.4), number of rows ear$^{-1}$ (12.4), number of grains ear$^{-1}$ (450), thousand grains weight (346.1 g), biological yield (12769 kg ha$^{-1}$), grain yield (5392 kg ha$^{-1}$), stover yield (7377 kg ha$^{-1}$), harvest index (42.3 %) and shelling percentage (84.9 %) was noticed when phosphorus was applied in the form of compost. Phosphate solubilizing bacteria significantly enhanced ear length (22 cm), number of grains per row (32.8), number of rows per ear (10.9), number of grains per ear (358.9), thousand grains weight (315.5 g), biological yield (11825 kg ha$^{-1}$), grain yield (4899 kg ha$^{-1}$), stover yield (6927 kg ha$^{-1}$), harvest index (41.5 %) and shelling percentage (80.1 %). It was concluded from the study that application of phosphorus applied at the rate of 120 kg ha$^{-1}$ from compost and PSB could improve yield and yield components of maize hybrid.

# IMPACT OF ORGANIC MATTER AND PHOSPHATIC FERTILIZER SOURCES ON GROWTH AND YIELD OF WHEAT WITH AND WITHOUT BENEFICAL MICROBES

Asghar Khan, Amanullah, and Shah Khalid

Department of Agronomy, Faculty of Crop Production Sciences
The University of Agriculture, Peshawar-Pakistan
Email:

**ABSTRACT**

The impact of different organic sources, organic and inorganic phosphorus was investigated on plant growth, yield and yield components of wheat with and without phosphate solubilizing bacteria. The research was conducted at the Agronomy Research Farm of The University of Agriculture Peshawar, during winter 2016. Experiment was laid out in randomized complete block design with split plot arrangement, using three replications. Combination of organic sources and phosphorus sources were used as main plot factor, and phosphate solubilizing bacteria (with and without PSB) as sub plot factor. Each sub plot will be consist of 10 rows, 3 m long and 30 cm apart. The results revealed that organic sources, P sources and PSB significantly affected all parameters under study. Early phenological development, growth yield and yield components was observed at plots receiving poultry manure and 90 kg P $ha^{-1}$ from single super phosphate. Similarly, application of poultry manure as a source of organic matter improve phenological development, growth, yield and yield components than other organic sources. Seed inoculation with PSB enhanced phenological development, improved growth, yield and yield components as compared to plots having no PSB. Application of P (90 kg P $ha^{-1}$) from rock phosphate along with seed inoculation (+PSB) and poultry manure could improve wheat growth and productivity in the study area.

# COMPOST AND PHOSPHORUS MANAGEMENT IMPROVE PROTEIN AND OIL YIELDS, PRODUCTIVITY AND PROFITABILITY OF SOYBEAN WITH AND WITHOUT PHOSPHATE SOLUBILIZING BACTERIA

[1*]Amanullah, [1]Junaid Ali Khan Khalil, [1]Shah Khalid, [2]Abdur Rehman, and [2]Sajid Ali

[1]Department of Agronomy, Faculty of Crop Production Sciences, The University of Agriculture Peshawar
[2]Agriculture Research Officer, Agriculture Research Institute Tarnab Farm, Peshawar
***Email: amanullah@aup.edu.pk**

**ABSTRACT**

Population growth and associated changes in the consumption and demand of oilseed crops as bio-fuel and vegetable oil are putting increasing pressure on our soil resources and environment. Sustainable oilseed crops cultivation practices are therefore important to increase crop productivity and profitability without harming soil and environment. Stable and productive soils having enough organic matter affect the resilience of farms to cope with the effects of climate change. The objective of this research was to study the response of oilseed soybean (Glycine max L. Merrill) to the integrated use of organic sources (compost) [sole poultry and cattle manures composts (each applied @ 10 t $ha^{-1}$ as sole), and integration of poultry manure compost + cattle manure compost (each applied @ 5 t $ha^{-1}$ in combination)] and phosphorus (0, 30, 60 and 90 kg P $ha^{-1}$) management on the yield components, seed protein and oil contents, yield (protein, oil and grain yield) and growers income with (+) and without (-) biofertilizers [phosphate solubilizing bacteria (PSB)]. Two separate field experiments [one with (+) and second without (-) PSB seed inoculation] were conducted during summer 2016 at the Agriculture Research Institute Tarnab Peshawar-Pakistan (semiarid climate). The results revealed that sole application of poultry manure compost (10 t $ha^{-1}$) or integrated use of poultry manure compost + cattle manure compost (5 t $ha^{-1}$ each) improved yield components, seed quality, protein, oil and grain yields, harvest index and profitability as compared with sole cattle manure compost application. Plots treated with PSB (+) was declared more economical in terms of higher seed protein and oil contents, protein, oil and grain yields, harvest index and profitability than without (-) PSB inoculated seeds. The increase in P levels resulted in in higher number of pods $plant^{-1}$, thousand grains weight, protein and oil contents and yield as well as grain yield and harvest index (90 > 60 > 30 > 0 kg P $ha^{-1}$). We concluded from this study that application of highest phosphorus level (90 kg P $ha^{-1}$) along with sole poultry manure compost (10 t $ha^{-1}$) or combined (integrated) use of poultry + cattle manure composts (5 t $ha^{-1}$ each) and seed inoculation with PSB (+) could improve soybean quality, productivity and profitability under semiarid climates.

# GROWTH AND YIELD OF WHEAT AS AFFECTED BY PHOSPHORUS, ZINC AND EFFECTIVE MICRO-ORGANISMS

Muhammad Ibrahim Khan, Amanullah and Shah Khalid

Department of Agronomy, Faculty of Crop Production Sciences
The University of Agriculture, Peshawar-Pakistan
**Email: ibrahimagrian@gmail.com**

**ABSTRACT**

Field experiment was conducted to evaluate growth, phenology, dry matter partitioning, yield and yield components of wheat (cv. Siren-2010) to phosphorus (40, 60, 80 and 100 kg P $ha^{-1}$), zinc (5, 10 and 15 kg $ha^{-1}$) and effective micro-organisms application timings (EMO) (0 DAE, 20 DAE and 40 DAE). The experiment was conducted at the "Agronomy Research Farm", The University of Agriculture (UOA) Peshawar in randomized complete block design using three replications with split plot arrangement during winter 2013-14. Combination of P and Zn levels were allotted to main plots, while effective microorganism's application timing was allotted to sub plots. The results exhibited that applied phosphorus at the rate of 80 kg P $ha^{-1}$ enhanced days to physiological maturity (155), leaf area $tiller^{-1}$ (134.61 $cm^2$), leaf area (25.2 $cm^2$), leaf area index (3.6), leaf (159.9 g $m^{-2}$), stem (238.6 g $m^{-2}$) and total (422.2 g $m^{-2}$) dry matter at booting, leaf (112.7 g $m^{-2}$), stem (357.6 g $m^{-2}$), spike (220.8 g $m^{-2}$) and total (691.2 g $m^{-2}$) dry matter at anthesis, leaf (370.5 g $m^{-2}$), stem (275.3 g $m^{-2}$), grains (474.7 g $m^{-2}$), spike straw (353.6 g $m^{-2}$) and total (1474.1 g $m^{-2}$) dry matter at physiological maturity respectively, un-productive tillers $m^{-2}$ (11), plant height (101.5 cm) grains $spike^{-1}$ (48.4), thousands grains weight (48.81 g), biological yield (11365 kg $ha^{-1}$), yield components and grains yield (4637 kg $ha^{-1}$) ≥ 100 > 60 > 40 (3679) and harvest index (41.0 %). Applied phosphorous at 100 kg P $ha^{-1}$ enhanced days to anthesis (123), spike dry matter at booting (25.8 g $m^{-2}$), productive tillers $m^{-2}$ (266). Applied zinc at 15 kg Zn $ha^{-1}$ enhanced days to physiological maturity (156), spike dry matter at booting (22.4 g $m^{-2}$), leaf (105.9 g $m^{-2}$), stem (311.2 g $m^{-2}$), spike (200.1 g $m^{-2}$), total (617.3 g $m^{-2}$) dry matter at anthesis, biological yield (11039 kg $ha^{-1}$), grains yield (4408 kg $ha^{-1}$), Zinc applied with 10 kg Zn $ha^{-1}$ increased leaf area $tiller^{-1}$ (127.11 $cm^2$), leaf area (24.3 $cm^2$), leaf area index (3.3), leaf (146.4 g $m^{-2}$), stem (218.9 g $m^{-2}$) and total (385.7 g $m^{-2}$) dry matter at booting, leaf (343.2 g $m^{-2}$), grains (456.1 g $m^{-2}$) and total (1396.7 g $m^{-2}$) dry matter at physiological maturity, productive tillers $m^{-2}$ (246), grains $spike^{-1}$ (46.3), thousands grains weight (46.73 g) and harvest index (41.0 %). In case of EM application timing, EM applied at 20 DAE increased dry matter into leaf (99.5 g $m^{-2}$), stem (299.4 g $m^{-2}$), spike (194.6 g $m^{-2}$) and total (593.6 g $m^{-2}$) at anthesis, productive tillers $m^{-2}$ (252), non productive tillers $m^{-2}$ (10) and grains yield (4322 kg $ha^{-1}$). All the interactions of P x Zn found non-significant except leaves $tiller^{-1}$, leaf area ($cm^2$), leaf area index, leaf, stem and total dry matter accumulation at anthesis, grains $spike^{-1}$, biological yield (kg $ha^{-1}$), grain yield (kg $ha^{-1}$). The experiment concluded that P applied with 80 kg P $ha^{-1}$ and Zn with 15 kg Zn $ha^{-1}$ along with EM applied at 20 DAE enhanced phonological development, improved growth parameters, increased dry matter into various plant parts, yield and yield components in the study area.

# INTEGRATION OF BIOCHAR, BENEFICIAL MICROBES AND ORGANIC SOURCES FOR IMPROVING MAIZE YIELD AND SOIL FERTILITY

Talha Jan and Muhammd Arif
Department of Agronomy, The University of Agriculture Peshawar
**Email: talhajan@aup.edu.pk**

**ABSTRACT**

Organic sources of plant nutrients have been proven as a key to sustainable crop production. However, farmers are usually reluctant in using organic sources of nutrients due to their low status and slow release of nutrients. Beneficial microbes accelerate the decomposition of organic matter but they are lost from the soil due to lack of suitable refuge against predatory microorganisms and water-holding material for their survival. Biochar, a biomass product of pyrolysis, has both these properties and flourish microflora population in the soil for the speedy decomposition of organic matter. A field experiment on Maize (Hybrid CS-200) laid out in Randomized Complete Block Design (RCBD) was conducted at Agronomy Research Farm, the University of Agriculture Peshawar during Kharif 2018. Three factors including beneficial microbes (with and without microbes), biochar rates (0, 7.5 and 15 t $ha^{-1}$) and organic sources (no organic source, decomposed farmyard manure (FYM) and non-decomposed FYM) were included in the experiment. Results showed that beneficial microbes resulted in higher stover yield (3.1%), grain yield (7.2 %), grains $cob^{-1}$ (6.9 %) thousand grains weight (3.8 %) and harvest index (2.8 %) compared to no microbe application. Biochar application at the rate of 7.5 t ha-1 resulted in significantly higher stover yield (10833 kg $ha^{-1}$); which was 5 % and 3.1 % higher compared to plots receiving 0 and 15 tons biochar $ha^{-1}$ respectively and grain yield (6810 kg $ha^{-1}$); which was 11% and 8 % higher than plots receiving 0 and 15 tons biochar $ha^{-1}$ respectively. Higher number of grain $cob^{-1}$ (485) and thousand grains weight (295 g) was recorded from plots receiving 7.5 t $ha^{-1}$ biochar. Among organic sources, decomposed FYM performed better in terms of thousand grains weight (298 g compared to 290 g and 284 g in plots receiving no FYM and decomposed FYM). Overall, results showed that application of microbes, a moderate application rate of biochar and application of decomposed organic sources is better for improving maize productivity.

