NATIONAL SEMINAR

ON

DEVELOPMENTS IN SOIL SCIENCE – 2022

ABSTRACTS

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15-18 November 2022

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Abstracts

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National Agricultural Science Centre Complex
Dev Prakash Sastri Marg, Pusa, New Delhi -110 012
Phone : 91-11-25841529; 25841991
Email: isss1934@gmail.com; isss.secretary@gmail.com
Web page : www.isss-india.org

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Phone : 91-11-25841529; 25841991
Email: isss1934@gmail.com; isss.secretary@gmail.com
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Site-Specific Crop Suitability Recommendation in Krishnapur Micro-Watershed of Semi-Arid Region of Kalaburagi District, Karnataka Using Remote Sensing Techniques

Basavaraj Kasaraddy[1]*, Mahesh Kumar[2], N.L. Rajesh[3] and B.K. Desai[4]

[1]Zonal Agricultural Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, 584104, Karnataka

[2]WDPD Project, Zonal Agricultural Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, 584104, Karnataka

[3]College of Agriculture, Raichur,University of Agricultural Sciences, Raichur, 584104, Karnataka

[4]Director of Research, University of Agricultural Sciences, Raichur, 584104, Karnataka

**Email: bctidigol@yahoo.co.in*

A detailed land resource inventory of Krishnapur micro-watershed at 1:8000 scale, was conducted to evaluate the land suitability to existing major field and horticultural crops. The evaluation of land interms of suitability classes were based on the method described in FAO guideline for land evaluation. The factors considered for evaluation of the land suitability were soil slope, soil drainage, soil texture, soil depth, soil fertility and the present land use of the study area. Eight soil series were tentatively identified and mapped into 15 mapping units in Krishnapur micro-watershed of Sedam taluka, Kalaburagi District in North Eastern Dry Zone (Zone-2) of Karnataka for sustainable land use planning. Weighted mean of each soil property was calculated and soil-site characteristics of different soil mapping units were matched. The results revealed that fifteen soil phases were grouped into three land capability class (III, IV and VI) with limitations of rooting depth, erosion and physico-chemical properties. Major area (Bhutpur, Kadacharana, Krishnapur, Ranjol and Shabazpura series) of 445 ha (67.15%) was currently not suitable for mango, sapota and guava cultivation, an area (Bhutpur, Ranjol and Shabazpura series) of 251 ha (37.85%) was marginally suitable (S3) for sorghum and pigeonpea due to soil depth constraints. Bengalgram and blackgram showed moderately suitable (S2) in 425 ha (63.96%) area (all series except Kadatala, Krishnapur and Kadacharana) with rooting depth, topography, gravelliness and texture as productive constraints. Kadatala series (2.82%) was highly suitable (S1) for field crops but marginally suitable (S3) for mango, sapota and guava due to limitation of clay texture. Soil suitability maps provides farm specific crop choices, to evolve location specific soil and water conservation measures and to provide inputs needed for planning, implementing and monitoring of all land based developmental programmes to develop tools, packages and thematic outputs.

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Geo-Spatial Technologies for Sustainable Watershed Development-A Case Study of Sawalagi Sub-Watershed of Semi-Arid Region of Kalaburagi District, Karnataka, India

Basavaraj Kasaraddy[1]*, Mahesh Kumar[2], N.L. Rajesh[3] and B.K. Desai[4]

[1]Zonal Agricultural Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, 584104, Karnataka

[2]WDPD Project, Zonal Agricultural Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, 584104, Karnataka

[3]College of Agriculture, Raichur,University of Agricultural Sciences, Raichur, 584104, Karnataka

[4]Director of Research, University of Agricultural Sciences, Raichur, 584104, Karnataka

**Email: bctidigol@yahoo.co.in*

A case study was undertaken to evaluate land resources to classify soils to parcel level and to derive land capability and suitability classes of Sawalagi Sub-watershed located in North Eastern Dry Zone of Karnataka (Zone-2) in Semi-Arid Region of Kalaburagi district. A detailed land resource inventory was carried out at 1:8000 scale using IRS-P6 LISS-IV merged cartosat-I imagery overloaded with cadastral maps. The generated database thus mapped using Arc view 2.3 GIS software. The analysis and interpretation of the spatial and non-spatial database generated has revealed that in most of the areas, very shallow (<25 cm) to shallow depth (25-50 cm), very gently sloping (1-3%) with moderately eroded (e2), clay textured soils occurs and sodicity affected even up to 60 to 80% of the area followed by gravelly (15-35%), thus reducing the production potential and crop choices. The fertility status of soils revealed that soils were low in organic carbon content (<0.5%, 95.90%), low (<23 kg ha^{-1}, 95.90%) in phosphorus (P_2O_5), medium (144-337 kg ha^{-1}, 9.52%) to high (>337 kg ha^{-1}, 88.37%) in potassium (K_2O) content. Zinc (<0.6 ppm) and iron (<2.5 ppm) were below the critical limit in 95.90 per cent and 72.49 per cent area, respectively. Two Land capability classes were identified which are moderately suitable (IIIs & IIIes) and fairly good cultivable lands (IVes) with limitations of erosion and soil limitations, majority of the soils are currently not suitable (N1) for growing most of the agricultural and horticultural crops with limitations of rooting depth, texture and topography fallowed by moderately (S2, 60% of maximum attainable yield) and marginally suitable (S3, 40% of maximum attainable yield). By interfacing land resource data with Remote Sensing, GIS techniques, different management scenarios were analyzed to arrive at the best management alternatives (optimum land use plans) that would be most suitable.

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Vertical Distribution of Different forms of Potassium in Soils of Southern Transect of Bengaluru

Chikkadibburahalli Thimmappa Subbarayappa[1]*, T. Vanitha[1] and V. Ramamurthy[2]

[1]Department of Soil Science and Agricultural Chemistry,University of Agricultural Sciences, GKVK, Bengaluru, 560065, Karnataka

[2]Regional Centre, National Bureau of Soil Survey and Land Use Planning, Hebbal, Bangalore, 560024, Karnataka

**Email: ctsubbarayappa@gmail.com*

The research work was conducted to study the vertical distribution of different forms of potassium in soils of southern transect of Bengaluru by exposing profiles. For this study eight sites were selected from southern transect of Bengaluru. Soil texture ranged from sandy clay loam to clay. In majority of the profiles, clay content increased with depth. The soil pH was acidic to alkaline in nature. The organic carbon content varied from 0.18 to 1.32%. In majority of the profiles, the organic carbon content showed a decreasing trend with depth.The distribution of the different forms of potassium *i.e*. water soluble, exchangeable, non-exchangeable, lattice and total potassium in these soils ranged from 0.98 to 40.76 mg kg^{-1}, 3.22 to 63.49 mg kg^{-1}, 67.73 to 876.15 mg kg^{-1}, 734 to 15,771 mg $kg^{-1}$and 813 to 16,050 mg kg^{-1}, respectively. Under different soil profiles, the water soluble, exchangeable and non-exchangeable forms of potassium decreased with depth. Whereas, total potassium and lattice potassium did not show any definite trend with depth. The exchangeable potassium showed significant and positive correlation with organic carbon content and clay content of the soils. A highly significant and positive relationship was observed between various forms of potassium, these relationships imply that there was equilibrium between these forms of potassium and that deprivation of one is instantly renewed by one or more of the other forms of potassium.

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Geo Spatial Techniques for Productivity Enhancement Through Inventorization in Kammanakote-1 Micro-Watershed of Madhugiri Taluk, Tumkur District

A. Sathish*, B. Mamatha, Jahnavi Katti and K.S. Pratibha
Department of Soil Science and Agricultural Chemistry,University of Agricultural Sciences, GKVK, Bengaluru, 560065, Karnataka
**Email: soilsathish@gmail.com*

To assess the land suitability for both agricultural and non-agricultural uses, it is crucial to conduct a scientific study of the soil and land. Determining the land's potential and limitations for growing different crops contributes to the proper and sustainable use of the land. As a means of enhancing the production, productivity and profitability of an area, along with various soil characteristics, land resources inventory (LRI) become pre-requisite. Keeping this in view a detailed LRI was carried out in Kammanakote-1 Micro-watershed of Madhugiri Taluk, Tumkur district using RS and GIS techniques and identified 9 soil series and 24 mapping units with a total geographical area of 545 ha based on soil morphological, physical and chemical properties. Majority of the soils were having sandy loam (165.7 ha) texture with moderate erosion (184.5 ha) and gently sloping (137.9 ha) lands. The land evaluation for Land Capability Classification (LCC) indicated that out of 545 ha area, 184 ha was classified under class III with erosion as major limitation. Suitability assessment of the crops grown in the area revealed that majority of the area was moderately suitable for maize (136.3 ha), ragi and minor millets (136.3 ha), redgram (140.3 ha), groundnut (153.7 ha), amla (121.4 ha), cashew (144.8 ha), coconut (122.9 ha), gauva (122.9 ha), lime (122.9 ha), mango (127.4 ha) and sapota (122.9 ha) with limitations of depth, erosion and slope. Growing of crops suitable for coarse textured soils, contour bunding/contour ploughing to arrest slope, practicing mulching and vegetative cover to reduce erosion losses in agricultural crops and construction of crest moon bund structures in horticultural crops under moderately sloping (5-10%) area, thereby maintaining soil qualities and enhance crop productivity.

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Crop-Land Suitability Analysis Using Remote Sensing and GIS in Tumkur Penta-1 Micro-Watershed of Pavagada Taluk, Tumkur District

B. Mamatha*, Jahnavi Katti, K.S. Pratibha and A. Sathish
Department of Soil Science and Agricultural Chemistry,University of Agricultural Sciences, GKVK, Bengaluru, 560065, Karnataka
**Email: mamatha.bhavya@rediffmail.com*

Land evaluation is concerned with the assessment of land performance when used for specified purposes. It involves the execution and interpretation of basic surveys of climate, soils, vegetation and other aspects of land in terms of the requirements of alternative forms of land use. The main purpose of land use planning is to guide decisions on land use in such a way to utilize environmental resources to the maximum, along with conserving those resources for the future. The detailed land suitability assessment was carried out in Tumkur Penta-1 Micro-watershed of Pavagada taluk, Tumkur district using RS and GIS techniques and the study resulted in identifying 16 soil series and 37 mapping units with a total geographical area (TGA) of 427 ha based on soil morphological, physical and chemical properties. By the LRI study it was clear that the area had variation with respect to texture, slope, erosion, gravelliness and depth. Land evaluation revealed that 259 ha area of TGA was classified under class II of Land Capability Classification (LCC) with texture, depth and gravel limitation. The micro-watershed area was also assessed for various crops and the results obtained indicated that the majority of the area were moderately suitable for maize (264.4 ha), ragi and minor millets (233.9 ha), redgram (161.2 ha), groundnut (190.7 ha), chilli (234 ha), amla (105.6 ha), cashew (121.1 ha), coconut (121.1 ha), custard apple (105.6 ha) gauva (121.1 ha), lime (121.1 ha) and sapota (121.1 ha), whereas bengal gram (207.3 ha) and mango (121.3 ha) crops were marginally suitable with depth and gravel limitation. Thus the land suitability data indicated that with some corrective measures with respect to selection of crops based on texture, types of bunds to reduce slope and measures to reduce erosion can be followed.

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Assessment of Soil and Ground Water Quality of Hingoli District, Maharashtra by Using Geospatial Techniques

Nikhil Patil[1]*, P.H. Vaidya[1], S.P. Zade[1] and A.U. Waikar[2]
[1]Department of Soil Science and Agricultural Chemistry, V.N. Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
[2]CDKS-NAHEP, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: nikhilmpatil8@gmail.com*

Remote Sensing technology has great potential of identifying, characterizing and classifying the problems and potentialities of the natural resources. Satellite Remote Sensing data has as emerged as a vital tool in soil resource survey and generation of information, which help to derive optimum land use plan for sustainable development at scale ranging from regional to micro level. Remote Sensing technology together with GIS has spined off the new dimensions in the storing and retrieving and to arrive at optimum solution plan or action plan for sustainable development. Hingoli district lies between 19°14′ to 20°01′ North latitude and 76°16′ and 77°28′ East longitude comes under dry and tropical climate with hot summer and mild winter with humid SW monsoon season of moderate rainfall (890.28 mm). The length of growing period is 144 days. Soil resource inventory of Hingoli district, Maharashtra was prepared using geospatial techniques. Various thematic maps of Hingoli district at 1:5,00,000 scale was used as base map for study. The terrain analysis was carried by using Cartosat-1 DEM in SAGA-GIS. The satellite image (Sentinental-2) and SOI toposheet were used for the delineation of landforms and physiographic units. Based on the variation in satellite image, physiography, soils and yield of commonly grown crops ten pedons were characterized and classified. Taxonomically these soils were classified as Typic Haplustepts Typic Ustorthents Vertic Haplustepts, Typic Haplusterts, Calcic Haplusterts and Sodic Haplusterts. The quality of irrigation water groups under C_2S_1 (medium saline and low sodium) and C_3S_1 (highly saline and low sodium). Soil site suitability of these soils indicating Vertic Haplustepts and Typic Haplusterts were highly suitable (S1) for the cultivation of turmeric, soybean, pigeon pea, sorghum and cotton. The databases will be helpful to choose best cropping system suitable for given land.

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Assessment of Physico-Chemical Properties of Soil under Different Cropping Pattern of Aurangabad District, Maharashtra

Swati Zade*
Department of Soil Science and Agricultural Chemistry,
V.N. Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: spzade@yahoo.co.in*

The eight soil profiles under different cropping pattern *viz*. red gram, maize, and cotton, in Aurangabad district of Maharashtra, was examined and horizon wise soil samples were collected for laboratory analysis and yield data were collected from adjoining area. The soils of the study area are shallow to deep, very dark gray (10 YR 1/3) to light brown (10 YR 5/4) in colour, loamy to clay in texture. The bulk density of the soil varied from 1.23 to 1.63 Mg m^{-3}. Hydraulic conductivity range between 1.4 to 5.13 cm hr^{-1}. Clay content varies from 14.9 to 54.00 percent, which was significantly correlated with CEC and PAWC (r = 0.96 and r = 0.73) indicating CEC and PAWC closely associated with the clay content in soil. The soils of the study area are alkaline in nature and the electrical conductivity varies from 0.15 to 0.46 dS m^{-1}. Taxonomically these soil classified into Lithic Ustorthents, Typic and Calcic Haplustepts and Typic and Calcic Haplusterts. The yield of cotton, maize and pigeon pea positively correlated with (soil organic carbon) SOC (r = 0.063, r = 0.0.42 and r = 0.258 respectively) indicating the soil organic carbon increased the yield of cotton, maize and pigeon pea increased. The yield of cotton, maize and pigeon pea negatively correlated with (soil inorganic carbon) SIC (r = -0.28), SIC (r = -0.375) and SIC (r = -0.161) indicating decrease in yield with increasing soil inorganic carbon stock (SICS). Therefore, it's need to control the formation of SIC and its adverse effect on yield of commonly grown crop under semiarid climate.

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Digital Soil Mapping of HAU- Research Farm, Balsamand, Haryana, Northwest India

Dinesh, Pankaj Kumar, Anurag, Virender Dalal and Ankit Gill
Department of Soil Science, CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: dineshtomarhau@hau.ac.in*

Spatial variability of soil fertility by applying GIS provides an elicit information for current and future use. A survey of Research Farm, Balsamand, CCS HAU, Hisar was carried out to determine the fertility status and prepare the spatial variability maps. Twenty-four surface soil samples (0-15 cm) were collected to evaluate the spatial distribution of nutrients using grid and GPS system. The soils of the study area were sandy in texture and neutral to slightly alkaline (6.8-7.9) in reaction and non-saline ($EC_{(1:2)}$: 0.05-0.14 dS m^{-1}) in nature. The soils of farm were found low in organic carbon (0.15-0.42%) and available nitrogen (42-84 kg ha^{-1}), low to medium to high in available phosphorus (4-27 kg ha^{-1}) and medium to high in available potassium (160-480 kg ha^{-1}). In case of DTPA extractable micronutrients, soils were found low to moderate in Zn (0.33-1.12 mg kg^{-1}) and Fe (2.40-8.64 mg kg-^{1}), moderate to high in Cu (0.22-0.46 mg kg^{-1}) and high in Mn (11.22-19.8 mg kg^{-1}). Organic carbon (0.01), zinc (0.05), iron (1.71), copper (0.01) and manganese (3.57) showed small variation as indicated by low variance. Organic carbon was significantly correlated with N and K suggesting synergistic effect. The highest variance was observed with K indicating higher spatial variability. All the soils were low in available nitrogen therefore, the application of nitrogenous fertilizers is necessary to ameliorate nutrient deficiency and enhance crop production. The spatial variability maps of fertility nutrients provide an insight of status of the study area and will help in easy monitoring of precision fertilizer management.

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Characterization and Classification of Soils of Keonjhar District, Odisha, India

Prava Kiran Dash* and Antaryami Mishra
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: dashprava111@gmail.com*

The present investigation aims at characterizing and classifying the soils of Keonjhar, a topographically diverse tribal district of Odisha having a geographical extent of 8,303 square km. Soil pits of ~1m×1m×1.5m dimensions were exposed at 17 different locations in the study area and horizon-wise samples were collected for laboratory analysis. Soil colour hue varied from 10YR through 5Y with most horizons belonging to the hue of 10YR (31%). Sandy loam (63%) and sub-angular blocky (78%) were observed to be the major textural class and structural type, respectively. Ferruginous mottles and concretions were observed in 90% of horizons. Per cent sand, silt, clay, porosity, and water holding capacity varied from 61.3 to 82.5%, 4.7 to 21.5%, 7.7 to 29.8%, 26.0 to 40.7%, and 22.2 to 37.9%, respectively. Bulk and particle densities varied from 1.4 to 1.9 and 2.3 to 2.8 Mg m^{-3}, respectively. The mean pH, electrical conductivity, and soil organic carbon in the soil profiles were observed to be 5.80, 0.46 dS m^{-1}, and 0.50%, respectively. Correspondingly, the mean exchangeable bases, exchangeable acidity, and cation exchange capacity in the profiles were evaluated to be 6.60, 1.33, and 8.08 cmol(p^+)kg^{-1}, respectively. Base saturation varied from 56 to 97% with a mean value of 81%. Wavelength dispersive X-ray fluorescence and X-ray diffraction of the fine sand fraction indicated the dominance of quartz, zircon, orthoclase, anorthite, albite, and kaolinite in the fine-sand mineral fraction. At the subgroup level, soils were classified as *Typic Haplustepts*, *Typic Ustorthents*, *Fluventic Dystrustepts*, *Kandic Paleustalfs*, *Kanhaplic Haplustalfs*, *Oxyaquic Ustorthents*, *Kanhaplic Rhodustalfs*, *Udic Ustifluvents*, *Udic Haplustepts*, *Typic Ustifluvents*, *Fluventic Haplustepts*, *Oxyaquic Haplustepts*, and *Udifluventic Haplustepts*. Soil acidity, poor soil fertility status, soil erosion, and poor drainage conditions were identified as the major constraints requiring immediate soil management interventions.

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Temporal Changes in Soil Properties Under Intensive Cotton Growing Vertisols

Shubham Girdekar[1]*, P. Chandran[1], D. Vasu[1], M.V. Venugopalan[2] and P. Tiwari[1]
[1]ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, 440033, Maharashtra
[2]ICAR-Central Institute for Cotton Research, Nagpur, 440010, Maharashtra
**Email: girdekarshubham52@gmail.com*

The investigation was carried out to evaluate the temporal changes in soil properties under intensive cotton growing Vertisols in the CICR research farm, Panjri village of Nagpur (Maharashtra). In the research farm of CICR, cotton is being cultivated under different management practices. Here we have discussed about comparisons of the soil properties for knowing the effect of land use and management on the dynamic properties of soil. For that purpose, we have selected three different locations and representative soils were studied under different management practices *viz.* 1) Organic cultivation 2) A soil with inorganic cultivation and 3) Virgin or undisturbed soil with no crop. The soil properties of these 3 sites were compared for changes due to management interventions for surface (0-25 cm) and subsurface (25-50 cm) layers. The comparisons of temporal data indicated that most of the dynamic soil properties changed with time in organic, inorganic and undisturbed soils under cotton cultivation. The sHC decreased in all soils whereas, organic carbon increased over a period of time (23 and 10%, 23 and 26%) in surface and subsurface soils of organic and inorganic systems. Bulk density decreased about 15 and 6% in surface and sub-surface layers of soils in organic system. Calcium carbonate has decreased in organic as well as undisturbed systems whereas in intensively cultivated soil it has increased. The study shows that the organically managed soil management system had better yield as compared to other soil management systems. The prevalent system of management practices increased the organic carbon in soils and decreased the BD, sHC and pH of soils and inorganic carbon tends to increase in soils. These trends of changes in soil properties could be a threat to the cotton cultivation. These issues need to be handled with proper management intervention.

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Morphological and Soil Site Characteristics of Tribal Area in Dharni Tehsil of Melghat Region

Dilip Nalge*, S.M. Bhoyar, P.W. Deshmukh and B.A. Sonune
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: dilipnalge@gmail.com*

The Present study was undertaken in Dharni tahsil of Maharashtra State during the year 2017-19. This area is also popularly known as Melghat region, which is located in the physiographic unit *i.e*. eroded valley with the elevation of 316 - 642 meters above mean sea level. *Korku* is the dominant tribes inhabited in this region and have small land holding adjoining to forest. The data on natural resources such as climate, soil-site characteristics and land use system aspect were collected. Twenty four spot were selected on different land use system based on single crop, double crop, scrub land and forestland fallow land. Dharni Tehsil received an annual rainfall ranges from 1350-1450 mm. Temperature varies from 34°C in summer to 21°C in winter. The soils were developed on weathered basalt. The soils were very gently to steep sloping with moderately to very severe erosion. The soils are dark reddish brown to dark brown with shallow to medium deep in depth and structure was angular blocky to sub angular blocky.

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Development of National Soil Archive of India

Nirmal Kumar*, G.P. Obireddy, M.S.S. Nagaraju, S. Chattaraj, H. Biswas and R.K. Naitam

Division of Remote Sensing Application, ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, 440010, Maharashtra
**Email: urwithnirmal@gmail.com*

ICAR-National Bureau of Soil Survey and Land Use Planning has collected a large volume of soil profiles across the country in the past under soil resource mapping and district level soil mapping projects. Further, the institute is collecting several soil profile/surface samples under land resource inventory and various projects with precise locations. This can eventually help, a much needed, establishment of an Indian National Soil Archive (INSA) which will helpful in studies related to Digital Soil Mapping, Soil Spectroscopy, comparison of current soil conditions in particular location to that of past, and other studies arising from the changing climatic conditions. At present, no Soil Sample Archive having samples of national level exists in India. Soil samples are kept in the sample rooms with no proper digital database created. The Bureau has initiated a program to establish a National Soil Sample Archive with a system of physical storage of soil samples and digital system of soil database storage and its retrieval with QR Scan. The Indian National Soil Archive is a web application as well as android mobile application developed with the help of HTML, JavaScript, CSS, php, MySQL and GeoServer. Main functionality of application is entering the soil site characteristics and morphology data which are provided by soil surveyor from the field. Provision for adding field photographs and updation of laboratory data are also made. The authorized user can view, edit/update soil data, and delete soil record. The user can visualize sampling location on map for individual sample or can identify total number of samples in a particular region. The system generates QR code for each sample to be printed and pasted on soil sample boxes. A dedicated android mobile application has been developed to scan that QR code and retrieve the entire information of that soil sample.

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Influence of Soil Ameliorants on Physico-Chemical Parameters and Crop Growth in an Inceptisol of Coastal Soil

D. Burman, S.K. Sarangi, Shishir Raut* and T.D. Lama
ICAR-Central Soil Salinity Research Institute, S 24–Parganas, Canning Town, 743329, West Bengal
**Email: shi_cssri21@yahoo.com*

An experiment was carried out in the ICAR-Central Soil Salinity Research Institute, Canning Town research farm to study the effect of different ameliorants on soil physico-chemical properties and crop growth. The experiment was carried out in a split plot design where in the ameliorants were put in the main plot and their doses in the sub-plots. Soil samples were collected from 0-15 cm depth after two year of decomposition and were processed. Rice cv. Lal minikit (WGL-20471) was grown in winter (2021-22) for studying the effect of salinity and ameliorants on its growth. Saturated moisture content, bulk density, saturated hydraulic conductivity and organic carbon were also determined. Soil bulk density decreased with increase in amount of doses, 1.20 Mg m^{-3} for 12 t ha^{-1} amendments. The value was 1.33 Mg m^{-3} for control. The saturated hydraulic conductivities were also dependent on the treatment and doses. The hydraulic conductivity values were little higher for FYM and poultry manure treatment (5.0-5.2 cm h^{-1}) than to green leaf manure and tank silt treatments (3.7-4.5 cmh^{-1}) for the soil. Leaf area index and NDVI values were slightly higher in FYM and poultry manure treatments (3.5-3.6 and 0.42-0.45, respectively) which were higher than green leaf and tank silt treatments (3.2-3.3, 0.40-0.42, respectively). Similarly, rice grain and straw weights were higher for FYM and poultry manure treatments ((3.4, 4.5 and 3.5, 4.7 t ha^{-1}, respectively) than other treatments.

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Evaluation and Model Predictability of Infiltration Rates in Soils at RCSM College of Agriculture Kolhapur (M.S.)

G.D. Patil*, A.A. Shelke, B.M. Kamble, D.S. Potdar, P.N. Gajbhiye and V.N. Nale
Division of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413002, Maharashtra
**Email: patilgangadhar869@gmail.com*

An experiment entitled on "Evaluation and model predictability of infiltration rate in soils at RCSM, College Agriculture, Kolhapur district (M.S.)" was carried out in 25 GPS-GIS based spots. The low infiltration and cumulative infiltration rate in agronomy farm was observed as compared with horticulture farm soils. The infiltration rate of agronomy farm was found to be 385 mm h^{-1}, and it was lower than horticulture farm soils 456.67 m h^{-1}. It was decreased with increase in time period in both the types of soil up to final steady infiltration rate. As time increases there was drastically decrease in infiltration was observed on both the farms. The drastic lower down the infiltration rate five times in Agronomy farm soils than Horticulture farm soils. Among the infiltration models studied the Philip model is fitted the best over Horton and Kostiakov for predicting the infiltration rate of agronomy farm soils. The Philip model showed the higher values of coefficient of determination, less standard error and high value of decision factor. The results concluded that the positive significant correlation between cumulative infiltration with sand content, electrical conductivity and negative significant correlation between cumulative infiltration rate with clay content, field capacity, permanent wilting point, available water and calcium carbonate of soils was observed. The Philip model could be used for predicting the infiltration rate of soils at RCSM, College of Agriculture, Kolhapur as compared with Kostiakov and Horton models.

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Effect of Tillage, Crop Residue Mulching, Irrigation and Nitrogen Management on Water and Nitrogen Use Efficiency in Wheat

Sujan Adak*, K.K. Bandyopadhyay, R.N. Sahoo, P. Krishnan, V.K. Sehgal, A. Sarangi, Priya Bhattacharya and Sudipta Basu

Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: sujanadakhrw@gmail.com*

The three main inputs in agricultural production are water, nutrients and energy, and recently there has been a drop in the factor productivity of these inputs because of their improper management and deterioration of soil health. The available inputs must be used as effectively as possible while causing the least environmental harm as far as possible to achieve sustainable production. The best synergistic combinations of water, nutrients, and tillage should be identified for various cropping systems, soil types, and agro-climatic regions for improving resource use efficiency in agriculture, In light of this, observations were made during the 2019-20 and 2020-21 wheat growing season in a long-term field experiment being carried out in a Typic Haplustept at the Indian Agricultural Research Institute, New Delhi, since 2014 for improving nitrogen use efficiency, and water use efficiency of wheat (cv HD 2967). The experiment was laid out in split factorial design with two levels of tillage (Conventional tillage (CT) and No tillage (NT)), two levels of mulching (with or without crop residue mulch @ 5 t ha^{-1}) as main plot factors and two levels of irrigation (full irrigation and deficit irrigation) and three nitrogen doses (50, 100 and 150% of the recommended dose of N) as subplot factors. During both the years, it was observed that grain yield; water use efficiency (WUE) and partial factor productivity of nitrogen (PFPN) of wheat was not significantly influenced by tillage treatments. Application of crop residue mulch also did not significantly influence the grain yield and PFPN but WUE of wheat increased significantly under crop residue mulching. Under full irrigation, grain yield and PFPN of wheat increased significantly but WUE decreased significantly over deficit irrigation level. With the increase in N level, grain yield and WUE increased but PFPN of wheat decreased significantly. Thus from this study it may be concluded that wheat may be grown under no tillage with crop residue mulch @ 5 t ha^{-1} and with deficit irrigation and 150% of recommended dose of N to obtain higher water use efficiency but with full irrigation to obtain higher yield in Inceptisols of Indo-Gangetic Plain region.

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Simulating Agrophysical Processes of Conservation Agriculture Using Aqua Crop Model

Koushik Bag[1]*, K.K. Bandyopadhyay[1], V.K. Sehgal[1], S.P. Datta[2], A. Sarangi[1] and P. Krishnan[1]

[1]Division of Agricultural Physics, [2]Department of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: amikoushikbag@gmail.com*

Simulating the system performance, that too under conservation agriculture, using a dynamic crop simulation model, has lots of difficulties. But, this can efficiently guide in judicious management of inputs to obtain sustainability of crop production by enhancing our understanding about the agro-ecosystem. AquaCrop model (Version 6.1) was calibrated and validated under conservation agriculture system during 2017-19 on HD-2967 cultivar of wheat in semi-arid North India. The treatments were two levels of tillage (conventional tillage and No-tillage), two levels of residue mulch (With and without residue) and three levels of N fertilizer (50%, 100% and 150% recommended dose of nitrogen) as main plot, sub plot and sub-sub plot, respectively. We calibrated the model parameters for grain yield (GY) and biomass yield (BY) of wheat with some of the data generated in field during 2017-18 and some of the data were obtained iteratively varying the model parameters. The model was validated with independent dataset generated by field experiment during 2018-19 for prediction of GY, BY, transpiration, water productivity (WP), temporal variation of profile moisture (SM), canopy cover (CC) and aboveground biomass(BIO) of wheat. The observed R^2 values for simulation of GY, BY, ET and transpiration were 0.834, 0.829, 0.557 and 0.787, respectively while corresponding prediction error were -2.8, -13, -2.4 and -12.3%, respectively. The CC, BIO and SM during wheat growth were simulated with a R^2 range of 0.79-0.987, 0.749-0.963 and 0.503-0.763 and the corresponding nRMSE range of 11.9-37%, 23.5-66.8% and 6.3-11.4%, respectively. Thus, AquaCrop model can satisfactorily simulate the GY, BY, CC and SM of wheat under different tillage, residue and nitrogen management. Based on the simulation studies, it was recommended that wheat may be grown under CT or NT with crop residue mulching and 150% recommended dose of N with 3 irrigations (180 mm) at 21, 65 and 105 DAS in low rainfall years and with 2 irrigations (120 mm) at 21 and 85 DAS in high rainfall years to get maximum WP without any significant reductions in crop yield resulting in saving of irrigation water compared to farmers practice in the NWPZ of India.

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Delineation, Mapping of Ground Water Quality and Assessment of Sea Water Intrusion in Nagapattinam District (coastal) of Tamil Nadu

Baskar Murugaiyan*
Department of Soil Science and Agricultural Chemistry, Institute of Agriculture, Tamil Nadu Agricultural University, Trichy, 621712, Tamil Nadu
**Email: mbaskaruma@gmail.com*

To characterize the groundwater quality of Nagapattinam District 215 water samples were collected from different parts of Nagapattinam district. Collected samples were analyzed for pH, EC, cations (Ca, Mg, Na and K), and anions (CO_3, HCO_3, Cl and SO_4). Quality parameters like SAR and RSC were calculated. Classification of water quality is done on the basis of EC, SAR and RSC values as suggested by CSSRI, Karnal. Nagapattinam District has 11 Blocks *viz*., Keelaiyur, Kilvelur, Kollidam, Kuttalam, Mayiladuthurai, Nagapattinam, Sembanar Koil, Sirkazhi, Thirumarugal, Talanayar and Vedaranniyam. Out of the total samples collected in the Nagapattinam District, 72.6% is characterized as good quality, 12.7% are marginally saline, 7.8% are saline, 2.9% are marginally alkaline, 2.9% are alkaline and 0.4% are high SAR saline. More than 90% of water samples collected from Kuttalam and Mayiladuthurai blocks were good quality waters. Nagapattinam and Vedaranniyam blocks have less than 50 per cent good quality water Marginally saline water was observed in almost all the blocks except Kuttalam and Mayiladuthurai. The distribution of marginally saline water were 9.09% in Sembanarkoil, 9.0% in Sirkazhi, 16.7% in Kollidam, 18.2% in Thirumarumarugal, 18.5% in Kilvelur, 25 % in Keelaiyur, 38.5 % in Thalanayar and 17.6 % in Vedaranniyam Blocks. The distribution of saline water was 4.54% in Sembanar Koil, 9% in Sirkazhi, 0.09% in Thirumarugal, 44.4% in Nagapattinam, 6.25% in Keelaiyur, 7.69 in Talanayar and 7.8% in Vedaranniyam Block. Small quantity of marginally alkali and alkali water was distributed in almost all the blocks. High SAR Saline water is reported only in Kilvelur Block. Assessment of sea water intrusion study through piper diagram and ionic ratio indicates that there is a possibility of sea watrer intrution in some coastal blocks of Nagapattinam district.

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Effect of Tillage, Residue, Irrigation and Nitrogen Management on Soil Physical Properties and Root Growth in Wheat

Sudipta Basu*, K.K. Bandyopadhyay, D. Chakraborty, B. Chakrabarty, R. Pandey, Sujan Adak and Priya Bhattacharya

Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: sudiptabasu609@gmail.com*

Root architecture is an important plant morphological character which control growth and development of the entire plant. Modification of soil physical properties due to tillage practices, influence root morphology and its spatial distribution in soil. Field experiments were conducted in an ongoing long-term tillage experiment (since 2014) during the year 2021-22, rabi season with wheat (cv HD 2967) in a sandy loam soil (Typic Haplustept) at ICAR-IARI experiment farm (MB-4C), New Delhi to study effect of tillage, residue, irrigation and nitrogen management on soil physical properties and root growth in wheat. The experiment was laid out in split Factorial design with two levels of tillage (Conventional tillage (CT) and No tillage (NT)) and two levels of mulching (with maize crop residue mulch @ 5t ha^{-1} (R+) and without residue (R0)) as main plot factor, three nitrogen doses (50, 100 and 150% of the recommended dose of N and two levels of irrigation (full irrigation (I_F) and deficit irrigation (I_D)) as subplot factors. The results showed an increase in MWD at 0-5, 5-15 and 15-30 cm, soil depths under NT and crop residue mulch than CT and no mulch, respectively. With increase in nitrogen, the MWD (Mean Weight Diameter) of soil increased in these depths. There was decrease in BD and increase in SHC (Saturated Hydraulic Conductivity) of soil under NT and crop residue mulching. There was increase in root length density (RLD), root mass density (RMD) and root diameter (RD) of wheat under NT than that of CT. Global meta-analysis showed that under NT there was significant increase in RLD at 0-15 cm and 15-30 cm soil depths compared to CT. There was significant increase in RD (Root Average Diameter) under NT than CT at 0-15 and 15-30 cm soil depths at CRI and milking stage. RLD at 0-15 cm soil depth, was significantly positively correlated with MWD (r = 0.79**), WSA (r = 0.77**) and SHC (r = 0.70*), but negatively correlated with BD (r = -0.60*) at milking stage. Thus, NT with crop residue mulching, 100% RDN and five irrigations may be adopted in sandy loam soils of IGP region to improve the soil physical health and root growth in wheat.

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Water Productivity of Summer Mungbean in Relation to Deep Tillage, Irrigation and Mulch

Shantanu, C.B. Singh, Madhu Dhingra and Jeevanjot Dhaliwal*
Department of Soil Science, Punjab Agricultural University, Ludhiana, 141001, Punjab
**Email: jdhaliwal@pau.edu*

A field experiment was conducted on summer mungbean in factorial split plot design with three irrigation regimes based on IW/CPE ratios of 0.75, 0.50 and 0.25 in main plots and combination of two tillage *viz.* conventional tillage (CT) and deep tillage (DT) and mulch rates M_0 (0 t ha^{-1}) and M_6 (6 t ha^{-1}) in subplots in sandy loam soils. Mean cone index was 33% lower in DT as compared to CT. Deep tillage increased steady state infiltration rate by 35% as compared to conventional tillage. At harvest, soil moisture storage was 0.7 cm higher in CT plots in comparison to DT plots. Mulch application also improved soil moisture storage by 0.9 cm. Root mass density in lower depths was higher in least irrigated ($I_{0.25}$) regime as compared to frequently irrigated ($I_{0.75}$) and medium irrigated regime ($I_{0.5}$). Deep tillage resulted in higher root mass and length density than conventional tillage in 45-90 cm soil layer. Application of mulch reduced the diurnal temperature variation up to ±10°C which favoured the plant growth. Medium irrigated regimes ($I_{0.50}$) had higher seed yield than frequently irrigated $I_{0.75}$ (5.6%) and least irrigated $I_{0.25}$ (11.3%) regimes. Residue mulch and tillage increased the seed yield by 13.3 and 9.0%, respectively. Medium irrigated regime had higher water productivity (WP) as compared to frequently irrigated (23.1%) and least irrigated (11.2%).Further, DT and M_6 showed an increase of 7.7% and 12.5% in WP in comparison to CT and M_0. Thus, medium irrigated regime ($I_{0.5}$), deep tillage and residue mulch resulted in increased crop and water productivity of summer mungbean.

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Crop Productivity of Rice-Wheat-Moong Bean System as Influenced by Irrigation and Residue Management

Jeevanjot Dhaliwal*, Madhu Dhingra and M.S. Kahlon
Department of Soil Science, Punjab Agricultural University, Ludhiana, 141001, Punjab
**Email: jdhaliwal@pau.edu*

The experiment (2020-21) was carried out at the Research farm of Soil Science, Punjab Agriculture University, Ludhiana, Punjab, India. There were three irrigation regimes in rice crop *viz*. Continous flooding (CF), irrigation after two days of drainage (2-D) and irrigation after four days of drainage (4-D). The following wheat was sown with conventional tillage (CT), rice residue retained (RRR) and rice residue incorporated (RRI) rice. After the harvest of wheat crop, two cropping scenarios were kept in the experiment viz. with mungbean and without mungbean. At the time of maturity pods were handpicked and the residue was incorporated. All other recommended package of practices was followed to grow component crops in the cropping system. Rice yield was significantly higher under CF (5.23 t ha^{-1}) and 2-D (5.22 t ha^{-1}) than 4-D (4.24 t ha^{-1}). The mean wheat grain yield was highest under RRI (5.62 t ha^{-1}) followed by RRR (5.31 t ha^{-1}) and CT (5.21 t ha^{-1}). Seed yield of mungbean was highest in plots with RRI (1.02 t ha^{-1}), RRR (0.99 t ha^{-1}) and lowest in plots with CT (0.72 t ha^{-1}). Thus, irrigation after 2 days drainage in rice, rice residue incorporation in wheat proved to be promising in comparison to conventional management of rice-wheat cropping system.

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Characterization of Infiltration Rate in Dryland Soils of Western Maharashtra Plain Zone

M.K. Krishnapriya[1], Govind Kumar Yadav[2]* and G.D. Patil[3]

[1]College of Agriculture, Vellayani, Kerala Agricultural University, Thiruvananthapuram, 695001, Kerala
[2]Department of Soil Science and Agricultural Chemistry, SKN College of Agriculture, Jobner, 303329, Rajasthan
[3]College of Agriculture, Kolhapur, 416004, Maharashtra
**Email: yadav.govi004@gmail.com*

The precise assessment of infiltration rates is a vital aspect of water management in agricultural and water resource activities. The current experiment aims at describing the regional variability of surface infiltration rates in relation to specific soil physical and chemical properties and to predict the best infiltration model suited for the dry soils of western Maharashtra plain zone. GPS located ten spots each from inceptisol and entisol soils were selected and double ring infiltrometer was used for the infiltration study. The results of statistical overview showed that there were more or less similar values of standard error, standard deviation and variance in case of bulk density of both the soils of inceptisol and entisol regions. However, the variations were observed for the above mentioned statistical parameters of porosity, sand, silt and clay content in both the soils and it is because of greater variation in the physical properties of soils. The dominant textural class of soil in inceptisol was clay loam and for entisol was sandy loam. Inceptisol soils observed higher values of infiltration rate. The lower values of decay constant and higher values of coefficient of determination (R^2 = 0.7811) for infiltration rate was observed in inceptisol over entisol. Substantial reduction in time and cost of field measurement of infiltration are some of the benefits of using infiltration models in designing and optimizing irrigation projects, as they are adequate in predicting water infiltration to a reasonable level of accuracy. The coefficients of determination (R^2) between the field measured and model simulated data for both modified kostiakov and kostiakov were found to be very high (>0.95).This investigation showed that the modified kostiakov models are better than philips and hortons model at most sample points in the western Maharashtra plain zone mainly constituting the region of Pune.

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Soil Organic Carbon Stocks- A Sustainable Land Quality Indicator in Different Phases of Erosion, Tropical Humid Regions, India

M. Chandrakala*
ICAR-National Bureau of Soil Survey and Land Use Planning, Hebbal, Bangalore, 560065, Karnataka
**Email: chandra.ssac@gmail.com*

Soil is a significant state indicator as it integrates multifaceted processes *viz*., land use and management, biomass production, the overland flow of water and infiltration. Therefore, the decline in soil fertility, including a reduction in soil organic carbon, deterioration of physical properties, change in soil nutrient stock and build-up of toxic substances and soil erosion, are considered state indicators. A study has been conducted to know the status of organic carbon stock as a sustainable potential soil quality indicator in four different phases of erosion *viz*., slightly eroded (0.5% slope), moderately eroded (2.5% slope), severely eroded (4.5% slope) and very severely eroded (9.5% slope) under different land management systems such as fertilized and unfertilised conditions in maize-wheat cropping sequence. As the severity of erosion increases the soil quality indicator that is soil organic carbon stock (SOCS) decreases. Very severely eroded soils have lower SOCS as compared to slightly eroded soils. Land under fertilized conditions has better SOCS with a range between 1.448 and 0.892 kg m^{-2} in slightly eroded and very severely eroded soils compared to 1.229 and 0.804 kg m^{-2} in non-fertilized conditions, respectively. The decrease in SOCS with an increase in erosion is due to the lower organic carbon. There is a negative correlation existing between organic carbon and bulk density (r = -0.81) and also SOCS and bulk density (r = -0.70). The data also show that SOCS recorded <3.0 kg m^{-2} which is very low land quality characteristics. Moreover, a critical level of C input requirements for maintaining SOC at the antecedent level is suggested as 1.1 to 3.5 Mg C ha^{-1} yr^{-1}. This implies that there is a sufficient loss of soil quality indicator in severe and very severe erosion phases particularly in the unfertilized condition which needs suitable soil conservation measures to maintain soil/land quality.

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Impact of Crop Residue Mulching on Soil Temperature, Moisture and Nutrient Availability in Rabi Sorghum under Rainfed Condition

D.B. Kadam*, A.L. Pharande, A.G. Durgude and A.D. Kadlag
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kadamdarshana92@gmail.com*

The field experiment was conducted at AICRP on Soil Test Crop Response Correlation Project, Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, during two successive years 2018-19 and 2019-20 to study the "Impact of crop residue mulching on soil temperature, soil moisture and nutrient availability in *rabi* sorghum under rainfed condition" in *Inceptisol*. The experiment was laid down in Randomized Block Design, consisted of 12 treatments replicated thrice, *viz*. pearl-millet straw(T_1), *kharif* sorghum straw(T_2), maize straw (T_3), sugarcane trash (T_4), takala foliage (T_5), glyiricidia leaves (T_6), wheat straw (T_7), byer waste (T_8), sugarcane baggase (T_9), pigeon pea straw (T_{10}), soil dust mulch (T_{11}) and control (T_{12}). From the present investigation, it was observed that the crop residue mulch increased the soil temperature by 2.0 to 2.2°C during winter and reduced soil temperature by 2.4°C to 2.5°C during summer season in comparison with soil dust mulch. The application of wheat straw mulch @ 5 t ha^{-1}, 15 days after sowing significantly regulate the soil temperature, conserved soil moisture, increased the moisture use efficiency, nutrient availability and yield of rainfed *rabi* sorghum. However, the application of glyricidia leaves mulch @ 5 t ha^{-1} was found at par and significantly increased the nutrient availability in soil as compared to soil dust mulch and control treatment.

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Effect of Crop Residue Mulching on Soil Temperature, Moisture and Nutrient Availability in Rabi Sorghum under Rainfed Condition

D.B. Kadam*, A.L. Pharande, S.D. Kale, A.G. Durgude and A.D. Kadlag
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kadamdarshana92@gmail.com*

The field experiment was conducted at AICRP on Soil Test Crop Response Correlation Project, Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, during two successive years 2018-19 and 2019-20 to study the "Effect of crop residue mulching on soil temperature, soil moisture and nutrient availability in *rabi* sorghum under rainfed condition" in *Inceptisol*. The experiment was laid down in Randomized Block Design, consisted of 12 treatments replicated thrice, *viz*. pearl-millet straw (T_1), *kharif* sorghum straw (T_2), maize straw (T_3), sugarcane trash (T_4), takala foliage (T_5), glyiricidia leaves (T_6), wheat straw (T_7), byer waste (T_8), sugarcane baggase (T_9), pigeon pea straw (T_{10}), soil dust mulch (T_{11}) and control (T_{12}). These results clearly indicated that, in rainfed *rabi* sorghum, the application of wheat straw mulch @ 5 t ha^{-1} (in between the two rows) at 15 DAS along with general recommended dose of fertilizers (50:25 N: P_2O_5 kg ha^{-1} with 5 t ha^{-1} FYM) significantly conserved soil moisture, regulate soil temperature, increased yield, moisture use efficiency, nutrient uptake, net monetary returns, benefit cost ratio and improved the soil health. However, the application of glyricidia leaves mulch @ 5 t ha^{-1} at 15 DAS was found at par and significantly improved chemical and biological properties of soil under rainfed *rabi* sorghum in *Inceptisol*. Therefore, organic mulching specifically wheat straw mulch is cost effective measure not only for improving soil quality indicators but also enhancing crop yield, conservation of soil moisture and regulate soil temperature under rainfed condition.

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Influence of Fertigation Doses and Mulching on Growth Parameters and Yield of Garlic (*Allium sativum*)

Varsha Rattan*
Department of Soil Science and Agricultural Chemistry, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 176062, Himachal Pradesh
**Email: varsharattan2403@gmail.com*

Garlic is an odoriferous bulb crop which belongs to family Alliaceae and is the second most important allium crop after onion. It is a perennial crop which has higher nutritive value as compared to other bulb crops. Garlic is a shallow rooted crop which requires regulated moisture during its growth stages, but dependency only on rains may hamper the quality and yield of the crop. Hence, field experiment was conducted to study the influence of fertigation doses and mulch on growth parameters and yield at the Experimental Farm of Department of Soil Science and Water Management, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, (HP). The field experiment was laid out in randomized block design with three replications and eight treatments *viz.*, F_1M_0 - fertigation at 100% recommended dose of fertilizer (RDF) through water soluble fertilizer, F_2M_0 - fertigation at 80% RDF through water soluble fertilizer, F_3M_0 - fertigation at 60% RDF through water soluble fertilizer, F_4M_0 -surface irrigation at 100% RDF, F_1M_1 - fertigation at 100% RDF through water soluble fertilizer+ polyethylene mulch, F_2M_1 - fertigation at 80% RDF through water soluble fertilizer + polyethylene mulch, F_3M_1-fertigation at 60% RDF through water soluble fertilizer + polyethylene mulch, F_4M_1 -surface irrigation with 100% RDF through water soluble fertilizer + polyethylene mulch. Results showed that the application of different doses of N, P and K through fertigation in association with mulching increased the growth attributes and yield of garlic crop. Further, the maximum values for the growth attributes such as plant height (80.70 cm), mean number of leaves (10.33), neck thickness (0.85 cm), bulb diameter (5.47), mean number of cloves (15.17), dry matter content (41.22%) and biological yield (273.33 q ha^{-1}) were recorded under the treatment F_1M_1. This treatment (F_1M_1) resulted in significantly higher yield (86%) and reduced fertilizer use to 28% when compared to surface irrigation with 100 per cent recommended dose of fertilizer. Thus, fertigation along with mulch proved to more efficient than surface irrigation.

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Ensemble Surface Soil Moisture Estimates at Farm-Scale Combining Satellite-Based Optical-Thermal-Microwave Remote Sensing Observations

Debashis Chakraborty[1]*, Bappa Das[2], Debasish Roy[3], Pooja Rathore[3], Raghuveer Jatav[3], Deepak Sethi[3] and Bimal Kumar Bhattacharya[4]

[1]Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
[2]ICAR-Central Coastal Research Institute, Ola Goa, 403402, Goa
[3]ICAR-Indian Agricultural Research Institute, New Delhi, 110012
[4]Space Application Centre, Ahmedabad, 380015, Gujarat
**Email: debashisiari@gmail.com*

The current attempts to evaluate the synergistic use of microwave and optical/thermal infrared remote sensing and an ensemble-of-all approach for monitoring surface soil moisture (SSM) over a semi-arid irrigated agricultural farm. The performance of the Water Cloud Model (WCM) using Sentinel-1 & -2, Thermal-Optical TRApezoid Model (TOTRAM) and Optical TRApezoid Model (OPTRAM) using Landsat-8 short-wave infrared (SWIR)/thermal infrared sensor (TIRS) data and an ensemble model were evaluated for nine dates covering the entire post-monsoon period. The ensemble model was built using Gradient Boosting Machine (GBM), and outputs from the microwave and optical/thermal approaches provided a better SSM estimate over the crop season. Although the model performances varied with crop growth stages, the overall lowest RMSE was measured in the ensemble model (0.056 $m^3 m^{-3}$), followed by OPTRAM (SWIR2) (0.065 $m^3 m^{-3}$) and the highest for TOTRAM (0.09 $m^3 m^{-3}$). WCM or TOTRAM mapped SSM better during the early phases of crop growth, whereas OPTRAM (SWIR 1 or 2) was found more reliable during the latter stages. Although optical and optical-thermal synergy was better for a dry-moist soil moisture regime, all the approaches could effectively delineate high- and low-intensive irrigation zones. The study highlights the limitations of WCM regarding its calibration requirement for changing vegetation structure using *in situ* data. In contrast, TOTRAM needs local calibration due to land surface temperature sensitivity to ambient atmospheric conditions. OPTRAM, being simple, low data- and resource-intensive, and surface reflectance-soil moisture relationship independent of local calibration, is advantageous for generating soil moisture maps during the post-monsoon period in semi-arid climate with prevailing clear sky conditions. Overall, the ensemble technique can be recommended for farm-level irrigation mapping over an entire post-monsoon period.

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An Evaluation of Infiltration Models Across Major Soil Groups of India

Debashis Chakraborty[1]*, Tridiv Ghosh[1] and Debasish Roy and Bappa Das[2]
[1]Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
[2]ICAR-Central Coastal Research Institute, Ola Goa, 403402, Goa
**Email: debashisiari@gmail.com*

Characterization of infiltration of water is useful for designing and evaluating hydrological processes. The aim of the present work is an inter-comparison of infiltration models to evaluate the infiltration rates (cm h^{-1}) of 73 locations across major soil types in India. The *in-situ* measurements were carried out by using the double ring infiltrometer on different land use systems. Basic infiltrations rates were obtained as 2.88 cm h^{-1} (grassland), 4.26 cm h^{-1} (forest), 0.78 to 10.92 cm h^{-1} (fallow land), and 0.84 to 12.78 cm h^{-1} (cultivated land). A set of six infiltration models (Kostiakov, Philip, Horton, Holtan, Green & Ampt, and modified Kostiakov) were evaluated by least square fitting based on statistical parameters *viz*., R^2, d-index, RPD, and RPIQ, and ranked. Based on average rank, Phillip's and Kostiakov's model could explain the variation most satisfactorily, however, Kostiakov's model had a better consistency across land use and soil types.

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Effect of Precise Irrigation Under Conservation Agriculture on Soil Water Dynamics, Yield and Water Productivity of Maize

Sanatan Pradhan*, B. Behera, P. Panigrahi, P. Deb Roy, R.K. Panda, P.P. Adhikari, Ajit Kumar Nayak, R.K. Jena and S.K. Rautaray

ICAR-Indian Institute of Water Management, Chandrasekharpur, Bhubaneswar, 751023, Odisha
**Email: sanatan28@gmail.com*

A field experiment was conducted during 2021-2022 at ICAR-IIWM, Bhubaneswar to study the effects of precise irrigation under conservation agriculture on soil water dynamics, yield and water productivity in maize. The treatments imposed were (1) TPR-CTM-CTG with CI, (2) TPR-CTM-CTG with PI, (3) (TPR+GR)-(ZTM+RR)-(ZTG+MR) with CI, (4) (TPR+GR)-(ZTM+RR)-(ZTG+MR) with PI, (5) (ZTDSR+GR)-(ZTM+RR)-(ZTG+MR) with CI, and (6) (ZTDSR+GR)-(ZTM+RR)-(ZTG+MR) with PI. ZTDSR: zero tillage direct seeded rice, GR: green gram residue, ZTM: zero tillage maize, RR: rice residue, ZTG: Zero tillage green gram, MR: Maize residue, TPR: transplanted rice, CTM: conventional-till maize, CTG: conventional-till green gram, CI (Conventional irrigation) and PI (Precise irrigation based on soil matric potential (-60 kPa). The treatments were imposed in RBD with three replications in Sandy clay loam soil with field capacity and permanent wilting point of 27% and 11%, respectively. Before the maize crop, the rice crop (cv. MTU 1009) with a spacing of 20 × 10 cm was grown to stabilize the experimental site and to generate crop residues. The mean dry biomass (3.38 t ha^{-1}) of rice plant was added in the residue-required plots. After the rice, maize (cv. Nilesh) was sown with a spacing of 60 × 30 cm.The fertilizer dose was 150-75-75 ha^{-1}. The study revealed that ZT+R stored 18% higher soil moisture than CT-R in top 60 cm soil. The PI registered higher soil moisture content (upto 69%) than CI. ZT with residue reduced surface soil temperature up to 1.9 °C compared to CT. The %IPAR increased from 37 to 57% during 55 to 61 DAS. The %IPAR was 7-8% higher in PI compared to CI. The SPAD value did not vary significantly among the treatments. However, the SPAD value increased from 43 to 49% during 55 to 61 DAS. Under PI, seven irrigations of 50 mm each were applied. However, under CI, five irrigations of 70 mm each were applied. The water use in maize under various treatments varied from 387 mm to 399 mm. The highest maize yield was observed in ZT + R with PI (6.71 t ha^{-1}). The maize yield and water productivity under PI were 19-26% and 18-24% higher than the CI, respectively.

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Alternate Wetting and Drying Irrigation System Can Reduce Phosphorous Availability in Typical Lowland Paddy Soils Irrespective of Nitrogen Fertilizer Application

Partha Pratim Adhikary*, S. Mohanty, S.K. Rautaray, S. Pradhan and Ankhila R. Handral
ICAR-Indian Institute of Water Management, Chandrasekharpur, Bhubaneswar, 751023, Odisha
**Email: ppadhikary@gmail.com*

At the end of fiscal year 2021, India had approximately 45 million hectares of land area for cultivation of rice. This area had been fluctuating over during the past three years. In fiscal year 2021, rice was the most produced food grain across the south Asian nation. As the demand for rice is increasing the water use in rice production systems has to be reduced and water productivity has to be increased. Water for irrigation and low soil fertility are among the main challenges for rice production. One way to decrease water consumption in paddy fields is to change the irrigation regime for rice production, replacing continuous flooding (CF) with alternate wetting and drying (AWD). Rice production is highly impacted by soil phosphorus (P) availability which is poor and susceptibly affected by soil moisture. However, how water management affect paddy soil P availability is still not well known. A field experiment was conducted to evaluate the effects of two water management regimes: CF and AWD irrigations combined with different nitrogen levels (90, 120 and 150 kg N ha^{-1}) on P availability in paddy soil. The experiment was conducted in irrigated lowlands and followed AWD practices as recommended by International Rice Research Institute, Philippines. The site had sandy clay loam soil with 61.6, 16.2 and 22.2% sand, silt and clay, respectively. Soil pH was 5.57, EC 0.36 dS m^{-1}, organic carbon 0.47%, available N 206 kg ha^{-1}, P 14 kg ha^{-1} and K 178 kg ha^{-1}, bulk density 1454 kg m^{-1}. Soil moisture regime was Ustic and soil temperature regime was Hyperthermic. The puddle layer is up to 18 cm depth and after that up to 32 cm there is a plough layer which is very hardened. The plough layer has more organic matter and clay content. Side by side its bulk density is also very high (1668 kg m^{-3}). Total N content varied between 0.91 and 1.27 g kg^{-1}, of which top soil layer contains more N. there was shallow groundwater table and hydraulic conductivity varies between 2.3 and 5.7 mm h^{-1}. Water management significantly affected soil available P, total reductant, and ferrous iron. However, addition of N showed no effect on soil P availability. Compared to CF, AWD consistently decreased the soil available P content under N addition at different rates. The main reason was that AWD increased microbial biomass for immobilizing P and decreased ferrous iron content for increasing soil P absorption, reducing available P content. In conclusion, AWD reduces available P content in paddy soil compared to CF. Water management has a more significant regulatory effect on soil P availability than addition of N fertilizer in the field management.

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Effects of Resource Conservation Technologies on Soil Moisture Content, Yield and Water Productivity of Rabi Sunflower Crop in Eastern India

Biswaranjan Behera*, Sanatan Pradhan, Pravukalyan Panigrahi, R.H.Ankhila and Rabindra Kumar Panda

ICAR-Indian Institute of Water Management, Chandrasekharpur, Bhubaneswar, 751023, Odisha
**Email: b.behera@icar.gov.in*

Sunflower, with water-stress tolerant ability and low water requirements, is a potential crop for intensifying the rabi fallow area (12.54 M ha) of eastern India, having water and soil-based constraints. Therefore, an experiment was conducted in the ICAR-IIWM research farm, Bhubaneswar, to study the effect of different resource conservation technologies (RCTs) involving different irrigation methods, conservation tillage, and preceding maize crop residues on sunflower crop yield and water productivity during the winter season of 2021. The experiment was laid out in a randomized block design with four replications. The treatments included eight RCT treatments, *viz.*, permanent broad-bed furrow irrigation (PBBF), permanent narrow-bed furrow irrigation (PNBF), zero-till surface drip irrigation (ZTDI) and zero-till sub-surface drip irrigation (ZTSDI), with (+R) and without residue; two controls, *viz.*, zero-till flatbed flood irrigation with residue (ZTFBF + R) and conventional till flatbed furrow irrigation (CTFBF). The results revealed that drip irrigations with residue led to 17.8-24.6%, 22.1-16.8%, 13.4-20.9% higher seasonal soil moisture content than the CTFBF in 0-15, 15-30, and 30-45 cm soil depths, respectively. The crop under drip irrigations with residue and furrow irrigations with residue accumulated 35-43% and 13-18% higher biomass, respectively, compared to the CTFBF at 60 DAS. The better soil moisture distribution and higher crop growth under drip irrigations with residue led to 29-45% higher filled seeds per head. The ZTSDI + R resulted in 13%, 27%, 41% and 47% higher seed yield as compared to ZTDI + R, PBBF + R, ZTFBF + R and CTFBF, respectively. The water saving under the ZTSDI + R was up to 49% as compared to the others. The higher yield and lower water use led to the highest water productivity under the ZTDI + R, which was 34%, 56%, 154%, and 189% higher than the ZTDI + R, PBBF + R, ZTFBF + R, and CTFBF, respectively. Therefore, the results of the study suggest resource conservation technologies involving efficient irrigation methods, conservation tillage, and residue retention could be promising for enhancing the yield and water productivity of sunflower during the winter season in eastern India.

