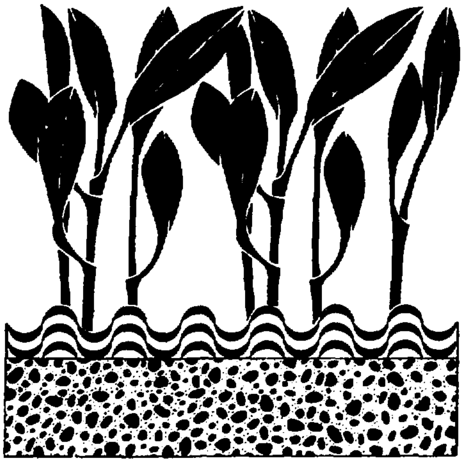
XA9128719

INIS-mf--12853



Soils Newsletter

JOINT FAO/IAEA DIVISION
OF NUCLEAR TECHNIQUES IN FOOD AND AGRICULTURE
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

Vol. 13, No. 1
July 1990

ISSN 1011-2650

CONTENTS

TO OUR READERS

Preparations are well advanced for our International Symposium on the "Use of Stable Isotopes in Plant Nutrition, Soil Fertility and Environmental Studies" to be held in Vienna, October 1-5. The programme of presentations and posters has been finalized but you may still register to attend - the earlier the better in order to facilitate accommodation arrangements and so on. We have 14 keynote papers on a wide range of topics, 37 other oral presentations and 52 posters. Unfortunately, lack of space has precluded the inclusion of more posters.

This year, in our Interregional Training Course in Seibersdorf, under the technical guidance of Cevat Kirda and the organization of Course Director Felipe Zapata, we emphasized soil water management. You may recall that this is the third in our special topics series - in 1988 it was the study of roots and in 1989 we focussed on biological nitrogen fixation.

This year's course is the last to be held in the present training facilities. In September we expect to officially open the new Training Center at the IAEA's Laboratories Seibersdorf. This has 90m^2 of main laboratory (with adjacent instrument rooms), a large auditorium and a large study room for course participants.

Next year (1991) we expect our interregional training course will be held in Tbilisi, Georgia, USSR. The teaching language will be English, with core lecturers from our own staff and other lecturers drawn from the USSR. We will then revert to Seibersdorf in 1992. In 1991, we hope to hold a regional training course in Africa integrating nuclear and non-nuclear methods in soil/plant relations with some emphasis on agroforestry. There <u>may</u> be 1-2 places available from non-African participants. This course will integrate well not only with some of our Technical Co-operation Projects in Africa but also with our SIDA-funded CRP on "Increasing and Stabilizing Plant Productivity in Low Phosphate and Semi-Arid and Sub-humid Soils of the Tropics and Sub-Tropics", and our (Regular Budget) CRP on "Measurement and Management of Nitrogen Fixation by Trees", which is about to commence.

The General Conference votes on various matters in September, including funds for Technical Co-operation Projects for the years 1991 and 1992. Funds for 1993/1994 will be allocated in late 1992. If you wish to apply for a TC project for 1993/1994 you should start thinking hard about it in the very near future, with a view to having it at the Agency by about September-November next year (1991). The national body submits a group of proposals in various fields and allocates their (suggested) priority; dialogue between yourself (or your institute) and the national department responsible for nuclear energy is highly recommended. More information is included on the Technical Co-operation Programmes in a later section of this News Letter.

As well as national projects, we are also moving toward having a few Regional Projects, usually serviced by the one expert (plus some more specialized experts where necessary). These usually have regular workshops and help develop a good collaborative network in a region for exchange of plant material, results, experience, etc. At present, the Soil Fertility Section has a Regional Africa Project on Biological Nitrogen Fixation. The possibilities of a Regional Project in the Europe/Middle East Area on nitrogen fixation in semi-arid areas (also including components of water studies) are being investigated as well as an African Regional Project on integration of fertilizer recommendations (aspects of fertilizer use efficiency) with soil water status in relation to seasonal climatic predictions.

Finally, it is a pleasure to welcome Dr. Peter Salema from the Morogoro University of the United Republic of Tanzania who will be our expert to the Regional Africa Project on Biological Nitrogen Fixation. Peter comes to us with long experience in Rhizobium ecology and the production and use of legume inoculants.

For those of you in the northern hemisphere who have your holidays in summer, I wish you good weather. For those of you with your major growing season over the next few months, I also wish you good weather, although the definition of "good" may differ with the two cases above.

Glynn Bowen

STAFF

1. IAEA Headquarters, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna International Centre, Wagramerstrasse. 5, P.O. Box 100, A-1400 Vienna, Austria.

