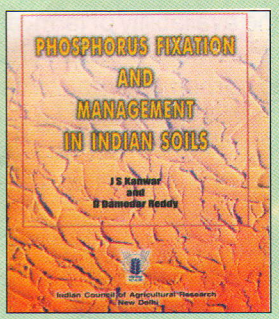
भाकृअनुप
ICAR

IISS Newsletter

Vol.6 No.2 July- December 2003

New publication



J. S. Kanwar and D. Damodar Reddy (2003) Phosphorus Fixation and Management in Indian Soils, ICAR, New Delhi.

In this Issue

Editors
Muneshwar Singh
Head, Soil Chemistry & Fertility
K.Sammi Reddy
Sr. Scientist

Design & Layout
A. K. Sharma
Documentation Officer

Published by
A. Subba Rao
Director

Dr. Subba Rao Takes Over as Director, IISS

Dr. A. Subba Rao took charge as Director, Indian Institute of Soil Science (IISS), Bhopal on 5th February 2004 from Dr. A. K. Misra, Officiating Director. Prior to this, Dr Rao was the Project Coordinator, Soil Test Crop Response Correlation (STCR) since 1997. During this period, he played a pivotal role in developing fertilizer recommendations for different crops/cropping systems of the country.

Dr. Rao started his career as Assistant Professor, in Andhra Pradesh Agricultural University, Bapatla (1980-84) and later served as Soil Scientist, Potash Research Institute of India, Gurgaon (1984-89), Principal Scientist, Indian Institute of Soil Science, Bhopal (1989-97). During this illustrious career, he has made significant contributions in delineation of potassium supplying power of Indian soils, management of phosphorus in soybean-wheat system and dynamics of P and K in soil-plant system. His wide knowledge and innovative thinking in soil science research have been reflected in his presentations and publications. He has to his credit more than 100 research papers and several books/book chapters on a wide array of aspects of plant nutrient management. Dr Subba Rao is the fellow of National Academy of Agricultural Sciences, India and has also received several National Awards. He has traveled to France, Germany, England, Philippines and Switzerland and presented papers in seminars or undergone short-term training. The staff of IISS extends their warm welcome and wishes him a successful tenure.

Union Minister of State Visits IISS

The Honourable Minster of State for Agriculture and Cooperation, Sh. Hukum Dev Narayan Yadav visited the IISS, Bhopal for an interaction with all the ICAR and other DOAC officials at Bhopal on August 25, 2003. He appreciated the research efforts and the existing facilities at IISS and inaugurated a children's park located in the residential area of the campus. Later the Honourable Minister addressed a gathering of scientists, officers and other employees of all the three ICAR institutes located in Bhopal. He emphasized the importance of various aspects of indigenous technology, livestock management, specialization vs globalization and agricultural extension services. He appealed to the scientists to imbibe the qualities of simplicity and commitment to work and asked to develop technologies in consultation with the farmers.

Indian Institute of Soil Science
Nabi Bagh, Berasia Road, Bhopal - 462 038 (M.P.)
Telephone : (0755) 2730946, 2747375, 2730970, 2734221 Fax : (0755) 2733310 E-mail : iiss@iiss.mp.nic.in

Innovations in Nutrient Management and Soil Fertility Improvement

The vast majority of Indian soils are generally poor in fertility with multiple nutrients deficiencies. If the agricultural production is to be increased and sustained, the soils that are beset with fertility-related constraints must, therefore, receive greater research attention in terms of nutrient management and fertility improvement.

Nutrient management and fertility improvement is one of the four priority research programmes of the Indian Institute of Soil Science. The basic and applied research under this programme essentially covers three important components *Viz.*, (a) enhancing and balancing nutrient supplies (input) through diverse nutrient sources, (b) understanding nutrient transformation and cycling processes in relation to management practices and (c) improving nutrient use efficiency.