# WHEAT GROWTH AND YIELD RESPONSE TO PHOSPHOROUS AND BIO-FERTILIZER UNDR FULL AND LIMITED IRRIGATED CONDITIONS

Siddique Khan, Shah Khalid and Amanullah

Department of Agronomy, Faculty of Crop Production Sciences
The University of Agriculture, Peshawar
**Email: siddiquekhan0009@gmail.com**

**ABSTRACT**

Experiment was conducted to investigate growth and yield response of wheat (Triticum aestivum L., cv. Siran 2010) to phosphorus (P) and bio-fertilizer (BF). The experiment was conducted under full (four irrigations) and limited (one) irrigation condition at the Research Form of The University of Agriculture Peshawar during winter 2012-13. The experiment under both full and limited irrigated condition was laid out in randomized complete block design using three replications. The results showed that irrigated plots took more days to maturity (158), produced taller plants (96.6 cm), maximum leaves tiller$^{-1}$ (5.5), larger leaf area tiller$^{-1}$ (115.6 cm$^{-2}$), maximum spikes m$^{-2}$ (254), more grains spike$^{-1}$(55.5), heavy thousand grains weight (39.4 g), maximum biological (9368 kg ha$^{-1}$) and grain yields (3612 kg ha$^{-1}$), and harvest index (38.4%) than limited irrigated condition. Application of P at the highest rate of 90 kg P ha$^{-1}$ enhanced maturity (155 days), produced taller plants (94.5 cm ), increased leaf area (114.9 cm$^{-2}$), leaf count (5.9), more number of spikes m$^{-2}$ (260), grains spike$^{-1}$ (52.4), thousand grain weight (39.1 g), biological yield (9013 kg ha$^{-1}$), grain yield (3617 kg ha$^{-1}$) and harvest index (40.0%). Maximum leaf, stem, spike and total dry matter accumulation at anthesis and maturity was produced when P was applied at 90 kg P ha$^{-1}$. Application of BF @ 30 L ha$^{-1}$ reduced days to maturity (156), produced taller plants (94.1 cm ), larger leaf area (115.0 cm$^{-2}$), high leaf count (5.8), maximum spikes m$^{-2}$ (257), more grains spike$^{-1}$(51.7), more thousand grains weight (39.1 g), maximum biological (9169 kg ha$^{-1}$), grain yield (3765 kg ha$^{-1}$) and harvest index (41.1%). Application of BF @ 20 L ha$^{-1}$ produced maximum leaf, stem, spike and total dry matter accumulation at anthesis, but maximum dry matter partitioning to leaf, stem and spike at physiological maturity was recorded when BF was applied @ 30 L ha$^{-1}$. Under full irrigated condition the increase in both P and BF levels i.e. 90 kg P ha$^{-1}$ and 30 L ha$^{-1}$, respectively was increase wheat productivity in the study area. But under limited irrigated condition the intermediate levels of both P and BM i.e. 60 kg P ha$^{-1}$ and 20 L ha$^{-1}$, respectively was increase wheat productivity in the study area.

# EFFECT OF PHOSPHORUS LEVELS AND PHOSPHATE SOLUBILIZING BACTERIA (PSB) ON GROWTH AND SEED PRODUCTION IN CORIANDER

Faryal and Gohar Ayub

Department of Horticulture
The University of Agriculture Peshawar
**Email: gohar.ayub@aup.edu.pk**

**ABSTRACT**

A field trial on "Effect of phosphorus levels and phosphate solubilizing bacteria (PSB) on growth and seed production in coriander" was performed at Horticulture Research Farm, The University of Agriculture Peshawar, Pakistan during 2016-17. The research was carried out using RCBD with split plot arrangement, having two factors repeated three times. Different Phosphorus levels (0, 20, 40, 60 and 80 kg $ha^{-1}$) were used along with and without PSB treatment. Different levels of phosphorus and PSB showed significant effect on all growth parameters except days to emergence. The interaction of phosphorus and PSB was non-significant for most of the parameters except for days to flowering, seed yield $plant^{-1}$ and seed yield $ha^{-1}$. Early flowering (95.4 days), maximum plant height (122.3 cm), minimum days to maturity (132.3), maximum number of umbel $plant^{-1}$(41.8), number of umbellate $umbel^{-1}$ (8.5), number of seeds $umbellate^{-1}$ (8.3), 1000 seed weight (11.4 g) and seed yield $ha^{-1}$ (1212 kg) were recorded in plants supplied with 40 kg P $ha^{-1}$. Similarly PSB treatment caused early flowering (101.5 days), maximum plant height (114.9 cm), minimum days to maturity (139.5), maximum number of umbel $plant^{-1}$(36.5), number of umbellate $umbel^{-1}$ (7), number of seeds $umbellate^{-1}$ (7.8), 1000 seed weight (10.3 g) and seed yield $ha^{-1}$ (1105 kg). Thus, phosphorus at the rate of 40 kg $ha^{-1}$ along with phosphate solubilizing bacteria were found as influencing factors that improve seed yield in coriander and hence recommended for coriander grower under the agro climatic conditions of Peshawar.

# EFFECT OF PHOSPHORUS WITH AND WITHOUT PHOSPHATE SOLUBILIZING BACTERIA ON GROWTH AND YIELD OF TOMATO

Saeed and Gohar Ayub

Department of Horticulture
The University of Agriculture Peshawar
**Email: gohar.ayub@aup.edu.pk**

**ABSTRACT**

Field experiment entitled "The effect of various phosphorus levels and with and without phosphate solubilizing bacteria on growth and yield of tomato" was conducted at Agricultural Research Station Buner, during March 2016. Randomized Complete Block Design was used replicated three times. Various phosphorus levels (0, 50, 75, 100 and 125 kg $ha^{-1}$) with and without (PSB) were used. The application of phosphorus and PSB significantly influenced all the studied parameters. Phosphorus at @125 kg $ha^{-1}$ early flowering (32days), number of branches $plant^{-1}$ (9.12), stem "diameter" 1.26 (cm), leaf area $plant^{-1}$ (2340.3$cm^2$), increased plant height (8.64 cm), diameter of fruit (17.21 cm), No. of fruits $plant^{-1}$ (64), yield (25.9 tons $ha^{-1}$). root length (14.62cm) and fresh root weight (89.92 gm), and Application of phosphate solubilizing bacteria took minimum flowering days (31), number of branches $plant^{-1}$ (6.9), stem diameter (1.2 cm), increased plant height (76.34 cm), fruit diameter (13.62 cm), number of fruit $plant^{-1}$ (63.56), fruit yield (24.6 tons $ha^{-1}$), Root length (14.27 cm), fresh root weight (87.94 gm), except leaf area $plant^{-1}$ (1911 $cm^2$). It is concluded that of 125 kg $ha^{-1}$phosphorus along with seedling inoculation with PSB resulted higher yield in the study area.

# EFFECT OF FARM YARD MANURE WITH AND WITHOUT BIOZOTE ON YIELD AND NUTRIENTS UPTAKE BY WHEAT CROP

Abrar Ahmad

Department of Agronomy, The University of Agriculture Peshawar
**Email: abraruap@gmail.com**

**ABSTRACT**

A field experiment was conducted at Research Farm, The University of Agriculture Peshawar with the aim to investigate the effect of combine application of biozote, organic and inorganic fertilizers on yield and yield components of wheat crop. Nitrogen at 120 kg $ha^{-1}$ was supplied from FYM and urea in ratios of 100:0, 75:25, 50:50, 25:75 and 0:100 with and without biozote at 2.5 kg $ha^{-1}$. All treatments were arranged in RCB design with split plot arrangements where the biozote was assigned to the main plot while FYM and urea to subplot with three replications. The plot size was 5 x 2.4 $m^2$. Recommended doses of phosphorus ($P_2O_5$) & potassium ($K_2O$) were applied at the rate of 90 and 60 kg $ha^{-1}$ in the form of SSP and SOP respectively at the time of sowing. The results revealed that maximum plant height (85.9 cm), grains per spike (48), spike length (10.4 cm), biological yield (8631 kg $ha^{-1}$), thousand grain weight (40.56 g), grain yield (3491 kg $ha^{-1}$) and harvest index (40.24 %) were significantly improved with the combined application of biozote with inorganic fertilizers at the ratio of 25% FYM and 75% urea. The application of biozote with organic and inorganic fertilizers improved the concentration of nutrients in wheat crop. The maximum concentration of plant nitrogen (0.69 %), phosphorus (0.09 %) and potassium (1.27 %) were recorded at the ratio of 25:75 of organic (FYM) and inorganic (urea) fertilizers with biozote. Similarly, the analysis of post-harvest soil samples showed that the increased FYM content decreased soil pH (7.57), soil bulk density (1.29 g $cm^3$) and also increased soil organic matter content (1.2 %), soil mineral nitrogen (22.8 mg $kg^{-1}$), soil phosphorus (6.32 mg $kg^{-1}$) and soil potassium content (123.8 mg $kg^{-1}$). The findings of the experiment revealed that the application of biozote with 25% FYM and 75% urea enhanced wheat yield and yield parameters, plant N, P and potassium concentration in the wheat crop.