   Björn Sigurbjörnsson, Director, Joint FAO/IAEA Division
   Leo E. LaChance, Deputy Director, Joint FAO/IAEA Division

   Soil Fertility, Irrigation and Crop Production Section

	Special expertise
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
Saliya Kumarasinghe, 2nd Officer.	Plant Physiology, Soil Fertility
M. Peter Salema, Coordinator, Regional Africa Project in BNF	Microbiology, Plant Nutrition

   Secretarial staff:
   Marina Kneissl
   Ruth Rossi

2. Agricultural Laboratory, Soil Science Unit of the IAEA Seibersdorf Laboratory, A-2444 Seibersdorf, Austria.

	Special expertise
Felipe Zapata, Head of Unit.	Soil Fertility, Plant Nutrition
Gudni Hardarson, Research Officer.	Microbiology
Helga Axmann, Head Analyst	Analytical Chemistry

   Technical Staff:

   José Luis Arrillaga, Laboratory Technician
   Leopold Mayr, Laboratory Technician
   J. Aldo Sebastianelli, Laboratory Technician
   Stefan Borovits, Laboratory Assistant
   Gerhard Eckhardt, Laboratory Assistant
   Habib-Ben-Brahim, Laboratory Assistant
   Christine Ficker, Laboratory Assistant

   Secretarial staff:
   Ma. P. Santayana

CO-ORDINATED RESEARCH PROGRAMMES

A. <u>Increasing and stabilizing plant productivity in low phosphate and semi-arid and sub-humid soils of the tropics and sub-tropics.</u>
(Project officer: Saliya Kumarasinghe)

This project was initiated in October 1989. At present ten contract holders from Africa and four agreement holders: Federal Republic of Germany (1) from France (1) and from Sweden (2) are involved in this project. The first year's preliminary experiments on screening for plant genotypes for high phosphate and water use efficiency are already under way. Results of these experiments are expected to be presented at the second research co-ordination meeting to be held at the Kenya Forestry Research Institute, Nairobi, Kenya, in March 1991.

B. <u>Improvement of yield and N_2 fixation of grain legumes with the aim of increasing food production and saving N-fertilizer in tropics and sub-tropics of Asia</u>
(Project officer: Seth Danso)

Upon reactivation of this programme with fresh funds from UNDP, a Research Co-ordination Meeting was held from 2 to 11 May 1990 in Pakistan.

The meeting was attended by 10 participants and three observers. At the meeting, results of research carried out until this CRP was temporarily stopped (due to financial reasons). The data presented showed large genotypic differences in the nodulation capacity of selected cultivars and mutant lines of several legumes. Results showing dramatic nodulation and growth response of some legumes to inoculation in soils containing indigenous rhizobia were presented. Detailed plans were drawn up for new or follow-up experiments. The emphasis was still to be put on further screening of legume cultivars and mutant lines. The initial selection criteria would involve simple techniques such as nodulation, suppression of nodulation by high N, relative yield differences under high versus low soil N conditions, the ureide (solute) export techniques. Also, lectures on N-15 techniques, plant physiology, <u>Rhizobium</u> ecology, mutation and mutation breeding were delivered by Dr. K. Malik of the Nuclear Institute for Agriculture and Biology (NIAB), and the following FAO/IAEA staff: E. Amano, S.K.A. Danso and K.S. Kumarasinghe.

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

The field experiments testing biological amelioration potential of salt tolerant field crops grown in salt-affected soils are in good progress. Among the crops under test are sorghum, millet, barley, fababean, wheat and lentil. The third research co-ordination meeting of the programme, originally planned in 1990, is postponed to 1991 and is proposed to be held in Lahore, Pakistan in early March 1991.

D. <u>The use of isotopes to improve yield and N_2 fixation of grain legumes in Latin America</u>
(Project officer: Gudni Hardarson)

The third and final research co-ordination meeting of this programme is to be held at the Vienna International Centre, Austria, 24-28 September 1990. The meeting will include presentations by all contractors and agreement holders of research performed during the five year programme. The writing up of results will be continued and recommendations for further research in this field will be made. A report of this meeting will be published in the next issue of the newsletter.

E. <u>The management of nitrogen fixation by trees for restoring and maintaining soil fertility</u>
(Project Officer: Seth Danso)

Eleven contracts in Africa, Asia and Latin America from this programme have been recommended to the appropriate in-house committee, and it will commence in the next few months. We are hoping to hold the first research co-ordination meeting in Vienna in late October 1990.

F. <u>Assessment of irrigation schedules of field crops to increase effective use of water in irrigation projects</u>
Project officer: Cevat Kirda)

We first announced this co-ordination programme in the December 1989 issue of the Soils Newsletter. The programme aims at testing the concept of water-deficit irrigation to improve traditionally used irrigation management practices. It is expected that modification of existing irrigation schedulings based on water-deficit irrigation periods which are synchronized with crop growth stages when they are less sensitive to water stress can save 20% or more of water used in traditional practices - an important implication in management of scarce water resources.

