भाकृअनुप
ICAR

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New Publications

In This Issue

Forthcoming Events

- MTC on Conservation Agriculture in Rainfed Ecosystem during Sept. 24 to Oct. 1, 2010.
- Midterm workshop of the project entitled "Preparation of GIS based fertility mapping of selected districts for the farmers of India" during Oct. 13-14, 2010
- 75th Annual Convention of the Indian Society of Soil Science during Nov. 14-17, 2010.
- Short Course on "Carbon Stabilization, Saturation and Sequestration: Evolving Concepts, Mechanisms and Approaches" during Nov. 23 - Dec. 2, 2010

From the Director's Desk

Biochar-a new option for carbon sequestration and mitigation of climate change

Soils are the largest carbon reservoirs of the terrestrial carbon cycle. Soil, if managed properly, can serve as a sink for atmospheric carbon dioxide. Worldwide about 1500 Pg carbon is stored in first 30 cm of soil (Batjes 1996); for India it is only 9 Pg (Bhattacharya et al. 2000). Soils contain 3.5% of the earth's carbon reserves, compared with 1.7% in the atmosphere, 8.9% in fossil fuels, 1.0% in biota and 84.9% in the oceans (Lal 1995).

Given the fact that there is a critical amount of carbon dioxide already in our atmosphere, soil carbon has a significant and urgent role to play in shaping the world community's response to the climate crisis. The mitigation of elevated carbon dioxide by sequestering carbon in terrestrial ecosystem promises a low cost effective tool for developing strategies for countering the challenges posed by climate change. A new approach of sequestering carbon in soil by application of biochar is gaining momentum in recent times. The term 'biochar' denotes black carbon formed by the pyrolysis of biomass i.e. by heating biomass under oxygen-free or stress environment so that it does not completely combust. Conversion of biomass C to biochar C leads to sequestration of about 50% of the initial C compared to the low amounts retained after burning (3%) and biological decomposition (<10-20% after 5–10 years), therefore yielding more stable soil C than burning or direct land application of biomass (Lehman et al., 2006).

The application of biochar to soil is proposed as a novel approach to establish a significant, long-term, sink for atmospheric carbon dioxide in terrestrial ecosystems (Lehman et al., 2006). The use of biochar in agriculture is not a new phenomenon, in primitive age farmers were using it for enhancing the production of agricultural crops. One such example is the slash and burn cultivation, which is still being practiced in some parts of north-eastern India. For any material to qualify for the purpose of sequestering carbon, it is necessary that it must have long residence time and should be resistant to chemical processes such as oxidation to carbon dioxide or reduction to methane. Biochar, due to its aromatic structure and long mean residence time in soil (more than hundred years), has the potential for long-term carbon sequestration in soil. A potential abatement to increasing levels of carbon dioxide in the atmosphere is the use of pyrolysis to convert vegetative biomass into a more stable form of carbon (biochar) that could then be applied to the soil. Biochar decomposition rate is very slow in soil which indicates that it could be the possible answer to mitigation of elevated atmospheric carbon dioxide.

Response of crops to biochar application is essential for devising suitable strategy for long term carbon sequestration goal. Apart from positive effects in both reducing emissions and increasing the sequestration of greenhouse gases, the production of biochar and its application to soil will deliver immediate benefits through improved soil fertility and increased crop production. It is reported that black C can produce significant benefits when applied to agricultural soils in combination with some fertilizers. Increase in crop yield to the tune of 45-250% has been reported by application of biochar along with chemical fertilizers. Soil water retention properties, saturated hydraulic conductivity and nutrients availability increased with the application of biochar. Biochar application reduced CO_2 respiration, nitrous oxide (N_2O) and methane (CH_4) production, and decreased dissipation rate of herbicide in soil. Although, biochar as soil amendments for improving soil quality and soil carbon sequestration has attracted wide scale global attention, there is inadequate knowledge on the long term application of soil amendment properties of these materials produced from different feed stocks and under different pyrolysis conditions. The institute is gearing up to take a leadership role in harnessing the opportunity and challenges on use of biochar in soil science and plant nutrition studies. In this direction a workshop on prospects of biochar was organized at the institute, which was attended by the scientists from IISS, CRIDA and NGOs. A general consensus was emerged that IISS should take a lead role to initiate a project for comprehensive understanding on biochar's action mechanism, response to crops and impact on soil ecological settings so that its feasibility could be explored for Indian Agriculture.