# GROWTH AND YIELD RESPONSE OF MAIZE TO PHOSPHATE SOLUBILIZING BACTERIA, COMPOST AND PHOSPHORUS

Adil Khan and Amanullah

Department of Agronomy, Faculty of Crop Production Sciences
The University of Agriculture, Peshawar-Pakistan
**Email: a_khan@aup.edu.pk**

**ABSTRACT**

Field trial was conducted to investigate impact phosphorus(P) levels (25,50,75 and 100 kg P $ha^{-1}$), compost application time (30,15 and at sowing time) and phosphate solubilizing bacteria (PSB) on the growth and yield of maize at the Agronomy Research Farm of The University of Agriculture Peshawar, during autumn 2014. The experiment was laidout in randomized complete block design with split plot arrangement, using three replications. Combination of PSB (+ and -) and compost timings were used as main plot factor, while P levels as subplot factor. Compost at sowing time delayed tasseling (55 days), silking (63 days), physiological maturity (94 days), increased plant height (219.6 cm), mean single leaf area (371.2 $cm^2$), leaf area index (3.2), total dry matter (143.8 g) at silking, total dry matter (242.5 g) at physiological maturity, ear length (16.1 cm), grains $ear^{-1}$ (373), grains $row^{-1}$ (39), 1000 grains weight (344.0 g), biological yield (11696 kg $ha^{-1}$), grain yield (4422 kg $ha^{-1}$), harvest index (37.6 %) and shelling percentage (81.5). Phosphorus application at the rate of 100 kg P $ha^{-1}$ had earlier tasseling (55 days), silking (64 days), physiological maturity (93 days), increased 1000 grains weight (377g), grain yield (4471 kg $ha^{-1}$) and harvest index (37.6%). Phosphorus application at 100 kg P $ha^{-1}$ increased plant height (221.7 cm), mean single leaf area (370.6 $cm^2$), leaf area index (3.3), dry matter (145.8 g) at silking, total dry matter (245.4 g) at physiological maturity, ear length (16.5 cm), grains $ear^{-1}$ (379), grains $row^{-1}$ (39), biological yield (12035 kg $ha^{-1}$) and shelling percentage (82.4%). Phosphate solubilizing bacteria significantly increased plant height (218.5 cm) mean single leaf area (370.6 $cm^2$), dry matter (140.3 g) at silking, dry matter (241.3g) at physiological maturity, grains $ear^{-1}$ (362), grains $row^{-1}$ (38), 1000 grains weight (243 g), biological yield (12247 kg $ha^{-1}$), grain yield (4993 kg $ha^{-1}$) and shelling percentage (82.9 %). Application of phosphorus at the rate of 75 kg P $ha^{-1}$, along with compost application at sowing time and PSB could improve yield and yield component of maize.

# GROWTH AND YIELD RESPONSE OF MAIZE TO PHOSPHATE SOLUBILIZING BACTERIA, ANIMAL MANURES AND PHOSPHOROUS

Shah Khalid and Amanullah

Department of Agronomy, Faculty of Crop Production Sciences
The University of Agriculture, Peshawar-Pakistan
**Email: shahagronomist@aup.edu.pk**

**ABSTRACT**

Field trial was conducted to investigate the effects of phosphorus (P), animal manures (AM) and phosphate solubilizing bacteria (PSB) on the growth and yield of maize (Zea mays L.) hybrid (CS-200) at the Agronomy Research Farm of The University of Agriculture Peshawar, during summer 2014. Experiment was laid out in randomized complete block design with split plot arrangement, using three replications. The combination of PSB (with and without) and AM (poultry, cattle and sheep manures) were used as main plot factor, while P levels (40, 80, 120 and 160 kg $P_2O_5$ $ha^{-1}$) as sub plot factor. Animal manures and P application significantly affected all parameters under study. The PSB had significant effects on plant height, mean single leaf area, dry matter partitioning at silking and physiological maturity, grains $ear^{-1}$, grain $row^{-1}$, 1000 grains weight, biological yield, grain yield and shelling %. Among AM poultry manure delayed tasseling (62 days), silking (68 days), physiological maturity (104 days), increased plant height (181 cm), mean single leaf area (431 $cm^2$), leaf area index (4.10), dry matter at silking (153.4 g) and physiological maturity (240.1 g), ear length (24 cm), number grains $ear^{-1}$ (414), grains $row^{-1}$ (33), 1000 grains weight (348.2 g), biological (12368 kg $ha^{-1}$) and grains yields (5216 kg $ha^{-1}$), harvest index (42.09 %) and shelling percentage (84). Phosphorus application at 160 kg $ha^{-1}$ enhanced days to tasseling (60 days), silking (66 days), physiological maturity (102 days), increased 1000 grains weight (347.8 g), grain yield (5245 kg $ha^{-1}$) and harvest index (43.13 %). Phosphorus application at the rate of 120 kg $ha^{-1}$ increased plant height (185 cm), mean single leaf area (435 $cm^2$), leaf area index (4.20), total dry matter at silking (159.6 g) and physiological maturity (247.9 g), ear length (25 cm), number of grains $ear^{-1}$ (417), grains $row^{-1}$ (34), biological yield (12753 kg $ha^{-1}$) and shelling (83.6%). Phosphate solubilizing bacteria significantly increased plant height (181 cm) mean single leaf area (427 $cm^2$), total dry matter at silking (149.3 g) and physiological maturity (238.1 g), number of grains $ear^{-1}$ (409), grain $row^{-1}$ (33), 1000 grains weight (342 g), biological yield (12247 kg $ha^{-1}$), grain yield (4993 kg $ha^{-1}$) and shelling (82.9 %). Application of P at the rate of 120 kg $ha^{-1}$, along with poultry manure and PSB could improve yield and yield component of maize hybrid.

# CO-INOCULATION OF RHIZOBIA AND PHOSPHATE SOLUBILIZING BACTERIA ALONG WITH PLANT GROWTH REGULATORS FOR IMPROVING GROWTH, NODULATION, YIELD AND QUALITY OF LENTIL (LENS CULINARUS L)

Muhammad Ashfaq Anjum, Muhammad Amjad Qureshi, Muhammad Asif Ali, Fakhar Mujeeb, Munazza Rafique, Aneela Riaz, Hina Javed and Faraza Ejaz.
Soil Bacteriology Section, Agri. Biotechnology Research Institute, AARI, Faisalabad, Pakistan
**Email: ashfaq1038@gmail.com**

## ABSTRACT

Twenty strains each of Rhizobium leguminosarum and phosphate solubilizing bacteria (Bacillus megaterium) were isolated from different locations of Punjab, Pakistan. Rhizobia were tested for auxin biosynthesis with and without L-tryptophan supplementation while phosphate solubilizing bacteria were tested for phosphate solubilization under axenic conditions. All the bacterial isolates varied in auxin biosynthesis and phosphate solubilization to a different degree of efficacy. One most prolific strain each from Rhizobia in auxin biosynthesis and Bacillus megatreium efficient in phosphate solubilization were selected for further experimentation. A field experiment was conducted at the research Farms of Pulses Research Institute, AARI, Faisalabad, Pakistan with eight treatments in RCBD with three replications. Both Rhizobia and PSM inoculation significantly improved the growth and yield of lentil crop. But the combined use of Rhizobia + L-tryptophan and PSM further significantly improved the growth, nodulation, yield and quality of inoculated lentil crop. It is inferred from this study that extensive experimentation is required for the validation of biofertilizer biotechnology beneficial to the farming community.

# INTEGRATED USE OF PLANT RESIDUES, PHOSPHORUS AND BENEFICIAL MICROBES IMPROVE HYBRID MAIZE PRODUCTIVITY IN SEMIARID CLIMATES

Amanullah[1]* and Asif Iqbal[1],

[1]Department of Agronomy, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, Pakistan
**Email: amanullah@aup.edu.pk**

**ABSTRACT**

Phosphorus (P) unavailability and lack of organic matter in calcareous soils under semiarid climates are the major reasons for low crop productivity. Field experiment was conducted at The Agronomy Research Farm of The University of Agriculture Peshawar (semiarid climate), during summer 2015. The objective of the research was to investigate the effect of plant residues, organic and inorganic P management on improving yield and yield components of hybrid maize (CS-200) with (+) and without (-) phosphate solubilizing bacteria (PSB). Experiment was laid out in randomized complete block design with split plot arrangement, using three replications. Plant residues and phosphorus sources were used as main plot factor, and phosphate solubilizing bacteria (PSB) was used as sub plot factor. The results revealed that plant residues, P sources and PSB significantly affected all parameters under study except number of plants at harvest. Application of legume residues (Faba bean) increased ear length (22.9 cm), grains row$^{-1}$ (46) and ear$^{-1}$ (419), 1000 grains weight (365 g), grain yield (6175 kg ha$^{-1}$) and shelling percentage (83) as compared to paper mulberry and garlic residues. Phosphorus application at the higher rate of 120 kg ha$^{-1}$ from inorganic source (single super phosphate) was superior in terms of higher ear length (24.4 cm), number of grains row$^{-1}$ (48) and ear$^{-1}$ (455), 1000 grains weight (380 g), grain yield (6558 kg ha$^{-1}$), harvest index (42.7 %) and shelling percentage (83%) than lower rate of P (60 kg P ha$^{-1}$). Inoculation of maize seeds with beneficial microbes (phosphate solubilizing bacteria) significantly increased ear length (22.9 cm), number of grains row$^{-1}$ (45) and ear$^{-1}$ (413), 1000 grains weight (364 g), grain yield (6237 kg ha$^{-1}$), harvest index (41.8 %) and shelling percentage (82) than without seed inoculation. On the basis of our results from this study we concluded that application of faba bean residues, 120 kg P ha$^{-1}$ as SSP along with seed inoculation with PSB could improve yield and yield components of hybrid maize under semiarid climates.

# BIOCHEMICAL EVALUATION OF CRUDE EXTRACT AND ITS DERIVED FRACTIONS OBTAINED FROM DIFFERENT PARTS OF FAGONIA INDICA, WITHANIA COAGULANCE, MENTHA PIPERITA AND CORIANDRUM SATIVUM

Naila Hayat[1], Abdul Momin[1], Dr. Ghazala Nawaz[1], Neelam Afroz[1] and Naheed Akhtar[1]

[1] Department of Botanical and Environmental sciences, Kohat University of Science & Technology, Kohat-26000, Khyber pakhtunkhwa, Pakistan
**Email: nailahayatktk@gmail.com**

**ABSTRACT**

Present study is about Fagonia indica, Withania coagulance, Mentha piperita and Coriandrum sativum belonging to family Zygophyllaceae, Solanaceae, Lamiaceae and Apiaceae respectively and there antibacterial activities. The aim of the present research is to evaluate the antimicrobial activities of four medicinal plants to look into possible natural therapy agents. Different methanolic extracts of the plants were tested against two gram positive bacterial species Streptococcus pneumonia, Enterococcus faecelisand two gram negative bacterial species Escherichia coli, Salmonella typheae. The extracts of our research plants exhibited moderate to potential activities showing 13mm to 19mm inhibition against different tested pathogens as compared to control which gives a maximum of 30mm inhibition. The antibacterial profile of our research plants showed that Fagonia indica plant extract give potential inhibitions against all four tested bacteria followed by Withania coagulance, while Mentha piperita showed moderate activities and Coriandrum sativum show zero inhibition zone against tested bacterial pathogens. The bioactive extract of the plant can be further used for isolation of natural products from the plant and to add a number of valuable compounds to phyto chemistry and pharmaceutical industries.