We are requesting research contract submissions URGENTLY, by 28 September 1990, the latest. We hope the research contract awards will be given in October 1990 and the first research co-ordination meeting be held in late 1991. Please send your contract proposals to:

Contracts Administration Section
Department of Research and Isotopes
IAEA, P.O.B. 100, A-1400 Vienna, Austria

RECENTLY COMPLETED CO-ORDINATED RESEARCH PROGRAMME

<u>The use of nuclear techniques in improving pasture management</u>
(Project Officer: Seth Danso)

The programme had the following objectives:

1. To evaluate the suitability of the ^{15}N technique for measuring N_2 fixation in pastures, and/or to further develop the methodology.
2. To assess N_2 fixed by various legume species and cultivars with the aim of identifying genotypes with high N_2 fixing ability (and high yields also).
3. To assess the potential for N_2 fixation by legumes included in mixed pasture swards with grasses .
4. To evaluate the potential for nitrogen transfer from a legume to an associated non-legume crop.
5. To examine various management practices and how they affect N_2 fixation in pastures.

Some of the results are given briefly below.

<u>^{15}N Methodology</u>

Of the initial approaches examined, frequent (instead of single) applications of split doses of moderately enriched ^{15}N fertilizers (5-10% ^{15}N atom excess) was most suitable. The frequent additions, unlike the addition of large initial doses, did not inhibit N_2 fixation and yet allowed significant detection of ^{15}N above natural ^{15}N abundance. Further studies examined the best approach for applying the split fertilizer doses, i.e. (A) rotating the ^{15}N fertilizer application each time on a different plot (B) applying the ^{15}N fertilizer consecutively on the same plot after every other harvest, with unlabelled N fertilizer being applied during the intervening period, and (C) applying the ^{15}N fertilizer repeatedly to the same plot after each harvest. The time since the last ^{15}N application was the most important factor, with approaches A and C almost always giving identical results. The method B similarly gave identical results whenever ^{15}N was applied at the harvest immediately preceding the period of N_2 fixation assessment, but often not when it furnished residual ^{15}N from a previous application. In most cases method C was the most suitable and/or practical. These conclusions were also arrived at in studies with soils that had previously been used for ^{15}N experiments. The values obtained on these plots were higher or lower than those to which ^{15}N had recently been added; the frequent recommendation that previously labelled soils are good substrates for N_2 fixation studies need to be examined further. Studies were also conducted to compare the use of ^{15}N labelled organic matter with the more usual inorganic ^{15}N for estimating N_2 fixation. The organic matter labelling approach gave more precise estimates of N_2 fixed. In addition, the ^{15}N enrichments in soil remained high for long durations.

<u>Nitrogen fixation in species and cultivars</u>

The average %N_2 fixed in several cases was in the neighbourhood of 70 to 80%, with some species and cultivars deriving almost all their N from fixation. In some cases, however, values as low (or lower) than 40% N_2 fixed were obtained, either due to the influence of environmental factors, or to large genotypic differences in N_2 fixation. The amounts of N_2 fixed were in several cases around 100 kg N/ha/yr, and in some cases exceeded 200 kg N/ha. It was also conclusively demonstrated that although most pasture legumes are capable of satisfying a high proportion of their N from N_2 fixation, the greatest agronomic value of legumes is in total N_2 fixed. Whenever yields were low, high percentages of N_2 fixed were not translated into correspondingly high total N_2 fixed. We therefore conclude that there is a need for plant breeders to work together with microbiologists and agronomists to breed for higher yielding pasture legumes, and cultivars able to tolerate several adverse environmental factors.

<u>Nitrogen fixation in mixed stands</u>

With very few exceptions, there was a substantial increase in the proportion of the legume's N derived from fixation in mixed cultures compared to monoculture. The ^{15}N and soil N uptake data revealed that this enhancement was largely due to a lower competitive ability for soil N by the legume than by grass in the mixed stands, causing the legume to depend more on atmospheric N_2 fixation than when grown alone. It is not surprising however, that in general, the total N_2 fixed was greater in the sole-cropped legume, by virtue of the greater area it occuppied relative to that growing with grass. These results again confirm the importance of yield in determining the agronomic benefit to be derived through N_2 fixation. The lowered uptake of soil N by the mixed stand legume should certainly be one of the reasons behind grasses in mixed stands often having higher concentrations of N than those grown alone.

<u>Effect of management practices</u>

The most common factor that decreased both the % and total N_2 fixed was the level of soil or added N. Interestingly, the N-treated plants normally gave the same yields as those inoculated, indicating that N_2 in the fixation effectively substituted for the N from the fertilizer. For most areas, the greatest expanse of pastures occur on non-arable land, and on soils often very low in soil N. We thus do not expect much inhibition of N_2 fixation in many of these areas. All the same results were obtained showing that some species were capable of maintaining high levels of N_2 presence at high levels of inorganic N, and it should be possible to select legume species or cultivars for use on soils on which the initial N levels are high, without much sacrifice of N_2 fixed.

In the few cases where Rhizobium inoculation was examined, the results were variable. In some cases, inoculation was not necessary, in others, this was needed. The results obtained in one case are particularly interesting, in that in the same soil one medic genotype did not respond to inoculation but another showed great response. It can only be concluded that the need to inoculate cannot be generalized. What is required is to first carry out local tests not only for species (but because of cultivar strain specificities) for cultivars too.