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Suitable Adaptive Management Practices to Improve the Pigeon Pea Yield in Central India Using Simulation Modeling

Nishant K. Sinha[1]*, M. Mohanty[1], Vinay Nangia[2], J. Somasundaram[1], R.S. Chaudhary[1], Rana Pratap Singh[1], Jitendra Kumar[1], Dhiraj Kumar[1], Rahul Mishra[1], K.M. Hati[1] and Ashok K. Patra[1]

[1]ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
[2]International Center for Agricultural Research in the Dry Areas (ICARDA)
**EmailI: nishant.sinha76211@gmail.com*

India accounts for approximately 22% of the world's production of pulses. About 67% of the global Chickpea, 72% of Pigeon pea, and 38% of Lentil area fall in India, corresponding to 66%, 63% and 21% of the global production, respectively. Despite this fact, the yield of Pulses in India is much less than in the world. Pulses in India are grown mostly in a rainfed situation with less-than-ideal conditions, which may be the primary cause for the lower yield. Pigeon pea is an important pulse crop and is largely grown in Madhya Pradesh. However, Pigeon Pea productivity (1.133 t ha^{-1}) is relatively low compared to a developed nation. To work out a suitable strategy to improve the productivity of Pigeon pea, it is imperative to assess the potential yield in the region of interest and the gap between the potential yield and actual yield obtained by the average farmers. In this study, a well-calibrated and validated APSIM crop model was employed to assess the pigeon pea yield gap in Madhya Pradesh and identify suitable adaptive management practices to improve the pigeon pea yield in the state. Results indicate that one irrigation of 60 mm during the last week of November may improve pigeon pea yield in central India.

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Assessment of Irrigation Water Quality of Pentakli Dam Command Area in Buldhana District of Maharashtra

Satishchandra Jadhao*, Ajay Solanki, P.R. Kadu, N.M. Konde, D.V. Mali and Nilam Kanase

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra

**Email: smjadhao77@gmail.com*

The present investigation entitled Assessment of ground water quality in Pentakali command area of Buldhana district of Maharashtra was undertaken during 2017-2019 in Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The ground water was having high salinity and low sodium hazard (C_3S_1) during pre-monsoon (summer) and monsoon (rainy) season, medium salinity and low sodium hazard (C_2S_1) during post monsoon (winter) season, amongst the cation sodium was dominant in pre monsoon and monsoon season. The all anionic composition was below the permissible limit in all three seasons. The sodium adsorption ratio was within the permissible limit in all three seasons and Mg:Ca ratio all samples during pre monsoon (summer), monsoon (rainy) and post monsoon (winter) season falls in permissible limit. The adjusted sodium adsorption ratio falls in acceptable range in all three seasons. As per Kelleys ratio the all samples during pre-monsoon falls in acceptable range, during monsoon one samples and during post monsoon season three samples crossed the permissible limit. On the basis of permeability index ground water was fall in class II and III which categorized as medium to high during all three season. The residual sodium bicarbonate of all samples during pre-monsoon, monsoon and post were found in monsoon acceptable range. As per magnesium adsorption ratio all samples found within the permissible limit during all three seasons. Soluble sodium percentage of the all ground water samples during pre-monsoon, thirty-nine ground water samples during monsoon and all samples during post monsoon season are unsuitable for irrigation. Micronutrients *viz*. Iron, Manganese, Zinc, and Copper was observed within permissible limit in all three season, and rest of the nutrients was also in acceptable range. Therefore, the collected water is advisable for irrigation by adopting proper management practice and the irrigation water content appreciable amount of nutrient element which can substitute fertilizers same extent.

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Development of Pedotransfer Functions to Characterize Soil Physical Health Under Different Agricultural Management Practices

Vikas Kumar Rai*, Rajib Singha, Mukesh Kumar and Santosh Kumar Singh
Dr. Rajendra Prasad Central Agricultural University, Samatipur, Pusa, 848125, Bihar
**Email: vikas.soils@rpcau.ac.in*

Research was conducted on Development of pedotransfer functions to characterize soil physical health under different agricultural management practices during 2021-22 in the different district of North Bihar. A set of soil physical parameters were assessed in order to characterize and evaluate the influence of different cropping system and soil type on various soil physical health indicators. Soil samples were taken from 48 locations at 15 cm depth interval upto 60cm during March to April, 2022. Direct measurement of FC, PWP or bulk density in deeper soil profile is labour intensive, time consuming and expensive practices. However, pedotransfer functions (PTFs) can be used to estimate these parameters indirectly with fair level of accuracy. The major limitation of these PTFs are being site specific in nature. Therefore, a comprehensive PTF was developed with N=172 datapoints for different dependent and independent variables. In this study, stepwise multiple linear regression (SMLR) and artificial neural network (ANN) methods were used to develop FC and PWP. All the raw data of soil physical properties were grouped in to two classes of training (N=100) and testing (N=72) independent variables. While testing these developed PTFs for FC, PWP, BD and WHC using independent data, coefficient of determination (R^2) was 0.79,0.72,0.88,0.86 for SMLR and 0.77,0.76,0.82,0.85 for ANN approach respectively. Root mean square error (RMSE) for PTFs developed for FC, PWP, BD and WHC was found to be 0.01, 0.01, 0.05, 0.02 using SMLR and 0.02,0.02,0.08,0.03 using ANN respectively. Evaluation of few tested PTFs available in literature was found to have $R^2 < 0.16$ and 0.51 and RMSE was >0.06, for FC and PWP respectively. The PTFs developed in this study may be quite useful to researchers for use in simulation studies and also to farmers for scheduling irrigation water as per soil type.

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Influence of Different Soil Types and Moisture Regimes on Seed Hydration Value of Various Soybean Varieties

Papita Gourkhede*, Digvijay Dhama and Vilas D. Patil
Department of Soil Science & Agriculture Chemistry, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: pathrikar2012@gmail.com*

The experiment on "Studies on the effect of different soil types and moisture regimes on seed hydration value of various soybean varieties" was conducted during the season 2020-21 in CIC Laboratory of Soil Science and Agricultural Chemistry Department, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, to find out the seed hydration value and germination in different soybean varieties at different soil moistures in three types of soil.

This laboratory study was carried out in petri plates with four soybean varieties JS-335, MAUS-71, MAUS-158 and MAUS-162 at four soil moisture levels of 50, 75, 100 and 125 percent field capacities in Vertisols, Entisols and Inceptisols soils. The treatments were replicated two times in FCRD design and observations were taken at the regular time interval of 6 hours up to 96 hours from sowing. The results obtained from the investigation revealed that the germination parameters and seed hydration value for different soybean varieties were clearly influenced by different soil moistures in different soil types. Amongst all varieties, variety MAUS-162 showed the highest germination at different soil moistures and the lowest was noted in variety JS-335. In vertisols and Inceptisols, the highest seed hydration value was reported in variety MAUS-162 with the earliest germination among all varieties in all soil types. Better germination for soybean varieties was observed at soil moisture of 75 and 100 percent field capacities. Vertisols and Inceptisols showed early and better germination for soybean seeds. Among all soybean varieties, MAUS-158 and MAUS-71 showed lower seed hydration value so can be suitable for rainfed cultivation.

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Study of the Nutrient Release Pattern of Slag Based Gypsum in Alkaline Soil under Two Moisture Regime

Pema Khandu Goiba*, Nagabovanalli B. Prakash, Prabhudev Dhumgond, Shruthi and G.S. Yogesh

GKVK, University of Agricultural Sciences, Bengaluru, 560065, Karnataka
**Email: pemagoibassac@gmail.com*

Gypsum as a nutrient source has been used in agriculture for many years and it has proved to be beneficial for different crops under varied soil condition. Slag based gypsum (SBG) is a synthetic gypsum produced using LD slag (Linz- Donawitz slag) fines of steel industry. SBG is similar in composition to commercial gypsum (CG) which is a rich source of Ca and S. Additionally, it also contains P, Mg, Si and micronutrients (Fe, Mn and Zn). An incubation study was carried out at 0, 7, 15, 30, 60, 90 and 120 days after incubation (DAI) to know the nutrient releasing pattern of SBG in alkaline soil under field capacity and submerged condition. There was a steady increase in soil pH and EC with the application of SBG over the period of incubation. However, there was a decline in pH and EC at 120 DAI. Although, available P_2O_5, available K_2O, exchangeable Ca and Mg, available S, available Si (AASi and $CaCl_2$-Si) and DTPA extractable micronutrients were found to increase with the increase in application rate of SBG. There was no definite behaviour regarding the availability of nutrients analysed over the period of incubation. In general, application of 750 kg SBG ha^{-1} was reported superior in increasing the availability of nutrients studied in the current investigation and was found to be on par with 600 kg SBG ha^{-1}.

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Maize Straw Biochar Application Influences Soil Phosphorus Dynamics for Satisfying Crop P Demand

Jagmandeep Kaur*, Manpreet Singh Mavi and Jagdeep Singh
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: jagmandeepkaur3@gmail.com*

Phosphorus (P) is the second most important macronutrient essential for plant growth, whose deficiency is responsible for restricting crop productivity. Owing to its fixation in soil, limited availability of its natural reserves, and costly nature of phosphatic fertilizers, alternative sources of P should be sought. In this context, biochar, a product of thermochemical decomposition of biomass can serve as a sustainable P source. In the present study, a pot experiment was conducted with wheat as a test crop to study the effect of maize straw biochar and inorganic-P fertilizer on soil P availability and wheat yield in soil with varying P status i.e. low P (5 mg kg^{-1}) and high P (30 mg kg^{-1}). Treatments included four rates of maize straw biochar (0, 2, 4 and 8 t ha^{-1}) along with three levels of (0, 30 and 60 mg kg^{-1} through KH_2PO_4) inorganic-P. Application of biochar and inorganic-P fertilizer at increasing rates significantly improved the wheat grain yield and P availability (Olsen-P and microbial biomass P) of the amended soil. The wheat grain yield attained upon 2 t ha^{-1} biochar application alone was equivalent to inorganic-P alone (30-60 mg kg^{-1}) treatment in low and high P status soil. However, the increment observed in grain yield and soil P availability upon biochar application was better when applied alone rather than its co-application with the inorganic-P. Besides, the changes in P dynamics with biochar application were more visible in low P than in the high P status soil. Furthermore, the alkaline phosphomonoesterase activity (APA) decreased upon biochar and inorganic-P application indicating a slower P turnover rate in the soil. Therefore, it can be inferred from the study that maize straw biochar can serve as a promising substitute for inorganic-P fertilizer for satisfying crop P demand.

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Analysis of Seasonal Variations on the Ground Water Quality Parameters in Navalgund Taluk of Karnataka

Nagaraja Kulakarni[1], Gopal V. Dasar[2] and B.C. Punitha[3]*
[1]University of Agricultural Sciences, Dharwad, 580005, Karnataka
[2]College of Forestry (UAS Dharwad), Sirsi, 581401, Karnataka
[3]ICAR Krishi Vigyan Kendra, University of Agricultural Sciences, Dharwad, 580005, Karnataka
**Email: punithabc@uasd.in*

A survey work was carried out during 2019-20 to assess ground water quality for agriculture purpose in Navalgund taluk of Dharwad district of Karnataka. A total 120 representative water samples covering whole taluk were collected along with geographical location in both monsoon and summer seasons, respectively. Collected water samples were analysed for quality parameters and interpreted according to their standard classification using Arc.GIS with spatial analyst GIS software. The results revealed that the pH of irrigation water samples ranged from 6.90 to 8.90 with an average value of 7.69 during monsoon (July, 2019) and from 7.1 to 8.9 with an average value 7.86 during summer season (February, 2020), respectively. All irrigation water samples were found saline with the EC values ranging from 1.05 to 5.89 dS m^{-1} with a mean value 3.60 dS m^{-1} (monsoon) and 2.00 to 5.90 dS m^{-1} with an average value 3.88 dSm^{-1} in summer seasons, respectively. According to irrigation water quality classification given by CSSRI, Karnal, there was no good quality of irrigation water samples, 9 per cent of marginally saline, 4 per cent of saline, 53 per cent of high SAR saline, 1.6 per cent of alkali and 32 per cent of irrigation water samples found in high alkali in monsoon season. Whereas in summer, there is 1.6 per cent good quality of irrigation water samples, 5 per cent of marginally saline, 4 per cent of saline, 55 per cent of high SAR saline, 5 per cent of alkali and 30 per cent of irrigation water samples were found in high alkali. It was also noticed that all the cations and anions in water samples analyzed were low in monsoon as compared to summer season.

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Assessing the Potential of Some New Chemical and Organic Amendments in Sodic Water Irrigated Rice-Wheat System

Harjot Kaur*, O.P. Choudhary and M.S. Mavi
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: harjot-soccam@pau.edu*

Long-term sodic water (SW) irrigation leads to development of sodicity in soils which severely impacts soil health besides incurring yield losses. Adverse impacts of irrigation-induced sodicity can be ameliorated through Ca-containing amendments like gypsum. But, the issue with its assured availability as well as quality has propelled the scientific community to explore other Ca-containing resources. Yellow-gypsum, a by-product of steel industry can be one such option. Also, organic amendments such as FYM, rice-straw compost, rice-straw (RS) and rice-straw biochar (BC) can be applied to restore soil health and productivity of the sodic environments. A pot experiment was conducted to collate the effect of application of inorganic (yellow- and mined-gypsum, both @50% gypsum requirement) applied along with SW-irrigation and, organic amendments (FYM @15 t ha^{-1}, rice-straw compost and RS @6 t ha^{-1} and BC @4 t ha^{-1}, applied once before sowing wheat) on properties of two soils (loamy-sand; LS and sandy clay-loam; SCL) and biomass yield of wheat and rice. Two soils were irrigated with different RSC levels, i.e. 0, 5, 7.5 and 10 meq L^{-1}. Results revealed decrease in biomass yield and uptake of Ca, Mg and K under SW irrigation in both crops while Na uptake increased. Irrigation with high RSC water increased soil pH, SAR (higher in SCL), ESP (higher in LS) but it decreased microbial biomass carbon (MBC). Gypsum (both-types) application decreased soil pH, SAR and ESP along with significant improvements in biomass yield and MBC. Among the organic amendments, biochar reduced Na uptake whereas rice-straw compost and FYM gave promising results in improving soil properties and biomass yield. Further, field studies need to be conducted to evaluate restorative effect of yellow-gypsum vis-à-vis mined-gypsum and its combined application with organic amendments in soils under SW irrigation.

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Effect of Organic Amendments on the Distribution of Cadmium Species in Soil-Water System of Sewage Water Irrigated Soil

Dhanwinder Singh*, Samapti Saren, Sumita Chandel and R. Sikka
Department of Soil Science, Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: dhanwinder@pau.edu*

A Laboratory experiments was conducted to study the effect of applied farm yard manure (FYM), rice straw compost (RSC), vermicompost (VC), and biochar (BC) on the aqueous phase speciation of cadmium in a sewage water irrigated (SWI) soil. Effect of time of contact (7, 21, 42, 63, 84, and 105 days) of these amendments with soil (at field capacity and 25 ^{0}C) on the the distribution of aqueous cadmium species for the specified soil-water equilibrated systems were computed using Visual MINTEQ 3.0. The dominant species existed in the soil-water system of both amended as well as unamended soil were Cd^{2+}, $CdOH^+$, $CdCl^+$, $CdCl_2$ (aq), $CdSO_4$ (aq), $Cd(SO_4)_2^{2-}$, $CdHCO_3^+$ and $CdCO_3$ (aq). Among these, $CdSO_4$ (aq) was the most dominant followed by Cd^{2+}, $Cd(SO_4)_2^{2-}$ and $CdCl^+$ species. Application of the amendments to the soils resulted in decrease in both Cd^{2+} concentration and proportion of the species as compared to the unamended soil. The proportion of $CdCl^+$ also decreased in the amended soils. The decrease in the proportion of these species were balanced by the increase in proportion of $CdSO_4$ (aq), and $Cd(SO_4)_2^{2-}$. The proportion of other Cd species such as $CdOH^+$, $CdHCO_3^+$ and $CdCO_3$ (aq) remained unaltered even after the application of any of the four organic amendments. Increase in contact time with any of the four amendments decreased the aqueous Cd^{2+} concentration (the most bioavailable species) in soil amended with any of the four amendments., However, the maximum decrease in Cd^{2+} concentration was observed with the application of BC. The effect of pH on the aqueous species distribution of Cd in SWI soil was studied by employing Medusa Chemical equilibria model (Puigdomenech 2000). The Cd fraction distribution Vs pH diagrams are drawn for different scenarios of unamended and amended (FYM, RSC, BC and VC) soil using Medusa model.

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Assessment of Irrigation Water Quality in Pune Region

Shraddha Wable*, S.U. Deshmkha, V. N. Ghorpade, A.B. Jadhav, R.B. Nazirkar and S.V. Wableshraddha Wable

College of Agriculture Pune, Shivajinagar, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**EmailI: shraddhasaird@gmail.com*

The experiment was conducted to "assess the quality of irrigation water in the Pune region" during 2019-2021 under Soil Lab Analyst Scheme, Division of Soil Science and Agriculture Chemistry, College of Agriculture, Pune. There were total fifty two irrigation water samples collected from different sources *viz.*, bore well-29,well-13,lift on canal/river- 7 and farm pond-3 to assess the quality. These irrigation water samples were analysed for EC, SAR(sodium adsorption rato), RSC(residual sodium carbonate), Mg:Ca, Kelly's ratio and permeability index to assess its suitability for irrigation.

It could be observed from the data that there were 9 (31.02%), 2 (15.38%) and 1(33.34%) samples found in unsuitable category for electrical conductivity for bore well water, well water and farm pond respectively. However remaining samples were found in the low to moderate category. In case of SAR all the samples collected from different sources were found in the low category except 3 (10.34%) samples from bore well recorded more than 26 SAR. However 20 to 28 percent samples were recorded unsuitable for RSC in case of bore well water, well water and farm pond respectively. Similar trend was also reported for Mg:Ca ratio for bore well water, well water and farm pond by reporting almost 44.82 to 57.14% samples were in unsuitable category. Kelly's ratio (indicates dispersion/ aggregation index) was almost less than 1 for all the irrigation water sources except bore well.Internal movement of irrigation water was interpreted by using permeability index. Among different sources 6.90 to 42.85 % samples were in unsuitable category from bore well, well, river/canal lift irrigation water.It could be concluded from the analytical data of irrigation water collected from bore well and well was found unsuitable for irrigation on fine textured soil than river/canal lift irrigation water.

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Water Quality, Gypsum and City Waste Compost Application Affect P Leaching in Saline-Sodic Soils

Arvind Kumar Rai*, Parul Sundha, Nirmalendu Basak, Harshpreet Kaur, Rajender Kumar Yadav and Parbodh Chander Sharma

Department of Soil Science & Agriculture Chemistry, Central Soil Salinity Research Institute, Karnal, 132001, Haryana

**Email: ak.rai@icar.gov.in*

Sodic soils are inherently rich in water-soluble P. A high concentration of the P in leachate during reclamation also reaches surface water bodies to cause eutrophication and other associated environmental issues. The amount and rates of P loss vary with P sorption capacity, texture, and permeability of soil. Integrated application of gypsum and city waste compost is advocated for the reclamation of soil sodicity. Besides neutralization of sodicity, the use of amendments had a profound influence on P dynamics and leaching losses. The unamended (control) and amended sodic soil (pH_s 10.0, EC_e 12.2 dS m^{-1}) was incubated for a month at 60% field capacity with 25 (G25) and 50% (G50) of gypsum requirement alone or in conjunction with 10 Mg ha^{-1} farmyard manure (G25F) and city waste compost from Karnal (G25K) and Delhi (G25D). The soil was leached up to ten pore volumes individually with harvested rainwater (CW), and saline-SAR water (6.0 dS m^{-1}) with SAR of 5.0 (SAR5) and 15 $mmol^{1/2}L^{-1/2}$ (SAR15). The water–extractable P was greater than Olsen's P ($P_{NaHCO3\ and}$ P_{OP}) during incubation. The P_{NaHCO3} declined in proportion to the amount of gypsum applied. Application of the organics increased the P_{NaHCO3} and P_{H2O} compared to G25. Gypsum and compost amended soil had a significantly greater value of $P_{OP.}$ The conjoint addition of gypsum and compost favored a lower enrichment factor (Ef < 1). Different parameters were acting as a controlling factor for labile P pools under pre (Ca^{2+}, Mg^{2+}, Na^+, SO_4^{2-}, CO_3^{2-} and HCO_3^-) and post (Na^+, SO_4^{2-}, HCO_3^- and SAR) leaching soils. Cumulative P losses were decreased by 10–14% with adding of compost and/or gypsum ($P< 0.05$). The cumulative P losses were greater by leaching with CW compared to SAR5 and SAR15. The CO_3^{2-}, HCO_3^-, pH, and SO_4^{2-} content of the leachate controlled about 71% variability in total P transport during leaching (adj. $R^2 = 0.71$; $P < 0.001$). This study concludes that low SAR water with the conjoint application of gypsum and city waste compost could be recommended as best management practices for the rehabilitation of soil sodicity with reduced P transport.

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Bioactivity of Secondary Hardened Banana Roots as Influenced by Biostimulants Extracted from Various Organics

Shyam Jadhao*, Namrata Deshmukh, N.M. Konde, D.V. Mali, S.M. Bhoyar, B.A. Sonune, A.B. Aage and P.A. Gite

Department of Agriculture Chemistry & Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra

**Email: sdjadhao@rediffmail.com*

The present investigation entitled, "Bioactivity of secondary hardened banana roots as influenced by biostimulants extracted from various organics was undertaken during 2020-21 at Biotechnology unit, Jain Irrigation System Ltd, Jalgaon (Maharashtra). The experiment was laid out in Randomized Block Design with nine treatments and three replications. The results of the present experiment revealed that, the bioactivity of secondary hardened banana plantlets was significantly influenced by various biostimulants. Vermicompost extracted biostimulants shows the higher root acidification of secondary hardened banana plantlets in aqueous medium. Higher root CEC was observed with foliar spray of vermicompost extracted biostimulants. Root acid phosphatase activity was significantly influenced by foliar spray of NPS extracted biostimulants while root oxidase activity was significantly influenced by FYM extracted biostimulants. Parameters like root length, root volume, dry weight of root, root: shoot ratio and dry matter accumulation and growth parameters like number of leaves and plant height were significantly influenced by foliar spray of biostimulants extracted. However, dry weight of shoot and girth of pseudostem were significantly influenced by NPS extracted humic acid. From this study, it can be concluded that bioactivity of secondary hardened banana root was significantly influenced by various humic substances. Vermicompost extracted humic substances found to be significant for morphological and growth parameters. Drenching of NPS extracted humic substances significantly increased the NPK content.

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Effect of Various Levels of P on Fixation and Release Potential of Phosphorus in Vertisol

Shyam Jadhao*, S.M. Bhoyar, B.A. Sonune, A.B. Aage, P.W. Deshmukh, D.S. Kankal and D.N. Nalge

Department of Agriculture Chemistry & Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: sdjadhao@rediffmail.com*

The experiment was conducted to study the various levels of phosphorus on fixation and release potential of Phosphorus in Vertisol at Dr. PDKV, Akola (MS). The grain and straw yield of soybean was influenced significantly with the application of 30:90:30 kg N, P_2O_5 and K_2O ha^{-1}, however found at par with 30:75:30 and 30:60:30 kg N, P_2O_5 and K_2O ha^{-1}. The uptake of N, P and K were higher with the application of 30:90:30 kg N, P_2O_5 and K_2O ha^{-1}. The effect of various levels of P on soil chemical properties were non significant. However, the available P status was increased significantly with the incremental levels of P along with recommended dose of N and K. The various inorganic P fractions (Ca-P, Fe-P, Al-P organic-P) was improved with incremental levels of P showing sequential order of contribution of organic-P, Ca-P, Fe-P and Al-P. The uptake reponse was increased with increasing levels of P, however, the apparent P use efficiency was higher (22.86%) with the application of 30:60:30 kg N, P_2O_5 and K_2O ha^{-1}. The adsorption-desorption study of P indicate that, the fixation potential of soil under study was increased with increasing concentration of equilibrium P solution. The fixation potential of soil was ranged between 82.3 to 87.2% indicating most of the added P to soil get fixed and released. However, the release of the added P was ranged between 45.2 to 47.9%. The nodule number (238), nodule weight (0.324 mg) was increased significantly with the application of 60 kg P_2O_5, while higher dose of P was found beneficial for root length (181.5 cm) and root volume (0.081 cm^3).

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Effect of 24-years Long-Term Nutrient Management Practices on Soil Physical Properties and Carbon Dynamics in a Rice-Rice Cropping System of Tropical India

Samayita Basu*, Kaushik Batabyal and Abir Choudhury
Department of Soil Science & Agriculture Chemistry, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, 741252, West Bengal
**Email: sbasu2509@gmail.com*

The physical properties of soil, which create a favourable environment for the uptake and availability of the plant nutrients, are often ignored. Though the impact of manures on soil physical quality has been widely studied but that of inorganic fertilizers and integrated nutrient management practices is studied to a lesser extent. As any long term fertility experiment provides a mean of evaluating sustainable management system in agriculture, the present study has been carried out in a 24 years old LTFE site of Andhra Pradesh to characterize the soil physical quality and carbon fractions in relation to different nutrient management practices. The soil samples were collected at three depths (0-15, 15-30 and 30-45 cm) from seven treatments *viz*., 1.Control, 2.RDF, 3.RDF+GM, 4.RDF+FYM, 5.RDF+GM+FYM, 6.FYM, 7.GM+FYM. The treatments were replicated three times in randomized block design to understand dynamics of soil carbon along with essential physical characteristics . Results showed that the soils were clay loam texture, acidic to slightly acidic in reaction. RDF+GM+FYM improved the soil physical properties, aggregate stability and increased yield of rice over years. OM application with both FYM and GM increased the total soil porosity and decreased soil bulk density than that in control plots. In surface soil (0-15 cm), the different carbon pools followed the order of: NLC (39.23%)>VLC (37.41%)> LC (16.6%)> LLC (6.75%). The ROC along with VLC and LC followed a decreasing trend with depth. The application of FYM increased the very labile pool of organic carbon by 23%. Control treatment contributed to soil inorganic carbon pool than that of organic carbon pool. However, RDF+FYM treatment caused greater accumulation of carbon in recalcitrant pool over others indicating that FYM-C is more resistant to microbial attack. RDF+GM+FYM treatment has been proved to be more sustainable and beneficial alternative in clay loam soil of tropical India.

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Use of 13C Nuclear Magnetic Resonance Spectroscopy in Elucidating Soil Organic Carbon Stability

Shalini Sharma*, Chandini Pradhan and Amlan Kumar Ghosh
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005,Uttar Pradesh
**Email: shalini2460@gmail.com*

Stability of soil organic carbon (SOC) is the consequence of three key mechanisms *viz* biochemical recalcitrance, mineral association and physical protection. Studies on long term experiments provide us the basis for understanding the effect of management practices on long term carbon storage. However, in addition to SOC content, differences in the structural composition of SOC are crucial for analyzing the mechanism of soil carbon stability in these soils. Solid-state ^{13}C nuclear magnetic resonance (NMR) can not only directly determine the structural and conformational characteristics of natural soil organic matter (SOM), but also provide information on the stability of the SOC structure. Solid-state ^{13}C NMR studies of carbon materials involves the use of cross polarization, in order to enhance the polarization of rare ^{13}C nuclei through their interaction with abundant ^{1}H nuclei, combined to magic angle spinning. This non-destructive technology provides a semi-quantitative analysis of organic carbon and is an important method for the research of heterogeneous natural SOM. ^{13}C NMR analysis can distinguish between labile carbon (carbonyl carbon and O-alkyl carbon) and recalcitrant carbon (aromatic carbon and alkyl carbon) via ^{13}C NMR spectra, based on the ^{13}C isotropic chemical shifts, which fall typically in the range of 0-90 ppm for aliphatic and 110-160 ppm for aromatic groups. Comparison of study sites from long term experiments gives conclusive evidence that ^{13}C NMR spectra provides high quality indices which are basis for our understanding of SOC stability.

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Potassium Dynamics of a Long Term Vereal-Vegetable-Pulse Cropping System under INM in an Acid Inceptisols

Kshitendra Narayan Mishra*, Subhashree Subhadarshani and Sanjib Kumar Sahoo
Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: khiturajprav@yahoo.co.uk*

The study was conducted in an ongoing long term INM experiment of AINP on Soil Biodiversity and Biofertilizers, Bhubaneswar centre, during 2019-2021 at the end of 10th cropping cycle. The design is RBD with 3 replications and 10 treatments. The treatment details are T1: Control, T2:. STD (Soil test based dose), T3:. STD + FYM (5.0 t ha^{-1}), T4:. STD + VC (Vermicompost 2.5 t $ha^{-1)}$, T5: STD + FYM (5.0 t ha^{-1}) + BF (Bio fertilizer consortia of *Azotobacter* + *Azosprillum* + PSB at the ratio of 1:1:1 i.e @ 12 kg ha^{-1}), T6 : STD + VC + BF, T7: STD + FYM + BF + L (Lime @ 0.2 LR), T8 : STD + VC + BF + L, T9: Organic 1(FYM 5 t ha^{-1} + VC 2.5 t ha^{-1}), T10 : Organic 2 (FYM 5 t ha^{-1} + VC 2.5 t ha^{-1} + Neem oil cake.5 t ha^{-1} + Poultry manure 0.1 t ha^{-1}). Application of INM with lime (T7, T8) increased SOC by 75, 40% and WSK 80, 48%, EK by 161, 160%, NEK by 20% in the top two soil layers over control. The $ÄK^0$ values are higher in both surface and sub surface layers (-0.75, -0.59 cmol(p^+)kg^{-1}) in the same INM combination with lime (T7, T8). The soils exhibited wide variation in AR_e^K values [22.4 - 39.9 and 23.1 - 35.3$(ML^{-1})^{1/2}$]. Long term application of INM package with lime resulted the highest PBC^K of soils with the values of 19.1 and 18.5 cmol(p^+)kg^{-1}/$(mML^{-1})^{1/2}$ indicating higher K buffering capacity of these soils. The study provided useful information on the K dynamics under long term crop management practices that can be helpful in devising sound K management models for sustainability of productivity.

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Synthesis and Evaluation of Bentonite-based Nano Scale Zero Valent Iron for Remediation of Arsenic Contaminated Water-Sorption Isotherm Study

Md Basit Raza[1&2], Siba P. Datta[2], Debasis Golui[2] and H.C. Hombe Gowda[1]
[1]ICAR-Indian Institute of Soil and Water Conservation, RC Sunabeda, Odisha
[2]Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi

Arsenic (As), popularly known as the 'king of poison', is a colourless, tasteless and odourless trace element found throughout the environment. High groundwater levels of As can be attributed to geological causes associated with As bearing mineral dissolution which is further accelerated by indiscriminate withdrawal of groundwater. The iron (Fe) based adsorbents are very effective and widely used to remove arsenic from water for making it safe for human consumption. However, their practical field application is, so far, limited owing to their slow adsorption kinetics, and low adsorption capacity. In this study, wehave synthesized alow-cost bentonite supported zero valent nano Fe^0(B-nZVI). We have achieved a maximum removal capacity of ~200 mg g^{-1} for As (V) by bentonite based nZVI (B-nZVI) as opposed to ~354 mg g^{-1}in case of bare nZVI. The reduced As adsorption was due to bentonite shell which protects the inner nZVI core from rapid corrosion. This was shown by observing the transmission electron microscopy (TEM) image of bentonite based zero valent iron (B-nZVI). The ageing study of the adsorbents confirmed this by showingsignificant reduction in As removal by bare nZVI even at 60 days of incubation (Dose = 250 mg L^{-1}).

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Effect of Application of Pre Emergence Herbicide Atrazine on Microbial Population and Soil Enzyme Activity in Sugarcane

Sireesha Ambati*, Ch. S. Ramalakshmi, T. Sreelatha and M. Bharathalakshmi
Acharya NG Ranga Agricultural University, Hyderabad, 522304, Telangana
**Email: a.sireesha@angrau.ac.in*

The application of herbicides to soils induces either inhibitory (e.g., through effects on soil microorganisms) or stimulatory effects (e.g., through resistant microbes using herbicides as resources) on these microbial parameters. A variable effect was also observed depending on soil properties, a dose of herbicide, and time elapsed after its application. Repeated long-term application of herbicides to the soil may cause the chemical to accumulate to the point that it may have deleterious effects on soil microbiological and biochemical activities thereby creating an unhealthy soil and having a lasting impact on soil fertility. Investigations of the effects of long-term use, of herbicides would help to understand what might happen in practical agricultural situations

Atrazine is the popularly used pre-emergence herbicide in sugarcane. In the areas of sugarcane mono-cropping pre-emergence application of atrazine was a regular practice since its availability in the market. Hence, it is proposed to study the impact of continuous application of atrazine on soil microbial properties and enzyme activities in the sugarcane growing fields of Regional Agricultural Research Station, Anakapalle, Andhra Pradesh. Selected the fields which were under mono-cropping of sugarcane for the last ten years and collected information on management practices. After harvesting of the sugarcane crop, soil samples were collected and analyzed for microbial population and soil enzyme activities.

Among the soil microbial population, the bacteria population was found to be high followed by fungi and actinomycetes. Among the beneficial microorganisms estimated, acetobacter was found to be high as compared with azospirillum and PSB. Among soil enzyme activities, dehydrogenase enzyme activity ranged from 1.083 to 2.186 µg TPF per g per day, urease enzyme activity ranged from 28.74 to 41.88 µg per g per hr, acid phosphatase activity ranged from 11.33 to 21.62 µg pnp per g per hr and alkaline phosphatase activity ranged from 39.68 to 61.87 µg pnp per g per hr. Soil samples with a higher microbial population recorded the highest soil dehydrogenase enzyme activity. Acid phosphatase activity was found to be low in comparison with alkaline phosphatase activity. Among the collected soil samples, the crop cultivated under integrated crop management practices like trash mulching and trash incorporation, application of FYM and biofertilizers, etc.. recorded the highest population of beneficial soil microorganisms and soil enzyme activity.

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Efficacy of Microbial Consortia for Enhancing Decomposition Rate and Quality of Bio-Waste for Improving Soil Health

Asha Sahu*, A.B. Singh, Sudeshna Bhattacharjya, J.K. Thakur, Asit Mandal, M.C. Manna and Ashok K. Patra

ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: ashaars.iiss@gmail.com*

Successful utilization of compost in agriculture depends on its quality and understanding of the transformation of organic matter, which take place throughout the composting process. ICAR-IISS, Bhopal has developed Ekcel microbial consortia (bacterial, fungi, actinomycetes and yeast) and evaluated maturity parameters such as C/N ratio, L/C ratio, CEC/TOC ratio, etc. Thermophilic microbes enhance the decomposition process even at 50 to 60 °C. It was observed that maturity parameters reached much earlier in vegetable waste compost (20 days) followed by kitchen waste (25 days), horticultural waste compost (35 days) and farm waste compost (45 days) under Ekcel composter. The ratio of HA/FA was maximum in kitchen waste compost followed by vegetable waste compost. The degree of polymerization increased with increase in bio-inoculum at 7 days and thereafter the polymerization rate reduced. Further it was observed that rate of polymerization was relatively greater in inoculated compost than uninoculated control. The loss rate kinetics study revealed increased loss rate (K) of about 1.36 to 2-fold in kitchen, vegetable and horticultural waste compost compared to crop residue compost. Further the potential loss percentage was maximum (85.68%) in vegetable waste compost. Thus, Quality compost was ready for field application within 25-45 days. The field study results clearly indicate that the application of enriched compost significantly augment the crop productivity compared to recommended dose of fertilizer (RDF) and control.

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Siderophoregenesis and Biofortification of Fe by Promising Microbial Strains in Wheat (*Triticum aestivum)*

Rakesh Bagmare* and Syed Ismail
Division of Soil Science & Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: rakesh.bagmare@yahoo.com*

The capabilities of soil microorganisms to produce siderophore have been known for many years, but their application, isolation and use as a crop inoculants was not explored in agriculture commercially.

Field experiments were conducted during *Rabi* seasons of 2021 and 2022 at Research Farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani on iron deficient Vertisol to study the biofortification of Fe using promising microbial strains in wheat (*Triticum aestivum*). Experiment consists of ten treatments replicated thrice in recommended dose of fertilizer. Results of laboratory experiment indicated that *Pseudomonas striata* produced highest per cent of siderophore on CAS agar plate (*i.e.* 62.62 per cent) followed by *Bacillus megaterium i.e.* 58.69 per cent. On the basis of laboratory experiment these tested microbial strains were exposed to field condition as seed treatment. Results of field experiments indicated that biofortification of iron in grain of wheat was noted highest after coinoculation of *Azotobacter chroococcum* and *Pseudomonas striata* + RDF (86.08 and 79.74 per cent highest increase iron content in grain over control and only RDF) which was followed by coinoculation of *Azotobacter chroococcum* and *Bacillus megaterium* + RDF (82.18 and 75.97 per cent increase in iron content of grain over control and only RDF).

Available soil Fe was found significantly higher after coinoculation of *Azotobacter chroococcum* and *Pseudomonas striata* + RDF. Overall RDF + *Azotobacter chroococcum* + *Pseudomonas striata* was found as the best combination for improvement of yield attributes, enhanced the nutrient content specially Fein grain and straw, available nutrients in soil, microbial population, and enzymatic activity in soil.

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Nutrients Solubilization by Promising Microbial Isolates and their Impact under Growth, Yield and Quality of Guava

Akshay Ingole and Syed Ismail
Division of Soil Science & Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: akshuingole88@gmail.com*

The capabilities of promising microbial isolates for various growth promotion traits have been known for many years, but their isolation and use as crop inoculants in fruit crops was not explored in agriculture commercially. In laboratory experiment Ten microbial isolates were tested for various growth promotion traits in laboratory condition *i.e.* nitrogen fixation, phosphorous solubilization, siderophore production, Indole acetic acid (IAA) production and zinc solubilization both in plate and broth medium. Microbial isolates like *Pseudomonas striata, Bacillus megaterium, Pseudomonas fluorescens, Azotobacter chroococcum* and *Trichoderma viride* inoculating in traits specific medium showed positive and significant results as compare to other strain. After laboratory experiment a short term pot culture experiment with the same ten microbial strain was carried out using guava as test crop. In that inoculation of strain *Bacillus megaterium show* positive and significant results in terms of growth improvement, nutrient content in guava leaves, available nutrient status in soil of pot experiment and improved microbial and enzymatic activity followed by strain *Pseudomonas striata, Trichoderma viride* and *Azotobacter chroococcum.* Further, two field experiments were carried out on guava crop during *kharif* season of 2019 and 2020. Results of field experiments indicated that, the guava plant or row treated with strain *Pseudomonas striata*, *Trichoderma viride*, *Bacillus megaterium* and *Azotobacter chroococcum* along with recommended dose of fertilizers not only increase yield and quality of guava crop but also showed improvement in macro and micronutrients concentration in both soil and leaves of guava and improved microbial and enzymatic in soil.

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Evaluation of Plant Growth Promotion Traits in Laboratory and Plant Growth Parameters as Influenced by Inoculation of Promising Microbial Growth Promoting Agents in Pot Experiment

Akshay Ingole* and Syed Ismail
Division of Soil Science & Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: akshuingole88@gmail.com*

A short term experiment was carried out with ten microbial isolates were tested for various growth promotion traits in laboratory condition i.e. nitrogen fixation, phosphorous solubilization, siderophore production, indole acetic acid (IAA) production and zinc solubilization both in plate and broth medium. For nitrogen fixation using NF medium strains like *Azotobacter chroococcum, Azospirillum lipoferum, Bacillus megaterium* and *Pseudomonas striata* show significant higher nitrogen fixation as compare to other strains. In phosphorus solubilization using Pikovskaya agar medium with insoluble phosphorus compound strain *Bacillus megaterium, Pseudomonas striata and Trichoderma viride* shows significantly higher phosphorus solubilization index than any other strain tested in laboratory experiment. In IAA production strain like *Bacillus megaterium, Pseudomonas striata* and *Trichoderma viride* reported significant and positive results as compare to other strains. In Siderophore production strain *Pseudomonas fluorescens*, *Pseudomonas striata* and *Bacillus megaterium* shows significantly higher production of siderophore inoculated in CAS agar plate and broth medium. In zinc solubilization both in plate and broth assay the microbial inoculants, *Pseudomonas striata, Bacillus megaterium* and *Trichoderma viride reported* significantly highest colony diameter, clearing zone, halozone diameter, solubilization efficiency and solubilization index as compare to other strain in all insoluble zinc sources. After laboratory experiment a short term pot culture experiment with the same ten microbial strain was carried out using guava as test crop. In that inoculation of strain *Bacillus megaterium show* positive and significant results in terms of growth improvement, nutrient content in guava leaves, available nutrient status in soil of pot experiment and improved microbial and enzymatic activity followed by strain *Pseudomonas striata, Trichoderma viride* and *Azotobacter chroococcum.*

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Microbial Biofortification of Zn by Plant Growth Promoting Microorganisms in Wheat (*Triticum aestivum*)

Syed Ismail*
Division of Soil Science & Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: syed_ismail123@rediffmail.com*

Field experiments were conducted during *Rabi* 2021 and 2022 seasons at Research Farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani on Zn deficient Vertisol. Before starting of field trials the promising microbial isolates were evaluated in laboratory condition for their zinc solubilization capacity in control condition in modified PKV medium. Only selected isolates were exposed to field trials on the basis of laboratory results for zinc solubilizing capacity. Field experiments consists of ten treatments replicated thrice in RBD. Seed treatment of wheat was done at the time of sowing with different microbial inoculants and recommended dose of fertilizer was applied in soil. Results of laboratory experiment for zinc solubilization indicated that *Pseudomonas striata* shows higher zinc solubilization (188 to 227 mg lit^{-1}) at 5th and 7th day respectively, which was followed by *Bacillus megaterium and Trichoderma viride*. Further results of field experiments indicated that biofortification of zinc in grain of wheat was noted highest after coinoculation of *Azotobacter chroococcum* and *Pseudomonas striata* + RDF (*i.e.* 19.52 and 15.76 per cent increased zinc content in grain over control and only RDF respectively) which was followed by coinoculation of *Azotobacter chroococcum* and *Bacillus megaterium* + RDF (19.17 and 15.41 per cent 76 per cent increase of zinc content in grain over control and only RDF respectively). However, highest seed yield during both the years was noted with application of *Azotobacter chroococcum* and *Pseudomonas striata* along with RDF (*i.e.* 4421 kg ha^{-1}) which was higher as compared to uninoculated control. Application of microbial isolates also enhanced the growth attributes and improved the nutrient availability to the crop.

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Interaction effect of Graded Levels of Zinc and Zinc Solubilizing Microbes on Yield, Content and Uptake of Nutrients in Ginger Plant

Priya Satwadhar* and Syed Ismail
College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: satwadharpriya7@gmail.com*

Ginger is a long growing crop and requires more nutrients for higher rhizome yield and supply of adequate nutrient is important. Microbes are potential alternative that could supply plant nutrient requirement by solubilizing the complex nutrients in soil. Microbial inoculants are important constituent of an integrated nutrient management system that helps in sustainable agriculture. The present pot culture experiment was conducted during *kharif* season of 2019-20 in Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to evaluate the response of ginger to graded levels of zinc and zinc solubilizing microbes. Experiment consist of sixteen treatment combinations which includes four zinc solubilizing cultures (Control, *Pseudomonas fluorescens, Pseudomonas striata*, and *Trichoderma viride*) and four levels of zinc (0,20,30 and 40 kg $ZnSO_4$ ha^{-1}) inreplicated thrice in factorial complete randomized design. Significant effect of zinc solubilizing cultures particularly *Pseudomona striata and* zinc level of 40 kg $ZnSO_4$ ha^{-1} noted on yield, content and uptake of nitrogen, phosphorus, potassium, sulphur and micronutrients. There was significant interaction effect of *Pseudomona striata* X 40kg $ZnSO_4$ ha^{-1} on yield, content and uptake of nitrogen, phosphorus, potassium, sulphur and micronutrients like zinc, iron, copper and manganese. Microorganisms have the ability to mobilize metal ions by formation of various organic and inorganic acids by the processes of oxidation and reduction. The various organic acids released by the solubilizers in the rhizophere may be responsible for increased nutrient availability to ginger plants.

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Effect of Seed Inoculation with Rhizobium Species on Yield, Quality and Nutrient Dynamics of Pigeon Pea.

Suresh Waikar*
Division of Soil Science & Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: slwaikar@rediffmail.com*

Biofertilizer is one of the best modern tools for agriculture. Use of biofertilizer is one of the important components of integrated nutrient management and sustainable agriculture.The present investigation was carried out on "Effect of different *Rhizobium* species on growth, nodulation, soil nutrient dynamics and yield of Pigeon pea". during *Kharif* season 2020 at the Research Farm of Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.The research experiment was laid out in Randomized Block Design with three replications and ten treatments of different *Rhizobium* strains that are consist of T_1: Uninoculated control, T_2: Non-fixing control (Sorghum), T_3: *Rhizobium* MKV-1, T_4: *Rhizobium* MKV-2, T_5: *Rhizobium* BRP-2, T_6: *Rhizobium* BRP-4, T_7: *Rhizobium* BRP-6, T_8: *Rhizobium* BRP-20, T_9: *Rhizobium* BRP-24 and T_{10}: *Rhizobium* BRP-56. Seeds of pigeon pea were treated with these *Rhizobium* strains + PSB @ 100ml $10kg^{-1}$ seeds and application of RDF.

Availability of macro and micronutrient was tested at critical growth stages of pigeon pea. It is evident from the results that significantly superior amount of available macronutrient like N, P, K and S was found in MKV-1 (T_3) strain of *Rhizobium*. Likewise, same treatment gave similar results in case of available micronutrients (Fe, Zn, Cu and Mn). The nutrient uptake by pigeon pea, decreases the availability of macro and micronutrients in soil from flowering stage to harvest.

Nutrient content and nutrient uptake of macro (N, P and K) and micronutrients (Fe, Zn, Cu and Mn) was maximum in plants which treated with *Rhizobium* MKV-1 (T_3) strain and found to be at par with *Rhizobium* MKV-2 (T_4) and BRP-6 (T_7) strain of *Rhizobium* inoculation.

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Nutrient Status of Lateritic Soils as Influenced by Cattle Urine Application for Spinach Cultivation

Anand Jadhav*, V. S. Sakhare and G.D. Patil
Sugarcane Research Station, Dist. Pune, Pedegaon, 415521, Maharashtra
**Email: abjadhav1234@rediffmail.com*

An experiment was undertaken to study effect of soil application of cattle urine on growth and yield of spinach in Lateritic soil Division of Soil Science and Agriculture Chemistry, RCSM College of Agriculture, Kolhapur during *rabi-2019*-2020. There are total seven nitrogen substitution treatments through urea and cattle urine. The treatment consist of absolute control, recommended dose of fertilizers (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O), general recommended dose of fertilizers (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + FYM @ 10 t ha^{-1}), 75% RDN-urea + 25% N- cattle urine, 50% RDN-urea + 50 % N-cattle urine, 25% RDN-urea + 75% N- cattle urine, 100 % RDN-cattle urine replicated thrice in complexly randomized design.

It could be observed from the data that pH and EC of lateritic soil was increased with the application of cattle urine for nitrogen substation. Significantly higher pH (7.67) and EC (1.01dsm^{-1}) of lateritic soil was reported with the application of 100% RDN through cattle urine at first cut of spinach (46 DAS). Decreasing trend in soil EC was observed at second cut of spinach in all the treatments under study while non-significant results were obtained for soil reaction (pH) at second cut. Significantly higher organic carbon at I and II cut of spinach (1.40%) and (1.07%) in lateritic soil was reported with the application of 100 % RDN through cattle urine. Calcium carbonate content in lateritic soil at both the cuts of spinach were recorded non-significant result due to the application of nitrogen through fertilizer and cattle urine. Significantly higher soil available nitrogen (253.93 and 184.97 kg ha^{-1}), phosphorus (30.72 and 29.10 kg ha^{-1}) and potassium (313.43 and 303.00 kg ha^{-1}) were recorded at first and second cut of spinach with the application of 100% RDN through cattle urine respectively. Significantly higher DTPA Fe (26.55 and 24.30 mg kg^{-1}), Mn (23.39 and 21.70 mg kg^{-1}), Zn (7.09 and 3.84 mg kg^{-1}) and Cu (12.01 and 9.12 mg kg^{-1}) were recorded with the application of 100 % RDN thorough cattle urine. Further it can be seen from the data that DTPA availability of metallic micronutrients were higher in those treatments received cattle urine for either substitution of nitrogen @ 25,50, 75 or 100 percent.

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Microbial Activity and Nutrient Availability During Phosphocomposting with Parthenium and Cassia

Ritu Thakare*
Division of Soil Science & Agricultural Chemistry, College of Agriculture, Dhule, 424004, Maharashtra
**Email: ritu.thakre@gmail.com*

The present experiment was conducted at research farm of Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dhule. Phosphocompost was prepared by using parthenium and cassia weed along with low grade rock phosphate by pit method. Treatment composed of parthenium and cassia weed incorporated with three levels of rock phosphate *i.e.* 4, 8 and 12 per cent of weed residues. Organic carbon content was continuously decreased with increase in period of composting as well as slight decrease was also noticed with increased rock phosphate levels. The maximum total N (1.87%), total P (1.48%), citrate soluble P (0.86%), water-soluble P (0.068%) and total K (1.38%) contents were recorded in the phosphocompost prepared from cassia weed + 12 % rock phosphate. The total calcium and magnesium contents were significantly increased with time and rock phosphate levels. The C:N ratio was found to be gradually declined with period and rock phosphate levels. The lowest C:N ratio (16.33) was noticed under cassia weed + 12% rock phosphate compost. The highest humic acid and fulvic acid contents (1.12 and 10.42 g 100 g^{-1}) were noted in cassia weed + 12% rock phosphate compost. Also, the significant decrease in E4/E6 ratio of both humic acid and fulvic acid was noticed. The lowest E4/E6 ratio of humic and fulvic acid (1.25 and 4.55) recorded with cassia weed + 12 % rock phosphate compost. The significantly maximum fungal, bacterial, actinomycetes and PSB population were recorded in compost prepared from cassia weed. The dehydrogenase activity and alkaline phosphatase activity significantly increased with increased level of rock phosphate.

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Carbon Pool and Extracellular Enzymes as Influenced by Organic Amendments in Vertisol

Ritu Thakare*
Division of Soil Science & Agricultural Chemistry, College of Agriculture, Dhule, 424004, Maharashtra
**Email: ritu.thakre@gmail.com*

Carbon pools and extracellular enzyme activities may vary under application of different organic amendments. Therefore, present experiment was carried with an objective to assess the response of C pool and extracellular enzymes to applied organic amendments. This pot culture incubation study was laid out in completely randomized design with ten treatments replicated three times. The treatment comprised of Control, NPK @ 50:50:50 kg ha^{-1} and combination of inorganic and organic amendments. The incubation study was carried out in aerobic condition at ambient temperature for the period of 90 days. The total organic C, Walkley-Black soil organic C, particulate organic matter C, humic acid-C and fulvic acid-C contents were found to be decreased gradually after 15 DAI. However, water soluble C, soil microbial biomass C and permanganate oxidizable soil C were significantly increased from 15 to 45 DAI, there after it decreases up to 90 DAI. All enzyme activities are found highest at 15 DAI and thereafter gradually declined up to the end of incubation period. At the end of incubation (90 DAI), significantly highest acid phosphatase activity (15.47 µg PNP g^{-1} soil hr^{-1}), alkaline phosphatase enzymes activity (28.54 µg PNP g^{-1} soil hr^{-1}) and β-glucosidase activity (24.20 mg PNP g^{-1}soil hr^{-1}) was recorded with T_9 (T_2 + Cassia phosphocompost @ 5 t ha^{-1}) followed by T_{10} *i.e.* T_2 + Parthenium phosphocompost @ 5 t ha^{-1}. The increase in these enzyme activities due to the addition of organic amendments is in order cassia phosphocompost ? parthenium phosphocompost ? vermicompost ? FYM. While, significantly highest urease activity (36.47 mg NH_4-N g^{-1} soil hr^{-1}) and arylsulphatase activity (35.65 µg PNP g^{-1}soil hr^{-1}) was noticed with T_9 (T_2 + Cassia phosphocompost @ 5 t ha^{-1}) followed by T_4 *i.e.* T_2 + Vermicompost @ 5 t ha^{-1}. The increase in these enzyme activities due to the addition of organic amendments is in order cassia phosphocompost ? vermicompost ? parthenium phosphocompost ? FYM. Results concluded that cassia and parthenium phosphocompost application along with inorganic fertilizers showed the enhancement in different carbon pools and also stimulated the activities of extracellular enzymes.

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Soil Properties Regulating Urease Activity in Inceptisol

Shivaji R. Patil*, Avinash G.J., Suman Kumar Surendra, A.G. Durgude, Ritu S. Thakare and B.D. Bhakare

Division of Soil Science & Agricultural Chemistry, College of Agriculture, Dhule, 424004, Maharashtra
**Email: patilsr02019@gmail.com*

The use of urea by the farmers as a source of nitrogen has been increased in the recent years. However, the nitrogen use efficiency of applied chemical nitrogen fertilizers is less than 50% due to leaching, volatilization, dinitrification and surface runoff. These losses are undesirable because of environment concerns and the high cost of crop production. After application of urea to soil, it hydrolyses to ammonia and carbon dioxide in soil by soil urease enzyme which is under influences of soil factors. Thus, study of soil properties regulating soil urease activity are the most important in regulating the process of urea hydrolysis which is the main concern in improving the use efficiency of urea and minimize the problems related to use of urea. In this context, the present investigation entitled, "Soil properties regulating urease activity in Inceptisol" was undertaken during 2020-21 at the laboratory of the Department of Soil Science and Agricultural Chemistry, MPKV, Rahuri.

Total 15 surface (0-15 cm) GPS based soil samples of Inceptisol with wide range of variations in soil properties from the Central Campus of the MPKV, Rahuri were collected and analysed for important physic-chemical and biological soil properties for their correlation studies with urease activity. Correlation studies between soil properties and urease activity were analysed by using simple linear correlation analysis.

The present study results indicated that, the urease activity is positively and highly significantly correlated with organic carbon (0.87**), total nitrogen (0.806**), available nitrogen (0.61**) and Clay (0.52*). The content of $CaCO_3$ (-0.487*) has significant negative correlation with urease activity. The other soil properties studied *i.e.* pH, EC, silt, sand and microbial population did not show any significant correlation with urease activity in Inceptisol soils.

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Carbon Management under Long Term Nutrient Management Practices to Sorghum-Wheat Sequence in Vertisol

Nilam Kondvilkar*, S.R. Patil, A.L. Pharande and B.D. Bhakare
Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: nilamkondvilkar@gmail.com*

The present investigation was carried out to study the effect of long-term use of integrated nutrient management on soil carbon sequestration (soil organic carbon fractions, SOC stocks and CMI) under sorghum–wheat cropping system in Vertisol. The soil sampling done at 0-15, 15-30 and 30-45 cm depth from a permanent manurial field experiment, which was initiated during 1984-85 on the farm of Integrated Farming System Research Project, MPKV, Rahuri, Dist. Ahmednagar, Maharashtra. The experiment was laid out in randomized block design with twelve treatments and four replications, involving the use of various levels of NPK fertilizers, combination of NPK fertilizers with organic *viz.*, FYM, wheat cut straw and green manure and unfertilized control.

The highest soil carbon stock, C sequestration rate, carbon build up percentage and rate and carbon management index were recorded in the long term integrated nutrient management treatments which received 50% RDF + 50% N-FYM in *Kharif* and 100% RDF in *Rabi* followed by 50% RDF + 50% N-GM in *Kharif* and 100% RDF in *Rabi* at all three depths. Among the INM treatments, the treatment 50% RDF and 50% N-GM in *Kharif* and 100% RDF in *Rabi* recorded the highest CMI (343.66) at only surface layer and whereas, the treatment 50% RDF + 50% N-FYM in *Kharif* and 100% RDF in *Rabi* recorded significantly most superior values of CMI (306.41 and 267.92; respectively) at subsurface layers over the rest of treatments.

The highest soil quality index (1.00) was observed under both treatments of 50% RDF + 50% N-FYM in *Kharif* and 100% RDF in *Rabi* and 50% RDF + 50% N-GM in *Kharif* and 100% RDF in *Rabi* after the 32 years of experimentation.

The long term (32 years) continuous application of 50% RDF + 50% N-FYM (8.95 t ha^{-1}) in *Kharif* and 100% RDF in *Rabi* was proved the most efficient INM practice for improved crop productivity, sequestrating organic C and improving soil fertility and enhancing productivity on the sustainable basis in 0-45 cm soil profile under intensively cultivated soil with sorghum-wheat sequence in Vertisol of semi-arid tropic of Maharashtra.

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Influence of Microbial Consortia on Available Nutrient and Microbial Diversity in Vertisol

Shubham Singh*[1], N.G. Mitra[2], R.K. Sahu[2] and Sangya Singh[2]

[1]Department of Soil Science & Agricultural Chemistry, Rajmata Vijayaraje Scindya Krishi Vishwa Vidyalaya, Gwalior, 474002, Madhya Pradesh

[2]Department of Soil Science & Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 413722, Madhya Pradesh

**Email: shubhamsingh0734@gmail.com*

Microbial inoculation represents a new way of working towards a more sustainable and efficient agriculture. It is clearly beneficial to the farmers for enhancing crop production and sustain soil health through boost the soil biodiversity. Therefore, a filed-laboratory experiment was conducted during *Kharif* (2019-20) in the Department of Soil Science & Agricultural Chemistry, Jabalpur with 16 treatments, replicated thrice by comprising different beneficial microbial inoculants *viz*., *Rhizobium sp.*, Phosphate Solubilizing Bacteria (*Bacillus sp.*), Actinomycetes (*Streptomyces sp.*), *Rhodopseudomonas sp.*, *Lactobacillus sp.*, Yeast (*Saccharomyces sp.*) and Fungi (*Aspergillus sp.*) along with two types of control plots were maintained as fertilized uninoculated control (FUI) and unfertilized uninoculated control (UFUI). The findings revealed that the significant improvement was received by the treatment of T14 (*Rhizobium*+ PSB+ Actinomycetes+ *Rhodopseudomonas*+ *Lactobacillus*+ Yeast+ Fungi) performed best for the available nutrient's (Nitrogen, Phosphorus and Potassium) by 50.28, 57.60 and 34.48% and microbial bio-diversity *viz.*, *Rhizobium sp.*, *Bacillus sp.*, *Streptomyces sp.*, *Rhodopseudomonas sp.*, *Lactobacillus sp.*, *Saccharomyces sp.* and *Aspergillus sp.* by 2.43, 6.46, 1.61, 1.77, 2.25, 2.06 and 1.74 times more, respectively as compare to the FUI at harvest soil of soybean crop. The soybean yields (seed and stover) recorded higher by T14 by 57.79 and 65.53%, respectively over the FUI. The other ensuring group of treatments were T13 (T14 - Rhizobium) and T11 (T14 - Fungi and Actinomycetese). Thus, the biofertilizers as co-inoculation on seeds with different consortia might plusibly influence to the crop through direct and indirect mechanisms *viz.*, enhancing diazo-trophy, nutrient solubilization, siderophore formation for Fe availability, excretion of growth promoting enzymes and anti-oxidants against phytopathogens. The enhancements by the *Rhizobium*, *Actinomycetes*, *Bacillus* and *Aspergillus* hormonal activity of auxins, cytokinin's, and gibberellins on root formation growth and lateral roots leading to increase the solubility and availability of nutrients and subsequently increase in yield of soybean.

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A Novel Dye Reduction Assay for Quantitative Estimation of Soil Microbial Activity

K. Aparna[1]*, V. Sivaprasad[2] and K. Sathyanarayana[1]
[1]Soil Science Section, Central Tasar Research and Training Institute, Ranchi,835303, Jharkhand
[2]Central Silk Board, Bangalore, 560068, Karnataka
**Email: aparna.micro@gmail.com*

Soil microorganisms are one of the most crucial components of soil that determine soil health. Yet measurements related to soil microbial properties are seldom used as soil health indicators in routine soil health assessments. The complexity associated with these measurements, lesser scope for simplification and for setting upper and lower limits are the major setbacks associated with such measurements which inhibit their adaptation for routine soil health monitoring. A novel dye reduction assay was devised to assess the soil microbial activity more accurately which can be expressed in terms of Dye Reduction Potential (DRP%). The assay is simple and advantageous over other soil microbiological assessments and convenient to be adapted for routine soil health testing. The assay method involves addition of a dye solution which acts as a terminal electron acceptor in microbial respiration along with reagents to buffer the pH changes and to accelerate the soil microbial activity and measuring the colour change spectrophotometrically. Soils collected from mulberry gardens of sericulture farmers of West Bengal were assessed for existing soil health indicators and soil microbial activity using the novel test. The organic carbon content of these soils ranged from 0.40-0.95% and soil dehydrogenase activity ranged from 9-57 µg TPF g^{-1} $24h^{-1}$. The DRP ranged from 21-89% and correlated well with soil organic carbon and soil dehydrogenase activity. The test performed in Tasar host plantation soils of different regions indicated that sampling depth is a determining factor in drawing correlations. A kit has also been designed based on the assay principle and the results of the assay can be read visually without the use of any instruments. The assay may prove to be a valuable tool in soil microbial activity assessments in soil microbiological research as well as in routine soil health testing.