# EFFECT OF DIFFERENT PLANTS AQUEOUS EXTRACT ON SEED GERMINATION PERCENTAGE OF WHEAT SEEDS

Neelam Affroz[1], Abdul Momin[1], Naila Hayat[1], Naheed Akhtar[1] and Dr. Ghazala Nawaz[1]

Department of Botanical and Environmental sciences, Kohat University of Science & Technology, Kohat-26000, Khyber Pakhtunkhwa, Pakistan
**Email: afrozneelamktk@gmail.com**

**ABSTRACT**

Numerous plants are recognized for their phytotoxic and inhibitory influence on seed germination and seedling growth of different plants seeds. The present study was designed to found out phytotoxic effect of Calotropis procera, Tamarix aphylla and Peganum harmala for their effect on seed germination and seedling length of wheat seeds. It was found that different concentrations (5,10,15,20 and 25%) of three plants extracts have inhibitory effect on seed germination of wheat as compare to control. It was also found that Calotropis procera and Tamarix aphylla significantly reduced seedling length of wheat at all concentration (5,10,15,20 and 25%) while Peganum harmala significantly decreased seedling length at height concentration .It was observed that root and shoot of wheat showed resistance to lower concentration (5 and 10%) of Peganum harmala. These results concluded that inhibitory effect of plant extracts are concentrations dependent and increase with the increase of concentrations. It was also concluded that plant extracts have inhibitory which effect seed germination and seedling vigour of wheat.

# COMBINED EFFECT OF PLANT DERIVED SMOKE SOLUTION AND SILICON SIO2 NANOPARTICLES ON PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF PEA PLANT (Pisum setivum L.)

Abdul Momin[1], Dr. Amna Khatoon[1], Neelam Afroz[1], Naheed Akhtar[1], Naila Hayat[1] and Amara Aziz[1]

[1] Department of Botanical and Environmental sciences, Kohat University of Science & Technology Kohat-26000, Khyber pakhtunkhwa, Pakistan
**Email: abdulmomin.bio@gmail.com**

**ABSTRACT**

Present study is about Pisum setivum belonging to family Fabaceae and combined effect of plant derived smoke solution and silicon SiO2 Nanoparticles on this plant. Result show that plant-derived smoke solution is well known as a plant growth regulator. It shows positive effect on physiological and biochemical growth parameters, thus having potential application in agriculture. On the other hand, SiO2 Nanoparticles also having the potential to promote various physiological and biochemical parameters in plants. The use of Nanoparticles (NPs) in agriculture sector is a promising area which could potentially improve prevailing crop management techniques; however, their efficacy may be compromised due to various factors, Keeping in view the efficacy and constraints to efficacy of NPs and growth promoting role of plant-derived smoke solution, the present study was conducted to explore the combined effect of plant derived smoke solution of Cymbopogon jawarncusa (C. jawarncusa) and SiO2 NPs on various parameters of Pisum setivum including germination, photosynthetic pigments and growth. Results showed that seed germination percentage and seedlings vigor was significantly increased. The chlorophyll (a and b) pigments , total carotenoids, total soluble sugar and total soluble proteins were increased in seedling treated with SiO2 NPs dissolved in plant-derived smoke solution as compared to the SiO2 NPs alone. From these results it can be concluded that plant-derived smoke solutions has the potential to increase the efficacy of SiO2 NPs.

# RESPONSE OF FINE RICE (ORYZA SATIVA L.) TO VARIOUS PLANTING DATES AND SEEDLING DENSITIES UNDER ARID ENVIRONMENT OF DERA ISMAIL KHAN

M. Azam, Ghazanfar ullah, A. A. Khakwani, M. S. Baloch, K. Waseem, I. Hussaian, M. K. Javaid

Department of Agronomy, Gomal University, Pakistan

**ABSTRACT**

Climate change has emerged as the most prominent global environment issues and there is a need to evaluate its impact on agriculture. It is need of the hour to determine suitable transplanting time for rice in this changing scenario to have better yield. The experiment was conducted to study the response of transplanting dates and seedlings densities on fine rice variety "Super Kernel" at Agronomic Research Farm, Faculty of Agriculture, Gomal University, Dera Ismail Khan during 2017. The experiment was laid out in a Randomized complete block design with three replications, because of two factors and four levels of each; split plot design was carried out. Main plots were assigned seedlings hill-1 viz. 1, 2, 3 and 4 seedlings, while sub-plots were of four different transplanting dates i.e. 18th July, 25th July, 1st August and 8th August. Data was recorded on flag leaf area (cm2), chlorophyll content (µ g-2), plant height (cm), number of fertile tillers hill-1, number of unfertile tillers hill-1, panicle length (cm), spikelet fertility (%), number of grains panicle-1, 1000-grain weight (g), biological yield (kg ha-1), grain yield (kg ha-1), benefit cost ratio (BCR) and Harvest index (%). Seedling density showed significant differences for traits such as unfertile tiller hill-1, while transplanting dates also indicated significant differences for biological yield, grain yield, plant height, spikelet fertility (%), 1000-grain yield and number of unfertile tiller per plant. Seedling densities and transplanting dates interaction also showed significant differences for various parameters under study. Data revealed that 3 seedlings hill-1 transplanted on 18th July gave maximum grain yield (4700 kg ha-1) and benefit cost ratio (2.70). Therefore, fine rice variety "Super Kernel" is recommended for transplanting on 18th July by using 3 seedling hill-1 under the environmental conditions of Dera Ismail khan.

# GROWTH, YIELD AND BIOCHEMICAL RESPONSES IN BARLEY TO DAP AND CHITOSAN APPLICATION UNDER WATER STRESS

Abdel Rahman M. Al- Tawaha[1], Nusrat Jahan[2], Ezz Al-DeinAl-Ramamneh[3], Abdel Razzaq Al-Tawaha[4], Yousef M Abu-Zaitoon[1], , Amanullah[5], and Imran[5]

(1) Department of Biological Sciences, Al Hussein Bin Talal University, P.O. Box 20, Ma'an, Jordan e-mail: abdel-al-tawaha@ahu.edu.jo

(2) Department of Botany, Faculty of Life Sciences Aligarh Muslim University, Aligarh-202002, UP, India

(3) Department of Agricultural Sciences, AL-Shouback University College, Al-Balqa Applied University, AL-Shouback, Maan, Jordan

(4) Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

(5) Agronomy Department, The University of Agriculture Peshawar, Pakistan

**Email: abdeltawaha74@gmail.com**

**ABSTRACT**

The present investigation was aimed to enhance quality and productivity of barley by fertilizer and chitosan application. Field experiments were conducted in northern region of Jordan, under rain fed conditions in the main growing seasons of 2014/2015 and 2015/2016. The experiment was prepared in the form of split-plot with three replications and two fertilizer levels (0 and 100 kg/ ha DAP (Diammonium phosphate 46% $P_2O_5$) were randomly allocated to the main plots in each replicate. Three levels (0, 5, and 10 g/L) of chitosan were randomly used before each fertilizer plot as subplot treatments. The results revealed the highest seed dry weight (5.8 g per plant) with the application of 100 kg ha-1 of DAP while the lowest (5.2 g per plant) was recorded in the control which exhibited an increase of about 10 %. However, the grain yield per plant, number of spikes per plant, number of grains per spike was notably affected by chitosan application. There were also highly significant differences ($P<0.01$) among lines with and without chitosan treatment. The highest grain yield per plant and number of spikes per plant and grains per spike were obtained with the foliar application of 10g/L chitosan to barley plants at tillering stage. Similarly, grain quality, particularly with respect to protein and starch, was found to be enhanced significantly over control. The highest protein (12.6 %) and starch (62.3 %) were obtained with 100 kg/ha DAP fertilizer level mixed with 10g/L chitosan. Therefore, based on findings, it can be concluded that the fertilizer level 100 kg/ha DAP combined with 10g/L chitosan is economically best and recommendable for improving quality and productivity of barley in northern region of Jordan.

# ACTINOMYCETES AS MEANS OF INCREASING YIELD AND YIELD COMPONENTS AND DECREASING THE DISEASE INCIDENCE OF LENTIL PLANTS

Abdel Rahman M. Al- Tawaha[1], Nusrat Jahan[2], Ezz Al-DeinAl-Ramamneh[3], Abdel Razzaq Al-Tawaha[4], Yousef M Abu-Zaitoon[1], Amanullah[5], Shah Khalid[5], Imran[5]. H. Nasri[6] Swapnil Ganesh Sanmukh[7]

(1) Department of Biological Sciences, Al Hussein Bin Talal University, P.O. Box 20, Ma'an, Jordan e-mail: abdel-al-tawaha@ahu.edu.jo

(2) Department of Botany, Faculty of Life Sciences Aligarh Muslim University, Aligarh-202002, UP, India

(3) Department of Agricultural Sciences, AL-Shouback University College, Al-Balqa Applied University, AL-Shouback, Maan, Jordan

(4) Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

(5) Agronomy Department, The University of Agriculture Peshawar, Pakistan

(6) Laboratory of Biodiversity and Ecosystems Pollution, Faculty of Life and Nature Sciences, Chadli Bendjedid University El-Tarf, Algeria

(7) Institute for Bioengineering of Catalonia (IBEC), The Institute of Science and Technology, Baldiri Reixac 15-21, 08028, Barcelona, Spain

**Email: abdeltawaha74@gmail.com**

**ABSTRACT**

Actinomycetes is being involved in plant defense response and, plant-microbe interactions, flavonoid production by plants may be increased when the plant recognizes certain molecules or structures that characterize pathogen. Actinomycetes produce a wide variety of antibiotics and of extracellular enzymes. The objective of the present study was to determine the effects, under field conditions, of foliar applications of actinomycetes spores on the yield and yield components of mature lentil, and also on the disease incidence. Actinomycetes spores were suspended in sterile 10% glycerol solution and concentration were adjusted prior to use to 2.5 × 105 and 2.5 × 109 spores per mL using sterile distilled water. Actinomycetes were applied at 4 mL per plant using a hand-held spray bottle. Actinomycetes applied at two lentil stages of development [vegetative (V4), and early podding (R3)]. Untreated controls were also included. Results indicate that actinomycetes hold promise as a way of increasing yield and yield components of lentil plants. Also, our results indicated that, the application of actinomycetes reduced the disease incidence pronouncedly. As a conclusion the use of biotic and abiotic elicitors has been investigated and used successfully for a few years as a means of initiating plant defense responses in order to reduce yield losses due to pests. This study demonstrates the potential of using elicitors as a means of increasing the yield of lentil plants.

# EFFECTS OF SOIL TYPE AND YEAST EXTRACT TREATMENTS IN THE GROWTH, PRODUCTIVITY OF FENUGREEK PLANTS CULTIVATED IN SEMI-ARID ENVIRONMENT

Abdel Rahman M. Al- Tawaha[1], Abdel Razzaq Al- Tawaha[2] , Amanullah[3], Imran[3] , Alla Aleksanyan[4], Laila Trioui[5], Soha A. Murad[6], Saeedeh Rahimzadeha[7].