In general, plant yield did not influence the proportion of the legume's N that was derived from fixation, i.e. the yield of plants could be increased or decreased without much effect on the N_2 fixation capacity. What was often most affected was the total N yield, which increased with increased dry matter production. In general, yields of many of the pasture legumes were often low, due to the influence of environmental factors like deficiencies of P, K, water, etc. It is therefore essential to ensure that limiting nutrients such as P and K that commonly affect herbage yields in most tropical soil are supplied, to harness the full benefits expected from N_2 fixation.

Nitrogen transfer

That a legume transfers part of its N to a non-fixing crop during growth still remains controversial, and could not be resolved by the inconsistent results obtained by participants in the programme, and from our own studies in Seibersdorf. Significant N transfer, sometimes in excess of 50 kg N/ha was measured in some cases, while none was detected in others, or under a different set of conditions or in a different season. The conclusion therefore is, even if N transfer from fixing crops to non-fixing crops occurs, the conditions under which this process is significant are ill-defined. Conditions leading to root and nodule turnover would of course make fixed N available to associated plants as would leaf tissue by the legume. However, some of the large estimates of N transferred seemed to be methodology-induced errors. For most reliable estimates of N transfer, it is essential to minimize the rate of decline in $^{15}N/^{14}N$ ratio in soil, e.g. through the use of ^{15}N labelled organic matter rather than an inorganic ^{15}N labelled fertilizer, so as to minimize any errors induced by mismatched N uptake patterns of the reference crops in the different cropping systems. In one such completed study, what would have been taken to represent a substantial transfer was reduced to negligible or no N transferred by adopting conditions that resulted in more stable $^{15}N/^{14}N$ over time. The data presented by the participants seem to indicate that the grass grown in association with a legume can benefit in terms of N gain. What is uncertain is, the mechanism repsonsible for this surplus gain.

The above is only a summary of the major findings of the programme. For more details on results of the topics outlined in this newsletter or others, that were not reported, please contact Dr. S.K.A. Danso, Joint FAO/IAEA, P.O.B. 100, Wagramerstrasse. 5 A-1400 Vienna, Austria.

TECHNICAL CO-OPERATION PROGRAMMES

1. General

Technical Co-operation projects generally address problems significant to improving agricultural productivity and practices in developing countries. The projects may range from developing stable agricultural/agroforestry systems on fragile soils to designing the most effective use of fertilizers. Indeed, our present activities cover such topics as establishment of isotope laboratory facilities, water management and irrigation, studies of erosion, biological nitrogen fixation, fertilizer uptake efficiency, use of saline soils, micronutrient requirements of crop plants, foliar fertilization usage and basic studies in plant physiology and soil microbiology.

In 1989 the Soils Section had the technical responsibility for some 65 projects in developing countries of the world. These are spread throughout Latin America, Asia and the Pacific, Africa, the Middle East and Europe; this number will increase in 1991. Most projects run for between 1 and 3 years, but sometimes longer. One innovation to make the programmes more effectively is, where appropriate, to group projects with a similar central theme from different countries in order to institute some rappart between these e.g. by having them serviced by the same expert and by attempting to have regional workshop/training courses. For example presently we have a regional programme on legume nitrogen fixation in Africa which will benefit the relevant national projects in the region. Similarly, a regional technical co-operation project was proposed to tackle soil fertility problems in Latin America under a wide diversity of ecosystems ranging from arid and semi-arid areas in the Pacific Coastal area to sub-tropical and tropical areas in the Amazon basin.

Technical co-operation projects can provide equipment (usually mainly for isotope work), expert assistance, and training for counterparts tenable in advanced laboratories. Application for a TC project is made via the relevant national authority, who assigns a priority to it. A technical evaluation is then made by the Agency, and consideration for funding is made in the last quarter of every 2 years Applications for 1993/1994 should be received in Vienna by late 1991, certainly in early 1992. We can supply further information and application forms on request.

2. The effect of changing land use on the ecology and climate of the Brazilian Amazon

IAEA project (BRA/0/010) known in Brazil as 'Amazonia I', is a large multi-disciplinary project now into its 5th year and is concerned with isotope-aided studies of the effects of changing land use on the ecology and climate of the Brazilian Amazon. The project is primarily concerned with investigating the water, carbon and nutrient cycles. It brings together scientists from a number of Brazilian institutes, but especially from the National Research Institute for the Amazon (INPA) in Manaus, the Centro de Energia Nuclear na Agricultura (CENA) in Piracicaba and EMBRAPA of the Centre for Agricultural and Livestock Research for the Humid Sub-Tropics (CPATU) in Belem.

The project is supported by the IAEA and substantially from the Swedish Agency for Research Co-operation with Developing Countries (SAREC). It receives technical back-up from the Joint Division of the IAEA and Food and Agriculture Organization and the Isotope Hydrology Section of the IAEA Division of Physical and Chemical Sciences. Within Brazil, the project is co-ordinated by the Comisao Nacional de Energia Nuclear (CNEN). Local funding comes from CNEN and the institutes involved.