A. Subba Rao

(A. Subba Rao)

Research Highlights

Nanoporous zeolites on urease activity

Natural zeolites carry numerous adsorption sites and hold high internal surface area facilitating ion exchange process. This extremely high ion exchange property of zeolites can be utilized in enhancing the fertilizer use efficiency. As a part of improving the nitrogen use efficiency through zeolites, the urease activity in soil added with different proportions of zeolite was quantified. A significant negative correlation was observed between zeolite application and soil urease activity indicating that the added zeolites served as adsorption sites and trapped soil urease enzymes. Adsorption of urease by zeolites and thereby its reduced activity in soil may enhance the use efficiency of applied nitrogenous fertilizers through delay in urea hydrolysis.

INM intervention on soil carbon pools

Five years old soybean – wheat cropping system involving different INM interventions revealed the highest glucose equivalent carbohydrates in surface soil followed by 7.5-15 and 15-30 cm soil depth. The content of glucose equivalent carbohydrates varied between 93.2 and 138.9; 78.7 and 114.6 and 41.7 and 61.2 mg per 100g soil in 0-7.5, 7.5-15 and 15-30 cm soil depth, respectively. The build-up of glucose equivalent carbohydrates was significant in 0-7.5 and 7.5-15 cm, while 15-30 cm soil depth showed no significant variation due to INM intervention, indicating that the added carbon benefied the surface plough layer. The highest carbohydrate content was recorded in treatment that received 8 t FYM to soybean and 16 t FYM to wheat followed by treatment that received 20 t FYM once in four years in addition to 50% NPK to soybean and wheat every year. Carbon in soil particulate organic matter (POM-C) was also assessed and the highest POM-C was recorded in surface layer, where it varied between 1.5 and 2.85 g kg^{-1} soil. Higher content of POM-C was recorded under the treatments involving manure additions especially in the form of FYM.

Potassium response of crops grown in Vertisols

Potassium response to different crops in verlisols was studied at Akola, Jabalpur, Junagadh, Raipur and Parbhani centres of AICRP on LTFE. Yield data at these locations clearly demonstrated that application of K resulted in increase in yield of both the crops in sequence at Akola, Jabalpur and Parbhani although soils were high in available K status. However, no response to applied K at Junagadh and Raipur was recorded, even though soils of Junagadh were relatively low in K status. At Junagadh, irrigation water was responsible for non-response of crop to K as good amount of K was added through water during winter season. At Raipur, however, soil K was sufficient to meet K requirement of crops, but in the years to come K could be a limiting nutrient. Therefore, it is essential to monitor soil regularly to sustain the productivity and to prevent sudden drop in productivity.

Leaching losses of nutrients from farmyard manure pits

Simple mass balance studies have been conducted on representative farmyard manure (FYM) pit on farmers' fields in Geelakhedi village of Madhya Pradesh to work out the inputs and outputs of organic materials, N, P and K and their balance during FYM production through conventional method. Ion-exchange resin core method was used to estimate the leaching loss of nutrient from the pit. Cattle dung was the main component of the FYM (67%) followed by cattle shed wastes (20%), household wastes, ash and vegetable wastes. At the end, 3700 kg FYM (output) was produced from the 5756 kg (input) organic materials that were put into the pit. About 39%, 20% and 32% of N, P and K inputs, respectively got lost during the FYM preparation by conventional method. 19.98%, 30.13% and 49.88% of total loss of N, P and K, respectively, were through leaching, as estimated by ion exchange resin cores.