An integrated nutrient management (INM) package for soybean-wheat system on Typic Haplustert (Agro-ecoregion 10) has been developed to provide the farmers with different options of fertilizer use depending upon the availability of farmyard manure (FYM) to achieve a target productivity of 2.0 t ha^{-1} or more of soybean seed yield and 3.5 t ha^{-1} or more of wheat grain yield (with irrigation facility). The results showed that the INM in soybean-wheat system sequestered carbon and maintained equilibrium in soil and soybean left 20-25 kg N/ha for subsequent wheat. To maintain soil organic C stock, about 888 kg C is required to be added annually under typical climate of M.P. At a productivity level of 1.5 t soybean and 2.5 t wheat per hectare, approximately 1150-1250 kg C is being added to soil annually through leaf, root, nodule biomass and rhizodeposition under INM practice. For rice-wheat system on Vertisols, application of FYM (5 t ha^{-1}) and *Parthenium hysterophorus* as green manure (6 t ha^{-1}) has shown to result in a saving of 78 and 45 kg N ha^{-1}, respectively. Similarly, integrated use of FYM and fertilizer-P was effective in terms of enhanced and sustainable productivity of soybean-wheat system on P deficit Vertisols. Studies on maintenance fertilization approach showed the possibility of prescribing soil test maintenance P rates for soybean-wheat system in terms of P removal by crops under different P supply strategies involving inorganics and organics. On the basis of P fertility dynamics vis-à-vis P balance, it has been found that integrated use of manure +fertilizer P (1:1 P basis) was roughly 3 times as effective as fertilizer-P alone in improving the soil P fertility. With the aid of soil P fractionation analysis, the labile inorganic-P ($NaHCO_3$-P_i) and moderately labile inorganic and organic P (NaOH-P_i and P_o) forms have been identified as major sources and sinks for available P in Vertisols. The beneficial role of FYM and crop residues in accretion of soil organic-P (a long-term source for available P), mobilizing recalcitrant-P and in decreasing soil P sorption capacity has been elucidated.

Long-term impact of intensive cropping and fertilizer use practices on soil fertility dynamics with respect to N, P, K and S for major soil types under different cropping systems was comprehensively understood and documented. This valuable piece of information is being used for refining the fertilizer recommendations. In long-term studies, continuous application of fertilizer NPK alone or in combination with FYM to different cropping systems grown on major soil types led to a marked accumulation of applied N mainly in hydrolysable N pools in surface soils. The proportion of hydrolysable N decreased and that of non-hydrolzable N increased with the soil depth. Sulphur transformation studies showed that the $NaHCO_3$ and NaOH extractable organic S fractions could be used as indicators of S mineralization and availability in different soils that were subjected to long-term cropping and fertilization. Zinc sorption-release kinetics, transformations, soil factors influencing its availability, parameters controlling Zn mobility or the sinks for Zn in soil which would tap or mobilize soil Zn were thoroughly investigated. Means of accelerating the Zn desorption process through manipulation of soil factors or enriching the plant-available Zn pools in soils were identified. To overcome the difficulty in estimating very small amounts of P in various soil extracts by routine ascorbic acid method, an alternate malachite green method has been developed. The malachite green method was found to be 4 times sensitive and accurate compared to ascorbic acid method for estimating small amounts of P in water, 0.01M $CaCl_2$ and Olsen extracts obtained from a wide range of soils.

Understanding nutrient-use efficiency is obviously important for improving efficiency of native and applied nutrients. There exists many and varied opportunities for research on managing nutrients to increase their use efficiency and contribute to sustainable production. Maximizing nutrient use efficiency can be equated with minimizing nutrient losses from soil (volatilization, leaching, denitrification, runoff etc.) or within the soil (transformation to non-labile or less mobile pools). Besides management practices, modifying fertilizer materials is an important strategy to regulate nutrient release and thus enhance nutrient use efficiency. Cumulative volatilization loss of NH_3-N from applied urea in alkaline black soils could be reduced from 21 % to 5.1% by coating the urea with *neem* oil (2-3 % w/w) or *lac* (15 % w/w). The *neem* oil and *lac* coated urea can increase N use efficiency by 3.4 and 5 per cent, respectively. Also, placing urea at 6 cm soil depth significantly reduced volatilization loss of NH_3-N from alkaline Vertisols. Use of organic manures or crop residues is known to exert a favourable influence on fertilizer use efficiency by moderating the nutrient reactions in soils. Organic manure applied along with fertilizer-P increases P use efficiency by suppressing P sorption and minimizing P transfer tc relatively non-labile P pools in soil. Some nutrients particularly P exhibit residual effect contributing substantially to nutrition of crops grown subsequent to the one to which they