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Potential of Endophytic Fungi for Heavy Metal Tolerance Isolated from Municipal Solid Waste Dumping Site of Central India

Asit Mandal*, Ashwinkumar P. Rudrashetti, J.K. Thakur, A.B. Singh and Ashok K. Patra

ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: asit.iari@gmail.com*

Anthropogenic activities release wide range of heavy metal in the environment, which adversely affect the soil health, water quality and surrounding living organisms. In the present study, the endophytic fungi were isolated from dominant plants growing near municipal solid waste dumping site. Total 14 endophytic fungi were isolated from ten different plant roots of which 12 isolates were of morphologically distinct. All fungal isolates represented phylum *Ascomycota*. In heavy metal tolerance study, isolates showed tolerance towards Pb and Cr in the range of 150 to 200 ppm concentration, while many other isolates could tolerate Cd and Hg up to 50 ppm concentration with increasing biomass. Fungal isolates of genera, *Fusarium* and *Curvularia* showed tolerance against wide range of heavy metals such as Pb, Cr, Hg, and Cd with tolerance index (TI) ≥ 100%. The isolates with higher tolerance towards multiple heavy metals could be used as potential partner of hyper-accumulator plants in microbe-assisted phytoremediation of heavy metal contaminated soil.

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Long Term Effect of in Situ Recycling of Sugarcane Crop Residues and Sugar Industrial Wastes on Productivity, Quality and Economics Under Sugarcane Land Use System

Dharmendrakumar Phalke[1]*, S.U. Deshmukh, C.D. Sonunkar, A.B. Gosavi, A.V. Patil and D.D. Sawale

Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, 411005, Maharashtra
**Email: mtcm.rkvy@gmail.com*

On farm field experiment was carried out at Central Sugarcane Research Station, Padegaon, Dist. Satara (M.S.) during 2015-16 to 2019-20 under sugarcane - three successive ratoon system to evaluate impact of *in situ* sugarcane crop residues and sugar industrial wastes recycling techniques on productivity, recovery. In order to recycle available sugarcane crop residues and sugar industrial wastes generated from previous sugarcane ratoon crop at experimental field, the nine techniques were formulated for *in situ* recycling in holistic ways tried in randomized block design replicated thrice for 60 days and sugarcane – three successive ratoon crop sequence with four graded fertilizer levels were superimposed in split plot design with three replications. Results revaled that the *in situ* recycling of sugarcane crop residues + press mud cake + post biomethanated spent wash + bagasse ash (T_7) along with 100% recommended dose of fertilizers (F_3) recorded significantly higher cane and CCS yield per hectare with improvement in soil health. The highest nutrient uptake was observed in the treatment T_7F_3 receiving *in situ* recycling of sugarcane crop residues + press mud cake + post biomethanated spent wash + bagasse along with 100% recommended dose of fertilizers. The increase in fertilizer levels significantly increased cane productivity, CCS yield and total nutrient uptake by sugarcane. The higher gross and net returns were also observed in *in situ* recycling of sugarcane crop residues + press mud cake + post biomethanated spent wash + bagasse ash along with 100% recommended dose of fertilizers (T_7F_3) with higher benefit cost ratio. Further, it was observed that B:C ratio of 100% RDF, 70% RDF and 50% RDF was numerically same (3.30) indicating that 50% RDF of sugarcane crop can be reduced without effecting monitory returns. The burning of crop residues and removal of stubbles discourages the productivity as well as economics. Based on economics the higher sugarcane productivity was observed under integrated use of *in situ* decomposition of sugarcane crop residues + press mud cake + post biomethanated spent wash + bagasse ash along with 50% recommended dose of chemical fertilizers. Further, it was found cost effective technique to sustain cane productivity and quality in long term.

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Long Term Effects of Fertilizers and Manuring on Soil Health, Agronomic Productivity, and Sustainable Yield Index in Soybean - Safflower Cropping Sequence and NUE in Vertisol

Ramprasad Khandare*
Department of Soil Science & Agriculture Chemistry,Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: ram.khandare11@gmail.com*

Long term effects of chemical fertilizers and manuring in soybean (*Glycine max* L.) and Safflower (*Carthamus tinctorious*) cropping sequence at harvest of safflower were examined after 17th years of experimentation during the year 2020-21. The study encircles different levels of optimum fertilizer rate (30,60,30 Kg ha^{-1} and 60:40: 00 k ha^{-1} N, P and K, respectively) for soybean and safflower. The treatments were application of 50% NPK, 100%NPK, 150% NPK, 100% NPK + (HW), 100% NPK+ Zinc, 100% NP, 100% N, 100% NPK+ 5 t ha^{-1} FYM t ha^{-1}, 100% NPK–S and absolute control. The results were emerged out due to long term effects stated that grain and straw yield of soybean and safflower and sustainable yield index were recorded significantly highest by application of 100% NPK + FYM @ 5 t ha^{-1} followed by 150% NPK and 100% NPK + zinc. However, the physico - chemical, soil biological properties and enzyme activities in soil were improved by application of 100% NPK + FYM @ 5 t ha^{-1} and only FYM @ 10 t ha^{-1} at harvest of safflower. Similarly, the nutrient use efficiency was also differed significantly due to application of chemical fertilizers along with manures under long term fertilizer experiments. The soil quality index was also found better in balance use of chemical fertilizers than imbalance use chemical fertilizers and in absolute control in soybean – safflower cropping sequence under Vertisol.

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Response of Natural Farming Practices on Crop Productivity and Soil Health under Soybean-Wheat Cropping Systems

Amar Singh*, Shubham Singh, Asit Mandal, J.K. Thakur and Ashok K. Patra
ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: abs980649@gmail.com*

The magnitude of agricultural intensification and use of agrochemicals leads to increase crop production but simultaneously led to an adverse effect on soil environmental quality and soil health. Efficient nutrient management practices are the only way to sustain crop production, soil health and biodiversity. Therefore, an experiment was conducted at Research Farm of ICAR-IISS (All India Network Program on Organic Farming- AINPOF), Bhopal, during *Kharif* season (2021-22) to assess the effect of different nutrient management practices on crop production and soil biological properties in soybean-wheat cropping system. The experiment consisted of nine nutrient management treatments with three replications. Surface soil samples (0-15 cm) were analyzed for soil biological such as dehydrogenase activity, fluorescein di-acetate hydrolysis, acid and alkaline phosphatase, β-glucosidase and glomalin enzymes. The findings revealed significant improvement in different soil enzymatic activities under AI-NPOF package followed by Integrated Crop Management with Natural Farming. Integrated Crop Management with pesticides recorded maximum crop yield with 53.05%, followed by Integrated Crop Management with Natural Farming and AI-NPOF package with 48.98 and 39.98%, respectively over unfertilised control. Complete Natural Farming recorded 33.46% more yield as compare to unfertilized control.

The integrated crop management practices (ICM) with different organic supplements *i.e.*, farm yard manure, Vermicompost, Jeevamrit, Ghanjeevamrit, Beejamrit and also organic based pesticidal application (Agniastra, Brahmastra and Neemastra) provided a balanced and holistic management for soil health, and provided a protective environment towards diseases and pests incidence for enhancing crop productivity.

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Fertilizers- a Boon to Crop Production and Soil Quality- Lessons from Long Term Fertilizer Experiments

V. Thulasi*
Regional Agricultural Research Station (KAU), Pattambi, 679306, Kerala
**Email: thulasi.v@kau.in*

The Permanent Manurial Trials (PMT)-(tall and dwarf) with 8 treatments and Long Term Fertilizer Experiment (LTFE) with 12 treatments have been started at Pattambi with the main objective of studying the effect of continuous application of plant nutrients (NPK) in organic and inorganic forms and in combinations on sustainable production in the rice-rice cropping sequence.

In PMT (more than 50 years history), the organic nutrient management wherein whole of the mineral N was applied as cattle manure and Integrated Nutrient Management (INM)practice where 50 per cent N was substituted by cattle manure and 50%by fertilizers were equally superior in growth and productivity. and the soil biological properties indicating the positive role of fertilizers. The stabilization of soil organic carbon over a range of values in all treatments and the increased incorporation of carbon to the soil pool under INM indicate the chances of carbon emissions on packages of heavy organic manure application in tropical soils.

In LTFE with 20 years history, the soil quality indexing studies and the carbon sequestration pattern studied, indicated the positive role of fertilizers in improving the soil quality and sequestering carbon to the soil. The metagenomic analysis also supports the findings. Data on analysis of different carbon pools revealed that slow pool is the most predominant yield determining pool in the long run and is higher under INM. An incubation study was conducted at four different temperature regimes (15, 25, 35 and 45°C) using the soil collected from the plots of LTFE as well as PMT. The values on activation energy and the rate constants provided a good insight on decomposability of organic matter and the pace of mineralization in soil. and the carbon formed under INM was found more stable than the carbon formed under sole application of organic manures / fertilizers.

The study fortifies INM as a stable practice for sequestering soil organic carbon and crop productivity in the context of rising temperature scenario

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Ifluence of Tillage and Weed Management on Soil Biology and Productivity of wheat in Inceptisols

Nilam Kanase*, N.M. Konde, S.M. Bhoyar, S.D. Jadhao, P.A. Gite and J.P. Deshmukh
Department of Soil Science & Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: nilam.konde@gmail.com*

An investigation on "Influence of tillage and weed management on soil biology and productivity of Wheat in Inceptisols" was conducted at Research Farm of All India Coordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2020-21. Five weed control practices were superimposed in four strips of different tillage practices. The experiment was laid out in strip plot design with three replications. The soil of the experimental plot was alkaline in reaction and low to medium in organic carbon. The available nitrogen and phosphorus was low and potassium was high to very high. Soil biological properties were assessed after eight and thirty days of spraying of weedicide. The individual and interaction effect of tillage and weedicide were assessed on physical and biological properties of soil. Similarly, the yield of Wheat was also recorded.

The results reveal that the bulk density of soil was significantly influenced due to tillage and weed management practices. The highest bulk density was noted with zero tillage (1.46 Mg m^{-3}). The highest MWD (0.75 mm) was enumerated with minimum tillage and hand weeding management practice. The interaction of tillage and weed management practices showed non-significant results in respect of soil physical properties. In respect of biological properties, urease (43.14 and 58.98 mg NH4 kg^{-1} 24 hr^{-1}) and alkaline phosphatase (81.27 & 125.52 mg NH_4 kg^{-1} 24 hr^{-1}) were recorded in minimum tillage. The significant change in urease and alkaline phosphatase were registered in weedy check treatment. However, the highest grain yield (36.22 q ha^{-1} Straw- 52.90 q ha^{-1}) of Wheat was observed with conventional tillage. The minimum disturbance to soil and adoption of hand weeding has evolved promising findings towards long term sustainability of soil. However, the preventive use of weedicide can be advocated, if minimum tillage is followed.

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Characterization and Evaluation of Rhizobium Isolated from Root Nodules of Pea (Pisum sativum L.) from Different Pea Growing Regions of Varanasi

Shubham Sambhav Kamlapuri*
Institute of Agricultural Science, Banaras Hindu University,Varanasi, 221005, Uttar Pradesh
**Email: shubhamsambhav.1994@gmail.com*

Pea (*Pisum sativum* L.) is one of the important pulses grown in rabi season in eastern parts of Uttar Pradesh as a green vegetable as well as for grains. The amount of nitrogen as required by this crop is mostly dependent upon symbiotic N_2- fixation An attempt was made to isolate native *Rhizobium leguminosarum* from different pea growing soils around Varanasi where morphological and biochemical properties of *Rhizobium* isolates were studied. Further the best ten nodulated isolates were selected to know their efficiency with varied levels of nitrogen and there effect on yield in pot experiment. The presence of the distinct bacterial colonies on YEM (Yeast Extract Mannitol) plates with circular shape, white to pink color and gummy consistency were selected for further screening through series of confirmatory tests to distinguish from Agrobacterium. The nodulation studies made in Leonard jar assembly showed that the *Rhizobium* isolate-6 produced the highest number of nodules per plant (11.00 plant^{-1}) and the maximum germination percentage (83.33). *Rhizobium* isolate-6 recorded highest plant height, number of leaves as compared to other isolates of Rhizobium at 30, 60 and 90 DAS along with highest fresh and dry weight of nodules per plant *i.e.* (301.500 and 123.900) mg respectively. *Rhizobium* isolate-6 recorded maximum available N (199.33 kg ha^{-1}), maximum biomass. Hence there is need for inoculating pea with effective strain of *Rhizobium* which improves symbiotic nitrogen fixation in order to reduce the use of inorganic fertilizers and to obtain higher yields**.** Using the above isolate can be very useful in manufacturing an efficient biofertilizer to contribute in the concentration of the soluble nitrogen in the soil improving the soil health to achieve sustainable productivity.

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Soil Health and Resilience under Conservation Agriculture Based Rice-Wheat Cropping System in Indo-Gangetic Plain

Sunanda Biswas[1]*, Sujit Das[1], T.J. Purakayastha[1], T.K. Das[2], Ranjan Bhattacharyya[1], B. Ramakrishnan[4], Priya Singh[1], Partha Sarathi Ghorai[1], Saloni Tripathy[1] and Bikramjit Mandal[1]

[1]Division of Soil Science and Agricultural Chemistry, [2]Division of Agronomy, [3]Division of Environmental Science, [4]Division of Microbiology, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**EmailI: sunandabiswas13@gmail.com*

Rice-wheat is the most important cropping system in India and rice is the most staple food. To sustain productivity and mitigate adverse climatic impact, conservation agriculture (CA) is one of the best option. To assess soil health and resilience, soil samples were collected from six treatments *viz*. (Zero till direct seeded rice (ZTDSR) – zero till wheat (ZTW) (T1), ZTDSR+ wheat residue (WR) - ZTW+ rice residue (RR) (T2), ZTDSR + WR + sesbania brown manuring (SBM) –ZTW + RR (T3), ZTDSR –ZTW – zero till mungbean (ZTMB) (T4), ZTDSR + mungbean residue (MR) –ZTW + RR - ZTMB+ WR (T5), Transplanted rice (TPR)-conventional till wheat (CTW) – conventionally tilled mungbean (CTMB) (T6)) from long-term CA based experiment with rice-wheat system situated at ICAR-IARI farm, New Delhi. The soil samples were analysed for different labile fractions of organic carbon, soil enzyme activities and microbial population by using standard protocol. Molecular based qPCR technique was used to quantify the abundances of different phylogenetic groups and nutrient cycling genes. Inclusion of mungbean residues in T5 and SBM in T3 improve nifH gene abundance over other double and triple ZT treatments. PCA analysis was done to screen out key indicators of soil health and â-glucosidase (PC1), Bacterial amoA (PC2), Archaeal 16S (PC3), Bacteroidetes 16S (PC4), Bacterial 16S (PC5), mineralizable C (PC6) were selected. Soil resilience study was done in terms of carbon mineralization with or without heat stress (48°C for 24 hr) and substrate addition (0.02 g glucose / g soil). The value of soil resilience index (SRI) was varied from 0.69 to 0.77. The highest SHI and SRI was found in ZTDSR + MR– ZTW + RR – ZTMB + WR treatment. Therefore, this practice may be recommended for CA based rice-wheat cropping system in Indo-Gangetic plain.

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Assessment of Resistance and Resilience of Soil Under Conservation Agriculture Based Rice-Wheat Cropping System in Indo-Gangetic Plain

Saloni Tripathy, Sunanda Biswas*, Priya Singh, T.J. Purakayastha, Nayan Ahmed, R.N. Pandey, T.L. Das and B. Ramakrishnan

Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: sunandabiswas13@gmail.com*

The productivity of crops will be impacted by changes in land and water regimes brought on by temperature and precipitation changes resulting from climate change. Concerned about possible long-term climatic change implications on agriculture soil samples were collected from 0-15 cm depth from a 11 years old long-term conservation agriculture (CA) based rice-wheat-mungbean cropping system, conducted at the Research Farm of the Division of Agronomy, Indian Council of Agricultural Research-Indian Agricultural Research Institute (ICAR-IARI), New Delhi with eight treatments *viz*. (ZTDSR-ZTW, ZTDSR + WR – ZTW + RR, ZTDSR + WR + CBM – ZTW + RR ,ZTDSR + WR + SBM – ZTW + RR, ZTDSR-ZTW – ZTMB, ZTDSR + MR – ZTW + RR – ZTMB + WR, TPR-ZTW-ZTMB,TPR – CTW- CTMB). Enzymatic activity, microbial populations following heat stress and moisture stress were examined in the soil samples. Results revealed that enzyme activity and microbial population are significantly reduced by heat and moisture stress. The recovery rate of microbial population ranged from 63% to 89% and the recovery rate of enzyme activity ranged from 57% to 88% at 45 days after stress (DAS). Zero-tilled plots outperformed conventional plots in terms of resistance and resilience of enzyme activity and microbial population. The triple zero tillage with triple residue retention treatment demonstrated the highest resilience and resistance to heat and moisture stress among all the zero tilled treatments. Under a CA-based rice-wheat system in the Indo-Gangetic plain, triple zero tillage with triple residue retention may be advised.

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Impact of Integrated Nutrient Management on Crop Productivity and Soil Fertility under Rice (*Oryza sativa* L.) - Chickpea (*Cicer arietinum* L.) Cropping System in Chhattisgarh Plain

Risikesh Thakur*, N.K. Bisen, A.K. Shrivastava, S.K. Rai and S. Sarvade
Department of Soil Science & Agriculture Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 482004, Madhya Pradesh
**Email: drrkthakur28@gmail.com*

Field demonstrations were conducted during *kharif* and *rabi* seasons (2016-17, 2017-18 and 2018-19) at farmer's field under Farmer FIRST Project (FFP), JNKVV, College of Agriculture, Balaghat, Madhya Pradesh, to assess the impact of integrated nutrient management on crop productivity, soil nutrient balance and economics of rice (*Oryza sativa* L.) - chickpea (*Cicer arietinum* L.) cropping system. Application of 75% NPK + 5t FYM ha^{-1} + biofertilizers (BGA / *Rhizobium* & PSB) noted significantly higher grain yield of rice and chickpea (4429 kg ha^{-1} and 1538 kg ha^{-1}, respectively) over the Farmer Practice (3644 kg ha^{-1} and 1036 kg ha^{-1}, respectively). Maximum nutrients uptake (N, P & K) by rice and chickpea crops were recorded in the treatment receiving 75% NPK + 5t FYM ha^{-1} + biofertilizers. The conjunctive use of inorganic fertilizers along with organic manure and biofertilizers gave highest availability of soil N, P, K and Zn at post-harvest of chickpea crop as compared to other treatment combinations. Further, results showed that the highest rice equivalent yield (4131 kg ha^{-1}), cost of cultivation (Rs. 58200 ha^{-1}) and net returns (Rs. 96832 ha^{-1}) in 75% NPK + 5t FYM ha^{-1} + biofertilizers treatments. The benefit cost ratio computed for rice-chickpea cropping system suggested that the higher B:C ratio is associated with higher production and better quality of the produce.

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Dynamics of Manganese Fractions under Different Land Uses in Gurdaspur District of Punjab

Gayatri Verma*, Tushar Mahajan, S.S. Dhaliwal and Vivek Sharma
Department of Soil Science, Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: drgayatriverma@gmail.com*

To assess the impact of land use change on the dynamics of manganese (Mn) and its fractions, soil samples were collected at five depths 0-15, 15-30, 30-60, 60-90 and 90-120 cm under four land use systems; forestry, horticulture, agriculture and uncultivated land followed by their sub-systems in Gurdaspur district of Punjab. The DTPA extractable Mn content under different land use systems ranged from 1.90 to 7.66 mg kg^{-1} which was higher in forestry systems than in horticulture, agriculture and uncultivated land. Depth-wise distribution in different sub-systems revealed that under the agriculture system DTPA extractable Mn varied from 3.46 to 3.73 mg kg^{-1} among rice-wheat, maize-wheat and sugarcane. In the horticulture system, DTPA extractable Mn ranged from 6.26 to 6.52 mg kg^{-1} in mango and litchi sub systems whereas in the forestry system DTPA extractable Mn varied between 7.37 to 7.66 mg kg^{-1} among poplar and eucalyptus sub systems. There was a decrease in DTPA extractable Mn content from surface soil layer to lower soil depths however the decrease was non-significant at deeper soil depths. Fraction distribution of element manganese under different land use systems in the study area followed the order: RES-Mn > MnOX-Mn > AFeOX-Mn > CFeOX-Mn > OM-Mn > SpAD-Mn > WS+EX-Mn fractions which varied from 193.5 to 288.9, 76.5 to 103.0, 48.9 to 84.8, 46.5 to 74.2, 4.59 to 11.3, 0.99 to 1.68 and 0.92 to 2.45 mg kg^{-1}, respectively. Mn fractions were higher in forestry followed by horticulture, agriculture, and uncultivated land use systems. The Res-Mn and total Mn fractions increased with increasing soil depth whereas all the other Mn fractions decreased with soil depth.

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Impact of Continuous Fertilizer and FYM Application on Nutrients Uptake by Soybean

Birendra Swaroop Dwivedi*, B.K. Dixit and Abhishek Sharma
Department of Soil Science & Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 482004, Madhya Pradesh
**Email: bsd_75@rediffmail.com*

A field experiment was performed to find out the influence of continuous application of inorganic fertilizers and organic manure on uptake by soybean in a Vertisol at the Research Farm of, JNKVV, Jabalpur. There were eight treatments *i.e.* 50% NPK, 100% NPK, 150% NPK, 100% NP, 100% N, 100% NPK+FYM, 100% NPK-S and control (without fertilizer) with four replications in randomized block design. The highest nutrient uptake was associated with integrated application of fertilizer along with Farmyard manure (100% NPK + FYM) in comparison to optimal dose of NPK (100% NPK). While, the lowest uptake was found in control as well as 100% N alone. Hence, increasing rates of fertilizer addition resulted in successive increment in the uptake of nutrients. In general, higher uptake of nutrients N, P, K, S and Zn was recorded in grain rather than the straw at the harvest of the crop.

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Identification of Cropping Systems Module for Different Sequences and its Effect on Soil Properties

Adinath Takate*
Mahatma Phule Krishi Vidyapeeth, Dist. Ahmednagar, Rahuri, 413722, Maharashtra
**Email: aditakate@gmail.com*

A field trial was conducted during 2020-21 at AICRP on Integrated Farming System Research Farm, MPKV, Rahuri, Maharashtra to evaluate the cropping systems module for specific farming systems, to assess the resources dynamics of indentified cropping system module. The ten cropping sequences were laid out in Randomized Block Design with three replications. The initial soil status having pH 8.25, EC 0.25 dS m^{-1}, organic carbon 0.45%, available N, P and K (160, 14 and 320 kg ha^{-1}).The cropping system consist of following sequences. T_1: Soybean-Onion, T_2: Soybean-Wheat, T_3: Groundnut-Chickpea, T_4: Soybean-Chickpea, T_5: Maize + Green Gram-Groundnut, T_6: Pearl millet-Chickpea,T_7: Cowpea (F)-*Rabi* Sorghum (F), T_8: Maize (F)-Berseem (F), T_9: Cotton-Onion, T_{10}: Pigeon pea-Okra. Crop wise recommended dose of fertilizer was applied at the time of sowing. The result revealed that the Soybean-Onion (T_1) cropping sequence registered maximum gross monetary returns, net monetary returns and B:C ratio (Rs. 4,14,089 ha^{-1}, Rs. 2,89,145 ha^{-1}, and 3.31 respectively) followed by treatment T_9: Cotton-Onion (Rs. 3,71,683 ha^{-1}, Rs. 2,42,440 ha^{-1} and 2.88 respectively). The data in respect of soil chemical parameters stated that numerically higher available nitrogen 196 kg ha^{-1} was noticed in Maize + Green gram-Groundnut cropping sequences followed by cowpea (F) - Rabi sorghum (F) and Cotton-Onion sequence. Numerically higher phosphorus (21 kg ha^{-1}) was observed in Maize (F) - Berseem (F) cropping sequence followed by soybean-wheat sequence and higher potassium (359 kg ha^{-1}) was observed in soybean-onion cropping sequence followed by soybean-wheat cropping system.

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Enhancing Crop Production and Soil Health Through Manures and Biochar in Maize-Black Gram Cropping System

Shaon Kumar Das[1]*, Goutam Kumar Ghosh[2], Ramgopal Laha[1] and V.K. Mishra[3]

[1]ICAR Research Complex for NEH Region, Sikkim Centre, Toding Sikkim, Gangtok, 737102, Sikkim
[2]Palli Siksha Bhavana, Visva Bharati, Shantiniketan, 731236, West Bengal
[3]ICAR Research Complex for NEH Region, Umiam, 793103, Meghalaya
**Email: shaon.iari@gmail.com*

With increase in pyrolysis temperature the higher heating value of all the four-biochar decreased. The crystallinity index deceased (average 8.98%) in all biochar with increase in pyrolysis temperature. At low temperature pyrolysis the polarity index tends to increase and vice-versa. The biochar under study enhanced the seed germination and seedling growth significantly at a reasonable application rate than higher rate which might be due to secretion of chemical substances by the respective biochar. The organic manure / biochar (co-compost) ratio at 75:25 enhanced maximum yield in poultry manure (4528 and 1027 kg ha^{-1}) followed by goat manure (4378 and 1016 kg ha^{-1}), vermicompost (4278 and 986 kg ha^{-1}), pig manure (4218 and 956 kg ha^{-1}), and FYM (4178 and 949 kg ha^{-1}) for maize and black gram, respectively. The microbial biomass carbon was highest in goat manure 5 t ha^{-1} + biochar 5 t ha^{-1} (476.58 mg kg^{-1} soil) and lowest in FYM @ 10 t ha^{-1} + biochar 5 t ha^{-1} (458.53 mg kg^{-1} soil) than control (301.43 mg kg^{-1} soil). The nitrogen use efficiency followed as BGB-SRF (38.3%) > MSB-SRF (37.5%) > LCB-SRF (36.2%) > PNB-SRF (35.7%) than fertilizer (22.8%). After 288 hr of incubation the N-P-K nutrient release from hydrogel-biochar composite varied 36.49-81.37%. Similarly, it exhibited 35.46-90.83% release of N-P-K in soil after 45 days study. The release kinetics fitted by Korsmeyer-Peppas model illustrates that the *n* values were 0.5-1.0 (anomalous transport). Utilizing four different biochars, the average removal rate of heavy metal from aqueous solution was 49.5-66.1%(Cd), 47.3-60.0%(Pb), 45.5-60.6%(Ni), 46.6-60.8%(Zn), 49.3-63.2%(Cu) and 52.7-64.2% (As) compared with no biochar treatment. Biochar amendment has attracted a fair amount of research interest due to its abundant usage and wide potential. Assuming that the science of biochar is 'unambiguously beneficial', all the scientific community should support the biochar application for modern science and technological intervension.

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Potassium forms and their Relationships with Various Soil Properties from Selected Cropping Systems in Southern Transect of Bengaluru

Chikkaramappa Dibburahalli Thimappa Subbarayappa[1]*, T. Vanitha[1] and V. Ramamurthy[2]

[1]Department of Soil Science & Agriculture Chemistry, University of Agricultural Sciences, GKVK, Bengaluru, 560065, Karnataka

[2]Regional Centre, National Bureau of Soil Survey and Land Use Planning, Hebbal, Bangalore, 560024, Karnataka

**Email: ctsubbarayappa@gmail.com*

The research work was carried out in order to get an insight about the status, availability and supplying behaviour of potassium (K) for a meaningful K-fertilizer management strategy for sustainable crop production in southern transect of Bengaluru during 2020-22. Eighty surface (0-15 cm) soil samples were collected from the southern transect of Bengaluru to assess the important physico-chemical properties and distribution of different forms of potassium, including total K, lattice K, non-exchangeable K, exchangeable K, hot water-soluble K and water-soluble K. Results of the study revealed that the content of the K in selected cropping system varied between 3136 to 9717 mg kg^{-1} (Total K), 2887 to 7625 mg kg^{-1} (Lattice K), 220 to 800 mg kg^{-1} (Non exchangeable K), 15.13 to 49.51 mg kg^{-1} (Exchangeable K), 3.20 to 12.05 mg kg^{-1} (Hot water-soluble K) and 1.20 to 7.25 mg kg^{-1} (water soluble K). The different forms of K in the soils of selected cropping systems were in the following order: agricultural cropping system soil > mulberry cropping system soil > vegetable cropping system soils > plantation cropping systems. Among the forms of K, correlation studies showed that water soluble K had significant positive correlation with sand, while exchangeable K, lattice K and total K was found to be significant and had a positive correlation with organic carbon and the same forms had negative correlation with sand. All the forms of soil potassium were interrelated, indicating the existence of a dynamic equilibrium among them.

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Sulfur Dynamics in Acidic Soils during Incubation with Externally Added Elemental Sulfur

Gourav*, N.K. Sankhyan and Pardeep Kumar
CSK Himachal Pradesh Agricultural University, Palampur, 176062, Himachal Pradesh
**Email: gchouhan1@gmail.com*

Sulfur is deficient in acidic soils and meager information is available on the dynamics of S fractions in acidic soils. Generally soil sulfur increases with increase in soil pH and clay content of soil. Study of sulfur transformation in relation to different contents of clay and values of pH is imperative to ensure sulfur's long term availability. Twenty one acidic soils that varied in pH and clay contents were selected. These soils were incubated in laboratory at room temperature with five levels of sulfur (0, 20, 40, 60 and 80 kg ha^{-1}) for 60 days. Soil samples were drawn after 60 days of incubation to determine the status of different S fractions (available S, water soluble S, heat soluble S, organic S and total S). All the S fractions increased with increasing levels of applied S and the highest content of all S fractions was found with 80 kg S ha^{-1}. Amongst different S fractions water soluble sulfur was found to be the lowest one. In the soils where no external S was added, all the sulfur fractions were increased with incubation except organic sulfur. Organic sulfur decreased with incubation due to its mineralization to other S fractions.

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Soil Chemical Properties and Maize Yield as Influenced by Long Term Fertilizer Application under Finger Millet-Maize Cropping Sequence

T. Jayanthi*, G.G. Kadalli, Chandrakant, K.R. Lavanya and G.S. Shruthi
Department of Soil Science and Agricultural Chemistry,University of Agricultural Sciences ,GKVK, Bengaluru, 560065, Karnataka
**Email: jayanthiuasb@gmail.com*

An investigation was carried out to study the changes in soil chemical properties and crop yield were investigated in a long term fertilizer application under finger millet-maize cropping sequence following 35 years of fertilizer application since 1986 at ZARS, UAS, GKVK, Bengaluru during 2020-2021. The experiment comprised of 11 treatments which includes absolute control, three levels of recommended dose of NPK fertilizers (50, 100 and 150%), 100% NPK + Hand weeding, 100% NPK + lime, 100% NP(-K), 100% N(-PK), 100% NPK + FYM@10 t ha^{-1}, 100% NPK (S-free), 100% NPK + FYM@10 t ha^{-1} + lime. The results revealed that the soil pH decreased from an initial value of 6.17 to 4.60 due to application of 100% N. Similarly in the treatments where 150% NPK and 100% NP was applied, the pH declined to 4.82 and 4.85, respectively. The organic carbon was recorded maximum (0.59 and 0.65%) in the treatments T_8 and T_{10}, respectively and significantly decreased in control (0.41%), 100% N (0.43%) and 100% NP (0.44%) treatments. Similarly, available nitrogen content in soil was recorded maximum (206.88 and 233.53 kg ha^{-1}) in T_8 and T_{10}, respectively. Except control and T_7 (100% N) treatments, the phosphorus buildup was observed in all the treatments and it was maximum (214.11 kg ha^{-1}) in T_3 (150% NPK). Maximum potassium (232.15 kg ha^{-1}) content was observed in 150% NPK. Higher Exchangeable Ca and Mg contents were found in T_{10} followed by T_8 and T_5. The available sulphur content in soil was found sufficient in all treatments except in T_9: 100% NPK-S free (8.70 mg kg^{-1}).Application of FYM resulted in maintaining the micronutrient concentration at higher level in the soil compared to treatments without FYM. Significantly higher grain and stover yield of maize were recorded in T_{10}:100% NPK+ FYM + lime (56.82 and 89.44 q ha^{-1}, respectively) treatment compared to all other treatments and was followed by T_8 and T_3 treatments.

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Residual Effect of Water Soluble Fertilizers Through Different Approaches on Soil Chemical Properties and Yield of Cowpea Crop

Jayanthi*, P.K. Basavaraja, G.G. Kadalli and Chandrakant
University of Agricultural Sciences ,GKVK, Bengaluru, 560065, Karnataka
**Email: jayanthiuasb@gmail.com*

A field experiment was carried out to study the "Residual effect of water soluble fertilizers on soil chemical properties and yield of cowpea (*Var*. KM-5)" during 2016 and 2017 summer season at ZARS, University of Agricultural Sciences, GKVK, Bengaluru. Totally 16 treatments were imposed for preceding aerobic rice crop during *Kharif* 2015 and 2016. The experimental design adopted was RCBD which included T_1: Control, T_2: 100% RDF-Conventional Fertilizers (CF), T_3 and T_4: 100% RDF with CF at 4 and 8 days interval (DI), respectively, T_5, T_6 and T_7: 100, 50 and 30% RDF with Water Soluble Fertilizers (WSF) at 4 DI, respectively, T_8, T_9 and T_{10}: 100, 50 and 30% RDF with WSF at 8 DI, respectively, T_{11}, T_{12} and T_{13}: 100, 50 and 30% STCR dose with WSF at 4 DI, respectively, T_{14}, T_{15} and T_{16}: 100, 50 and 30% STCR dose with WSF at 8 DI, respectively. The results indicated that there was no significant difference in soil pH and EC values between the treatments. However, significantly higher organic carbon (0.64%) and available NPK content in soil (178.77, 116.29 and 162.30 kg N, P_2O_5 and K_2O ha^{-1}, respectively) were recorded in T_{11} with STCR approach. Significantly higher exchangeable calcium [4.49 cmol (p^+) kg^{-1}], magnesium [2.64 cmol(p^+)kg^{-1}] and available sulphur content in soil (16.66 mg kg^{-1}) were recorded in T_2. Significantly higher DTPA extractable Fe and Zn content (22.11 and 1.67 mg kg^{-1}, respectively) were recorded in T_8 treatment, Significantly higher DTPA extractable Mn and Cu content in soil (24.57 and 0.62 mg kg^{-1}, respectively) were recorded in T_5 and T_{11}, respectively. The treatment with 100% RDF through water soluble fertilizers at 8 DI (T_8) has recorded significantly higher seed and haulm yield of cowpea (12.94 and 26.17 q ha^{-1}, respectively).

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Effect of Foliar Application of ArkaVegetable Special on Growth and Yield of Tomato

Rajeshwar Naik Malavath*, Ullangula Sravanthi, Rajeshwar Malavath, Shivakrishna Kota, Nagaraju Alugozu, Thirupathi Islavath and Sathish Bollaveni

Professor Jayashankar Telangana State Agricultural University, Rajendranagar, 500030, Telangana
**Email: rajeshoct31naik@gmail.com*

Tomato (*Solanum lycopersicum* L.) is universally treated as protective food and is a very good source of income to small and marginal farmers and contributes to the nutrition of the consumers. An experimental trial was conducted on effect of Arka Vegetable Special which contains Zinc 4.5%, Boron 1% , Manganese 0.85%, Iron 2.1% and Copper 0.1% and used as foliar application at the vegetative growth, flowering, and early fruit stage of tomato in the farmers fields of Mancherial district during the year 2020-21 and 2021-22 (Yasangi). The treatments consist of farmer practice (T_1) with application of RDF (150: 75:75 kg NPK ha^{-1}) and foliar application of Arka Vegetable special 5 g lit^{-1} along with application of RDF (150: 75:75 kg NPK ha^{-1}) (T_2). A total number of 3 sprayings including at vegetative stage, (40-45 days after sowing), 2nd spraying after 20 days of 1st spray and 3rd spraying after 20 days of 2nd spray. The result revealed that, foliar application of Arka Vegetable special 5 g lit^{-1} along with application of RDF (150: 75:75 kg NPK ha^{-1}) (T_2) recorded highest numbers of fruits per plant (38) and yield (42.33 t ha^{-1}) over farmer practice (T_1) with application of only RDF (150: 75:75 kg NPK ha^{-1}) with 32.5 fruits/plant and 37.1 (t ha^{-1}) yield. The foliar application of Arka vegetable special (5 g lit^{-1}) along with RDF showed a positive effect on all the important parameters with high benefit cost ratio (2.57) and better fruit quality in terms of appearance, keeping quality and taste.

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Effect of RDF and Bio-Fertitilizers in Relation to Rice Yields and Economics in Mancherial District of Telangana

Rajeshwar Naik Malavath*, Thirupathi Islavath, Rajeshwar Malavath, Shivakrishna Kota, Nagaraju Alugoju, Ullangula Sravanthi and Sathish Bollaveni

Professor Jayashankar Telangana State Agricultural University, Rajendranagar, 500030, Telangana
**Email: rajeshoct31naik@gmail.com*

Rice (*Oryza sativa* (L.) is major important staple food crop in Asia as well as in India which is extensively cultivated in all the districts of Telangana State both in *Kharif* and *Rabi* seasons. Rice production in Telangana has been increased by more than 20 per cent in about 14.19 lakh ha. with its share to the national rice production improve considerably from 2.84% in 2015-16 to 5.54% by 2017-18 where the production levels became doubled within in three years and it is the second largest crop cultivated in the Mancherial district after cotton crop**.** Bio fertilizers are eco-friendly fertilizers which will improves soil quality and provides yield increments which greatly benefit farmers at very low input cost. *Azospirillum* is recognized as a dominant soil microbe, mainly used to cereal crop which saves up to 25-30% quantity of nitrogen fertilizer. Krishi Vigyan Kendra (KVK), Bellampalli, Mancherial conducted on farm trail for three years during *Rabi* 2018-19, 2019-20 and 2020-21 in 5 different locations with three treatments. The treatments consist of farmers practice (T_1), RDF-120-60-40 NPK kg/ha (T_2) and 100% RDF along with Bio fertilizer (*Azospirillum* (T_3)). One kg *Azospirillum* applied through seedling root dipping method at the time of transplanting. The three years average results shows that, the highest yield recorded with 100% RDF along with biofertilizer application (5809 kg ha^{-1}) followed by farmers practice (5488 kg ha^{-1}) and RDF (5363 kg ha^{-1}). The application of fertilizers along with biofertilizers (*Azospirillum*) based on increases the yield up to 8.3% compare to farmers practice and RDF. The Application of biofertilizers along with Recomonded dose of fertilizers saved the cost of inputs with high net returns (Rs. 62749 ha^{-1}) and B: C ratio (2.45) when compared to farmers practice (net returns @ 56456 ha^{-1}) and BC ratio (2.33).

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Farm Soil Fertility Mapping for Site Specific Nutrient Management in Indo-Gangetic Plain Zone of India

Ram Ratan Verma*, T.K. Srivastava and Pushpa Singh
ICAR-Indian Institute of Sugarcane Research, Lucknow, 226002, Uttar Pradesh
**Email: ratan.verma@rediffmail.com*

A study was conducted for developing scientific aids for site-specific nutrient management through variable mapping of soil properties at the research farm of ICAR-Indian Institute of sugarcane Research, Lucknow in the Indo-Gangetic plain zone of India. Grid-based (70x70 meter) 240 soil samples were collected from 0-15 cm soil depth during year 2021. These samples were analyzed for soil pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (AN), available phosphorus (AP), available potassium (AK), available sulfur (AS), zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn). The research farm soils were found neutral to alkaline in reaction with an average pH of 8.1. Electrical conductivity was found in the neutral range. Organic carbon content showed variation from low to high however, the average content was in the medium range (0.52%). Variation in available nitrogen was found from low to medium status but the average was in low status (240.6 kg h^{-1}). Wide variation was observed in available phosphorus which varied from low to high in range however, an average status was found in the medium category. Available potassium varied from medium to very high. It was found in medium category in sugarcane-based cultivated soils and in the medium category under forest soils. Available sulfur analysis revealed 59%, 38% and 3% of farm area under low, medium and high status, respectively. DTPA extractable zinc, iron and manganese were found deficient in certain areas however average, values of all these nutrients were found above their critical limits. Organic carbon showed significantly positive correlation with AN and Cu. Spatial distribution maps of soil pH, EC, SOC, AN, AP, AK, AS, DTPA extractable Zn Cu, Fe and Mn were developed through GIS-based ordinary kriging technique for implementation of site-specific nutrient management in various sugarcane-based crops at the research farm of ICAR-IISR, Lucknow.

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Study of Soil Fertility Parameters in Northern Transect of Bangalore, Karnataka by using Remote Sensing and GIS

A. Sathish*, J. Venkate Gowda, P.V. Vinay Kumar, H. Vimalashree and G.S. Jagadeesha*
University of Agricultural Sciences, GKVK, Bangalore, 560065, Karnataka
**Email: soilsathish@gmail.com*

Land resource inventory of selected villages in northern transect of Bangalore (rural, transition and urban areas) representing eastern dry zone of Karnataka (Zone 5) was carried out using geospatial techniques. Totally 133 surface soil samples at 250 m 2 grid were collected, characterized for chemical and fertility properties and soil fertility maps were prepared using geographic information system (GIS). The results revealed that the soils were acidic to neutral (pH 5.16, 5.06, 5.87 and 6.82) with low total salt content (EC 0.13, 0.15, 0.23 and 0.32 dS m^{-1}) and medium to high in organic carbon (OC) (0.79, 0.75, 0.64 and 0.60 per cent) status in Kachahalli, Karanalu, Kudaragere and Shyamarajapura, respectively. Low in available N (202.35, 181.71, 217.17 and 239.12 kg ha^{-1}), medium to high in available P_2O_5 (49.38, 46.49, 55.06 and 67.40 kg ha^{-1}) and low to medium in available K_2O (207.66, 191.85, 291.16 and 211.56 kg ha^{-1}) contents were recorded in Kachahalli, Karanalu, Kudaragere and Shyamarajapura, respectively. Medium range of available S and 100 per cent sufficient exchangeable Ca and Mg were present in all the villages. Available micronutrients (Cu, Zn, Fe and Mn) were observed sufficient range in all the 4 villages except available Fe (deficient) in urban transect village (Shyamarajapura). Soil pH, available N, K_2O and Fe were found important soil fertility constraints for crop production in the northern transect of Bangalore. Thus, proper nutrient management along with correction of soil reaction and soil conservation measures needs to be done in order to enhance productivity.

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Influence of FYM, Sulphur and Zinc on Yield, Nutrients Content and Fertility Status of Soil under *Rabi* Maize (*Zea mays* L.) - Green Gram (*Vigna Radiata*)

Shubhangi Kadam*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: shubhangipatil2612@gmail.com*

A field experiment was conducted in the *rabi* seasons for maize and in the summer seasons for succeeding green gram during the year 2019-20 and 2020-21 at College of Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand.The experiment was laid out in a randomized block design with factorial concept, comprising eighteen treatment combinations of two levels of FYM (0 and10 t FYM ha^{-1}) three levels of sulphur (0, 20 and 40 kg S ha^{-1}), and three levels of zinc (0, 2.5 and 5 kg Zn ha^{-1}) with three replications. The soil of the experimental plot was loamy sand in texture, alkaline in reaction ($pH_{1:2.5}$8.30), low in soluble salts ($EC_{1:2.5}$ 0.23), organic carbon (0.30%) and available nitrogen (197 kg ha^{-1}), medium in available phosphorus (44.5 kg P_2O_5 ha^{-1}) , high in potash (287 kg K_2O ha^{-1}) and deficient in sulphur (7.56 mg kg^{-1}) and zinc (0.55 mg kg^{-1}).The recommended dose of fertilizer was applied to maize (150:60:00 kg NPK ha^{-1}) and greengram (20:40:00 kg NPK ha^{-1}) at the time of sowing. In light of the two years of experimentation, conclusion was that the application of 10 t FYM ha^{-1}, 40kg S $ha^{-1}$and 5.0 kg Zn ha^{-1} besides RDF (150:60 kg N:P_2O_5 ha^{-1}) applied to *rabi* maize crop not only found beneficial to maize crop, and also found beneficial for succeeding crop of summer greengram [RDF (20:40 kg N:P_2O_5 ha^{-1})] in terms of growth, yield, quality, content and uptake of nutrients and availability of nutrients in soil. Application of FYM 10 t ha^{-1}, 40 kg S $ha^{-1}$and 5.0 kg Zn ha^{-1} also recorded higher values of different fractions of S and Zn in soil after completion of two successive cropping sequence of maize-greengram grown in sequence.

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Response of Potassium Levels in Combination with FYM on Sunflower under Dryland Agriculture

Archana Pawar[1]*, Iqbal Bagwan[1], Shubhangi Kadam[2] and V.M. Amrutsagar[1]

[1]Zonal Agricultural Research Station, Solapur, 413002, Maharshtra
[2]Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: pawarab.2009@rediffmail.com*

The Field experiments was conducted during the seven consecutive years (*kharif*) from 2012-13 to 2018-19 at the Zonal Agriculture Research Station, Solapur to study the effect of potassium levels in combination with FYM on yield, nutrients uptake by sunflower and residual nutrients status of soil under dry land agriculture. The treatment where NPK 50:25:50 kg ha^{-1} with 2.5 tone FYM ha^{-1} applied were recorded significantly highest grain and straw yield (16.02 and 21.43 q ha^{-1}, oil yield and oil content (6.18 q ha^{-1} and 38.70 %) and moisture use efficiency for grain (6.41 kg ha^{-1} mm^{-1}) over rest of the treatments. However, all the parameters were on par with treatment T_5 *i.e.* NPK 25:50:25 kg ha^{-1} with 2.5 tone FYM ha^{-1}. The lowest value for MUE for grain and straw were recorded in treatment T_1. The T_6 treatment (NPK 50:25:50 kg ha^{-1} + FYM 2.5 t ha^{-1}) recorded significantly higher uptake of nitrogen, phosphorus and potassium (57.10, 12.26 and 94.13 kg ha $^{-1}$ respectively) which was on par with T_5 for N and K uptake. The treatment NPK 50:25:50 kg ha^{-1} + FYM 2.5 t ha^{-1} treatment recorded significantly higher mean residual available nitrogen and phosphorus content (170 and 22.82 kg ha^{-1}). The higher mean residual available potassium content (677 kg ha^{-1}) was found in treatment T_5 and it was on par with T_4 and T_6 treatment. It was observed that, the treatment T_6 NPK 50:25:50 kg ha^{-1} with 2.5 tone FYM ha^{-1} recorded significantly higher gross monetary returns (Rs. 76,601/-), net returns (Rs. 48,123/-) with B:Cratio (2.69) over rest of the treatments. The lowest values of yield, oil contents, uptake of nutrients and available potassium were recorded for without potassium application. The better yield and quality of sunflower can be obtained with the application of higher rates of potassium under dryland condition. Also, addition of FYM along with this adds more benefits regarding the improvement in soil physical, chemical and biological properties.

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Production and Nutrient Use by Bitter Gourd under Fertigation in Inceptisol

Kailas Kale*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kd_kale@rediffmail.com*

A field experiment was conducted during 2019-2020 at Research Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra), India to find out the effect of application of water soluble fertilizers on yield, nutrient availability and uptake by bitter gourd in Inceptisol. The experiment consists of eight treatments with three fertigation levels (100%, 80% and 60% RDF), two fertilizer sources (conventional fertilizers applied through soil and water soluble fertilizer applied through fertigation). The recommended dose of fertilizer for bitter gourd was 100:50:50; N: P_2O_5: K_2O kg ha^{-1} was applied as per growth stages in 17 weekly splits in fertigation treatments. Whereas in conventional fertilizer treatments (T_5 and T_8) 50% of N and total dose of P_2O_5 and K_2O was applied as a basal and remaining 50% RD of nitrogen was applied in two splits at 30 and 60 days after planting (DAP). The results indicated that drip irrigation (DI) with 100% RDF through fertigation treatment (28.36 t ha^{-1}) showed 31.30% increase in yield over DI with 100% RD of CF applied through soil. However, it was on par with DI with 100% RD of fertigation in 17 equal weekly splits (26.80 t ha^{-1}) and DI with 80% RDF through fertigation (26.25 t ha^{-1}). The treatment DI with 80% RDF through fertigation resulted into 20% fertilizer saving and 21.53% increase in yield over DI with 100% RD of CF applied through soil (21.60 t ha^{-1}). The treatment T_5 recorded maximum availability of NPK (161.2, 17.30 and 332.0 kg ha^{-1}) at harvest. The NPK uptake by bitter gourd was more in treatments where fertilizers were applied as per growth stages (17 splits) through fertigation as compared to DI with 100% RD of CF applied through soil and surface irrigation (SI) with conventional fertilizers. The treatment T_1 *i.e.* DI with 100% RDF through fertigation recorded maximum NPK uptake (82.20, 23.70 and 87.90 kg ha^{-1}) at harvest and it was significantly superior over all other treatments except T_7 and T_2. On the basis of the results obtained, it can be concluded that drip irrigation with 80% RDF through fertigation in 17 splits at weekly interval is necessary for achieving higher yield and nutrient use of bitter gourd under silty clay loam soils of western Maharashtra.

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Remote Sensing and GIS — An Effective Tool for Soil Fertility Evaluation in Begur Microwatershed Chamarajnagar District, Karnataka

B.G. Vasanthi*, M.S. Sheelarani, B. Nethravathi, K.R. Ashok and A. Sathish
University of Agricultural Sciences, GKVK Bengaluru, 560065, Karnataka
**Email: vasubgkvk@gmail.com*

Soil quality reflects how well soil performs the functions of maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, nutrient cycling, and providing support for plants and other structures. The present study focus on spatial variability and temporal variability of soil quality in Begur microwatershed representing southern dry zone in Gundlupete taluk of Chamarajanagara district. Cadastral map of 1:7,920 scale was used as base map for the study. The satellite image (quick bird 0.6 M) along with cadastral overlaid on grid map was used to collect the soil samples at 320 m grid interval. There were 61 grids in the micro watershed covering an area of 617 ha. Surface soil samples were collected in the respective grids in the field following standard procedure. Soil fertility parameters *viz.*, pH, EC, available macro and micro nutrients were determined and soil fertility maps were prepared using GIS technology from remote sensing data in ArcGIS 10.8.2. The results revealed that, soil pH varies from neutral values to very strongly alkaline values. Macro nutrients like available nitrogen was low in maximum areas (76%), medium in available phosphorous (42%) and high in available potassium (69%). Major portion of the study area, soils recorded medium organic carbon, low in available Sulphur (49 %) respectively. Among the micro nutrients, copper, manganese were sufficient, iron and zinc content were deficient. Hot water extractable boron content was low in maximum area. From the study, it can be concluded that, very strongly alkaline soils are need to be treated with gypsum and FYM. The deficient macro and micronutrients in soils should be applied to soils based on soil test based nutrient recommendations to avoid the crops suffering from their deficiency and for optimum utilization of other nutrients.

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Effect of Sulphur on Soil Fertility, Nutrient Use Efficiency and Yield of Chickpea

Prashant Sarap*, S.S. Hadole, A.J. Ingole and S.D. Nandurkar
Department of Agricultural Chemistry & Soil Science, Dr. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: sarap.prashant@gmail.com*

Chickpea (*Cicer arientinum L.*)is one of the foremost rabi pulse crop of Maharashtra and premier pulse of India. The sulphur research in soils and plant carried out in the state is inadequate and could not give clear picture on sulphur nutrition in major crops and soils of the state. Therefore, three years field experiment was carried out to study the effect of sulphur application soil fertility, nutrient use efficiency yield of Chickpea at Pulses research station, Wasim Road, Akola. Design of experiment is Randomized block design with nine treatments and three replication. Results indicated that The soil pH recorded slightly lower in the treatment of sulphur application. The highest organic carbon (5.33 g kg^{-1}) was recorded with the application of S @ 30 kg ha^{-1} through Bentonite sulphur along with RDF. The significantly highest available nitrogen (223.5 kg ha^{-1}), available phosphorus (15.99 kg ha^{-1}), available sulphur (14.88 mg kg^{-1}) was registered in treatment of application of S @ 30 kg ha^{-1} through Bentonite sulphur along with RDF. Similarly the highest GMR and B:C ratio was also noticed with soil application of S @ 30 kg ha^{-1} through Bentonite Sulphur + RDF followed by soil application of S @ 30 kg ha^{-1} through Gypsum + RDF.

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Effect of Sulphur Application on Yield, Uptake and Quality of Chickpea

Sandeep Hadole*, P.A. Sarap and A.J. Ingole
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: hadolesandeep@yahoo.com*

Chickpea (*Cicer arientinum*) popularly known as "Gram" OR "Bengal gram" is most important and premier pulse crop of India. Sulphur is a secondary nutrient and plays a vital role in plant metabolism as the main constituent of the sulphur containing amino acids, Vitamin C, lipoic acid and acetyl CO-A. Sulphur has positive effect on root growth in plants and this elements also help in the nodule formation in legumes crops. The sulphur research in soils and plant carried out in the state is inadequate and could not give clear picture on sulphur nutrition in major crops and soils of the state. Therefore, three years field experiment was carried out to study the effect of sulphur application on yield, nutrient uptake and quality of Chickpea at Pulses research station, Wasim Road , Akola. Design of experiment is Randomized block design with nine treatments and three replication. Results indicated that significantly highest grain yield (24.18 q ha^{-1}) and straw yield (30.16 q ha^{-1}) were recorded with the application of S @ 30 kg ha^{-1} through Bentonite sulphur along with RDF. Similarly maximum N, P, K, S and micronutrient uptake and improved quality were observed with application of @ 30 kg ha^{-1} through Bentonite sulphur along with RDF followed by the treatment of application of S @ 30 kg ha^{-1} through Gypsum + RDF.

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Tillage and Residue Retention for Resource Conservation in Improving Soil Fertility and Productivity of Blackgram - Rabi Sorghum Sequence on Inceptisol

Vijay Amrutsagar*, S.K. Upadhye and G. Ravindra Chary
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: vijayamrutsagar@gmail.com*

The rainfed agriculture in India is a low input farming covers 84.2% area (arid - 15.6%, semi-arid - 37.6% and sub humid zone - 31%). The forty four percent of the food grains in the country are contributed from rainfed agriculture which feed to 40 % of the nation's population. The inherent advantages of rainfed areas may be capitalized by encouraging inter cropping, mixed cropping, sequence cropping with minimum tillage and residue management which can be sustain the yield of the crops, moisture use efficiency, reduce runoff losses, soil health and also can be fight with the abnormal adverse climatic situations in scarcity zone. Considering the all above conditions, a field experiment was initiated during 2012-2013 to 2021-22 at All India Coordinated Research Project for Dryland Agriculture, Main Center, Solapur. The experiment is conducted with three main tillage treatments *viz.*, Conventional tillage (CT), Reduced tillage (RT) and Zero tillage (ZT) and three sub residue management treatments with three replications in Split Plot Design. The results obtained after ten years data, it is revealed that, in *kharif* blackgram – *rabi* sorghum cropping sequence grown on medium deep black soils with reduced tillage *i.e.*, harrowing on set of monsoon, sowing of black gram with ferti-seed drill- with 75% of RDF (19.0:38.0 $N:P_2O_5$ kg ha^{-1}) subsequent light harrowing + hoeing at 3rd week, harvesting of black gram either for green manuring or grain, harrowing after harvest of black gram, sowing of *rabi* sorghum with ferti-seed drill- with 75% of RDF (38.0 :19.0 :25.0 $N:P_2O_5:K_2O$ kg ha^{-1}) subsequent light harrowing, two hoeing at 3rd and 5th week after sowing of *rabi* sorghum, harvesting of *rabi* sorghum above ground level recorded higher yield q ha^{-1} (grain - 15.91, stover - 35.96), net monetary returns, Rs ha^{-1} (38,642) and rain water use efficiency, Kg ha^{-1} mm^{-1} (29.17) with maintaining soil health.

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Effect of Continuous use of Inorganic Fertilizers and Manures on Onion Production and Soil Fertility Status

Thangasamy Arunachalam*, P.S. Soumia, V. Karuppaiah, Komal A. Gade, Suraj D. Satpute and Vijay Mahajan

ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune, 410505, Maharashtra
**Email: astsamy@yahoo.co.in*

Permanent manurial experiment was initiated during rabi 2013-14 with eight treatments. Each block was assigned for specific fertilizer treatment and care was taken to avoid mixing of soil from one block to another. Vermicompost (VC) @ 10 t ha^{-1} was included as ninth treatment during 2015-16. Field experiment was carried out to monitor the effect of soybean and maize (*kharif*) - onion (*rabi*) cropping system and four fertilizer treatments on onion production and soil fertility status. Inclusion of maize as preceding crop and combined application of mineral fertilizers and vermicompost produced significantly higher bulb yield compared to other fertilizer treatments. Furthermore, application of 10 t vermicompost ha^{-1} alone produced 16.6 t ha^{-1} onion yield which was significantly lower than other fertilizer treatments. From 2018-19 to 2020-21, the onion yield in INM treatments and chemical fertilizer treatments of soybean block were decreased significantly in comparison to maize block. Combined application of mineral fertilizers and vermicompost showed higher soil organic carbon (SOC) and soil available N compared to mineral fertilizer alone applied treatments. SOC and soil available nutrients were higher in soybean block compared to the maize block. Initial soil fertility status was maintained in all the fertilizer treatments. Higher nitrogen uptake was recorded in soybean block, whereas PKS uptakes were higher in maize block. In addition, observations on natural enemy population were recorded in all the treatment using the sticky traps. The results showed that Coleopteran insects dominated the onion ecosystem in terms of species diversity irrespective of the treatments. With respect to the number of insects, the Thysanoptera order ranked first in all the treatments. However, maximum species diversity was found in organic treatments in comparison to inorganic treatments.

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Response of Soybean to Different Slow Release and Controlled Release Fertilizers in Pot Culture Experiment

Sanjay Todmal*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: sanjaytodmal2009@rediffmail.com*

The pot experiments were conducted during *kharif-* 2019 to study the response of soybean to different slow release and controlled release fertilizers. The pot culture experiments was conducted with soybean in CRD with three replications and nine treatment combinations *viz.;* absolute control, CDU, SCU, Karanj oil coated DAP, Polymer coated DAP, WDG-S, Bentonite S, RDF (SCU + Karanj oil coated DAP + Bentonite sulphur), RDF (CDU + Polymer coated DAP + WDG of Sulphur). The significantly highest seed and straw yield, number of seeds per plant, test weight and oil content was recorded in the treatment with RDF through CDU + Polymer coated DAP + WDG of sulphur. The significantly highest seed protein content of soybean was recorded in the treatment with application of CDU (T_2). The treatment RDF through CDU + Polymer coated DAP + WDG of sulphur recorded significantly highest total nutrient uptake (N, P, K and S) and micronutrient uptake (Fe, Mn, Zn and Cu) in soybean at harvest. The effect of different slow release and controlled fertilizers on soil pH, EC and $CaCO_3$ content was found non significant at harvest of soybean in pot culture experiment. There was increase in organic carbon content in all the treatments over the initial values. The significantly highest soil available nitrogen was observed at 40 DAS and at harvest in the treatment RDF through SCU + Karanj oil coated DAP + Bentonite sulphur. However, the significantly highest soil available nitrogen was observed at 60 DAS and 80 DAS in the treatment RDF through CDU + Polymer coated DAP + WDG of sulphur. The treatment RDF through SCU + Karanj oil coated DAP +Bentonite sulphur recorded significantly highest soil available phosphorus at 40 DAS whereas, significantly highest soil available phosphorus was recorded at 60 DAS, 80 DAS and at harvest in the treatment RDF through CDU + Polymer coated DAP + WDG of sulphur (T_9). Soil available potassium was non significant at 40 DAS, 80 DAS and at harvest. The availability of sulphur was increased up to 60 DAS and thereafter decreased slightly at harvest in all the treatments. The results of soil available micronutrients (Fe, Zn, Mn and Cu) were found non significant at harvest of soybean. The highest PFP, AE and ANR for nitrogen was recorded in CDU (T_2). The highest PFP, AE and ANR for phosphorus was recorded in polymer coated DAP treatment (T_5). The highest PFP, AE and ANR for sulphur in Bentonite sulphur treatment (T_7).

