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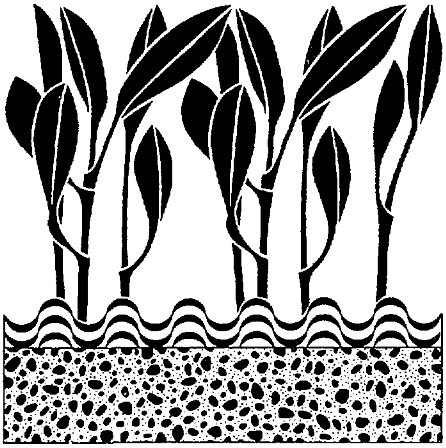

Soils Newsletter

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

Vol. 8, No. 1 January 1985

1. TO OUR READERS

Rightly this newsletter should be the second in Vol 7, that is No.2 for 1984. However the extremely busy end of last year in the Section meant that it could not be produced before December so we have decided to designate this one as the first for 1985. Consequently it may be a little "fatter" than usual.

In addition the Section has decided to include more detailed information on our own and our collaborator's research. Specifically, abstracts of some of the papers published by staff, or presented by them at scientific meetings, have been reprinted here. We hope to be able to continue the practice and would welcome abstracts from you, our readers, for inclusion in subsequent issues of the Newsletter. We ask however that the following requirements are 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,
b) not exceed 200 words,
c) be typewritten, double-spaced, and
d) 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. If the response to this initiative is overwhelming the Section will decide which of those submitted will be placed in the next issue, the remainder being held over for a subsequent time. Our purpose in making this change is quite simple. We wish to stimulate the exchange of ideas among our readership, especially between those working with adequate resources in more developed countries and those in less developed areas of the world where both resources and outside contact is limited.

2. STAFF

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3. CONSULTATIVE MEETING ON FUTURE TRENDS IN FAO AND IAEA PROGRAMMES IN AGRICULTURAL BIOTECHNOLOGY. Vienna, 17-19 October 1984.

The meeting comprised a group of consultants from Austria, Canada, Italy, Hungary, USA, UK and Australia together with, representatives of different substantive divisions of FAO Rome and members of all sections of the Joint FAO/IAEA Division. Advances in a broad range of agricultural biotechnolgies were considered, areas of relevance to improving productivity were identified and specific recommendations for implementing transfer of the necessary knowledge to agricultural scientists in developing countries were made.

Co-operation between the substantive divisions of FAO in Rome and the Joint FAO/IAEA Division, particularly in the area of training, was emphasized as an effective and readily implemented means to transfer biotechnological methods for use in research programmes of developing countries. Improved facilities and a wider role for the FAO/IAEA Agricultural Biotechnology Unit, Seibersdorf in providing training, through courses and fellowships, were supported.

Of particular relevance to the Soils Section's work were a series of recommendations relating to Biological Nitrogen Fixation (BNF). The exploitation of this process, either in close or loose association with crop plants, was seen as a biotechnology with immediate application in developing countries. Continued work should emphasize the development of techniques to evaluate BNF in the field, the development and evaluation of methods for storing and utilizing bacterial and other soil microbial isolates, the use of small fermentor technology for culturing microbial inoculants and development of methods for regeneration of economically-important legume species from single cell and tissue culture. This latter was viewed as necessary for progress in the practical application of genetic engineering for enhancing N_2 fixation or improving legume yield.

4. ONGOING COORDINATED RESEARCH PROGRAMMES

4.1. CRP on the Use of Nuclear Techniques in Development of Fertilizer and Water Management Practices for Multiple Cropping Systems.

During 1984 most of the contractors in this proramme have completed a second year (crop) field experiment, the main purpose of which was to compare

Table 1 — First crop experiment

Treatment no.	Dry matter yield (kg/ha)		Total N and P yields (kg/ha)		% Fert. N. utilization	NdfFix (%)		Total uptake of N (kg/Ha) from:		
	Grain	Stover	N	P		Grain	Stover	Fert.	Fix	Soil
1. Soybean Orba P_{30} N_{20}*	1278	1955	81.8	9.6	20.1	38.6	45.6	4.02	32.78	45.00
2. Soybean Orba P_0 N_{20}*	917	1744	63.8	7.7	14.3	48.1	36.9	2.86	29.36	31.58
3. Soybean Lokon P_{30} N_{20}*	770	1669	35,9	6.8	9,2	36.4	30.1	1.83	12.85	21.21
4. Soybean Lokon P_0 N_{20}*	735	1535	34.1	7.2	9.2	42.0	26.2	1.83	13.20	19.09
5. Maize P_{30} N_{20}	1532	1526	27.5	6.7	–	–	–	–	–	–
6. Maize P_{30} N_{60}	1879	1832	33.8	7.8	–	–	–	–	–	–
7. Maize P_0 N_{20}	1263	1040	21.3	5.7	–	–	–	–	–	–
8. Maize P_0 N_{60}	1641	1438	30.0	6.3	–	–	–	–	–	–
H.S.D. Fert 5 %	123.1	85.2	3.3	–	2.9	4.8	5.2	0.56	n S.	4.53
1 %	165.8	114.7	4.5	–	n.S.	6.6	7.2	n.S.	n.S.	6.28
C.V. (%)	16.68	9.06	13.89	–	24.52	13.38	17.21	24.52	14.66	17.86

n.s. = not significant

N and P "A-values" of soil when the preceeding crop was either a legume or cereal. However some of the contractors had already completed both experiments in the one year period (two seasons). The results of the two experiments conducted in Indonesia are given below. The plants (soybean-varieties: Orba and Lokon and non-nodulating Chipewa as control, and maize-variety: Arjuna) were sown on March 22, 1983 and harvested in two terms (soybean varieties Lokon and Chipewa on June 7 and soybean Orba and maize on June 18). The results of the first crop experiment including dry matter, P and N, yields, NdfFix and uptake of N from different sources are shown in Table 1.