Evaluation of zinc efficiency in pigeon pea varieties

Twenty varieties of pigeon pea namely C11, ICPL 87119, AKT 8811, PKV Trombay, Hisar Manak, Hisar Paras, Hisar H02-60, Pusa 9, BDN 2, JKM 7, Virsa Arhar-1, SKNP 05-05, GAUT 93-17, DT-23, AAUT 2007-04, GT-101, T 15-15, BSMR 853, GT 1, AAUT 2007-10 were grown in a zinc deficient vertisol with control (no zinc), soil application of Zn (@ 20 kg Zn ha^{-1}) and soil application + foliar spray treatments. On an average, the highest seed yield of 2891 kg ha^{-1} of pigeon pea was obtained from ICPL 87119, whereas the lowest was recorded from PKV Trombay across the treatments. Almost all the varieties responded positively, with respect to grain yield to soil as well as soil + foliar application of Zn. Zinc efficiency of the pigeon pea varieties based on grain yield ranged from 67 to 97.

Bioinoculants for aerobic rice

Combined inoculation of Arbuscular mycorrhizal (AM) fungi with Azophos (Azospirillum + PSB) was better than control for aerobic rice at Coimbatore. Rice grain yield was 7.5 % higher in AM Fungi (colonized root bits + sand based AM inoculum) + Azophos + NP (75%) K (100%) than 100% NPK. The combined inoculation of AM fungi with Azophos was found to be comparatively better than control. Maximum infection of AM fungi and glomalin content in soil of 0.75 mg were observed at flowering stage. AM inoculation had significant impact on phosphatase activity. Application of rhizobacterial inoculants increased the soil urease and dehydrogenase activities of aerobic rice which were maximum at flowering stage.

Varietal evaluation of scented rice in iron toxic soil

Fifteen scented rice varieties, namely, Acharmati, Basmati -1, Khosa kani, Thakursuna, KetakiJuha, CRM 2007-1, Badsa bhog, ORS 199-5, Sujata, Dhanaprasa, Magura, Ganga bali, Heerakani, Nanu, Kalikati were screened with respect to their performance in a sandy loam soil of OUAT, Bhubaneshwar with pH 5.1, OC 0.41 %, CEC 5.0 cmol (P+) kg^{-1}, DTPA extractable Fe 410 ppm, Mn 5.0 ppm and Zn 0.45 ppm. The symptoms of Fe toxicity were recorded in 1-9 scale as recommended by IRRI. The results showed that out of fifteen varieties tested in iron toxic soil, Acharmati, Khosakani, Thakursuna and CRM-2007-1 were proved to be better yielder. Acharmati and Thakursuna varieties are good tolerant to iron toxicity with score value of 0.67 and gave higher yield of 19.21 q ha^{-1} and 18.20 q ha^{-1}, respectively. However, other varieties like ORS 199-5, Magura , Nanu and Kalikati were tolerant to Fe toxicity but produced less yield.

Effect of heavy metals on soil biochemical activity

Six batches of pot experiments were conducted under screen house condition to study the effect of different heavy metals on microbe mediated soil biochemical activity measured by different substrates. Acidic alluvial soils were incubated with graded levels of different heavy metals; Cd, Cr, Cu, Ni, Pb and Zn (added through municipal solid waste compost) for 60 days in separate batches. Subsequently, spinach crop was grown on these contaminated soils for 50 days. Post-harvest soil samples were analyzed for soil enzyme assay using different substrates, namely, 2,3,5-triphenyl tetrazolium chloride (TTC, for measuring dehydrogenase activity), fluorescein diacetate (FDA, for measuring activities of

proteases, lipases and esterases), disodium p-nitrophenyl phosphate (PNP, for measuring acid phosphatase activity) and potassium p-nitrophenyl sulphate (PNS, for measuring aryl sulphatase activity). Results have shown that all the heavy metals had significant adverse effect on biochemical activities measured through FDA and TTC. However, Pb didn't have significant effect on acid phosphatase and aryl sulphatase activities and Cd and Zn didn't have significant effect on aryl sulphatase activity. The order of metal contamination levels causing 20% reduction (ED_{20}) in biochemical activities measured through FDA and TTC was Cd<Pb<Cr<Ni<Cu<Zn. Similarly, order of metal contamination levels related to ED_{20} measured through PNP and PNS were Cd<Cr<Ni<Cu<Zn and Cr<Ni<Cu, respectively. This study showed that cadmium had maximum toxicity followed by Pb, Cr, Ni, Cu and Zn on the soil microbial activity in MSW compost amended soil.