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Study of Nutrient Release Pattern, Soil Enzyme Activity and Microbial Diversity as Affected by Different Slow Release and Controlled Release Fertilizer under Incubation

Sanjay Todmal*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: sanjaytodmal2009@rediffmail.com*

Incubation study was conducted during *kharif*- 2020 to study nutrient release pattern, soil enzyme activity and microbial diversity as affected by different slow release and controlled release fertilizer. The incubation experiments was conducted in CRD with 3 replications 10 treatment combinations *viz.;* absolute control, recommended dose of fertilizers through conventional fertilizers (urea, DAP, MOP and elemental S) and combinations of slow release and controlled release fertilizers (CDU, SCU, Polymer coated DAP, Karanj oil coated DAP, Bentonite S and WDG-S). An incubation study was conducted in the laboratory under ambient conditions for 100 days. In laboratory incubation study, the significantly highest soil available N, NH_4-N and NO_3^--N were recorded in RDF at 20 DAI and 40 DAI. The soil available N was higher in RDF through CDU + Polymer coated DAP + Bentonite sulphur at 60 DAI and 80 DAI. The RDF through SCU + Karanj oil coated DAP + Bentonite sulphur recorded higher soil available N at 100 DAI. At 60 DAI, the higher soil NH_4-N was recorded in RDF through CDU + Polymer coated DAP + Bentonite sulphur. The soil NO_3^--N found significantly highest in the treatment RDF through CDU + Polymer coated DAP + Bentonite sulphur at 60 DAI, 80 DAI and 100 DAI. The soil available phosphorus was recorded higher in RDF through CDU + Polymer coated DAP + Bentonite sulphur at 60 DAI and 80 DAI. At 100 DAI, the soil available phosphorus was higher in RDF through SCU + Polymer coated DAP + WDG of sulphur. The highest release of available sulphur in later stage of incubation (60 DAI, 80 DAI and 100 DAI) was found in RDF through SCU + Polymer coated DAP + Bentonite sulphur. The significantly highest soil urease, dehydrogenase, acid phosphatase, alkaline phosphatase and arylsulphatase enzyme activities were observed in RDF at 20 DAI and 40 DAI. The treatment RDF through CDU + Polymer coated DAP + Bentonite sulphur reported significantly higher soil urease enzyme activity at 80 DAI. The soil urease enzyme activity was significantly higher at 100 DAI in the treatment RDF through SCU + Polymer coated DAP + Bentonite sulphur. RDF through CDU + Polymer coated DAP + Bentonite sulphur treatment recorded higher soil dehydrogenase enzyme activity at 80 DAI and 100 DAI. The treatment RDF through SCU + Polymer coated DAP + WDG of sulphur recorded significantly highest soil acid enzyme activity at 80 DAI and 100 DAI. Whereas, significantly highest soil alkaline phosphatase enzyme was observed in RDF through CDU + Polymer coated DAP + Bentonite sulphur at 60 DAI, 80 DAI and 100 DAI. The significantly highest soil arylsulphatase activity was observed in RDF through SCU + Polymer coated DAP + Bentonite sulphur at 60 DAI, 80 DAI and 100 DAI. Soil bacterial and actinomycetes population was recorded highest in RDF through CDU + Polymer coated DAP + Bentonite sulphur at 40 DAI and 60 DAI. The significantly highest soil actinomycetes population was recorded in RDF through CDU + Polymer coated DAP + WDG of sulphur at 60 DAI. The significantly highest fungal population was recorded in RDF through CDU + Polymer coated DAP + Bentonite sulphur at 60 DAI and 80 DAI.

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Effect of Urban Ccompost om Ssoil Quality, Yield and Quality of Seasonal-Sugarcane in Vertic Inceptisols

Krisnpal Singh Parihar, A.G. Durgude, B.D. Bhakare, A.M. Navale, U.S. Surve, V.S. Wani and Santosh Kale*

Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kale143santosh@gmail.com*

Field experiment was conducted during the year January 2020-January 2021 at PGI Farm and Incubation study was done at MRS Wire-house, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) to study the effect of urban compost on soil quality, yield and quality of *seasonal*-sugarcane in *Vertic Inceptisol.* The field experiment was laid out in RBD and incubation study was done in CRD with three replications and eight treatments. There were five levels of nitrogen 0, 25, 50, 75 and 100% of recommended dose (RD) of nutrients with 100% P_2O_5, 100% K_2O along with organic manures *viz.*, FYM and urban compost (UC). The application of 75% N through urban compost and remaining 25% N through urea, with RD 115 kg P_2O_5 and 115 kg K_2O ha^{-1} in *seasonal*-sugarcane significantly increased cane and CCS yield followed by GRDF, 100% N through UC and 50% N through UC + 50% N through Urea. Total uptake of nitrogen, phosphorus, potassium, micro nutrients and yield attributing characters *viz.*, no. of tillers, total cane height, millable cane height, no. of millable canes, girth and length of internodes, Apparent Nitrogen Recovery Efficiency, yield of cane and CCS were significantly higher in 75% N through UC + 25% N through urea treatment. However, Actual Nitrogen status and actual gain of nitrogen were highest in GRDF treatment (250:115:115::N:P_2O_5:K_2O + FYM@20 t ha^{-1}). B:C ratio was found significantly highest (3.62) in 25% N through UC and 75% N through urea treatment. Application of 75% nitrogen through UC and remaining 25% nitrogen through urea along with RD of phosphorus@115 kg ha^{-1} + potassium@115 kg ha^{-1} to *seasonal*-sugarcane found beneficial for increase in growth parameters (millable cane height, total plant height, No. of tillers and millable cane, number, length and girth of internodes), uptake of macro & micro nutrients, nutrient use efficiency, net returns and yield of sugarcane grown in *Vertic Inceptisol*. However, on the basis of treatment of 25 to 50% N through UC and remaining 75 to 50% N through urea along with RD of P and K to *seasonal*-sugarcane found beneficial for increased in agronomic efficiency and B:C ratio of *seasonal*–sugarcane. In incubation study, the treatment of GRDF and 100% N through UC found improvement in organic carbon, soil properties, micronutrients and biological properties of soil.

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Effect of Soil Fertility on Nutritional Quality of Maize in a Long Term Fertilizer Experiment

G.G. Kadalli*, T. Jayanthi, Bommireddy Mamatha and Chandrakant
Department of Soil Science & Agricultural Chemistry, University of Agricultural Sciences, Bangalore, 560065, Karnataka
**Email: ggkadalli@rediffmail.com*

A study on effect of soil fertility on nutritional quality of maize was carried out in an ongoing long term fertilizer experiment which has been in progress since 1986 at UAS, GKVK, Bengaluru with finger millet–maize cropping sequence. The experiment consists of eleven treatments replicated thrice in RCBD. The treatments include different levels of nutrients (control, 50% NPK, 100% NPK, 150% NPK, 100% N and 100% NP, 100% NPK with S free) in combination with or without FYM and lime. Maize crop was grown during *Rabi*-summer 2021 and soil fertility status was determined by analyzing the soil samples (0-15 cm) collected before maize sowing (after 36 cropping cycles). Soil Quality Index (SQI) was calculated considering all soil quality indicators, which were transformed into scores (0 to 1) using linear scoring function into soil quality indices following principal component analysis. The maize grain samples were collected and analyzed for nutritional quality. The results indicated that application of FYM and lime along with 100% NPK improved all the soil quality parameters and nutritional grain quality. Continuous cropping without fertilization, imbalanced nutrition and sub-optimal fertilizer dose led to decline in soil quality parameters. SQI varied from 0.67 to 0.95 and highest being in 100% NPK+FYM+Lime (0.95). Lower SQI values were observed in control (0.67) followed by imbalanced nutritional plots [100% N (0.70) and 100% NP (0.72)]. Nutritional quality of maize grain *viz.*, crude protein content (11.04%) was higher with application of 150% NPK. Wherein, crude fibre, crude fat and carbohydrate contents (1.85%, 4.65% and 71.86%, respectively) and mineral compositions *viz.*, P, K, Ca, Mg, Fe, Mn, Cu and Zn (290.68, 333.33, 7.67, 234.67, 4.24, 2.91, 0.23, 2.35 mg 100 g^{-1}, respectively) were higher in 100% NPK +FYM+Lime. Hence, integration of organics with balanced inorganic fertilizers is necessary to maintain better soil quality and in turn quality produce.

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Effect of Application of Urban Compost on Yield and Quality of Onion

B.D. Bhakare, G.D. Sakore, Rajeev Ahal, Indraneel Ghosh, Navin Horo and Anil Durgude*

Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: durgudeag@rediffmail.com*

The field experiment on response of onion to urban compost was conducted at Department of Soil Science and Agril. Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during 2020-21. The study area falls under semi-arid climate. The soil at the experimental site is medium deep black soil (Typic Haplustept). Soil texture was clay, moderately alkaline (8.22) in reaction, normal in EC (0.16 dSm^{-1}), low in organic carbon (0.38%), medium calcareous in nature. Soil was low in available N and P and very high in available K status. However, soil was sufficient in micronutrients. The statistical design used RBD with three replication and seven treatments which comprised of T_1: Absolute Control, T_2: General recommended dose of nutrients (100:50:50 kg ha^{-1} $N:P_2O_5:K_2O$ + 20 t ha^{-1} FYM), T_3: Only Urban Compost @ 20 t ha^{-1}, T_4: 100% N through Urban Compost, T_5: 75% N through Urban Compost + 25% N through Urea, T_6: 50% N through Urban Compost + 50% N through Urea, T_7: 25% N through Urban Compost + 75% N through Urea. The results revealed that, the application of general recommendation dose of fertilizer (100:50:50 kg ha^{-1} $N:P_2O_5:K_2O$ + 20 t ha^{-1} FYM) to maize was significantly found beneficial for increase in yield and yield contributing characters, macro and micronutrient uptake. However, these results were at par with the treatments of 25 to 50% N through urban compost and 75 to 50% N through urea, respectively with the higher B:C ratio was recorded in treatment of 25% N through urban compost and 75% N through urea along with recommended dose of P and K to onion.

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Effect of Different Levels of Zeolite for Improvement of Sodic Soil

Shriganesh Shelke* and Abhang Koyal Prashant
Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: shelke_shriganesh@rediffmail.com*

The present investigation was carried out in Department of soil science and agricultural chemistry, PGI, MPKV, Rahuri to study the "Effect of different levels of zeolite for improvement of sodic soil". The sampling site was the representative black sodic soil. Soil amendments viz. Gypsum, Zeolite with FYM were added in the soil column. The saturated soil columns were allowed to leach out with water collected from column for 120 days. The experiment was laid out in completely randomized design. The treatments were T_1 : Absolute control, T_2 : Gypsum as per GR, T_3 : Zeolite @ 400 kg ha^{-1}, T_4 : Zeolite @ 600 kg ha^{-1}, T_5 : Zeolite @ 800 kg ha^{-1}, T_6 : Zeolite @ 1000 kg ha^{-1}, T_7 : Zeolite @ 1200 kg ha^{-1}, T_8 : Zeolite @ 1400 kg ha^{-1}, T_9 : Zeolite @ 600 kg ha^{-1}+ 100% Gypsum as per GR. The pHe and electrical conductivity (ECe) of leachate were decreased due to application of zeolite @ 600 kg ha^{-1} + 100% gypsum as per GR with successive leaching. The result showed that the application of zeolite @ 600 kg ha^{-1} + 100% gypsum as per GR was effective in reducing the salts from soil followed by Gypsum as per GR. pHe and electrical conductivity (ECe) of soil after continuous leaching with amendments (zeolite and gypsum) and irrigation water were decrease at all three soil depths *i.e.* 0-30, 30-60 and 60-90 cm than initial values. Calcium content after leaching in soil was increased over initial. Magnesium content in soil was increased in first layer *i.e.* 0-30 cm and decreased thereafter. Sodium content after continuous leaching with different amendments were decreases at all three depths *i.e.* 0-30, 30-60 and 60-90 cm than initial values.

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Effect of Application of Different Levels of Potassium Humate as Foliar Sprays on Yield and Quality of Cowpea under Pot Culture Condition

Archana Tathe* and Sampat Kolape
Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: archana.tathe@gmail.com*

An experiment was conducted using five levels of potassium humate (100 to 500 PPM) as foliar sprays to study its effects on yield and quality of cowpea (cv. *Phule sonali*) under pot culture condition at College of Agriculture, Karad in *kharif* 2020-21.The Inceptisol soil used for pot culture experiment was slightly alkaline, low in organic carbon content, calcareous in nature with available N, P_2O_5 and K_2O content as low, medium and high, respectively. The FYM used for pot culture experiment and extraction of potassium salt of humic acid was found to be good quality. The humic substances extracted from FYM as humic and fulvic acid were aromatic and aliphatic in nature, respectively. The experiment was laid out in CRD with seven treatments and three replications as T_1 (Absolute control), T_2 (GRDF (FYM 5 tha^{-1} + 25:50 NP kg ha^{-1}) + water spray), T_3 (GRDF + Potassium humate foliar spray @ 100ppm), T_4 (GRDF + Potassium humate foliar spray @ 200ppm), T_5 (GRDF + Potassium humate foliar spray @ 300 ppm), T_6 (GRDF + Potassium humate foliar spray @ 400 ppm), T_7 (GRDF + Potassium humate foliar spray @ 500 ppm). The foliar application of potassium humate @ 400 ppm along with GRDF (T_6) significantly increased average number of seeds pod^{-1} (18.00), 100 seed weight (9.59 g), seed yield (91.10 g pot^{-1}), and dry straw yield (113.88) as compared to absolute control and treatment T_2, however treatment T_7 found to be at par with T_6. The significantly highest protein content as quality parameter was noticed under treatment T_6 as compared to the rest of concentration of potassium humate and absolute control. Results concluded that the application of potassium humate as foliar sprays @ 400 ppm + GRDF improved the yield and protein content of *kharif* cowpea under pot culture condition.

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Effect of Urban Compost on Wheat-Maize (Fodder) Cropping Sequence on Soil Quality and Carbon Stock

Bapusaheb Bhakare* and A.D. Raut
Department of Soil Science & Agricultural Chemistry,, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: bapusaheb1661@gmail.com*

The field experiment was conducted during 2019-20 at PGI, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in RBD comprising of eight treatments and three replications for wheat crop. The treatments comprised of T_1: Absolute control – No fertilizer, T_2: GRDF @ 120:60:40 N, P_2O_5, K_2O kg ha^{-1} + FYM 10 t ha^{-1}, T_3: Only urban compost @ 10 t ha^{-1}, T_4: 100% N through vermicompost, T_5: 100% N through urban compost, T_6: 75% N through urban compost + 25% N through urea, T_7: 50% N through urban compost + 50% N through urea, T_8: 25% N through urban compost + 75% N through urea. For maize (fodder), experiment was laid out in split plot design superimposed on the treatments of preceding crop wheat as sub plot comprising eight main plot and five sub plot treatments, comprising of U_1: Residue of 100% N through vermicompost, U_2: 75% N through urban compost (residual) + 25% N through urea, U_3: 50% N through urban compost (residual) + 50% N through urea, U_4: 25% N through urban compost (residual) + 75% N through urea, U_5:100% N through urban compost and one treatment taken outside of the plot as control i.e. GRDF @ 100:50:50 N, P_2O_5, K_2O kg ha^{-1} + FYM 10 t ha^{-1}. The total bacterial population found highest at 45 DAS with the treatment T_2 in main plot while, in sub plot was highest under the treatment U_4 and at harvest 100% N through vermicompost in main plot and in sub plot, its residual treatment, similar results were observed in fungal and actinomycetes count as bacterial count at harvest. The ß-glucosidase and dehydrogenase enzymes activity found highest with T_4 in main plot while, in sub plot ß-glucosidase activity highest with the treatment U_4 and dehydrogenase enzyme activity was highest in the treatment T_5. At the end of cropping sequence, the lowest bulk density was found where sole application of organic manure applied. MWHC, pore space, volume expansion and porosity were highest in the treatment 100% N through vermicompost in main plot while for sub plot MWHC, pore space and volume expansion were highest in the treatment U_1. The application of organic manure treatments significantly recorded higher values of carbon fractions namely WSC, POSC, POMC and TOC. The soil organic carbon stock was significantly highest with the treatment T_7 (20.92 t ha^{-1}) and was at par with T_2 in main plot and treatment U_4 found highest carbon stock (19.17 t ha^{-1}) in sub plot.

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Effect of Application of Sulphur along with Organic Amendments on Yield of Kharif Groundnut and on Status of Forms of Sulphur in Sulphur Deficient Inceptisol

Sampat Kolape* and Archana Tathe
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: samkolape77@gmail.com*

A field experiment entitled "Effect of application of sulphur along with different organic amendments on yield of *Kharif* groundnut and on status of forms of sulphur in sulphur deficient Inceptisol." was carried out at Post Graduate Research Farm, RCSM College of Agriculture, Kolhapur during *Kharif* 2019. The experimental soil belongs to the Inceptisol order with slightly alkaline and deficient in available sulphur. The experiment was laid out in RBD with seven treatments and four replications. The treatment consisted of T_1 - RDF only, T_2 - RDF + 40 kg S ha^{-1} through elemental sulphur, T_3 - RDF + FYM @ 10 t ha^{-1}, T_4 - RDF + vermicompost (VC) @ 5 t ha^{-1}, T_5 - RDF + press mud compost (PMC) @ 5t ha^{-1}, T_6 - RDF + poultry manure (PM) @ 5t ha^{-1}, T_7 - RDF + city waste compost (CWC) @ 5t ha^{-1}. Elemental sulphur @ 40 kg S ha^{-1} was incubated for 30 days with organic amendments *viz.* FYM (T_3), VC (T_4), PMC (T_5), PM (T_6), CWC (T_7) and applied to soil before sowing of groundnut. The results showed that the significantly highest dry pod (20.18 q ha^{-1}) and haulm yield (71.15 q ha^{-1}) was recorded due to the treatment T_6 followed by treatment T_4 over the control (T_1). The content of forms of sulphur in soil after harvest of groundnut was also influenced due to application of sulphur along with different organic amendment. The highest values of total sulphur (199.0 mg kg^{-1}), organic sulphur (174.85 mg kg^{-1}), sulphate sulphur (19.8 mg kg^{-1}) and non sulphate sulphur (4.4 mg kg^{-1}) recorded due to the treatment T_6 followed by treatment T_4 as compared to only RDF (T_1). The application of elemental sulphur @ 40 kg S ha^{-1} along with good quality poultry manure or vermicompost @ 5 t ha^{-1} RDF to *kharif* groundnut significantly increased the yield and quality of groundnut as well as improved the status of forms of sulphur in sulphur deficient Inceptisol.

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Phosphorus Management in Sugarcane under South Gujarat Condition

Kranti Balasaheb Patil*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kpmpkv@gmail.com*

The clay fraction was the dominant factor responsible for P fixation in major soil groups of India. More P fixation would be expected in the finer fractions with their large specific surface and a large number of active ions at the lattice edges. In such a low P use efficient soils the optimum P chemical fertilizer dose, time of it's application along with biofertilizer are most important factors affecting the better fertilizer use efficiency. With this aim the present field experiment was conducted during 2017-18 and 2018-19 on soil *Inceptisols*, *Vertic Ustrochrepts* to study the effect of P levels as A_1 - 100% and A_2 - 75% RD of P_2O_5, B_1 - 100% P_2O_5 as basal dose and B_2-Split application of P as 50% P_2O_5 at planting + 50% P_2O_5 at final earthing up and arbuscular mycorrhiza (AM) C_1-Without AM and C_2 - with AM on yield, phosphorus use efficiency (PUE), soil physical and chemical properties and to work out the economics. Sugarcane yield increased by 10% and CCS yield with 12% with an application of 100 % P level. The periodical soil available P observed significantly highest with the 100% RD of P. Physiological PUE was significantly highest in the tune of 26% with the application of 75% RD of P_2O_5 level over 100% RD of P_2O_5 kg ha^{-1}. With the split application of P_2O_5 sugarcane yield increased significantly with 15% and CCS 17% over P applied as basal dose. Also with splitting of Phosphorus, the P uptake, periodical soil available P, PUE indices were remarkably improved. The application of biofertilizer as AM found significant for sugarcane growth and yield attributes resulted in yield were significantly increased in the tune of 21% and 22%. Mycorrhizal root colonization found significantly highest in AM treated plot. The PUE indices and highest net monetary returns and B:C ratio also responded significantly. The split application of P_2O_5 and use of AM recorded significant interaction effect for yield attributes, cane and CCS yield, periodical P content and uptake in Sugarcane.

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Assessment of Different Doses of Boron on Performance of Broccoli (*Brassica oleracea* var. *italica*) Through on Farm Trial (OFT)

Bappa Paramanik[1]*, Nakul Mandal[1], Indranil Das[4], Siddikul Islam[1], Bisweswar Mahato[5], Debraj Saha[1], Manas Mandal[3] and Swarbinay Mahanta[2]

[1]Dakshin Dinajpur Krishi Vigyan Kendra, UBKV, Dakshin Dinajpur, 733133, West Bengal
[2]College of Agriculture, Uttar Banga Krishi Viswavidyalaya, Majhian, Patiram, Dakshin Dinajpur-733133, West Bengal
[3]Dhaanyaganga Krishi Vigyan Kendra, Ramkrishna Mission Ashrama, Sargachi, Murshidabad, 742408, West Bengal
[4]Fertiliser Control Laboratory, Government of West Bengal, Medinipur, West Bengal
[5]KrishiVigyan Kendra, Kalyan, Dist. Purulia, Purulia, 723126, West Bengal
**Email: paramanikbappa@gmail.com*

Hallow stem disorder of broccoli is a common problem in different farmer's field which seemed to cause by the boron deficiency in soil. The deficiency was confirmed through soil testing of these field soils. Therefore, a field experiment was conducted as On Farm Trial (OFT) during *rabi* 2019-2020 to 2020-2021 at the different Farmers' Fields of Hili Block under the supervision of Dakshin Dinajpur Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya, Majhian, Patiram, Dakshin Dinajpur, West Bengal to control the hallow stem disorder of broccoli(*Brassica oleracea* var. *italica*) through the application of different doses of boron coupled with major nutrition broccoli in *rabi* season. In OFTs the treatments were kept minimal to avoid multicollinearity effect which would also evoke better understanding of the study by the farming community. The experiment was laid out in a Randomised Block Design consisting of four treatments T_1 = application of only use of major nutrient (NPK::110:50:30 kg ha^{-1})as farmers' practice (derived from the Farmer's Participatory survey), T_2 = application of RDF (NPK::120:60:40 kg ha^{-1}) + soil application of boron (in the form of borax)@ 15kg ha^{-1}, T_3 = application of RDF + soil application of boron @ 10kg ha^{-1} and T_4 = application of RDF + soil application of boron @ 7kg ha^{-1} in broccoli fields. Each treatment was replicated by using different farmer's field (having similar soil fertility including soil boron status and also receiving similar fertiliser application pattern) be fitting the statistical design. The results of the experiment revealed that the Treatment T_3 *i.e.* application of RDF + soil application of boron @ 10 kg ha^{-1} in broccoli fields gave better control of hallow stem disorder and the result was statistically significant. The plant height of broccoli was more (78.7 cm) but individual curd weight (843 g), yield (19.75 t ha^{-1}) and return per rupee invested (3.12) was recorded highest in T_3 *i.e.* application of RDF + soil application of boron @ 10 kg $ha^{-1}$and the result was statistically significant from other treatments. Highest curd weight was recorded in T_3which was statistically at par with T_2 treatment. The beneficial role of boron might be attributed to the better cell division, stabilization of plant tissues and improved plant and crop strength, translocation of sugar and nitrogen element in plant, improved uptake of phosphorus and potassium maintaining proper functioning and structure of cell membrane. Treatment T_2 failed to prove its superiority over T_3 due to the antagonistic effect of boron in high dose when applied in soil.

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Coarse Fragments Dilute Exploitable Soil Volume - Consequent Adjustments are Required for Soil Fertility Management

D.V.K. Nageswara Rao[1]*, M.D. Jessy[2], K. Surekha and R.M. Sundaram
[1]ICAR - Indian Institute of Rice Research, Hyderabad, 500030, Andhra Pradesh
[2]Rubber Research Institute of India, Kottayam, 686009, Kerala
**Email: dvknrao@gmail.com*

Soil, a three-dimensional natural body supporting plants, has variable proportions of solid, liquid, and gaseous phases. Higher surface area of fine earth, consisting of clay, silt, and sand influences soil fertility. Soils can have variable quantities of coarse fragments, diluting exploitable volume. It is thus required to assess agronomic impact of coarse fragments on soil fertility. Usually, a soil sample is passed through 2 mm sieve and the fine earth is analysed for nutrients while discarding coarse fragments thus concealing the real situation of nutrient availability. Consider two jars of similar volume, one filled with fine earth while the other one filled with 50% each of fine earth and gravel. Chemical analysis of fine earth will indicate similar quantity of an element, for example, % available phosphorus, in both jars. But can it be construed that phosphorus content is the jars is same? Can it be construed that the plants grown in these jars will receive similar supply of phosphorus? The answer is emphatic 'no', because of the dilution in exploitable actual soil volume in the jars, due to coarse fragments. Hence, the word, 'effective soil volume' (ESV) was introduced earlier to represent fine earth and pore space. Some literature on the importance of ESV is accumulated, including analysis of soil survey data of about one million hectares under rubber, to include ESV in fertilizer management. The practical application of this learning is evident by inclusion of 'gravel' layer in https://rubsis.rubberboard.org.in, which is based on applied remote sensing, geographical information system and geostatistical tools resulting in an effective fertilizer management. This concept is extendable to other crops, including rice grown in fields with considerable coarse fragments. When crops are reaching a plateau in production, it is required to think differently to identify the reason(s) and this is one such experience.

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Soil and Foliar Application of Molybdenum on Yield and Biochemical Quality of Greengram (*Vigna radiata* L.) Grown in an Fe Rich Inceptisols

Bandita Jena*[1], R.K.Nayak, S.Sahoo, R.Bhol[4], J.Das[2], S. Mohanty and S.Nayak

[1]Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
[2]Microbiology, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
[3]Department of Soil Science & Agricultural Chemistry, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
[4]Plant Physiology, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: bjena8763@gmail.com*

More than 70 % of soils of Odisha are acidic with dominance of Fe,Al where Mo deficiency in soils affects the yield of rabi greengram crops which is much below the national average. With this background an experiment was conducted by taking four soil application dose of molybdenum (0,250,500,750 g ha^{-1}) and two foliar spraying of molybdenum @0.1% Mo (F_1), 0.2% Mo (F_2) on green gram crop of variety IPM 02-14.The experiment was conducted on a light texture acidic sandy loam soil of central farm, OUAT, Bhubaneswar dominated by micronutrients like Fe, Mn deficient in molybdenum. It was found from results that growth attributing and yield attributing characters increased with increase in foliar spraying of molybdenum as well as combined application of foliar with soil application upto (250 g ha^{-1} soil with 0.2% foliar application) after which a decrease in all the attributes were observed. Highest significant seed yield of 549 kg ha^{-1} recorded by combined application of 250 g ha^{-1} soil with 0.2% foliar spraying of molybdenum treatment. Uptake of major nutrients NPK increased with highest uptake was observed at Mo_3F_2 dose and improvement in soil fertility observed in post harvest soil with a positive balance in availability of nitrogen after meeting the crop requirement was observed. Optimum molybdenum dose for green gram grown in poor fertile Fe rich acidic soil was at combined application of both soil an foliar spraying (250 g ha^{-1} soil with 0.2% foliar spraying of molybdenum).

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Optimum Boron Dose and Frequency for Rice-Vegetable Cropping System of Odisha

S. Mohanty, J. Das, Bandita Jena* and R.K. Nayak
Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: bjena8763@gmail.com*

Boron deficiency in light textured sanyloam soils under high rainfall affects the marketable quality of high value crops. Both deficiency and toxicity of boron creates many unfavourable nutrient interactions leading to yield loss .Finding a suitable sustainable profitable Boron application dose for a rice-vegetable cropping system.A field experiment was laid for 6 year by phasing application of 4 doses of Boron over different years such as every year, alternate year, once in 6 year to a rice-vegetable cropping system constituting 12 treatments with one no boron control. Results revealed that both rice and vegetable crop responded to Boron application with highest mean rice grain yield of 4.24 t ha^{-1} and followed by vegetable yield of 15.5 t ha^{-1} under residual condition with highest B:C ratio. Highest yield and response was obtained in the treatment of alternate year boron application @ 2.0 kg ha^{-1} $year^{-1}$ without any toxic effect or boron accumulation in post harvest soil followed by every year B applied@1.5 kg upto 6 year and sufficient boron getting converted to less labile pools to avoid toxicity under every year application. Farmers has the option to choose any of the method and periodicity of boron application according to available resources as well as the soil health. A small dose of 1.5 kg B every year or 2.0 kg B in alternate year is the best option with respect to enhanced yield of both direct and residual crop.

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Spectral Reflectance Pattern in Soybean for Assessing Nitrogen Content and its Use Efficiency under Long Term Fertilizer Experiment in Vertisol•

Pravin Vaidya[1]*, Mahanand Kumar[1], R.N. Khandare[1], G.U. Shande, A.U. Waikar and A.R. Deshmukh[2]

[1]Department of Soil Science, [2]NAHEP, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra

**Email: pravinamt@yahoo.com*

Hyper spectral images have found many applications in soil and water resource management in agriculture, environmental monitoring and prediction of nutrients by different vegetation indices like NDVI, GNDVI etc. However, different band images *i.e.* green, red, red-edge, and near-infrared wavelength bands taken by the parrot sequoia (Spectroradiometer) from soybean plant grown at Long Term Fertilizer Experiment at VNMKV, Parbhani and further being interpreted by using QGIS software and by this software, the calculation of different indices *i.e.* red normalized difference vegetation index (RNDVI), green normalized difference vegetation index (GNDVI), normalized difference red-edge index (NDRE), red-edge chlorophyll index (RECI) and normalized green red difference index (NGRDI) is being done at 30, 60, 75 DAS and at maturity of soybean crop from different treatment plot. The data obtained from it showed that when nitrogen fertilizer doses is being increased due to application of different amount of inorganic and organic fertilizer dose in the soybean plants. The Multi-Spectral Vegetation Indices values also increased consequently with it. Also, data showed that indices values are being higher during flowering and highest at mass flowering stages of soybean due to maximum nitrogen fixation at this stage and significantly decreased during maturity stages due to leaf senescence of soybean plant. The Maximum NC and NUF recorded with the application of 100 NPK + FYM @5 t ha^{-1} and 50% NPK (T1) respectively the lowest value of nitrogen use efficiency was observed in treatment N alone due to imbalance nutrient supply. The height correlation of NC, NUE and yield of soybean with RNDVI (r = 0.99,0.98 & 0.98 at 45, 60 and 75 DAS respectively), GNDVI (r = 0.99, 0.98 & 0.90 at 45, 60 and 75 DAS respectively) and GNDVI (r = 0.98 at maturity) respectively. This indicating spectral indices RNDVI may help to prediction of nitrogen content in soybean and GNDVI for estimation of NUE and yield of soybean in precision agriculture.

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Influence of Iron Nutrition on Soil Properties, Uptake and Yield of Soybean Grown on Iron Deficient Inceptisol

Bhimrao Kamble*, R.K. Meena, P.N. Gajbhiye, G.D. Patil, D.S. Potdar and V.N. Nale
Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth Rahuri, 413722, Maharashtra
**Email: bmkamble2007@rediffmail.com*

The present study was initiated with an objective to evaluate response of soybean crop to soil and foliar application of iron. The experiment was carried out at Agricultural Research Station, Kasbe Digraj, Dist. Sangli (MS) in iron deficient soil. The treatments comprised of application of NPK fertilizers in conjunction with 10 t FYM ha^{-1}, soil application of $FeSO_4$ @ 10 and 20 kg ha^{-1} with and without 0.2 per cent spray of chelated Fe. The results showed that the soil pH and electrical conductivity did not differ due to different treatments. The soil application of $FeSO_4$ @ 20 kg ha^{-1} + two foliar sprays of chelated Fe @ 0.2 per cent at 30 and 50 days after sowing (DAS) recorded significantly higher available N, P, DTPA Fe and total uptake of N, P, K, Fe, Mn, Cu, Zn by soybean over control treatment whereas, available K, DTPA Zn, Mn and Cu were found to be statistically non-significant due to different treatment of iron nutrition along with NPK fertilizers and organic manure. Significantly higher grain yield (24.93 q ha^{-1}), straw yield (37.79 q ha^{-1}) of soybean was recorded by soil application of $FeSO_4$ @ 20 kg ha^{-1} + two foliar sprays of chelated Fe @ 0.2 per cent at 30 and 50 DAS. Results concluded that the soil application of $FeSO_4$ @ 10 or 20 kg ha^{-1} is adequate for obtaining optimum soybean yield and sustaining soil fertility in an iron deficient, slightly calcareous Inceptisol soil.

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Organo Mineral Biochar and Bacillus Application Enhances *Cajanus Cajan* L. Growth and Yield in Low pH Soils by Augmenting Phosphorous Availability and Utility

Kannan Pandian*, S. Kavin, R. Indirani, R. Anandham and D. Krishnaveni
Department of Soil & Environment, Agricultural College & Research Institute,Tamil Nadu Agricultural University, Madurai, 625104, Tamil nadu
**Email: pandian.kannan@gmail.com*

The low soil phosphorous availability in low pH soil severely affected the red gram (*Cajanus cajan L.*) production. In low pH soil applied phosphorous get fixed as iron and aluminium phosphate complex, which is insoluble and inaccessible to plant roots. Increasing the availability and utility of applied P is essential to augment red gram yield. Chelation of P using organics widely adopted practice to enhance P availability. Recently biochar is being used as a soil conditioner, which has a great surface area, pores, pore-volume, and multifunctional groups. So, we intended to utilize the multifaceted property of biochar for increasing P nutrition to the red gram. We prepared organo mineral biochar and organo mineral phosphorous fertilizer using maize stalk biochar and Farmyard manure with Rock phosphate and single super phosphate. An experimental trial was laid out during Rabi 2020 and 2021 in a randomized block design replicated thrice to evaluate the effect of organo- mineral biochar phosphorous fertilizer and Bacillus megaterium var phosphaticum (PB-1) on phosphorous availability, utility, and yield of red gram (VBN3) under irrigated condition. The experimental soil is acidic with a sandy loam texture and low in available bray phosphorous (18 kg ha^{-1}). Application of rockphosphate enriched organo biochar @750 kg ha^{-1} and phosphobacteria 2 kg ha^{-1} recorded the greater soil available P (22.4 kg ha^{-1}) and uptake (21.8 kg ha^{-1}) which was 26 and 52 percent higher than rockphosphate alone application. The biomass phosphorous, microbial biomass carbon, Acid phosphatase and microbial load also showed a similar trend as that of soil available phosphorous. The same treatment combination registered a maximum seed yield of 1538 kg ha^{-1} and boosted the yield by 26 percent over superphosphate and gave the highest return of 2.2 rupees per rupee investment.

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Electrochemical Senior Based Soil Health Analysis for Real Time Fertilizer Management for Sustainable Crop Production

Kannan Pandian[1]*, J. Mathiyarasu, M. Bhavadharani, S. Ponmani[3], C. Suresh[3] and J. Kennedy[3]

[1]Department of Soil & Environment, Agricultural College & Research Institute, Tamil Nadu Agricultural University, Madurai, 625104, Tamil Nadu

[3]Electrodics & Electrocatalysis Division, Central Electrochemical Research Institute, Karaikudi, 630006, Kerala

**Email: pandian.kannan@gmail.com*

Soil is a store house of nutrients required by the plants to complete its life cycle. To increase the agricultural productivity in a sustainable way and feed the expanding global population, quick soil testing and site-specific nutrient management are essential. Presently, soil nutrients were analyzed by adapting standard method and various instrumental methods such as UV-Vis spectroscopy, molecular emission spectroscopy, atomic absorption spectrometry (AAS), flame emission spectroscopy (FES), inductively coupled plasma spectroscopy (ICP-MS), and nuclear magnetic resonance (NMR) spectroscopy. Unfortunately, these methods are often expensive and slow due to the extraction and pretreatment processes and also requires specific equipment and skilled personnel. Hence, new, effective, low-cost, rapid, accurate, user friendly and non-destructive methods of soil analysis are essential. Sensor based soil analysis is a recent approach is being used for soil health monitoring. A sensor is a device that transforms chemical information into an analytical signal. Sensors can be classified as physical, chemical, or biological sensors. In soil analysis, mostly chemical sensor and biosensor are employed. Chemical sensor is further categorized into an electrochemical sensor based on how they convert chemical signals into electrochemical signals. The electrochemical sensing combined with ion selective-membrane based transducers is an attractive approach to monitor soil parameters such as nitrate, phosphate, potassium and other soil parameters. In this study, a new electrochemical sensor was developed and used for analyze the soil nutrients. For extracting soil nutrients from soil, the use of multi-nutrient extractant is an effective and easy approach for extraction of maximum quantity of nutrients. For extraction, the soil and multi-nutrient extract was used in the ratio of 1:5. The results were compared with standard methods. The phosphorus showed very good correlation (R^2 = 0.81) and potassium showed moderate correlation (R^2 = 0.78) with standard methods. For nitrogen exhibited very less correlation with multi-nutrient extractant.

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Integrated Nutrient Management in Soybean-Wheat Cropping System on Inceptisol

Adinath Takate*
Mahatma Phule Krishi Vidyapeeth, Dist. Ahmednagar, Rahuri, 413722, Maharashtra
**Email: aditakate@gmail.com*

A long term field trial was conducted at AICRP on Integrated Farming System Research Farm, MPKV, Rahuri, with view to study the effect of integrated nutrient management on productivity of soybean-wheat cropping system, soil properties and nutrient uptake. The experiment was laid out in Randomized Block Design with twelve different integrated nutrient management treatments with four replications. The initial soil status having pH 8.16, EC 0.23 dS m^{-1}, organic carbon 0.63%, available N, P and K (175, 17 and 632 kg ha^{-1}). The higher grain yield of soybean (2961 kg ha^{-1}) and wheat (3371 kg ha^{-1}) and that of the system in terms of soybean grain equivalent yield (4395 kg ha^{-1}) was recorded under treatment 50% N through FYM + 50 % RDF followed by 75 % RDF during *Rabi* which was at par with 100% RDF in *kharif* and *Rabi*. The total nitrogen, phosphorus and potassium uptake (195,31 and 62 kg ha^{-1}) was significantly higher in 50% N: FYM + 50% RDF followed by 75% RDF which was at par with 100% RDF. While in case of wheat, total N, P and k uptake (75, 17 and 58 kg ha^{-1}) was recorded significantly higher in the treatment 50% N: FYM + 50% RDF followed by 75% RDF. The data on soil fertility revealed that, the organic carbon content was slightly increased in the treatments where organic sources were used and decreased where there was no use of organic sources. At harvest of soybean higher organic carbon, available N, P and K (0.78%, 230, 27 and 693 kg ha^{-1}) was observed in 50% N: FYM + 50% RDF followed by 75% RDF treatment. In *Rabi* same treatment recorded the higher residual organic carbon, available soil N, P and K (0.76%, 237, 26 and 690 kg ha^{-1}) respectively. The highest gross monetary returns, net returns with B:C ratio was recorded in the treatment involving use of 50% N through FYM + 50 % RDF followed by 75 % RDF during *Rabi* which was closely followed by treatment 100% RDF in both the seasons.

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Plant Nutrition Management with Foliar Fertilization to *Kharif* Onion in Entisol

Adinath Takate*
Mahatma Phule Krishi Vidyapeeth, Dist. Ahmednagar, Rahuri, 413722, Maharashtra
**Email: aditakate@gmail.com*

The field experiment was conducted on onion in *kharif* during the year 2020-21 at, Department of Soil Science and Agricultural Chemistry, MPKV, Rahuri, in order to study "Plant nutrition management with foliar fertilization to *kharif* onion in Entisol". The experiment was laid out in randomized block design, with nine treatments and three replications. The treatments were, T_1:Absolute Control, T_2 : GRDF (100 N : 50 P_2O_5 : 50 K_2O kg ha^{-1} + FYM @ 20 t ha^{-1}), T_3 : GRDF + foliar spray of silicic acid @ 0.2% ,T_4 : GRDF + foliar spray of 13:00:45 @1% ,T_5 : GRDF + foliar spray of 19:19:19 @ 1% ,T_6 : GRDF + foliar spray 0:52:34@ 1% , T_7 : GRDF+ foliar spray of 0:0:50 @ 1% ,T_8 : GRDF+ foliar spray of Potassium schoenite @ 1%,T_9 : GRDF + foliar spray of Micronutrient Grade II @1%. Foliar sprays was applied at 45 and 60 DAT to treatment T_3 to T_8 and for T_9 at 30 and 45 DAT. The results revealed that, the application of foliar sprays of 19:19:19 @ 1% along with GRDF recorded significantly higher bulb yield (23.57 t ha^{-1}) over rest of the treatments. Yield contributing characters like equatorial diameter, polar diameter, neck thickness, and average weight of onion bulb were improved significantly by application of 19:19:19 @ 1% at 45 and 60 DAT. Higher total nutrient uptake of N,P,K and S (48.33, 18. 32 55.34 and 20.03 kg ha^{-1}) and micro nutrients *viz.*, Fe, Mn, Zn, Cu and B (1603, 481, 441, 160 and 150 g ha^{-1}) also improved significantly by foliar application of 19:19:19 @ 1% at 45 and 60 DAT. Highest soil available nitrogen (164.6 kg ha^{-1}) after harvest was found in application of foliar sprays of 19:19:19 @ 1% at 45 and 60 DAT along with GRDF (100:50: 50 N: P_2O_5: K_2O kg ha^{-1}+ 20 t FYM ha^{-1}) and highest soil available phosphorus (16.26 kg ha^{-1}) was found to be in application of foliar sprays 0:52:34@ 1% at 45 and 60 DAT +GRDF (100:50: 50 N: P_2O_5: K_2O kg ha^{-1} + 20 t FYM ha^{-1}).Significant soil available potassium (361.5 kg ha^{-1})after harvest was found in application of GRDF+ Foliar sprays of 0:0:50 @ 1% at 45 and 60 DAT.

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Soil Test Crop Response Correlation Studies for Yield Targeting of Rajma Bean in Inceptisol

Vijay Kumar Patil*, Kranti Patil, D.S. Potdar and Ritu Thakare
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: vijayspatil67@gmail.com*

Soil Test Crop Response Correlation Study was conducted to formulate the yield target equations for Rajma bean *cv.* Phule Rajma under integrated plant nutrition system on Inceptisol. Fertilizer adjustment equations under IPNS were formulated for Rajma bean by following Ramamoorthy's inductive cum targeted yield model. The nutrients requirement to produce one quintal yield of Rajma bean were 7.04, 1.32 and 3.11 kg ha^{-1} N, P_2O_5 and K_2O, respectively. The per cent contribution from soil for Nitrogen, Phosphorus and Potassium were 40, 48, and 7 respectively. The contribution of fertilizer nutrients in absence and presence of organic manure (FYM) were 78.42 and 84.7 per cent for Nitrogen, 19.65 and 21.7 per cent for Phosphorus and 70.80 and 78.5 per cent for Potassium, respectively. The per cent contribution of organic manure were 25.1, 12.7 and 24.3 per cent for Nitrogen, Phosphorus and Potassium, respectively. The fertilizer prescription equations developed for Rajma bean by using above basic data.

Fertilizer prescription equations are as below.

Without Organic manure	With organic manure
$FN = 8.98 \times T - 0.51 \times SN$	$FN = 8.31 \times T - 0.47 \times SN - 1.48 \times FYM$
$FP_2O_5 = 6.74 \times T - 2.44 \times SP$	$FP_2O_5 = 6.10 \times T - 2.21 \times SP - 1.75 \times FYM$
$FK_2O = 4.39 \times T - 0.09 \times SK$	$FK_2O = 3.96 \times T - 0.08 \times SK - 1.86 \times FYM$

Where, FN, FP_2O_5 and K_2O is fertilizer N,P_2O_5 and K_2O in kg ha^{-1}, T is yield target (q ha^{-1}) and SN,SP and SK are soil available N,P and K in kg ha^{-1} and FYM is Farm Yard Manure in t ha^{-1} (Fresh weight basis).

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Evaluation of Methods Zinc Application for Zn Enhancement in Wheat

Avinash Gosavi*, Ganesh Pawar and Abhay Patil
Mahatma Phule Krishi Vidyapeeth, Dist. Ahmednagar, Rahuri, 413722, Maharashtra
**Email: gosaviavi@rediffmail.com*

Zn deficiency affects more than one-third of the human population in the world. A close relationship exists among soils, crops and human health nutrition. In this context, the research was undertaken to study the effect of zinc application methods for yield and quality of wheat grown on Inceptisol. The trial was conducted at Agricultural Research Station, Niphad, Dist. Nashik, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The soil application of $ZnSO_4$ @ 20 kg ha^{-1} + sprays of Zn EDTA (0.2 %) at tillering and milking stage with Recommended Dose of Fertilizers (RDF) produced significantly higher grain (48.69 q ha^{-1}) (18.43 % higher over RDF) and straw yield (64.73 q ha^{-1}). This also resulted into significantly higher total nitrogen uptake (148.46 kg ha^{-1}) and potassium uptake (100.86 kg ha^{-1}) of wheat while application of recommended dose of fertilizers (120:60:40 N:P_2O_5:K_2O kg + 10 t FYM ha^{-1}) resulted into higher phosphorus uptake (27.24 kg ha^{-1}). Sprays of Zn EDTA (0.2 %) at tillering and milking stage along with RDF significantly increased the Fe uptake (425.96 g ha^{-1}). Mn uptake (310.82 g ha^{-1}) was significantly higher due to soil application of $ZnSO_4$ @ 20 kg ha^{-1} + sprays of Zn EDTA (0.2%) at milking and dough stage along with RDF. The soil application of $ZnSO_4$ @ 20 kg ha^{-1} + sprays of Zn EDTA (0.2%) at tillering and milking stage along with RDF resulted into significantly higher Cu (42.39 g ha^{-1}) and Zn (239.73 g ha^{-1}) uptake. The soil application of $ZnSO_4$ @ 20 kg ha^{-1} + sprays of Zn EDTA (0.2%) at tillering and milking stage with RDF resulted into significantly higher protein (13.42 %), protein yield (648 kg ha^{-1}), gluten (12.96%) and grain zinc content (51.03 mg kg^{-1}) while the hectoliter weight (81.41 kg h^{-1}) of wheat was significantly improved due to soil application of $ZnSO_4$ @ 20 kg ha^{-1} + sprays of Zn EDTA (0.2 %) at milking and dough stage with RDF.

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Effect of Integrated Phosphorus Management on Yield and Nutrient Uptake by Mustard (*Brassica juncea* L.) and Soil Fertility

Deepak Potdar*, V.N. Nale, H.S. Purohit, B.M. Kamble and G.D. Patil
Mahatma Phule Krishi Vidyapeeth, Dist. Ahmednagar, Rahuri, 413722, Maharashtra
**Email: ds_potdar@rediffmail.com*

Field experiment was conducted at Rajasthan College of Agriculture, Udaipur (Raj.) to study the effect of integrated phosphorus management on Mustard yield, nutrient uptake and soil fertility. The experiment was laid out in split plot design with four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5 ha^{-1}), two levels of FYM (0 and 5 t ha^{-1}) and four levels of microbial inoculum (no inoculum, Phosphate solubilizing biofertilizers, Vesicular arbuscular mycorrhiza and PSB + VAM). The result revealed that the application of 60 kg P_2O_5 ha^{-1}, 5 t FYM ha^{-1} and PSB + VAM inoculation significantly enhanced the seed yield, straw yield and oil yield of mustard over respective control. Integrated application of 60 kg P_2O_5 ha^{-1} + 5 t FYM ha^{-1} reported significantly higher seed and oil yield. The maximum and significantly higher uptake of N, S, Zn, Fe, Cu and Mn was recorded with application of 60 kg P_2O_5 ha^{-1} + FYM @ 5 t ha^{-1}. Combined application of 40 kg P_2O_5 ha^{-1} + FYM @ 5 t ha^{-1} and FYM @ 5 t ha^{-1} + dual inoculation of PSB+VAM showed significantly higher available phosphorus after harvest of mustard. Integrated application of 40 kg P_2O_5 ha^{-1} + 5 t FYM ha^{-1} alongwith dual inoculation of PSB+VAM recorded the higher B:C ratio (1.42) indicating saving of 20 kg P_2O_5 ha^{-1}.

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Evaluation of N, P and K Fertigation Applied Alone and in Combination for Best Alternative at Varying Irrigation Levels for Suru Sugarcane under Subsurface Drip

Chandrakant Palwe*, P.G. Popale, S.A. Kadam and S.D. Gorantiwar
Department of Soil Science & Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: crpalwe@rediffmail.com*

A field experiment on NPK fertigation alone and in combination on productivity of suru sugarcane *var. COM-265* under varying irrigation levels for subsurface drip was conducted for three years in split plot design at MPKV, Rahuri. The experiment was replicated thrice, with four drip irrigation levels *viz.*, I_1: 40% ETc, I_2: 60% ETc, I_3: 80% ETc, I_4: 100% ETc and seven fertigation levels *viz.*, 80 % N in 30 splits with P and K as basal, 80% N and P in 30 splits with K as basal, 80% N and K in 30 splits with P as basal, 80% N, P and K in 30 split, 80% of NPK through fertigation in 26 splits with basal dose, RDF (Band placement + surface) as a control and No fertilizer (absolute control). The soil was neutral to alkaline in reaction, low in soluble salts, O.C., available nitrogen, phosphorus and high in available potassium. The pooled results revealed that amongst, the irrigation and fertigation treatments, the maximum yield was observed in treatment I_4 (130.73 t ha^{-1}) and F_4 (107.89 t ha^{-1}) which was significantly superior over all remaining irrigation and fertigation treatments. The maximum yield in treatment I_4 was followed by I_3 (117.72 t ha^{-1}), I_2 (90.08 t ha^{-1}) and I_1 (59.58 t ha^{-1}), respectively. The maximum yield of F_4 (107.89 t ha^{-1}) was followed by fertigation treatments F_5 (101.45 t ha^{-1}), F_3 (98.59 t ha^{-1}), F_2 (97.13 t ha^{-1}) and F_1 (92.56 t ha^{-1}), respectively. The interaction effect was found significant with treatment I_4F_4 (135.93 t ha^{-1}) which was at par with treatment I_3F_4, 80% ETc and 80% NPK through fertigation (132.48 t ha^{-1}) and was significantly superior over all remaining treatments. The water requirement of sugarcane was noticed highest in I_4 (100% ETc) treatment (132.71 cm) and lowest requirement was noticed in I_1 (40% ETc) treatment (66.11 cm). The maximum water use efficiency (1066.11 kg ha cm^{-1}) was recorded in I_3 (80% ETc) followed by I_2 (1022.94 kg ha cm^{-1}), I_4 (985.08 kg ha cm^{-1}) and I_1 (901.23 kg ha cm^{-1}), respectively. The maximum water saving was observed in I_1 (40% ETc) 50.18% followed by I_2 (33.64%), I_3 (16.80%), respectively. Hence, it is observed that the I_4F_4 recorded highest yield (135.93 t ha^{-1}) and monetary returns (Rs. 185888/- ha^{-1}) along with B:C ratio (2.18) with no water saving, however, the I_3F_4 recorded 132.48 t ha^{-1} yield which was at par with I_4F_4 with 16.80% water saving, highest monetary returns (Rs. 214637/- ha^{-1}) and B:C ratio (2.13), respectively.

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Response of Rice to IFFCO Nano Formulations

Rajeev Sikka*, Anu Kalia, S.S. Dhaliwal and Radha Ahuja
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: sikkar@pau.edu*

In modern agriculture, there is a need for a more innovative fertilizer approach that can increase the productivity of agricultural systems and more environmental friendly than synthetic fertilizers., Adoption of nano technology based nutrient application to plants might lend a hand in reducing use of chemical fertilizers as nano nutrient may fulfil the need for higher nutrient mobility and efficient fertilization in plants by delivering nutrients directly into plants and facilitate smart uptake. Therefore, the present study was conducted for two years to evaluate the effects of foliar application of IFFCO nano urea, IFFCO nano Cu and IFFCO nano Zn (in different combinations with recommended dose of fertilizers) on the performance of rice. The field experiment was carried out at Research Farm, PAU, Ludhiana during Kharif seasons of 2020 and 2021. The experiment was laid out in randomized complete block design with 10 treatments in three replications. During 1st year of investigation, highest grain yield was recorded under 100 % recommended dose of fertilizers (RDF) (PAU protocol) treatment (71.73 q ha^{-1}) which was statistically at par with that obtained under 100% NPK+ 50% RD Zn + Nano Zn (71.23 q ha^{-1}) treatment but was significantly higher than that obtained under 50% RDN + 2 sprays of nano N (IFFCO protocol) treatment. Similar results were recorded during 2nd year, where treatment100% NPK+ 50% RD Zn + Nano Zn resulted in highest grain yield (78.66 q ha^{-1}) which was statistically at par with that obtained under 100% RDF treatment (78.64 q ha^{-1}). During both years, there was significant reduction of 17.28 and 9.12% in grain yield under 50% RDN + 2 sprays of nano N (IFFCO protocol) treatment compared with 100% RDF treatment. Nitrogen uptake also followed the same trend with highest observed in 100% RDF treatment.

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Productivity of Wheat as Influenced by Foliar Spray of IFFCO Nano Urea

P. Chaitra*, Rajeev Sikka and Anu Kalia
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: sikkar@pau.edu*

A field experiment was conducted to evaluate the effect of foliar spray of IFFCO nano urea on the performance of wheat (var. Unnat PBW 550) during *rabi* 2020-21 at the Research Farm, Department of Soil Science, PAU Ludhiana in split plot design with four main plots and four subplots. In main plots 0, 50, 75 and 100 per cent recommended dose of nitrogen was applied to soil and in subplots the four treatments were foliar spray of 4 ml l^{-1} (IFFCO RECOMMENDED PROTOCOL) 6 ml l^{-1}, 8 ml l^{-1} nano urea and 2% urea. All the treatment combinations were replicated thrice. All other package of recommendation were followed to grow wheat crop till maturity. Yield and yield parameters were recorded. The yield of wheat was significantly affected by graded levels of nitrogen application. The minimum yield was recorded in control where no nitrogen was applied (24.3 q ha^{-1}) and highest mean wheat yield was recorded where 100 per cent of nitrogen was applied (50 q ha^{-1}) overall there was successive and linear increase in wheat yield with increase in levels of applied nitrogen. There was 31.40% decrease in grain yield of wheat in 50% basal application of nitrogen plus two sprays of nano urea treatment (36.24 q ha^{-1}) as compared to 100% RDF treatment (52.83 q ha^{-1}). The straw yield and yield attributing characters also followed the same trend. Maximum spike length, spike weight, grain weight/spike, number of grains/spike and 1000 grain weight was observed in the treatment where 100% recommended nitrogen was applied to soil which was significantly better than all other treatments. No significant influence was observed on soil characters recorded after harvest of the crop. It may therefore be concluded that foliar spray of IFFCO nano urea along with 50% basal nitrogen is inferior in terms of wheat productivity.

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Effect of Vermicompost and Organic Formulations on Growth and Yield of Soybean Grown on Vertisol

Priyanka Lokhande* and A.L. Dhamak
Department of Soil Science and Agricultural Chemistry, College of Agricultre, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani, 431402, Maharashtra
**Email: priyankalokhande0704@gmail.com*

The field experiments were conducted at Research Farm, Department of Soil Science and Agril. Chemistry, College of Agriculture, VNMKV Parbhani, during *kharif*-2020 and *kharif*-2021 to study the effect of vermicompost and organic formulations on growth and yield of soybean grown on Vertisol. The experiment was laid in factorial randomized block design with twelve treatments and three replications. Experimental treatments consist of two factors in which one factor consist of vermicompost consist of three levels C_1 - RDF, C_2 - Vermicompost eq. to RDN, C_3 - Vermicompost eq. to RDN + RD of vermicompost @ 5 t ha^{-1}, another factor organic formulations consist of four levels OF_0- control, OF_1- Pancahgavya, OF_2- Beejamruth + Jeevamruth, OF_3 - Beejamruth + Jeevamruth + Pancahgavya. The growth parameters like leaf area, number of pods and chlorophyll a, chlorophyll b and total chlorophyll showed significant increased with the application of RDF as compared to other treatments. Among organic formulations treatments highest value recorded in combined application of Beejamruth + Jeevamruth + Pancahgavya (OF_3) as compared to alone application. The significant increase in seed and straw yield recorded in treatment receiving of RDF (C_1) along with combined application of Beejamruth + Jeevamruth + Pancahgavya (OF_3). The result of the experiment revealed that application of RDF along with combined application of Beejamruth + Jeevamruth + Pancahgavya was found beneficial for increase in growth and yield of soybean grown on Vertisol during *kharif* season.

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Appraising P Release by PSM in Soils Having Varying Soil Test Phosphorus

Pravin Gajbhitye*, Smita Kabali, B.M. Kamble and G.D. Patil
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: npraving@rediffmail.com*

The ability of PSM to transform insoluble organic and inorganic phosphorus is associated with, the nutritional richness of the soil. The present investigation was aimed to evaluate the P release in soils having different soil test P values. The experiment comprised of twelve treatments replicated thrice and tested using RBD design. Three soils having high, medium and low soil test P were evaluated for P release using PSM with and without FYM. At 0, 15, 30, 45 and 60 DAI the soil pH, EC, organic carbon and $CaCO_3$ was found to be non-significant during incubation. However, $CaCO_3$ registered a slight decline after 30, 45 and 60 days. In inherently high soil test P soil, treatment receiving PSM consortia + FYM (T_4) showed significant highest Olsen's P at 30 and 45 DAI which was at par with T_3 (without FYM). Irrespective, of native soil test P, all the soil revealed higher Olsen's P at 30 and 45 DAI due to PSM + FYM as compared to other treatments. DHA was found to be significantly highest in T_4 at 30, 45 and 60 DAI over all the other combination treatments nevertheless; it was at par with $T_8$and T_{12}. The alkaline phosphatase activity was generally high in soil having high soil test P. Significantly highest alkaline phosphatase activity was observed in T_4 (High P + PSM + FYM) which at par with T_8 (Medium P + PSM + FYM) at 15, 30 and 45 DAI. The native soil P content had a role to play in solubilizingPdue to PSM as low P soils exhibited significantly lesser phosphatase activity. PSM consortia has played vital role in improving soil P availability, it was indeed more pronounced in medium P status soil as compared to high or low P status soil.

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Nutrient Composition of Vermicompost as Influenced by Different Substrates

Anand Jadhav*, A.B. Gosavi and A.V. Patil
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: abjadhav1234@rediffmail.com*

An experiment was conducted to assess the nutrient composition of vermicompost as influenced by different substrates at Soil Science and Agricultural Chemistry, College of Agriculture, Pune during winter 2021. The object of this experiment is to assess the nutrient composition in vermicompost prepared by using rain tree litter and wheat straw spent mushroom compost (WSSMC). Different proportions of rain tree litter and wheat straw spent mushroom compost was used for the production of vermicompost. HDPE Vermibeds of size 12 × 4 × 2 feet were used for this study. The treatment consisted of 25% rain tree litter (RTL) + 75% wheat straw spent mushroom compost (WSSMC), 50% tree litter + 50% wheat straw spent mushroom compost (WSSMC), 75% tree litter + 25% wheat straw spent mushroom compost (WSSMC), 100% rain tree litter, 100% wheat straw spent mushroom compost (WSSMC) replicated thrice in completely randomized block design. Vermibeds (20) were installed as per the treatments by using bamboo supports. All the required quantity of raintree litter and wheat spent mushroom compost were partially allowed to degrade aerobically for 45 days and thereafter used for vermicomposting. The vermibeds were filled layer wise as first with 10-15 cm layer of dry leaves at bottom second layer of cow dung @ 30 kg uniformly spread third with 15-20 cm layer of partially decomposed substrates and last layer with cow dung slurry with decomposing culture (40 kg cow dung + 100 lit + 1 kg decomposing culture) was sprinkled. Similar layering was carried out for both the substrates and allowed for decomposition. It could be concluded that vermicompost prepared from 100% rain tree litter was found significantly higher for total N (2.28%), P (1.03%), K (1.9%), Fe (11.5 ppm), Mn (3.8 ppm), Zn (1.3 ppm) and Cu (2.5 ppm) with C:N ratio 13.36 than rest of the substrate combinations. However, wheat straw spent mushroom compost (WSSMC) reported total N (1.68%), P (0.85%), K (1.29%), Fe (8.5 ppm), Mn (1.8 ppm), Zn (1.1 ppm) and Cu (1.6 ppm) with C:N ratio 27.97. Vermicompost prepared by using 100% rain tree litter required less period (78 days) than that of 100% wheat straw spent mushroom compost (WSSMC) (85 days).