The contractor concluded that highly significant differences occurred between soybean varieties in plant dry weight, utilization of fertilizer N and the amount of N fixed. For Lokon there was no significant influence of P-fertilizer on plant dry weight, utilization of fertilizer N or fixation. But for Orba there was a significant influence on N-uptake and utilization of fertilizer-N.

The results of the second crop (maize) experiment are shown in Table 2. The previous crops (corn or soybean) had a significant effect on the growth of the second crop as did application of P-fertilizer in the previous season. Soil-P uptake was 10,64 kg $P.ha^{-1}$ when the previous crop was soybean and 8,76 kg P/ha when the previous crop was maize. But apparently the A-value was only influenced by P-fertilizer added in the preceeding season. Maize and soybean in the previous season did not significantly influence the % of N in the plant derived from fertilizer, fertilizer N-uptake, fertilizer-N utilization ond A-value.

4.2. CRP on the Use of Nuclear Techniques in Improving Pasture Management

The second Research Coordination Meeting (RCM) of this programme, which is now in its third year, was held in Vienna from 26-30 November 1984. It was attended by 25 participants from Brazil, China, Cyprus, Greece, Iceland, India, Kenya, Malaysia, New Zealand, Peru, Spain, Sri Lanka, Sudan Switzerland, United Kingdom, Uruguay, and Colombia.

The major research objectives being tackled by the group have been:

1. To develop suitable techniques for quantifying N_2 fixed by pasture legumes and,
2. To establish suitable management practices which optimise the yield and N_2 fixed in legume-grass mixtures.

Earlier studies, using N-15 to estimate N_2 fixed in pastures subjected to periodic cutting, had employed either highly enriched fertilizer, or heavy doses of N, or a combination of these applied at establishment. These

Table 2 — Second crop experiment

(Maize after soya treatments Ns 1-4 and maize after maize treatments Ns 5-8)

Treatment no.	Dry matter yield (kg/ha)		Total N and P yields (kg/ha)		Uptake of Fert.N and P (kg/ha)		% Fert. N and P. utilization		A-value of soil (Kg/ha)	
	Grain	Stover	N	P	N	P	N	P	N	P
1. P^*_{30} N^*_{60} (previous year P_{30} N_{20})	2066	2959	42.8	12.7	14.79	1.60	24.65	5.34	114.84	214.16
2. P^*_{30} N_{60} (P_0 N_{20})	1923	2649	43.9	12.3	-	0.91	-	3.02	-	384.99
3. P^*_{30} N^*_{60} (P_{30} N_{20})	1866	2761	45.2	12.3	15.03	1.70	25.05	5.65	120.81	195.90
4. P^*_{30} N_{60} (P_0 N_{20})	1841	2603	40.6	10.5	-	0.94	-	3.14	-	313.44
5. P^*_{30} N^*_{60} (P_{30} N_{20})	1768	2458	40.7	10.4	13.82	1.06	23.02	3.52	116.25	279.06
6. P^*_{30} N^*_{60} (P_{30} N_{60})	1530	2476	37.7	9.4	13.88	1.12	23.13	3.72	104.38	226.08
7. P^*_{30} N_{60} (P_0 N_{20})	1462	2454	34.1	9.2	-	0.94	-	3.13	-	268.02
8. P^*_{30} N_{60} (P_0 N_{60})	1553	2449	38.0	10.2	-	1.02	-	3.40	-	276.55
H.S.D. Fert 5 %	123.1	85.2	3.3	-	2.9	4.8	5.2	0.56	n S.	4.53
1 %	165.8	114.7	4.5	-	n.S.	6.6	7.2	n.S.	n.S.	6.28
C.V. (%)	16.68	9.06	13.89	-	24.52	13.38	17.21	24.52	14.66	17.86

methods were expensive and the amounts used were often sufficient to significantly reduce fixation by many legumes. While the level of detection of N-15 in plants in early harvests may have been high, N turnover processes in soil often resulted in less available N-15 for later harvests, thereby reducing the precision of N fixation estimates. For these reasons the programme has examined other methods of N-15 application to estimate N_2 fixed in pastures.

TABLE 3. Evaluation of methods of N-15 application to estimate N_2 fixed in consecutive harvests of alfalfa-ryegrass mixtures at Seibersdorf.