were applied. In soybean-wheat system, for example, the P (39 kg P/ha) applied to soybean showed residual effects in two succeeding crops (wheat and soybean), whereas the same amount of P applied to wheat showed a residual effect in one succeeding crop (soybean). The P utilization efficiency can be improved if such residual effects are accounted for while making P recommendations. Some cropping systems where organic matter is generated through natural phenomenon (such as leaf fall in soybean) can offer natural opportunities for effective use of alternate P sources like low-grade rockphosphates. In a pilot study, decomposing soybean leaf litter was found effective in solubilizing otherwise insoluble P to the extent of 11 to 20% of total P in low-grade rockphosphates.

The future research activities in the domain of nutrient management and fertility improvement are needed to address three crucial issues: (i) assessment of nutrient substitution rates or fertilizer equivalent values of diverse organic materials having potential for use as soil fertility restorer inputs and evolving effective IPNS modules with diverse nutrient sources available at the farm level, (ii) modifying fertilizer products using low-cost and locally available additives and assessing the potential of such modified materials to minimize losses and improve use efficiency of nutrients, and (iii) Modeling nutrient release characteristics of organic manures to synchronize with crop demand. Finally, the critical role of competent interpretation of our knowledge of soil fertility and nutrient management for achieving higher nutrient use efficiency in a given production system needs to be recognized and given due attention. A competent interpretation must generate practical rules-of-thumb that will be used by farmers and that are sound ecologically and economically.

Dr. Muneshwar Singh
Programme Leader
Nutrient Management & Fertility Improvement

Research Highlights

Soybean leaf litter offers a natural opportunity for direct use of low-grade rock phosphates

Investigations to assess the potential of soybean leaf litter (SLL) to mobilize phosphorus from two low-grade rock phosphates (JRP: Jhabua rock phosphate and HRP: Hirapur rock phosphate) revealed that the SLL promoted the availability in Vertisol of P added through low-grade rock phosphates. Amending rock phosphates with pyrites further helped to increase P availability. The P released from rock phosphates in the presence of decomposing SLL was primarily transformed into labile inorganic and moderately labile organic P fractions, thus indicating an improvement in P fertility. Pot culture experiment showed further that the yield response of wheat to P added through rock phosphates increased significantly in the presence of soybean leaf litter.

Sulphate sorption behaviour of a Haplustalf under long-term fertilizer treatments

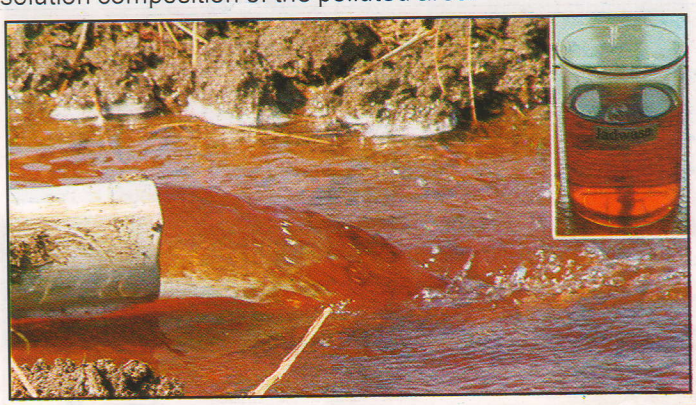
Sulphate sorption behaviour of Haplustalf (Ranchi) fertilized differentially under long-tem soybean-wheat rotation revealed that the sulphate sorption was maximum in S-free NPK treated soil suggesting the exhaustion of native S. In contrast, the 100%NPK(+S) treated soil showed minimum sorption due to larger accumulation of residual S. Continuous addition of either farmyard manure or lime with optimum dose of NPK reduced the sulphate sorption.

Effect of cropping systems on soil organic carbon content

Soil organic carbon (SOC) in natural forest soils under teak and sal was two times higher than that of the corresponding soils under field crops. Among the field crops, legume based intercropping system (soybean + pigeonpea and green gram + pigeonpea) restored higher amount of soil organic C and soil microbial biomass C compared to the double crop in rotation (soybean-wheat/paddy-paddy cropping system). Among the horticulture based cropping systems, citrus with high management has better SOC restoration compared to mango orchard. Cotton based cropping system either as intercropping or sequential cropping registered the least improvement in SOC storage.