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Effect of Cattle Urine and Nitrogen Levels on Growth, Nutrient Uptake and Yield of Wheat Grown in Inceptisol

Abhay Patil*, A.B. Jadhav, S.V. Khatate and D.H. Phalke
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: patilssac1978@gmail.com*

The experiment was conducted to study the effect of cattle urine and nitrogen levels on growth, nutrient uptake and yield of wheat in Inceptisol at Division of Soil Science and Agricultural Chemistry and Animal Husbandry and Dairy Science, College of Agriculture, Pune during *Rabi* 2018. The experiment was conducted with three levels of nitrogen (0, 75 and 100%) through urea and five levels of cattle urine spray (CUS) (0, 2.5, 5, 7.5 and 10%) (20, 40 and 60 days after sowing (DAS)) replicated thrice in Factorial Completely Randomized Design. It could be concluded that interaction effect of 75% N through urea along with 7.5% cattle urine foliar sprays (at 20, 40, 60 DAS) recorded significantly higher plant height, number of tillers, number of functional leaves, leaf length, leaf width, chlorophyll content at 30, 50 and 70 DAS of wheat. Similar significant interaction effect with similar treatment were also recorded for spike length, number of spikelets per spike, number of grains per spike, test weight of wheat. Combine application of 75% N through urea along with foliar spray of cattle urine @ 7.5% taken at 20, 40 and 60 DAS reported significantly higher grain (87.67 g pot^{-1}) and straw (114.50 g pot^{-1}) yield of wheat. Nitrogen (3.08 gm pot^{-1}), phosphorus (1.12 gm pot^{-1}) and potassium (3.72 gm pot^{-1}) uptake by wheat was also found significantly higher with the application of 75% N through urea than 100% N application. While three foliar spray of cattle urine @7.5% taken at 20, 40 and 60 DAS recorded significantly nitrogen (3.15 gm pot^{-1}), phosphorus (1.09 gm pot^{-1}) and potassium (3.54 gm pot^{-1}) uptake by wheat. But interaction effect for combined application was found non significant for the uptake of nitrogen, phosphorus and potassium.

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Assessment of Plant Enzyme Activities and Yield of Different Sugarcane Genotypes Grown in Sodic Soil

Abhay Patil*, A.L. Pharande, A.G. Durgude, A.B. Jadhav and A.B. Gosavi
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: patilssac1978@gmail.com*

A field experiment was conducted to assess the plant enzyme activities in sugarcane genotypes grown on sodic soil during the preseason of 2015-16 at Post Graduate Instructional Farm, Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in randomized block design comprising 27 sugarcane genotypes with two replications. The experimental soil was clay fine montmorillonite, isohyperthermic family of *Sodic Calciustert* and calcareous in nature with pHs 8.64, ECe 3.56 dS m^{-1}, exchangeable sodium percentage (ESP) 18.68 with high cation exchange capacity (CEC) 52.29 C mol (p+) kg^{-1} having swell-shrink property and categorized as sodic soil. Enzyme activities *viz*., ascorbate peroxidase (APX), superoxide dismutase (SOD), nitrate reductase (NRA) and lipid peroxidase (LPO) along with chlorphyll content were assayed at 75 and 240 days after planting (DAP). The NR activity was found significantly higher in the sugarcane genotype CoM 0265 (0.86 and 0.74 µ Mole nitrite produced g^{-1} fr. wt. hr^{-1}) which was followed by MS 6847 (0.84 and 0.72 µmole nitrite produced g^{-1} fr. wt. hr^{-1}) and MS 10001 (0.79 and 0.68 µMole nitrite produced g^{-1}fr. wt. hr^{-1}) at 75 and 240 DAP respectively. The sugarcane genotypes *viz*., CoM 0265, MS 6847 and MS 10001 recorded higher activity of APX at 75 DAP (2.84, 2.77 and 2.58 µmole ascorbate oxidized mg^{-1} protein min^{-1} respectively) and at 240 DAP (2.62, 2.52 and 2.38 µmole ascorbate oxidized mg^{-1} protein min^{-1} respectively). Further, the SOD activity in MS 6847, Co 99004 and CoM 0261 were higher at 75 DAP (8.64, 7.86 and 7.85 units mg^{-1} protein respectively) and at 240 DAP (6.95, 6.71 and 6.88 units mg^{-1} protein respectively) than rest of the genotypes. However on the contrary, LPO activity (membrane damaging enzyme) was recorded statistically lower in CoM 0265, MS 6847 and MS 10001 at 75 DAP (0.97, 1.08 and 1.18 µmoles MDA g^{-1} fr. wt.) and at 240 DAP (0.81, 0.91 and 0.99 µmoles MDA g^{-1} fr. wt.) respectively. Significantly higher chlorophyll content was also recorded by CoM 0265 and MS 6847 than rest of the genotypes. The higher cane and commercial cane sugar yield was recorded by CoM 0265 (164.70 and 21.90 MT ha^{-1}), while at par results were obtained by MS 6847 (131.90 and 14.58 MT ha^{-1}), CoM 10051 (128.27 and 15.86 MT ha^{-1}) and MS 10001 (100.91 and 14.84 MT ha^{-1}).

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Response of Macro and Micro Nutrients Applied Through Foliar Spray on Yield and Quality of Groundnut (*Arachis hypogaea L.*)

Anil Bulbule*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: avbulbule@rediffmail.com*

An experiment was conducted at Post Graduate Research Farm, College of Agriculture, Kolhapur during Kharif season to study the effect of foliar application of macro and micro nutrients applied to groundnut. The treatments comprised of foliar treatments of GRD + water spray, GRD + 19:19:19 spray (2%), GRD + $Ca(NO_3)_2$ spray (2%), GRD + Micro. gr.II spray (0.25%) and GRD + Schoenite spray (1%), respectively. The foliar sprays were applied to the crop at 45 and 60 DAS. Findings revealed that foliar spray of $Ca(NO_3)_2$ applied at 2% at 45 and 60 DAS has significant effect on yield and yield attributes of groundnut crop. It recorded highest pod, kernel and haulm yields (32.6, 22.36 and 39.1 q ha^{-1}) respectively. The yields obtained were at par with the treatment foliar spray of 2% of 19:19:19 (29.9, 20.40 and 38.0 q ha^{-1}, respectively was significantly superior over 0.25% Micro. gr. II spray, 1% Schoenite spray and water spray. The highest oil yield was recorded by the treatment of 2 % $Ca(NO_3)_2$ spray (1016 kg ha^{-1}) which was at par with the foliar spray treatment of 2% 19:19:19 spray (924 kg ha^{-1}) respectively. While the the oil content as influenced by the different foliar spray treatments was non-significant. The shelling percentage was found to range between 67-69% however the effect of various treatments on shelling percentage was observed to be non-significant. The observations on plant height, number of nodules, uptake of macro and micro nutrients was found to reveal similar trend.

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Economising Phosphorus Use in Maize - Effect of Various Phosphorus Fertilisers

S. Meena*
Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
**Email: meenus_69@yahoomail.com*

A field study was carried out to investigate the effect of the application of three sources of phosphorus (P) *viz.*, SSP @ 100% Recommended Dose of Phosphorus (RDP), Enriched FYM with Rock phosphate (RP) @ 75% RDP, RP @ 75% RDP + humic acid, RP @ 75% RDP + Phosphobacteria and Chitosan coated DAP @ 75% RDP on maize. The field experiment with maize (Co 8) was conducted in a farmer's holding at Kariampalayam village, Annur taluk, Coimbatore district in a soil of medium phosphorus status. Rock Phosphate was incubated with FYM (750 kg ha^{-1}) for 45 days and applied. DAP was coated with chitosan @ 2% before application. Liquid chitosan was used for coating DAP and was sprayed on the fertilizer granule surface in the rotary pan granulator and dried. All the treatments received a uniform application of N and K (250: 75 kg N and K_2O) as urea and muriate of potash respectively. The recommended dose of P_2O_5 for maize was 75 kg ha^{-1}. The maize crop was raised from Jan. 2020-May 2020. The grain yield of maize was significantly influenced by the treatments. The highest grain yield of 7686 kg ha^{-1} was recorded by the treatment applied with SSP @ 100 %RDP and was comparable with chitosan-coated DAP @ 75% RDP (7256 kg ha^{-1}). The highest P uptake was recorded by SSP at @100% RDP followed by chitosan-coated DAP (75% RDP). Chitosan-coated DAP treatment recorded the highest response ratio (130 kg grain kg^{-1} P_2O_5 applied) and percent P recovery (41.26 kg P uptake / P_2O_5 applied). So, for medium phosphorus status soil application of chitosan-coated DAP @ 75% recommended dose of phosphorus (RDP) is comparable with SSP @ 100% RDP.

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Effect of Soil and Foliar Applications of Humic Acid on Yield and Soil Fertility Status After Harvest of Brinjal

Prerana Bhosale*, V.S. Supe and Prerana Bhosale
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: bhosale.pip@gmail.com*

The field experiment on " Effect of soil and foliar applications of humic acid on yield and soil fertility status after harvest of Brinjal" conducted consequently three years *viz*., 2017-2018, 2018-19 and 2019-2020 with 11 treatments on same site at Research Farm of Zonal Agriculture Research station, Ganeshkhind, Pune. The initial soil samples were collected from the experimental field and analyzed the initial chemical properties. The texture of the soil was sandy loam. The field experiment was laid out in Randomized Block Design (RBD) and consisted of eleven treatments.Among the 11 treatments T_5 GRDF + humic acid @ 30 kg ha^{-1} surpassed other treatments by achieving the highest fruit yield (39.97 t ha^{-1}) per hectare The pooled yield of brinjal ranged from 25.26 to 39.97 t $ha^{-1}$of various treatment of humic acid alogwith GRDF. The total uptake nitrogen (96.76 kg ha^{-1}), phosphorous (31.57 kg ha^{-1}) and potassium (105.26 kg ha^{-1}) was significantly superior by the application of treatment T_5 GRDF + humic acid @ 30 kgha^{-1} rest of all the treatments. The organic carbon content in soil significantly increased in treatment of T_2 to T_{11} (0.60%). The highest available nitrogen (276.7 kg ha^{-1}) was recorded in T_5 treatments GRDF + humic acid @ 30 kg ha^{-1}, which was at par with T_4 (273.9 kg ha^{-1}), T_3 (271.0 kg ha^{-1}), T_8 (266.2 kg ha^{-1}), T_9 (265.8 kg ha^{-1}), T_{10} (269.7 kg ha^{-1}) and T_{11} (266.2 kg ha^{-1}). The significantly maximum available phosphorous (29.87 kg ha^{-1}), available potassium (416.9 kg ha^{-1}), observed in T_5 treatments GRDF + humic acid @ 30 kg ha^{-1}. The available potassium (416.9 kg ha^{-1}), was significantly highest by the application of treatment T_5 GRDF + humic acid @ 30 kg ha^{-1}.

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Effect of Split Application of Nitrogen, Phosphorous and potassium on Yield and Economics of Soybean on Inceptisol

Bhanudas Rathod*, Bhanudas Rathod, S.R. Patil and A.G. Durgude
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: rathd.bg@rediffmai.com*

The field experiment on soybean grown on Inceptisol was laid out in a randomized block design with the nine treatments and three replications at Central Research Farm of PGI MPKV; Rahuri. The results revealed that, the growth parameters *viz*., plant height, number of branches per plant, root nodule counts were significantly influenced by split application of NPK to soybean. The significantly highest plant height (80.60 cm), number of branches (12.20) and root nodule counts (19) were observed in treatment T^6 (application of 50:75:25 kg ha^{-1} in two splits-50% N,P_2O_5 and K_2O at sowing and 30 DAS which was at par with treatment T_7 The total uptake of NPK by soybean and available nutrient in soil were significantly influenced by the split application of NPK and maximum total uptake and available of NPK in soil at harvest was observed in the treatment T_7 and it was at par with treatment T_6. The treatment T_7 (application of 50:75:50 kg ha^1 in two splits-50% N,P_2O_5 and K_2O at sowing and 30 DAS) were recorded the highest number of pods per plants (51.73), grain yield (34.53 q ha^{-1}) and stover yield (44.04 q ha^{-1}) which was at par with treatment T_6. The B:C ratio of soybean cultivation under treatments of split application of NPK was found maximum (2.85) in the treatment T_6 followed by treatments T_7 (2.80) and T_8 (2.27). Thus, application of 50:75:25 kg ha^{-1} in two splits-50% N, P_2O_5 and K_2O at sowing and 30 DAS was proved to be profitable for soybean cultivation on Inceptisol.

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Effect of Nutrient and Beneficial Sources on Yield, Nutrient Content and Uptake by Rice

Avadhut Walekar*, S.S. More, M.C. Kasture and S.S. Patil
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: avadhutwalekar96@gmail.com*

The pot culture experiment was carried out to evaluate the impact of different nutrient and beneficial sources on yield, nutrient content and uptake by rice. The experiment was laid out in FCRD design and replicated thrice. The first factor comprised nutrient sources application consisted RDF (100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1}) through chemical fertilizers, 100 kg N ha^{-1} through vermicompost and RDN through Konkan Anapurna Briquettes (KAB) (34:14:6 $N:P_2O_5:K_2O$). The second factor denoted beneficial sources application viz. control, silica @ 150 kg ha^{-1}, azolla @ 1 t ha^{-1}, rice husk biochar @ 5 t ha^{-1} and potassium sulphate @ 50 kg ha^{-1}. The results showed that, grain yield of rice significantly improved by sole application of RDF through chemical fertilizers and silica @ 150 kg ha^{-1}; whereas straw yield by rice husk biochar @ 5 t ha^{-1}. The phosphorous, potassium and silicon content was significantly influenced in grain and straw by application of RDF through chemical fertilizers and KAB respectively. The nitrogen and silicon content in straw was improved by silica @ 150 kg ha^{-1}, while azolla @ 1 t ha^{-1} enhanced phosphorous and potassium content in grain. The RDF through chemical fertilizers significantly improved total uptake of phosphorous, potassium and silicon. The total nitrogen uptake recorded significant by KAB application. Total nitrogen and silicon uptake improved by silica as well as biochar application; whereas azolla @ 1 t ha^{-1} enhanced total uptake of phosphorous and potassium.

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Yield and Nutrient Content of Rice Influenced by Different Levels of Nitrogen and Silica in Lateritic Soils of Konkan

H.D. Rane*, N.B. Gokhale, M.C. Kasture, S.S. More, A.A. Dademal and A.A. Walekar
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: avadhutwalekar96@gmail.com*

The study was intended to evaluate the effect of different levels of nitrogen and silica on nutrient content and yield of rice in lateritic soils of Konkan region of Maharashtra. The experiment laid out with factorial randomized block design with two factors and three replications. Four levels of each nitrogen and silica were applied in the form of Konkan Annapurna Briquettes (KAB) (34:14:06 $N:P_2O_5:K_2O$) and potassium silicate respectively. The nitrogen was applied at 0, 40, 60 and 80 per cent of the recommended dose (100 kg N ha^{-1}) along with silica at 0, 50, 75 and 100 kg ha^{-1}. The significantly highest grain yield (35.99 q ha^{-1}) and straw yield (48.24 q ha^{-1}) were recorded with application of 80 per cent RDN through KAB. The silica application at 100 kg ha^{-1} recorded significant results in relation to grain yield of rice. The maximum N content at 30 DAT, at 60 DAT and at harvest in straw and grain was found by 80 per cent RDN was applied through KAB and 100 kg silica ha^{-1}. Similarly the highest phosphorous as well as potassium content inn straw at 30 DAT, 60 DAT and at harvest as well as in grain was recorded by highest level of nitrogen and silica application. The application of N @ 80 per cent and silica @ 100 kg ha^{-1} significantly improved silica content in straw and grain. Therefore it is concluded that, application of 80 per cent nitrogen through KAB along with 100 kg silica through potassium silicate significantly improved yield and nutrient content in rice with effective saving of 20 per cent nitrogen application.

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Response of Different Levels of Silica on Growth and Yield of Rice in Lateritic Soils of Konkan

S.S. More, M.C. Kasture, A.A. Dademal and A.A. Walekar*
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: avadhutwalekar96@gmail.com*

To evaluate the effect of silica application and soil silica status on growth and yield of rice, 3 year pot culture experiment was carried out using lateritic soils of Konkan region. The experiment consisted 18 treatment combinations laid out in F-CRD design and replicated twice. The first factor comprised with different silica levels *viz*. 0, 50, 75, 100, 125 and 150 kg silica ha^{-1} through potassium silicate. Whereas, second factor consisted different types of soils indicated low, medium and high available silica content, collected from different locations of Konkan region. The pooled data of trials revealed that, significant highest grain yield (47.00 q ha^{-1}) and straw yield (62.86 q ha^{-1}) was recorded by silica application @ 150 kg ha^{-1} (Si_{150}). The soil with high silica content (L_3) reported highest for grain (45.01 q ha^{-1}) and straw yield (58.22 q ha^{-1}). The treatment combination consisting 150 kg silica application and high silica content of soil observed highest (49.72 q ha^{-1}) for grain yield. The pooled data regarding plant height and number of tillers at harvest stage of rice stated that, significantly highest plant height (123.22 cm) and highest number of tillers (28.75) was observed by Si_{150} treatment application. Amongst different silica status, the high silica containing soil noticed significant highest results in relation to plant height (117.48 cm) and number of tillers (28.01). It is concluded from the study that, for getting maximum yield and growth of rice silica should be applied @ 150 kg ha^{-1} along with recommended dose of fertilizers.

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Response of Soil and Foliar Micronutrients Formulation on Yield, quality and Economics of Soybean-Wheat Cropping Sequences

M.A. Ajabe* and A.G. Durgude
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: maheshajabe11111@gmail.com*

A field experiment was conducted at Post Graduate Institute, Research Farm, Department of Soil Science and Agricultural Chemistry, MPKV, Rahuri during 2018-19 on soybean-wheat and maize-onion crop sequence. The initial chemical properties showed moderately alkaline in reaction, normal in electrical conductivity, $CaCO_3$ content was medium and organic carbon content was moderately high. The soil was low in available nitrogen, medium in available phosphorus and very high in available potassium. The initial soil micronutrients were sufficient except marginally deficient in DTPA- Zn and Fe. The design was randomized block design with ten treatments and three replications. The highest significant response in terms of grain (31.15, 41.09 q ha^{-1}) yield of soybean and wheat was noticed in the soil application Govt. notified Grade-I (c) @ 25 kg ha^{-1} (Gypsum based). The application of GRDF + Phule Grade-I (a) @ 25 kg ha^{-1} (Gypsum based) significantly increased the protein yield (1247.25 kg ha^{-1}), oil content (20.94%) and oil yield (652.28 kg ha^{-1}) in soybean. The highest gross and net monetary returns (180540 and 71411 R.s ha^{-1}) with benefit : cost ratio 1.65 were obtained from soybean-wheat cropping sequences in treatment GRDF + Phule Grade-I (a) @ 25 kg ha^{-1} (Gypsum based) followed by treatment GRDF + Govt. notified Grade-I (c) (a) @ 25 kg ha^{-1} (Gypsum based) which recorded the highest gross and net monetary returns (174085 and 66956 Rs ha^{-1}) with benefit cost ratio 1.62.

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Standardization and Formulation of Soil and Foliar Grades of Micronutrients and their Response to Field Crops

M.A. Ajabe*
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: maheshajabe11111@gmail.com*

A field experiment were conducted on "Standardization and formulation of soil and foliar grades of micronutrients and their response to field crops" at Post Graduate Institute Research Farm, Department of Soil Science and Agrilcultural Chemistry, MPKV, Rahuri during *kharif* and *rabi* seasons 2018-19 with ten treatments replicated thrice in randomized block design. The treatments were comprised of T_1 - Absolute control, T_2 - GRDF (As per crop), T_3 - GRDF + Phule Grade-I (a) @ 25 kg ha^{-1} (Gypsum based), T_4 - GRDF + Phule Grade-I (b) @ 25 kg ha^{-1} (Bentonite based), T_5- GRDF + Grade-I (c) @ 25 kg ha^{-1} (Gypsum based), T_6 - GRDF + Phule micro Grade-II (a) @ 0.5 & 1% (Chelation with EDTA),T_7 - GRDF + Phule micro Grade-II (b) @ 0.5 & 1% (Chelation with glycine), T_8 - GRDF + Phule micro Grade-II (c) @ 0.5 & 1% (Chelation with EDTA), T_9 - GRDF + Phule micro Grade-II (d) @ 0.5 & 1% (Chelation with citric Acid), T_{10} - GRDF + Govt. notified Grade-II (e) @ 0.5 & 1% (Chelation with EDTA). The soil belonged to order Inceptisol (*Vertic Haplustept*). The experimentals soils were moderately alkaliene in nature and low in soluble salt content. Medium in $CaCO_3$, moderately high in organic carbon, low in available N and P and very high in K. The available Zn and Fe was deficient and available Mn, Cu, Mo, and B were sufficient. Source of boron as borax was not suitable for foliar liquid micronutrient formulations Phule Grade-II (a). Rests of formulations were successful and not any precipitation occurred. Thus, it can be concluded that, soil application of Phule grade I (Gypsum based: Zn 5%, Fe 5%, Mn 1%, Cu 0.5% and B 1%) or Govt. notified grade-I (Gypsum based: Zn 5%, Fe 2%, Mn 1%, Cu 0.5% and B 1%) along with general recommended dose of fertilizer to soybean-wheat and maize-onion crop sequence were found beneficial for yield of soybean, wheat, maize and onion and increase in uptake of nutrients grown on Fe and Zn deficient medium deep black soils (Inceptisol). Two foliar applications of Phule grade II (Chelation with citric acid: Zn 4%, Fe 3%, Mn 1%, Cu 0.2%, B 0.5% and Mo 0.1%) @ 0.5 and 1.0 per cent at critical growth stages of respective crops along with general recommended dose of fertilizer to soybean-wheat and maize-onion sequence were found beneficial for yield of soybean, wheat, maize and onion and increase in uptake of nutrients grown on Fe and Zn deficient medium deep black soils (Inceptisol).

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Effect of Foliar Application of Potassium Rich Nutrients with Micronutrient in Potato (*Solanum tuberosum* L.) cv. Kufri Himalini under Terai Region of West Bengal

Sandip Hembram*
Cooch Behar Krishi Vigyan Kendra, UBKV, Pundibari, Cooch Behar, 736165, West Bengal
**Email: sandiphembram@yahoo.co.in*

On order to determine the impact of foliar application of Potassium rich nutrients in association with micronutrient in potato (*Solanum tuberosum* L.) cv. Kufri Himalini, a field trial was carried out on potato cv. Kufri Himalini during the rabi seasons of 2019-20 and 2020-21 at Instructional Farm of Cooch Behar Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. Three replications of the experiment were used in its Randomized Block Design layout. The treatments included T_0 - Control, T_1 - Recommended dose of fertilizer (RDF) NPK @ 150:100:100 kg ha^{-1}, T_2 - RDF NPK @ 150:100:100 kg ha^{-1} + KNO_3 @ 1% as foliar spray, T_3 - RDF NPK @ 150:100:100 kg ha^{-1} + K_2SO_4 @ 1% as foliar spray, T_4 - RDF NPK @ 150:100:100 kg ha^{-1} + Potassium Schoenite @ 0.5% as foliar spray; T_5 - RDF NPK @ 150:100:100 kg ha^{-1} + KNO_3 @ 1% as foliar spray + Boric acid @ 0.1% as foliar spray; T_6 - RDF NPK @ 150:100:100 + K_2SO_4 @ 1% + Boric acid @ 0.1% as foliar spray and T_7 - RDF NPK @ 150:100:100 kg ha^{-1} + Potassium Schoenite @ 0.5% as foliar spray + Boric acid @ 0.1% as foliar spray. Foliar treatment of potassium-rich nutrients with boric acid was shown to strongly affect all growth and production measures. T_6 considerably produced the highest tuber yield (33.65 tonnes per hectare), followed by T_5 (25.31 tonnes per hectare) and T_7 (21.89 tonnes per hectare), while T_0 (9.64 tonnes per hectare) had the lowest output. According to their individual yield criteria, T_1, T_2, T_3, T_4, and T_7 produced 17.67, 20.21, 20.55, 19.84, and 21.89 tonnes per hectare of land respectively.

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Exploring the Variability in Greengram Genotypes for Zinc (Zn) Utilisation Efficiency

Chitdeshwari Thiyagarajan*, B. Viveka and D. Jegadeeswari
Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
**Email: chithukesh@gmail.com*

Micronutrients malnutrition affects more than 2 billion people in developed and developing countries and among all, Zinc (Zn) deficiency hampers immune systems, growth and development of human beings. Pulses are great sources of dietary proteins, complex carbohydrates, vitamins, and minerals required for human nutrition. Hence bio-fortification through various agronomic approaches for improving the nutritional profile of pulse crops has gained momentum in recent decades. In this regard, an attempt was made to explore the variability in utilising applied Zn by various greengram genotypes for enriching the Zn in grains on Zn deficient soils. Field experiments were conducted with eight greengram genotypes *viz.*, COGG 16-10, COGG-13-39, COGG-13-19, MDU 1, VBN 2, VBN 4, COGG 7 and CO 8 for assessing their differential responses to applied Zn. The genotypes differed significantly among themselves in growth, yield and Zn utilisation efficiency. Higher grain yield was observed in VBN 4 (1111 kg ha^{-1}) followed by CO 8 (1102 kg ha^{-1}) and COGG13-39 hence grouped as Zn efficient genotypes. The Zn absorption and utilisation efficiency was also higher in CO 8 (76 to 93.5%) and COGG-13-39 (82.5 to 91.4%). Lesser yield and Zn utilization efficiencies were noted with MDU 1 (61.2%) and VBN 2 (86.0%) indicating their sensitiveness to Zn deficiency and grouped as Zn inefficient. Rests of the genotypes were categorised as moderate in Zn utilisation efficiency. Better genotypic efficiency was highly correlated with increased activities of catalase, super oxi dismutase and peroxidase in plants. Hence it can be concluded that, greengram genotypes COGG13-39, CO8, VBN 4 and COGG16-10 can be recommended for grain Zn bio-fortification through various management strategies.

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Effect of Foliar Spray of Cow Urine on Yield and Quality of Byadgi Chilli (*Capsicum annuum L.*) in a Vertisols

K.L. Shaziya[1]*, B.I. Bidari[2], G.G. Kadalli[3], C.T. Subbarayappa[1] and N.S. Hebsur[2]
[1]University of Agricultural Sciences, GKVK, Bengaluru, 560065, Karnataka
[2]University of Agricultural Sciences, Dharwad, 580005, Karnataka
**Email: shaziyakl47@gmail.com*

A field experiment was conducted during *kharif* 2018 in the farmer's field at Agadi village (Tq: Hubballi) in Dharwad district of Karnataka state to study the "Effect of foliar spray of cow urine on yield and quality of Byadgi chilli in a *Vertisol*". The experiment consisted of 12 treatments with three replications laid out in RCBD. The cow urine was tried at three levels (5, 10 and 15%) sprayed at 60 and 90 Days After Transplanting (DAT) as single spray and as two sprays. NAA @ 50 ppm and Urea @ 1% were taken as two check treatments. The recommended dose of fertilizers (100:50:50 N, P_2O_5, K_2O kg ha^{-1}) and FYM @ 25 tonnes ha^{-1} was common for all the treatments. Foliar application of 15% cow urine at 60 and 90 DAT recorded significantly highest fruit yield (14.07 q ha^{-1}) compared to NAA and Urea spray (10.30 and 9.90 q ha^{-1}, respectively) and was on par with two foliar applications of cow urine @ 10% (13.06 q ha^{-1}). Two foliar applications of 15% cow urine recorded significantly highest colour value (201.65 ASTA units) and oleoresin content (20.23%) in chilli which was on par with treatment having two sprays of cow urine at 10% (194.50 ASTA units and 19.56%, respectively) but found significant over NAA (162.66 ASTA units & 13.67% respectively) and Urea spray (125.19 ASTA units & 17.78% respectively). Foliar spray of 15% cow urine at 60 and 90 DAT recorded highest capsaicin (0.16%) while lowest recorded in control (0.04%). Two foliar spray of 15% cow urine recorded highest B:C ratio (3.46) than 10% foliar spray of cow urine (3.21). Hence, treatment involving two foliar sprays of 15% cow urine is superior in improving the yield and quality of Byadgi chillies compared to NAA (50 ppm) and urea spray (1%).

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Evaluation of Different Management Practices in Bt. Cotton under Different Planting System

Krishan Kumar Bhardwaj*, Vishal Goyal and Rajni Yadav
CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: krishansoils@gmail.com*

To test the validity of soil test based fertilizer and FYM application for achieving the yield targets of Bt. cotton, different management practices were tested under different planting system in semi arid south western zone of Haryana. The experiment was conducted at Soil Research Farm, CCS HAU, Hisar during *kharif* 2021. Five treatments were employed which included T1: control; T2: FYM @ 15 t ha^{-1}; T3: FYM @ 15 t ha^{-1} + Biofertilizers and cow urine based formulation; T4: STCR recommendations for 28 q ha^{-1} seed cotton yield target of Bt. cotton and T5: STCR recommendations for 32 q ha^{-1} seed cotton yield target of Bt. cotton. The seed cotton yield of cotton in TY 32 statistically increased with increase in fertilizer dose than TY 28 treatments but TY 32 and TY 28 was found significantly higher than all other treatments. The data of seed cotton yield in control and FYM was statistically at par. This might be due to the fact that only FYM could not contribute significantly to increase the yield of the crop when applied during first year of study but when FYM was applied along with seed treatment with bio-fertilizer and cow urine based formulation (two times). However, in organic treatment (T3) the yield was far less than the acceptable limit of ±10% which shows that only organic manures along with bio-fertilizer and cow urine based formulation would not be sufficient to achieve the target yield of 28 and 32 q ha^{-1} for cotton. Straw yield under both method of planting followed the similar trend but the yields were more in case of raised bed sowing.

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Soil Test-Based (STB) Integrated Plant Nutrient Supply (IPNS) for Enhancing Maize Yield and Improving Soil Physical and Chemical Environment

Varun Parmar*, Naveen Datt and S.P. Dixit
CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, 176062, Himachal Pradesh
**Email: v.parmar21505@gmail.com*

The present investigation was undertaken as a part of an ongoing long-term experiment on soil test-based optimum integrated plant nutrients supply based on soil test crop response (STCR) approach initiated during *kharif*, 2007 in a maize-wheat sequence at the experimental farm of department of Soil Science and Agricultural Chemistry, CSK HPKV, Palampur. The experiment was conducted on maize crop during kharif season of 2019 and laid out in a randomized block design with eight treatments *i.e.*, control, farmer's practice, recommended dose of fertilizers, soil test-based fertilizer application, applying fertilizers as per target yield of 30 q ha^{-1} and 40 q ha^{-1} with and without FYM which were replicated thrice. The objective of the study was to investigate the effect of prescription-based fertilizer application on changes in soil properties after 13 years of maize-wheat cropping sequence. The results indicated that soil was found to be more compact in treatments without farmyard manure (FYM) but combined application of chemical fertilizers and FYM had greater pore space, water holding capacity, electric conductivity, organic carbon, availability of nutrients in soil and maize grain yield. In general, soil physical and chemical environment was found to be improved significantly in the treatment coinciding with target yield of 40 q ha^{-1} with 5 t ha^{-1} FYM compared with treatments without fertilizers and farmyard manure. The relationship between soil available nutrients and maize grain yield was found to be significant indicating that maize grain yield was highly dependent on higher availability of nutrients using soil-test based integrated plant nutrient management. The results suggest that the large-scale implementation of the prescription-based fertilizer application by integrating manure plus inorganic fertilizer amendments will help to enhance the soil quality and promote food security in the region.

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Effect of Balanced Fertilization on Soil Properties under Raised Bed and Flat Bed Planting in Bt. Cotton-Wheat Cropping System

Rajni Yadav*, Vishal Goyal and Krishan Kumar Bhardwaj
CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: rajniyadav211295@gmail.com*

Cotton-wheat cropping system is the second most important wheat based system in South Asia (4.5 M ha) and India (2.6 M ha) and contributes significantly to food security in the region. However, the productivity of this system reduces with conventional method of crop establishment. Although raised bed planting systems can enhance productivity relative to other system but mechanism for this remain unclear. Therefore, we examine the effects of raised bed planting and different nutrient management practices on various parameters in 2019 crop season at 0-15 & 15-30 cm soil depth. The experiment was planned in a randomized block design with raised bed and flat bed method, three replication and five treatments viz. T1-control, T2-FYM @ 15 t ha^{-1}, T3- FYM @ 15 t ha^{-1} + biofertilizer +cow urine formulation, T4-STCR with TY 5.5/2.8 t $ha^{-1}$and T5-STCR with TY 6.0/3.2 t ha^{-1} was applied in *rabi* and *kharif* season. Result confirmed that organic treatment (T2 and T3) had significantly increased the SOC, macro (N P K) and micronutrient (Zn, Fe and Mn) content of the surface and sub-surface soil as compared to chemical fertilizer treatment while Cu content decreases with increase in SOC content. The chemical properties was found higher under raised bed compared to flat bed planting at both soil depths. Results showed that microbial quotient values varied from 10.41 to 11.53 and 10.27 to 11.27 %, respectively for raised and flat bed system of planting at surface 0-15 cm soil. However, at 15-30 cm soil it varied from 10.04 to 11.41 and 11.52 to 13.15 %, respectively for raised and flat bed system of planting. Therefore, growing cotton-wheat system under raised bed planting with application of organic treatments will proved to be beneficial under irrigated conditions due to its potential to increase production, profitability and resources conservation.

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Impact of Long-Term Application of FYM and Fertilizer Nitrogen on Aggregate Bound Nitrogen Fractions

Usha Vasisth*, Saloni Yadav, Devraj and Pooja Jangra
CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: kasuhikusha63@gmail.com*

The present investigation focused on analyzing the impact of long term FYM and fertilizer nitrogen application on aggregate bound nitrogen fractions. The ongoing long-term field experiment initiated in 1967 at Research Farm, Department of Soil Science, CCSHAU, Hisar (India) was selected for this study. The experiment was laid out in split plot design. There were 3 replications with 7 FYM levels in main plot, 2 N levels in sub plot and 2 aggregate size class in sub-sub plot treatments. The mean value of available nitrogen in macroaggregates increased from 101 to 209 kg ha^{-1} and in microaggregates increased from 93.8 to 202.4 kg ha^{-1} soil with increasing doses of FYM from F0 to F15+F15. Similarly available nitrogen of macroaggregates and microaggregates increased from 146 to 161.9 and 138.5 to 154.8 kg ha^{-1} respectively, with increasing doses of fertilizer nitrogen from 0 to 120 kg ha^{-1}. The organic nitrogen ranged between 1392 to 4364 kg ha^{-1} among different treatments in macroaggregates and 1120 to 3903 kg ha^{-1} among different treatments in microaggregates. The total nitrogen in macroaggregates and microaggregates was significantly affected by the continuous application of FYM and fertilizer N in soil. The total nitrogen ranged between 1426 to 4665 kg ha^{-1} among different treatments in macroaggregates and 1156 to 4356 kg ha^{-1} among different treatments in microaggregates. Macroaggregates recorded higher amount of NH_4^+ and NO_3^--N as compared to microaggregates by 7.77 and 5.26 %, respectively. Maximum NH_4^+-N (63 kg ha^{-1}) and NO_3^--N (102.8 kg ha^{-1}) was obtained under FYM amended soils with 15 t ha^{-1} in both seasons and nitrogen @ 120 kg ha^{-1} in macroaggregates.

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Organic Carbon Content in Soils of Haryana: Impact of Modern Agricultural Practices

Dev Raj*
CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: devraj_chauhan@rediffmail.com*

The importance of soil organic matter is both direct as well as indirect in crop production. It is assumed that our soils are low in organic carbon (OC) content due to intensive cropping system. Hence in this study, the data of previous years and present OC status of soil was interpreted to know the actual situation of the state. The data of various soil testing laboratories revealed that most of soils of Haryana fall in low category of organic carbon content in the year 1980, 1996 and 2004 and area under low category increased from 80 to 92% in the year 2004 over that of 1980. However, area under medium and high category decreased from 18 to 7.5% and 2.0 to 0.4%, respectively. The result of soil samples collected by soil scientist in the year 2011 indicated that 68.4 and 31.5% soils of Haryana were in low and medium category, respectively. The latest data generated from the soil samples collected in the year 2021 from three districts of Sirsa, Kaithal, and Karnal revealed that area under low category decreased while area under medium category was found increased over that of year 2011. It is very encouraging that 7.8, 16.6 and 10.7% area of these districts was found under high category. Periodical monitoring of some benchmark sites located at different research station and KVKs of the university indicated that OC content at all the sites was found increased over the initial value of 2001. The possible reasons for improving OC content in soils are: Popularization of mechanical harvesting of crops,decreasing instances of crop residue burning,farmers awareness about importance of organic manures/matter in sustaining soil productivity.

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Effect of LD Slag and Potassium Feldspar Formulations on Performance of Maize and Nutrient Availability in Soil

T. Pallavi* and N.B. Prakash
University of Agricultural Sciences, GKVK, Bangalore, 560065, Karnataka
**Email: pallavisac15@gmail.com*

The present study was undertaken to evaluate the effect of Linz-Donawitz slag (LDS) and potassium feldspar formulations on growth, yield, nutrient uptake by maize and nutrient availability in acidic soil. Field studies were conducted in complete randomized block design (RCBD) with five different formulations F_1, F_2, F_3, F_4 and F_5 consisting 10:90, 20:80, 30:70, 40:60 and 50:50 proportions of LDS and PF, respectively applied @ 500 kg ha^{-1} in comparison with control (Recommended dose of fertilizer-RDF) and sole application of LDS and PF. In control plots, RDF i.e 100:75:40 Kg ha^{-1} of N: P_2O_5: K_2O was applied through urea, DAP and MOP. In the plots receiving LDS + PF formulations, only N: P_2O_5 were applied through urea, DAP as per RDF and the recommended K_2O (40 kg ha^{-1}) was applied through muriate of potash (MOP) by balancing the quantity of K_2O supplied through the respective formulations. These eight treatments were replicated thrice. The results revealed that maize crop has responded on par with the application of different formulations in terms of plant height, number of leaves, cob length, cob diameter, number of rows per cob and number of grains per row, grain and stover yield in comparison with RDF. However, a maximum increase was noticed with F_5 formulation which contributed ~14 and 9 per cent increase in grain and stover yield, respectively over RDF (grain yield: 8.24 t ha^{-1} and stover yield: 6.54 t ha^{-1}). The F_5 formulation has also significantly enhanced the total uptake of Si, K, Ca, Mg, Fe, Mn by crop, beside improving their available status in the soil.

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Short Term Effect of Nutrient and Associated Crop Management Practices on Soil Organic Carbon Dynamics under Rice-Maize-Green Manure Cropping System in Vertisols of Central India

Dibakar Roy[1], Dibakar Ghosh[2], Rudra Prakash Dubey[1], C.R. Chethan[1] and Subhas Chandar[3]

[1]ICAR-Directorate of Weed Research, Jabalpur, 482004, Madhya Pradesh
[2]ICAR-Indian Institute of Water Management, Bhubaneswar, 751023, Odisha
[3]ICAR-National Bureau of Plant Genetic Resources, New Delhi, 110012
**Email: dibakar499176@gmail.com*

Research from the past highlighted that nutrient management practices play important role in soil carbon dynamics and its stabilization. Therefore, an attempt was made to assess short term effect of nutrient management with 4 different levels of nitrogen fertilization (NM1: 75%, NM2: 100%, NM3: 125% and NM4: 150% recommended dose of N, recommended dose of fertilizer for hybrid rice: 175-60-60 and sweet corn: 225-60-60 in kg ha^{-1}; *Sesbania* will be grown as greenmanure during summer season under residual fertility) and varying weed management practices (5 different levels) on agronomic performance and over all soil properties including soil carbon dynamics in vertisols of central India. Soil was sampled in replications from 0-15 cm from all treatments and analyzed for various soil C pools with standard procedures. Results revealed that, nitrogen fertilization had significant effect on total organic carbon (TOC), walkley and black carbon (WBC), very labile carbon (C_{VL}), labile carbon (C_L) and non labile carbon (C_{NL}) respectively. Both the content TOC and WBC were increased with increasing order of nitrogen fertilization *i.e.* NM4 > NM3 > NM2 > NM1; on average TOC and WBC content were higher by 9.3 and 7.9% in NM4 and 9.0 and 7.1% in NM3 over NM1 (11.93 and 10.13 g kg^{-1}) respectively. The NM4 registered highest C_{VL} (5.05 g kg^{-1}) and C_{NL} (1.99 g kg^{-1}) content among all nutrient management options. Weed management practices shown no effect on TOC, WBC and other carbon pools. Thus our study highlighted that higher dose of nitrogen fertilization (125% and 150% N) is required for over all soil organic carbon improvement compared to current recommended fertilizer dose in input intensive rice-maize-green gram cropping system in vertisols of central India.

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Available Nutrient Status of Cotton Growing Soils of Sirsa District in Haryana

Vijendra Kumar Verma[1], Devender Singh Jakhar[1]* and Dev Raj[2]
[1]CCS Haryana Agricultural University, Krishi Vigyan Kendra, Sirsa, 125055, Haryana
[2]CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Emai: dsjakhar@gmail.com*

A survey of fertility status of 350 surface soil samples collected from a cotton (*Gossypium hirsutum*) growing Soil of Sirsa district, Haryana, India, was conducted. The available nitrogen (125 to 470 kg ha^{-1}) status were low to medium in cotton growing soils of Sirsa. Ten percent of soils were low in available phosphorus and 42% were in medium category, ranging from 3.10 to 42.40 kg ha^{-1}. The available potassium varied from 215 to 699 kg ha^{-1} and approximately 24 and 75% soils were in medium and high category, respectively. The available sulfur status varied from 1.90 to 318 mg kg^{-1} soil and approximately 26% soils were found deficient in available sulfur.

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Effect of Organic Amendments Incorporation on P Sorption in Soils

Jagdeep Singh*
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: jagdeep_76@pau.edu*

Transformations of applied phosphorus (P) to unavailable residual soil P is the major cause of limited P supply in most of the cultivated soils. The present study was designed to study the effect of incorporation of wheat straw [WS]), farmyard manure [FYM] and green manure [GM]), biochar and the combination of crop residue with organic manures (WS+FYM, WS+GM) and biochar (WS+Biochar) on P sorption in different Olsen-P status (medium P and high P) soils under different soil moisture regimes (flooded and aerobic conditions). Bulk soil samples (0-0.15m) were collected from plots with 'medium P' and 'High P' soils from an ongoing field experiment having different Olsen-P build-up levels after the harvest of wheat crop during 2020-21. The soil samples were air dried and sieved to 2 mm and stored at room temperature. The incubation study was carried out in wide mouth polythene bottles at field capacity (aerobic) and flooded environments over a period of 30 days. Water absorption and evaporation were determined by regularly weighing the bottles. Deionized water was used whenever required for maintaining the moisture of soil. The incubated soil was thoroughly mixed with a spatula once in a week. The results showed that the sorption of P occurred relatively more in 'medium' P soils than 'high' P soils and appears to be caused by availability of more number of reacting sites in 'medium' P soils. Generally, more P was sorbed under flooded conditions than under aerobic conditions. Incorporation of organic amendments decreased P sorption, bonding energy and increased P concentration in soil solution over the control. Among organics, WS showed highest sorption in soils, indicating a higher potential of this organic residue for P retention and the lowest sorption was observed in FYM treated soil, followed by biochar, GM, WS+FYM, WS+Biochar and WS+GM treated soils.

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Zinc Enrichment in Organic Manures Through Zinc Solubilising Bacteria (*Pseudomonas aeruginosa*)

Sangya Singh, G.S. Tagore and Shubham Singh*
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 482004, Madhya Pradesh
**Email: shubhamsingh0734@gmail.com*

Zinc (Zn) is an essential micronutrient and the most widespread deficient in Indian soils which restricts yield. Inorganic fertilizers are costly and have a relatively lower nutrient utilization efficiency. Manure enrichment improves the soil's fertility status by improving its nutrient content, microbial population and enzyme activity. An emerging strategy to treat the Zn deficit in soil is bacterial solubilization of soil-unavailable forms of zinc which could be a substitute for chemical Zn fertilizer. Keeping in view of these facts, a pot experiment was conducted in Department of Soil Science, Jabalpur (2019-20). Treatments were divided into two sets organic manures *viz.,* Fresh Cow and Buffalo dung, Farm Yard Manure (FYM), Vermicompost and Poultry manure which were enriched with Zinc Solubilising Bacteria (ZSB- *Pseudomonas aeruginosa*) and without ZSB to see the zinc enrichment in manures. Total Zn content of organics used were 177 mg kg^{-1}, 116 mg kg^{-1}, 65 mg kg^{-1}, 45 mg kg^{-1} and 36 mg kg^{-1}, respectively for Poultry manure, FYM, Vermicompost, Fresh Cow dung and Fresh Buffalo dung. The highest available Zn content was found in Poultry manure (33.29 mg kg^{-1}), followed by FYM (28.88 mg kg^{-1}), Vermicompost (26.53 mg kg^{-1}), Fresh Cow dung (18.03 mg kg^{-1}) and Buffalo dung (17.20 mg kg^{-1}). The increase in Zn availability by 12.58, 38.11, 38.61, 29.43 and 44% due to Enriched compost *viz.*, with Poultry manure, FYM, Vermicompost, Fresh Cow and Buffalo dung with ZSB over without ZSB, respectively. Results showed that all the sources of organic manures having ZSB showed a higher percent of DTPA-Zn than treatments without ZSB.

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Impact of Different Data Transformations on Predictive Performance of Soil Fertility Spectral Models

Yelagada Sravanthi[1], Bharpoor S. Sekhon[1]* and Rabi N. Sahoo[2]
[1]Punjab Agricultural University, Ludhiana, 141004, Punjab
[2]ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: bsekhon@pau.edu*

Visible near-infrared (VIS-NIR) reflectance spectroscopy ensures rapid, eco-friendly and cost effective soil testing. Objectives of this study were to assess the impact of different data transformation methods on the performance of spectral models. It was conducted on three differently textured soils, namely, loamy sand, sandy loam, and loam soils collected, respectively, from Mansa, Ludhiana and Patiala districts of the Punjab state. Spectral signatures (350-2500 nm) were collected by using spectroradiometer in a dark room. Various data pre-processing techniques like first derivative transformation, second derivative transformation and SNV after Savitzky- Golay smoothing were evaluated. In case of pH, second derivative transformation increased R^2 from 0.59 to 0.84 in loamy sand soil, 0.48 to 0.73 in sandy loam, and 0.56 to 0.65 in loam soil. In case of EC, the corresponding changes were 0.57 to 0.79, 0.24 to 0.51, and 0.53 to 0.79. In case of soil organic carbon, however, pre-processing techniques did not help always. In case of Olsen P, SD transformation induced increases were 0.23 to 0. 38, 0.34 to 0.51, and 0.73 to 0.84, respectively. In case of potassium, SD improved R^2 from 0.78 to 0.87 in loamy sand, 0.81 to 0.85 in sandy loam, and 0.68 to 0.81 in loam soils. In case of Zn, the corresponding changes were 0.35 to 0.62 in loamy sand, 0.61 to 0.85 in sandy loam and 0.59 to 0.75 in loam. Prediction of Cu remained unimpacted by various data transformations. Our results suggest that second derivative transformation can help considerably in improving prediction efficiency of spectral models.

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Ammonium Acetate Extractable Potassium (K) Does not Truly Represent Plant Available K for Potato

Lovedeep Kaur Pandher*
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: bsekhon@pau.edu*

Plant available potassium (K) in soil is regulated by dynamic equilibrium among its various pools. However, boundaries between these pools are quite diffuse. In India, mostly 1M ammonium acetate extractable K (AA-K), which is assumed to extract both water soluble K and exchangeable K, is used as an index of plant available K. Existing K fertilizer recommendations are also based on this test. However, crops grown on K deficient soils do not exhibit any deficiency symptoms or do not respond to K fertilizer. Thus, our objective was to examine whether AA-K truly represents plant available K vis-à-vis some other commonly used K extractants, namely, 1M Ammonium bicarbonate DTPA (AB-DTPA), Mehlich-3, Sodium tetraphenylboron (STPB), and 1M boiling HNO_3. Thirty bulk soil samples (0-15 cm) collected from different parts of Punjab were supplied @ 0 and 60 K ha^{-1} soil (completely randomized design, in triplicate) in a potato crop grown in pots. AAK was not significantly related to both K uptake (r = 0.24) and tuber yield (r = 0.15). However, STPB-K (0.76**), Mehlich-3 K (r = 0.72**), AB-DTPA K (r = 0.64**) and HNO_3 K (0.44*) were significantly correlated, in that order, with plant K uptake. Respective correlation with tuber yield was 0.58**, 0.78**, 0.75**, and 0.55*. Mehlich-3 is already used as a multi-nutrient extractant in North America. However, some restrictions on the use of ammonium nitrate work against adoption of this extractant in India. STPB method is a K specific method. Our results suggest that K fertilizer recommendation practices need to be based on AB-DTPA method due to its better correlation with plant K uptake and yield, and due to its multi-nutrient capabilities.

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Interactive Effect of Phosphorus and Zinc on Nutrient Content of Wheat in Different Phosphorus Status Soils

Sunitha Fogat*, Rohtas Kumar and K.K. Bhardwaj
CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: phogatsunitha@gmail.com*

A pot experiment was conducted during *rabi* season of 2018-19 in screen house of the Department of Soil Science, CCS Haryana Agricultural University, Hisar (Haryana). The objective of the experiment was to evaluate the response of different rates of phosphorus and zinc application in low and high P status soils on nutrient content in grain and straw of wheat (*cv* WH 1105) crop. Five levels of P (0, 30, 60, 120 and 180 mg P kg^{-1} of soil) were combined with four different levels of Zn (0, 2.5, 5 and 10 mg Zn kg^{-1} of soil) in completely randomized design and treatments were replicated thrice.The content of different nutrients (N, P, K and Zn) in grain and straw of wheat were analyzed by using their standard methodology. Experimental results revealed that in both the soils, the average P content in grain and straw of wheat increased significantly in all the treatments over control. Similar trend was observed for Zn content in grain and straw. In low and high P status soils, highest P content in grain (0.32 and 0.37%) and straw (0.028 and 0.032%) was recorded at 180 mg P kg^{-1} level and highest Zn content in grain (24.16 and 28.03 mg kg^{-1}) and straw (12.76 and 14.01 mg kg^{-1}) was recorded at 10 mg Zn kg^{-1} level. Whereas, application of P and Zn either alone or in combination did not have significant effect on N and K content in grain and straw of wheat crop in both the soils.

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Nutrient Partitioning and Removal by Guava with High Plant Density

T.K. Radha*, G. Sridhar, Rupa Thimmasamudram Raghavareddy and B. Aruna
ICAR-Indian Institute of Horticultural Research, Bengaluru, 560089, Karnataka
**Email: Rupa.TR@icar.gov.in*

The objective of this study was to determine nutrient partitioning pattern and assess nutrient removal by guava with high plant density for optimization of orchard fertilization. An experiment was carried out with newly planted guava (variety Arka Kiran) during 2017-2021. A strip plot design was used with two different plant densities 3×2.5 m (1333 plants ha^{-1}) and 2×1.5 m (3333 plants ha^{-1}) as main-plots and eight nutrient modules as sub-plots [T1: 450:300:300 g N:P:K; T2: 450:300:300 g N:P:K + Arka Actino Plus (AAP); T3: 450:300:300 g N:P:K + secondary and micronutrients + AAP; T4: 450:150:300 g N:P:K + secondary and micronutrients + AAP; T5: 337.5:225:225 g N:P:K + secondary and micronutrients + AAP; T6: 337.5:112.5:225 g N:P:K + secondary and micronutrients + AAP; T7: 225:150: 150 g N:P:K + secondary and micronutrients + AAP and T8: 225:75:150 g N:P:K + secondary and micronutrients + AAP]. Significant differences in total dry weight removed from the tree were observed between two plant densities at every nutrient removal event. Average removed dry weight (kg) for 3x2.5 m plant density and 2x1.5 m plant density trees, respectively were 3.73 and 2.38 (harvested fruits), 6.28 and 3.61 (pruning), 1.45 and 0.79 (leaf fall). When we estimated the total nutrient content, guava trees allocated more N, P, K and Mg to leaf fall and Ca, S, Fe, Mn, Zn Cu and B to pruned material but less N, P, K, Mg, Fe, Mn, and B in harvested fruits. The average of removed elements expressed in g ton^{-1} of fresh fruit of the guava with high plant density follows this order: N-4.7, P-0.695, K-4.45, Ca-1.75, Mg-1.35, S-1.46, Fe-0.072, Mn-0.0065, Zn-0.023, Cu-0.0083 and B-0.0098. The results of the present investigation provide a basis for the development of nutrition guidelines for guava with high plant density to meet the plant's nutrient requirements.

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Effect of Sulphur Nanoparticles on Yield, Nutrient Content of Soybean and Periodical Availability of Sulphur in Soils

Khushvadan Patel[1]*, Priyanka Choudhary[2], Bhavik Prajapati[2] and Dileep Kumar[2]
[1]Micronutrient Research Scheme (ICAR), Anand Agricultural University, Anand, 388110, Gujarat
[2]Anand Agricultural University, Anand, 388110, Gujarat
**Email: kcpatel_05@yahoo.co.in*

A pot study was conducted at net house of Micronutrient Research Scheme, AAU, Anand during rabi season of 2021-22 to study the "Effect of sulphur nanoparticles on yield, nutrient content of soybean and periodical availability of sulphur in soils. The pot experiment was laid out in Completely Block Design (CRD) with four repetitions and twelve (12) treatments were comprised of T_1 (control only NPK), T_2 (T_1 + sulphur nanoparticles @ 1mg S kg^{-1} soil),T_3 (T_1 + sulphur nanoparticles @ 2 mg S kg^{-1} soil) ,T_4 (T_1 + sulphur nanoparticles @ 3 mg S kg^{-1} soil), T_5 (T_1 + sulphur nanoparticles @ 4 mg S kg^{-1} soil), T_6 (T_1 + sulphur nanoparticles @ 5 mg S kg^{-1} soil), T_7 (T_1 + sulphur nanoparticles @ 6 mg S kg^{-1} soil), T_8 (T_1 + sulphur nanoparticles @ 7 mg S kg^{-1} soil), T_9 (T_1 + sulphur nanoparticles @ 8 mg S kg^{-1} soil), T_{10} (T_1 + elemental sulphur @ 4 mg S kg^{-1} soil), T_{11} (T_1 + elemental sulphur @ 6 mg S kg^{-1} soil) and T_{12} (T_1 + elemental sulphur @ 8 mg S kg^{-1} soil. The application of sulphur nano-particles @ 8 mg S kg^{-1} soil along with RDF (NPK 30:60:00 kg ha^{-1}) significantly increased growth and yield attributes, seed and stover yields of soybean over control (RDF only) and elemental sulphur @ 4, 6 & 8 mg S kg^{-1} soil. The nutrients content and uptake and status of available P, K, S and Zn in soil after harvest of crop were found significantly higher due to treatment RDF+ SNPs @ 8 mg S kg^{-1} soil. All forms of sulphur was found higher in SNPs treatments except non-sulphate sulphur in both loamy sand and clay soils. Under incubation study, the periodical availability of sulphate sulphur was found increasing pattern up to 40 days after application in soil and thereafter in declining trend in both soils and source of sulphur. The sulphur use efficiency of sulphur nanoparticles was comparatively found superior as compared to elemental sulphur.

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Screening of Wheat Genotypes/Varieties for Iron (Fe) Efficiency

Khushvadan Patel[1]*, Dileep Kumar[2], A.K. Shukla[2] and R. A. Patel[2]
[1]Micronutrient Research Scheme (ICAR), Anand Agricultural University, Anand, 388110, Gujarat
[2]Anand Agricultural University, Anand, 388110, Gujarat
**Email: kcpatel_05@yahoo.co.in*

Micronutrient deficiency is the fifth major global challenge to human health. The iron and zinc deficiency leads to crop yield losses and human health problem. Recently, new approach called biofortification has been developed for alleviating malnutrition problem. Biofortification strategy involves developing crop varieties with superior nutrient qualities and it includes both increasing nutrient levels in the edible parts of fruit crops as well as their bioavailability. In order to evaluate Fe efficiency of different wheat genotypes/varieties, field experiments were conducted during *rabi* season for two consecutive years (2019-20 and 2020-21) at Anand Agricultural University, Anand. Twenty diverse wheat genotypes/varieties were evaluated in Fe deficient (3.98 mg kg^{-1}) soil with two treatments *viz.* Control (RDF: 120-60-0 NPK kg ha^{-1} & without Fe) and RDF + 50 kg FeSO4 ha^{-1} soil application through ferrous sulphate + two foliar sprays of 0.5% ferrous sulphate at 45-50 DAS and 75-80 DAS. The grain yield of genotypes/varieties under control (RDF + No Fe) ranged from 3658 to 5469 kg ha^{-1} with an average value of 4699 kg ha^{-1}. The grain yield of genotypes/varieties with soil application as well as foliar spray (RDF + 50 kg $FeSO_4$ ha^{-1} soil application through ferrous sulphate + two foliar sprays of 0.5% ferrous sulphate) varied from 4107 to 6304 kg ha^{-1} with a mean value of 5455 kg ha^{-1}. The genotypes differed significantly in their response to applied Fe as the grain Fe concentration increased from 6.4% to 28.6% among the different genotypes/varieties. Based on grain yield and Fe efficiency, the genotypes were classified as efficient and responsive (GW-496, GAW 16-16, GW 451,GW 16-14,GW-366, GAW 16-03), efficient and nonresponsive (HI-1544, GW-513, LOK-1, GW-322, GAW 16-21), inefficient and responsive (GW-514, GAW 16-07, GAW 16-12, GAW 16-04) and inefficient and nonresponsive (GW 495, GAW 16-10, MP-3288, GAW 16-15, GAW 16-13). The efficient and responsive genotypes are most desirable as they would yield more with higher Fe content under low Fe and also respond better to Fe additions.

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Available Macro and Micro Nutrient Status of Pomegranate (*Punica granatum* L.) Orchard Soil Influenced by Integrated Nutrient Management

Bhagyaresha Gajbhiye*, R.N. Khandare and Tejswini R. Kachave
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431402, Maharashtra
**Email: bhagyabr123@yahoo.co.in*

The present investigation was conducted during the year 2017-18 and 2018-19 at research farm, College of Agriculture, Golegaon, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Five years old, fifty six pomegranate trees having uniform growth and vigor were selected for experiment. The experiment was laid out in Randomized Block Design (RBD) with seven treatments replicated four times. The result revealed that soil pH, EC, organic carbon and calcium carbonate content were improved due to application of 25 kg Umber rhizosphere hybridized soil per tree along with 15 kg FYM, *Azotobacter* @ 8 ml per tree, PSB@ 8 ml per tree and *Trichoderma* @ 100 g per tree, 625:250:250 g N, P_2O_5 and K_2O per tree (T_7). The highest organic carbon content was recorded in surface (8.03 and 7.74 g kg^{-1}) and subsurface (7.75 and 7.39 g kg^{-1}) soil at flowering and harvesting stage, respectively. Also, application of treatment T_7 registered maximum available N, P, K at flowering and harvesting at 0-22.5 and 22.5-45 cm depth, which was superior over all the treatments. Maximum DTPA extractable micronutrients content *i.e.* Fe (5.88 and 4.81 mg kg^{-1}), Zn (1.59 and 1.33 mg kg^{-1}), Cu (4.05 and 3.79 mg kg^{-1}), Mn (12.24 and 11.02 mg kg^{-1}) and available B (1.00 and 0.98 mg kg^{-1}) was recorded at flowering stage in treatment T_7 at 0-22.5 and 22.5-45 cm depth, respectively. Similar trend was noticed at harvesting.