(1) Department of Biological Sciences, Al Hussein Bin Talal University, P.O. Box 20, Ma'an, Jordan e-mail: abdel-al-tawaha@ahu.edu.jo

(2) Department of Crop Science, Faculty of Agriculture, University Putra Malaysia, 43400 Serdang, Selangor, Malaysia

(3) Agronomy Department, The University of Agriculture Peshawar, Pakistan

(4) Institute of Botany aft. A.L. Takhtajyan NAS RA/ Department of Geobotany and Plant Eco-Physiology, Yerevan, Armenia.

(5) Laboratory of Microbiology, Pharmacology, Biotechnology and Environment, Faculty of Sciences Ain Chock, University Hassan II of Casablanca

(6) Department of Plant Biochemistry, National Research Center, Tahrir Str., Dokki, 12311 Cairo, Egypt

(7) Urmia University Urmia, Iran University of Kurdistan Sanandaj, Iran cUniversity of Mohaghegh Ardabili Ardabil, Iran

**Email: abdeltawaha74@gmail.com**

**ABSTRACT**

Field experiments were conducted in the years 2014/2015 with two soil types from northern part of Jordan. The soil types that were chosen for the study were yellow Mediterranean sandy loam soil (site A) and red Mediterranean silt loam soil (site B), to determine the effect of foliar application of yeast extract on the fenugreek seed yield and related variables. Weeds were controlled by hand weeding throughout the season. In both sites fenugreek plants were subjected at the vegetative stage to foliar applications of yeast extract at a range of concentrations (1, 2, 3 and 4 mg $mL^{-1}$). A non-treated control was also included. Foliar applications of elicitors were made using a hand-held spray bottle with a volume of 4 mL applied per plant. Seed yield, 100-seed weight, seeds per pod, pods per plant, pod length, pod width, seed length, seed width and crude protein concentrations were concurrently determined. Results indicated that fenugreek plants grown at red Mediterranean silt loam soil (site B) location had higher seed yield, 100-seed weight, seeds per pod, pods per plant, pod length, pod width, seed length, seed width than those grown at the yellow Mediterranean sandy loam soil (site A) location. All yeast extract treatment increased the fenugreek seed yield when compared to an untreated control plants. The greatest seed yield was observed following the foliar application of yeast extract 4 mg $ml^{-1}$ at vegetative stage, which represented a 10 % increase compared to an untreated control. On the other hand, most elicitor treatments did not increased the crude protein content.

# EFFECTS OF SOIL TYPE AND CHITOSAN TREATMENTS IN THE GROWTH, PRODUCTIVITY OF WHEAT PLANTS CULTIVATED IN SEMI-ARID ENVIRONMENT

Abdel Rahman M. Al- Tawaha[1], Abdel Razzaq Al- Tawaha[2] , Amanullah[3], Imran[3] , Shah Khalid[3], Alla Aleksanyan[4], Samia Khanum[5], Mohammad Ali Shariati[6]

(1) Department of Biological Sciences, Al Hussein Bin Talal University, P.O. Box 20, Ma'an, Jordan e-mail: abdel-al-tawaha@ahu.edu.jo
(2) Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
(3) Agronomy Department, The University of Agriculture Peshawar, Pakistan
(4) Institute of Botany aft. A.L. Takhtajyan NAS RA/ Department of Geobotany and Plant Eco-Physiology, Yerevan, Armenia.
(5) Department of Botany, University of the Punjab, Lahore, Pakistan.
(6) Kazakh Research Institute of Processing and Food Industry (Semey Branch), Semey, Kazakhstan
**Email: abdeltawaha74@gmail.com**

**ABSTRACT**

Field experiments were conducted in the years 2014/2015 with two soil types from northern part of Jordan. The soil types that were chosen for the study were yellow Mediterranean sandy loam soil (site A) and red Mediterranean silt loam soil (site B). To determine the effect of foliar application of chitosan on the wheat seed yield and related variables. Plots were fertilized with 20 kg $ha^{-1}$ of nitrogen, and sufficient phosphorus and potassium during field preparation as recommended by soil tests. Weeds were controlled by hand weeding throughout the season. In both sites' wheat plants were subjected at the tillering stage to foliar applications of chitosan at a range of concentrations (1, 2, 3 and 4 mg $mL^{-1}$). A non-treated control was also included. Foliar applications of elicitors were made using a hand-held spray bottle with a volume of 4 mL applied per plant. Our results indicated that wheat plants which were grown in red Mediterranean silt loam soil had higher grain yield, increased number of spikes per plant, high amount of grains per spike, 1000-grain weight, increased plant height and higher spike length than those plants grown at yellow Mediterranean sandy loam soil. The highest seed yield were recorded when the wheat plant were subjected to highest concentration of chitosan applied at tillering stage.

# INOCULATION OF NITROGEN-FIXING BACTERIA IN CONJUGATION WITH ORGANIC AND INORGANIC FERTILIZERS INDUCE CHANGES IN GROWTH, NITROGEN ASSIMILATION AND PRODUCTIVITY OF WHEAT

Imadud Din1, Hamayoon Khan1, Nazir Ahmad Khan2, Rozina Gul3

1 Department of Agronomy, The University of Agriculture Peshawar
2 Department of Animal Nutrition, The University of Agriculture Peshawar
3 Department of Plant Breeding and Genetics, The University of Agriculture Peshawar
Correspondence
**Email: imaduddin@aup.edu.pk**

**ABSTRACT**

Nitrogen being an essential nutrient for plant growth and development strongly influence crops productivity around the world. Proper management of nitrogen fertilization of crops is required for the optimization of N accumulation, plant growth and productivity. A field experiment was conducted during 2016-17 to test the effects of N-fixing bacteria inoculation in conjugation with farmyard manure (FYM) and urea on growth, N assimilation and grain yield of wheat crop. Wheat seeds was inoculated with N-fixing bacterial strains such as Azotobacter, Rhizobium Sk-8, Pseudomonas K-1 and Azospirillum Er-20, whereas N was applied from different combination of farmyard manure (FYM) and urea (U) such 100% urea, FYM-75+U-25, FYM-50+U-50. Analysis of the data revealed that seeds inoculation with N-fixing bacterial strains and N sources significantly ($P<0.05$) delayed days to anthesis and physiological maturity, improved leaf area duration (LAD), crop growth rate (CGR), net assimilation rate (NAR), physiological nitrogen use efficiency (PNUE), apparent N re-translocation, relative N accumulation rate (RN), nitrogen harvest index (NHI) and grain yield against control. Planned mean comparison depicted significant variation in treatments vs control. Higher PNUE, apparent N re-translocation, RN, NHI and grain yield were increased by inoculation of Pseudomonas K-1, while days to anthesis, days to physiological maturity and CGR were increased by inoculation of Azospirillum Er-20 with application of N from FYM-50+U-50. However, higher LAD and NAR was attained on inoculation of Rhizobium SK-8 with FYM-50+U-50 and 100% N from urea respectively. Grain yield shown strong correlation with CGR (0.75), PNUE (0.69) and NHI (0.72). The regression analysis exhibited that grain yield ($R2 = 0.71$) was strongly dependent on soil available N. Overall result indicated that strains of N-fixing bacteria under integration of FYM and urea augmented plant growth, N accumulation and productivity of wheat crop. Long term experiments are, however, required to explore the potential of N-fixing bacteria with integration of organic and inorganic N sources in wheat crop.

# MICROBES ROLE IN THE ECONOMIC DEVELOPMENT

Dr. Naushad Khan

Institute of Development Studies, The University of Agriculture Peshawar
**Email: drkhan@aup.edu.pk**

**ABSTRACT**

Microbes are microorganism and with the help of microscope these are seen. It consists of bacteria, archaea, viruses, fungi, protists, protozoa and algae etc. Some microorganisms are beneficial while some are non-beneficial for human beings. These all live on the earth in different forms. Seeing to its importance the present study was arranged in December, 2019 to examine the role of microbes in the development of a world. Secondary data was used for this study. Total 15 articles were downloaded from the web and 20 times were reviewed critically to fully know what role microbes play in world development. The analysis indicates that microbes are the permanent member of this world and in different form give benefits to humanity and keep the balance of ecosystem for the survival of human being while some are very dangerous which kill human and other living organism of this world. Microbiologists have discovered so many microbes, some make the yogurts, but some make the cheese and beer for humanity. Similarly, some add nitrogen to the soil for the growth of plant while few microbes convert the soil structure and make it favourable for the growth of plant. Some microbes release the methane gases in the air and create the heat in the environment which makes the problem of global warming. Some microbes spread different disease in the world and make the world polluted but some clean the pollution of the world. Vaccine of virus help in smallpox controlling, while some play great role in insulin manufacturing for the control of diabetes. The story of microbe is very long, and some bacteria help in digestion process in ruminant animal while some spread the cancer and T.B in the arena of this world. Some microbes help in conversion of carbon dioxide into starch and glucose. Few scientists think that to remove the microbes from this world but majority stress that without microbes this world running is impossible and they told that microbes are very important and useful organism of this world because they play great role in different sector of economic development of the world. It is indicated from the mentioned discussion that without microbes this world business is impossible, so on the basis of this importance it is necessary for every government of the world to include this debate in the national policy at world level and keep a proper budget for implementation of the project for discoveries of new microbes for the beneficiary of society. Government of every country should be focused on microbes what microbes are beneficial and what are non-beneficial and further also link this study with the world for advancement of the country.