In brief, the scientific objectives of the project are:

1. to study quantitatively the water, nitrogen, carbon dioxide and nutrient cycles in forest and cultivated ecosystems;

2. to seek better identification of the origin of water vapour producing precipitation (e.g., recycled or of Atlantic or Pacific origin) and to establish better water vapour circulation models in order to define the water economy of the region and how it might be affected by deforestation;

3. to indicate the changes to be expected in soil structure and fertility, and in the levels of important agricultural nutrients as a result of forest cleaning, and subsequent agricultural practice such as pasture, crop species, crop rotation and fertilizer use;

4. to quantify the changes to be expected in the quality of river and other derived water bodies as a result of forest clearance, e.g. effects of increased run-off; and

5. where appropriate to establish models for describing the changes in hydrological and nutrient cycles, and for predicting trends or changes expected in the future.

The long-term objective is to make available to the Government, information and data essential for the protection of the natural resources of the region and its long-term agricultural stability.

The Amazon Project has become the focus for much collaboration on research within Brazil and for collaboration with international groups such as SAREC (Sweden), the University of Washington (CAMREX Project) the Max Planck Institute of Limnology (Plön, Federal Republic of Germany), and University of Waterloo, (Canada).

In connection with the atmospheric water vapour and related studies, the accumulated ^{18}O isotope data has been reviewed and this so far confirms that water vapour is re-cycled in the Amazon, and that spillage of excess water vapour from the Basin finds its way south into central Brazil. The significance of this is that continued deforestation may break the existing re-cycling system, more water will go as run-off to the rivers and local temperatures will rise. This would affect local conditions and possibly result in less water vapour being available for export to the cerrados of central Brazil. This is under investigation.

A new basin-wide chain of precipitation stations has been installed and sample collection and isotope determination are underway. Studies are being carried out on water balance of hydrographic basins, determining infiltration and percolation of rain water in the soil surface using a tritium label (forest soil).

Work is attempting to quantify the effects of local deforestation on the micro-environment and to determine how far into the forest the effects extend from the margin of a remaining forest patch. The work is also examining the consequences of such micro-environmental changes for the water relations of understory plants. Studies have included soil moisture profiles using the neutron probe technique, and plant water relations.

Natural variation in stable isotopes of carbon, nitrogen, and sulphur are being used to trace the flow of energy through aquatic food webs. The most surprising discovery to date is the carbon-4 grasses, which account for more than half of the primary production in the Amazon floodplain, contribute very little energy to aquatic food webs. Phytoplankton which account for for much less of the total production - appear to be a much more important source of energy for 90% of the fish normally consumed.

Sedimentation and erosion studies utilizing environmental ^{210}Pb and ^{137}Cs are taking place in the Mamari and Jiparana rivers which drain

Rondonia, where much development is taking place. Preliminary results indicate a ten-fold increase in sedimentation during the last decade. This increase is directly correlated with increases in deforestation and mining.

A technique has been developed to determine growth rate of trees based on ^{14}C measurements of two segments of equal radial distance from the outer part of the tree trunk.

Work on the carbon cycle in the project has concentrated on soil organic matter studies. Changes in soil organic matter following deforestation and/or changes in land use, the significance of carbon-4 versus carbon-3 plants, and the CO_2 atmospheric phase of the carbon cycle are all receiving attention. Techniques using $^{13}C/^{12}C$ isotope ratio have been both pioneered and used extensively in the project. One year after clearing forest and planting to pasture the proportion of pasture derived carbon was 5% in the 0 to 20 centimeter layer, while after 2 years it was 20% and about 40% of carbon derived from forest had disappeared. Decomposition rates of litter have been determined.

The undisturbed Amazon forest is assumed to have reached biological equilibrium, particularly with respect to nitrogen, visual signs of nitrogen deficiency, even on the varzea soils, are seldom evident. The prime objective of work on the nitrogen cycle is to quantify the undisturbed nitrogen cycle and document changes in the cycle brought about as a result of alternative land use. Stable isotope methodology using both enriched and natural levels of ^{15}N are being used. A range of experiments are in progress, including the fate of nitrogen applied to upland rice. Other studies will assist in arriving at estimates of input of nitrogen into the nitrogen cycle through biological nitrogen fixation.

In primary production studies work in the project has concentrated on primary production of surface waters of lakes using the ^{14}C incubation method. Efforts are being made to extend detailed primary production studies to the various types of forest and other terrestrial systems. However, progress is severely limited by funding constraints, despite the importance of the topic.

This has been a very brief review of the project. It shows the range of topics being undertaken , and indicates that isotopes are virtually indispensable for understanding many of the major environmental systems and problems. The Amazon, represents 20% of the world's fresh water. The scale of the Amazon System is enormous, but the present project shows that broken down into separate researchable pieces, with the expertise of many institutes and individuals, and good organization, the problems of understanding the Amazon system are capable of solution.

FROM OUR READERS

We invite scientists to send us copies of their papers where isotope and nuclear methods are used - not only for our own information, but for the information of our readers.

