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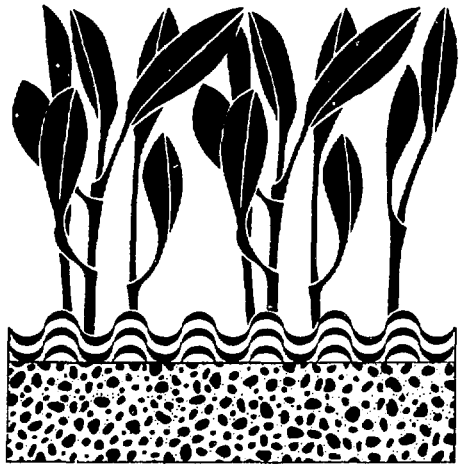

Soils Newsletter

JOINT FAO/IAEA DIVISION
OF ISOTOPE AND RADIATION APPLICATIONS
OF ATOMIC ENERGY
FOR FOOD AND AGRICULTURAL DEVELOPMENT
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

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CONTENTS

1. TO OUR READERS

Greetings.

The last months in the Soil Fertility, Irrigation and Crop Production Section have, as usual, been busy for us. There have been a number of staff changes and appointments. Our professional team is up to full strength for the first time for well over a year; and we look forward to vigorously implementing the new directions we wish to go in, some of which were indicated in our last Newsletter.

Brief details of procedures with submission of applications for Technical Co-operation Projects, Co-ordinated Research Programmes, Training Courses and Fellowships and Scientific Visits were given in our December 1986 issue, and will not be repeated in this issue. Please write to us if you need detailed information on these procedures.

In keeping with our earlier policy, in this and subsequent newsletters we will be including detailed information of our own and collaborators' research. For those who would like us to highlight summaries of their research findings, we ask that the following requirements be borne in mind. The abstract should:

a) relate to work which has been published, is in press or has been presented at a scientific meeting or is of a preliminary nature but containing some new information,
b) not exceed 200 words,
c) be typewritten, double-spaced, and
c) be in English.

For technical reasons we cannot include diagrams or photographs and the Section reserves the right to accept or reject submissions on the basis of their scientific merit. We wish to stimulate the exchange of ideas among our readership, especially between those working with adequate resources in more developed countries or institutions and those in less developed areas of the world where both resources and outside contact are limited.

2. STAFF

Dr. Kir Kalinin who had been with us as a First Officer (specializing in Plant Nutrittion and Soil Fertility) for 5 years returned to the Soviet Union at the end of April. Many will know Kir through their participation in the Co-ordinated Research Programmes, particularly, those on the use of Nuclear Techniques in Development of Fertilizer and Water Management Practices for Multiple Cropping Systems, and the use of Nuclear Techniques to Improve Crop Production in Salt-affected Soils. Kir was technical officer for several technical assistance projects in developing countries and actually visited many of them to advise on their implementation.

We wish him all the best for the future and we look forward to keeping up our contacts with him.

Dr. Cevat Kirda, a soils physicist specialized in the use of nuclear techniques in soil/plant moisture relations has replaced Kir Kalinin. Cevat graduated from the University of Ankara, Turkey in 1965 and obtained M.Sc. and Ph.D. degrees in Soil Science at the University of California, Davis, in 1969 and 1972, respectively, specializing in soil physics - water and solute transport in unsaturated soils. He worked for the Kearney Foundation at the University of California as Research Water Scientist in 1973, and published several papers on salt leaching phenomena under different irrigation regimes. He also published on the kinetics of nitrification and denitrification in soil columns, using N-15 enriched NH_4+ and NO_3- nitrogen. After his return to Turkey, he worked in the University of Cukurova, Adana, for the Department of Water Science and Agricultural Engineering of the Faculty of Agriculture, where he taught and studied irrigation and plant-water relationships. He joined the Agency in 1984 at the Seibersdorf Laboratories in the Physics Section until his recent appointment to the Soils Section of the Joint FAO/IAEA Division. His research interests are crop yield response to water, reclamation of salt affected soils and comparison of nuclear and non-nuclear methods in soil water studies. He has responsibility for two CRPs: "Nuclear Techniques to Improve Production in Salt-affected Soils" and "Evaluation and Calibration of Nuclear Techniques as Compared to Traditional Methods in Soil Water Studies."

Dr. Bogdan Astvatsatrian arrived in January 1987 as a visiting Professor attached to the Joint Division. He comes to us from the Agricultural Research Institute of the Armenia, Yerevan, Armenian SSR, where he was Director of the Institute and Head of the Agrochemistry and Biochemistry Department. He has worked on a wide range of closely related topics - soil fertility, accumulation and transformations of major nutrient elements and management of crops in mountainous ecosystems. He has published over 240 research papers, monographs and chapters for books. Over the last 10 years he interacted with scientists in developing countries of Asia and the Caribbean.

Dr. Saliya Kumarasinghe, formerly of the University of Peradeniya, Sri Lanka, joined the Soil Fertility, Irrigation and Crop Production Section in January 1987 as the Co-ordinator for the Regional Project on Biological Nitrogen Fixation in Africa. He is a plant physiologist with a Ph.D. from the University of London obtained in 1975, and specialized in photosynthetic carbon metabolism and biological nitrogen fixation. Saliya, has integrated these skills with agronomic/plant nutrition

skills. He has periodically served in the Soils Unit of the Agency's Laboratory in Seibersdorf as a consultant, and also as a lecturer in training courses since 1982. Recently, he was used more and more as an Agency expert on biological nitrogen fixation in a number of developing countries in Africa, Asia and Latin-America and the Middle-East. Saliya is located at the Soils Unit, Seibersdorf.