Application of nano-particles in soil

A laboratory experiment was conducted to investigate recovery of P from nano rock phosphate particles in sandy soil of Jodhpur. Different graded doses of nano rock phosphate particle, hydroxy apatite (<200 nm) (0, 2.5, 5, 7.5, 10 ppm) and KH_2PO_4 (0, 2.5, 5, 7.5, 10 ppm) were applied to soil. As hydroxy apatite (<200 nm) was not so stable in aqueous medium, solution was ultrasonicated at 100W for 30 minutes. Treated soil was kept in incubation for 15 days and after that P was estimated in a spectrophotometer. Experimental results revealed that recovery of P from nano rock phosphate particles (45%) particularly at lower concentration (2 ppm) was higher than the KH_2PO_4 source (29.8%) in Aridisol.

Methane (CH_4) production and oxidation

Greenhouse gas methane (CH_4) production and oxidation in long term fertilizer experiment (LTFE) sites were investigated. Soils from Pantnagar and Ranchi were incubated under flooded and 60% MHC conditions to simulate methanogenic and methane oxidizing microbial metabolic processes. CH_4 regulating microbes were differentially influenced by the soil factors as well the fertilizer components. Both soils exhibited similar CH_4 production potential while varied in CH_4 oxidizing activity. Rate of CH_4 oxidation (k) was higher in Pantnagar than in Ranchi soil. Fertilizer input like N alone stimulated CH_4 production, while applied along with P and K alleviated this process. CH_4 oxidation activity in Pantnagar soil was stimulated by P and K application than that of only N. Results revealed the differential effect of N, P, K fertilizers on methane production and oxidation in tropical soils under long term fertilizer application.

Improving yield and quality of pomegranate under organic farming

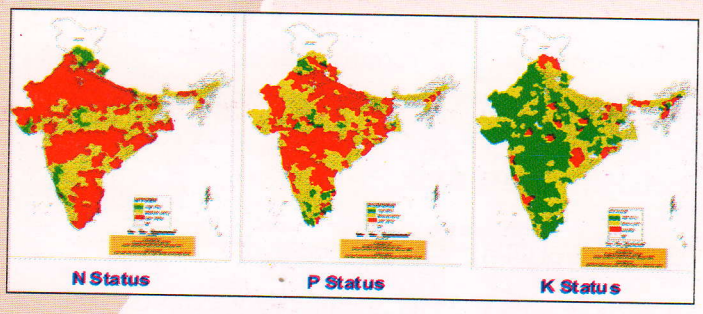
Application of 18 kg vermicompost or 21 kg phosphocompost or 29 kg cattle dung manure (CDM) per plant or a combination of 50% CDM+50% RDF improved the yield and quality of pomegranate. Fruit quality parameters viz. sugars, TSS and ascorbic acid content increased significantly due to application of INM, organic and inorganic alone as compared to control. Overall trends of pomegranate yield and quality was in the following order: integrated nutrient management > organic nutrient sources> chemical fertilizers > unfertilized.