		N application (kg N/ha)			
	%N-15	1st year		2nd year	
Method	a.e.	T_1	T_2	T_3	T_4
1a	50.0	5*	5	5	5
1b	50.0	5	5*	5	5
1c	50.0	5	5	5*	5
1d	50.0	5	5	5	5*
2	5.7	5*	5*	5*	5*
3	16.7	5*	5	5*	5
4	5.7	45*	0	0	0

T_1 = At establishment
T_2 = After first harvest
T_3 = Spring, at the beginning of growth
T_4 = After first harvest in second year
* N-15 labelled fertilizer application

The initial experiments on methods of N-15 application at the Seibersdorf laboratory examined four methods (Table 3). In Method 1, a small dose, 5kg N/ha, of 50 % N-15 atom excess (a.e.) ammonium sulphate was applied to a separate sub-plot at the beginning of the experiment and to a new subplot after each harvest. Sub-plots which did not receive labelled fertilizer at any given period were fertilized with 5 kg N/ha of ordinary ammonium sulphate. Method 2 involved the application only 5 kg N/ha of low N-15 enrichment (5.7 % N-15 a.e.) ammonium sulphate to a sub-plot at the beginning of the study and again to the same sub-plot after each harvest. With method 3, 5 kg N/ha of 16.7 % N-15 a.e. ammonium sulphate was applied as a starter dose and only applied again after the 2nd harvest. Thus N-15 fertilizer was not applied to the re-growth following the 1st and 3rd harvests which instead received 5 kg unlabelled ammonium sulphate. In method 4, 45 kg N/ha of 5.7 % N-15 a.e. ammonium sulphate was applied at establishment no N application thereafter.

TABLE 4. Percent N in alfalfa derived from N_2 fixation (% Ndfa) using methods outlined in Table 3.

Method	% Ndfa 1st year H_1^*	H_2	2nd year H_3	H_4
1a	88	92	90	75
1b	-	92	93	78
1c	-	-	93	86
1d	-	-	-	85
2	86	89	91	84
3	90	93	93	85
4	79	86	90	71

* H_1 - H_4 = Harvests

The results shown in Table 4 indicate that Methods 2 and 3 were suitable for assessing N_2 fixed by pasture legumes subjected to periodic cutting. These methods offer the special advantage of reduced costs, high precision and in each case the relatively small amounts of N added had little effect on N_2 fixation.

In the next issue of the Newsletter, we hope to present some of the results using these methods which have been obtained by participants of the programme in various Member States. If you have any comments or your own results which you would like to bring to our notice, please write to S.K.A. Danso, project officer for the programme.

4.3. Studies of Nitrogen Fixation and Nitrogen Cycling in Azolla and Blue-green Algae

The first meeting in the *Azolla* and blue-green algae coordinated research programme was held at the Vienna International Centre from December 10-14, 1984. The meeting was attended by contractors, agreement holders and consultants from 18 countries and international organizations.

The main emphasis in the programme is being placed on developing management techniques to improve the availability of *Azolla*-N to rice. This reflects the opinion of the participants in the meeting that the chances of successfully using *Azolla* to enhance rice yields was greater than with free-living blue-green algae.

Two major research problems which require more attention became apparent during the meeting. Most experiments to date on *Azolla*-N recovery by rice have shown 20-30% recovery, and only minimal recovery by subsequent crops. Little N balance work has been done to determine the fate of the unrecovered N. Is it still in the soil, or is it lost through enhanced denitrification caused by the extra carbon source supplied by incorporating Azolla?

The second problem is the effect of the age of the Azolla plants on N availability. Although Azolla is relatively rich in protein, animal feeding studies have shown a remarkably low digestibility. The cellulose content increases with age and, in Azolla filiculoides, lignin increases from 3 to 24 %. At the moment we have no idea how these changes affect the fertilizer value of Azolla and future experiments will obviously focus on these important points. Readers who may have information pertinent to these problems are requested to write to D.L. Eskew, project officer for the programme.

Although it will not be possible to take any more contractors in the coordinated research programme, it is still possible to participate through the IAEA fellowship programme. Several of the participating research institutes have indicated that they would be able to take fellows into their laboratories for training. Among the possibilities are, Dr. I. Watanabe, IRRI; Dr. Liu Chung Chu, Fujian Academy of Agricultural Scienes, China; Dr. K. Malik, Nuclear Institute of Agricultural Biology, Faisalabad, Pakistan; and of course the FAO/IAEA Seibersdorf Agricultural Biotechnology Laboratory. in Austria. Prospective fellows should contact the Head, Soil Fertility, Irrigation and Crop Production Section directly.

Experiments conducted in the summer of 1984 in collaboration with the Research Institute for Irrigation in Szarvas, Hungary, again indicated that Azolla N is equivalent to Urea-N as a source of N to paddy rice. Azolla N added 30 days after the first addition was recovered by rice with the same efficiency as the first addition. Application of 96 kg N/ha as Azolla caroliniana increased grain yield by 140%, while 60 kg N/ha as urea resulted in a 100% increase. (Table 5).

A time course study of uptake of N from Azolla and urea (Table 6) showed that the greatest uptake of urea-N had occurred by 30 days after incorporation, but the major uptake from Azolla occurred between 30 and 60 days. These data suggest that N from Urea and Azolla may have different physiological effects on rice growth and yield and may in fact complement each other. However, these results were from experiments in a temperate zone rice field, and results under tropical conditions may be quite different. Investigations of this sort form the "core" experiments of our co-ordinated research programme so we expect to have data relevant to the major tropical rice-growing areas of the world in the near future.

TABLE 5. Yield response of rice and recovery of N applied as Azolla or urea.