1. <u>The use of neutron moisture gauge in soil physics research</u>
   Ilia Christov
   Pushkarov Institute of Soil Science and Yield Programming, Sofia, Bulgaria and
   Burmaa Badral
   Research Institute for Plant Growing and Farming, Darhan, Mongolia

Calibration of a Troxler neutron moisture gauge for calcareous chernozem soil was done using 120 experimental measurement sites in field conditions. The results showed that the calibration curve provided by the manufacturer over estimates of the soil mositure by 4.91 to 5.56%.

The following were studied: (a) the root activity distribution during the vegetation period of maize, (b) wetting depth of soil under different sprinkling irrigation intensities, (c) evaluation of the residual soil moisture supply at the start of the growing season under different soil water regimes maintained in the previous year, (d) irrigation scheduling based on different water status during the vegetation period of maize.

2. A physical model for determination of the effect of moisture distribution irregularity in soil profile on the measurements carried out by a neutron moisture gauge.

Ilia Christov
Pushkarov Institute of Soil Science and Yield Programming, Sofia, Bulgaria

A physical model, accounting the effect of moisture distribution irregularity in the soil profile on the measurements made by a neutron gauge, was developed. Some basic cases with practical importance for the application of the method have been studied. A numerical evaluation of the effect has been made by comparing 'differential' and 'integral' values of the volume moisture at special water profile points. It has been found that depending on the degree of irregularity (accounting through assigning an index) within the zone of influence for the neutron probe, the indicated effect considerably increases or decreases the measured moisture, especially near a wetting front. The method can be used in soil physics and hydrology.

SOME PAPERS WE HAVE NOTICED

1. Phillips, F.M., Mattick, J.L., Duval, T.A., Elmore, D., Kubik, P.W. 1988. Chlorine 36 and tritium from nuclear weapons fallout as tracers for long-term liquid and vapor movement in desert soils. Water Resources Res., 24-1877-1891.

Chlorine 36 and ^{3}H have been widely used as laboratory tracers for the advection and dispersion of anionic solutes and water, respectively. Advances in accelerator mass spectrometry have recently made possible the analysis of ^{36}Cl in natural soil water samples. Field investigations analogous to the laboratory experiments can now be conducted. Pulses of ^{36}Cl and ^{3}H released into the atmosphere by nuclear weapons testing in the 1950s and 1960s serve as the tracers. We report ^{36}Cl and ^{3}H measurements on desert soil profiles from New Mexico. In both cases where the two tracers were measured in the same profile, the ^{3}H bomb pulse had penetrated between 1 and 3m, but much of the ^{36}Cl was retained near the soil surface. In contrast, the laboratory experiments usually show more rapid movement of ^{36}Cl than ^{3}H due to the anion exclusion effect. We attribute the difference to the lower water content, fluctuating temperature gradients, and longer time scale of the field situation, which may enhance vapor movement of the tritiated water relative to solute advection of the ^{36}Cl. The spreading of the ^{36}Cl and ^{3}H pulses may be modelled by dispersivities ranging from 5 to 8 cm, much larger than most corresponding laboratory values. These larger apparent dispersivities are probably more a result of vertical velocity fields varying with depth and time than of soil heterogeneity. These results illustrate how the bomb pulse ^{36}Cl and ^{3}H can be useful links between laboratory solute transport studies and the corresponding field applications.

2. Sahrawat, K.L. 1988. Use of ^{15}N in nitrification inhibitor studies with special reference to indigenous materials. J. Nuclear Agric. Biol., 17:238-242.

Non-edible oil seed cakes and their constituents have been advantageously used for increasing the efficiency of fertilizer nitrogen (N) for crop production. The beneficial effects of these materials have been attributed to retardation of nitrification, which lessen the loss of N associated with nitrification by leaching and denitrification in situations where these losses are high. However, it is possible that some of the effects of these materials could be due to immobilization-remineralization of N particularly when the carbonaceous materials are added with fertilizers at high rates. A methodology involving the use of ^{15}N-labelled fertilizers is advanced to sort out whether the beneficial effects of non-edible oil seed cakes and other materials are due to retardation of nitrification and or immobilization-remineralization of fertilizer N. Using the proposed technique it would be possible to make realistic evaluation of the wealth of indigenous products as nitrification inhibitors. Following the proposed approach it would also be possible to widen the scope and depth of research in this area for ultimately better exploitation of indigenous materials as nitrification inhibitors.

3. John, P.S., Buresh, R.J., Prasad, R., Pandey, R.K. 1989. Nitrogen gas (N_2+N^2O) flux from urea applied to lowland rice as affected by green manure. Plant and Soil, 119:7-13.