Soil organic carbon dynamics vis-à-vis anticipatory climate changes

The relationships among C-mineralization, biological activities and C pools under different moisture regimes were investigated under selected treatments, such as, control (no fertilizer), 100% recommended NPK, 60 % NPK+FYM @ 5 Mg ha^{-1}, 60 % NPK+ crop residue (CR) and 100 % FYM after 5 cycles of soybean-wheat in rotation. Interactive effects of three temperature situations (25, 35 and 45°C) and three hydrological regimes, such as, 60% moisture holding capacity (MHC), 100% MHC and submerged condition on microbiological activities and soil carbon decomposition were investigated. The increase in CO_2 evolution was noted with increase in temperature and attained maximum at 40 days of decomposition at 45°C, whereas C-mineralization rate constant (k) increased with increase in temperature from 25 to 45°C from all treatments. Q_{10} (e^{10K}) increased with increase in moisture holding capacity from 60 % MHC to 100 %MHC and decreased under submerged condition except unfertilized control. The water soluble-C and acid hydrolysable-C also followed a similar trend to that of CO_2-C evolution. Emission of gaseous-C significantly increased due to exhaustion of the labile pools of carbon which acted as bio-energy source under 60% MHC as compared to submerged condition, whereas integrated nutrient management practice of 100% NPK+FYM minimized it.

GIS based soil fertility mapping

- AICRP on STCR prepared GIS based soil fertility maps of India using soil test data of 21 states. In case of N 283 (57%), 182 (36%), and 33 (7%), in case of P, 257 (49%), 200 (45%) and 40(6%) and in case of K, 47 (9%), 212 (39%) and 239 (52%) districts were low, medium and high, respectively.



Development of best management practices (BMPs) and decision support systems (DSS)

- Some of the collaborative centres of AICRP on STCR like Uttarakhand, Bangalore, Kalyani, Jabalpur have developed soil test based fertilizer prescriptions along with BMPs to enable the farmers' to integrate all the available technology and to obtain maximum productivity of that particular crop.
- DSS for making soil test based recommendations to the farmers by using the web enabled software programme have been developed for the states like Maharashtra, Punjab, Chhattisgarh and Orissa states in collaboration with NIC, Pune. For other states like Rajasthan and Kerala they are under process.

Extension activities

Farmers' day

Farmers' day was organized at Dhakna-Chapna village on 9-3-2010. About 100 farmers from Dhakna-Chapna and surrounding villages, project scientists from IISS, BIAF and Dr. Neal Menzies from Australia had participated in the Farmers' Day. About six farmers spoke about their experiences and expressed their views. Many farmers expressed that they realized the importance of S and Zn and would apply all the deficient nutrients at recommended rates to get maximum yields. Both the host and non-host farmers visited the demonstration trials on "Balanced and Integrated Nutrient Management".

Project scientists giving improved nutrient management tips to farmers at the Farmers' Day

Training programme for KVK personnel

A short-term training programme on "Soil Health and Fertility Management" for KVK personnel was organized during February 12-15, 2010. This programme was sponsored by the Zonal Project Directorate, Zone -7, Jabalpur. The training programme was inaugurated by Dr. U. S. Gautam, Zonal Project Director, Jabalpur, and Dr. A. Subba Rao, Director, IISS, Bhopal presided over the inauguration. Sixty one subject matter specialists (SMPs) from Madhya Pradesh and Orissa states had participated in the training programme. The trainees were given hands-on training on practical aspects of nutritional constraints of crop production and improved nutrient management practices relevant to the states of Madhya Pradesh, Chhattisgarh and Orissa.

Dr. U.S. Gautam inaugurating the training programme.

Awards & Honours

- Dr. A. B. Singh was elected as Fellow of the Indian Society of Agricultural Biochemists, BHU, Varanasi
- Best Poster Award on the research paper entitled "Synthesis of rock phosphate nano particle and its effect on seed germination of selected crops" by Tapan Adhikari, Arunava Goswami, A.K. Biswas, S. Kundu, J. C. Tarrafdar and A. Subba Rao; in "International Conference on Nanoscience and Nano-technology (ICONN 2010), February 24-26, 2010 at SRM University, Kattankulathur, Chennai, Tamilnadu, India.

Major Events

Republic Day

The Staff Recreation Club (SRC) celebrated the 'Republic Day' on 26th January, 2010 in the Institute premises. The National Flag was hoisted by the Hon'ble Director, and Mrs. Laxmi Subba Rao also graced the occasion. All the staff of IISS and their children participated in various events with thrill and great enthusiasm. Activities included racing, poem recitation, songs, drawing competition for children and musical chair for the family members of the staff. Prizes were distributed to the children on this occasion.