Treatment	Dry Matter Yield ($t.ha^{-1}$)	Total N Yield ($kg.ha^{-1}$)	Fertilizer N Recovery (%)
1.Azolla, 96 kg $^{15}N.ha^{-1}$.	8.5 ± 1.1**	75.0 ± 8.4	21 ± 4
2.Urea, 60 kg ^{15}N ha^{-1}.	6.7 ± 1.1	60.5 ± 8.0	14 ± 4
3.Azolla, 50 kg $N.ha^{-1}$ + 55 kg $^{15}N.ha^{-1}$ 30 days later.	8.7 ± 1.1	83.2 ± 8.1	22 ± 4
4.Control*	3.6 ± 0.6	38 ± 5.1	-

* no addition, ** $\bar{x}$ ± SE (n = 4).
*** Recovery from Azolla added 30 day after first addition.

Table 6. Time course of N uptake from Azolla and urea by rice.

Harvest DAF*	Dry Matter Yield ($kg\ ha^{-1}$)	Total N Yield ($kg\ ha^{-1}$)	NdfF*** (%)	Fertilizer N Recovery (%)
Azolla, 96 kg N ha^{-1}				
30	195 ± 55**	6.6 ± 1.8	48 + 4	4 ± 2
60	2836 ± 383	43.2 ± 4.8	40 ± 3	18 ± 2
125	8500 ± 1250	75.0 ± 8.4	27 ± 3	21 ± 4
Urea, 60 kg N ha^{-1}				
30	364 ± 84	11.7 ± 2.8	59 ± 4	12 ± 3
60	2628 ± 517	33.6 ± 6.8	31 ± 1	17 ± 4
125	6700 ± 1100	60.5 ± 8.0	13 ± 3	14 ± 4

* DAF - Days after fertilizer application ** $\bar{x}$ ± SE (n = 4)
*** % N derived from fertilizer.

5. PLANNED CO-ORDINATED RESEARCH PROGRAMMES

Readers will be aware that in the previous few issues of Soils Newsletter a number of co-ordinated research programmes were described as being planned. These include: -

a. Improvement of the capability of the grain legume-*Rhizobium* symbiosis to fix atmospheric nitrogen.

b. Nuclear techniques to improve crop production in salt-affected soils.

- which have been approved by the IAEA for initiation, together with -

c. Nuclear techniques in tree fertilization, and

d. Nuclear techniques in studies of rock phosphate utilization,

- which are at a more formative stage.

In common with many national and international organizations the Joint FAO/IAEA Division, and its Soils Section, is working with a "zero-growth" budget and this has meant that our plans in the above areas have been temporarily slowed down. At present the generosity and far-sightedness of the Italian Government and the Swedish Government, through SIDA, have supported our Pasture and Azolla programmes, respectively. We hope that we can attract significant funding from other international organizations or national governments to support our work and that the planned programmes will not be "shelved" for long.

6. TECHNICAL COOPERATION PROGRAMMES.

The Soils Section has, in 1985, the technical responsibility for more than 50 projects in developing countries of the world. These are spread throughout Latin America, Asia and the Pacific, Africa, the Middle East and Europe. Their scope ranges from establishment of isotope laboratory facilities, to projects of water management and irrigation, studies of erosion, BNF, fertilizer efficiency, exploitation of saline soils, micronutrient requirements of crop plants, foliar fertilizer usage and basic studies in plant physiology and soil microbiology. These projects, which constitute a significant means of transferring techniques and equipment to research institutes and individual scientists in developing countries, generally address problems which are signficant to improving agricultural productivity. As technical officers in charge of these projects, the staff of the soils section are continuously seeking to recruit "experts" for short technical assistance missions (a few weeks to months). If you feel your qualifications and experience, particularly in the use of nuclear or isotope techniques, could be of value to our projects, please get in touch with the Head, Soil Fertility, Irrigation and Crop Production Section as soon as possible. Our range of activities in this area has become so broad we can probably find a mission suitable for you!

7. ACTIVITIES IN THE FAO/IAEA AGRICULTURAL BIOTECHNOLOGY LABORATORY, SEIBERSDORF, AUSTRIA.

7.1 Research in Nitrogen Fixation

During 1984 research projects were carried out to assist ongoing Co-ordinated Research Programmes, which are described in item 4 of this newsletter. The following series of abstracts may give the reader a broad idea of the results obtained under these projects:

Selection for nitrogen fixation associative traits in legumes. G. Hardarson. This paper describes investigations carried out to develop screening procedures to select for plant characteristics associated with symbiotic nitrogen fixation. The procedures described are to select for early nodulation, effectiveness in nitrogen fixation, and uniform nodulation by an effective strain of *Rhizobium*. The use of the acetylene reduction technique to select for nitrogenase activity and its correlation with other plant traits is discussed. The use of nuclear techniques to increase genetic variability in legumes and to evaluate legume germplasms bred for nitrogen fixation associative traits is also discussed in the context of crop improvement. (In: "Selection in Mutation Breeding", IAEA, Panel Proceedings Series, Vienna, 1984, 97-105.)

Field evaluation of symbiotic nitrogen fixation by rhizobial strains using ^{15}N methdology. G. Hardarson, F. Zapata and S.K.A. Danso. Small differences in N_2 fixation by nodulated soybeans (*Glycine max*. (L.) Merr.), inoculated with various strains of *Rhizobium japonicum*, were assessed in field experiments using ^{15}N methodology, and compared with yields of plant dry matter and total N. Percentage of plant-N derived from atmospheric N_2 and from fertilizer, and values of % ^{15}N atom excess had lower coefficients of variation than did total N and dry matter yield. Nevertheless the precision of estimates of Kg N/ha fixed were sufficient to differentiate only the extremes of the range of strains tested, and there were discrepancies between ranking of strains based on % N derived from fertilizer and on total N yield. (In Plant and Soil 82, 369-376 (1984).)