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Study of Soil Amendments on Fluoride-Contaminated Soils

Elayarajan Maharajan[1]*, P. Pramila[3], K. Bhattacharya[2] and K. Panigrahi[4]

[1]Department of Soil Science & Agricultural Chemistry, [3]Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu

[2]Bidhan Chandra Krishi Viswavidyalay, Mohanpur, Nadia, 741252, West Bengal

[4]Indian Institute of Water Management, Bhubaneswar, 751023, Odisha

**Email: elayarajanm@tnau.ac.in*

In fluoride contaminated soil, a field experiment was conducted during the Rabi season 2020 to evaluate the effects of soil amendments on plant growth, chlorophyll, plant fluoride content, and yield parameters of maize crops. In the Tiruppur district of Tamil Nadu, India, Muthayanpatti village, Kundadam block, was selected as the experimental site. The implemented treatments are T_1 - without amendments and fertilizers, T_2 - 100% RD dose of NPK + without amendments, T_3 - 100% RD dose of NPK + FYM (12.5 t ha^{-1}), T_4 - 100% RD dose of NPK + Vermicompost (5 t ha^{-1}), T_5 - 100% RD dose of NPK + Lime (2 t ha^{-1}), T_6 - 100% RD dose of NPK + Gypsum (2 t ha^{-1}). These treatments were replicated thrice under randomized block design. The length of each plot is 20 m and 12 m respectively and certified seeds of maize hybrid (CO HM 6) were sown in the spacing of 20 × 20 cm. At critical stages of growth, plant parameters were analyzed and yields were calculated. Using organic amendments resulted in significant increases in plant growth and yield parameters, providing plants with resistance to fluoride stress. In contrast, control plots recorded low physiochemical, biochemical, and yield values, suggesting that fluoride has deleterious effects on plants. The lowest soil fluoride concentration was found in T6 gypsum complexes, which convert most water-soluble fluoride into total form, as well as reducing plant-available fluoride in gypsum plots. In alkaline soils, calcium is combined with exchangeable sodium in gypsum and lime, causing higher fluoride accumulation in roots and shoots. Overall, organic manure, lime, or gypsum application in agroecosystems is effective in preventing fluoride degradation. In fluoride contaminated soil, a field experiment was conducted during the Rabi season 2020 to evaluate the effects of soil amendments on plant growth, chlorophyll, plant fluoride content, and yield parameters of maize crops. In the Tiruppur district of Tamil Nadu, India, Muthayanpatti village, Kundadam block, was selected as the experimental site. The implemented treatments are T_1 - without amendments and fertilizers, T_2 - 100% RD dose of NPK + without amendments, T_3 - 100% RD dose of NPK + FYM (12.5 t ha^{-1}), T_4 - 100% RD dose of NPK + Vermicompost (5 t ha^{-1}), T_5 - 100% RD dose of NPK + Lime (2 t ha^{-1}), T_6 - 100% RD dose of NPK + Gypsum (2 t ha^{-1}). These treatments were replicated thrice under randomized block design. The length of each plot is 20 m and 12 m respectively and certified seeds of maize hybrid (CO HM 6) were sown in the spacing of 20 × 20 cm. At critical stages of growth, plant parameters were analyzed and yields were calculated. Using organic amendments resulted in significant increases in plant growth and yield parameters, providing plants with resistance to fluoride stress. In contrast, control plots recorded low physiochemical, biochemical, and yield values, suggesting that fluoride has deleterious effects on plants. The lowest soil fluoride concentration was found in T6 gypsum complexes, which convert most water-soluble fluoride into total form, as well as reducing plant-available fluoride in gypsum plots. In alkaline soils, calcium is combined with exchangeable sodium in gypsum and lime, causing higher fluoride accumulation in roots and shoots. Overall, organic manure, lime, or gypsum application in agroecosystems is effective in preventing fluoride degradation.

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Rescheduling the Fertigation Through Crop Growth Curve Nutrition Approach in Tomato

Elayarajan Maharajan* and T. Vinitha Reddy
Department of Soil Science & Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
**Email: elayarajanm@tnau.ac.in*

A field experiment was carried out with TNAU tomato hybrid CO 4 as a test crop at Irrigation Cafeteria of Water technology Centre, Tamil Nadu Agricultural University, Coimbatore, from February to June 2022, to investigate the Fertigation Scheduling through Crop Growth Curve Nutrition Approach in Tomato on sandy clay loam soil of periyanaickenpalayam series (Vertic Ustropept). The field experiments was comprising of treatments replicated thrice in a randomized block design. The treatments imposed were T_1 - Fertigation NPK @100% Recommended dose *i.e.*, 200:250:250 kg ha^{-1}, T_2 - Fertigation NPK @ 75% N + 100% P & K, T_3 - Fertigation NPK @125% N + 100% P&K, T_4 - Fertigation NPK @ 75% P + 100 % N&K, T_5 - Fertigation NPK @125% P + 100 % N&K, T_6 - Fertigation NPK @ 75% K + 100 % N&P, T_7 - Fertigation NPK @ 125% K+ 100 % N&P. The soil samples were drawn during the crop growth period and analyzed for Nitrogen, phosphorus and potassium at every 15 days and calcium, magnesium, iron, copper, manganese, zinc at every 30 days. The samples of were analyzed for Nutrient uptake, nutrient uptake efficiency was estimated. The uptake of nutrients were differed among different stages of crop growth, but at all the stages highest nutrient uptake was showed in Fertigation NPK @ 75% K + 100% N&P (T_6). The order of uptake of macro nutrients by tomato plants was Potassium, followed by nitrogen, and then phosphorus. The overall nutrient uptake efficiency of the tomato plant was recorded and found that in Fertigation NPK @ 75% K + 100% N&P (T_6) there was a superior macronutrient efficiency. Although the cost of cultivation was relatively high in the water soluble fertilizer treatments, the higher returns, net income, and longevity made it economically viable in the long run. The highest B:C ratio was observed in Fertigation NPK @ 75% K + 100 % N&P (T_6). As a result of this study, it was revealed that the fertigation of 75% K along with 100% N and P recorded the highest fruit yield and quality parameters of tomato. Among the different N, P, K doses applied, the dose which predicted to be optimal was excelled in almost all the parameters of tomato. Thus, it was concluded that Fertigation NPK @ 75% K + 100% N&P (T_6) under the appropriate fertigation schedule can be recommended for field level adoption to increase tomato yield in sandy clay loam soil.

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Soil and Crop Specific Multi-Nutrient Mixtures for Foliar Application- Case Study of Sampoorna KAU Multimix for Improving Crop Productivity in Kerala

V. Thulasi[1]*, P.P. Moossa[2] and P. Sureshkumar[2]
[1]Regional Agricultural Research Station (KAU), Pattambi, Palakkad, 679306, Kerala
[2]Kerala Agricultural University, Thrissur, 680656, Kerala
**Email: thulasi.v@kau.in*

A state wide study on soil fertility indicated that nearly 60 percent of the soil samples indicated deficiency of Mg, B, Cu K and Zn the fields all over the Kerala. Hence crop and soil specific multi-nutrient mixtures suitable for foliar application were developed. Initially, compatible chemicals were identified and with the compatible nine compound base formula, experiments were conducted to formulate crop specific nutrient mixtures. The nutrient uptake by the crops, status of available nutrients in Kerala soils and the optimum, sufficiency and toxic ranges of the nutrients in the particular crop were considered while fixing the proportion of the compatible chemicals in the mixture. The mixture, released as Sampoorna KAU multimix contain potassium, magnesium, sulphur, zinc, copper, boron and molybdenum. The field experiments conducted at RARS Pattambi and fields of farmers with different schedules of application indicated that the foliar application of Sampoorna KAU Multimix (rice) 0.5% at two days before pulling out in the nursery and 1.0% twice at tillering and panicle initiation (PI) stages emerged as the most effective schedule in increasing yield in rice. The recommendation for Sampoorna KAU multimix (banana) is: foliar application @10 g per litre at 2, 4, 6 and 8 months after planting in banana and foliar application @0.5% at 30, 45 and 60 DAS (days after sowing) in direct sown vegetables and at 15, 30 and 45 DAP (days after planting) in transplanted vegetables. The Front line demonstrations conducted in different locations in the state indicated that the foliar application of the mixtures could increase the productivity by more than 20%. The technologies had been transferred to different stations and Krishi Vigyan Kendras of the state and to private agencies for adoption after getting notified in the gazette by the state Government.

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Effect of Consortium of Endophytic Nitrogen Fixing Bacteria on Nutrient Uptake, Yield and Quality of Pre-Seasonal Sugarcane (Third Ratoon)

K.B Patil* and M.R. Chauhan
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kuldeeppatil817@gmail.com*

The experiment was laid out at M.P.K.V Rahuri, P.G.I farm in RBD design with four replications and six treatments. Which comprises, T_1 - Absolute control, T_2 - RDF + 100% Nitrogen (250 kg N ha^{-1}), T_3 - 50% N + Acetobacter diazotrophicus @ 2.5 kg ha^{-1} (foliar spray), T_4 - 25% N + Consortium of endophytic bacteria @ 3 L ha^{-1} (foliar spray at 60 DAHR), T_5 - 0% N + Consortium of endophytic bacteria @ 3 L ha^{-1} (foliar spray at 60 DAHR), T_6 - 0% N + without consortium of endophytic bacteria.The application of 250 kg N, 115 kg P_2O_5 and 115 kg K_2o ha^{-1} (RDF) to third ratoon sugarcane significantly increased cane and CCS yield followed by 25% N with foliar application of consortium of endophytic bacteria (T_4). Total uptake of phosphorus by sugarcane and B:C ratio was found significantly highest in 25% N with foliar application consortium endophytic bacteria (T_4). Total cane height , millable cane height, no. of millable canes, length girth of internode were significantly higher in RDF treatment followed by 25% N with foliar application of consortium endophytic bacteria. It is found that application of 25% N (136 kg urea ha^{-1}) + 100% P_2O_5 (719 kg SSP ha^{-1}) + 100% K_2O (192 kg MOP ha^{-1}) with foliar application of consortium of endophytic bacteria @ 3 L ha^{-1} in 500 L water at 60 days after harvesting of ratoon crop of sugarcane found beneficial increased in the cane yield, commercial sugar yield and saving of 75% N with higher B:C ratio.

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Release Pattern of Dissolved Silicon and its Budgeting under Acidic, Neutral and Alkaline Soils

Mohsina Anjum* and N.B. Prakash
Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Bengaluru, 560065, Karnataka
**Email: mohsinaa12@gmail.com*

Silicon (Si) stored in the phytoliths are called phytogenic Si (PhSi). Information about the importance of PhSi and influence of agricultural management practices on Si cycling in paddy soil is lacking. Accordingly, a pot experiment was conducted on the comparative study of different sources of PhSi to study the dissolution of PhSi and Si budgeting in soils of contrasting pH. The experiment was laid out with the treatments T_1: control without plant (Ck-RP), T_2: control with plant (Ck + RP), T_3: Rice straw @ 20 t ha^{-1}, T_4: rice straw biochar @ 20 t ha^{-1}, T_5: rice husk @ 20 t ha^{-1} and T_6: rice husk biochar @ 20 t ha^{-1}. Soil solution sampler (rhizon) was placed horizontally at 10 cm depth of the pots. Soil solution samples were collected at 0, 7, 15, 30, 45, 60, 90, and 120 days after transplanting (DAT) and analysed for dissolved silica (DSi) content. Soil Si pools *viz.*, calcium chloride extractable Si (CCSi), acetic acid extractable Si (AASi) and phytogenic Si (PhSi) were also analyzed. Among the soils the DSi (mg L^{-1}) content in soil solution ranged from 0.63-12.67 mg L^{-1}, 3.74-31.49 mg L^{-1} and 8.24-48.25 mg L^{-1} in acidic, neutral and alkaline soils, respectively. Delta (Δ) Si content, is calculated by differences in post-harvest and initial content of soil Si pools such as CCSi, AASi and PhSi to determine the Si budget. Among all three soils, the extent of soil Si stock (±ΔCCSi, ±ΔAASi and ±ΔPhSi) was recorded lower in the acid soil compared to neutral and alkaline. the study results indicates that phytoliths are readily dissolvable and therefore recycling of rice residues increases Si availability in soil. However, the extent and magnitude of Si bioavailability may further depend on soil properties and processes, hence soil type.

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Within-field Spatial Variability of Potassium in a Potato Growing Region of Punjab State and its Implications for Sampling Strategies

Lovedeep Pandher* and B.S. Sekhon
Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: lovedeeppandher@pau.edu*

Variability chart technique, quantile distributions and correlation analyses were used to assess the within-field spatial variability of soil test potassium (K) to develop an economical sampling method. One hundred eighty geo-tagged surface soil (0-15 cm) samples were collected by following a 20 m by 10 m grid pattern, from three (60 each) different potato fields. The samples were tested for soil test K using five different extractants *i.e.* 1M Ammonium acetate extractable K (AAK), 1M Ammonium bicarbonate-0.005M Diethylenetriaminepentaacetic acid extractable K (AB-DTPA K), Sodium tetraphenyl boron extractable K (STPB K) and 1M boiling nitric acid extractable K. The AAK showed highest spatial variability (CV 45.8%) followed by AB-DTPA K (CV 38.6%), nitric acid K (CV 24.5%) and STPB K (CV 15.9%). The 1M boiling HNO_3 method, however, yielded largest minimum sample size (28804 to 53650) among all soil K tests. Plotting variability along northing and easting by following variability chart technique, however, helped divide fields into 2-4 zones and it can address large sample size worked out by making Fisher's least significant difference computations in reverse order. The study has implications in designing economical sampling plans and refining soil test based K fertilizer recommendations.

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Impact of Organic, Inorganic and Integrated Farming System on Soil Physical and Microbial Properties

Brijesh Yadav[1], Somasundaram Jayaraman[2]*, A.B. Singh[2], J.K. Thakur[2], Nishank K. Sinha[2], Anil Nagwanshi[2], Amar Singh Rathore[2], R.S. Chaudhary[2] and Ashok K. Patra[2]

[1]ICAR-National Bureau of Soil Survey & Land Use Planning, Regional Center, Udaipur, 313001, Rajasthan
[2]ICAR-Indian Institute of Soil Science, Nabibagh, Bhopal, 462038, Madhya Pradesh
**Email: somajayaraman@gmail.com*

The rapid increase in the global population is exploiting/degrading natural resources and threatens the sustainability of farming systems in many parts of the world. Intensification without sustainable management (appropriate techniques) and the over/under-use of chemical fertilizers decreases organic matter and soil fertility and increases soil erosion and environmental degradation. Therefore, present study was conducted to evaluate the impact of organic farming on soil biological and physical properties after 13 years of experimentation. The mean soil organic carbon (SOC) was maximum in 100 % organic (0.90%) and 50% Organic + NF (0.90%) and lowest was recorded in state recommendation (0.75%). Soil pH was higher in 100 % organic and the lowest was recorded state recommendation. While, electrical conductivity (EC) was highest under state recommendation treatment for 0-10 and 10-20 cm soil depths. The bulk density (BD) was lowered in 100 % organic as compared to inorganic practices. The mean value of DHA enzyme was highest in 100% organic treatment followed by 50% Organic + NF and lowest in 100% inorganic at 0-10 cm soil depth. Similarly, FDA and â-glucosidase enzyme activities were highest in 100 % organic treatments over inorganic treatments. The study findings suggest that organic farming improved soil physico-chemical properties and soil health.

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Enhanced Vascular Lignin Deposition in Soybean Stem through Trichoderma Inoculation

Subhadip Paul[1]* and Amitava Rakshit[2]
[1]ICAR-Indian Agricultural Research Institute, New Delhi, 110012
[2]Banaras Hindu University, Varanasi, 221005, Uttar Pradesh
**Email: l12near14paul88@gmail.com*

Soybean, being a legume, is very sensitive to soil nutrient status. Several reports have shown that lodging due to nutrient stress occurs frequently in soybean under field conditions. Mostly, these nutrient imbalances were treated with mineral fertilizers; however, microbial intervention is now a day become the prime focus to sustain long-term crop productivity along with soil health. The genus *Trichoderma* is best known for its plant stress alleviation. Researchers have shown that different species of *Trichoderma* upon inoculation have increased the stem lignin deposition in different field crops. Stem lignification assists in promoting resistance against lodging under unfavourable field conditions such as impaired soil fertility status. The objective of this experiment was to facilitate stem lignification of soybean through *Trichoderma viride* priming under graded soil application of nitrogen, phosphorus, and potassium. The phloroglucinol staining method was followed for lignin visualization under the light microscope. Total lignin content and activities of lignifying enzymes (cinnamyl alcohol dehydrogenase and guaiacol peroxidase) were determined spectrophotometrically. Root colonization of *Trichoderma* was assessed in Trichoderma Specific Medium. Rectangular and thick lignification pattern was observed in all *T. viride*-treated soybeans; while, untreated plants showed comparatively thin and circular lignification pattern. Significantly ($P < 0.05$) higher lignin contents were recorded from all inoculated treatments. Similarly, the activities of guaiacol peroxidase and cinnamyl alcohol dehydrogenase were found comparatively higher in treated soybeans than in untreated ones. Principle component analysis revealed that higher colonization of *T. viride* in treated soybeans had strongly influenced the lignification process as compared to untreated soybeans. This lignified stem of soybean has the potential to withstand lodging under different stress conditions in the field.

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Quality Assessment of Vermicompost and Vermiwash prepared from litters of Horticultural Crops.

S.R. Patankar, S.B. Dodake, R. Parulaekary, V.G. Salvi, M.C. Kasture, S.S. More, N.H. Khobragade and Rajesh Dhopavkar*

Department of Soil Science and Agricultural Chemistry, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: rajeshdhopavkar@rediffmail.com*

Vermicomposting is a biotechnological process, in which organic material is converted into valuable product by earthworms. The present investigation pertaining to "Ouality Assessment of Vermicompost and Vermiwash Prepared from litters of Horticultural Crops" was carried out during the year 2020-2021 at Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The experiment was laid out in a Factorial Randomized Block Design (FRBD) With eight treatments and Four Replications using the leaf litter waste of Jackfruit (*Artocarpus heterophyllus*), Coconut (*Cocus nucifera*), Areaca-nut (*Areca catechu*) and Sapota (*Manilkara zapota*) in combination with Epigeic species of earthworms namely *Eudrilus euginae* and *Eisenia foetida.* The decomposer is used for rapid composting of leaves wastes and cattle dung is used as substrate. The Vermicompost and Vermiwash samples from each experimental pot were collected at 30, 60, and 90 days interval and these samples were analysed to monitor the changes in nutrient content. The results indicated that the in case of chemical properties the pH of vermicompost and vermiwash considerably decreased with increase in electrical conductivity throughout the composting period. In case of major nutrients in vermicompost, the jackfruit leaf waste was found significantly superior with highest total nitrogen content (1.42%), highest total phosphorus content (0.51%) and highest total potassium content (1.06%). The lowest result of total N, P, K content (1.22%, 0.39%, 0.86%) respectively were observed in case of coconut leaf waste. With respect to the micronutrients, the maximum total iron, manganese, zinc and copper content (1618.07, 109.93, 26.58 and 7.43 ppm) respectively was registerd in case of jackfruit leaf waste. In case of nutrient content in vermiwash, the maximum NPK content (114.57, 30.84, 197.24 ppm) respectively and Fe, Mn, Zn and Cu content (2.98, 0.88, 0.75 and 0.49 ppm) respectively was noticed in case of jackfruit leaf waste at the end of composting period. With the advancement of composting period from 30 DAI to 90 DAI, there was gradual and considerable reduction in C:N ratio in vermicompost and vermiwash were observed. On the basis of data obtained from present investigations, it can be concluded that amongst the different sources, jackfruit leaf waste was found the best source in terms of preferable quality of vermicompost and vermiwash production with respect to major and minor nurtrient content and optimum vermicompost production followed by sapota leaf waste. Amongst two different epigeic species of earthworms, *Eudrilus euginae* was found superior than *Eisenia foetida* for enhancing the composting process quality of composting material.

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Effect of Phosphate Rich Organic Manure (PROM) on Wheat Yield and Soil Properties of an Acid Alfisol

Rewangini Ranjha*, Dhanbir Singh and Sanjay Kumar Sharma
Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 176062, Himachal Pradesh
**Email: sunilgarhwaal@gmail.com*

Wheat is a major staple crop after rice and is extensively grown in India. But, productivity of wheat is quite low in an acid Alfisol as compared to national average. This may be due to low nutrient use efficiency especially of phosphorus in acid soils, as approximately 70 per cent of inorganic P get fixed by iron and aluminium oxides and hydroxides present in it. Therefore, it is necessary to use alternative and low-cost organic sources of P like phosphate rich organic manure (PROM). Considering these facts, a field experiment during *rabi* 2021-22 was conducted in research farm of soil science department, CSK HPKV, Palampur, H.P. to study the effect of phosphate rich organic manure on wheat yield and soil properties of an acid Alfisol. Treatments of experiment were T_1: Farmer's practice, T_2: 100% NPK, T_3: 100% NPK + Lime, T_4: 100% NPK + 10 t FYM ha^{-1}, T_5: 0.5 t ha^{-1} *Ghanjeevamrit* + *Jeevamrit* spray (natural farming), T_6: 100% NK + 3 t PROM ha^{-1}, T_7: 100% NK + 75% P + 0.75 t PROM ha^{-1}, T_8: 100% NK + 50% P + 1.5 t PROM ha^{-1} and T_9: 100% NK + 25% P + 2.25 t PROM ha^{-1}. The results revealed that 1.5 t PROM ha^{-1} + 50% P through SSP resulted in maximum crop growth, grain yield (38.7 q ha^{-1}) and straw yield (62.7 q ha^{-1}). It also had a significant effect on soil organic carbon, CEC and available NPK (277, 32.9 and 222 kg ha^{-1}, respectively). Therefore, PROM can be used as better alternative source of phosphorus in an integration with chemical phosphatic fertilizers for better sustainability of soil productivity for longer period of time.

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Iron Seed Priming Effects on Germination, Growth and Yield of Direct-Seeded Aerobic Rice

Vivek Sharma*, Vikash Kharb and S.S. Dhaliwal
Punjab Agricultural University Ludhiana, 141004, Punjab
**Email: sharmavivek@pau.edu*

Direct seeded rice (DSR) in aerobic conditions is an emerging production system in India. Iron (Fe) deficiency is a severe problem in aerobic rice which results in a decline in crop yields, food quality and human nutrition, especially in alkaline and calcareous soils having coarse textures. Iron seed priming can be a good alternative to increase germination percentage and ensure the supply of iron in rice seedlings at the initial growth stages. The experiments were conducted to evaluate the different sources of iron for seed priming in alleviating its deficiency and improving crop productivity in direct seeded aerobic rice. The experiments comprised of eight seed priming treatments i.e. Control, 1.0% $FeSO_47H_2O$ foliar application, $FeSO_47H_2O$ (0.5% Fe), $FeSO_47H_2O$ (1.0% Fe), Fe-EDTA (0.25% Fe), Fe-EDTA (0.5% Fe), FeONPs (0.025% Fe) and FeONPs (0.05% Fe) for 12 hours. on rice crop' cv PR 126 during *kharif* 2021 in two types of soil *i.e.* sandy loam, and sandy clay loam, respectively. In seed priming, The Fe content of paddy seeds showed a significant increase and varied from 38.0 to 302 mg kg^{-1}. The highest Fe content was recorded in treatment T_3 ($FeSO_4.7H_2O$-1.0% Fe), followed by T_2 ($FeSO_4.7H_2O$-0.5%Fe) and the lowest in control, respectively. Similarly the germination percentage (6.16%), root length (9.09%) and shoot length (18.9%) was highest in treatment $FeSO_47H_2O$ (1.0% Fe). The Fe seed priming with $FeSO_4.7H_2O$ (1.0%Fe) increased grain yield by 9-16 % in both soils. The plant height and chlorophyll content also showed a significant increase as compared to the control. The iron content in rice grain increased by 44 to 80% in both experiments. Among different treatments, $FeSO_4.7H_2O$ (1.0%Fe) was found most effective for enhancing the yield and yield attributes along with Fe content in grains.

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Effect of Zinc Application Strategies on Growth, Productivity and Nutrient Uptake by Soybean under Vertisols of Central India

Suwa Lal Yadav[1], Hitendra K. Rai[2] and Devilal Birla[1]
[1]Anand Agricultural University, Anand, 388110, Gujarat
[2]Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 482004, Madhya Pradesh
**Email: suwalalyadav96@gmail.com*

The experiment was carried out with soybean variety JS 20-29 at research farm of JNKVV, Jabalpur (23° 10' N latitude, 79° 57' E longitudes and at elevation 393.0 m mean sea level) during *Kharif* season of 2019. Experiment was laid out in randomized block design with fourteen treatments of RDF + basal application of $ZnSO_4$ 5.0 kg ha^{-1} and 0.25% foliar application of $ZnSO_4$ with and without salicylic acid which were replicated three times. Best field management practices followed for growing soybean crop were adopted. Basal and foliar application of $ZnSO_4$ with and without salicylic acid affect significantly on most of the growth and yield attributes and yield of soybean. And levels of $ZnSO_4$ application significantly affect the growth and yield attributes and yield of soybean. Maximum plant height was found with RDF+5.0 kg Zn ha^{-1} + Spray of 0.5% $ZnSO_4$ + 150 ppm Salicylic acid at 35 and 55 DAS. Yield was highest under RDF + 5.0 kg Zn ha^{-1} + Spray of 0.5% $ZnSO_4$ + 150 ppm Salicylic acid at 35 and 55 DAS followed by RDF + 5.0 kg Zn ha^{-1} + Spray of 0.5% $ZnSO_4$ + 150 ppm salicylic acid at 35 DAS. N, P, K and Zn content and uptake by soybean was significantly affected by RDF + basal application of $ZnSO_4$ 5.0 kg ha^{-1} and 0.25% foliar application of $ZnSO_4$ with and without salicylic acid and highest values were found in RDF + 5.0 kg Zn ha^{-1} + Spray of 0.5% $ZnSO_4$ + 150 ppm Salicylic acid at 35 and 55 DAS. Based on experimental result the performance of soybean was best with RDF + 5.0 kg Zn ha^{-1} + Spray of 0.5% $ZnSO_4$ + 150 ppm Salicylic acid at 35 and 55 DAS.

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Organic and Inorganic Fertilization on Soil Fertility, Yield and Proximate Composition of Elephant Foot Yam

K. Laxminarayana*
ICAR-Central Tuber Crops Research Institute, Regional Centre, Bhubaneswar, 751019, Odisha
**Email: klnarayana69@rediffmail.com*

Field experiments were conducted for two consecutive years during 2018-2020 to study the effect of integrated use of inorganic fertilizers and organic manure on soil health and yield performance of elephant foot yam (*Amorphophallus paenifolius* L.) in an acid Alfisol of Eastern India. Elephant foot yam (*cv* Gajendra) corms were planted at a spacing of 75×75 cm and grown up to maturity. Significantly highest mean corm yield of elephant foot yam (26.50 t ha^{-1}) was recorded due to integrated application of FYM @ 10t ha^{-1} + ½ N, P and K followed by soil test based doses of NPK *i.e.* 80-30-80 kg ha^{-1} of N, P_2O_5 and K_2O. Graded doses of nitrogen or potash fertilizers showed a corm yield response of 21, 39 & 33% and 24, 39 & 46% in elephant foot yam due to addition of 40, 80 and 120 kg ha^{-1} of N or K_2O fertilizers over control, respectively. Dual application of N, P and K fertilizers showed higher yield response over that of single nutrient application. Incorporation of FYM alone recorded an increase of 24% corm yield (19.80t ha^{-1}) over control. The bio-chemical constituents in the corms of elephant foot yam were found highest due to integrated use of FYM + ½ NPK. The soil bacteria and actinomycetes are involved in nutrient transformations in the soils and had significant relationship with yield and proximate composition of elephant foot yam. Highest dehydrogenase (1.86µg TPF hr^{-1} g^{-1}), fluorescein diacetate hydrolysis assay (2.86 µg TPF hr^{-1} g^{-1}), urease (282 µg NH_4-N g^{-1} hr^{-1}), acid and alkaline phosphatase activities (82.3 & 70.3 µg PNP g^{-1} hr^{-1}) were observed due to conjoint application of FYM+½ NPK. Integrated application of FYM and half of the soil test based NPK not only sustain the soil quality but also enhanced productivity of elephant foot yam in Alfisols.

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Partial Substitution of Chemical Fertilizers by Organic Manures Affects Soil Organic Carbon and its Pools at Varying Depths of Soils under Semi-Arid Inceptisols of Haryana

Vishal Goyal[1]*, Supriya Ranjan[2], K.K. Bhardwaj[1] and Pradip Dey[2]
[1]CCS Haryana Agricultural University, Hisar, 125004, Haryana
[2]STCR, ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: vishal_goyal11@rediffmail.com*

Understanding the dynamics of soil organic carbon as affected by nutrient management is imperative for maintaining soil health. The effect of long-term partial substitution of chemical fertilizers by organic manures on soil organic carbon and their pools in pearl millet-wheat system under the semi-arid region of Inceptisols is unclear. The study aimed to identify the long-term effect of fertilizers and manures on the availability of organic carbon and nitrogen due to changes in its organic and inorganic pool at 0-5, 5-15, and 15-30 cm soil depth. The experiment was initiated in 2009 with seven treatments viz. control (Ck), FYM @ 15 tha^{-1} (FYM), Package recommendation (PR) of CCSHAU, Hisar, TY 3.0 $Mgha^{-1}$ (TY 3.0), TY 3.5 $Mgha^{-1}$ (TY 3.5), TY 3.0 $Mgha^{-1}$ IPNS (TY 3.0 IPNS) and TY 3.5 $Mgha^{-1}$ IPNS (TY 3.5 IPNS) yield targets of 3.0 and 3.5 $Mgha^{-1}$ without and with FYM. The highest value of total organic carbon (C_{TOC}) (19.28 g kg^{-1}) and heavy fraction of organic carbon (C_{HFOC}) (3282.50 mg C kg^{-1} soil) was observed in sole FYM treatment while the lowest was in Ck. The long-term nutrient management using STCR approach showed an increase of 1.6, 6.4, and 3.4 percent in mineral-associated organic carbon (C_{min}) at 0-5, 5-15, and 15-30 cm soil depth in chemical fertilizer treated plots. The study also showed that the content of C_{DOC}, light fraction organic carbon (C_{LFOC}), very labile (C_{VL}) and labile (C_L) fraction of organic carbon increased significantly in FYM treated plots, which contributes to enhancing the microbial biomass of carbon (C_{MBC}). Continuous incorporation of FYM in soil for 12 cycles of the pearl millet-wheat cropping system significantly increased the grain yield of pearl millet and wheat due to increased carbon stock and carbon management index (CMI), thus revealing the sustainability of management practices for enhancing the soil productivity and health.

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Effect of Integrated Nutrient Management in Brinjal on Soil Nutrient Availability under Zone I of Himachal Pradesh

Saurabh Thakur, Anil Kumar, Swapana Sepehya and Aanchal
Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, 173230, Himachal Pradesh
**Email: kapoor.aanchal88@gmail.com*

A field experiment was carried out to study the effect of integrated nutrient management in brinjal on soil nutrient availability under Zone I of Himachal Pradesh at the Experimental Farm of the Department of Soil Science and Water Management, College of Horticulture and Forestry, Neri, Hamirpur during kharif (2020) season in a randomized block design with eleven treatments replicated thrice.The nitrogen application through inorganic fertilizer was substituted by vermicompost which was quantified on the basis of its nitrogen content on dry weight basis and full doses of phosphorus and potassium fertilizers were applied in all the treatments. However, in control plots, there was no application of any kind of fertilizer or manure.The soil of the Experimental Farm was sandy loam in texture, neutral in reaction, medium in organic carbon, P & K and low in available N content. The results of the study revealed that application of 100 per cent RDN through vermicompost + Azotobacter (T_{11}) registered highest available N, P, K and S content while the lowest were recorded in control. The highest value of exchangeable Ca and Mg content was also recorded under the same treatment. Therefore, it was concluded that the application of 100 per cent RDN through vermicompost + Azotobacter (T_{11}) resulted in improved nutrient availability in soil which could be an important factor affecting the production of brinjal crop.

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Yield and Quality of Safed Musli as Influenced by Various Organic Inputs and Foliar Spray Humic Acid in Vertisol

A.B. Aage, S.D. Jadhao*, S.M. Bhoyar, G.S. Laharia, Varsha Tapre, P.W. Deshmukh, D.V. Mali and D.S. Kankal

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra

**Email: sdjadhao@rediffmail.com*

The present investigation was conducted during kharif, 2019-20 at Research Farm, Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The soil of the experimental site was Vertisol which was moderately alkaline in reaction, low in available nitrogen, and medium in available phosphorus and high in available potassium. The experiment was laid out in Randomized Block Design with nine treatments replicated in three replications. The treatments comprised of absolute control, Vermicompost @ 5 t ha^{-1}, NPS compost @ 3 t ha^{-1}, Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5% humic acid, Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % humic acid, Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5% humic acid, NPS compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % humic acid, NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5% humic acid, NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5% humic acid. The results indicated that the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5% humic acid at 60 and 90 DAP was e recorded significantly highest fresh root and dry root yield which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5% humic acid. The significant improvement in quality *i.e.* saponin ,protein and fiber were recorded with application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5% humic acid which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5% humic acid. The application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5% humic acid were recorded significantly highest nutrient uptake by safed musli which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5% humic acid.

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Nutrient Availability as Influenced by Micronutrient Fortified Briquettes in Lateritic Soils of Konkan

S.B. Dodake[1], Sagar S. Patil[1] and M.C. Kasture[2]
[1]Department of Soil Science and Agricultural Chemistry, [2]Directorate of Research (Agri.),
Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: suresh_dodake64@rediffmail.com*

Incubation study was carried out to study the effect of micronutrient fortified briquettes application on nutrient availability in lateritic soils of Konkan at Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli, during 2021. The experiment was laid down in Completely Randomized Design with three replications and nine treatments *Viz.* T_1: Absolute control, T_2: RDF (150:50:50 NPK Kg ha^{-1}), T_3: 100 % N through Konkan Annapurna Briquette (KAB) through straight fertilizers, T_4: 80 % N through Konkan Annapurna Briquette (KAB), T_5: 60 % N through Konkan Annapurna Briquette (KAB), T_6: RDF + 2 kg Boron + 3 kg Zinc ha^{-1}, T_7: 100 % N through KAB fortified with 2 kg Boron + 3 kg Zinc ha^{-1}, T_8: 80 % N through KAB fortified with 2 kg Boron + 3 kg Zinc ha^{-1} and T_9: 60 % N through KAB fortified with 2 kg Boron + 3 kg Zinc ha^{-1}. The soil samples were collected at 30 days interval by complete destruction method *i.e.*, 30, 60, 90 and 120 days after incubation and analysed for available nutrients in soil. The soil pH and available Cu (mg kg^{-1}) decreased over initial soil values. The values of electrical conductivity (ds m^{-1}) increased over initial values. The soil available nitrogen was increased up to 90 DAI except in absolute control and thereafter, it found decreased at 120 DAI. As regard nitrogen levels, the application of 100 % N through KAB fortified with 2 kg Boron + 3 kg Zinc ha^{-1} significantly increased the soil available nitrogen than other levels of nitrogen. The highest hot water extractable boron values were recorded at 120 DAI over 30, 60 and 90 DAI in the treatment receiving application of 100 % N through KAB fortified with 2 kg Boron + 3 kg Zinc ha^{-1}.

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Prediction Equation for Brinjal Crop in Mannadipet Soil Series of Puducherry

Bagavathi Ammal[1]*, M. Pradeepa[1], K.Coumaravel[1], R. Sankar[1] and Pradip Dey[2]
[1]Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal, 609603, Puducherry
[2]ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: pancham112@gmail.com*

To apply soil test based fertilizer recommendations, the soils are to be tested after each crop. Hence it has become necessary to predict the soil test values after the harvest of the crop. It is done by developing post-harvest soil test value prediction equations making use of the initial soil test values, applied fertilizer doses, yields and uptake of nutrients obtained following the methodology outlined by Ramamoorthy *et al.* (1971).The post-harvest soil test values were taken as dependent variable and a function of the pre-sowing soil test values and the related parameters like yield, uptake and fertilizer doses.

The functional relationship is as follows

YPHS=f (F, ISTV, yield/uptake)

Where, YPHS is the post-harvest soil test value; F is the applied fertilizer nutrient and ISTV is the initial soil test value of N/P/K. The equation will take the mathematical form,

$YPHS= a+b_1F+ b_2IS+b_3$ yield/uptake

Where, a is the absolute constant and b_1, b_2 and b_3 are the respective regression co-efficients. Using these regression equations, the post-harvest soil test values of N, P and K were predicted after brinjal crop.

The results indicated that under NPK alone treatments, in the case of prediction of $KMnO_4$-N, 87.7 and 87.8 per cent of the variations was accounted by the fruit yield and nitrogen uptake respectively. With respect to Olsen-P, the variation was 76.8 per cent with fruit yield and 77.8 per cent with phosphorus uptake. The variation of NH_4OAc-K was 89.2 per cent with fruit yield and 90.8 per cent with potassium uptake were accounted by soil potassium and fertilizer potassium, yield and uptake respectively. When the field was imposed with NPK + FYM @ 6.25 t ha^{-1}, 81.4 and 80.6 per cent of the variations for $KMnO_4$-N was accounted by the fruit yield and nitrogen uptake respectively. With respect to Olsen-P, the variations were 87.1 and 85.9 per cent with brinjal fruit yield and phosphorus uptake . The variation of NH_4OAc-K was 84.7 per cent with fruit yield and 84.8 per cent with potassium uptake were accounted by soil potassium and fertilizer potassium, yield and uptake respectively. When the field was imposed with NPK + FYM @ 12.5 t ha^{-1}, 99.8 per cent of the variations for $KMnO_4$-N was accounted by the fruit yield and nitrogen uptake respectively. With respect to Olsen-P, the variation was 80.9 and 78.0 per cent with fruit yield and phosphorus uptake respectively. In the case of NH_4OAc-K the variation was 90.2 and 87.8 per cent with fruit yield and potassium uptake. Significantly higher R^2 values recorded for the post-harvest soil test values prediction equations proved that these equations can be used with much confidence for predicting the soil test values after rice.

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Effect of Long Term Manuring and Fertilization on Carbon Budgeting under Sorghum Wheat Cropping Sequence in Vertisols

Prashant H. Rathod, S.M. Bhoyar, S.D. Jadhao*, P.W. Deshmukh, G.S. Laharia and B.A. Sonune

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: sdjadhao@rediffmail.com*

The field experiment entitled "Appraisal of carbon dynamics and its sequestration under long term sorghum-wheat cropping sequence in Vertisols" was superimposed on the 32nd and 33rd cycle of the ongoing long term fertilizer experiment (LTFE) on sorghum-wheat sequence during 2019-20 and 2020-21, at Dept. of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was conducted in randomized block design with twelve treatments in four replications. The results of present experiment reveal that, the highest carbon build up, build up rate, stabilization rate and sequestration were found with the application of FYM @ 10 t ha^{-1} continuous as source of nutrients followed by application of 100% NPK+FYM @ 5 t ha^{-1}. Among the inorganically treated plot, the application of 150% NPK fertilization recorded highest carbon build up, build up rate, stabilization and sequestration of carbon. Similarly, the highest total organic carbon and organic carbon were noticed with plot incorporated with sole FYM @ 10 t ha^{-1} and statistically at par with 100% NPK+FYM @ 5 t ha^{-1} while, lowest was observed under control, sub optimal and imbalanced fertilization.

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Influence of Boron on Yield of Okra and Soil Microbial Activities in Inceptisols of Odisha

Ranjan Kumar Patra*, Rabindra Kumar Nayak, Narayani Meher, Kiran Kumar Mohapatra and Kshitipati Padhan

Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: granjanpatra@gmail.com*

A study was carried out at Central Farm, OUAT, Bhubaneswar during January to April, 2021 with the objectives of studying the effect of foliar spray of boron on yield of Okra and the soil microbial activities. The experiment was laid out in RBD with ten treatments replicated thrice. The treatments included one no B control (only soil test dose NPK), NPK+B@1.0 kg B ha^{-1} soil application and eight treatments of foliar application of B @ 0.25, 0.5, 0.75 and 1.0% borax sprayed once or twice at 25 and/or 50 DAS. There was a marginal increase in pH of the treated plots over the initial value of 4.56. There was no significant change in organic carbon content of the treated plots over the initial value of 0.45% and also among the treatments. The yield attributing characters like plant population, plant height, leaf area per plant were recored to increase significantly with boron application over no B control treatment irrespective of dose and method of application of B. The mean yield of fresh fruit varied from 6.52 to 8.64 t ha^{-1} due to different doses and frequency of boron application. Soil application of boron @ 1.0 kg B ha^{-1} or two foliar sprays @ 0.5% borax at 25 and 50 DAS were found to be suitable for giving higher yield of okra compared to no or once foliar application. The B uptake by fruits in different treatments was statistically significant and varied from 0.58 to 1.46 g ha^{-1}. The highest uptake was observed in the treatment receiving NPK + 0.5% Borax 2 sprays (151% increase over control) followed by the treatment receiving NPK+B@1.0 kg B ha^{-1} soil application (134% increase over control) and the lowest was recorded in no B control treatment. The bacterial, fungal and actinomycetes population of soil in different treatments measured one week after 1st and 2nd foliar spray of B recorded a significant increase in number of count in all treatments including the one applied with B as basal in soil over that in control. A reduction in population of fungus (2-16%) and actinomycetes (9-43%) measured one week after 2nd spray was observed over that recorded after 1st spray. In contrast, an increase in population of bacteria (up to 28%) measured one week after 2nd spray was observed over that recorded after 1st spray. The urease and dehydrogenase activity of soil due to different boron treatments varied significantly among the treatments from 25.2 to 38.6 mu g NH_4^+ N g^{-1} soil 2 h^{-1} and 0.7 to 46.6 micro g TPFg^{-1} soil 24 h^{-1}, respectively. The urease and dehydrogenase activities of soil measured one week after 2nd foliar spray of B increased with application of B to okra irrespective of dose and application methods.

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Soil Fertility Assessment of Upper Banas River Basin of Southern Rajasthan

Kamal Kishore Yadav*, Kishan Damor, D.P. Singh, Manjeet Singh and P.K. Singh
Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan
**Email: kk_yadav75@rediffmail.com*

A survey of Upper Banas River Basin was conducted in pre monsoon season (April-May) 2022 in a systematic grid square pattern. The study area falls under southern Rajasthan which covers17 tehsils of Udaipur, Rajsamand, Chittorgarh and Bhilwara districts of Rajasthan. The grid size was 7.5 km × 7.5 km. From each grid a surface soil samples (0-15 cm depth) was collected and total soil samples were 100. The location of the soil samples were recorded with the help of Global Positioning System (GPS). The soil samples were processed and analyzed for EC, pH, OC, available N,P,K, S, Fe, Mn, Zn and Cu in the laboratory following standard procedures. It was found that $EC_{(1:2)}$ (dSm^{-1}), $pH_{(1:2),}$ OC (%), available N,P,K (kg ha^{-1}) and available S, Fe, Mn, Zn and Cu (mg kg^{-1}) ranges from 0.01-1.64, 7.00-7.98, 0.05-1.25, 184.80-603.00, 11.75-47.70, 120.56-371.17, 5.03-15.25, 0.79-16.00, 1.00-21.69, 0.68-3.50, 0.10-2.40, respectively, with the mean values of 0.49, 7.48, 0.56, 358.15, 26.43, 223.18, 8.64, 6.79, 6.74, 2.05, 1.35 respectively. Further, using point information different soil fertility maps were prepared under GIS environment which are highly useful for the policy makers and planners for soil fertility management of the study area.

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Influence of Different Organic Manure on Release of Iron in Calcareous Soils

Pramod Jagtap*
Zonal Agricultural Research Station, Ganeshkhind, Pune, 411067, Maharashtra
**Email: pbjagtap1964@gmail.com*

An incubation study and pot culture experiments were conducted to study the release of iron as influenced by organic manures in calcareous soils in the Division of Soil Science and Agricultural Chemistry at Rajarshee Chhatrapati Shahu Maharaj, College of Agriculture, and Kolhapur. The experiment consisted of two factors *viz* three soil types based on their CaCO3 levels *viz*. low, medium and high CaCO3 content and different organic manures *viz.* FYM, vermicompost and press mud compost and no organic manure in factorial completely randomized design (FCRD). The low, medium and high level of CaCO3 was having 4.4, 9.06 and 12.20 per cent CaCO3 content respectively. The FYM was added @ 10 t ha-1, vermicompost and press mud compost @ 5 t ha^{-1} each and all these organic manures were added with $FeSO_4.7H_2O$ @ 25 kg ha^{-1}. The higher $CaCO_3$ content had an adverse effect on available iron in soil. The application of organic manures helped to improve availability of iron in all the levels of $CaCO_3$ content in soil. The application of vermicompost and press mud compost each @ 5 t ha^{-1} along $FeSO_4.7H_2O$ @ 25 kg ha^{-1} was found better over application of only $FeSO_4.7H_2O$ @ 25 kg ha^{-1} in respect of availability of iron in soil. In pot culture experiment nutrient uptake by wheat crop was studied. The iron uptake was more in low calcareous soil. The application of different organic manures along with $FeSO_4.7H_2O$ @ 25 kg ha^{-1} found to be increased iron uptake by wheat crop as compared with application of FeSO4.7H2O @ 25 kg ha^{-1} without organic manures in soil.

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Effect of Combined Application of Innovative Organic and Inorganic Fertilizers on Maize Productivity and Available Nutrient Status in An Acid Alfisol

Rushali Katoch*
CSK Himachal Pradesh Agricultural University, Palampur, 176062, Himachal Pradesh
**Email: rushalikatoch19@gmail.com*

Integration of organic and inorganic fertilizers is a holistic approach necessary to obtain maximum crop productivity and maintaining soil fertility. To study the performance of maize (*Zea mays* L.) as influenced by different combinations of locally available new products namely, Sagarika (bio-stimulant), NPK Consortia (biofertilizer) and Water-Soluble Fertilizer (18:18:18), a field experiment was carried out at the experimental farm of department of Soil Science and Agricultural Chemistry, CSK HPKV, Palampur. The experiment was conducted using randomized block design with 10 treatments, viz. 100% NPK, 75% NPK, 75% NPK + foliar spray of Sagarika, 75% NPK + soil application of Sagarika, 75% NPK + foliar spray of Water Soluble Fertilizers (18:18:18), 75% NPK + seed treatment with NPK Consortia, 75% NPK + foliar cum soil application of Sagarika, 75% NPK + foliar spray of Sagarika and Water Soluble Fertilizer (18:18:18), 75% NPK + foliar cum soil application of Sagarika + foliar spray of Water Soluble Fertilizers (18:18:18) and 50% NPK + foliar cum soil application of Sagarika + foliar spray of Water Soluble Fertilizers (18:18:18) + seed treatment with NPK Consortia during *kharif*, 2019 in an acid *Alfisol*. The integrated use of inorganic fertilizers and Farm Yard Manure at optimum levels (100% NPK + 10 t FYM ha^{-1}) is generally recommended for profitable production of maize in mid hills of Himachal Pradesh. Soil cum foliar application of Sagarika and foliar application of Water Soluble Fertilizer (18:18:18) along with 75% NPK produced significantly highest grain yield of maize and out-yielded 100% NPK alone by 10.6 per cent. A similar trend was observed with stover yield of maize. However, significantly lowest productivity of crop was recorded with 75% NPK application alone. Though available macro- and micronutrient contents differed significantly, there was no change in soil fertility status over the initial ones in different treatments. The soil was medium in available N, P and K and sufficient in other nutrients.

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Carbon Dynamics as Influenced by Flax Based Cropping Systems

Sonali Paul Mazumdar*, Dhananjay Barman, Ritesh Saha, Sabyasachi Mitra and Gouranga Kar

ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, 700120, West Bengal
**Email: sonalimazumdar110@gmail.com*

One of the challenges of the effects of global climate change is to maintain agricultural productivity to meet current and projected trends in food production, at the same time as maximizing the sequestration of carbon (C) and nitrogen (N) in soil. Implementing sustainable cropping practices helps to maintain levels of soil organic matter (SOM) and soil fertility, and provides an opportunity to sequester C. Complex agro-ecosystems such as cropping system, where more than one crop is grown on the same land area at the same year, may be more sustainable because they make a more effective use of resources compared with single species crops. Very little review has been there carbon dynamics in flax based cropping system. We know Flax (*Linum usitatissimum L*.) for seed and fibre production has emerged as an alternative crop species for increased diversification of cropping systems. A field experiment was conducted for 4 years to study the impact of flax based cropping systems {Fallow-Flax, Rice-Flax (Conventional Tillage), Rice-Flax (Zero tillage) and nitrogen application on soil carbon pools, nutrient availability and crop productivity. After 4 years of crop rotation, in top 0-20 cm soil depth, Rice-Flax (Zero tillage) had higher total organic carbon (TOC) over Rice-Flax (Conventional Tillage). Meanwhile, Rice-Flax (Zero tillage) had higher water stable macro-aggregates, macro-aggregate: micro-aggregate ratio, over Rice-Flax (Conventional Tillage). Rice-Flax (Zero tillage) significantly increased the soil quality parameters over Rice-Flax (Conventional Tillage). Therefore, zero tillage in rice-flax cropping system was most effective for sequestering soil organic carbon, therefore it could be the best option for improving soil quality and Carbon storage in flax based cropping systems.

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Response of Rice to Boron Fertilization Grown in Inceptisol Deficient in Boron

Sriramachandrasekharan Venkataraman*, A. Kowsalya, P. Poonkodi, P. Senthilvalavan and R. Manivannan[1]
Annamalai University, Annamalainagar, 608002, Tamil Nadu
**Email: ram_uthrat@yahoo.com*

Boron has become a limiting factor for crop productivity in rice based cropping system. In Indian soils, boron has become second most important micronutrient deficiency next to zinc. Pot experiment was conducted in Inceptisol deficient in boron to examine the performance of rice grown in such soil to application of different levels and sources of boron. The experiment was conducted with two sources viz., borax and solubor with five levels *viz*., 0, 0.5, 1.0, 2.0 and 3.0 mg kg^{-1} in factorial completely randomized design. The test crop was rice ADT 43. The outcome of the experiment revealed that rice cop responded significantly to different levels of boron applied through two different doses over control. The various growth characters like plant height, tiller count, chlorophyll content, DMP besides rice yield netted highest with application of 2.0 mg kg^{-1} through solubor and decreased at 3.0 mg B kg^{-1} .The rice yield increased linearly with B levels and the highest grain yield (33.1 g pot^{-1}) and straw yield (43.3 g pot^{-1}) was noticed with application of 2.0 mg kg^{-1} through solubor and declined at 3.0 mg B kg^{-1}. The grain and straw boron uptake increased linearly with B levels and the highest B uptake was netted with addition of boron at 3.0 mg kg^{-1} through solubor. Apparent B recovery, agronomic efficiency and boron utilization efficiency was highest with 0.5 mg B kg^{-1}. The optimum dose of B to get maximum yield was noticed to be 1.85 mg kg^{-1}.

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Effect of Integrated Nutrient Management on Yield of Chickpea (*Cicer arietinum* L.)

D.P.S. Dudi*, Pramod Kumar, K.K. Yadav and S.C. Meena
Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan
**Email: dudi_dps@yahoo.co.in*

A field experiment was carried out at the Instructional Farm of Rajasthan Collage of Agriculture, Udaipur during *rabi* season 2021-22 to find out the effect of integrated nutrient management on yield and quality of chickpea. The experiment comprised of 12 treatments including one common control. The experiment was laid out in randomized block design with three replications. The soil of the experimental site was clay loam in texture, slightly alkaline in reaction (8.19 pH), medium in available nitrogen (238.23 kg ha^{-1}) and phosphorus (17.20 kg ha^{-1}) while high in potassium (376.12 kg ha^{-1}) and sufficient amount of DPTA extractable micronutrients. The use of 75% RDF + poultry manure @ 2.5 t ha^{-1} + PSB + *Rhizobium* significantly improved plant height, dry matter accumulation, grain and haulm yield (1985 and 2607.57 kg ha^{-1}) over control with a corresponding increase of 43.32 and 41.66 per cent in grain and haulm yield, respectively which was found at par with 75% RDF + Vermicompost @ 3 t ha^{-1} + PSB + *Rhizobium* and 75% RDF + FYM @ 6 t ha^{-1} + *Rhizobium* + PSB.

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Status of Different Physico-Chemical Properties of Soils of Ashoknagar District of Madhya Pradesh

S.K. Trivedi, Shankar Lal Yadav, Anjali Bhargava and Rahul Morya*
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, 474002, Madhya Pradesh
**Email: rahulh065@gmail.com*

Generally, different physico-chemical properties of soils are depending on the timing period and sources of irrigation system. In Ashoknagar District, the main classes of soil are black, brown and bhatori (stony) soil. The volcanic, clay-like soil of the region owes its black colour to the high iron content of the basalt from which it is formed. Keeping in view, One hundred twenty five GPS based surface soil samples (0-15 cm) were collected from five blocks (Mungavali, Chanderi, Ishagarh, Ashoknagar and Sadora) of Ashoknagar district during April to May 2018. Soils were studied for their physical and chemical characteristics and status of different physico-chemical properties of soils. The different physico-chemical properties of soils *i.e.* mechanical compositions (sand, silt and clay), soil pH, soil Ec, organic carbon, calcium carbonates and total-N were observed in the range of 36.6-56.6 (sand), 3.9-38.0(silt), 25.2-42.4(clay), 7.2-8.6 (soil pH), 0.32-0.62 dS m^{-1} (soil Ec), 2.14-7.06 g kg^{-1} (OC), 0.5-3.5% ($CaCO_3$) and 0.01-0.24% (total N) under different villages of investigated area with the average value of 8.0 (soil pH), 0.45 dSm^{-1}, 4.35 g kg^{-1}, 1.7% and 0.011%, respectively. The soil of Ashoknagar district of Madhya Pradesh is slightly alkaline in reaction and normal to soluble salts. Surface soil samples were non calcareous with low organic carbon content. The pH and electrical conductivity of all the blocks were observed in normal range. Low calcium carbonate content in the surface soil might be due to leaching of soluble salts in the lower layers of the soil profile. it might be due to incorporation of higher amount of organic matter in these soils due to higher foliage by good yield of irrigated crops. The soil requires less irrigation because of its high capacity for moisture retention. nitrogen metabolism in plant is regulated by physico-chemical properties of soils and consequently better yields are recorded in all types of crops. Such relationship suggests that a physico-chemical property exists in a state of dynamic equilibrium in these soils.

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Impact of Organic and Inorganic Amendments on Secondary and Micronutrients Status of Acidic Soil in Rice-Cowpea Cropping System

Hari Mohan Meena[1]* and H.C. Prakasha[2]
[1]Punjab Agricultural University, Ludhiana, 141004, Punjab
[2]University of Agricultural Sciences, GKVK, Bengaluru, 560065, Karnataka
**Email: harimohanmeena46@gmail.com*

Soil acidity has a detrimental effect on agricultural sustainability and soil health. Therefore, a field experiment was conducted during *Kharif* and *Summer* seasons for two consecutive years of 2016-17 and 2017-18 with rice (*Oryza sativa* L.) and cowpea (*Vigna unguiculata* L.), grown in a sequence at Zonal Agricultural Research Station, Mandya to study the impact of biochar, lime and mangala setright on secondary and micronutrients status of acidic soil. The experiment was laid out in a randomized complete block design with seven treatments and three replications. Application of lime along with STV (soil test value-based fertilizer application) + FYM (Farmyard Manure) + $ZnSO_4$ recorded highest exchangeable Ca (4.83 cmol (p^+) kg^{-1}) followed by biochar + STV + FYM + $ZnSO_4$ (4.55 cmol (p^+) kg^{-1}) as compared to RDF + FYM + $ZnSO_4$ (3.35 cmol (p^+) kg^{-1}). In case of exchangeable Mg and available S, application of biochar along with STV + FYM + $ZnSO_4$ increased the exchangeable Mg and available S by 65.32 and 27.47 %, respectively followed by lime + STV + FYM + $ZnSO_4$ (38.73 and 14.88%, respectively) than RDF + FYM + $ZnSO_4$. Likewise, the addition of mangala setright along with RDF + FYM + $ZnSO_4$ significantly increased the secondary nutrients content than farmers' practice. Application of biochar and lime along with + FYM + $ZnSO_4$ significantly decreased DTPA extractable Zn, Cu, Fe and Mn content as compared to RDF + FYM + $ZnSO_4$, but values were sufficient for available to plants. Similarly, the residual effect of biochar, lime and mangala setright on secondary and micronutrient content after harvest of residual cowpea crop followed an almost similar trend as observed after harvest of rice. Results suggested that the addition of biochar in combination with FYM significantly increased the secondary nutrients, and maintained the micronutrient status in acid soil.

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Quality of Small Onion Under Fertigation of TNAU Water Soluble Fertilizer (TNAU-WSF)

C. Vairavan[1]* and S. Thiyageshwari[2]

[1]Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
[2]Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
**Email: vairavanc99@gmail.com*

Fertilizer and water are the two most important inputs for agricultural production. Fertigation can save water from 40 to 60% over conventional irrigation methods. Fertigation offers fertilizer saving of 30-50 percent due to "improved fertilizer use efficiency" and "reduced leaching". Effective management of these resources is needed to achieve higher productivity in a sustainable way in arid and semi-arid of India. With this in view, maiden attempt was made to synthesize indigenous Water Soluble Fertilizer (WSF) named as Tamil Nadu Agricultural University - Water Soluble Fertilizer (TNAU-WSF) @ 19:19:19% of N, P and K by Tamil Nadu Agricultural University, Coimbatore, at the Department of Soil Science & Agricultural Chemistry. A field experiment was carried out to study the effect of TNAU-WSF on growth, yield and quality of small onion var. CO 4 at 75%, 100% and 125% level of NPK with and without Sulphur @ 40 kg ha^{-1} and foliar spray of TNAU Liquid Multi Micronutrient (TNAU- LMM) (1%). The quality parameters of small onion *viz*., total soluble solids (TSS) (14.78 ^{0}Brix), pyruvic acid (2.270 µmol g^{-1}), ascorbic acid (15.34 mg $100g^{-1}$) and total sugar (5.91 mg g^{-1} FW) were significantly higher with soil test based fertigation of TNAU-WSF @ 125% NPK in combination of S and TNAU LMM. Application of Sulphur @ 40 kg ha^{-1} recorded significantly higher pyruvic acid content indicating the positive response of small onion to Sulphur application.

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Controlled Release Formulations: a New Paradigm of Nutrient Supply to Plants

Abhijit Sarkar[1]*, D.R. Biswas[2], Madhumonti Saha[1], Khurshid Alam[2], D.K. Yadav[1], J.K. Saha[1] and A.K. Patra[1]

[1]ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
[2]ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: asiari2012@gmail.com*

Nitrogen (N) and phosphorus (P) are two most important and limiting nutrients for plants. Hence, fertilizer application to supplement these nutrients become inevitable to sustain the crop production and productivity. Used fertilizers are indeed water soluble and trendy to release the nutrients without bothering about plant nutrient demand. Here the concept of 'controlled release formulations' came. Literature suggested among several techniques, coting with biodegradable synthetic, natural polymers are most efficient and environment friendly. In this study commercial-grade di-ammonium phosphate (DAP; 18% N and 46% P as P_2O_5) and acidulated-rock-phosphates (ARPs) were used as nutrient core and coating was done with poly(vinyl alcohol) (PVA), liquid paraffin (LP), linseed-mustard oil formulations and clay-polymeric (starch/PVA) blended coating films (CPSBs). Products were characterized with different modern (XRD, FTIR, SEM, TEM) and conventional techniques to know their properties and modifications; finally assessed nutrient supplying capacity in pot culture with wheat as test crop. Results revealed that phosphoric acid based coated ARPs produced greater biomass yield than uncoated-DAP and sulphuric acid-based ARPs. Polymer coating of commercial-DAP delayed the P release compared with uncoated-DAP, while LP coating showed slower P release than PVA coated-DAP. Despite, LP coated-DAP showed greater temperature sensitivity (Q_{10}), but the PVA coated-DAP resulted significantly higher yield and biomass accumulation of wheat, with concomitant increase in crop P uptake and P use efficiency. On the other hand, 8%-CPSB-10-DAP recorded maximum grain yield (11.1 g pot^{-1} and 10.6 g pot^{-1}), straw yield (~32 and 37%) and total biomass yield (~33 and 30%) in Inceptisol and Vertisol, respectively. Similarly, linseed-mustard oil formulation coated DAPs had also produced better crop yield than that of uncoated-DAP, but not higher than the CPSB-coated DAPs. Hence, controlled release formulations using coating could be a better option for fertilizer use in agricultural crops.

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Effect of Foliar Application of Nano Nitrogen and Nano Zinc on Yield and Nutrient Uptake by Mustard

Kriti Sharma*, R.H. Meena, S.C. Meena, Devendra Jain and Gajanand Jat
Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan
**Email: ramharim@gmail.com*

An experiment was laid out in order to determine the effect of nano nitrogen and nano zinc on yield and nutrient uptake by mustard at Instructional farm of Rajasthan College of Agriculture, MPUAT, Udaipur during *Rabi* season of the year 2021-22. The experiment was laid out in a randomized block design with three replications. The experiment was consisted ten treatments The results showed that maximum seed yield (1596.17 kg ha^{-1}) and stover yield (3510.67 kg ha^{-1}) was reported under the treatment T_6 (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) which was significantly superior over treatments T_1(Control) T_2 (100% NPK Zn), T_3 (75% N Zn + 100 % PK) and T_4 (50% N Zn + 100 % PK). The higher nutrient uptake by seed and stover were observed with application of (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS (T_6) followed by application of 75% N Zn + 100 % PK +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS(T_8). However, maximum gross return (Rs. 118736.50 ha^{-1}), net return (Rs. 85330.20 ha^{-1}) and BC ratio (2.55) were obtained with application 75% N Zn + 100 % PK + 1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS.