Children Participating in Drawing Competition at the Republic Day

CAC and CIC meetings of NAIP sub-projects

- The Consortium Advisory Committee (CAC) meeting for the NAIP sub-project "Assessment of Quality and Resilience of Soils in Diverse Agro-ecosystems" was held at IISS, Bhopal on May 15, 2010. The meeting was chaired by Dr. N. Panda, Ex-vice-chancellor, Sambalpur University. Dr. M. Velayutham (Member CAC), Dr. D. K. Das, (Member CAC), Dr. A. Subba Rao, Dr. S. Kundu and other CCPI's and CoPI's attended the meeting.
- The third CIC meeting of the NAIP subproject entitled "Understanding the mechanism of variation in status of a few nutritionally important micronutrients in some important food crops and the mechanism of micronutrient enrichment in plant parts" was held at IISS, Bhopal on April 18, 2010.

Launching of INM project in Nagaland

A participatory INM technology demonstration project has been initiated at different districts of Nagaland. Scientists of IISS, Bhopal demonstrated the benefits of green manuring namely Dhaincha in the INM for rice cultivation in the farmers' fields.

Demonstration of green manuring as a part of INM at Dimapur, Nagaland

Personnel

New Appointments

Dr. J.S. Virgine Tenshia joined as Scientist in the Division of Soil Chemistry and Fertility on May 28, 2010.

Dr. M. Vassanda Coumar joined in the Division of Environmental Soil Science as Scientist on March 15, 2010.

Transfer

Dr. Ranjit Kumar, Sr. Scientist (Agricultural Economics) got transferred to NAARM, Hyderabad w.e.f. 19.06.2010.

Scientists' Participation in Conferences/ Seminar/ Workshop / Training / Group Discussion

Name	Programme	Venue	Period
Dr. A. B. Singh & Dr. A. K. Tripathi	Role of Bio-molecules in Food Security and Health Improvement	Indian Society of Agricultural Biochemists, BHU, Varanasi.	Feb 17-20, 2010
Dr. A.K. Biswas & Dr. B.L. Lakaria	Launching workshop of INM project	DAO Office, Dimapur, Nagaland	May 17-22, 2010
Drs. A.Subba Rao & M. C Manna	Agriculture and Global warming: Challenge and potential	RRVSKVV, Gwalior	June 5-6, 2010
Dr. Ajay	Training programme on "Greenhouse Gas Emission and its Mitigation in Relation to Soil Organic Carbon (SOC) Pool".	CRRI, Cuttack.	Jan 5-25, 2010
	Use of fly ash in agriculture	India Habitat Center, New Delhi	Mar 10, 2010
Ms. I. Rashmi	Training on "Ethnic Issues and Community Management for Young Scientists"	IIFM, Bhopal	Jan 18-22, 2010
	Training on "Finance Management and Audit Sensitization"	XIM, Bhubnaeshwar	Feb 15-20, 2010
	Training on "Knowledge Management"	ISTM, New Delhi	Mar 3-4, 2010
	Training on "Introduction to GIS and its Application"	NRSC, Hyderabad	Mar 22-Apr16 2010
Dr. J.K. Saha	National Workshop on Repair, Renovation and Restoration (RRR) of water bodies	North-Central Region of Water Board at Dr. Hari Singh Gaur Central University, Sagar	Feb 4-5, 2010
	National Brainstorming Workshop on "Preparation of Activity Guide Book for National Children Science Congress 2010-2011'	organized by NCSTC-Network, Dept. of Science & Technology, GOI at B.C.K.V., Mohanpur, W.B.	Feb 14-17, 2010
	Knowledge sharing workshop on "Innovations for scaling up organic wastes management in India"	Mangolia Hall, India Habitat Center, New Delhi	May 15, 2010
	Capacity Building training programme of Scientists and Technologists on IPR & WTO related issues	Consumer Unity & Trust Society, Jaipur	May 25-29, 2010
Dr. K. Ramesh	7th International Conference on Biometeorology (BIOMET 7)	Albert-Ludwigs-University, Freiberg, Germany	Apr 12-14, 2010
Dr. K. Sammi Reddy	Short-term training programme on "Creative Writing in Agriculture"	Indian Institute of Mass Communication (IIMC), Dhenkanal, Orissa	May 3-8, 2010
Dr. M. V. Singh	MDP workshop on PME of Agricultural Research and Development Project under NAIP	NIRD, Hyderabad	Mar 8-12, 2010
Ms. Neenu.S	Winter School on "Enhancing Input Application Efficiency for Seeds, Fertilizers and Chemicals using Precision Farm Machinery, Decision Support Systems (DSS) and Electronic Controllers for Precision Agriculture in Vertisols"	CIAE, Bhopal	Jan 01-21, 2010
Dr. Tapan Adhikari	International Conference on Nano Science and Nano-Technology (ICONN 2010)	SRM University Chennai	Feb 24-26, 2010
	National Seminar on Role of Innovative Environmental Bio-technologies for Greening India	Career College Bhopal	Mar 16-17, 2010