Effect of plant genotype and nitrogen fertilizer on symbiotic nitrogen fixation by soybean cultivars. G. Hardarson, F. Zapata and

S.K.A. Danso. Isotopic as well as non-isotopic methods were used to assess symbiotic N_2 fixation within eight soybean [*Glycine max* (L.) Merr.] cultivars grown at 20 and 100 kg N/ha levels of N fertilizer under field conditions.

The ^{15}N methodology revealed large differences between soybean cultivars in their abilities to support N_2 fixation. In almost all cases, the application of 100 kg N/ha resulted in lower N_2 fixed in soybean than at 20 kg N/ha in the first year of the study. However, N_2 fixed in one cultivar, Dunadja, was not significantly affected by the higher rate of N fertilizer application. These results were confirmed by measurements of acetylene reduction activity, nodule dry weight and N_2 fixed within soybean cultivars and the ability of Dunadja to fix similar amounts of N_2 at 20 and 100 kg N/ha was obtained during a second year experiment. Dunadja yield was affected by N fertilizer and produced larger yield at 100 kg N/ha than at 20 kg N/ha. This type of cultivar could be particularly useful in situations where soil N levels are high or where there is need to apply high amounts of N fertilizer.

The present study reveals the great variability between legume germplasms in the ability to fix N_2 at different inorganic N levels, and also the potential that exists in breeding for N_2 fixation associative traits. The ^{15}N methodology offers a unique tool to evaluate germplasms directly in the field for their N_2 fixation abilities at different N fertilizer levels. (In: Plant and Soil 82, 397-406.)

Spatial Variability of Soil Water status, Nitrogen Uptakeand N_2 fixation in Pasture. C. Kirda, G. Hardarson, F. Zapata and K. Reichardt. The spatial variability of a field soil was studied using the neutron probe to measure soil water status of the plant root zone, and isotopically-labeled fertilizers to evaluate N fertilizer recovery and atmospheric N_2 fixation. The work was carried out along three transects, 96m long, with 64 plots each. The first was bare soil, the second planted to rye grass and the third planted to alfalfa. Sampling domains for soil water content measurements, N_2 fixation and fertilizer uptake are discussed using geostatistical theory for the experimental site. Based on preliminary analysis the sampling domain for soil water content measurements was found to be 20m. (In: "Agronomy Abstracts"ASA, CSSA, SSSA, 1984.)

Quantitative assessment of symbiotic nitrogen fixation in diverse mutant lines of field bean (Vicia faba minor). H. Brunner and F. Zapata. Homozygous mutant lines of field bean selected for (a) improved yielding potential and (b) altered plant architecture and/or physiological response were tested for symbiotic N_2-fixing ability under field conditions in comparison with their parent cultivar. ^{15}N-tracer techniques were applied to determine %N derived from atmosphere. Data were collected on assimilate and N accumulation and distribution among various plant parts during two stages of reproductive growth. Symbiotic N_2 fixation was closely correlated with total plant top biomass and N yield. A similar close association was found between crop yield and N harvest index. Both harvest indices tended to be negatively correlated with stage of maturity and with the amount of N derived from air per unit of area. The generally high % N derived from symbiotic N_2 fixation and its comparatively small variability implies that this parameter may be difficult to improve in V. faba under field conditions. It is concluded, that the main genetic potential for improving the amount of biological N_2 fixation in this crop depends upon factors that promote high photosynthetic productivity and efficient N-use under appropriate agronomic conditions and with effective rhizobial associations. The establishment of ideotypes with positive impact on yield appears to be of practical significance for increasing the amount of symbiotically fixed N. In: Plant and Soil 82, 407-415.)

Evaluation of the availability of Azolla-N and urea-N to rice using ^{15}N. K.S. Kumarasinghe, F. Zapata, G. Kovacs, D. L. Eskew and S.K.A. Danso. The symbiotic association of the water fern Azolla with the blue-green alga Anabaena azollae can fix 30 - 60 kg N/ha per rice cropping season. The value of this fixed N for rice production, however, is only realized once the N is released from the Azolla biomass and taken up by the rice plants. The availability of N applied as Azolla or as urea was measured in field experiments by two ^{15}N methods. In the first, Azolla caroliniana (Willd.) was labelled with ^{15}N in nutrient solution and incorporated into the soil at a rate of 144 kg N/ha. The recovery of Azolla-N in the above ground parts of rice [Oryza sativa (L) cv Nucleoryza] was found to be 32% vs. 26% for urea applied at a rate of 100 kg N/ha; there was no signficant difference in recovery. In the second 100 kg N/ha of ^{15}N-urea was applied separately or in combination with either 250 or 330 kg N/ha of unlabelled Azolla. At the higher rate, the recovery of Azolla-N was significantly greater than that of urea. There was a significant interaction when both N sources were applied together, which resulted in a greater recovery of N from each source in comparison to that source applied separately. Increasing the combined urea and Azolla application rate from 350 kg N/ha to 430 kg N/ha increased the N yield but had no effect on the dry matter yield of rice plants. The additional N taken up at the higher level of N application, accummulated to a greater extent in the straw compared to the panicles. Since no assumptions need to be made about the contribution of soil N in the method using ^{15}N-labelled Azolla, this method is preferable to the ^{15}N dilution technique for assessing the availability of Azolla-N to rice. Pot trials using Azolla stored at -20^{o} C or following oven-drying showed that both treatments decreased the recovery of N by one third in comparison to fresh Azolla. (submitted for publication in Plant and Soil.)