Impact of the use of polluted ground water on soils near Ratlam industrial area

Groundwater in 12 villages, situated at both sides of Dosinala covering about 6000 ha land near Ratlam industrial area, has turned reddish since last 20 – 25 years and has developed salinity due to contamination with industrial effluents flowing through natural creeks. This polluted water contains, on an average, EC 2.84 dS/m, 520 ppm Na, 65 ppm SO_4^{-2}-S, 775 ppm Cl^- which are about 221%, 244%, 427% and 364% more respectively, than those in uncontaminated groundwater in villages. Due to continuous irrigation with polluted groundwater, soils of several villages near Ratlam industrial area showed increase in pH (from 7.8 to 8.3), EC (from 0.42 to 0.96 dS/m), SAR (from 2.6 to 5.9) and ESP (from 2.7 to 6.7). Considerable increases in Na (174%) and Cl (1443%) and SO_4 concentrations (53%) have also been noticed in soil solution composition of the polluted area.



Biofertilizers for Vegetable crops

In an acid soil, application of *Azotobacter* + *Azospirillum* + PSB to brinjal and tomato saved 25% N in Orissa. Integration of biofertilizers with chemical fertilizers gave higher apparent nutrient recovery. The ascorbic acid content of tomato increased with increase in the dose of chemical fertilizers or bioinoculation of crop. Bioinoculation brought further increase over and above that brought by chemical fertilizers.

Response of turmeric to sewage irrigation

Sewage irrigation increased the heavy metal (Cd, Ni, Pb) content significantly in turmeric at maturity stage as compared to normal irrigation. The content of heavy metals was higher in rhizome than other plants parts. The higher uptake of heavy metals by turmeric indicated that this crop could be used as a phytoremediator provided that the curcumin may be used in dye industry and not in domestic consumption.

Awards & Honours

Dr. T. R. Rupa awarded with the Lal Bahadur Shastri Young Scientist Award of the Indian Council of Agricultural Research (ICAR) for the biennium 2001-2002 on July 16.

Dr. T. R. Rupa received the Golden Jubilee Young Scientist Award – 2003 of the ISSS at CSAUAT, Kanpur on November 4 for her professional contributions in the field of soil science.

Dr. D.L.N.Rao, Project Coordinator (BNF) was admitted to the Fellowship of the Indian Society of Soil Science at the 68th Annual Convention of the society at CSAUAT, Kanpur on November 4 for his "Outstanding Contributions on Soil Biological Research in Salt Affected Soils and Modelling for Predicting BNF by Field Crops and Trees".

Dr. C. L. Acharya elected as the Fellow of National Academy of Sciences, Allahabad for the year 2003.

Dr. T. R. Rupa bagged the 7th S. N. Ranade Memorial Award for Junior Scientist of the Shobhana Shrikrishna Ranade Memorial Trust for excellence in micronutrient research for the year 2003.

Dr. A. K. Misra chaired a technical session on Watershed Hydrology in the International Symposium on Water and Environment held at RRL, Bhopal, December 15-18.

Drs. A. Subba Rao, D. Damodar Reddy and K. Sammi Reddy received the prestigious 'IMPHOS-FAI Award –2003 on December 4 in recognition of their outstanding contribution in the field of 'Role of Phosphorus on Yield and Quality of Crops'.

Dr. P. K. Ghosh was awarded with the PPIC- FAI award on December 4 for his 10 years research achievements on "Management and balanced use of inputs in achieving maximum yield".

Events

Independence Day: All the staff members and their families celebrated Independence Day with great enthusiasm.

Hindi Pakhwada: Different literary and cultural activities were organized on the occasion of Hindi Pakhwada during September 14- 28.

Workshops/Trainings Organized

A review-cum-workshop meeting was conducted at IISS, Bhopal on August 16 of the NATP-RNPS-25 "Identifying systems for C-sequestration and increased productivity in semi-arid tropical environments".

Division of Soil Chemistry and Fertility organized a short-term training programme on soil testing for Agribusiness/ Agriclinc participants during September 25-27.