Training Conducted / Imparted to Students

Coordinating Scientist	Name of the Trainee	Duration of the Training	Nature of Training Imparted
Drs. J.K. Saha and N.R. Panwar	Miss Neha Jain	03 months	Effect of lead contaminated municipal solid waste (MSW) compost on soil biological and biochemical properties of acid soil
	Miss Rubi Haldar,	03 months	Effect of cadmium contaminated municipal solid waste (MSW) compost on soil biological and biochemical properties of acid soil
Dr. N.R. Panwar	Miss Deepshikha Singh,	03 months	Effect of zinc contaminated municipal solid waste (MSW) compost on soil biological and biochemical properties of acid soil
	Miss Tashi Thakur.	03 months	Effect of copper contaminated municipal solid waste (MSW) compost on soil biological and biochemical properties of acid soil
	Miss Nitya Pakhmode,	03 months	Effect of chromium contaminated municipal solid waste (MSW) compost on soil biological and biochemical properties of acid soil
	Miss Saima Shameem,	03 month	Characterization of polluted soils for their physico-chemical properties collected from different parts of central India
Dr. Tapan Adhikari	Miss Varsha Shukla,	03 month	Effect of nickel nanoparticles (<50 nm) on growth of Spirulina and Azolla
	Miss Monika Patidar,	03 month	Effect of copper nanoparticles (<50 nm) on growth of Spirulina and Azolla
Dr. Ajay	Miss Paru Rajput,	03 month	Rock phosphate and phosphate solubilising microbes as a source of nutrients for crops
	Mr. Tawheed Parvaiz Bhat	10 days	To study the extraction of alkaloids and essential oils from different plants
Dr. Brij Lal Lakaria	Ms. Anunita Mukherjee	03 months	Carbon mineralization as affected by land use systems and water regimes
	Mr. Manish Kumar Patne	03 months	Effect of different land use systems on soil organic carbon and microbial properties in a vertisol
Dr. Pramod Jha	Mr. Arpan De	03 months	Effect of soil carbon content on mineralization of applied organic matter
Dr. K. Ramesh	Mr. Umesh Pankaj	03 months	Soil urease activity and N release kinetics in urea blended with natural zeolites
Dr. M. C. Manna	Kushi Baliyan	06 months	Long-term effect of integrated nutrient management of methane emission and soil biological activities
Dr. S.R. Mohanthy	Kesin Paliwal	06 months	Methanogenesis in tropical soils under long term fertilizer application
	Nindiya Singh	06 months	Biogeochemical processes in soils under long term fertilizer application
Dr. S. Srivastava	ITC Personnel	5 days	Soil testing
Ms. Neenu, S	Ms. Nidhi Ram	15 days	Soil analysis
Dr. N.K. Lenka	Anju Prajapati, Rinki Prajapati, Priya Bele and Sangeeta Sahu	15 days	Soil analysis

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