Dr. Nteranya Sanginga joined the Soils Unit at Seibersdorf on July 26. His particular area of research will be nitrogen fixation (and nutrition) by trees, an area we wish to develop (see later in this Newsletter). Nteranya comes from Zaire and obtained his Ph.D. in Soil Microbiology, working both at IITA (Ibadan, Nigeria) and the University of Zaire (Yangambi), on nodulation of Leucaena leucocephala and its contribution to the nitrogen status of soils. For the last year he has been on a post-doctoral with Prof. M.J. Swift, Dept. of Biological Sciences, University of Zimbabwe (Harare) studying tropical soil biology and fertility, especially in respect to the effects of trees on nutrient cycling.

Sabbaticals

We are delighted to have two well known scientists on sabbatical leave with us:

Dr. Mohan Saxena of ICARDA (The international Center for Agricultural Research on Dry Areas) arrived in late July for 12 months. Mohan is noted for his studies on legume nitrogen fixation and is leader, Food Legume Improvement Programme, ICARDA, Aleppo, Syria.

Dr. Eric Craswell, of the Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia will be spending a 6 months sabbatical with us, from early October. After a well known research career on nitrogen in soils and on biological nitrogen fixation, Eric is currently Research Programme Co-ordinator for ACIAR in the area of plant nutrition.

The present staff therefore is:

(a) IAEA Headquarters Joint FAO/IAEA Division, Vienna International Centre, Wagramerstr. 5, POB 100, A-1400 Vienna, Austria.

Glynn D. Bowen, Head of Section. Root Biology, Plant Nutrition
Seth K.A. Danso, 1st Officer. Soil Fertility, Microbiology.
Cevat Kirda, 1st Officer. Soil Physics, Soil Water Irrigation
David L. Eskew, 2nd Officer. Plant Physiology, Soil Fertility.
Bogdan Astvatsatrian. Visiting Professor, Agricultural Chemistry.
Mohan Saxena. Sabbatical visitor. Biological Nitrogen Fixation.

(b) FAO/IAEA Agricultural Biotechnology Unit of the IAEA Seibersdorf Laboratory, A-2444, Seibersdorf, Austria.

Felipe Zapata, Head of Unit. Soil Fertility, Plant Nutrition
Gudni Hardarson, Research Officer. Soil Fertility, Microbiology.
Nteranya Sanginga. Research Officer. Soil Fertility, Microbiology.
Eric Craswell. Sabbatical visitor. Biological Nitrogen Fixation.
Helga Axmann, Head Analyst
Aldo Sebastianelli, Analyst
Leopold Mayr, Analyst.
Saliya Kumarasinghe. Co-ordinator, African Regional Programme on Biological Nitrogen Fixation.

3. CO-ORDINATED RESEARCH PROGRAMMES
(More details are given in the December 1986 issue.)

A. The use of nuclear techniques in improving pasture management
(Project Officer - Seth Danso)

This programme focusses on increasing the yield and nutritive value of pastures, by incorporating high N_2-fixing legumes species and varieties within traditional grass pastures. This would limit the need to use costly N fertilizer for high pasture productivity. This CRP is funded by the Italian Government. This CRP will come to an end in September 1987, after a five-year duration.

B. Isotope studies of nitrogen fixation and nitrogen cycling by blue-green algae and Azolla.
(Project Officer: David Eskew).

The major objectives of this CRP involve the use of isotopic techniques to assess N_2 fixed by Azolla, and the quantitative evaluation of the available N from Azolla biofertilizer to flooded rice under various management conditions. This CRP is funded by the Swedish International Development Authority (SIDA).

The programme is now beginning its fourth year. The third research co-ordination meeting is planned to be held from November 2 - 6, 1987 at the Fujian Academy of Agricultural Sciences in Fuzhou, People's Republic of China. Since the last RCM, the contractors have performed field experiments comparing the N availability from Azolla green manure applications at transplanting and at maximum tillering, comparing dried versus fresh azolla, and comparing different species and strains of Azolla. Most recently, a new experimental plan was developed to study the effects of different P fertilization regimes on the growth and N accumulation by Azolla. The effect of differing P fertilization levels on N availability to rice will also be examined. The results of these experiments will be discussed at the upcoming RCM. Experiments are also planned to study ^{15}N balance of N incorporated into the soil as an Azolla green manure versus urea.

C. The use of nuclear and isotopic techniques to improve crop production on salt-affected soils.
(Project Officer: Cevat Kirda)

The major objective of this CRP is the amelioration of the physical, chemical and biological properties of salt-affected soils and the effects on plant growth. The first Research Co-ordination Meeting of this programme was held December 8-12 1986, in Vienna. A more detailed report of the meeting is given later in the Newsletter.

D. Improvement of yield and nitrogen fixation of common bean (Phaseolus Vulgaris) in Latin America.
(Project Officer: Gudni Hardarson)

This programme examines genetic variation in symbiotic nitrogen fixation by common bean and, through this, aims to save N-fertilizer and increase food production. The next Research Co-ordination meeting will be held at CIAT, Cali, Colombo November 23-27, 1987.