A field study was conducted on a clay soil (Andaqueptic Haplaquoll) in the Philippines to directly measure the evolution of (N_2+N^2O) ^{15}N-labelled urea broadcast at 29kg N ha^{-1} into 0.05-m-deep floodwater at 15 days after transplanting (DT) rice. The flux of (N^2+N_2O) ^{15}N during the 19 days following urea application never exceeded 28 g N ha^{-1}. The total recovery of (N_2+N_2O)-^{15}N evolved from the field was only 0.51% of the applied N, whereas total gaseous ^{15}N loss estimated from unrecoverd ^{15}N in the ^{15}N balance was 41% of the applied N. Floodwater (nitrate + nitrite)-N in the 5 days following urea application never exceeded 0.14g N m^{-3} or 0.3% of the applied N. Prior cropping of cowpea [Vigna unguiculata (1.) Walp.] to flowering with subsequent incorporation of the green manure (dry matter = 2.5Mg ha^{-1}, C/N = 15) at 15 days before rice transplanting had no effect on fate of urea applied to rice at 15 DT. The recovery of (N_2 +N_2O)-^{15}N loss during the 19 days following urea application were 0.46 and 40%, respectively. Direct recovery of evolved (N_2+N_2O)-^{15}N and total ^{15}N loss from 27kg applied nitrate-N ha^{-1} were 20% and 53% during the same 19-day period. The failure of directly-recovered (N_2+N_2O)-^{15}N to match total ^{15}N loss from added nitrate-^{15}N might be due to entrament of denitrification end products in soil or transport of gaseous end products to the atmosphere through rice plants. The rapid conversion of added nitrate-N (N_2+N_2O)-N, the apparently sufficient water soluble soil organic C for denitrification (101 µg C g^{-1} in the top 0.15-m soil layer), and the low flood water nitrate following urea application suggested that denitrification loss from urea was controlled by supply of nitrate rather than by availability of organic C.

4. Douglas, L.A., Weaver, R.W. 1989. Partitioning of biological fixed nitrogen in cowpea during pod development. Plant and Soil, 116:129-131.

Two days after exposure of roots to ^{15}N labelled N_2, partitioning of biologically fixed N into leaves, stems, peduncles, pods, roots and nodules was measured in the early pod development stage of cowpea (Vigna unquiculata L.). The experimental objective was to determine the quantity of biologically fixed N that is incorporated into vegetative tissue before being mobilized to pods. For the three varieties of cowpea included in the experiment a maximum of 50% of the N, biologically fixed two days earlier, was contained in the pods. The remaining N was distributed throughout the vegetative portion of the plant with at least 30% in stems and leaves which indicates that much of the newly fixed N must cycle through a N pool in these tissues before reaching the pods.

5. Cheshire, M.U., Christensen, B.T., Sorensen, L.H. 1990. Labelled and native sugars in particle-size fractions from soils incubated with ^{14}C straw for 6 to 18 years. Journal of Soil Sci., 41:29-39.

Four soils of different texture (6% to 46% clay and 6% to 32% silt) were incubated with ^{14}C-labelled barley straw for periods ranging from 16 to 18 years. Incubations were eith under laboratory (three soils, 20°C) or field conditions (one soil).

Soils samples were separated into clay-size (<2 µm), silt-size (2-20 µm) and sand-size (20-2000 µm) fractions using ultrasonic dispersion and gravity sedimentation. Whole soils and size fractions were hydrolyzed with 12 M sulphuric acid, the released neutral sugars isolated and their amounts and specific activities determined.

The proportion of C present as carbohydrate decreased in the order: clay, silt and sand, but the sugar compositions of the various fractions were similar. No relationship could be descerned between the soil particle-size distributions and the persistence of sugars.

The specific activity of xylose remained higher than that of any major sugar, indicating the persistence of straw polysaccharides. This was true for all soils and size fractions. Galactose and mannose retained a greater proportion of their initial activity than did arabinose, xylose or glucose. This was ascribed to synthesis of microbial polyaccharides.

Total activity present in whole soils decreased in the order glucose, xylose and arabinose, galactose and mannose. The total activity of individual sugars in size fractions decreased in the order clay, silt, sand. The hexose to pentose ratio (galactose+mannose to arabinose+xylose) tended to be higher for silt than for clay, but the trend was not consistent for all soils.

6. Hall, A.E., Mutters, R.G., Hubick, K.T., Farquhar, G.D. 1990. Genotypic differences in carbon isotope discrimination by cowpea under wet and dry field conditions. Crop Sci., 30:300-305.

Theory and empirical evidence have demonstrated that ^{13}C discrimination (Δ) by leaves of C_3 plants may be associated with intrinsic water-use efficiency or productivity. Consequently, selection for Δ has potential value in breeding plants with improved adaptation. This study evaluates genotypic differences in Δ among cowpea [Vigna unguiculata (L/) Walp.] and genotype x drought level interactions, and compares Δ measured in leaves and grains. Sixty cowpea accessions were subjected to drought by growing them on stored soil moisture in six randomized blocks, and genotypes differed significantly ($P<0.001$) in leaf Δ. Seventeen cowpea accessions were grown under weekly irrigation (wet) and stored moisture (dry) conditions in four randomized-split blocks. Genotypes differed significantly in Δ under both conditions using either leaves or grains. Plants under dry conditions had lower Δ, which theory predicted could be associated with 62% higher water-use efficiency. The same plants showed a 62% higher ratio of CO_2 assimilation rate to leaf diffusive conductance. Genotypic rankings for Δ were similar under wet and dry conditions for most genotypes, but a significant ($P < 0.05$) genotype x drought interaction was observed, which was mainly due to one genotype. Correlations between Δ in grain and subtending leaves were highly significant ($P < 0.001$), but two genotypes exhibited substantial differences in ranking for Δ determined in grain compared with leaves. Genotypic differences were more readily detected in leaves than grains with broad sense heritabilities of 0.76 and 0.35, respectively. Heritabilities were similar under wet and dry conditions.