# EFFECTS OF CORRONA VIRUS ON THE WORLD COMMUNITY

(A Case Study of China Wuhan and Hubei Provinces)

Dr.Naushad Khan

Institute of Development Studies, The University of Agriculture Peshawar
Mahnoor Naushad
Student of Agriculture University Peshawar
**Email: drkhan@aup.edu.pk**

**ABSTRACT**

The study was carried out since Feb, 2020. The major objective was that to examine the effect of corona virus on the world community. Total fourteen articles were downloaded from the net and read 10 to 20 times in depth and analyzed the situation and draw the conclusion. The result indicates that corona virus problem was raised in late December 2019 in Wuhan and Hubei provinces in China. The hub of the center was Huanan Seafood Wholesale Market and the source of the virus was bat soup. A team at the Wuhan Institute of Virology led by virologist Zheng-Li Shi isolated the virus from a 49-year-old woman, who developed symptoms on 23 December 2019 before becoming critically ill. Doctor, Li Wenliang on 31 December told that an unknown virus has been developed in the province of Wuhan and Hubei provinces as like SARS and MERS. The symptoms were found fever, throat sore and sneezing by woman in the hospital. The Doctor Li has shared the knowledge on E-Chat while police department has declared the rumors against the country and told to Dr.Li to delete the said statement from the E-Chat and keep the data in secrecy while latter on 20, January, 2020 it was announced by government media that Corona Virus has killed many people in the provinces of Wuhan and Hubei . Due to late coverage in the mean time the virus was spread to the whole world which has damaged majority people in their area and emergency was announced by China and world Health Organization. They have sealed majority airports and visas were cancelled by different countries in the world. Globally 4594 cases of the corona Virus was confirmed. China total confirmed cases number was 4537 while 6973 were suspected and 976 were found severe and 106 deaths were recorded. Similarly outside of China 57 cases were confirmed and 16 countries were declared affected. According to data Japan affected number was 6, Republic of Korea 4, Viet Nam 2 ,Singapore 7. Australia 5, Malaysia 4, Cambodia 1, Thailand 14, Nepal 1, Sri Lanka 1, United States of America 5 ,Canada 2, France 3, Germany 1 and Pakistan 1. World Health Organization has tried best for its controlling and the Director General did meeting with the President Xi Jiping for overcoming this problems in the emergency in china. Mostly Halal food should be provided to China community in future. World wise Quarantines should be developed by each country for different germs protection.; Good hospital and quality Doctors should be produced by each country; Give freedom to media for awareness of community to take action in time to protect the world from the epidemic disease; Safety net should be provided by WHO in the developing countries in time. More funds should be provided to health department in the world. Similarly research fund should be increased in all hospital of the world for conducting research on the medical background. Testing laboratories and food inspectors should be multiplied for protection of different diseases in the world.

Key Words:- Effects, Corona Virus, , World, Community

# SUSTAINABLE PRODUCTION OF COMMERCIALLY IMPORTANT MEDICINAL AND AROMATIC PLANTS IN DISTRICT SWAT: A STEP TOWARD SUSTAINABLE RESOURCE CONSERVATION

Hassan Sher[1*], Rainer W. Bussmann[2]

[1]Centre for Plant Sciences and Biodiversity, University of Swat, Khyber Pakhtunkhwa, Pakistan
[2]Ilia State University, Institute of Botany and Bakuriani Alpine Botanical Garden, Department of Ethnobotany

**ABSTRACT**

One major goal of the Centre for Plant Sciences and Biodiversity, University of Swat, Pakistan is to improve the quality of life for people living in Swat district through utilization of indigenous resources particularly plant resources. In this context a highly significant component of the biodiversity identified for sustainable production and economic development is Medicinal and Aromatic plants (MAPs) through community ecosystem-based enterprises. This study on sustainable production and use of wild populations of MAPs was, therefore, designed and then conducted during August, September and October 2018 in selected valleys of district Swat, Pakistan, that are known to have wild populations of high value MAPs. As in many other locations, gathering and processing of MAPs for family use and/or treatment of livestock is a long-established practice in the valleys of District Swat but it has also become an important economic activity in the area. Present harvesting practices result in unsustainable use and this, coupled with habitat loss, is leading to decreasing population sizes of many valuable MAPs with some species that used to be abundant having become both rare and sparse. The survey showed that wild populations of MAPs were the major source of MAPs material being marketed. Collectors are rural people, prominent among them being women and children of Gujars or Middle Hill tribes and nomads. Collection of MAPs is generally the primary source of supplementary income. The individuals involved have not been formally trained in identify and how to distinguish their target species from similar species in the area and have little knowledge of the appropriate post-harvest treatment for the material they collect. Most material collected is sold to local middlemen at a very low price. Progress towards more sustainable use of wild MAPs can be assisted by identifying the appropriate harvest times for each species, times there the desired part can be harvested effectively while minimizing impact on the plant's ability to regrow. In case of species that are threatened with local extirpation, guidelines should be developed and annual quotas established for their harvest. These guidelines and quotas must be cleared and also be made known to all concerned parties and stakeholders. A proper mechanism of the implementation of collection quotas should be designed to enforce conservation and management efforts. It is also clear that local communities must be involved in setting and helping enforce adoption of such regulations if they are to be successful. In this context, the present project may be of high interest to rural development programs aimed at fostering community-based management strategies of natural resources in general and MAPs in particular.

# COMPARATIVE EFFECT OF SMOKE SOLUTION AND PESTICIDE ON GROWTH OF MAIZE

Saja Ullah[1], Faiq Allaud din[1], Shafiq ur Rehman[1], Muhammad Adnan[1] and Iram Parveen[2]

[1]Department of Botanical and Environmental Sciences, Kohat University of Science and Technology, Kohat-26000, Khyber Pakhtunkhwa
[2]Department of Education and Psychology, Kohat University of Science and Technology, Kohat 26000, Khyber Pakhtunkhwa

**ABSTRACT**

Use of pesticides has resulted to increase agriculture production worldwide but some persistent pesticide residues have great potential of adverse impact on the environment and human health. Application of pesticides in modern agriculture has boosted farm productivity. Plant derived smoke solution is widely known for its promotary effect on plant growth. In this study effects of pesticide (Emamectin) concentrations were assessed on the non-targeted maize plant growth along with alleviation of inhibitory effect of pesticide with the help of plant derived smoke solution. Emamectin concentrations (20, 40, 80 and 160 ppm) were applied to maize seeds. It was observed that effect of pesticide on maize seed germination, seedling length, seedling mass, and pigmentation concentration were dependent and increase with the increase in concentrations. It was observed that pesticide has inhibitory effect on maize plant. Alleviation solution of smoke and pesticide (1:500+20, 1:500+40, 1:500+80, and 1:500+160 ppm) significantly reduced the inhibitory effect of pesticide on seed germination, seedling length, and seedling mass. Hence, it might be concluded that smoke dilution might block the way of pesticides uptake or stop the channel of pesticides absorption.

# STUDYING THE PHYSIOCHEMICAL ANALYSIS AND QUALITY PARAMETERS OF ALLIGATOR WEED (ALTERNANTHERA PHILOXEROIDES MART.) COMPOST UNDER VARIOUS CONDITIONS

Asif Tanveer[1], Mubashar Nadeem[1], Intazar hussain[1], Muhammad Sarwar[1], Muhammad Ibrahim[2]

[1]Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

[2]Department of Agronomy, Faculty of Agricultural Sciences, Ghazi University, Dera Ghazi Khan, Pakistan

***Email: mubasharuaf@hotmail.com**

**ABSTRACT**

Composting the weeds and their utilization as an organic fertilizer is an economically beneficial practice. A laboratory trial was conducted at Weed Science Laboratory, Department of Agronomy, and ISES University of Agriculture, Faisalabad to analyze the physiochemical and quality parameters of alligator weed compost. The experiment was laid out in Completely Randomized Design (CRD) with three replications. Alligator weed biomass was harvested from four different places i.e. maize field, biogas plant, fallow land and water channel. Collected biomass was well dried and chopped into smaller pieces (1-2 inches). Finally, chopped materials were composted under anaerobic conditions to evaluate nutritional values and quality of compost at Soil Science Research Area, University of Agriculture Faisalabad. The collected data were statistically analyzed by applying Fisher's analysis of variance technique at the probability level of 5%. The LSD test was used to check significance between treatment's means. Results of the experiment indicated that compost prepared from biomass collected near biogas slurry has significant value of organic matter (69.98%) organic carbon concentration (40.69%), pH (9.2), C:N ratio (24.67) and C:P ratio (126.34). Compost prepared from biomass collected from maize field had significant value of nitrogen (3.69%), phosphorous concentration (0.43%) and C: K ratio (28.34). Compost biomass collected from fallow land had significant value of heavy matels i.e. lead (6 ppm), cadmium concentration (1.17) ppm, potassium concentration (1.50%) and water holding capacity (12.38%).

# DIVERSITY IN LEAF AND SHOOT MORPHOLOGICAL CHARACTERISTICS AMONG VARIOUS GRAPE (VITIS VINIFRA L.) CULTIVARS IN AGRO-CLIMATIC REGION OF BAJAUR, PAKISTAN

Farman Ullah, Shujaul Mulk Khan, Abdul Rehman, Abdullah, Zeeshan Ahmad, Shakil Ahmad Zeb, Yaseen Khan and Shahab Ali

Department of Plant Sciences, Quaid-i-Azam University Islamabad Pakistan
**Email: farman@bs.qau.edu.pk**

**ABSTRACT**

The present study was aimed to study leaf and shoot morphology of twelve different grape cultivars, viz., Shoogran, Sundarkhani, NARC-Black, Sultania-C, Gedar kwar, Local Line1, Local Line2, Local Line3, Local Line4, Local Line5, Local Line6, Local Line7 grown in the agro-climatic conditions of the district Bajaur a tribal belt of Khyber-Pakhtunkhwa, Pakistan. The data sets were analyzed through fisher's analysis of variance (ANOVA) using Newman-K euls test and Principle Component Analysis (PCA) using XLSTAT software version 2.3. Significant differences in leaf and shoot morphological characters were observed among different cultivars. The various morphological parameters are as survival percentage, number of leaves, number of nodes, plant height, internode length and leaf area ($p$-value $< 0.0001$), petiole length ($p < 0.002$), internode width ($p < 0.005$) were found statistically significant except days to sprouting with $p$-value= (0.322). Our findings showed that the edaphological and climatic conditions of the study area have great potential and suitability for grapes production, therefore cultivation of different grape varieties should be encouraged and recommended in the region of Bajaur and Tribal belt of Khyber-Pakhtunkhwa in general.

# ALLELOPATHIC EFFECT OF SUNFLOWER EXTRACT ON WEEDS SUPPRESSION AND PRODUCTIVITY OF WHEAT

Faisal Khan and Shad Khan Khalil

Department of Agronomy, The University of Agriculture Peshawar, Pakistan
**Email: faisalkhanaup366@gmail.com**

**ABSTRACT**

Effective weeds control is a key for achieving high yield. An experiment was conducted during 2014-15 at Agronomy Research Farm, The University of Agriculture, Peshawar Pakistan. Four sunflower extract concentration 1:3, 1:4, 1:5 and 1:6 (1 kg sunflower 3, 4, 5 and 6 litres of water) respectively was sprayed at three stages (emergence (E), tillering (T) and 1/2 at E + 1/2 at T) on Atta Habib-2010 variety of wheat. Hand weeding, herbicides (Puma super 75 WE @ 1.25 L $ha^{-1}$ and Buctril super 60 EC @ 2 L $ha^{-1}$) and control (no spray) were also included for comparison. Herbicide application and hand weeding significantly affected weeds density and wheat productivity. Sunflower extract applied at 1:3 concentration resulted in lower weeds density (49.0 $m^{-2}$), lower fresh (236.9 g $m^{-2}$) and dry (52.5 g $m^{-2}$) weeds weight, high CGR (16.2 g $m^{-2}$ $day^{-1}$), high AGR (4.9 g $day^{-1}$), maximum height (92.2 cm), maximum leaf area $tiller^{-1}$ (93.3 $cm^2$), maximum spike length (9.84 cm), more spike $m^{-2}$ (343.3), more grain $spike^{-1}$(50.1), more thousand grain weight (46.96 g), high biological yield (9458 kg $ha^{-1}$), high grain yield (4111 kg $ha^{-1}$), and high harvest index (43.48). While sunflower water extract applied at tillering stage resulted in lower weeds density (50.8 $m^{-2}$), lower fresh weight (254.9 g $m^{-2}$), lower dry weeds weight (60.3 g $m^{-2}$), high CGR (15.5 g $m^{-2}$ $day^{-1}$), high AGR (4.7 g $day^{-1}$), maximum height (87.46 cm), maximum leaf area $tiller^{-1}$(90.4 $cm^2$), more spike $m^{-2}$ (329.8), more grain $spike^{-1}$(46.7), more grain weight (43.4 g), high biological yield (9006 kg $ha^{-1}$) and high grain yield (3768 kg $ha^{-1}$). Net income was maximum (Rs 70493 $ha^{-1}$) for 1:3 concentration applied at tillering stage. Therefore, it was concluded from the results that sunflower water extract at 1:3 concentration applied at tillering stage is recommended for suppressing weeds and enhancing wheat productivity.