Nitrogen Fixation and Nitrogen Availability of Azolla Studies Using ^{15}N. D.L. Eskew, K.S. Kumarasinghe, G. Kovacs and F. Zapata. The N_2-fixing symbiosis of the water fern Azolla with the blue-green algae Anabaena azollae can potentially provide large amounts of nitrogen for rice production. The techniques to measure N_2 fixation and N availability of Azolla caroliniana using ^{15}N were developed and tested under field conditions. The ^{15}N dilution technique using Salvinia and Lemna as non-fixing control plants was employed to measure N_2 fixation. These experiments indicatd that approximately 25-30 kg N/ha was fixed and that more than 80 % of the N in Azolla was derived from N_2 fixation. Direct and indirect ^{15}N labelling techniques were used to measure the availability of Azolla biomass N for rice plants. These experiments indicated that Azolla N is more efficiently used than urea N. (In "Agronomy Abstracts" ASA, CSSA, SSA, 1984.)

An Improved ^{15}N Emission Spectrometer with Increased Accuracy and Sample Throughput. G. Meir, W. Nitschke, G. Schmidt, S. Hollenthoner, L. Mayr and D.L. Eskew. Emission spectrometry has been limited by complex high-vacuum sample preparation and by relatively low accuracy. In the NOI-6-e, need for a high-vacuum system has been eliminated by using He gas to remove all the air from liquid samples and the capillary system. N_2 gas is then evolved from NH_4 by NaOBr injection, and it is swept into the discharge tube by the He gas stream. Measurement of ^{15}N abundance is performed by scanning the 2-0 band of the N_2 emission spectrum. An oscillating slit is employed to scan the flowing N_2 gas sample at a frequency of 70 x sec^{-1}. The analytical process from liquid sample to printed result requires less than 150 sec. Samples of 10 ugN can be measured with a coefficient of variation of 0.6 %. All procedures are computer menu guided and a minimum of operation skill is needed. This new instrument can process 200 samples per day from Kjeldahl distillates, and will facilitate the use of ^{15}N in a greater range of agricultural, biological and medical applications. (In "Agronomy Abstracts" ASA, CSSA, SSSA, 1984.)

7.2 Fertilizers Research

a. Evaluation of rock phosphate (RP) materials by means of radioisotope techniques, F. Zapata. Greenhouse experiments were used to determine the suitability of RP materials, from "FAO-Fertilizer Programme"- countries, for direct application as fertilizers. The main objectives were to assess the "plant-available amounts" of P supplied by these materials and to determine their relative agronomic effectiveness in terms of equivalent units of ordinary superphosphate. Fourteen RP materials of different origin were tested at two P levels. Two soluble P-fertilizers were also included. The fertilizer standard for comparison was ^{32}P-labelled OSP. A local acid soil was used for the experiment and Italian rye-grass (*Lolium italicum*) was the test crop. Marked differences among different RP materials were found after 7 wk and based on the results of this evaluation three classes of material for direct application as fertilizer were established (Table 7). RP are "slow release" forms of fertilizer and their overall value to a cropping system can only be assessed in "on site" long-term field studies. Thus an extension of the section's work in this area would logically be in such longer-term studies within a co-ordinated research programme.

b. Agronomic evaluation tests of guano samples from Zaire by means of isotope techniques. F. Zapata, J.L. Arrillaga. Upon request of Mr. C. Joly, Manager PNE-Zaïre, preliminary evaluation tests were carried out at the Seibersdorf laboratory, to obtain basic information on the potential value of several guano samples from Zaïre as fertilizer sources. In this connection, greenhouse experiments using isotope techniques were designed to compare the

Table 7. Suitability of rock phosphate materials for direct application

Suitability class	Rock phosphates at 1g $P.Kg^{-1}$ soil		Rock phosphates at 2g $P.Kg^{-1}$ soil	
I HIGH (< 10)	TIGBAO-CALATRAVA RP	(3)**	TIGBAO-CALATRAVA RP	(3)
	FERIWISATA RP	(6)	No data available for FERIWISTA RP	
	GIRI-JAVA RP	(6)	GIRI-JAVA RP	(8)
	* CIREBON RP	(7)		
	* SOFT RP MINJIGU	(9)		
II MEDIUM (10-20)			* CIREBON RP	(14)
			* SOFT RP MINJIGU	(14)
	TIMUR II RP	(11)	KODJARI RP	(14)
	KODJARI RP	(12)	TIMUR I RP	(18)
	TIMUR I RP	(13)	TIMUR II RP	(19)
	SAPHOS-JORDAN RP	(18)	SAPHOS-JORDAN RP	(20)
	*LAGARBAN RP-EAST	(18)	*SP III-TIMANGEA RP	(20)
III LOW (> 20)	KAKUL RP	(21)	*LAGARBAN RP-EAST	(28)
	*SP III-TIMANGEA RP	(24)	APATITE POWDER	(32)
	APATITE POWDER	(26)	KAKUL RP	(41)
	LAGARBAN RP-SOURTH	(30)	LAGARBAN RP-SOUTH	(71)

(*)The asterics indicate rock phosphate materials with an intermediate degree of agronomic effectiveness.

(**) The numbers in parenthesis indicate the amount, in Kg P as RP, equivalent to 1 kg P as ordinary superphospate.