E. Improvement of yield and N_2 fixation of grain legumes with the aim of increasing food production and saving N-fertilizer in the Tropics and Sub-tropics of Asia. A joint programme of the Soils Section and the Plant Breeding Section.

(Project Officers: Seth Danso, Nobuo Murata)

This CRP has similar objectives to those for the Phaseolus CRP in Latin America (see above). However, cowpeas, groundnuts, soybean, chickpea and munbean are being examined rather than only 1 grain legume. The first Research Co-ordination Meeting was held from 17-21 November 1986, in Chiang Mai, Thailand.

F. Evaluation and calibration of nuclear techniques as compared to traditional methods in soil water studies.

(Project Officer: C. Kirda)

This programme is run under the auspices of our section of the Joint FAO/IAEA Division and the Industrial Application and Chemistry Section of the Division of Physical and Chemical Sciences. The programme was first implemented in 1985. Presently it has four research contracts (from Brazil, China, Republic of Korea and Turkey) and three agreement holders (from France, Portugal and USA). Efforts are being made to find additional funds to award more research contracts. The Programme's objective is to evaluate and calibrate present and recent development in nuclear methods in soil water studies in comparison with traditional non-nuclear methods such as gravimetric sampling, capacitance and the use of resistance blocks.

The present emphasis is on the theoretical calibration of neutron moisture and gamma density gauges, and simple procedures are being sought for readjusting existing calibration curves, for use in the gauges currently on the market. The programme compares all existing methods used in soil water content and density measurements, with the aim of eventually assisting irrigation specialists, agronomists and all other related professionals to establish sound criteria for choosing the appropriate methodology to meet their own needs. Special emphasis is given to differences in field application of the methods, how they effect the accuracy of the measurements, as well to cost-benefit relations of the instruments for a given purpose. The first co-ordination meeting of the project will be held in Vienna during November 2-4, 1987.

4. NEWS FROM SEIBERSDORF

The Seibersdorf Soils Unit provides back-up research and analytical services (where necessary) for Co-ordination Research Programmes and performs research in the broad areas of (i) Biological Nitrogen Fixation and (ii) Root Biology and the Use of Soil Resources. It is also actively involved in running Training Courses, providing Fellowship Training and some aspects of the Technical Co-operation Programme.

We have 2 intakes of 3 fellows (analytical fellows) each per year for 3 months to learn analytical techniques (especially ^{15}N analysis). Research fellows, the other category, are accepted only for 6 months to 12 months and are assigned a problem in one of our research areas, in the course of which they learn the relevant, often varied, research techniques. At present we have 4 Research fellows:

Precha Wadisirisuk (Thailand)	Biological Nitrogen Fixation (competition between effective and ineffective rhizobia).
Victor Martin Cutinella (Uruguay)	The bases of genotypic differences uptake and use of soil phosphate by clovers.
Toan Nguyen Van (Vietnam)	Genotypic differences in rice tolerance to acid soils.
Charles Mwamba (Zambia)	*N and P nutrition of* Phytolaca dodecandra (a perennial shrub with strong molloscicidol properties useful in control of bilharzia).

5. TECHNICAL CO-OPERATION PROGRAMMES

The Section currently handles 73 Technical Co-operation programmes, in Africa, Asia, Latin America and the Middle East and Europe. For general information or Technical Co-operation programmes see Soils Newsletter, December 1986.

Regional Africa Project *on Biological* Nitrogen Fixation

In January 1987, the Division of Technical Assistance and Co-operation initiated a Regional Project in Africa on biological nitrogen fixation. Member States presently involved in this project are: Egypt, Ghana, Nigeria, Senegal, Tunisia and Zaire. Niger and Morocco may join shortly. The main aim of this programme is to co-ordinate, under one umbrella, the activities of these National projects on biological nitrogen fixation. A Regional Co-ordinator (Dr. S. Kumarasinghe) has been recruited for this purpose. While emphasis on the particular area of research may vary depending on the country, all projects, in general, aim at enhancing the capacity for biological nitrogen fixation in grain and tree legumes, and non-leguminous tree species in order to increase food production and soil fertility.

As part of its initial activities, a Regional Workshop was held from 6 - 10 July 1987 at the University of Ghana, Legon-Accra, in collaboration with the Ghana Atomic Energy Commisssion in Kwabenya, Ghana. Thirteen collaborators from 8 Member States participated in the workshop as well as 13 local participants. The workshop was designed to exchange ideas and information and finalize guidelines for future research activities. In addition, a Regional Africa Training Course on the Use of Isotope and Radiation Techniques in Studies of Biological Nitrogen Fixation and Soil/Plant Nutrition will be held in Africa in 1988. Further information on this would be announced in due course.

6. TRAINING COURSES

(1) From May 12 to July 3, a training course was held in Seibersdorf on "The Use of Isotope and Radiation Techniques in Studies on Soil-Plant Relationships". There were 21 participants from 21 countries. Eleven professional staff from Seibersdorf and 6 scientists from other groups in Europe gave instruction.