# PREVALENCE OF CLOSTRIDIUM PERFRINGENS IN CALVES IN DISTRICT PESHAWAR

Ms. Saima

Department of Microbiology
Kohat University of Science and Technology
**Email: sweetykhan283@gmail.com**

**ABSTRACT**

Early calf mortality is a major issue in livestock raising which causes huge economic losses. Clostridial Perfringens associated diarrhea is one of the main causes of early calf mortality. In the current study our main objective was to identify the prevalence of Clostridium perfringens types in calf in district Peshawar. For this purpose, a total of 250 fecal samples were collected from calves (< 1 year) of five different regions (I, II, III, IV, V) of Peshawar district between the months of October to December 2019. Fecal samples were processed for the isolation of different types of C. perfringens followed by their identification through colony characterization, Gram staining, and biochemical tests. The C. perfringens isolates were further examined for various type of toxin production by Polymerase chain reaction (PCR). Out of 250, 53(21.2%) samples were positive for C. perfringens based on morphological and biochemical procedures. These isolates were further examined for alpha and epsilon toxin (released by C. perfringens type D(CPD)) by using PCR assay with an amplicon size of 247bp and 206bp respectively. PCR results showed a higher prevalence of CPD in region IV (38%) followed by region I (7.6%), region II (15%), region III (15%) and region V (23%). Collectively our observation suggests that CPD is highly prevalence in calves compared with C. perfringens type C. For more study we should sequence the whole genome and prepare vaccine for the local isolates

# ASSESSMENT OF PESTICIDES TOXICITY IN DUCKWEED AND ITS ALLEVIATION BY EXOGENOUS APPLICATION OF SALICYLIC ACID

[1]Rakhshanda Hina*, [1]Nadia Taimur, [1]Azizullah Azizullah

[1]Department of Botanical and Environmental Sciences, Kohat University of Science and Technology, Kohat, 26000, Khyber Pakhtunkhwa, Pakistan
[*]**Email: Rakhshandahina95@gmail.com**

**ABSTRACT**

Pesticides have become an important factor for preventing crop losses and increasing food production in modern agriculture system. However, their extensive applications can cause negative impact on the environment. Salicylic acid (SA) is a regulator of different metabolic and physiological processes in plants. It plays a role in both local and systemic defense responses of plants and is involved in signaling during abiotic stresses. The goal of the present study was to assess the toxicity of two commonly used pesticides (Emamectin benzoate, Lambda cyahalothrin) on the physiological and biochemical parameters of aquatic plant Lemna minor and to evaluate the defensive role of exogenous salicylic acid. Both of these pesticides were used in concentration 1mg/L, 5mg/L, 10mg/L, 25mg/L, 50mg/L and 100mg/L respectively. The pesticides treatments resulted in oxidative stress with an increase in superoxide dismutase (SOD; EC 1.15.1.1) and elevating levels of $H_2O_2$.Furthermore, activities of antioxidant enzymes catalase (CAT; EC 1.11.1.6) and peroxidase (POD; 1.11.1.7) were increased. There was a reduction in fresh and dry weight, and chlorophyll content of samples treated higher concentrations of pesticides. Among the tested concentrations, most toxic effect was observed at 25, 50 and 100mg/L of pesticides. In order to study the alleviation of pesticides stress by SA (50µM), a set of experiment involving treatment of Lemna minor L. with pesticides alone and in combination with 50µM SA was designed. SA showed positive effect on Lemna minor L. treated with pesticides by decreasing the concentration of $H_2O_2$ level, enhancement of photosynthetic pigments and regulation of antioxidant enzymes. In addition, exogenous application of SA alleviated pesticide stress causing an increase in fresh and dry weight of samples treated with higher concentrations of pesticides. The above results revealed that pesticides cause an oxidative stress however their toxic effects can be alleviated by exogenous application of SA.

# POTENTIAL ROLES OF EXOGENOUS APPLICATION OF GLUTATHIONE IN INDUCING TOLERANCE TO ARSENIC OR MERCURY STRESS IN WHEAT
## (TRITICUM AESTIVUM L.)

Anam Khattak, Naila Hayat, Sara Ali, Sania Nawaz and Ghazala Nawaz*

Department of Botanical and Environmental Sciences, Kohat University of Science and Technology, Kohat26000, Khyber Pakhtunkhwa, Pakistan
Email: **anamktk2017@gmail.com**

**ABSTRACT**

Despite the increasing understanding of the potential roles of glutathione (GSH) in plants, less is known about the exogenous application of GSH against heavy metal stress in crop species including wheat (Triticum aestivum). Here, we provide compelling evidence that GSH contributes to alleviate the toxic effects of Mercury (Hg) or Arsenic (As) stress on wheat germination and seedling growth. Recently, we have reported that Hg or As stress negatively affects the germination rate, root/shoot length and fresh weight of wheat seedlings. To determine the role of exogenous GSH on wheat seedlings, we analyzed seed germination and seedling growth of wheat treated with various concentrations of GSH and Hg or As stress. We show that GSH significantly mitigated the inhibitory effects of Hg or As stress on germination rate, root/shoot length and fresh weight of wheat as compared to control plants. Exogenous glutathione significantly affected activities of antioxidant enzymes including Catalase (CAT), superoxide dismutase (SOD) and ascarbate peroxidase (APX). Importantly, GSH treatment significantly decreased $H_2O_2$ levels. However, application of GSH increased chlorophyll a & b contents in the presence of Hg or As stress. Collectively, the present findings reveal that GSH is a potent molecule capable of developing tolerance to Hg or As stress by alleviating their effects in wheat.

# A REVIEW ON CURRENT SCENARIO AND ISSUES OF ORGANIC FARMING IN INDIA

Owais Bashir, Tahir Ali, Z.A. Baba, Sheikh Amjid

Division of Soil science and Agricultural Chemistry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir ,193201, Kashmir India
**Email: Owaisbashir10@gmail.com**

**ABSTRACT**

Organic farming system in India is not new and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes and other biological materials along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution-free environment. India holds a unique position among 172 countries practicing organic agriculture: it has 6,50,000 organic producers, 699 processors, 669 exporters and 7,20,000 hectares under cultivation. But, with merely 0.4 per cent of total agricultural land under organic cultivation, the industry has a long journey ahead (Bordolo, 2016). India produced around 1.35 million MT (2015-16) of certified organic products which includes all varieties of food products namely sugarcane, oil seeds, cereals and millets, cotton, pulses, medicinal plants, tea, fruits, spices, vegetables, coffee etc. With the increase in population, our compulsion would be not only to stabilize agricultural production but to increase it further in sustainable manner. The scientists have realized that the 'Green Revolution' with high input use has reached a plateau and is now sustained with diminishing return of falling dividends. Thus, a natural balance needs to be maintained at all cost for existence of life and property. The obvious choice for that would be more relevant in the present era, when these agrochemicals which are produced from fossil fuel and are not renewable and are diminishing in availability. There is neither subsidy for organic cultivators nor incentives to practice organic cultivation. There are many areas in India where farmers use crop residues, manures, legumes and neem to grow their crops. They rely on crop rotation and interplanting, to do their job. These farmers practice, farming through organic inputs. Now it is the high time to make attempts to classify these practices accordingly. If this is done, the poor farmers will get a premium price for their low yields. This will also go a long way in alleviating poverty and raising the living standards of the poor villagers. Most of the agriculture in backward and tribal areas especially in the hills of northern, eastern and northeastern region could be safely classified as organic. We must take advantage of this opportunity by arranging a market for these products both for domestic and export market.

# IMPACT OF CLIMATE CHANGE ON AGRICULTURE

Owais Bashir, Tahir Ali, Z.A. Baba, Sheikh Amjid

Division of Soil science and Agricultural Chemistry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir ,193201, Kashmir India
**Email: Owaisbashir10@gmail.com**

**ABSTRACT**

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions or the distribution of events around that average (e.g., more or fewer extreme weather events). Climate change means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Despite technological advances, such as improved varieties, genetically modified organisms, and irrigation systems, weather is still a key factor in agricultural productivity, as well as soil properties and natural communities. The effect of climate on agriculture is related to variability's in local climates rather than in global climate patterns. The Earth's average surface temperature has increased by 1 °F (−17 °C) in just over the last century. The Intergovernmental Panel on Climate Change (IPCC) has produced several reports that have assessed the scientific literature on climate change. The IPCC Third Assessment Report, published in 2001, concluded that the poorest countries would be hardest hit, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect pest incidence. In Africa and Latin America many rainfed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places. Climate change induced by increasing greenhouse gases is likely to affect crops differently from region to region. For example, average crop yield is expected to drop down to 50% in Pakistan according to the UKMO scenario whereas corn production in Europe is expected to grow up to 25% in optimum hydrologic conditions. In the long run, the climatic change could affect agriculture in several ways likewise productivity, agricultural practices, environmental effects, rural space and adaptation. Most agronomists believe that agricultural production will be mostly affected by the severity and pace of climate change, not so much by gradual trends in climate. If change is gradual, there may be enough time for biota adjustment. Rapid climate change, however, could harm agriculture in many countries, especially those that are already suffering from rather poor soil and climate conditions, because there is less time for optimum natural selection and adaption.