(***) R = 2000 mg P/Kg Soil.

relative ability of these materials to supply "plant-available" amounts of N and/or P during a limited period of time. The main results of these evaluation tests can be summarized as follows:

(1) One guano from Zaïre (13N-13P-13K) was found to supply N and P at a similar efficiency to a standard guano from Peru under the experimental conditions used. The plant-available-N from this material was high and similar to that of ammonium sulphate. However, plant-available-P was low compared to that of the OSP in the calcareous, clay loam soil used.

(2) Three other guano samples from Zaïre, (Bas Zaïre, Randoux and Mont Hoyo) showed similar amounts of plant-available P. The P in these materials was about 1/3rd as available as the P OSP in the acid soil used.

It should be stressed that these evaluation trials were carried out under controlled conditions and the data cannot be directly extrapolated for fertilizer recommendation under local field conditions in the country of origin. On the basis of the available evaluation however, it is recommended that these guano materials are now tested under field conditions. The use of isotope techniques, (i.e. ^{32}P-labeled superphosphate as a standard) would enable the amounts of guano, in terms of equivalent amounts of OSP under the local conditions, to be determined. Since the experiments reported here, like those with RP above, do not take into account the residual value of N and P from these materials, follow-up, longer-term experiments should be designed to evaluate their fertilizer value to subsequent crops.

c. The evaluation of rock phosphate utilisation using methods of "soil labelling" and "A"-value K.V. Kalinin, J. Pascuali. The comparision of two methods (soil labelling with carrier-free P-33 and "A"-value with P-32) for assessing the availability of P from rock phosphate (RP) was made in a greenhouse experiment. Ordinary superphosphate (OSP) containing 8.37 % P and Bayovar rock phosphate (13.0 % P) were used for the experiment. The soil was labelled by carrier-free P-33 (14.5 mCi/pot). The total activity of P-32 was 23 mCi for the full dose of P (100 mg P/pot) and 11.5 mCi for the half dose of P (50mg P/pot). The RP was applied in doses of 1250 (2/2) and 625 (1/2) mg P/pot. The results were the same with either method, (Table 8). (Submitted for publication in ESNA Bulletin)

TABLE 8. Comparison of two methods to measure availability of P from rock phosphate (RP), ordinary super phosphate (OSP) and soil-P sources.

Method	Soil-P	OSP-P	RP-P	Total-P
		(mg P. pot^{-1})		
Soil labelling	38.2	7.1	5.7	51.0
"A"-value	39.3	7.1	5.1	51.5

7.3. Training in the Seibersdorf laboratory

During 1984 the Soils Section of the Agricultural Biotechnology laboratory offered training to 13 fellows, hosted scientific visits, accommodated a number of cost-free interns and carried out one training course in studies of soil/plant relationships (see Vol 7(1) p 6). In this year a similar number of trainees, especially in areas of N_2 fixation research is expected and, as indicated below (8.2) an Interregional training course similar to that in 1984 will be mounted. Table 9 lists the fellows at Seibersdorf during the past year. The great variety in country of origin,

Table 9.

Name	Country	Period in 1984	Topic
Fellows:			
Pascuali, Mr. Jorge A.	Bolivia	11 months	Soil Fertility
Hirimburegama, Mr. W.K.	Sri Lanka	12 months	Azolla/Rice
Mohd-Nasir, Ms. Norliah	Malaysia	3 months	N-15 Analysis
Shawa, Mr. Charles Tumbo	Tanzania	4 months	-"-
Luthra, Mr. M.K.	India	3 months	-"-
Afza, Ms. Rownak	Bangladesh	3 months	Soil Fertility
Kovacs, Ms. Gariella	Hungary	6 months	Azolla/Rice
Amornpimol, Ms. Chitima	Thailand	12 months	Soil Fertility
Wibowo, Mr. Zuhdi Sri	Indonesia	7 months	-"-
Shah, Mr. Syed K.H.	Pakistan	1.5 months	-"-
Senaratne, Mr. Ranjith	Sri Lanka	8 months	N_2 Fixation
Perdomo, Mr. Carlos,Trainee	Uruguay	3 months	Soil Physics
Nordin, Mr Razhy bin Mohd	Malaysia	1 week	-"-
Scientific Visitors			
Azmi, Mr. Abdul Razzaque	Pakistan	1week	
Skarlou-Alexiou, Ms. V.	Greece	2 days	
Libardi, Mr. P.L.	Brazil	3 days	
Cost-free Interns:			
Senaratne, Mr. Ranjith	Sri Lanka	4 months	
Nasir, Mr. Mohammad	Pakistan	2 days	

length of fellowship and topic studied is indicative of the broadly-based capability of the laboratory and its staff. Additionally it is pleasing to note that a number of the abstracts above carry the names and include the research of a number of the fellows from 1984.

7.4 Services

As a backup Service for Coordinated Research and Technical Cooperation programmes, our laboratory carries out $^{15}N/^{14}N$ ratio analysis of enriched plant and soil sample and assists in the installation and maintenance of vacuum lines for ^{15}N sample preparation and emission spectrometers. Those of you who have visited Seibersdorf will be aware of the extremely efficient and effective way that Ms. Helga Axmann, Mr. Mayr, Mr. Sebastianelli and their staff provide $^{15}N/^{14}N$ analysis of field materials. For the record, in this last year more than 15000 samples for co-ordinated research programmes and technical assistance projects were analyzed - at a conservative commercial value of more than US$ 300,000!