(2) An FAO/IAEA Interregional Training Course on "Use of ^{15}N in Soil Science, Plant Nutrition and Agricultural Biotechnology" was held from May 12 to June 12 in Leipzig, German Democratic Republic. The course was attended by 14 participants from 14 countries. The participants received theoretical and practical training in the use of ^{15}N with emphasis on ^{15}N analysis by emission spectrometry and mass spectrometry. Two of the participants stayed for a further 2 months of intensive training in ^{15}N analysis. This was the seventh course in this topic which has been held every other year in Leipzig.

Training Courses 1988

In line with our decision to hold specialist and generalist training courses at Seibersdorf on alternate years and to give more Regional Training Courses, the training courses for 1988 will be

(1) "The Use of Isotope and Nuclear Techniques in Soil/Plant Productivity with Emphasis on Root Studies."

This will be held at Seibersdorf May 24 to July 1, 1988. This will focus particularly on methods of studying various phenomena in, root biology, and physiology, the use of soil resources, and the management of roots. Isotopes and nuclear techniques are especially useful for this. The course will not be restricted to the use of isotope techniques but will seek to integrate valuable isotope and non-isotope approaches. The uptake of nutrients and water, effects of soil physical and chemical factors on root growth and function and microbial associations of roots will be among the topics examined.

The objective is to equip scientists from developing countries with knowledge and practice of isotope and nuclear techniques (including appropriate experimental design and interpretation) in order to contribute significantly to national programmes on the management of soil resources (nutrient and water) and fertilizer use for optimum productivity. Particular emphasis will be placed on root functions and the management of roots by agronomic means, by plant selection and microbial symbionts. This is the key to the effective use of soil resources, it is an area of research receiving increasing attention in developed countries..

(2) An African Regional Course on "The Use of isotopes and radiation techniques in studies on biological nitrogen fixation and soil/plant nutrition".

This will be held for 4-5 weeks at a venue in Africa, yet to be decided.

The objective of this training course is to give scientists from African countries a sound working knowledge of the relevant nuclear techniques used in studies of biological nitrogen fixation and soil

fertility, the correct field experimental study and design, and data interpretation so that their knowledge and skills may be effectively utilized in research aimed at increasing crop production. The participants are expected to be at least at University degree level with substential research experience in the field of soil/plant studies.

7. REPORTS OF MEETINGS

(1) The first Research Co-ordination Meeting on "Nuclear Techniques to Improve Production in Salt-affected Soils", 8-12, December 1986, IAEA Headquarters, Vienna, Austria.

The problem of salt affected soils interests a wide group of disciplines from plant physiology, agronomy and plant breeding to soil fertility, irrigation, soil physics, soil microbiology and soil chemistry. The scientific interests of the participants of the programme varied widely. However, the main focus was on the on biological amelioration of salt affected soils. Excerpts from presented reports:

S.M. Rahman et el., Bangladesh, Institute of Nuclear Agriculture, Mymensingh, Bangladesh.
Nuclear techniques to improve crop production in salt affected soils. Yields of wheat and lentil in saline soils were compared and it was found that substantial yield increase for both crops was possible with irrigation. No nodulation occurred in lentil, suggesting that inoculation was essential.

R. Ansari et al., Atomic Energy Agricultural Research Centre, Tandojam, Pakistan. Growth physiology of soybean and associated changes in the nitrogen economy of soil as affected by substrate salinity.

Soybean cultivars tested were found to be salt tolerant up to 25 mM NaCl at the germination stage. Although, all 36 cultivars tested germinated at 50 mM NaCl, none showed more than 50 % germination. The influence of substrate salinity on plant dry weight was more pronounced than on plant height. Ion uptake was generally reduced, with the exception of Na, with increase of substrate salinity.

M. Popp et al., Institute of Plant Physiology University of Vienna, Austria. Comparative studies on mangroves and salt-affected road side trees. Na and Cl concentrations in mangrove leaves were very close to that of sea water, irrespective of whether the leaves were from salt secreting or non-secreting species. Road-side trees tested differed in susceptibility to salt stress, Robinia pseudacacia being the most salt tolerant.

M. De Boodt et.al., of the Agriculture Department of Soil Science, Faculty State University of Ghent, Ghent, Belgium. The dynamics of saline seepage in the coastal area due to potential gradients in the saturated and unsaturated zone. Preliminary results of a field experiment located in a polder area at the Western Belgian coastal plain having highly saline ground water reservoirs were reported. Monthly fluctuations of ground water table in the area, and electrical conductivity of upper layer soil to assess probable salinization hazards as a result of the rise of ground water were recorded.

O.A. Folurunso, Department of Soil Sience, University of Maiduguri, Maiduguri, Nigeria. Evaluation of crop response and improvement in salt-affected, vertisol soils.

Field spatial variability in physical and chemical characteristics of salt-affected soils were examined for the field experiments to be implemented in subsequent years.

W.D. Jeschke, W.D., Lehrstuhl für Botanik I., University of Würzburg, Federal Republic of Germany. Studies on fluxes and xylem transport of sodium (^{22}Na) in two varieties of barley and on net ion translocation in barley under saline stress. Properties of barley roots responsible for highly salt tolerant characteristic of this species were studied. Salt tolerance of barley was partly due to selective uptake of K, Na, and controlled uptake and root to shoot transport of Na and Cl.