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Effect of Rock Phosphate, Poultry Manure and Phosphate Solubilizing Bacteria on Availability of P and Yield of Chickpea

Deshraj Meena*, R.H. Meena, Gajanand Jat and Devendra Jain
Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan
**Email: ramharim@gmail.com*

A field experiment was conducted to study the rock phosphate, poultry manure and phosphate solubilizing bacteria on the availability of phosphorus and yield of chickpea at instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur during *rabi* 2021-22. The experiment was laid out in randomized block design with three replications. The experiment comprises 9 treatments *viz*., T_1: Control; T_2: PSB, T_3: 100% P through SSP; T_4: 100% P through RP; T_5: 100% P through PM; T_6: 50 % P through RP+ 50 % P through PM; T_7: 100% P through RP+ PSB; T_8: 100% P through PM + PSB and T_9: 50 % P through RP + 50 % P through PM + PSB. The results showed that application of 50% P through RP + 50% P through PM + PSB (T_9) significantly improved seed and stover yield. However it did not significantly differe from the treatments T_6 (50% P through RP + 50% P through PM), T_8 (50% P through PM + PSB). Maximum availability of available phosphorus was also recorded with the application of 50% P through RP + 50% P through PM + PSB (T_9). The best economic grain yield (2056 kg ha^{-1}) and net profit (91657 Rs. ha^{-1}) were observed under application of 50% P through RP + 50% P through PM + PSB (T_9).

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Effect of Foliar Application of Nano Fertilizers on Soil Properties under Maize (*Zea mays L.*)

Neha Khardia*, R.H. Meena, Gajanand Jat and Sonal Sharma
Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan
**Email: ramharim@gmail.com*

Nano fertilizers are one of the recent advancement tools in agriculture that are developed with an aim to increase nutrient use efficiency, reduce overuse of conventional fertilizers and indirectly the cost of cultivation. A field experiment was conducted during *kharif* 2020 at the Rajasthan College of Agriculture, Udaipur, Rajasthan to evaluate the influence of foliar application of nano fertilizers (nano N, Zn and Cu) on soil physio-chemical and biological properties of soil after harvest of maize crop. The treatments consisted of 12 treatments which were replicated thrice. The treatments having various combination of conventional and nano fertilizers (N, Zn and Cu). The result indicated that the soil physio-chemical and biological properties were significantly influenced by the foliar application of nano fertilizer (nano N, Zn and Cu). The available macronutrients (N, P, K), micronutrients (Zn and Cu), soil microbial population (bacteria, fungi and actinomycetes) as well as the dehydrogenase and acid phosphatase enzyme activity in post harvest soil of maize significantly highest under T_{12} [100% PK + 50% NZn + two sprays of nano N (4 ml l^{-1})+ nano Zn (1.25 ml l^{-1}) + nano Cu (2 ml l^{-1})]. The outcome of the present experiment demonstrates that the recommended dose of conventional fertilizers can be decreased by 50% by applying two sprays of nano fertilizers. Nano fertilizers reduce the overuse of conventional fertilizer as well as maintain the soil fertility and soil health for sustainable future.

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Monitoring Conversion of Grassland to Agro-Ecosystem: An on-Farm Study of Soil Fertility and System Productivity

Madhumonti Saha[1]*, Madhumita Das[2], Abhijit Sarkar[1], Jayanta Kumar Saha[1] and Ashok Kumar Patra[1]

[1]ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
[2]ICAR-Indian Institute of Water Management, Bhubaneswar, 751023, Odisha
**Email: madhumonti2609@gmail.com*

Introduction of cropping practices in grassland soil could be an option for system productivity. The objective of this study was to analyze the extent of soil organic carbon (SOC) and other major nutrient changes from the conversion of native grassland to diversified cropping system after nineteen years under tropical climate and to evaluate the system productivity, production and land use efficiency of different cropping systems. Selected cropping systems were, one uncultivated grassland (CP0) one rice-fallow (CP1) and three rice-based diversified cropping practices (CP2, CP3, CP4). Results revealed that the sharing of reactive SOC fraction was ranging between 49 and 80% of total SOC; whereas, recalcitrant SOC fraction was ranging between 20 and 51% of total SOC. Uncultivated soil (CP0) has significantly higher oxidative stability of SOC than rice-fallow (CP1) and other diversified rice-based cropping practices. CP1 recorded maximum mineral N and available P in 0-15, 15-30 and 30-45 cm soil depth. CP2 had highest exchangeable K, which was significantly higher (45.6%) than CP0. Higher bioavailable stoichiometric index (SBI) of nutrients was observed at 30-45 cm soil depth. The reactive fraction of SOC was positively correlated with soil clay content at 0-15 (R^2 = 0.69), 15-30 (R^2 = 0.83) and 30-45 cm (R^2 = 0.51); whereas, beyond 15 cm recalcitrant fraction of SOC was non-significantly correlated to clay content in soil. Beyond 30 cm soil depth, mineral N availability had non-significant dependency on SOC and clay content; whereas, available P had positive correlation with SOC at 0-15 and 15-30 cm depth. Exchangeable K pretends negative dependency on SOC and clay content over the entire profile (0-45 cm) under study. The total system productivity, production efficiency and land utilization efficiency were improved with higher crop diversification in the rice-based agro-ecosystem which may also enrich total SOC beyond 30 cm soil depth.

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Long-Term Eeffect of Potassium Fertilization on Physical and Chemical Properties of Inceptisols and Yield of Sorghum and Wheat

Komal Singh* and S.K. Bansal
Potash Research Institute of India, Sector-19, Gurgaon, 122001, Haryana
**Email: komals31@rediffmail.com*

To assess the long-term effect of potassium fertilization on physical and chemical properties of inceptisols and yield of sorghum (fodder) and wheat, a long-term fertilizer experiment was started in 1985 at research field of Potash Research Institute of India, Gurgaon (Haryana). Soil of experiment, in 1885, was loamy sand in texture, medium in 1N NH_4OAc-K and 1N boiling HNO_3-K status. There were seven treatments: $N_0P_0K_0$, $N_{120}P_{60}K_0$, $N_{120}P_{60}K_{60}$, $N_{120}P_{60}K_{120}$, $N_{240}P_{120}K_0$, $N_{240}P_{120}K_{120}$, $N_{120}P_{60}K_{60+\ 10\ t\ FYM.}$ Sorghum (fodder) and wheat were cultivated with these treatments. Per hectare doses of N, P and K (P_2O_5 andK_2O), showed in subscript, were applied in sorghum and wheat. An equal dose of 25 kg zinc sulphate per hectare was also applied. Sources of N, P and K were urea, Diammonium phosphate, Murate of potash, respectively. The Experiment is continued till date. Results showed that up to 35 sorghum and wheat cycles, till 2020, there was no significant changes in pH, EC, organic carbon, bulk density, saturated hydraulic conductivity, water holding capacity values of soils of plots of all treatments excepted $N_{120}P_{60}K_{60+\ 10\ t\ FYM}$. This shows long-term application of murate of potash for supplying K did not affect these soil properties. Both 1N NH_4OAc-K and 1N boiling HNO_3-K status of soils of plots which did not receive K application decreased to low level at surface and subsurface layers. Both sorghum and wheat responded to K application largely. Sorghum gave more response to K than wheat. This response was more at higher doses of N and P in sorghum and wheat. Therefore, to sustain yield of sorghum and wheat, K application is needed in soils representing this long-term experiment.

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Effect of Long Term Integrated Nutrient Management Practices on of Potassium Balance and Sustainability in Inceptisol of a Rice-Rice ecosystem

Raghabananda Nayak*
Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: nayakraghabananda@yahoo.com*

Continuous rice (*Oryza sativa*) cultivation with two crops per year is common in tropical Asia and also in India. But the yield of this system has already stagnated even declining after few years of continuous cropping. This is due to heavy mining of nutrients particularly potassium. The negative balance is wide spread in rice-rice system. There is few reports regarding balance of different soil potassium fractions and its effect on sustainability. In order to explore the impact of inorganic fertilizers, farm yard manure, and lime on apparent K balance, the current study was conducted in a long-term fertilization experiment with a rice-rice cropping system in an acidic Inceptisol. The soil K balance, changes in K fractions of surface soil, and its effect on yield sustainability was studied. The NPK and 5tFYM ha^{-1} was most sustainable followed by NPKFYM Lime in both dry season and wet season. There was depletion of total K of surface layer soil. In all the treatments apparent K balances was negative. The apparent K balance has very poor negative correlation with sustainability of dry season, wet season and System yield (r = -0.132,-0.323,-0.242), the total K balance of surface soil has much stronger –ve correlation with the SYI of both the seasons and system(r = -0.503, -0.718** and -0.592*). Out of four fractions the Lattice K registered a decline where as other three fractions WSK, EK and NEK registered an increase. The NEK had highest and significant correlation with sustainability followed by WSK and EK. Substantial quantity of K released from Lattice K and converted to other three pools from which K is taken up. For higher sustainability, reduced depletion of lattice K is essential. Integrated use of NPK and FYM is essential for minimizing true -ve balance for higher yield sustainability under humid subtropical situation.

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Residual Effects of Nickel and its Interaction with Applied Zinc on Availability and Uptake of Nitrogen and other Micronutrients in Cowpea

Sarbasree Goswami* and Satish Kumar Singh
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh
**Email: goswamisarbasree25@gmail.com*

Nickel (Ni) and zinc (Zn) have been considered as an essential nutrient for plant growth and development. A pot experiment was conducted in *kharif*, 2018, taking soybean as a test crop. Different treatment combinations of nickel and zinc was applied with recommended dose of fertilizers (RDF). In the next season, with cowpea as test crop, residual effect of Ni in soil was observed along with application of RDF and Zn. Treatments were: T_1: RDF; T_2: RDF + Ni @ 2.5 mg kg^{-1} + Zn @ 2.5 mg kg^{-1}; T_3: RDF + Ni @ 2.5 mg kg^{-1} + Zn @ 5 mg kg^{-1}; T_4: RDF + Ni @ 2.5 mg kg^{-1} + Zn @ 10 mg kg^{-1}; T_5: RDF + Ni @ 5 mg kg^{-1} + Zn @ 2.5 mg kg^{-1}; T_6: RDF + Ni @ 5 mg kg^{-1} + Zn @ 5 mg kg^{-1}; T_7: RDF + Ni @ 5 mg kg^{-1} + Zn @ 10 mg kg^{-1}; T_8: RDF + Ni @ 10 mg kg^{-1} + Zn @ 2.5 mg kg^{-1}; T_9: RDF + Ni @ 10 mg kg^{-1} + Zn @ 5 mg kg^{-1}; T_{10}: RDF + Ni @ 10 mg kg^{-1} + Zn @ 10 mg kg^{-1}; T_{11}: RDF + Ni @ 20 mg kg^{-1} + Zn @ 2.5 mg kg^{-1}; T_{12}: RDF + Ni @ 20 mg kg^{-1} + Zn @ 5 mg kg^{-1}; T_{13}: RDF + Ni @ 20 mg kg^{-1} + Zn @ 10 mg kg^{-1} (For soybean) and T_1: RDF; T_2: RDF + Zn @2.5 mg kg^{-1}; T_3: RDF + Zn @ 5 mg kg^{-1}; T_4: RDF + Zn @ 10 mg kg^{-1}; T_5: RDF+ Zn @ 2.5 mg kg^{-1}; T_6: RDF + Zn @ 5 mg kg^{-1}; T_7: RDF + Zn @ 10 mg kg^{-1}; T_8: RDF + Zn @ 2.5 mg kg^{-1}; T_9: RDF + Zn @ 5 mg kg^{-1}; T_{10}: RDF + Zn @ 10 mg kg^{-1}; T_{11}: RDF + Zn @ 2.5 mg kg^{-1}; T_{12}: RDF+ Zn @ 5 mg kg^{-1}; T_{13}: RDF +Zn @ 10 mg kg^{-1} (Residual crop, cowpea). All the attributes *viz.* concentration of Fe, Mn, Cu, Zn and N in both stover and grains were highest at 10 mg Ni kg^{-1} applied in the previous crop with Zn @ 10 mg kg^{-1} in the current experiment (T_{10}) and beyond this, a reduction in concentration was observed. Behaviour of micronutrients with respect to uptake in both grain and stover was similar as that of their concentration. Application of Ni improved the N uptake of crop by activating urease enzyme in soil and hydrogenase enzyme for symbiotic N_2-fixing bacteria of leguminous plants. So, emphasis should be given to manage the Ni content of soil in such a way that optimum Ni can be absorbed by the plants without having any toxicity issues.

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Effect of Foliar Application of Nutrients on Yield Contributing Characters, Yield, Nutrient Uptake, and Soil Chemical Properties of Kharif Onion on Entisol

M.S. Omji Nath[1]*, Adinath Takate[2] and M.V. Nayana[1]
[1]*Kerala Agricultural University, Thiruvananthapuram, 695522, Kerala*
[2]*Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra*
**Email: omjinath@gmail.com*

The onion is a heavy feeder, which uptake nutrients from soil resulting in depletion of essential nutrients from the native soil reserves. However, the effect of foliar application of nutrients at the appropriate growth stages for plant uptake has to be evaluated as an effective additional means of increasing the yield of onion and maintaining soil fertility status. The experiment was laid out in randomized block design with nine treatments and three replications in order to study the impact of foliar application of nutrients *viz.*, silicic acid @ 0.2%, 13:00:45 @ 1%, 19:19:19 @ 1%, 0:52:34 @ 1%, 0:0:50 @ 1% and potassium schoenite @ 1% at 45 and 60 DAT and application of Micronutrient Grade II @ 1% at 30 and 45 DAT. Soil and plant samples were processed in the laboratory and analyzed for various parameters by adopting standard analytical methods. Foliar application of nutrients significantly affected the bulb yield and yield contributing characteristics. The higher uptake of nutrients and available N status in soil after harvest of onion were found in application of GRDF + foliar application of 19:19:19 @ 1%. Interestingly supremacy in soil available phosphorus was found in the application of foliar sprays 0:52:34@ 1% at + GRDF. Significant available potassium in the soil after harvest was found in the application of GRDF+ Foliar sprays of 0:0:50 @ 1%. The soil available B along with DTPA available Fe and Zn after harvest of onion significantly increased by application of GRDF + Foliar sprays of Micronutrients Grade II @ 1%.

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Phosphorous Release from Rock Phosphate and Superphosphate in Rubber Growing Soils Varying in pH and Base Status

K.K. Ambily*
[1]Rubber Research Institute of India, Rubber Board, Kottayam, 686009, Kerala
**Email: ambili@rubberboard.org.in*

Phosphorous deficiency due to P-fixation is a limitation in acid soils and the pH and base status has profound influence on release of P. The reactions of P fertilizers is different in different soils. The present study is an incubation experiment to know the release pattern of rock phosphate (RP) and super phosphate (SP) in soils with pH 4.4, 5.5 and 7.5 with varied base status. Six hundred gm of soil was incubated with rock phosphate (55.5 g) and super phosphate (62.5 g) as per recommended dose (40 kg P_2O_5 ha^{-1}) used in young rubber plants for 30 days in three soils separately. At 5, 10, 15, 20, 25 and 30 days interval, the soil samples were extracted and analysed the available P. The result of the study indicated that the P availability from rock phosphate was the highest in pH 5.5soil and lowest in pH 7.4 soil. Among the two acidic soil the P availability was low in pH 4.4, but in pH 5.5 this was not observed indicated that pH 5.5 is favorable for super phosphate reactions. In comparison of two fertilizers, rock phosphate provides better P availability in two acidic soils and among two acidic soils, super phosphate was superior in pH 5.5 soil. In pH 7.4 soil super phosphate was inferior to rock phosphate. The fertilizer changes in three soils indicated that the pattern of fertilizer reaction in three soils were different and the choice of fertilizers in three soils can be done based on the experiments with plant response further.

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Urea Transformation in Rubber Growing Soils Varying in pH ad Base status

K.K. Ambily*
Rubber Research Institute of India, Rubber Board, Kottayam, 686009, Kerala
**Email: ambili@rubberboard.org.in*

Urea mineralization and soil pH variations are directly related. The NH^+ N and NO_3^- N release from urea fertilizer in pH 4.3, 7.09 and 9.15 was different. In this study the influence of varying pH and base status on transformation of urea in rubber growing soils was attempted. The study was an incubation experiment in three soils of pH 4.4, 5.5 and 7.5. A known weight of soil with fertilizer urea as per recommended dose (40 kg ha^{-1}) of young rubber plants were incubated for 20 days. At periodic interval soil (10 g) was extracted and quantified the NH_4-N and NO_3-N using Kjeltech auto N- analyser. The result of the study indicated that on the first day, highest value of NH_4-N and NO_3-N was recorded in pH 5.5 soil and in the seventh day in pH 4.4 soil and there after started decreasing. In pH 5.5 and 7.4 soils, decreasing trend was recorded. Nitrate nitrogen content in soils indicated the highest value on the 20th day in all three soils. On the first and second day, nitrate -N was very low. The rate of nitrification of fertilizer materials is influenced by the initial pH, the amount of N applied and the effect on soil pH. Unlike the acid soil, in neutral soil the majority of applied N was in the form of ammonium. When comparing three soils, NO_3^-N was lower in pH 4.4 and the other two soils were on par. The reactions of fertilizer urea depending on pH and base status were different, the selection of apt fertilizer in different soils can be based on the field experiments on plant growth and yield.

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Integrated Plant Nutrient Supply (IPNS) Modules for Improving Soil Organic Carbon (SOC) Pools and their Stocks in Vertisols

Bharat Prakash Meena*, A.K. Biswas, R.S. Chaudhary, A.B. Singh and A. K. Patra
ICAR- Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: bharatmeena24@gmail.com*

A field experiment to study the effect of long term Integrated plant nutrient supply (IPNS) modules on soil organic carbon storage under Maize-Chickpea cropping Sequence in a Vertisols" was conducted at the research farm, ICAR-Indian Institute of Soil Science, Bhopal (23º18´N, 77º24´ E,), Madhya Pradesh, India. The experiment was following in a randomized block design consisting of 12 different treatment combinations of organic manures and soil test crop response (STCR) based fertilizers and Integrated plant nutrient supply (IPNS) modules with three replications. The soil of experimental field was a deep black in texture with 24.5, 23.5 and 52.0% of sand, silt and clay, respectively. The soil of the experimental site was follows: soil organic carbon 0.53%, available N 68.8 mg kg^{-1}, available P 12.8 mg kg^{-1} available K 237 mg kg^{-1}, soil pH 7.8 and electrical conductivity (EC) 0.48 dSm^{-1}. Results showed that the IPNS modules increased the SOC contents, different carbon fractions (*C*frac I, *C*frac II, *C*frac III, and *C*frac IV) and their stocks with application of higher amount of FYM (25 t ha^{-1}) followed by 75% NPK based on STCR along with 5 t ha^{-1} FYM as compared to GRD and 100% NPK based on STCR. Among the SOC pools, active pools of carbon storage (Cfrac I and Cfrac II) contributed nearly 56% and passive pools (Cfrac III and Cfrac IV) represent about 44% in the upper layer (0-15 cm) while at lower layer (15-30 cm) of soil the active pools of carbon storage was reported about 46% and passive registered about 54% carbon storage in Vertisols. Similarly, crop yield was significantly improved with application of IPNS modules as compared to organic and inorganic modules. Maize yield was significantly highest with FYM based INM modules (FYM + STCR based 75% NPK) and followed by FYM at 20 t ha^{-1} and 75%NPK + poultry manure than general recommended dose (GRD) and 100% NPK based STCR alone. Therefore, it can be inferred that adoption of STCR based INM modules is the best technology to improve SOC stocks in Vertisols of Central India.

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Impact of Long-Term Fertilization and Manuring on Soil Quality and Crop Productivity Under Double Rice System

Sunanda Biswas[1], Saloni Tripathy[1]*, Priya Singh[1], T.J. Purakayastha[1], Nayan Ahmed[1], R.N. Pandey[1], T. J. Ghose[2], T.K. Das[1] and B. Ramakrishnan[1]

[1]ICAR-Indian Agricultural Research Indtitute, New Delhi, 110012
[2]Assam Agricultural University, Jorhat, 785013, Assam
**Email: sunandabiswas13@gmail.com*

One of the country's most important agro-ecosystems is rice-based. The soil's natural nutritional status may be depleted if the same crop is grown on the same land year after year. To study the impact of long-term fertilization and manuring on soil quality and crop productivity under double rice system, soil samples were taken from a 32-year-old long-term rice-rice cropping system at the Assam Agricultural University's (AAU) Regional Rice Research Station in Titabar, Assam. The system had eight treatments: control, 100%N, 100%NPKZnS, 100%NPKZn-S, 50%NPK+50%GM-N, 50% NPK +50% FYM-N, 50% NPK +50%FYM-N, and FYM@10 ton/ha. The key indicators of soil health were determined to be available Zn, available K, acid phosphatase activity, and bulk density. The value of SQI ranged from 0.45 to 0.88, where the highest SQI was found with 50%NPK+25% GM-N+25% FYM-N treatment and lowest was with control treatment. The trend of SQI was found to be $T\text{-}_7$ (0.88)>$T\text{-}_8$ (0.84)>$T\text{-}_6$ (0.73)>$T\text{-}_5$ (0.71)>$T\text{-}_4$ (0.64)>$T\text{-}_3$ (0.63)>$T\text{-}_2$ (0.55)>$T\text{-}_1$ (0.45). The soil quality index (SQI) and annual rice yield (ARY) had a strong agreement (61.8%) with each other. Therefore, double rice growing farmers in Assam may get benefit from integrated nutrient management practices leading to better soil quality and crop productivity.

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Long Term Manuring and Fertilization Effect on Soil Quality and Yield Sustainability of Major Crops in LTFEs in India

Ravindra Wanjari*, Dhiraj Kumar, Ashok K. Patra and Muneshwar Singh
ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: wanjariravi@gmail.com*

Decline in soil quality and yield across major cropping systems in India is considered as a key constraint for sustenance of productivity. In that context, a study was undertaken with the objective to study effect of fertilizer and manures on soil quality and yield sustainability in major crops and soils across the country under the aegis of AICRP on Long Term Fertilizer Experiments (LTFE). The findings emanated from the long term investigation indicated that the long term fertilizer application along with organic manure led to a significant improvement in soil biological condition in which soil microbial biomass carbon (SMBC) is key parameter. The SMBC at Coimbatore, Pantnagar and Pattambi revealed that, irrespective of the treatments, 100% NPK+FYM (INM) registered significantly higher SMBC. Similarly, significantly higher soil quality index (SQI) was exhibited by 100% NPK+FYM in comparison to other nutrient management options at Coimbatore and Pantnagar. However, in rice-rice system of Pattambi, 100% NPK+FYM and 100% NPK+ green manure (Dhaincha) recorded higher SQI compared to imbalanced nutrient management. Thus, sustainability of nutrient management options derived in terms of sustainable yield index (SYI) for finger millet-maize in Inceptisols of Coimbatore, in rice-wheat system in Mollisols of Pantnagar and rice-rice system in Alfisols of Pattambi indicated that imbalanced nutrient application (Control, 100% N, 100% NP and 50% NPK) recorded significantly lower values compared to balanced and integrated nutrient management. The lowest SYI was observed in 100% N alone in Alfisols of Pattambi. Integration of inorganic fertilizers with organic manures and balanced nutrient applications proved as the best way for restoring and maintaining soil quality, crop productivity and microbial activity in LTFE. Thus, integrated nutrient management through 100% NPK+FYM improved soil quality as well as sustained crop productivity of major crops and cropping systems in major soils of India.

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Soil Fertility Assessment of Different Villages of Sanganer Block in Jaipur District of Rajasthan (India)

Sonal Sharma[1]*, Y.V. Singh[2], D.P. Singh[1] and Neha Khardia[1]
[1]Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan
[2]Banaras Hindu University, Varanasi, 221005, Uttar Pradesh
**Email: sonasharma2731198@gmail.com*

A study to examine soil fertility status was conducted in Sanganer block of Jaipur district, Rajasthan. The study area lies between 26°49' N to 26°51' N latitude and 75°46' E to 75°51' E longitude at an altitude of 372m above mean sea level (a m s l). A total of forty soil samples were collected from eight different villages of the block at a depth of 0-15 cm. A GPS device was used to identify the location of the soil sampling points. Soil sample thus, collected were examined for various physical and physico-chemical parameters which includes BD, PD, WHC, porosity, pH, EC, OC, also macro and micronutrients including N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu by standard analytical methods. Results showed that the soil was neutral to alkaline in pH (6.2 to 8.9), low in organic carbon (0.3 to 1.92%) and available sulphur (0.97 to 11.47 mg kg^{-1}). The available nitrogen (150.32 to 350.3 kg ha^{-1}), zinc (0.21 to 0.64 mg kg^{-1}), iron (1.2 to 4.83 mg kg^{-1}) and manganese (0.14 to 1.02 mg kg^{-1}) were found low. Furthermore available potassium (123.2 to 504 kg ha^{-1}) was moderate and available phosphorus (14.68 to 36.13 kg ha^{-1}) and copper (1.19 to 4.68 mg kg^{-1}) were found high. To compare the levels of soil fertility in different areas and to obtain a single value for each nutrient, nutrient index approach was used. The current study is expected to help the farmers of Sanganer block in guiding techniques required for long-term soil fertility management and creating future agricultural research strategies on the farm.

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To Study the Effect of Rescheduling Fertilizer Application on Nutrient Availability, Soil Chemical Properties, Yield and Agronomic Parameters of Widely Spaced Sugarcane Crop

Kiran Kumari Khokhar*, Ankush Kamboj, Mehar Chand, Roohi and Kiran Kumari Khokhar

CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: kirankhokhar123@gmail.com*

A field experiment was conducted during the year 2020-21 at Regional Research Station, CCS HAU, (Uchani), Karnal, Haryana. The experiment consisted of two main treatments along with four sub plot treatments and was laid out in split plot design with three replications with each plot size of 8.4m × 6.8m. The eight treatment combinations were the two main plot B1 (Broadcast) and B2 (band placement), and 4 subplots of split doses of Nitrogen and Potassium *i.e.* T1-Recommended dose of N and K in five splits (Basal 10% and remaining at 45, 75, 90 and 120 DAP), T2- Recommended dose of N and K in six splits (Basal 10% and remaining at 45, 75, 90, 120 and 150 DAP), T3-Recommended dose of N and K in seven splits (Basal 10% and remaining at 45, 75, 90, 120, 150 and 180 DAP), T4- Recommended dose and schedule of nutrient applications (Half of total N and full dose of P and K at planting and rest of the N at 45 and 90 DAP). Significantly higher cane yield (96.58 t ha^{-1}) was reported with treatment which received RDF through band placement (B1) which was 8.01 % higher than treatment receiving RDF through broadcast method (B1) with which 88.84 t ha^{-1} cane yield was obtained. The higher (131.86 kg ha^{-1}) values of available N were recorded in band placement (B2) compared to broadcast (B1) (125.73 kg ha^{-1}) at the stages after 45 DAP upto harvest. The available K were higher (220.50 kg ha^{-1}) in broadcast (B1) compared to band placement (B2) (214.60 kg ha^{-1}) at all the time intervals upto harvest. No significant changes were recorded in the organic carbon content, pH and EC of the soil. The juice quality parameters (Brix, Pol %, CCS %) cane girth, number of internodes per cane, length of internodes were not affected by either of band and broadcast method of fertilizer application. Among the sub plots at 60 DAT, significantly higher plant height was recorded by T4 (100.41 cm). Significantly, higher tiller population (110.59 000 ha^{-1} and 102.68 000 ha^{-1}) was recorded with band placement of fertilizers both at 60 and 150 DAP compared to broadcasting (B1) of fertilizers. The band placement method of fertilizer application (B2) produced significantly higher NMC (100.79 000 ha^{-1}) at the time of harvesting.

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Assessment of Soil Fertility Status of District Karnal, Haryana

Kiran Kumari Khokhar*, Manisha Arya and Roohi
CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: kirankhokhar123@gmail.com*

In order to evaluate soil fertility status of district Karnal, Haryana two hundred thirty surface soil samples were randomly collected from all the blocks of Karnal using GPS. The results revealed that the pH range of Assandh, Indri, Nilokheri, Karnal and Ghauranda blocks were 6.7-8.7, 7.7-8.9, 7.1-8.7, 7.9-8.9 and 7.3-8.8, respectively, indicating that soils of all the blocks of Karnal are neutral to alkaline in reaction. The electrical conductivity of the soil of Assandh, Indri, Nilokheri, Karnal and Ghauranda blocks ranged from 0.09 - 0.68, 0.08 - 0.62, 0.13 - 0.90, 0.10 - 0.67 and 0.09 - 1.34 dS m-1 with a mean value of 0.30, 0.24, 0.40, 0.25 and 0.25 dS m-1 respectively, indicating that most of the samples were non-saline in nature. The OC content in soils of different blocks of Karnal viz. Assandh, Indri, Nilokheri, Karnal and Ghauranda ranged from 0.07-1.12, 0.07-1.03, 0.12-1.12, 0.11-0.82 and 0.10-0.79 % with mean values of 0.60, 0.45, 0.41, 0.42 and 0.54% respectively. The maximum number of soil samples i.e. 72, 45, 56 and 84% fall under medium category (0.40-0.75%) in Assandh, Indri, Karnal and Ghauranda block respectively as far as OC content was concerned. The available nitrogen content of the soils ranged from 86-249 Kg ha^{-1} in Assandh, 79.4-238.1 Kg ha^{-1} in Indri, 93-200.8 Kg ha^{-1} in Nilokheri, 110.3-195.84 Kg ha-1 in Karnal and 108-200.6 Kg ha-1 in Ghauranda with a mean value of 169.05, 147.44, 150.24, 147.41 and 160.23 Kg ha^{-1} respectively. All the soil samples were found deficient in available nitrogen content. The phosphorous content of soils ranged from 20-68 kg ha^{-1} in Assandh, 9-52.2 kg ha^{-1} in Indri, 9-39.80 kg ha^{-1} in Nilokheri, 8-38.40 kg ha^{-1} in Karnal and 14.8-49.8 kg ha-1 in Ghauranda block with a mean value of 33.16, 25.58, 24.19, 21.28 and 27.94 kg ha^{-1}, respectively. 94% samples in Assandh block, 78% of samples in Indri block 74% of samples in Nilokheri block, 58% of samples in Karnal block and 76 % in Ghauranda block fall under high soil phosphorus content. Six per cent in Assandh block, 21% in Indri block, 23% in Nilokheri block 39% in Karnal block and 24% in Ghauranda block fall under medium soil P rating. The potassium content of the Assandh block varied from 79.5-753.8 kg ha^{-1} with a mean value of 337.64 kg ha^{-1}, Indri block varied from 79.5-697.3 kg ha^{-1} with a mean value of 251.82 kg ha^{-1}, Nilokheri block varied from 97.1- 417.87 kg ha^{-1} with a mean value of 239.57 kg ha-1, Karnal block varied from 86.3-522.2 kg ha^{-1} with a mean value of 261.75 kg ha^{-1} and Ghauranda block varied from 70-749 kg ha^{-1} with a mean value of 207.89 kg ha^{-1}. The soils of all blocks of Karnal district fall under the medium soil potassium range *i.e.* 46 % in Assandh, 79% in Indri, 77% in Nilokheri, 69% in Karnal and 65% in Gharaunda block. In the Assandh block, 48% of soil samples were in the high potassium range. The sulfur content of soil ranged from 19.91-76.23, 16.8-53.9, 16.23-69.37, 22.34-54.96 and 16.8-54.72 kg ha^{-1} in Assandh, Indri, Nilokheri, Karnal and Ghauranda blocks respectively. The sulfur content of all blocks of Karnal district falls under the medium category *i.e.* 77, 89, 84 and 87% in Assandh, Indri, Nilokheri and Ghauranda blocks, respectively.

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Effect of Different Approaches of Fertilizer Recommendation on Productivity of Wheat and Soil Residual Nutrients Status in Vertisol

Karabasayya Math*
University of Agricultural Sciences, Dharwad, 580005, Karnataka
**Email: mathkk@uasd.in*

The field experiments were conducted at the research farm of All India Co-ordinated Wheat and Barley Improvement Project (AICW&BIP), MARS, UAS, Dharwad during *rabi* 2020-21 and 2021-22 to assess the productivity, quality and uptake of nutrients by wheat and residual nutrient status in soil through different nutrients management practices. The treatments consisted of different fertilizer recommendation approaches namely Site Specific Nutrient Management (SSNM) and Soil Test Crop Response (STCR) for targeted yields at 40, 45, 50 and 55 q ha^{-1}, Nutrient Expert (NE) target yield at 40 q ha^{-1} and Soil Test Laboratory (STL) approach and these were compared with graded levels of fertilizer application (125 and 150% RDF) and RPP. The field experiment was laidout in randomized completely block design with 15 treatments replicated thrice. The growth, yield and quality of wheat were significantly influenced by the different nutrient management approaches. The yield target at 50 q ha^{-1} under SSNM practice significantly increased the number of effective tillers (276.8 m^{-2}), number of grains $panicle^{-1}$ (40.2), grain weight $panicle^{-1}$ (1.86 g), test weight (45.2 g) and grain yield (50.5 q ha^{-1}) in wheat and it was on par with yield targets at 55 and 45 q ha^{-1} under the same practice. Further, the same treatment recorded significantly higher protein (13.29%) and wet gluten (34.3%) contents, sedimentation value (44.7 ml) and yellow pigment (5.78 ppm) with higher uptake of NPK and S (187.0, 36.1, 96.2 and 38.4 kg ha^{-1}, respectively) and Cu, Fe, Mn and Zn (225.6, 1820, 964 and 352 g ha^{-1}, respectively). The soil available nitrogen was significantly higher in target yield of 55 q ha^{-1} under STCR practice while, higher available phosphorus and sulphur status in soil was observed in 150 per cent RDF. The available potassium status was significantly higher under SSNM approach for targeted yield of 55 q ha^{-1}. Further, higher net returns (Rs. 90, 343 ha^{-1}) and B:C ratio (2.73) were recorded in SSNM approach targeted yield at 50 q ha^{-1}. Hence, productivity in wheat can be achieved through SSNM yield target at 50 q ha^{-1}.

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Effect of Nano Nitrogen, Copper and Zinc Liquid Fertilizers on Growth, Yield and Quality of Potato (*Solanum tuberosum* L.)

Channakeshava S. Seshachar*
College of Agriculture, Hassan, 573002, Karnataka
**Email: channa_2005@rediffmail.com*

A field experiment was conducted in farmers field of Hassan district, Karnataka during *Rabi* season of 2020, to study the "Effect of nano nitrogen, copper and zinc liquid fertilizers on growth, yield and quality of potato (*Solanum tuberosum* L.)". The experiment was laid out in randomized complete block design comprising ten treatments replicated thrice. The treatment consists of three nano fertilizers *i.e.* nitrogen, copper and zinc liquid fertilizers sprayed either alone or in combinations @ 0.4% concentration with and without Recommended Dose of Fertilizers (RDF).The results revealed that significantly higher growth and yield parameters *i.e.* plant height (52.87 cm), number of branches plant^{-1} (10.55), number of leaves plant^{-1} (107.32), tuber yield (28.93 t ha^{-1}) and total dry matter production of potato (5.01 t ha^{-1}) was recorded in treatment which received RDF (50% Zn, 50% N & 100% PK) + 1st spray of Nano N at 25-30 DAP + 2nd spray of nano Zn after 10-15 days of 1st spray + 3rd spray of nano Cu after 10-15 days of 2nd spray (T_{10}) and was on par with treatment RDF (50% N 100% PK) + 2 sprays of Nano Nitrogen (T_7) and RDF (50% Zn 100% NPK) + 2 sprays of Nano Zinc (T_8) compared to control (T_1) plot (0% N and Zn, 100% P & K fertilizers). Significantly higher starch content was recorded in the treatment T_{10} (73.27 %) followed by T7 (71.02%) and lowest starch content recorded in control(64.83%). The higher gross returns (Rs. 2,02,520 ha^{-1}), net returns (Rs. 1,46,371 ha^{-1}) and B:C ratio(2.61) in T_{10} compared to other treatments.

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Effect of Nitrogenous Fertilizer Products on Yield and Nitrogen Content of Wheat Grown under Plant Phenomics Facility

Kapil Atmaram Chobhe[1]*, Ann Theresa Jose[1], K.M. Manjaiah[1], S.P. Datta[1], Rajeev Ranjan[1], Sudhir Kumar[3], Vijay Pooniya[2] and Anil Kumar[1]

[1]Division of Soil Science and Agricultural Chemistry, [2]Division of Agronomy, [3]Division of Plant Physiology, ICAR-Indian Agricultural Research Institute, New Delhi, 110012

**Email: chobhekapil27@gmail.com*

Nitrogen (N) is one of the most important plant nutrients for crop growth, development and yield. Nitrogen fertilizers are used by 50% of the world's population to meet global food production. India's urea use has increased from 6 million tonnes in 1980 to 35 million tonnes in 2021. Excessive use of nitrogen in crop production has become a serious global concern, as it is degrading the environment through soil-water and the atmosphere. On the other hand, the usage efficiency of urea, or plant uptake, is only about 30-40% due to unaccounted nitrogen fertilizer escapes through a variety of pathways, including ammonia volatilization, nitrate leaching, and nitrous oxide emission, and may pollute water bodies and the environment. To address this, several initiatives to improve the nitrogen use efficiency (NUE) while lowering N inputs for lowering environmental and agricultural production costs are being commenced. The use of superabsorbents as well as coated fertilizer products as a slow or controlled release fertilizer has emerged as one of the most promising technologies for overcoming the shortcomings of conventional fertilizers. The current study seeks to develop novel nitrogenous fertiliser products, such as nanoclay polymer and biopolymer composites (NCBPC), as well as slow-release coated urea fertilizer products for improving NUE. The experiment was conducted using four wheat varieties (GW 322, HD 2329, Raj 3765, Kauz) as test crops at Nanaji Deshmukh Plant Phenomics Centre, Division of Plant Physiology, IARI, New Delhi. Total five treatments combinations [Control, 100% N through urea, 75% N through coated urea, 75% N through 25% wheat flour (maida) NCBPC and 75% N through 25% maize flour NCBPC] in each variety were replicated five times in a completely randomized design under pot study. The application of 75% N through the newly synthesized N products resulted in statistically similar yield, higher nitrogen use efficiency, grain nitrogen content as well as biological properties as that of 100% N through urea. Among the varieties, HD 2329 had the statistically significant highest grain yield, while Kauz had the statistically significant highest grain N content, total nitrogen uptake and apparent nitrogen recovery efficiency (ANR). The N supply through slow or controlled release nitrogen fertilizers, as well as nanoclay polymer composites containing nitrogen fertilizers, have yielded promising results in terms of yields, nitrogen use efficiency in wheat even at the lower N doses in all the four varieties. Thus, the newly synthesized novel N fertilizer products can be successfully used as slow-release fertilizers for crop production and 25% N could be saved.

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Short-term Response of Grain Yield of Rice and Wheat to Different Levels Annual Straw Retention Rates in a Rice–Wheat Cropping System

S.K. Samal*, A.K. Singh, K.G. Mandal and Vikash Paradkar
ICAR-Mahatma Gandhi Integrated Farming Research Institute, Piprakothi, 845429, Motihari, Bihar
**Email: saubhagya.ssac@gmail.com*

In India, about 500 Mt of crop residues are generated every year. The cereal crops (rice, wheat, maize, millets) contribute 70%. while rice crop alone contributes 34% to the crop residues followed by wheat with 22%. These crop residues are used in various unproductive ways and burnt on the field itself by the farmers.Rice-wheat is the major production system covering an area of 13.5million hectares across the Indo-Gangetic Plains (IGP) of south Asia. Therefore, proper management of residues of rice and wheat is important. A handful of literature is available which shows that CA practice with crop residue retention is the superior practice for sustainable rice-wheat production in IGP. In general, 30% crop residue retention is recommended for CA practice.The optimum level of crop residue retention required for getting higher crop yield and for maintaining good soil health need to be investigated. The present study was initiated in the year 2020 to evaluate the effect of different levels of rice and wheat residues retention i.e. 30%, 40%, 50% and 60% of total straw from previous crop retained in rice and wheat seasons on grain yield of rice and wheat.The results of the above treatments compared with treatments of 0% rice and wheat residue retention and farmers' practice of growing rice and wheat. Results revealed that in the first crop i.e. wheat (grown during 2020-21), significantly higher grain yield was recorded (4.66 Mg ha^{-1}) in conventional tillage (CT) plot with 0% rice and wheat residue retention than all the residue retention plots. In the subsequently grown rice crop (during 2021-22), grain yield in all residue retention plots and 0% residue plot were comparable. The grain yield of the crop in both seasons under farmers practice plot was recorded as lowest.

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Converting Waste to Resource: Utilization of Organic Wastes with Elemental S for Exploring Sodicity Reclamation

Sandeep Bedwal[1]*, Arvind Kumar Rai[2], Nirmalendu Basak[2], Parul Sundha[2], Subedar Patel[2], Dev Raj[2], Anita Mann[2] and Rajender Kumar Yadav[2]

[1]ICAR-Central Soil Salinity Research Institute, Karnal, CCS Haryana Agricultural University, Hisar, 125004, Haryana

[2]ICAR-Central Soil Salinity Research Institute, Karnal, 132001, Haryana

**Email: sbedwal519@gmail.com*

Human civilization is facing a great challenge in the utilization of several wastes. We hypothesized that the use of elemental S (S°) is an easy and simple way to acidify the available manure, compost, or wastes for increasing the reclamation potential because chemical and microbiological conversion of S° produces mineral acids that cause rapid acidulation. Therefore, individual organics [farmyard manure (F), pressmud (P_{mud}), poultry manure (PM), city–waste compost (CWC), sewage and sludge (SS)] were incubated separately with and without S^0 and S^0–oxidizers @20 kg Mg^{-1} of organics at field capacity for 56 days. Acidulation decreased the pH at 28 days after incubation (DAI) and the highest decrement and increment appeared with S^0 compared to non–acidulated organics. Among substrates, acidulated PM produced a greater value of titratable acidity (TA) followed by FYM > P_{mud} > CWC > SS ($P< 0.05$). Acidulated organics showed a significant decrement in $CaCO_3$ content at 28 DAI compared to non-acidulation and was greater in PM followed by CWC, P_{mud}, FYM, and SS ($P< 0.05$). The pH decline was because of the production of TA on addition of S^0. The SS showed a greater release of Ca^{2+} followed by P_{mud}> FYM≥ CWC> PM ($P< 0.05$). The Mg^{2+} release was greater with P_{mud} while the lowest was in CWC. Multiple regression showed that water–soluble SO_4^{2-}, Mg, and dissolve organic C were the key variables controlling the equivalent neutralization potential of acidulated organics. Acidualation of organics with S° increased the alkali neutralization potential of manures, therefore acidulated organics is an option for sodicity reclamation. Using PM or FYM generates an appreciable quantity of TA than P_{mud}, CWC and SS.

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Developing Soil Quality Indices for Sodic Soil under Different Reclamation Strategies

Nirmalendu Basak*, Arvind Kumar Rai, Parul Sundha, Rameshwar Lal Meena, Sanjay Kumar, Sandeep Bedwal, Rajender Kumar Yadav and Parbodh Chander Sharma

ICAR-Central Soil Salinity Research Institute, Karnal, 132001, Haryana

**Email: nirmalendubasak@rediffmail.com*

Gypsum and conjunctive application of elemental sulphur, pressmud, acids, acid-formers, pyrites, phosphogypsum, fly ash and aluminum chloride are generally recommended for sodic soils reclamation. However, inherent soil biophysical environment, sodicity, and available water quality use for irrigation have an immense role in the progress of reclamation. Physical, chemical, and biological properties of soils were analyzed after amending sodic soil with gypsum, sole, conjunctive application of gypsum and reliance formulated sulphur. For developing soil quality indices soil properties were screened. Therefore, soil attributes were correlated with the mean yield of rice and wheat for the selection of soil attributes. Soil properties showing a significant positive correlation with crop yield were picked for principal component analysis. The indicators were interpreted by transforming the minimum data set (MDS) by a weighted linear scoring function. Exchangeable sodium percent (ESP), exchangeable Ca, aggregate stability, Mg^{2+} and CO_3^{2-} saturation in paste extract, Walkley-Black organic C (WBOC), $CaCO_3$ and porosity for soils of Patiala, Punjab; pHs, Ca^{2+} and total alkalinity in saturation paste extract, aggregate ratio, WBOC, exchangeable Na, $CaCO_3$, microbial biomass N and exchangeable Na for soils of Etah, Uttar Pradesh; ESP, exchangeable Ca and Mg ratio (ExCa: ExMg), $CaCO_3$, fluorescein di-acetate hydrolyzing activity, HCO_3^- and SO_4^{2-} concentrations in saturation paste extract and exchangeable Mg for soils of Kaithal, Haryana; whereas cation exchange capacity, ExCa: ExMg, EC and sodium adsorption ratio of saturation paste extract, exchangeable K, exchangeable Mg, microbial biomass C to N ratio, DTPA extractable Fe, ESP and β-glucosidase activity for soils of Barwah, Madhya Pradesh were identified as master indicators after wheat in different sodic soils. Further, the indicators interpretation was done by transforming MDS into linear scoring function. In most of the cases, reclamation with the application of amendment increased the soil quality indices more than the unamended control.

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Development of National Soil Grid of India

Nirmal Kumar*, Nirmal Kumar, M.S.S. Nagaraju, J.N. Surya, H. Biswas and G.P. Obireddy

ICAR-Central Soil Salinity Research Institute, Karnal, 132001, Haryana
**Email: urwithnirmal@gmail.com*

Recently ICAR-NBSS&LUP has developed digital soil maps (DSM) of Bundelkhand and Vidarbha regions using machine learning tools. The products are in six standard soil depth intervals (according to the GlobalSoilMap IUSS working group and its specifications) at a spatial resolution of 30 meters. A Geo-portal and an Android app have been developed in line with World Soil Grid showing key soil properties of standard DSM depth intervals for different regions of India. The development of the web geo-portal system uses HTML, JavaScript, CSS, php, MySQL and GeoServer. The Android operating system has also been developed in order to enhance its availability to users since this operating system is the most extended worldwide. The user can visualize the map on region basis. Additionally, the user can generate a bar chart of any property for all the depths by clicking at any location. Maps of the following soil properties are available: soil reaction, electrical conductivity, soil organic carbon content, sand content, silt content, clay content, calcium carboate, and available water capacity. Pan-India information will be available with the passage of time. Provisions are being made for providing these layers as Web Map Service (WMS) for visualization in any GIS software.

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Phule Smart Fertilizer Calculator - A Android and Web Application for a Digital Solution of the Futures Climate Smart Precision Farming

Nilam Kondvilkar[1]*, B.D. Bhakare[1], A.G. Durgude[4], V.S. Patil[4], S.D. Gorantiwar[2] and M.G. Shinde[3]

[1]Centre for Advanced Agricultural Science and Technology for Climate Smart Agriculture and Water Management and Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra

[2]Centre for Advanced Agricultural Science and Technology for Climate Smart Agriculture and Water Management and Department of Agril Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra

[3]Centre for Advanced Agricultural Science and Technology for Climate Smart Agriculture and Water Management and Department of Soil and Water Conservation Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra

[4]Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra

**Email: nilamkondvilkar@gmail.com*

In precision agriculture, it is necessary to apply fertilizers quantity as per yield target and crop requirement in precise form. In this aspect, the Centre for Advanced Agricultural Science and Technology for Climate Smart Agriculture and Water Management and The Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri have developed android and web-based and bilingual (English and Marathi) Phule Smart Fertilizer Calculator application. It is a completely offline app for deciding the fertilizer quantities based on Soil Test Crop Response (STCR) equation, Recommended Dose of Fertilizer (RDF), and As per Soil Test (AST) for different crops. For registration user needs to fill name, address, mobile no., email ID, user ID, password details and registration of farms including farm name, Gat no/ Survey no, its size (Are, Acre or Hector), latitude and altitude of farm. The user also can register multiple farms along with its crop details (Name and area), soil details (pH, EC, Organic Carbon, $CaCO_3$, Available Nitrogen, Phosphorus and Potassium, and micronutrients (Optional)) as per soil test report for each farm separately.

The fertilizers recommendations can be calculated by using different three ways. In fisrt method calculates GRDF with FYM as per crop, STCR based yield target method calculates fertilizer requirement by using STCR equations and yield target provided by user and in Soil test-based method calculates fertilizer requirement as per soil test report. After taking all inputs from users the fertilizer dose will be calculated and recommended dose of fertilizer will be suggested in seven different fertilizer combinations along with advisory about how to apply, when to apply, how much quantity should be applied likewise. The Phule Smart Fertilizer Calculator – is a fantastic tool for precise recommendations and applications of fertilizer for crop-specific growth. The results would help to use the fertilizer appropriately and in a balanced and environment friendly approach and it seems to a digital solution of the futures climate smart precision farming.

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Estimation of Terrestrial Carbon Stock and Depth Wise Soil Carbon Fractions as Influenced by Mango Orchard in Different Shrink-Swell Soil Series

Neha Navnage[1]*, A.L. Pharande[3], B.D. Bhakare[1], S.A. Ranpise[4], S.B. Nandgude[5] and M. R. Patil[2]

[1]Department of Soil Science and Agricultural Chemistry, [2]Department of Statistics, [4]Department of Horticulture, [5]Department of SWCE, CAET, [3]Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: navnageneha31@gmail.com*

The experiment was carried out on existing mango orchard of horticultural field in central campus of Mahatma Phule Krishi Vidyapeeth Rahuri, Ahmednagar India. The mango orchard was around 25 years old, conventionally cultivated land mostly with vegetables crops and fallow land of three major soil series Pargaon (Shallow soil), Sawargaon (Medium soil) and Nimone (Deep soil) were selected to conduct this experiment. The present experiment was laid down in Incomplete Factorial Completely Randomized Design with 30 treatments and two replications. Treatments involved three factor *viz.* Factor A: Soil Series i) Pargaon ii) Sawargaon iii) Nimone. Factor B: Land use pattern i) Fallow ii) Conventionally cultivated iii) Mango orchard and Factor C: Soil depth i) 0-15 cm ii) 15-30 cm iii) 30-60 cm iv) >60 cm. Among the selected different soil series mango plantation under Sawargaon soil series recorded higher tree height (8.45 m), diameter at breast height (1.58 m), above ground biomass (31.24 t ha^{-1}), below ground biomass (6.25 t ha^{-1}) and total plant biomass (37.48 t ha^{-1}) which resulted into higher accumulation of plant carbon (18.74 t ha^{-1}) followed by mango plantation under Nimone and Pargaon soil series. Active carbon pool *viz.* water soluble carbon (70.80, 53.00, 40.95 and 21.75 mg kg^{-1}) permanganate oxidizable soil carbon (750.17, 597.96, 441.82 320.56 mg kg^{-1}) soil microbial biomass carbon (631.84, 391.94, 219.43, 87.77 mg CO_2-C kg^{-1}) and passive carbon pools *viz.* particulate organic carbon (10.75, 7.76, 5.43, 3.05 g g^{-1}) humic acid carbon (48.38, 42.43, 50.24, 32.48 %) and fulvic acid carbon (31.39, 28.99, 32.85, 28.75 %), soil organic carbon stock (21.01, 18.55, 14.35, 9.18 Mg C ha^{-1}) carbon management index (308.60, 248.95, 215.90, 182.25) and E_4/E_6 ratio (HA and FA), functional groups *viz.* CO_2H group, Alcoholic group, Phenolic group, total C=O group, Quinonoids C=O and Ketonic C=O Group of humic acid and fulvic was significantly improved in soil under mango plantation as compare to other land use system *i.e.* conventionally cultivated and fallow land at depth 0-15, 15-30, 30-60 and >60 cm respectively Therefore, from this study it was concluded that horticulture based land use system under medium to deep black soil could be possible way out to improve soil quality in terms of physical chemical biological properties as well as soil organic carbon stock than conventionally cultivated and fallow land.

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Quantification of Terrestrial Carbon Stock and Soil Organic Fractions as Influenced by Mango Orchard in Different Shrink Swell Soil Series

Neha Navnage[1]*, A.L. Pharande[3], A.D. Kadlag[4], B.D. Bhakare[1], S.A. Ranpise[5], S.B. Nandgude[6] and M. R. Patil[2]

[1]Department of Soil Science and Agricultural Chemistry, [2]Department of Statistics, [4]STCRC, Post Graduate Institute, [5]Department of Horticulture, [7]Department of SWCE, CAET, [3]Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra

**Email: navnageneha31@gmail.com*

The study was carried out on existing mango orchard of horticultural field in central campus of Mahatma Phule Krishi Vidyapeeth Rahuri, Ahmednagar India The mango orchard was around 25 years old, conventionally cultivated land mostly with vegetables crops and fallow land of three major soil series Pargao (Shallow soil), Sawargao (Medium soil) and Nimone (Deep soil) were selected to conduct this experiment.The present experiment was laid down in Incomplete Factorial Completely Randomized Design with 30 treatments and two replications. Treatments involved three factor *viz.* Factor A: Soil Series i) Pargao ii) Sawargao iii) Nimone. Factor B: Land use pattern i) Fallow ii) Conventionally cultivated iii) Mango orchard and Factor C: Soil depth i) 0-15 cm ii) 15-30 cm iii) 30-60 cm iv) >60 cm. Among the selected different soil series mango plantation under Sawargao soil series recorded higher tree height (8.45 m), diameter at breast height (1.58 m), above ground biomass (31.24 t ha^{-1}), below ground biomass (6.25 t ha^{-1}) and total plant biomass (37.48 t ha^{-1}) which resulted into higher accumulation of plant carbon (18.74 t ha^{-1}) followed by mango plantation under Nimone and Pargao soil series. The soils of the farm belong to the broad group of black soils with variation in depth. The soil pH was neutral to alkaline in soil reactions (soil pH- 7.89 to 8.39). The soil texture was clay loam for Pargao soil series and clayey in both cases of Sawargao and Nimone soil series. Higher soil available organic carbon, nitrogen, phosphorus, potassium and hot water soluble boron along with DTPA extractable iron, manganese, zinc and copper were recorded in soil of 25 years mango orchard over conventionally cultivated and fallow land were observed. The significant decreasing trend of all soil chemical properties along with soil depths. The result revealed that among different soil series, Nimone soil series recorded significantly higher soil biological properties and soil organic carbon fractions. Therefore, from this study it was concluded that horticulture based perennial land use system under medium to deep black soil could be possible way out to improve soil quality in terms of physical chemical biological properties as well as soil organic carbon stock than conventionally cultivated and fallow land. In other words mango based land use system is one of the best systems to sustain soil health, enhancing soil biodiversity and storing more carbon in soil by capturing ever increasing atmospheric carbon dioxide.

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Persistence and Dissipation Behaviour of Deltamethrin, Chlorantraniliprole and Indoxacarb in Sapota under South Gujarat Condition

Ikbal Bagwan[1]* and K.G. Patel[2]

[1]Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
[2] Department of Soil Science and Agricultural Chemistry, N.M. College of Agriculture, Navsari Agricultural University, Navsari, 396450, Gujarat
**Email: ikbalbagwan97@gmail.com*

The persistence and dissipation behavior of deltamethrin, chlorantraniliprole and indoxacarb in / on sapota fruit under South Gujarat condition was investigated by using GC-ECD and LC-MS / MS after QuEChERS based extraction procedure. The linear dynamic range of deltamethrin in sapota fruit matrices was obtained between 0.01 to 0.1 µg g^{-1}. The recovery of deltamethrin in sapota fruit ranged from 98 to 101%. RSD ranged from 1.59% to 5.66%. The half-life of deltamethrin in sapota fruit were ranged from 1.74 and 2.19 days for recommended dose (28 g a.i. / ha) and 1.83 and 2.00 days for double to recommended dose (56 g a.i. ha^{-1}) for the year 2019-20 and 2020-21. The residue of chlorantraniliprole in sapota fruit dissipated upto 20 days and reached to BQL at 30th day at either dose of application by chlorantraniliprole twice at a fortnightly interval starting from fruit initiation stage of sapota for year 2019-20 and 2020-21. The graphical and calculated half-life values varied from 4.68-4.95 days and 5.78-6.13 days for dose of 185 and 370 g a.i. / ha in sapota fruit (R^2, ranged between 0.875-0.885 and 0.831-0.844). The validated method was linear (0.001-0.25 µg ml^{-1}) having correlation coefficients (R^2) value lyinges between 0.998 to 0.999 for indoxacarb. The LOD and LOQ (0.001 and 0.004 µg g^{-1}), recoveries (98.63 ± 6.20 to 100.50 ± 1.21%) at 0.01, 0.05 and 0.10 µg g^{-1} spiking level with RSD range from 1.20 to 6.29%. Initial deposit on sapota fruits of indoxacarb 14.5% SC at 145 and 290 g a i ha^{-1} was 0.203 µg g^{-1} and 0.243 µg g^{-1} and dissipated to 0.009 and 0.015 µg g^{-1}, respectively, on 10 days after application during both years. Half-life were 2.15 and 2.51 days. The dietary risk quotient (RQ) was found < 1 which signifies that sapota fruits collected from the field was safe for consumption of Indian population.

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Impact of Land Use Patterns on Soil Carbon Sequestration in Agroclimatic Zones of Western Maharashtra

Santosh Kale*, B.D. Bhakare, Ritu S. Thakare, V.S. Patil and A.G. Durgude
Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharashtra
**Email: kale143santosh@gmail.com*

The experiment was carried out on seven land use patterns in agroclimatic zones of western Maharashtra, India. GPS-based soil samples were collected at the depths of 0-15 cm and 15-30 cm from agriculture, forest, fallow, pasture, salt affected, horticulture and agroforestry land use patterns. The results emerged out from the study revealed that pH of different land use patterns of western Maharashtra region were found slightly acidic to strongly alkaline in reaction. The organic carbon content of different land use patterns of western Maharashtra region were found low to very high in range. The lowest bulk density and highest porosity values were observed in Mahabaleswar forest soil samples at 0-15 cm and 15-30 cm depth. In case of available nutrients, different land use patterns of western Maharashtra region were found very low to moderate in available nitrogen, low to high in available phosphorus and moderate to very high in available potassium. Furthermore, as regard of micronutrients deficient to sufficient in DTPA-Fe and Zn, sufficient in DTPA- Mn and Cu. Among land use patterns, the soil sample collected under Mahabaleswar forest was recorded higher soil microbial population (Bacteria, fungi and actinomycetes), enzymatic activities *viz.*, dehydrogenase and acid and alkaline phosphatase (118.37 cfu$\times 10^6$ g^{-1} soil, 93.78 cfu$\times 10^4$ g^{-1} soil, 86.48 cfu$\times 10^5$ g^{-1} soil, 69.56 µg TPF g^{-1} soil h^{-1}, 87.43 µg PNP g^{-1} soil h^{-1}, 97.68 µg PNP g^{-1} soil h^{-1}) at 0-15 cm soil depth, respectively as compare to conventionally cultivated and fallow land. Active carbon pool *viz.*, water soluble carbon (92.1 and 90.2 mg kg^{-1}) permanganate oxidizable soil carbon (793.07 and 791.40 mg kg^{-1}) soil microbial biomass carbon (923.22 and 920.57 mg kg^{-1}) and passive carbon pools *viz.*, particulate organic carbon (20.82 and 19.71 g kg^{-1}) humic acid carbon (59.15 and 58.41%) and fulvic acid carbon (56.15 and 55.41%), soil organic carbon stock (38.7 and 38.01 Mg C ha^{-1}) carbon management index (748.4 and 702.96) and E_4/E_6 ratio (HA and FA), functional groups *viz.*, CO_2H group, alcoholic group, phenolic group ware recorded higher in soil under Mahabaleswar forest as compare to other land use patterns *i.e.* conventionally cultivated and fallow land in surface and subsurface soils, respectively. Therefore, from this study it was concluded that forest based land use pattern could be possible way out to improve soil quality in terms of physical, chemical and biological properties as well as soil organic carbon stock than conventionally cultivated and fallow land. In other words forest based land use pattern is one of the best systems to sustain soil health, soil biodiversity and storing ever increasing environmental carbon dioxide.

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Integrated Nutrient Management for Climate Change Mitigation and Adaptation

Purbasha Priyadarshini Padhi*
Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture,
Sri Sri University, Cuttack, 754006, Odisha
**Email: padhi.purbasha@gmail.com*

Integrated nutrient management (INM) can play a vital role on climate change mitigation by reducing emission of greenhouse gases (GHGs), and adaptation by reducing nutrient and moisture stresses with improved soil health. We analysed the potential of GHGs mitigation and carbon sequestration in major cropping systems of India and abroad as impacted by long-term practices of INM. The INM practices included use of farmyard manure (FYM), biofertilizer, biochar and compost along with balanced use of chemical fertilizers (NPK) on crop yield, GHG mitigation and carbon storage at 13 locations and 14 major cropping systems. The GHG emissions could be reduced by 12 to 47% and C-sequestration could be enhanced by 38 to 100%. Climate change adaptation with INM through higher water holding capacity of soil and water saving in climate stress situations were also reviewed. It is concluded that the site-specific INM approach could be considered as a component of 'climate smart agriculture'. It helps in mitigating GHG emissions, increasing C sequestration, enhancing adaptation, improving soil health, sustaining crop productivity, and thereby developing resilience of the crops and cropping systems to climate change.