AICRP (STCR) conducted training workshops sponsored by Department of Agriculture and Cooperation on soil testing at PAU, Ludhiana, September 23-24; IGKVV, Raipur, October 14-15; RAU, Bikaner, October 14-15.

Group meeting of NATP-RRPS-19 entitled "Organic pools and dynamics in relation to land use, tillage and agronomic practices for maintenance of soil fertility" was held at IISS, Bhopal on October 7-9 to review the work done under the project.

Participation in Seminars / Symposia/ Meetings/ Conferences/ Workshops/ Training Programmes

Dr. D.L.N.Rao: 7th Executive Development Programme in Agricultural Research Management at NAARM, Hyderabad, July 18 – 22.

Dr. A. K. Sharma and Mrs. Nirmala Mahajan: ICAR-INFLIBNET training programme for agriculture librarians on net working and E-resource management at INFLIBNET, Ahmedabad, September 1-12.

Dr. K. G. Mandal: Short-term training on Participatory Watershed Management at ICRISAT, Hyderabad, September 1-20.

Dr. P. Ramesh: National Symposium on Organic Farming at Khandwa, September 22-23.

Mr. M. Mohanty: Workshop for the project development and validation of simulation model to predict the long-term consequences of different tillage and residue management strategies at PAU, Ludhiana, October 17 -18.

Drs. A. K. Misra, Muneshwar Singh, D.L.N.Rao, T.K.Ganguly, B. Maji, A. K. Biswas, A.B.Singh, A. K. Tripathi, K. Sammi Reddy, K. M. Hati, M. Mohanty, K. K. Bandyopadhyay and R. K. Singh: 68th Annual Convention of Indian Society of Soil Science at CSAUAT, Kanpur, November 4-8.

Dr. Ajay: Training programme on Marketing, Cultivation, Processing aspects of Medicinal and Aromatic Plants at Indian Institute of Himalayan Bio-resource Technology, CSIR, Palampur, November 10-14.

Drs. J.K Saha and K. G. Mandal: National Symposium on Crop Production under Changing Environment at BCKV, Kalyani, November 26– 29.

Dr. S. Ramana: National Seminar on Physiological Interventions for Improved Crop Productivity and Quality: Opportunities and Constraints at RARS (ANGRAU), Tirupati, December 12-14.

Dr. A. K. Misra: International Symposium on Water and Environment at Bhopal, December 15-18.

Dr. A. K. Sharma: XXVI All India IASLIC Conference at Wadia Institute of Himalayan Geology, Dehradun, December 15-18.

Dr. D.L.N.Rao: Seminar on "Intellectual Property Rights" organized by MAPCOST and National Law University at Bhopal, December 22.

Distinguished Visitors

Dr. P. K. Chonkar, Head, Division of Soil Science & Agricultural Chemistry, IARI, New Delhi on July 9.

Shri D. Sahu, Dean of Research, Orissa University of Agriculture & Technology, Bhubaneshwar on September 11.

Dr. J. S. Samra, DDG (NRM), ICAR, New Delhi on September 25.

Dr. P. N. Takkar, Founder Director of IISS, Bhopal on October 10.

Shri V. P. Singh, Professor, Louisiana State University, Baton Rouge, USA on December 12.

Staff News

Dr. P. K. Singh, T-4, left the institute on August 14 to join as Lecturer at the Nagaland University.

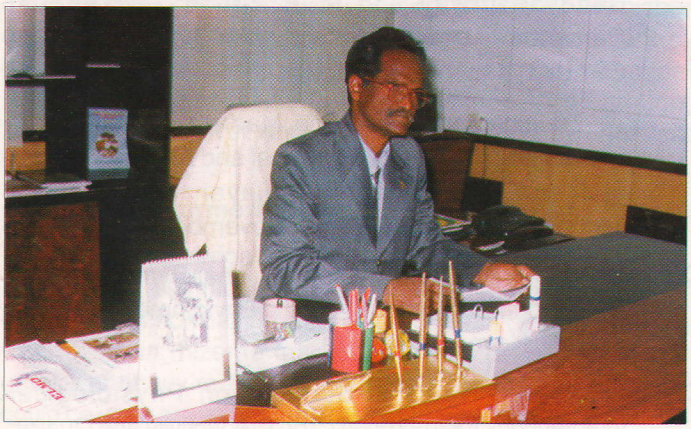
Mr. N.R. Panwar, Scientist, joined the Institute on August 25.