P.I. Orphanos, G. Eliades, G. Agricultural Research Institute, Nicosia, Cyprus. Grain yield of trickle irrigated Phaseolus beans as affected by three levels of sodium chloride applied with the irrigation water. Dry seed yield was not influenced with irrigation water chloride content, ranging from 1.4 to 17 meq/l. "Rhizobium inoculum applied prior to planting at a rate of 0.6 kg/ha failed to induce inoculation.

M.I. Haq, Nuclear Institute for Agriculture and Biology, Faisalabad, Pakistan. Biological control of salinity in relation to use of saline ground water for irrigation.

Powdered lucerne, press-mud, (a waste of sugarcane industry) were compared as organic amendments to ameliorate alkaline soils. The influence of farm-yard manure and green manuring with Sesbania aculeata on soil reclamation was examined.

M. Kutilek, Faculty of Civil Engineering, Technical University, Dept. of Irrigation and Drainage, Prague, Czechoslovakia. Infiltration in salt-affected soils with regard to water quality and sodic hazard in laboratory and field conditions. Preparatory research work to characterize soil hydraulic properties under salt-affected soil conditions was reported.

A future work-plan of the project was discussed. It was agreed that there will be two types of activity in the programme: (a) core activity and optional activities. The core activity is compulsory and it deals with amelioration of salt affected soils. Three different lines of interest arose for optional (subsidiary) activities: (1) Biological nitrogen fixation, (2) Irrigation management and (3) Mechanisms of salt tolerance. In the core programme each contractor, in 1987, will screen salt tolerant genotypes of at least three plant species, having potential benefit to the local farmers. Field experiments will be implemented in subsequent years, to evaluate effectiveness of salt tolerant plant species in biological amelioration of salt-soils laden. Physical and chemical soil properties will be continously monitored during the 4 to 5 years period. Attempts will be made to relate plant yield and changes in soil properties to root biomass, root activity, root distribution and root turnover, and to organic matter decomposition. All contractors will be using Kallar grass as a reference species to assess existing soil salinity in their region and thus to enable them to comparison of results with those of other contractors. A bare-soil plot, included in the field experiments, will be used to assess soil amelioration over the years, with biological means.

The main objective of the biological nitrogen fixation, one of the options to the core activity, is to know how this is influenced by salinity and as soil amelioration progresses over the years. The work will be carried out using only one legume crop and one of the non-legume crops tested will be used as control crop to estimate nitrogen fixed. More detailed studies of the effects of salinity of various phases of infection, nodule development and nitrogen fixation may also be made.

Two irrigation treatments will be incorporated, in the optional irrigation activity. Choice of treatments were left to the contractors, which may either be testing of two different qualities of irrigation waters, comparison of different irrigation methods or irrigation management practices influencing plant-root-zone salt balance. Salinity and water profiles will be examined in relation to root growth and function and finally, plant growth.

(2) An Advisory Group Meeting on the use of "Nuclear and Related Techniques in Studying the Roles of Trees in Restoring and Maintaining Soil Fertility" was held in Vienna from November 24 to 28, 1986.

The meeting examined the roles of trees in restoring soil fertility (soil nitrogen and organic matter), in contributing to a stable agricultural system on fragile soils and in soil conservation (especially in semi-arid and arid ecosystems). The participants considered what research had been accomplished to date, and made recommendations on further research that needs to be conducted. The meeting dealt with such topics as nodulation and nitrogen fixation by leguminous and non-leguminous tree species, the measurement of nitrogen fixation by trees, litter decomposition and changes in soil properties on clearing and after planting trees, nutrient uptake (including mycorrhizal relations), root dynamics, and the relation of these to agroforestry and to soil conservation and rehabilitation by trees.

Large parts of the tropics are faced with severe soil deterioration, erosion and desertification. This has been caused by population growth causing pressures on land for food production, shortening of rotations and bringing marginal lands under cultivation (and associated deforestation). This situation is likely to get worse: for example, despite the breeding of superior crop genotypes, population growth has now outstripped food production in 35 of 41 sub-Saharan African countries.

The majority of tropical soils deteriorate rapidly under cultivation; the chemical status of many agricultural lands in developing countries is low (especially in nitrogen and phosphorus). There is a loss of organic matter following cultivation, a loss of soil nutrients through removal in grain etc, leaching and run-off, a decrease in desirable soil physical properties and an increase in erosion (and desertification in semi-arid and arid areas). Some 65 % of tropical soils are fragile. In many soils yields have decreased in 2 years to a mere fraction of the yield in the first year after clearing of the native vegetation, and this is exacerbated in marginal soils. To some extent degradation can be postponed by high inputs such as fertilizer but this solution is not possible for most developing countries and other methods of restoring and maintaining fertility must be developed. Tree crops commonly build up the soil organic matter level and it should be possible to develop mixed tree-cropping systems to maintain organic matter and soil fertility at acceptable levels.

There is also a fuelwood crisis in many developing countries, and this is spreading at a fast rate, especially as the soils carrying indigenous forests (often of marginal quality for agriculture) are cleared for agriculture. Half of the world's population (i.e. 2-2.5 billion people) rely overwhelmingly on wood for daily living and this is irreplaceable by other energy sources. In Africa, 55 million people are now living in a wood crisis and this number is expected to increase 10-fold by the year 2000. The World Bank has suggested that by the year 2000, 3 billion people in the world will be living in areas where fuelwood is acutely scarce or has to be obtained from elsewhere. The loss of forests in the developing world (in response to the need for more agricultural land) is approximately 11 million hectares per annum. Desertification occurs with a further 6 million hectares annually.