# THEMATIC STRATEGY AND INDICATORS FOR SOIL PROTECTION

Owais Bashir, Tahir Ali, Z.A. Baba, Sheikh Amjid

Division of Soil science and Agricultural Chemistry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir ,193201, Kashmir India
**Email: Owaisbashir10@gmail.com**

**ABSTRACT**

Indicators are becoming progressively critical tools for assessing threats to the soils, caused by soil organic matter decline, soil sealing, soil erosion, contamination, salinization and loss of biodiversity. According to the European Environmental Agency an indicator is a character, generally quantitative, that defines and analyses complex phenomena simply, including trends and progress over time. Practically, the implementation of an indicator system for soil monitoring necessitates a limited number of easily available and quantitatively measurable indicators in order to avoid ineffectiveness of using the system by various stakeholders. Several European and Asian research projects have been proposed for determining critical indicators for assessing the effectiveness of the various land management practices and technologies for monitoring soils and combating land degradation. These researchers have proposed several indicators for each of the land degradation threats. The primary criteria of indicator selection included significance to the issue, existence of necessary measurement procedures, policy relevance, and geographical coverage. Some of them, easily evaluated, could substitute a number of others. Some of the indicators could be estimated from others by using pedotransfer functions. Furthermore, when crucial indicators, such as soil depth, water scarcity, reach or exceed critical thresholds values, land is leading to severe degradation, regardless of other favorable state and influx indicators. The effects of the influx's indicators (such as rainfall, fires, land management) on the state indicators (soil depth, slope gradient, rock fragments) are usually complex and interdependent. They may also have opposite effects depending on the state indicators (e.g. land abandonment, land terracing). This makes the accurate scaling and the weighing of the indicators difficult. Scaling the indicators on experience, observations, and educated guessing could be useful tool for some practical applications and for comparative evaluations. They should, however, be checked against real situations in the field. Based on the existing research results, even though more research work is needed, indicators may be widely, even globally, used for assessing the various soil degradation processes or causes or threats at field level. Processes of soil degradation can not be easily simplified. A reasonable number of indicators is necessary to assess the impact of the various threats on soils and more generally on ecosystems. Indicators must be considered as valuable tools for understanding and managing complex systems, especially at stakeholder or decision-making level.

# SOIL PROTECTION AND ITS STRATEGIES – HOW TO BRIDGE BETWEEN SCIENCE AND DECISION MAKING?

Owais Bashir, Tahir Ali, Z.A. Baba, Sheikh Amjid

Division of Soil science and Agricultural Chemistry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir ,193201, Kashmir India
**Email: Owaisbashir10@gmail.com**

**ABSTRACT**

Introduction Soil degradation is escalating worldwide and therefore the question arises: Is something wrong with our strategies for soil protection? Even taking into consideration that the tasks of science and technology on one side and politics and decision making on the other side are very different and admitting that science can only develop proposals based on scenarios, in order to convince politicians to take decisions and to protect soils, we need urgently to analyze our actual concepts for soil protection. Methodological aspects Soil degradation is a complex issue, deriving from social, economic, technical, environmental and cultural impacts, which altogether have to be considered in order to come to a conclusive concept or a strategy for soil protection. Regarding soil protection, politicians and decision makers must be informed in detail about the complexity of the processes and especially about the economic and social impacts of soil degradation, because this is targeting their political positions, by whom they are elected and appointed. It seems therefore necessary to use an approach which considers all the different aspects of soil degradation. One of these approaches is the DPSIR-framework approach, which looks into the Driving forces, the Pressures arising from those, the State of degradation which they cause, as well as the environmental, technical, social and economic Impacts, thus allowing for formulating Responses through politics and decision making. In the following, a concept is described, which helps science to develop sound scenarios for soil protection on this basis. The approach involves five main steps, which aim at the following targets: 1. To know the processes in the environmental system, leading to soil degradation; 2. To know where these processes occur and how they develop with time (monitoring); 3. To understand the relationship between those processes and existing land use policies as well as land use management systems; 4. to analyze and understand the impacts of soil degradation on further environmental compartments such as air, water, biomass production, as well as on the social and economic wellbeing of human societies and on human health; and finally, on the basis of 1-4, 5. To develop clear targets for combating soil degradation processes, based on arguments which are important and easily understandable for politicians and decision makers. This stepwise approach will be discussed in detail, as well as the question which sciences have to be involved in order to make soil degradation understandable. In view of the complexity of the subject, political, social, economic, technical and further sciences will be needed to elaborate scenarios and proposals for politics and decision making. On the basis of the DPSIR-approach it seems to be possible to improve strategies for soil protection, especially for the development of proposals and scenarios which are understood by politicians and decision makers and which therefore may lead to a future improvement of soil protection.

# DIVERSITY OF GENUS PUCCINIA IN DISTRICT HANGU, KHYBER PAKHTUNKHWA

M. Amir, A. Faiq, M. Adnan, Nisar Ahmad
Department of Botanical and Environmental Sciences, Kohat University of Sciences and Technology (KUST), 26000 Kohat, Khyber Pakhtunkhwa, Pakistan

**ABSTRACT**

This research work was undertaken to investigate and review the diversity of genus Puccinia in district Hangu, Khyber Pakhtunkhwa. The selected sites were visited and samples of rust infected host plants along with healthy plants were collected using standard protocol. Physical parameters such as temperature, pH, humidity, soils and rain fall were also noted. As a result of current investigation a large number of rust taxa were collected. After proper identification of the host plant species and subsequently going through morphological and anatomical investigation of symptoms a total 17 taxa belonging to genus Puccinia were identified on 17 different host species. The described taxa along with their host plants parasitized by them include Puccinia difformis on Galium aparine, Puccinia psidii on Eucalyptus globulus, Puccinia sorghii on zea mays, Puccinia melanocephala on Saccharum officinarum, Puccinia acetosae on Rumex crispus, Puccinia purpurea on Sorghum halepense, Puccinia allii on Allium sativum, Puccinia coronata on Arundo donax, Puccinia striiformis on Triticum aestivum, Puccinia xanthii on Xanthium strumarium, Puccinia cynodontis on Cynodon dactylon, Puccinia malvacearum on Alcea rosea, Puccinia exhausta on Clematis grata, Puccinia oxalidis on Oxalis articulate, Puccinia pelargonii on Marsilea quadrifolia, Puccinia helianthi on Helianthus annuus, Puccinia vincae on Catharanthus roseus. Among these all the species were first time reported in district Hangu, Khyber Pakhtunkhwa.

# SIGNIFICANCE OF CYTOKININS-TO-AUXIN INTERACTION ON SHOOT MORPHOLOGY AND MULTIPLICATION OF CHENOPODIUM AMBROSOIDES.

Tour Jan

Department of Botany, University of Malakand

Email: tour_jan@yahoo.com

**ABSTRACT**

*Chenopodium ambrosoides* produces natural products that shows a wide spectrum of biological activity include anticancer. Due to the unplanned urbanization and exploitation, many therapeutic plants are in deterioration and *Chenopodium ambrosoides* is facing tremendous pressure due to increased anthropogenic activities resulting in the shrinking size of the population. Developing protocol for *in vitro* propagation is crucial for their conservation. The aim of the present study is to investigate the interaction of cytokinin and auxin for the development of an effective protocol for propagation of *Chenopodium ambrosoides*. Organogenic callus was initiated on Murshige and Shoog (MS) medium supplemented with 1.5 mg/l Benzyladenine (BA) and 1.5/1.0 mg/l benzyl adenine/1-nephthalenaceitc acid (BA/NAA). The highest shoots number (16.02±0.82) was noted on MS medium with 1.5 mg/l BA. Some unique morphological anomalous characters were observed in culture like reddish (albino) shoots formation with narrow leaf lamina and long petiole. The anomalies were controlled by mounting cultures on medium augmented with BA/NAA (1.5/1.0 mg/l) where shoots number per explants was highest 21.89±1.94 without anomalies. The cultures mounted on medium augmented with Kinetin/NAA (1.5/1.0 mg/l) both normal and abnormal (albino) morphology shoots growth was recorded from the same explants. The highest number of roots (12.32±0.58) and length (12.81±0`.72 cm) was found in medium augmented with 1.0 and 1.5 mg/l NAA respectively. Plantlets were successfully acclimatized into pots under semi controlled condition. The survival potential of the *in vitro* regenerated plants into *ex vitro* condition was 71%.

# PHOSPHORUS SOLUBILIZING BACTERIA (PSB) IN COMBINATION WITH DIFFERENT FERTILIZER SOURCES TO ENHANCE YIELD PERFORMANCE OF CHICKPEA

Nawal Zafar*, Muhammad Kashif Munir, Siraj Ahmed, Muhammad Saqib, Muhammad Zafar, Muhammad Rafiq
Cereals and Pulses Section, Agronomic Research Institute, Faisalabad
**Email: nawazaf20@gmail.com**

**ABSTRACT**

The chickpea (*Cicer arietinum* L.) is an edible legume having high protein and is one of the most important cultivated pulse crops. As compared to consumption of country, the production of chickpea is very low which can be enhanced by managing nutrients requirement of the crop. To evaluate the effect of Phosphorus Solubilizing Bacteria (PSB) along with different fertilizer sources, a field experiment was carried out at Cereals and Pulses Section, Agronomic Research Institute, Faisalabad during Rabi 2018-19. The study was conducted in Randomized complete block design (RCBD), replicated thrice and having plot size of 9 m × 3 m. Five Fertilizer treatments ($T_1$= Recommended NP @ 32:85 kg $ha^{-1}$, $T_2$= Seed treatment of PSB + Recommended NP, $T_3$= FYM @ 3.5 t $ha^{-1}$, $T_4$= Seed treatment of PSB+ FYM @ 3.5 t $ha^{-1}$ and $T_5$= FYM @ 3.5 t $ha^{-1}$ + Remaining P from SSP) were evaluated. Data regarding yield and yield contributing factors was recorded by using standard procedures and were analyzed statistically using Fisher's technique of analysis of variance and treatment's means were compared by using Least Significant Difference (LSD) test. The results revealed that seed inoculation of PSB with different fertilizers significantly enhanced the yield and yield components. Seed treatment of PSB+ Recommended NP ($T_2$) significantly produced more plant height (53.66 cm), No. of branches per plant (4), No. of grains per pod (1.58), No. of pods per plant (36.66), 100- seed weight (18.48 g) and grain yield (1852 kg $ha^{-1}$) which is 6.62%, 8.11%, 10.49%, 15.79%, 12.48% and 15.37% respectively over treatment where only Recommended NP @ 32: 85 kg $ha^{-1}$ ($T_1$) was applied. Seed inoculation of PSB + FYM @ 3.5 t $ha^{-1}$ application also enhanced the yield and yield components over treatment $T_3$ (FYM @ 3.5 t $ha^{-1}$) and $T_5$ (FYM @ 3.5 t $ha^{-1}$ + Remaining P from SSP). That increase was 8.13%, 5.56%, 5.85% and 17.42% for plant height, No. of branches per plant, 100-seed weight and grain yield respectively over $T_3$ and 17.74%, 2.70%, 6.70%, 9.58%, 3.67% and 12.54% for plant height, No. of branches per plant, No. of grains per pod, No. of pods per plant, 100-seed weight and grain yield respectively over $T_5$. However, all the parameters were found significantly lower in all treatments than $T_2$. It was found that seed treatment of PSB along with fertilizer application at the time of sowing enhances yield and yield contributing factors of chickpea.

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