Dr. A. K. Misra, Head, Division of Soil Physics, taken over charge as acting Director of IISS on September 5.

Dr. T. R. Rupa, Scientist (SS), left the institute on October 18 to join as senior scientist at SBI, Coimbatore.

From the Director's Desk.....

Emerging Role of Soil Scientists in Interdisciplinary Research



Although food security is a continuing global concern, environmental quality, appropriate land use, and protection of natural resources are equally important issues. The environmental and agricultural issues dealing with land use and management are likely to be increasingly studied in future by large interdisciplinary groups of ecologists, biologists, environmentalists, engineers, and social scientists. Given the fact that interdisciplinary research is bound to be more important in the future, we asked the question whether soil scientists are well equipped to deal with the challenges of future research opportunities. One way to do this is to review examples of interdisciplinary research that highlight the role of soil scientists.

Bioremediation is an engineered process for using microorganisms to transform hazardous chemicals into less toxic or innocuous compounds. It requires applying science and engineering to maximize the potential for biodegradation in a given environment. As the environmental characteristics and nature of the contaminants may impose strict limitations on this potential, it is important to understand the biological, chemical, and physical parameters and their effects on the potential efficacy. Soil expertise is crucial in understanding both the fate and transport of chemicals and heavy metals in soils and methods to accurately measure the risk reduction.

Soil scientists have a strong role to play in the future development of ecological research. Ecology is changing rapidly in response to the development of complex problems in environmental science. Since the technology for manipulating agricultural systems is readily available, ecologists have used agricultural systems as model systems for experiments in ecosystem ecology for many years. The input and output analysis of ecosystems rely heavily on soil based measurements of nutrient cycling and hydrologic loss.

The soil is a control layer in watershed systems and is the most bioactive, accessible, manipulated, amended, disturbed, and managed layer. It is hydrologically very important in determining surface runoff, available water for growing plants, and groundwater recharge. So the well-trained soil scientist provides technical expertise needed for watershed and hydrological research that are unlikely to be found elsewhere.

Soil scientists have played a unique role in explaining the dynamic behaviour of soil chemical properties and processes, microbial transformation, gas fluxes, and temporal and spatial nature of water, which influence volatilization, leaching and runoff pathways of chemical dissipation. This expertise can be used in chemical fate assessment in vadose zone, in groundwater and in watersheds. In interdisciplinary projects involving minimizing pollution, fate of introduced chemicals etc., Geographic Information Systems, simulation models and soil maps can be used as invaluable tools. The responsibility of a soil scientist is to advise on the applicability of various models and to evaluate their use and abuse. In doing this, emphasis should be placed on the applicability of processes, rather than on empirical models.

Wetlands are an important natural resource and play a significant role in regulating global environmental quality. Soil scientist can also play an active role in wetland delineation and characterization, wetland biogeochemistry, wetland restoration and water quality in wetlands.

Concerns for organic farming and increased recycling of organic residues (both rural and urban) are being raised in the country. The state-of-the-art picture in respect of organic residues shows that the recycling of these residues is an important source of organic matter and plant nutrients. Since most of this research information is projection based, soil scientists should quantify the residue influxes into soil and their effects on nutrient mineralization and balances and the soil organic matter maintenance. In this approach, the role of all organic residues should be examined in an integrated manner. With the increasing demand for organic food in society, the soil scientists should also explore as to whether global plant nutrient reserves would be sufficient for large-scale organic or low external input farming.

If the major issues facing the agricultural research community are to be resolved, then it is necessary for the soil scientists to interact more closely with the social scientists and end users through participatory research.

Soil scientists along with scientists of other disciplines of agriculture have played a pivotal role in enhancing agricultural production. However, in addition to food production, environmental issues are now emerging as newer challenges for soil scientists in terms of both basic and applied research. We believe that an effective communication of soil science expertise to colleagues in other related professions, and to outsiders as well, is crucial for the future of soil science. We hope the soil scientists will play a crucial role in dealing with the emerging complex issues in new world.

A. Subba Rao