8. COMING EVENTS

8.1. Final FAO/IAEA Research Cordination Meeting on Development of Fertilizer and Water Managemenbt practices for Multiple Cropping.

The Final Research Coordination Meeting on Nuclear Techniques in the Development of Fertilizer and Water Management Practices for Multiple Cropping Systems will be held in Vienna from 3-7 June, 1985.

It is expected that participants from Bangladesh, Ghana, Indonesia, Panama, Tanzania, Thailand, Turkey, U.S.A. and Zambia will take part in the meeting. Dr. J.B. Bole, Canada, a former Head of the Soils Section in Vienna, has been invited to the meeting as a consultant. The participants will discuss results achieved during the past years of the programme. Separate reports will be made by each contractor on the results of the initial experiments (optimal placement and time of application of N, including studies on N placement and timing for the cereal component of a legume-non legume intercropping systems, and the effect of P placement on nutrient uptake) and progress made during the last two years in experiments to compare N and P "A"-values in the soil when the preceeding crop was either a legume or a cereal.

8.2. Upcoming Training Courses.

The forthcoming FAO/IAEA Interregional Training Course on the Use of Isotopes and Radiation Techniques in Studies of Soil-Plant Relationships, to be hosted by the FAO/IAEA Agricultural Biotechnology Laboratory at Seibersdorf, near Vienna, Austria, will be held from 7 May to 28 June 1985. The objective of the course is to give scientists from developing Member States a sound working knowledge of relevant nuclear techniques in soil-plant studies, with emphasis on BNF research. Therefore, preference will be given to those who are actively engaged in these areas.

A second training course on the use of N-15 in soil science, plant nutrition and agricultural biotechnology will be hosted in Leipzig at the Zentralinstitut für Isotopen-und Strahlenforschung, German Democratic Republic, and will be held from 14 May to 7 June 1985. The objective of this course is to give scientists from developing Member States a sound working knowledge of ^{15}N analytical techniques for use in soil-plant studies, soil science and agronomy.

The usual procedure is that a Note Verbale, including the prospectus of the course, is sent to Member States. Applications may be submitted on the standard nomination form for training courses through official channel in FAO or IAEA.

For each of the above courses in 1985 nominations will close by the end of February so that if you have noted these courses for the first time in this issue of the Newsletter it is probably too late. The Seibersdorf course is however an annual event so that if you are interested consideration should be given to applying for the next course in 1986. Further details of the syllablus of the courses can be obtained from Dr. F. Zapata at the Seibersdorf Laboratory.

PAST EVENTS

Joint FAO/IAEA Seminar on the Use of Isotopes in Studies of Biological Nitrogen Fixation for Developing Countries in the Middle East and Africa, Ankara, Turkey, 12-16 November 1984

Report

The Seminar was attended by 73 participants from Denmark (1), Egypt (1), France (1), Gabon (1), Ghana (1), Iran (1), Mauritius (1), Morocco (1), Nigeria (2), Saudi Arabia (2), Senegal (1), Sierra Leone (1), Syria (1), Tanzania (1), Turkey (50), Uganda (1), Zaire (1), IAEA (3), ICARDA in Syria (1), and ILCA in Ethiopia (1).

The Seminar which took place on the premises of the National Library in Ankara, was opened by the Minister of State with an address which elaborated at length on biotechnology and its potential for inceased food production, especially in the developing countries. This was followed by addresses from the UNDP Resident Representative, Mr. S. Malik, and Dr. C. Atkins on behalf of FAO and IAEA.

The first 2 days of the meeting were devoted to presentation of reports on nitrogen fixation research conducted in various countries in Africa and the Middle East. During a greater part of the last 3 days, the 3 IAEA lecturers (Atkins, Zapata and Danso), and invited lecturers, Drs. Middelboe from Denmark, Domenach from France and Shearer from the U.S. lectured participants on the concepts of N-15 use, calculations and interpretation of data, N-15 instrumentation, etc. In addition, a visit was paid to the Ankara Nuclear Research and Training Centre on the afternoon of Wednesday, 14 November and participants were exposed to the agricultural research in this institute.

The Seminar, in the opinion of the organisers, was very useful. This is confirmed by the numerous letters that have been received from participants expressing interest in follow-up training or involvement in some of our programmes.

9. PUBLICATIONS

A. Printed:

Soil and Fertilizer Nitrogen: Review of studies world-wide with particular reference to plant nutrition and environmental protection. Technical Report Series N244, December 1984 (priced document). This report, which was compiled by Dr. P. Winteringham, is an extremely authoritative and timely documentation of the significance of N inputs to the environment. It contains a wealth of "up to date" information and should prove valuable in the long-term planning of policy for the use of fertilizer-N in both developed and developing countries.

B. In Press

A technical report of the Coordinated Research Programme on the Use of Radiation and Isotope Techniques in Studies of Soil-Water-Regimes.

An unpriced technical document entitled: "The Role of Isotopes in Studies of Nitrogen Fixation and Nitrogen Cycling by Blue-green Algae and their Associations."

A technical document entitled, "Improvement of Nitrogen Fixation in Grain Legumes through Mutation Breeding", is being published by Martinus Nijhoff as a special volume of Plant and Soil.

C. In Preparation

An unpriced technical document entitled: "Isotope and Radiation Techniques in Water and Fertilizer Use Efficiency Studies in the Semi-Arid Regions."

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