A solution to (or an alleviation of) the problems of declining soil fertility and the fuelwood crisis is possible by the appropriate use of trees in agricultural/pastoral systems. Judicious use of trees in the rural environment can provide the framework within which food and wood, production can be integrated, enhancing the quality of and stabilization of land systems. By their perennial nature, their extensive root system, and their frequently high biomass, trees have particular advantages over other systems: annual planting is not required, once established, trees play a year-round soil conservation role; they are multi purpose, providing not only shade and wind protection but also fuelwood and leaf material for manure for associated crops, or for fodder for animals. Nitrogen fixing trees (in association with nitrogen fixing organisms and appropriate micro-organisms such as mycorrhizal fungi) are particularly important because they can grow in nitrogen and phosphorus-deficient soils and can restore soil fertility by the organic matter and nitrogen they add to soil.

Agricultural or pastoral systems using trees have been developed by indigenous farmers (e.g. systems in Africa based on the nitrogen fixing tree Acacia albida,) or by astute agronomists, e.g. alley cropping Leucaena leucocephala. In some areas alley cropping has been shown to maintain and sometimes enhance soil fertility, but the basis of these changes has received relatively little detailed study. There is great potential for increasing the productivity of such agroforestry systems (and increasing the soil fertility) by a closer study of the processes involved and their management. There is a dearth of knowledge on what tree species are potential nitrogen fixers, e.g. leguminous trees used in existing agroforestry systems are not always nitrogen fixers, and because most soils contain some nitrogen, good plant growth is not always a reliable indicator of nitrogen fixation. Many plant/micro-organism combinations fix little nitrogen from the atmosphere even though producing abundant nodulation. In many (if not most) agronomic studies with trees, inoculation with selected high nitrogen fixing micro-organisms has not been used and the full potential of the system may not have been realized. Selection of highly effective symbionts for promising tree species is central to maximizing biological nitrogen fixation. Although some selections of symbionts have been made, there is need for more research in this area.

It was obvious at the meeting that there are many areas requiring more research, e.g. various aspects of identifying nitrogen fixing trees, measurement and management of nitrogen fixation, the nutrient and water use efficiency of trees, root turnover and its contribution to soil organic matter, rates of change of soil fertility in the presence of nitrogen fixing trees, sharing of soil resources between trees and associated crops and its management.

The great value of isotope and nuclear related techniques was recognized in helping study these problems. Several recommendations for future work were made, but the meeting recommended that the study of nitrogen fixation by trees, factors affecting it and the transfer of nutrients to associated plants should be the first priority. It also recommended that the Joint FAO/IAEA Division conduct an international training course on the roles of trees in maintaining soil fertility and in soil conservation, recognizing the use of both non-nuclear and nuclear methods as research tools. We are actively working toward implementation of these recommendations.

The papers presented at the meeting are being prepared for publication.

8. PUBLICATIONS

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Owiredu, J. and S.K.A. Danso (1987) An evaluation of streptomycin-resistant cowpea and Bradyrhizobium japonicum strains for suitability in ecological studies Nigerian Journal of Science.

Danso, S.K.A., C. Labandera, D. Pastorini and S. Curbelo (1987) Nitrogen fixation in a two-year old white clover - fescue pasture: influence of nitrogen fertilization. Soil Biol. & Biochem.

Danso, S.K.A., G. Hardarson, F. Zapata (1987). Nitrogen fixation estimates in alfalfa-ryegrass swards using different N-15 labelling approaches. Crop Science.

Danso, S.K.A. and J.D. Owiredu (1987) Competitiveness of introduced and indigenous cowpea rhizobium strains for nodule formation in three soils. Soil Biol. & Biochem.

Owiredu J.D. and S.K.A. Danso (1987) Response of soybean (Glycine max (L) Merrill) to Bradyrhizobium japonicum inoculation in three soils in Ghana. Soil Biol. & Biochem.

Hardarson, G., S.K.A. Danso, F. Zapata (1987) Nitrogen fixation measurements in alfalfa-ryegrass swards using nitrogen-15: influence of the reference crop. Crop Science.

Submitted

Danso, S.K.A. (1987) Nodulation of soybean in an acid soil: The influence of Bradyrhizobium inoculation and seed pelleting with lime and rock phosphate. (Soil Biol. & Biochem.).

Labandera, C., S.K.A. Danso, D. Pastorini, S. Curbelo and V. Martin (1987) Nitrogen fixation in a white clover - fescue pasture using three methods of nitrogen 15 uptake. (Agronomy Journal).

For further information on the above publications, please write to any of the individuals concerned, or, to the Head, Soil Fertility, Irrigation and Crop Production Section.

9. FROM OUR READERS

Nitrogen Fixation by Leucaean leucocephala (Lam.) de Wit under Nigerian Field Conditions Estimated by N-15 Technique. N. Sanginga[1], K. Mulongoy[2] and A. Ayanaba[3].