TRAINING MANUAL

A new training manual "Use of nuclear techniques in studies of soil-plant relationship", Training Course Series No. 2, Ed. G. Hardarson, was published by the IAEA in May 1990.

The contents are:

Stable and radioactive isotope
    H. Axmann, F. Zapata
Field experimentation in isotope-aided studies
    F. Zapata
Sample preparation techniques of biological material for isotope analysis
    H. Axmann, A. Sebastianelli, J.L. Arrillaga
Methods for ^{15}N determination
    H. Axmann
Isotope techniques in soil fertility and plant nutrition studies
    F. Zapata
Use of ^{15}N methodology to assess biological nitrogen fixation
    G. Hardarson, S.K.A. Danso
Techniques in studies of photosyntheses
    K.S. Kumarasinghe
Use of neutron water and gamma density gauges in soil water studies
    C. Kirda

We like to inform you that a Spanish version of the manual will also be available in the near future.

Request for the copies of the manual in English should be sent to Soil Fertility, Irrigation and Crop Production Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture or Soil Science Unit, Agency's Laboratories A-2444 Seibersdorf, Austria.

TRAINING COURSES

1. <u>The training course held at the IAEA's Laboratories, Austria.</u>

This year's FAO/IAEA Interregional Training Course on the use of isotope and radiation techniques in studies on soil-plant relationships with emphasis on soil water management was held from 28 May to 4 July 1990 at the Agency's Laboratories, Seibersdorf near Vienna, Austria. Following the pattern of the last two years, the course content consisted of a central core (nuclear techniques in soil/plant research) plus particular emphasis on an important topic. This year the course focussed on the management of soil water resources particularly in arid and semi-arid areas for increased crop productivity. Among the subjects dealing with soil water management the following were included: basic concepts in measuring soil water status, Theory and use of neutron moisture and gamma density gauges, Estimate of plant water consumption, based on water balance approach, using neutron moisture gauges, Measurement of soil hydraulic properties, Irrigation scheduling with computer simulation of crop water requirement, Use of isotopes in solute transport and fertilizer leaching problems, Spatial field variability and new concepts in field experiment design, Soil water management in desert soils and Isotope hydrology and irrigation works.

Twenty participants from Argentina, Bangladesh, Bolivia, Brazil, Cote d'Ivoire, Cuba, Egypt, Ghana, Guatemala, India, Indonesia, Iraq, Jordan, Mexico, Portugal, Romania, Sierra Leone, Sudan, Turkey , and Uganda successfully concluded the training. Those 20 participants were selected from over 100 applications. Some participants were irrigation science and soil physics specialists, while others were more agronomy oriented.

As invited lecturers we had the excellent contributions of Drs. K. Buchtela (Austria), D.R. Nielsen (USA), G. Vachaud (France), D.L. Lawlor (UK), H. Haunold (Austria), M. de Boodt (Belgium) and M. Smith (FAO).

2. FAO/IAEA Interregional Training Course on the use of isotope and radiation techniques in studies of soil/plant relationships.
Tbilisi, Georgia, USSR, May/June 1991.
(Technical officer: Saliya Kumarasinghe)

This training course is planned to be held at the Agricultural Radiobiological Scientific Research Institute in Tbilisi, Georgia SSR in collaboration with the Academy of Agricultural Sciences. The course is being organized to assist the participants from Member States to acquire a sound working knowledge of the use and applications of isotopes and relevant nuclear techniques in studies of plant nutrition, soil fertility and crop production. The language of the course will be English. The official announcement of this course will be issued to the relevant Government authorities in each country sometime around November 1990.

CONFERENCE

The 13th North American Symbiotic Nitrogen Fixation Conference will be held from August 25-30, 1991, at Banff, Canada. Contact persons are: L. Nelson, Plant Biotechnology Institute, Saskatoon, SK, Canada, (306) 975-5583, and C. van Kessel, Dept. of Soil Science, Univ. of Saskatchewan, Saskatoon, SK, Canada, (306)966-6854, FAX.(306)966-6881.

Notes from our readers for consideration for the next issue of the Soils Newsletter should reach us by October 31, 1990.

Soils Newsletter
Joint FAO/IAEA Division
of Nuclear Techniques in Food and Agriculture
International Atomic Energy Agency

Wagramerstrasse 5, P.O. Box 100
A-1400 Vienna, Austria

Printed by the IAEA Austria
July 1990

90-02625