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Transformations of Lead (Pb) as Influenced by Amendments, Moisture Regimes and Aging in a Sandy Loam Soil

Shehnaz Sharma* and Rajeev Sikka
Department of Soil Science, Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: shehnazsharma@pau.edu*

Heavy metals have no known biological or physiological function but are toxic to soil-plant-animal-human continuum. Lead (Pb) is one of the most widespread heavy metal contaminants of soil and plants. The bioavailability and toxicity of metals to animals and humans is controlled by their speciation which is further controlled by the soil solid phase. *In-situ* immobilization is one of heavy metal amelioration methods of soil by transforming heavy metals in forms which are not available to plants, thus reducing the negative health and environmental effects. Therefore, the present study was planned with an objective to study the effects of soil moisture regimes, amendments and ageing on the transformations of Pb in soil. A sandy loam soil (neutral pH, low organic carbon) was spiked with Pb @ 50 mg kg^{-1} soil through its nitrate solution. Lime, FYM and Zn were added @ 5%, 20 t ha^{-1} and 25 mg kg^{-1}, respectively. The treated soil samples (30 g in plastic vials, replicated thrice) were incubated at 35°C for 1, 45 and 90 days at field capacity and submerged soil moisture regimes along with a control. The fractionation scheme of Ma and Uren (1998) was employed to determine various fractions of lead.

The findings revealed a temporal decrease in the water soluble and exchangeable fractions of Pb with ageing and it was in the order of 90 days > 45 days > 1 day. The magnitude of this decrease was higher with the addition of amendments and it was in the order of lime > FYM > Zn > unamended soil. On the other hand, a temporal increase in organically bound, oxide bound and carbonate fractions with addition of amendments was observed, but the percent distribution among these fractions varied. Residual fraction of the metals was not much affected by ageing, amendments and moisture regimes. Overall, soil moisture regime did not change the direction and pathways of transformations of metal, but it increased the transformation rate and submerged conditions showed higher metal reactivity compared with field capacity resulting in the pronounced transformation of Pb towards stable fractions. The results enable us to understand the effect of ageing coupled with different amendments under various soil moisture regimes on Pb transformations, availability and provide useful information to work out the capacity of the soil to serve as a sink for lead.

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Influence of Soil Moisture Regimes, Amendments and Ageing on Cadmium (Cd) Availability in a Sandy Loam Soil

Shehnaz Sharma* and Rajeev Sikka
Department of Soil Science, Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: shehnazsharma@pau.edu*

Cadmium (Cd) is one of the prominent heavy metals found in the contaminated soil sites existing naturally in the groundwater or added by anthropogenic activities. Its accumulation is toxic to soil-plant-animal-human continuum evidenced by the spread of Itai-Itai disease in Japan due to consumption of rice grown in fields irrigated with Cd contaminated industrial wastewater. It is particularly hazardous pollutant due to high toxicity and solubility in water. So, in soils polluted with heavy metals, their availability has to be curtailed by various in-situ immobilization methods. In a range of cadmium (Cd) spiked soils the effects of soil moisture regimes, amendments and ageing were estimated on Cd availability. The soil (sandy loam, neutral pH, low organic carbon) was spiked with Cd @ 0, 10 and 25 mg kg^{-1} soil through its nitrate solution. Lime, FYM and Zn were added @ 5%, 20 t ha^{-1} and 25 mg kg^{-1}, respectively. The so treated soil samples were incubated at 35°C for 1, 45 and 90 days at field capacity and submerged soil moisture regimes. Available Cd was extracted with 0.005 M DTPA which was determined on ICP-AES. The results revealed that there was a temporal decrease in the available Cd with ageing and it was in the order of 90 days>45 days>1 days. The magnitude of decrease in Cd availability was higher with the addition of amendments in the order of lime > FYM > Zn > unamended soil. The decrease in available Cd was further pronounced under submerged moisture regime than under field capacity. The mean per cent recovery of DTPA-Cd in the 10 mg kg^{-1} Cd spiked treatments decreased from 80.3 after one day of incubation to 41.7 and 36.1 per cent, respectively after 45 and 90 days of incubation whereas in the 25 mg kg^{-1} Cd spiking it decreased from 76.0 after one day of incubation to 39.5 and 34.4%, respectively after 45 and 90 days of incubation. An overall reduction in the mean per cent recovery of DTPA-Cd was observed under submergence as compared to field capacity moisture regime in all lime, FYM, Zn amended soils and unamended soil. The results enable us to understand the effect of ageing coupled with different amendments under various soil moisture regimes on Cd availability and provide useful information to work out the capacity of the soil to serve as a sink for cadmium.

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Characterization and Mapping of Sodic Soil in Salt-Affected Ghaghar Plains of Haryana

Arijit Barman[1]*, A.K. Mandal[1], B. Narjary[1], P. Sheoran[1] and Sukirtee[2]
[1]ICAR Central Soil Salinity Research Institute, Karnal, 132001, Haryana
[2]CCS Haryana Agricultural University, Hisar, 125004, Haryana
**Email: arijit.barman@icar.gov.in*

Indiscriminate use of high RSC groundwater for exploiting harvestable potential in rice-wheat cropping system, little efforts for groundwater recharging and faulty agricultural practices in Ghaghar plains of Haryana are adversely impacting agricultural productivity and livelihood security. A total of 445 soil samples were collected during *rabi* season of 2019 and *prekharif* season of 2021 on grid basis (500 m × 500 m) for quantification and characterization of salt-affected soils (SAS) in the five villages (Mundri, Kathwar, Geong, Sampli Kheri and Bhaini Majra) of Kaithal district. Different thematic map of EC_e, pH_s, ESP, cation and anion were prepared by ordinary kriging method. Based on lowest RMSE and better R^2 values, the best-fitted model was selected for spatial modelling. A weak spatial dependency (N:S >0.75) was observed for Cl (0.88), SO_4, Ca + Mg (0.80) and CO_3 + HCO_3 (0.83), whereas moderate dependency (N:S ~0.25-0.75) was found in EC_e (0.56), pH_s (0.64), ESP (0.65) and Na (0.43). The nugget value increased from 0.05 (CO_3 + HCO_3) to 0.70 (SO_4). Herein, the higher range value defining inconsistent distribution pattern of different SAS parameters varied from 0.64 km (Ca + Mg) to 2.70 km (CO_3 + HCO_3). Close to zero slope value was found in the semivariogram of Cl. A total of 78.4% area showed sodic soil (pH_s:8.21-8.73) and the ESP value of <15 was distributed in 16.7% area. Surface slightly saline soil (4.9%) was observed (EC_e:2.01-2.40) in the study area. The RSC level of groundwater was reported high in this area. Therefore, irrigation water management is the key management issue that needs to be strongly addressed by holding strong farmers-scientist interface, strengthening farmers' participatory research and extension network, suggesting suitable adaptation (salt tolerant varieties) and mitigation (neutralization amendments) strategies to further control degradation (soil sodicity) trends and secure sustainable land management in salt-affected Ghaghar plain.

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Developing Grassland Towards Soil Health Improvement and Reducing Greenhouse Gas Emission in the Nilgiris of Western Ghats Region in Southern India

P. Raja[1]*, K. Kannan[1], P. Mahesh[2], U. Surendran[3], A.R. Suguna[1] and R. Keerthana[1]

[1]ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Ooty, The Nilgiris, 643004, Tamil Nadu

[2]Analytical Chemistry Division, Earth and Climate Sciences Area, National Remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO), Hyderabad, 500037, Telangana

[3]Centre for Water Resource Development and Management, Calicut, 673571, Kerala

**Email: prajapiooty@gmail.com*

Increase in atmospheric concentration of greenhouse gases (GHG) mainly CO_2 is the major reason for climate change, global warming and frequent occurrence of cloud bursts in the Western Ghats region. Therefore, the present study focuses on restoration of degraded grasslands by limiting soil disturbance, and planting various grass species suiting to this agroclimatic system. The main objective was to restore the degraded grasslands to improve carbon storage by adopting suitable grassland management strategies and also for recognizing the critical goal of maintaining grassland cover and preventing degradation to conserve the ability of that land to continue sequestering carbon. In the present study carbon assimilation potential of various grass species such as lemon grass, vetiver, signal grass, weeping love grass, guinea grass, Guatemala grass, Hybrid Napier (Co-4 and Co-5), was estimated using soil CO_2 analyser with canopy assimilation chamber (EGM-5 of PP systems). The results indicated that among all the grass species, vetiver adsorbs maximum amount of CO_2 from the atmosphere (85.17 tonnes $ha^{-1}yr^{-1}$) followed by lemon grass (78.35 tonnes $ha^{-1}yr^{-1}$) and *Cenchrus ciliaris* (68.69 tonnes $ha^{-1}yr^{-1}$) and Hybrid Napier [CO-5 (68.24 tonnes ha^{-1} yr^{-1})]. All the grass varieties studied were found to be very good sink for atmospheric CO_2 except for CO-4 grasses which adsorbs lower amount of CO_2 (27.37 tonnes $ha^{-1}yr^{-1}$). It is advocated to restore many degraded lands in Western ghats area by developing grassland system and preserve existing grasslands and develop varieties like vetiver, lemon grass which are not only having good medicinal values, but also act as a biological barrier for soil conservation as well as very good sink for atmospheric CO_2.

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Assessment of Ecosystem Services Under Jute Based Cropping Systems with Tillage and Residue Management Practices in Indo-Gangetic Plains

R. Saha*, S.P. Mazumdar, G. Kar, Alka Paswan, D. Barman, M.S. Behera, B. Majumdar and A.R. Saha

Division of Crop Production, ICAR- Central Research Institute for Jute & Allied Fibres Barrackpore, Kolkata, 700120, West Bengal

**Email: saharitesh74@rediffmail.com*

Ecosystem services are the benefits provided to humans through the transformations of resources (or environmental assets, including land, water, vegetation and atmosphere) into a flow of essential goods and services e.g. clean air, water, and food. Agriculture has certain positive impacts on the environment through various provisioning, regulating, supporting and cultural ecosystem services (ES). Intensive agricultural practices have resulted in the degradation of other valuable ecosystem services such as soil fertility, soil formation, water purification, climate regulation and biodiversity conservation. An attempt was made to quantify ecosystem services of jute based cropping systems under various tillage systems *i.e.*, conventional tillage (CT), no tillage (NT) and no tillage with additional crop residue retention (NT+R) in Lower Indo-Gangetic plains. Additional crop residues were applied as *Sesbania* spp. during sowing of jute @ 2 t ha^{-1}. Net as well as green income calculated for these treatments based on the data for quantification of ecosystem services under field experimentation with same set of treatments for last 6 years. Economic value of the ecosystem services was highest in NT+R (Rs. 71,224 ha^{-1}) followed by NT (Rs. 68,533 ha^{-1}), lowest being in CT (Rs. 59,086 ha^{-1}). Green income from conventionally tilled jute based cropping systems was Rs. 28,545 ha^{-1}, which increased to Rs. 41,528 ha^{-1} in NT and to Rs. 45,407 ha^{-1} in NT+R. Higher green income in the NT and NT+R treatments was due to the higher value of ecosystem services along with lower pollution cost and lower input cost. The study highlighted the significance of conservation agricultural practices with better ecosystem services for long-term sustainability of agricultural systems.

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Role of Pressmud for Mediating the Toxic Effect of Salinity

M.L. Dotaniya[1]*, M.D. Meena[1], R.L. Choudhary[1], M.K. Meena[1], V.D. Meena[1], C.K. Dotaniya[2], K.N. Meena[1], R.S. Jat[1] and P.K. Rai[1]

[1]ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, 321303, Rajasthan
[2]Department of Soil Science & Agricultural Chemistry, Swami Keshwanand Rajasthan Agricultural University, Bikaner, 334006, Rajasthan
**Email: mohan30682@gmail.com*

Indian soils are containing a low to medium range of soil organic carbon (SOC) and deficiency of most of the plant nutrients. Increasing the organic C content in soil improves the soil health parameters and crop yield. Salinity soils are limiting the choice of crop, yield and quality parameters. These soils are having a larger chunk of cultivating land and have a huge potential to feed the hungry stomach. Higher content of salt ions is the main limiting factor affecting carbon mineralization rate, fertilizer efficiency, secretion of plant root exudates, uptake pattern of plant nutrients etc. For this, a field experiment was conducted to monitor the comparative effect of pressmud and FYM on soil properties and crop yield. Graded doses of pressmud (0, 5, 10 t ha^{-1}) and FYM (0, 5, 10 t ha^{-1}) were applied in different combinations in RBD with three replications. The mustard crop was used as a test crop. After crop harvest, soil and plant samples were taken and analyzed for nutrient concentration. The result showed the application of pressmud at the rate of 10 t ha^{-1} enhanced the mustard crop yield at par with FYM @ 10 t ha^{-1}. However, the addition of PM and FYM in equal amounts (5 t ha^{-1} each) improved the soil fertility parameters. The increasing level of pressmud (control to 10 t ha^{-1}) improved the available nutrient status of N, P, K and S in soil. Soil enzymatic activities were also measured and found that increasing the FYM and PM level improved the DHA, acid and alkaline activities. Maximum activities were measured in soil treated with an equal amount of PM (5 t ha^{-1}) and FYM (5 t ha^{-1}). This study showed that the addition of pressmud incombination of FYM improved the soil health parameters and mustard yield and yield attributes. This study is helpful for preparing salinity management strategies for sustainable mustard production.

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Management of Lead Toxicity by Application of Pressmud to Spinach under Lead Contaminated Soils

M.L. Dotaniya[1]*, M.C. Nagar[3], Amita Sharma[3], C.K. Dotaniya[4] and R.K. Doutaniya[2]

[1]ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, 321303, Rajasthan
[2]Department of Agronomy, SKN College of Agriculture, Jobner, 303328, Rajasthan
[3]Department of Environmental Sciences, College of Agriculture, Gwalior, 474002, Madhya Pradesh
[4]Department of Soil Science & Agricultural Chemistry, Swami Keshwanand Rajasthan Agricultural University, Bikaner, 334006, Rajasthan
**Email: mohan30682@gmail.com*

Increased heavy metal toxicity as a result of the exploitation of low-quality natural resources, such as soil and water, has contaminated the food chain, affecting human and animal health. A pot experiment was conducted to monitor the effect of pressmud (PM) on lead (Pb) uptake by spinach under Pb contaminated soils. For this, graded doses of PM (control, 2.5, 5.0, and 10.0 g kg^{-1}) and Pb (control, 100, 150 and 300 mg kg^{-1} soil) were applied in CRD with three replications. After spinach crop harvest, plant parts were divided into root and shoot; and were analyzed for Pb concentration. Results showed that increasing Pb levels in soil reduced spinach root and shoot growth. However, increasing the PM (control to 10 g kg^{-1}) reduced the Pb concentration in the shoot from 6.16 to 3.39 µg g^{-1}. The Pb uptake by spinach crops was negatively altered as the concentration of PM in the soil increased. Increasing the amount of PM in the soil reduces the Pb accumulation in plant parts. However, application of PM (upto 10 mg kg^{-1}) reduced the bioconcentration factor (BCF) value from 0.182 to 0.136, transfer factor (TF) value 0.221 to 0.191, transfer efficiency 66.11 to 59.34 and Pb removal value 0.063 to 0.072% over control. Increasing the Pb level from control to higher levels, lowered DHA from 41.99, 32.91, 29.19, and 20.26 g TPF g^{-1} soil 24 h^{-1} in control, 100, 150 and 300 mg kg^{-1}, respectively and acid phasphatase activities from 34.500 to 29.114 g PNP g^{-1} soil 24 h^{-1}, which was 15.61 percent less than the control pot. Pb content in soil was found to have a significant impact on alkaline phosphataes activity, ranging from 71.230 to 42.890 g PNP g^{-1} soil 24 h^{-1}. Such findings are useful for minimizing Pb toxicity, particularly in peri-urban effluent-irrigated crop production systems.

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Energy and Economic Assessment of Boron Fertilization in Maize Grown on an Acid Alfisol

Pratibha Thakur, Pardeep Kumar and Nagender Pal Butail*
Village Lohna, P.O. Bundia, The-Palampur, Dist. Kangra, Kangra, 176061, Himachal Pradesh
**Email: nagender.butail597@gmail.com*

Ecological and economic sustainability are the two main emerging challenges in agriculture. Energy efficiencies need prime attention in every cropping system to evaluate and enhance the ecological sustainability of the system. The economic efficiencies of a system define its economic sustainability which is the biggest disquiet among farmers. To figure out the ecologically and economically sustainable B application method, rate, and frequency, a three-way factorial experiment was organized at Palampur (H.P.) in a randomized complete block design with three replications. The three factors were B application methods [Foliar application (A1) and soil + foliar application (A2)], B foliar application rates [0.017% (B1), 0.034% (B2) and 0.051% (B3)] and B foliar application frequencies [(2 sprays (C1) and 3 sprays (C2)]. Two economic efficiencies [relative economic efficiency (REE) and economic efficiency (EE)] and six energy efficiencies [Energy ratio (ER), Net Energy (NE), Energy Profitability (PE), Human Energy Profitability (HEP), and Energy Productivity (EP) were worked out. Among all the inputs, chemical fertilizers (70.2%) consumed the highest input energy followed by human labor (11.5%). The mean of all the treatments recorded significantly higher values of economic and energy efficiencies than the control. Conjoint soil and foliar application of B registered significantly higher efficiencies than sole foliar B application. The values of economic and energy efficiencies increased significantly with the increased foliar application rate and were highest at 0.051% foliar application rate. To conclude, conjoint soil and foliar application at 2 kg ha^{-1} and 0.051%, respectively through three foliar sprays were the most sustainable among all B fertilization methods, rates, and frequencies.

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Plant and Soil Nitrogen in Rice under Elevated CO_2 and Temperature Interaction

Partha Pratim Maity*, Bidisha Chakrabarti, T.J. Purakayastha, Arti Bhatia, S. Naresh Kumar, D. Chakraborty, A. Sharma and S. Kannojiya

ICAR-Indian Agricultural Research Institute, New Delhi, 110012

**Email: ppmaity35@gmail.com*

Changing climate will certainly have impact on agricultural production. Several researchers have reported that growth and yield of crops will be adversely affected due to increased atmospheric temperature. Rice (*Oryza sativa* L.) is an important food crop with half of world's population relying on it every day. Elevated atmospheric CO_2 concentration and increased temperature can have a substantial impact on soil nitrogen balance as well as nitrogen uptake in plants. A field experiment was conducted during the *kharif season* inside open top chambers (OTC) at the IARI farm in New Delhi to study the interactive effect of elevated CO_2 and temperature on changes in plant and soil nitrogen in rice crop. Rice variety Pusa44 was transplanted in crates and grown under ambient and elevated CO_2 (550 ppm) concentration and with two temperature levels: ambient and elevated (+2.7°C). Nitrogen concentration in rice grains decreased under elevated CO_2 concentration. In chamber control treatment grain N concentration ranged from 1.26 to 1.32% while in elevated CO_2 treatment it ranged from 0.98% to 1.0%. Straw N concentration was not affected by high CO_2 and temperature level. Lower yield of the crop in elevated temperature treatment resulted in lower N uptake in rice. Enhanced N mineralization in elevated temperature treatment led to depletion of soil N. Soil available N was found to be significantly lower in elevated CO_2 plus temperature treatment than ambient condition.

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Fluoride Incidence in Groundwater: A Case Study from Cuttack, Odisha, India

Shraddha Mohanty*, R.K. Nayak and Bandita Jena
Department of Soil Science and Agricultural Chemistry, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
**Email: shraddha.mohanty001@gmail.com*

Fluoride-rich groundwater is prevalent in granite aquifers in India and the rest of the world. In this study, the fluoride concentration of tube well water was investigated. Additionally, the relationship between fluorides and other indicators of water quality were discussed. The research area, namely the Narasinghpur block, is located in the western half of the Cuttack district in Odisha and is characterised by lateritic uplands and hilly terrain. Before the rainy season (January, 2020), 52 groundwater samples were collected from various locations in Narasinghpur. The strategies and procedures used for collecting, preserving, analyzing and interpreting various parameters of water samples were based on those of Richards (1954), APHA (1992) and BIS (2012). Fluoride concentrations ranged from 0.58 to 4.95 mg L^{-1}. Due to the alkaline pH and high bicarbonate levels, fluoride-containing minerals are released into the groundwater. The high concentration of fluorides in the groundwater is due to the region's arid climate, the predominance of granitic, khondalitic, and charnockitic rocks, longer contact time with fluoride-bearing minerals, and minimal freshwater exchange. F^- exhibited positive correlations with pH ($r = 0.681^{**}$), Na^+ ($r = 0.690^{**}$), and HCO_3^- ($r = 0.719^{**}$), as well as negative correlations with Ca^{2+} ($r = -0.565^{**}$) and Mg^{2+} ($r = -0.597^{**}$). The majority of groundwater samples collected from gram panchayats within the block exceeded the BIS/WHO standard for fluoride concentration, posing a threat to numerous ecosystems. Those who rely on these groundwater resources are susceptible to numerous health risks.

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Long-Term Water Quality Changes in Sutlej and Beas Rivers of Punjab

Dhanwinder Singh*, Sumita Chandel, Harsimran Kaur and Kuldip Singh
Department of Soils, Punjab Agricultural University, Ludhiana, 141004, Punjab
**Email: dhanwinder@pau.edu*

Water quality of Sutlej and Beas rivers of Punjab is under threat due to their escalating pollution, attributed mainly to illegitimate release of untreated effluents from industrial, agricultural, domestic and religious activities. A study was carried out to calculate the water quality index of these rivers, both w.r.t irrigation as well as drinking purposes, from the 30 water quality variables from 24 locations of the two rivers and after their confluence at Harike, recorded during 2004 to 2020 by Punjab Pollution Control Board. Exploratory analysis of these water quality parameters showed highest spatio-temporal variation in total coliform (*T. Coli*), faecal coliform (*F. Coli*), COD, BOD, TSS and free ammonia for both rivers and confluence waters. A greater number of quality variables crossed their respective permissible limit in Sutlej river water in comparison to Beas. Water has been designated into A to E categories corresponding to its best use for different purposes by CPCB . In case of Beas, 78% water samples fall under category B, whereas for Sutlej, 31% were under B and 32% were under C category. Mukerian stretch along Beas river and D/S Budha Nullah along Sutlej river were identified as the hot spots contributing most pollution in the respective river. Drinking water quality index (DWQI) calculated for the two rivers and after confluence water for the recent period (2016-2019) indicated poor index for Sutlej while it was marginal for Beas and after confluence waters. With respect to the irrigation water quality index (IWQI), Sutlej water fall under good category whereas Beas and after confluence waters fall under very good category. The key variables responsible for deterioration of DWQI were *T. Coli*, DO and BOD, whereas, in case of IWQI, Kelly's Ratio (KR) and Na% contributed the most deterioration. During the study period, DWQI improved from marginal to fair for Beas, deteriorated from marginal to poor for Sutlej and remained consistent after their confluence, whereas, IWQI remained consistent for Beas and after confluence waters, while it deteriorated for Sutlej. The study indicates an urgent need to take corrective measures for improving water quality of the two rivers, particularly the Sutlej.

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Evaluating the Degradation Efficiency of Microbial Innoculants for Degradation of Municipal Solid Biowastes

B. Bhakiyathu Saliha*, S. Suresh and R. Duraisingh

[1]Department of Soil Science and Agricultural Chemistry, Agricultural College & Research Institute, Tamil Nadu Agricultural University, Killikulam, Vallanadu, 628252, Tamil Nadu
**Email: bhakiyathus@yahoo.co.in*

Effective solid waste management is a major challenge in a country like India where urbanization, industrialization and economic growth have resulted in generation of increased municipal solid wastes (MSW). Disposal of MSW is at a critical stage of development in India and needs to be managed with economically efficient and environmentally effective technologies so as to protect public health and preserve key resources such as ground water, surface water, soil fertility and air quality. Hence the study was taken up to minimize degradation period of increasing quantity of solid wastes generated from Thoothukudi city Municipal Corporation (TCMC) using various microbial inoculants and evaluating the municipal bio compost for various quality parameters. The lab incubation study was conducted for a duration of five weeks with seven treatments of microbial inoculants under CRBD in three replications to evaluate the efficiency of sources and levels of microbial inoculants through assessing the microbial respiration rate, dehydrogenase activity and other parameters of the compost*viz.*, pH, EC, C:N ratio and temperature. An increase in pH and electrical conductivity and reduction in C:N ratio (16:1) were registered in PUSA decomposer inoculated treatment whereas the control (21:1) and sawdust (22:1) inoculated compost recorded higher C:N ratio during final stage of composting. The activity of dehydrogenase was significantly reduced during the incubation period in which novel microbial consortia inoculated compost registered 0.22 TPF 24 h^{-1} which was statistically on par with the inoculation of PUSA decomposer (0.23 TPF 24 h^{-1}) and EM solution (0.24 TPF 24 h^{-1}). The findings from the laboratory incubation study indicated that the novel microbial consortia (4 litres per tonne of MSW waste) and PUSA decomposer (4 capsules per tonne of waste) inoculation were on par in influencing the dehydrogenase activity (0.22 TPF 24 h^{-1}) and microbial respiration rate (982 mg CO_2 kg^{-1} per week) which were significantly influenced compared to other sources and levels of microbial inoculants used in the study.

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Non-linear Kinetics and Isotherm Studies for Reactive Black-5 Adsorption on Maize Cob Husk

Indu Chopra*, Chakrapani Saikrishna Kishore, V.K. Sharma, Manindra Barman and Thungashan Kikon

Department of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi, 110012
**Email: tinaindu@gmail.com*

Dye-laden water discharged by textile and other industries is becoming a significant polluter of the environment that is affecting water quality as well as human health. It has also led to an adverse impact on agriculture as it has depleted the quality of available freshwater being used for irrigation. On the other hand, the disposal of agricultural waste is also becoming a concern as the excess crop residue is burnt by the farmers which adds to environmental pollution. In order to find the solution for dual management of agricultural waste and quality of dye-laden wastewater, the study was therefore carried out to explore the potential of maize cob husk as an adsorbent for the removal of Reactive black-5 from the simulated aqueous solutions. To assess the adsorption efficiency of maize cob husk for Reactive Black-5 (RB-5) dye, the experiments were carried out in batch mode. Surface characterisation of the adsorbents was done through FTIR and SEM. In order to achieve maximum dye removal from the simulated solutions, optimization of different parameters including pH, adsorbent dose, contact time, initial adsorbate concentration was carried out. The concentration of dye before and after adsorption was estimated through the spectrophotometric technique. The results of the study showed that the removal efficiency of Reactive black-5 increased by enhancing the dose of cob husk and decreasing the dye concentration of the solution. From a quantitative point of view, pH and optimum dose of maize cob husk were found to be 3 and 350 mg 50 mL^{-1}, respectively. In order to assess the true picture of dye adsorption, the non-linear fitting of the data to different isotherm models (Langmuir, Freundlich and Temkin models) was carried out. It was found that the data could best be explained by the Langmuir adsorption isotherm model. Kinetic modelling of the experimental data showed that the sorption kinetics followed the pseudo-second-order kinetic model for cob husk at different concentrations with R^2 value of 0.99. In order to validate the studies, the studies need to be carried out with real water effluents.

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Use of RothC Model to Simulate Soil Organic Carbon Dynamics under Different Long-Term Fertilization Practices and Climate Scenarios in An Acid Alfisol of North-Western Himalayas

Anjali[1]*, Narender Kumar Sankhyan[1], Raj Paul Sharma[1] and Ranbir Singh Rana[2]

[1]Department of Soil Science, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 176062, Himachal Pradesh

[2]Department of Agronomy Forages and Grassland Management, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 176062, Himachal Pradesh

**Email: anjalidhiman214@gmail.com*

Soil, a major reservoir of terrestrial carbon pool, strongly influences the global carbon cycle and atmospheric levels of greenhouse gases. Soil organic carbon is vital for ecosystem functioning, and depending on the conditions, it can be a source or a sink of the greenhouse gases. Carbon content in soils changes depending on the land use system, type of management practice and time. Increasing concern about soil quality vis-à-vis organic carbon content in soils due to global warming has led to estimate soil carbon stocks at regional or global levels. The present investigation was carried out to estimate soil organic carbon changes under different long-term fertilization practices in an acid Alfisol of North-Western Himalayas using RothC 26.3 model. The model was initialized using the data set from ongoing long-term fertility experiment which was in operation since *rabi* 1972-73 at the experiment farm of Department of Soil Science, CSK HPKV, Palampur. The model was successfully initialized (forward mode) by iteratively adjusting the carbon input and inert organic matter stock of soil at steady state. The results revealed that RothC model could simulate changes in soil organic carbon stocks under present as well as future set of climate and management scenarios. The continuous application of NPK alone and in combination with FYM/lime increased soil organic carbon stocks over the initial value. The model predicted decline in total organic carbon stocks under changing climate scenario in comparison to baseline climate by 2100. The results highlighted the impact of higher temperature on the mineralization of soil organic carbon and necessitated the addition of higher carbon inputs to keep the current level of organic carbon stocks in the near future.

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Delineation and Characterization of Water Quality and its Effect on Cationic Properties of Soil in Saline Tract of Purna Velly

Nitin Konde*, V.K. Kharche, Nilam Kanase, P.R. Kadu, S.M. Bhoyar and D.V. Mali
Department of Soil Science & Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
**Email: nitinkonde75@gmail.com*

The changes in land use pattern are based on the quality of soil and water, both have great influence on crops grown. Sustainable crop production can be achieved by using high-quality irrigation water keeping other inputs optimal. The Purna valley is the most unique tract in Maharashtra, where entire groundwater is brackish and monocropping is being followed. With this view an investigation on "Delineation and characterization of water quality and its effect on cationic properties of soil in saline tract of of Purna Valley" was undertaken during 2019-2022 at Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola, Maharashtra with object to assess the electrolytic concentration of water in Purna tract and its effect on properties of soil. The soil and water samples were collected from eight blocks in Purna valley and assessed for various properties. The findings of water samples from Borewell and Farm Pond have been compared in post monsoon season (winter) and its influence on cationic characteristics was evaluated. It was observed that, the irrigation water in Purna valley was having very high salinity and medium sodium hazard (C_4S_2) during post monsoon (winter) season, the sodium was dominant in water samples. The sodium adsorption ratio was close to the permissible limit and Mg:Ca ratio all water samples during post monsoon (winter) season found to be disturbed. The residual sodium bicarbonate of water collected from borewell were above permissible limit. The soluble sodium percentage of the all-irrigation water samples were found above permissible limit. The soil properties were highly influenced due to application of borewell water during irrigation. The result exhibited that the water collected from borewell have shown adverse effect on soil properties. The consistent use of the borewell water can create unfavorable environment beneath the soil. Therefore, borewell water can be used with blending of other sources.

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Growth Performance of Brassica Cultivars under Elevated Temperature Gradients under Present Climate Change Scenario in Gwalior, Madhya Pradesh

Sudhir Trivedi*
College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, 474001, Madhya Pradesh
**Email: sudhirtrivedi60@gmail.com*

In the research work carried out at the climate change project unit, department of environmental science, College of agriculture, Gwalior, RVSKVV during 2021-22 to study the growth performance of *Brassica* cultivars under elevated temperature gradients under present climate change scenario in Gwalior, Madhya Pradesh. The experiment was carried out in open top chambers (OTC) unit with four different levels of temperatures (ambient in OTC, ambient + 1°C, ambient + 1.5°C and ambient + 2°C) and a control plot. Two *Brassica* cultivars (RVM-2 and Giriraj) were selected and Randomized Block Design (RBD) with two way analysis was applied for analysis. Growth, yield and qualitative parameters were compared at different levels of temperature. The study revealed that with an elevation of 1.5°C in the atmosphere, the growth, yield and quality of mustard cultivars was better as compared to other temperature levels in addition to ambient temperature in OTC unit & open field. Growth parameters *viz.*, plant height, LAI, root length, shoot length was 197.3 cm, 2.6, 11.9 cm, 175 cm at 120 DAS in RVM-2 and no. of leaves/plant 30.6 in Giriraj were observed with more values at elevated temperature of 1.5°C. Likewise, the yield contributing parameters like dry weight of root and shoot (5.3 gm & 53.9 gm), total biomass (599.6 gm), number of pods/plant (205.6), number of seeds/pod (10.9), number of seeds/plant (2,274.8), seed weight/plant (11.36 gm) was towards higher values at ambient + 1.5°C. Consequently, the yield was maximum (25.24 q ha^{-1}) in Giriraj at ambient + 1.5°C. Similarly, it was found that the quality parameters sulfur (1.12%), oil content (39.7%) and chlorophyll (38.6) was more at ambient + 1.5°C. Among the cultivars, Giriraj showed better results in yield and quality parameters while RVM-2 performed better in regard to growth parameters. Correlation coefficient analysis of temperature and growth, quality parameters were positively significant in most of the cases and a few were negatively significant (table no. 4.6). Thus, it can be concluded that increase in mean temperature of the earth by 1 or 1.5°C in upcoming years will not affect the growth performance of cultivars (RVM-2 and Giriraj) negatively. However, it was observed in the experiment that if temperature goes higher then 1.5°C then the growth and yield may not be the same and decline.

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Influence of Sano Urea along with Sea Weed Extract on Yield and Yield Attributing Characters of Sweet Corn in Coastal Zone of Odisha

Ashish Kumar Dash*, S. Pani and S.G. Sahu
Department of Soil Science & Agricultural Chemistry, Orissa University of Agriculture & Technology, Bhubaneswar, 751003, Odisha
**Email: dashashish63@yahoo.com*

A field experiment was conducted during *Kharif* season of 2021 in the Central farm of Regional Research and Technology Transfer Station (RRTTS), Costal zone, OUAT, Bhubaneswar to study the effect of nano urea on the yield and yield attributing characters of sweet corn (*Zea mays* var. *saccharata*). The soil of the experimental site was sandy loam with acidic pH (5.15), EC - 0.03 dS m?¹ and medium in OC (0.61%), low in available nitrogen, phosphorus and potassium. The soil test dose (STD) of fertilizer for the crop was 125-75-75 kg N, P_2O_5 and K2O ha^{-1}. The experiment was laid down in randomized block design (RBD) with twelve treatments *viz.*, T1 - Control, T2 -100% of STD for N applied in soil, T3 -75% of STD for N applied in soil, T4 -50% of STD for N applied in soil (50% of N), T5 -50% of N + twice foliar spray (FS) of nano urea (NU) @ 2 ml l^{-1}, T6 -50% of N + twice FS of NU @ 4 ml l^{-1}, T7 - 50% of N + twice FS of NU @ 6 ml l^{-1}, T8 - 50% of N + twice FS of seaweed extract (SE) @ 2.5 ml l^{-1}, T9 - 50% of N + twice FS of SE @ 3.5 ml l^{-1}, T10 - 50% of N + twice FS of SE @ 5 ml l^{-1}, T11 - 50% of N + twice FS of NU @ 2 ml l^{-1} + SE @ 5ml l^{-1}, T12 - 50% of N + twice FS of NU @ 4 ml l^{-1} +SE @ 2.5 ml l^{-1} along with three replications. The results indicated that highest total chlorophyll content of 1.69,1.93, 2.37 and 1.86 mg g^{-1} of fresh leaf was recorded with maize leaves collected at 30, 37, 45 and 55 days after sowing (DAS) respectively with T12 as compared to T_1. Significantly highest plant height (253 cm), leaves per plant (12.8), cobs per plant (2), width of cob (19 cm), grain yield (32.77 q ha^{-1}) and stover yield (44.35 q ha^{-1}) was recorded with T12. The lowest grain and stover yield of 18.33 and 23.75 q ha^{-1} respectively was recorded under control. From these observations it was thus concluded that application of 50% of STD for N applied in soil + twice FS of NU @ 4 ml l^{-1} +SE @ 2.5 ml l^{-1} significantly influenced the yield and yield attributing characters of sweet corn.

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Methane Emission from Transplanted Rice as Influenced by Organic Fertilization

Vinubhai Ramani*, V.H. Kadivala and A.S. Bhanvadia
College of Agriculture, Anand Agricultural University, Vaso, Anand, 388110, Gujarat
**Email: vpramani@yahoo.com*

Rice is grown on million hectares worldwide and is the most heavily consumed staple food on earth. Ninety percent of the world's rice is produced and consumed in Asia, and 90 percent of rice land is at least temporarily flooded. The unique semi-aquatic nature of the rice plant allows it to grow productively in places no other crop could exist, but it is also the reason for its emissions of the major greenhouse gas (GHG), methane. Field experiments were conducted to study the "Effects of organic and inorganic fertilization on growth, yield and methane emission from transplanted rice" the year 2020 at two different locations i.e., Anand and Thasra research station of Anand Agricultural University, Anand. Treatments comprising two methods of cultivations (M_1: Flooded rice, M_2: SRI method) in main plot and five fertilizer treatments (F_1: Control, F_2: 100% RDN: Inorganic, F_3: 100% RDN: Organic, F_4: 50% RDN: Inorganic + 50% RDN: Organic and F_5: 50% RDN: Inorganic + 25% RDN: Organic + *Azotobacter* in sub plot. The experiment was laid out in CRD Split Plot (Large Plot Technique) design with three (quadrates) replications. The soil of the Anand and Thasra was loamy sand and sandy loam in texture, respectively. The experimental results revealed that methods of cultivation and different fertilizer treatments had significant influence on growth, yield attributes, yield and soil nutrient status. Among the cultivation methods, maximum improvement in grain yield was 23.4, 13.6 and 18.9 and straw yield was 32.2, 30.6 and 31.5 per cent in M_1 method over M_2. Among the fertilizer treatments, maximum increase of grain yield was found under treatment F_2 (100% RDN: Inorganic) was of 35.8, 37.8 and 36.7, straw yield was 41.6, 42.8 and 42.1 as compared to F_1 (Control) at Anand, Thasra and pooled results, respectively. In case of methane emission method of cultivation and fertilization had found significant effect. Here, the extent of increase in methane emission in M_1 over M_2 was at 15 DAT (1.24, 2.23 and 1.73 mg m^{-2} h^{-1}), 30 DAT (0.11, 2.47 and 1.29 mg m^{-2} h^{-1}), 45 DAT (0.58, 2.08 and 1.33 mg m^{-2} h^{-1}), 75 DAT (0.21, 0.38 and 0.29 mg m^{-2} h^{-1}) and 90 DAT (0.31, 0.15 and 0.23 mg m^{-2} h^{-1}) at Anand and Thasra, respectively. In case of fertilization, the maximum increase of methane emission in F_3 over control was at 15 DAT (0.22, 4.96 and 2.59 mg m^{-2} h^{-1}), 30 DAT (0.10, 4.64 and 2.37 mg m^{-2} h^{-1}), 45 DAT (1.16, 4.17 and 2.67 mg m^{-2} h^{-1}), 60 DAT (0.28, 3.24 and 1.76 mg m^{-2} h^{-1}), 75 DAT (0.17, 0.48 and 0.33 mg m^{-2} h^{-1}) and 90 DAT (0.13, 0.11 and 0.12 mg m^{-2} h^{-1}) at Anand, Thasra and in pooled analysis, respectively. However, interaction among method of cultivation, fertilization treatments and location for yield as well as methane emission was found significant.

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Heavy Metals Fractionation of Sediments of Chilika Lake and Assessment of Ecological Risk

Dibyajyoti Panda*
Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh
**Email: dibyajyotipanda1996@gmail.com*

Multifunctional nature of lake attracts pollutants towards it and contamination of lake sediments by heavy metals pose threat for both aquatic and terrestrial organisms. One such important lake is Chilika, located in eastern India. To determine the status of risk associated with heavy metals, total 32 grid samples were collected in post-monsoon season. Modified Tessier sequential extraction scheme was followed to quantify the metals present in 5 different chemical forms (Fractions). Based on metal concentration present in five different fractions, it was concluded that more than 50% of Ni and Cr were present in residual fraction indicating less mobility and bioavailability due to strong binding of metals to crystal lattice, while Pb and Cd have less than 50% content in residual fraction indicating their significant presence in labile fraction thus having more mobility under changing environmental conditions. Average concentration of metals found to follow the order Cr > Ni > Pb > Cd. Significant correlation was found between metals concentration and finer fraction of sediments, thus favouring metal mobilization. Ecological risk index like, Risk assessment code (RAC) which indicate metals bound to exchangeable and carbonate fractions follows the order Cd > Cr > Pb > Ni *i.e.* low to medium risk for Ni, Cr and Pb while medium to very high risk for Cd. Pollution load index (PLI) is used to assess the level of sediments contamination using Contamination factor (CF) of above said four heavy metals and it ranges from 0.19 to 1.7, indicating presence of heavy metals pollution. Sea mouth and river confluence area were found to be more polluted due to agricultural runoff from nearby farm fields, domestic untreated waste water from nearby areas, industrial and municipal waste carried by Mahanadi river distributaries and boat trafficking in lake. Generally, metals bound to Fe-Mn oxide and organic fractions contribute more metal accumulation in to food chain, which upon consumption cause health hazard.

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Effect of Irrigation Levels, Planting Dates and Zero Tillage on the Yield of Field Bean in Saline Soil of Maharashtra

Manoj Wahane*, K.P. Vaidya, S.B. Dodake, S.S. Khobragade and D.K. Borse
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: manoj_358@rediffmail.com*

Two consecutive field experiments were conducted during *rabi* season of 2019-20 and 2020-21 at Khar Land Research Station, Panvel, to asses the effect of different irrigation levels, planting dates and zero tillage on yield of field bean in coastal saline soil of Maharashtra. The experiment was laid out in factorial randomized block design (FRBD) with four replications, comprising zero tillage, three levels of irrigation *viz*., no irrigation (I_0), one irrigation at flowering (I_1) and two irrigations at flowering and at pod formation (I_2) and three planting dates *viz*., immediate after harvest of rice (D_1), 10 days after harvest of rice (D_2) and 20 days after harvest of rice (D_3). The pooled data showed that the sowing of field bean immediate after harvest of rice (D_1) recorded significantly higher yield (9.15 q ha^{-1}) over the treatments of D_2 (7.13 q ha^{-1}) and D_3 (6.05 q ha^{-1}). Among the irrigation levels, treatment receiving irrigation water at the time of flowering (I_1) found to be significantly superior (8.56 q ha^{-1}) over two irrigations at flowering and at the time of pod formation I_2 (7.26 q ha^{-1}) and no irrigation I_0 (6.50 q ha^{-1}). The interaction of sowing date and irrigation (I_1D_1) *viz*., sowing immediate after harvest of rice with one irrigation at the time of flowering produced significantly higher yield (10.65 q ha^{-1}) over remaining interactions. The treatment D_1I_1 recorded higher seed yield of field bean (10.65 q ha^{-1}) with net realization of Rs.1,06,500/- ha^{-1}, net income of Rs. 55,222/- ha^{-1} and benefit cost ratio 2. 80.

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Effect of Saline Irrigation Water on Growth, Yield and Economics of Spinach, Radish and Dill under Coastal Saline Soils of Maharashtra

Kishor Vaidya*, M.R. Wahane, S.B. Dodake, D.K. Borse and S.S. Khobragade
Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, 415712, Maharashtra
**Email: kvkvaidya73@gmail.com*

Field experiment was conducted for three consecutive summer (*rabi*) seasons of 2017-18, 2018-19 and 2019-20 with application of saline irrigation water to asses the effect of soil salinization of coastal clayey saline soil on growth and yield of spinach, dill and radish at Khar Land Research Station, Panvel, Maharashtra. The experiment comprising of 5 levels of saline irrigation water (pond water, water with salinity (EC) 2, 4, 6 and 8 dS m^{-1}) which was replicated thrice in RBD. Being coastal saline soils, soil salinization was mainly caused by capillary rise from shallow water table. Also, the saline irrigation water was found responsible for enhancing soil salinization. The pH (1:2.5) data indicated that soils were of acidic in nature initially due to excessive leaching of salts as a consequence of heavy precipitation which favoured downward movement of salts and accumulation of salts through capillary rise caused conversion of acidic soils into saline soil. The data further revealed that the pond water treatment produced significantly highest yield of radish (19.57 t ha^{-1}) followed by dill (10.93 t ha^{-1}) and spinach (10.09 t ha^{-1}), respectively. Salinity of irrigation water affected crop yield adversely. The yields of spinach, dill and radish crops were found to be 15.65, 3.71 and 9.04 t ha^{-1} for saline irrigation water having salinity 8.0 dS m^{-1}. The pond irrigation water showed B:C ratios 2.87, 2.81 and 2.52 for radish, dill and spinach, respectively. However, B:C ratios of spinach and radish were found more than 2.0 and was 0.95 for dill for saline irrigation water having EC 8.0 dS m^{-1}. In general, cultivating spinach and radish were found to be more suitable than dill in coastal saline soils.

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Remediation Technology for Minimizing Heavy Metal Toxicity Using Hydrothermally Modified Fly Ash

Vassanda Coumar Mounissamy[1]*, Ramkishor Yadav[2], Pradeep Malviya[2], S.C. Gupta[2], R.C. Jain[2], J.K. Saha[1] and A.K. Patra[1]

[1]Division of Environmental Soil Science, ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh

[2]Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, R.A.K. College of Agriculture, Sehore, 466001, Madhya Pradesh

**Email: vassanda.coumar@gmail.com*

An incubation studies and pot culture experiment was conducted to study the effect hydrothermally modified fly ash (acid modified fly ash, alkali modified fly ash and humic acid modified fly ash) and their application rates (1, 2.5 and 5% dry w/w basis) on heavy metal (Cd, Pb and Cr) stabilization in a Cd, Pb and Cr contaminated soil. The application of modified fly ash (@ 5%) not only countered the Cd toxicity but also improved the spinach biomass growth by more than 15% compared to uncontaminated soil. Application of alkali modified fly ash resulted in reduction in DTPA extractable Cd (28%) and spinach leaf Cd (45%). The highest per cent reduction of 55.6% in spinach leaf Pb content as compared to control was observed in a Pb contaminated soil amended with alkali modified fly ash. Similarly, the highest per cent reduction of 64.6% in spinach leaf Cr content as compared to control was observed in a Cr contaminated soil amended with acid modified fly ash. The sorption of heavy metals increased with pH of the solution. Alkali modified fly ash completely removed Cd and Pb from solution due to significant increase in CEC. On the other hand, acid treatment reduced sorption of Cd and Pb at pH 5 and 7. To conclude, application of alkali modified fly ash as soil amendment has greater potential in reducing the mobility of heavy metal in soil and its subsequent transfer to edible plant parts (spinach leaf) as evidenced by reduction in DTPA extractable Cd and Pb in soil and lower transfer coefficient value in a Cd and Pb Contaminated soil.

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Eco-toxicological Effect of Environmentally Relevant Concentration of TiO_2 Nano Particles on Soil Enzymes and Microbial Community

Sudeshna Bhattacharjya*, Tapan Adhkari, Asha Sahu, A.B. Singh and A.K. Patra
ICAR-Indian Institute of Soil Science, Bhopal, 462038, Madhya Pradesh
**Email: sudeshna.bb@outlook.com*

Increasing use of TiO_2 nano particles (NPs) as well as their indiscriminate disposal in to the soil are raising concern about their ecotoxicological effects on soil microbial community and in turn on ecosystem functions. In spite of many recent reports regarding the ecotoxicological effect of TiO_2 NPs, a common conscience is yet to be reached. Besides, limited studies have reported about soil enzymes which are considered as sensitive indicator of soil health. With this backgroun, the present study has been executed in a microcosm for 45 days to assess the ecotoxicological effect of various doses of TiO_2 NPs (5, 10, 20, 40, 80, 100 mg kg^{-1} soil) on different soil enzymes and microbial community structure. Results revealed uniform response from soil enzyme and microbial biomass which showed increasing trend up to dose of 20 mg TiO_2 NPs kg^{-1} soil and there onwards reduced drastically at 100 mg TiO_2 NPs kg^{-1} soil dose. In contrast, soil respiration and metabolic quotient kept increasing up to 100 mg TiO_2 NPs kg^{-1} dose indicating sub-lethal stress on microbial community. Nonetheless, biomass of total phospho lipid fatty acid (PLFA), Gram positive and negative bacteria, fungi, actinomyctetes and anaerobes had been increased up to the dose of 80 mg TiO_2 NPs kg^{-1} soil, but, significantly declined at 100mg TiO_2 NPs kg^{-1} soil dose. However, 40°C temperature has less negative impact than 25°C. In addition alteration index (AI3), a well-documented indicator of soil pollution, has been found to be regulated by soil respiration, clay content, anaerobe and microbial community. Overall, the study provided valuable information regarding ecotoxicological impact of environmentally relevant concentrations of TiO_2 NPs in clay loam soils as well as improved our perception regarding the impact of NPs on soil functioning.

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Genesis of Salts in Soils and Their Management Options for Restoring Productivity to Achieve Land Degradation Neutrality

Anil Chinchmalatpure*
ICAR-Central Soil Salinity Research Institute, Regional Research Station, Bharuch, 392012, Gujarat
**Email: rcanil2014@gmail.com*

India's total geographical area is 328.7 million hectare (Mha) and net cultivable area is reported as 141.0 Mha although some of the agricultural land is diverted to other developmental activities. The per capita availability of land is decreased to around 0.20 ha and thereby productive land is also shrinking. Green revolution during 1970s enhanced the productivity of land by means of making availability of input factors like high yielding varieties, irrigation facility, inorganic fertilizer, etc., and we achieved self-sufficiency in food grain requirement but because of huge pressure on natural resources, degradation problems started. The intensive cultivated areas are now showing the plateau of the productivity but country needs more than 300 million tonnes of food grain production to feed burgeoning population. Availability of irrigation facility will help to increase the productivity of these lands. In many of canal command area, cropping intensity is doubled and increased production. Due to erratic rainfall, a visible effect of climate change, farmers are using groundwater for irrigation. Many time saline ground water, even industrial effluent are also being used. Use of irrigation without taking into consideration the proper management options related soil types, soil conditions, soil properties, topography, etc., will lead to severe land degradation in near future and will drastically affect the land productivity and production. Soils under canal command area are turning into saline land, soils irrigated with saline ground water are also becoming saline, soils near sea coast are also affected by sea ingress and becoming saline. Most of the cases genesis of salt in soils is water, may be it sea water, canal water or groundwater or effluent water and nature of salinity/salts also depends on water used. And hence if no proper and scientific management of water is opted, soil deterioration and degradation continues and ultimately productivity reduces. Some of the examples of salinization of soils which was hitherto productive have been narrated with causes of its formation and their properties. Some of the interventions also suggested for reclamation and management of these salty lands for restoring its productivity and achieving land degradation neutrality.

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Integrated Farming System (IFS) with Dairying-Based Livelihood: An NDDB Experience for Increasing Farmers' Income

M.R. Patel, Niranjan Karade and K.P. Patel*
National Dairy Development Board, Noida, 201301, Uttar Pradesh
**Email: patelkp1957@gmail.com*

Indian economy is predominantly rural and agriculture oriented where the marginal and small farmers constitute more than 80% of farming community. Dairying has emerged as an important source of income and employment in rural areas for these farmers. The farmers when concentrate mainly on crop production only, it is subjected to a high degree of uncertainty in income. However, whatever agriculture by-products are available, the farmer can manage 2-3 dairy animals from it. In view of several benefits as tested in the IFS model under different ecosystems, in which the "waste" from one component becomes an input for another intervention of the system. Thus, it reduces input costs and improves production and income of the small and marginal dairy farmers. Looking to the importance of different elements of IFS, in the present initiatives, suitable components like animal husbandry, agriculture, horticulture, fishery, poultry, duckery, biogas technology were selected; and a IFS model of about 2 acres was developed at Itola farm of NDDB during the year 2020-2021 by allotting appropriate land size for different components considering the local requirement and its economical importance. In the present model, it was felt that a farmer can earn about Rs.10,000 -12,000 per month in the first year; and the income will gradually increase over the years with fully commissioning of different components after three years. Hence, from the 4th year onwards farmer can earn net income around Rs. 20,000-25,000 per month; and it can still be enhanced in accordance with efficient management of the components. After installing the different components during the year 2020-2021, the data were collected for the expenses and income generated from April-2021 onwards; accordingly the data were recorded for the individual months of the year 2021-2022. Although, all the components were not fully operational, the total income was generated to the extent of about 2,64,000/- as against the total expenses of Rs. 1,68,000/- which showed the net income of about Rs 8000/- per month after meeting the food requirement of the caretaker farmer family. The first year's income was slightly less than the anticipated income in view of the unfavourable climatic conditions and damages caused by animals etc. The most important observation was recorded that the income generated during the year was found distributed across the year in almost every month; and hence the Model was found useful to the farmer.

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Socio-economic impact evaluation of Soil Health Card Scheme in the State of Andhra Pradesh

Ankhila Handral[1]*, Alka Singh[3], Pramod Kumar[3], Suresh Kumar[2], Mahesh Chandra Meena[3], Rashmi Singh[3], Sunil Sunani[4], Partha Pratim Adhikari[1], Dinesh Kumar[3] and Sanatan Pradhan[1]

[1]ICAR-Indian Institute of Water Management, Bhubaneswar, 751023, Odisha
[2]ICAR-Central Soil Salinity Research Institute, Karnal, 132001, Haryana
[3]ICAR-Indian Agricultural Research Institute, New Delhi, 110012
[4]ICAR-Indian Institute of Pulses Research, Regional Station, Khordha, 752057, Odisha
**Email: ankhila.ankhe@gmail.com*

The study aims to explore the effectiveness of the soil health card (SHC) scheme in the state of Andhra Pradesh (AP). The socio-economic analysis study relies on primary survey in the selected districts of the AP state. The primary data on fertilizer use for paddy by 120 SHC adopters and 60 non-adopters were collected in the year 2019-2020 from Nellore and Chittoor districts of Andhra Pradesh. The study evaluated the factors affecting the adoption of SHC in the selected states of AP. Among the various factors, the number of trainings attended, membership of farmer organizations, and the timely extension service availability has shown positive impact on adoption of SHC. However, distance to input market, age, and family size had significant negative impact on adoption of SHC by the farmers. The results of impact evaluation revealed that significant decline in use of nitrogen and phosphorus nutrients by 20 kg ha^{-1} and 19 kg ha^{-1}, respectively, among the adopters. However, there was no significant changes in the use of potash. At the same time the micronutrient use increased by 9.15 kg ha^{-1c} among the adopters. Hence, it can be concluded that the SHC scheme has achieved its major objective of reducing the excess usage of fertilizers in cultivation of paddy in the selected districts of Andhra Pradesh. The study recommends promoting such schemes with better extension service to have direct impact on fertilizer savings along with better farmer returns and restore the soil health by correcting the imbalance in fertilizer usage at the production site.

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Significance of Gypsum Application on Soil pH and Crop Yield in Different Soils

Nagabovanalli Prakash, Prabhudev Dhumgond, Shruthi, Pema Khandu Goiba, Laxmanarayanan M. and Yogesh G.S.
University of Agricultural Sciences, GKVK, Bangalore, Karnataka

Slag-based gypsum (SBG) is a synthesized product of iron and steel industry and it can be an excellent replacement for commercial gypsum (CG). There exists a common belief that application of gypsum decreases the pH of all soils. Hence, to know the changes in soil pH upon application SBG and CG (150-750 kg ha^{-1}), field experiments were conducted in acidic, neutral and alkaline soils with paddy, maize and groundnut as a test crop. Statistical tools such as correlation and linear regression models were used to distinguish the relationship of gypsum (SBG and CG) application with soil pH and yield of crops. Experimental results revealed that the application of SBG and CG didn't show any significant and linear relationship with pH of acid and neutral soils of paddy and acidic soil of groundnut. However, application of SBG and CG to paddy grown in alkaline soils recorded positive and significant relationship with soil pH. Further, maize grown in acid and neutral soils also shown positive and significant relationship with soil pH upon application SBG and CG. Irrespective of soils, application of SBG (R^2 = 0.001, 0.03 and 0.01, respectively) and CG (R^2 = 0.001, 0.04 and 0.0002, respectively) on paddy, maize and groundnut had a non-significant and poor correlation with soil pH. Application of SBG and CG was positively and significantly regressed with the yield of paddy, maize and groundnut in all the soils. In general, higher regression determination in the relationship between soil pH and yield of crops was found in acid and neutral soil when compared to alkaline soil. A higher correlation coefficient between gypsum application and yield of paddy, maize and groundnut was noticed with SBG when compared to CG. With this it can be concluded that, there is no significant effect on soil pH with present applications rates of 150-750 kg ha^{-1} of SBG and CG in rice and maize and 625 kg ha^{-1} in groundnut in different soil types.

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Effect of Different Sources and Levels of Sulphur Application on Yield of French bean under North-western Himalayas

Deepika Suri, Pardeep Kumar, Nagender P Butail, Munish Sharma and Praveen Kumar
Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur

French bean (*Phaseolus vulgaris L.*) belongs to family Leguminosae and occupies a premier place among grain legumes in the world including India. Nutritional study of this important crop was mainly confined to the primary nutrients while as secondary nutrients were least attended and micronutrients forgotten. Among secondary nutrients sulphur (S) deficiency is reported as yield limiting factor, particularly in production of pulses and oilseed crops. Keeping in view the role which sulphur play in pulse crops, an attempt has been made in the present investigation to study the effect of different sulphur levels on the yield of French bean. This experiment was initiated during *kharif*, 2019 with French bean as the test crop in the experimental farm of Department of Soil Science, CSK HPKV, Palampur. The experiment consists of 10 treatment combinations which were replicated thrice in a factorial randomized block design. Three soil application rates (20, 40 and 60 kg S ha^{-1}) were tested through gypsum, SSP and elemental sulphur. The maximum mean pod (109.5 q ha^{-1}) and straw (19.6 q ha^{-1}) yield were registered with gypsum which was significantly superior to SSP and elemental sulphur (ES) as sulphur sources. Data further revealed that the highest pod (107.5 q ha^{-1}) and straw (19.5 q ha^{-1}) yield were recorded with application of S @ 60 kg ha^{-1}, however, the same was statistically at par with treatment composing of S applied @ 40 kg ha^{-1}. Application of S through any source and rate significantly increased the pod and straw sulphur content over control. The per cent increase for pod and straw S concentration was to the tune of 31.5 and 45.0 % with S application over control (no sulphur), respectively.

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Macronutrient Indexing of Soils in Tomato Growing Areas of Sirmour District of Himachal Pradesh

Aanchal, Anil Kumar, Swapana Sepehya, Sanjay K. Sharma and Saurabh Thakur
Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, 173230, Himachal Pradesh
**Email: kapoor.aanchal88@gmail.com*

Soil plays a fundamental role in crop production and the assessment of the quality of soil is the main tool to help farmers to implement certain management practices in the field. The primary macronutrients (nitrogen, potassium and phosphorus) are required in large quantities by the tomato crop. Soil testing determines its fertility status and provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximization of crop yields. A total of one hundred representative soil samples were collected at surface (0-15 cm)and sub-surface (15-30 cm) depths from the tomato growing areas of Sirmour district of Himachal Pradesh and were analyzed for nitrogen, phosphorous and potassium. Nutrient index was calculated by the formula (NL × 1) + (NM × 2) + (NH × 3) / NT, where, NL= Number of samples falling in low category of nutrient status, NM = in medium category, NH = in high category and NT = Total number of samples analyzed for a given nutrient. The results showed that in the studied soils, 22 and 78 per cent samples were found to be in low and medium category, respectively in case of nitrogen. The status of phosphorous was found to be in medium category in 24 per cent samples and remaining was found to be in high category. In case of potassium, 32 and 68 per cent samples were in medium and high category, respectively.

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Soil Potassium Fractions under Prominent Rice-based Cropping Systems in Meerut, Uttar Pradesh

Pallabi Kalita[1]*, Satendra Kumar[1]*, Debasish Dutta[2], B.P. Dhyani[1], U.P. Shahi[1] and Marami Dutta[3]

[1]Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, 250110, Uttar Pradesh
[2]Indian Institute of Farming System Research, Modipuram, Uttar Pradesh
[3]Department of Soil Science, AAU, Jorhat, Assam
**Email: pallabi20kalita@gmail.com*

Although potassium (K) is not a structural element, it plays crucial roles in controlling a variety of plant metabolic processes, ensuring the quality and production of agricultural produce. Low potassium application rates in Indian agriculture endanger food security and soil health, which ultimately compromises long-term sustainability objectives. With this background, present study assessed 18 locations for potassium (K) pools under intensive cropping systems viz. Rice-potato, Rice-mustard and Rice-wheat across three depths 0-15 cm, 15-30 cm, 30-45 cm from Meerut, U.P. Exchangable K and Non-exchangeable K were used to further categorise these sites. According to the findings, the majority of sites under rice-potato and rice-mustard had low to medium levels of exchangeable K. Only five of the 18 sites have enough Exchangeable K supplies. Non-exchangeable pools are more plentiful, but their availability will depend on how quickly the associated minerals release potassium. Such classification of soils provides a clear image of K availability under intensive cropping systems and serves as a basis for K fertiliser recommendations for effective K management.