Nitrogen fixation by Leucaena leucocephala (Lam.) de Wit inoculated with Rhizobium strains IRc 1045 or IRc 1050 was assessed in a field experiment on an Alfisol of the Egbeda soil series using ^{15}N methodology. Of the total N in the plants inoculated with Rhizobium IRc 1045,39% was atmospheric N compared with 34% in those inoculated with strain IRc 1045. These proportions represented 134 and 98 kg N/ha fixed in 6 months, respectively. The percentages of biologically fixed N in different plant parts were similar but total N fixed was higher in leaves than in stems and roots. Comparison of N fixation as determined by means of ^{15}N with fixation as calculated by the difference method were similar for IRc 1045 inoculated and no fertilized plants but not for those of IRc 1050. The isotopic method gave a lower coefficient of variation for estimating N fixed and was therefore found more reliable than the difference method. The ^{15}N method was capable of both determining N fixation by leucaena and of distinguishing it from other nitrogen sources. Fertilizer utilization was 6% from the 40kg N/ha fertilizer application, whereas estimates by the difference method indicated that both 40 and 80 kg/ha fertilizer N depressed nitrogen fixation.

1 Department of Biological sciences, University of Zimbabwe MP 167 Harare, Zimbawe.

2 International Institute of Tropical Agriculture, PMB 5320, Ibadan, Nigeria.

3 Del Monte Corporation, AG. Research Box 36, San Leandro, California CA 94557, USA.

Evaluation of Indigenous Strains of Rhizobia Nodulating Leucaena and their Effects on Early Growth of this Legume in Nigeria Soils. N. Sanginga[1], K Mulongoy[2], A. Ayanaba[3].

Experiments were conducted at the International Institute of Tropical Agriculture (I.I.T.A.) and at Fashola, Southwestern Nigeria, to identify, characterize and evaluate indigenous rhizobia nodulating Leucaena leucocephala (Lam.) de Wit, and to monitor their effect on early growth of this legume. Rhizobia nodulating leucaena were few or absent in soils without a previous history of leucaena cultivation. Their numbers were high in the soil collected from a field cropped to leucaena. To obtain appropriate inoculants for leucaena, rhizobia were isolated from L. leucocephala, Tephrosia vogelii, Vigna unguiculata S. grandiflora, S. punctata, S. rostrata, and A. albida grown in soils from IITA and Fashola. Rhizobia isolated from leucaena were all fast growers and some showed resistance to 500 ug/ml of streptomycin. The relative effectiveness of the rhizobia in symbiosis with leucaena was tested in sterile sand in Leonard jars. Isolates from all plants except those from S. grandiflora and V. unguiculata were able to form nodules with leucaena but a wide range of effectiveness was demonstrated. Based on this experiment the ten most promising rhizobia were then tested in pots. Only isolates IRc 1045 and IRc 1050 isolated from leucaena performed well and were further tested in the field. At IITA only inoculated plants nodulated while at Fashola, all the plants produced nodules. In the

uninoculated treatments, nodules were due partly (69%) to Rhizobium IRc 1050 used in a previous inoculation trial at this site. At both locations, inoculation with Rhizobium IRc 1045 or IRc 1050 increased total dry matter and N of leucaena. This effect was equal to 150 kg/ha of nitrogen fertilizer applied in uninoculated plots. In addition to their effectiveness and competitive ability, the strains survived well in the field one year after their establishment.

1 Department of Biological sciences, University of Zimbabwe MP 167 Harare, Zimbawe.

2 International Institute of Tropical Agriculture, PMB 5320, Ibadan, Nigeria.

3 Del Monte Corporation, AG. Research Box 36, San Leandro, California CA 94557, USA.

T. Crisanto and I. Cuella, Effect of Liming on phosphorus content of some acid soils.

Centro de Edafologia y Biologia Aplicada, Ap. 257. Salamanca, España

The effect of calcium carbonate added at the rates of 0, 66.6, 133.3, and 200 mg respectively on six acid soils with different phosphorus contents was studied.

An evaluation was made of the effect of $CaCO_3$ on phosphorus sorption isotherms, according to Langmuir and Freundlich equations. The highly significant correlation coefficients indicate that the values obtained accomplish well with those equations. The relationship between isotherm variation and treatment applied allowed for a prediction of the sorption type concurring in each case, taking into account the actual final pH of the soil.

The isotopically exchangeable phosphorus in each of the treatments increased with the pH value, except for two soils.

A pot experiment was planted to calculate labile phosphorus (determined with ^{32}P) in soil, phosphorus uptake, and plant dry weight yield. Labile phosphorus generally increased at low liming doses, but decreased sharply when higher rates (200 mg CO_3Ca in 100 g soil) were applied suggesting the unsuitability of high liming rates for the soils under study.

10. CLEANINGS

As an experiment, in each of the next few Soils Newsletters, we will indicate some recent (occasionally not quite recent) papers which have attracted our attention. Perhaps some of our readers may not have seen them. We invite scientists from developed and developing countries to send us copies of their papers using isotopes and nuclear related techniques - not only for our own information but also for possible mention to our readers.

Please give us a feed back on the value of bringing a selection of papers to your notice. Send opinions and copies of your papers to Head, Soil Fertility, irrigation and Crop Production Section, Joint FAO/IAEA Division, Wagrammerstrasse 5, A-1400 Vienna, Austria.

McClure[1] P.R. Omholt[1] T.E. and Pace. G.M.[2] 1986 Anion uptake in maize roots: Interactions between chlorate and nitrate - Physiol. Plant 6:107-112. [1] Dept. of Chemistry, State Univ. of New York. College of Environmental Science and Forestry, Syracuse, NY 13210 USA, [2]G.M. Pace, United Agriseeds, Inc. P.O. Box 4011, Champaign, IL 61820, USA.

This is one of a number of papers by various authors over the last few years in which $^{36}ClO_3^-$ is used as a radio-active isotope analogue for NO_3^- in nutrient uptake studies. The method needs more testing (in our opion) but looks very promising, especially for short term uptake studies, where uptake kinetics rather than metabolic incorporation is the focus. It has the advantage of a readily counted radioactive isotope (^{36}Cl) using very small samples, and side-steps some difficulties of ^{15}N methods for this type of work. In the paper cited, the results support the existence of a shared nitrate/chlorate transport system in maize roots which is not inhibited by external chloride, and which is induced by nitrate, but not by chlorate or chloride. The suggestion is made that selection of chlorate-resistant mutants of maize can identify nitrate uptake as well as nitrate reductase mutants.

M. Kraus, A. Fusseder and E. Beck, 1987. In situ-determination of the phosphate-gradient around root by radioautography of frozen soil sections. Plant and Soil, 97: 407-18.
Department Plant Physiology, University of Beireuth, Beireuth, Federal Repbulic of Germany.

A radioautographic method is decribed which allows the determination of phosphate concentration profiles around a root in situ, i.e. under conditions of radial diffusional flow.

The device consisted of a soil column containing a distinct layer labelled with ^{33}P which was kept separated from the rest of the content of a (modified) Kick-Brauckmann vessel. The primary root of a maize plant was directed into the special soil core whereas the other roots were allowed to develop into the unlabelled portion of the pot. Two or five days after the roots had penetrated the labelled soil sections the soil blocks were immediately frozen in liquid nitrogen and sliced perpendicular to the growth direction of the root by means of a stone cutting saw. From the frozen soil slices radioautograms were prepared and densitometrically analysed for phosphate content within and outside the root. The

P-depletion zone around the primary root did not exceed the area of the root hair cylinder.

Although soil composition and the extent of water supply to the pot somewhat limit the applicability of the technique, it should be appropriate for the investigation of a variety of agricultural soil.

M.J. McLaughlin[1], A.M. Alson [1] and J.K. Martin [2] (1987).
Transformations and movement of P in the rhizosphere. Plant and Soil, 97:391-399.
[1]Department of Soil Science, Waite Agricultural Research Institute, The University of Adelaide, Glen Osmond, South Australia 5064. [2] CSIRO Division of Soils, Glen Osmond, South Australia 5064.

Wheat plants labelled with ^{33}P were grown in thin layers of soil amended with ^{32}P-labelled fertilizer. Roots were separated from the soil during plant growth by a porous membrane to overcome difficulties in measuring microbial P in rhizosphere soil. Over the 22 day growth period, net movement of ^{33}P out of healthy growing roots varied from 0.9% of the total ^{33}P translocated to the root. Over the same period the plants took up 12.0% and the microbial biomass 14.1% of the fertilizer ^{32}P. On drying and rewetting of the soil after the plants were harvested, a large proportion of root P moved into soil fractions while ^{32}P appeared to accumulate in the biomass and stable P forms.

11. IMPORTANT ANNOUNCEMENTS

1. International Symposia

The Use of Stable Isotopes in Plant Nutrition, Soil Fertility and Environmental Studies.

An international symposium will be held by the Joint FAO/IAEA Division in Vienna, 1989 (date to be decided) on the Use of Stable Isotopes in Plant Nutrition, Soil Fertility and Environmental Studies.

Stable isotopes are being used increasingly in nutrition, soil fertility and environmental studies, e.g., various ^{15}N methods in measurement of nitrogen fixation, N dynamics in soils,, ^{13}C natural abundance in soils, organic matter studies, and in ^{34}S studies.

The symposium will examine the uses of stable isotopes and their suitability in various studies.

2. The Management of Nitrogen Fixing Trees for Restoring and Maintaining Soil Fertililty.

A co-ordinated research programme on this topic has been approved in principle. We are optimistic that funds may be available for implementation of this in the relatively near future. This arose from the Advisory Group Meeting on Trees and Soil Fertility reported earlier in the Newsletter.

It will focus on the measurement of biological nitrogen fixation by trees in agricultural - pastoral ecosystems. It will have an agroforestry emphasis but studies relating to soil conservation and anti-desertification will not be excluded. The programme will also seek to examine the effects of:

(i) soil chemical status, especially the effect of adding small amounts of phosphate and trace elements.

(ii) season and age of the tree, and different management systems such as times and intensity of cutting of foliage or stems for green manure, fodder, and fuel.

(iii) soil moisture (and its interactions with soil nutrient); and

(iv) genetic variation in nitrogen fixation within species.

It will be important to measure also the rate of increase of soil fertility in response to management of nitrogen fixation, and the benefit derived by cropping systems associated with the tree stands, e.g., in alley cropping.

If you are interested in further information on the two announcements above, please write to: The Head, Soil Fertility, Irrigation & Crop Production Section, Joint FAO/IAEA Division, P.O. Box 100, Wagramerstrasse 5, A-1400 Vienna, Austria.

Notes for readers for consideration for the next issue of Soils Newsletter should reach the above by November 1, 1987.

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