SOME FIELD AND WATER CULTURE EXPERIMENTS WITH RICE.

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The results of these experiments have a direct bearing on the available nitrogen status of the soil and as such is reported here.

1. ASSIMILATION OF NITROGEN BY THE RICE PLANT.

The estimation of the weight and the percentage of nitrogen in the dry matter of 15 rice plants collected at random from an unmanured paddy field at eight different stages of growth from transplantation to harvest shows the following facts :—

TABLE 1.

	Before ear emergence.					After ear emergence.		
Sample ..	1	2	3	4	5	6	7	8
Weeks after transplantation ..	0	3	6	9	12	14	16	18
Weight of dry matter in gms. ..	4·38	7·7	20·7	95·8	194·6	330·9	540·3	538·2
Percentage of N (whole plant) ..	1·255	1·87	2·34	2·22	1·545	1·132	0·867	0·698
Total N in gms. ..	0·054	0·143	0·485	2·127	3·008	3·745	4·69	3·76
Wt. of N as % of the maximum	1·1	3·1	10·3	45·7	64·0	79·8	100	80·2
Absorption of N per week in gms. ..	·03	·114	·547	·294	·369	·473	−·47	..

The percentage of nitrogen in the rice plant increased until about six weeks after transplantation and thereafter decreased steadily until harvest. Since the weight of the dry matter increased from transplantation onwards, there can be only one reason for the rise in the percentage of nitrogen, viz. nitrogen was assimilated at a faster rate in comparison with carbon. Similarly the subsequent fall in the percentage of nitrogen was due to the assimilation of nitrogen at a slower rate than that of carbon. The determination of available nitrogen in the soil showed that the little nitrate that was present disappeared when the soil was water-logged, but ammonia accumulated until about six weeks from transplantation, when it fell off rapidly. Obviously

during the first six weeks after transplantation more ammonia was produced in the soil than the plant could consume. And as a result of this abundance of ammonia nitrogen was assimilated at a faster rate than carbon leading to the increase of percentage of nitrogen in the plant. On the other hand the period immediately following the sixth week after transplantation corresponded with the vigorous stage of plant growth. The demand for ammonia at this stage by the plant was greater in proportion to its production in the soil. In consequence soil ammonia decreased rapidly, which in turn resulted in the assimilation of ammonia nitrogen at a slower rate than carbon, leading to the fall in the percentage of nitrogen in the plant. It is therefore clear that available nitrogen status of the soil markedly affects the nitrogen composition of the crop especially during the early stages.

Furthermore, of the maximum quantity of nitrogen eventually absorbed by the rice plant two-thirds was only taken up at flowering (sixth row in the above table). During the milk stage therefore a considerable amount of nitrogen was assimilated. If the rate of absorption per week is considered (last row in the table), it will be found to shoot up again during this period. From the point of view of practical agriculture, therefore, it may pay to increase the available nitrogen status of the soil by manuring at this stage also.

A loss of nitrogen from the rice plant is indicated during the ripening stage but this requires further confirmation.

2. Nitrogen requirement of the rice plant.

In the preceding experiment the importance of maintaining an available nitrogen status in the soil almost throughout the life of the rice plant has been stressed. But it will be interesting to see what happens to the plant if the supply of nitrogen falls short or becomes nil after the plant has grown for sometime. Accordingly rice plants were grown in culture solutions containing all essential elements, N, K, P, Ca, Mg, S, and Fe up to different stages of growth and then transferred to solutions containing these elements excepting nitrogen. It was found that the growth of the plant was checked in absence of nitrogen at any stage, but the plant, even the four-week old seedling, managed to survive and eventually bore grain. In all cases nitrogen was found to increase in the plant during the period it lived in culture solutions without nitrogen. This indicated the possible capacity of the plant to assimilate elemental nitrogen. Similar observation was made in a sand culture experiment with rice and has been reported in a separate paper on the ' Nitrogen Supply of Rice ' for the Symposium.

On the other hand it will also be interesting to see what happens to the plant if the available nitrogen status in the soil becomes excessive, say by over manuring, or otherwise. It was found that when the rice plant in water culture was fed with increasing doses of nitrogen, the percentage of nitrogen in the straw and the seed increased, the total number of the filled seeds per ear

decreased, the total number of the empty seeds increased in proportion to the filled seeds, until the dose became such that all the seeds which appeared were empty and finally, when the percentage of nitrogen in the straw at harvest was 1·25 due to excessive nitrogen, no seed formation took place at all.

The adverse effect of excessive nitrogen on seed production was counteracted to some extent by the presence of boron in the culture solution. Boron stimulated both vegetative growth and seed formation. It was further found that the rice plant absorbed as much nitrogen in presence of boron as it did in its absence, but the total dry matter at harvest in the former case was almost double that in the other case. It is suggested that the beneficial influence of boron on seed formation lies not as much in controlling the absorption of nitrogen as in correcting the physiology of the plant by stimulating a proportionate increase in the carbon assimilation by the latter. Further experiments showed that this beneficial effect of boron was independent of its concentration from 1 p.p.m. to 12 p.p.m. in the culture solution. Higher concentrations were not tried as they might prove toxic.

3. Loss of nitrogen from culture solutions.

That loss of nitrogen takes place in submerged paddy fields as elemental nitrogen has been shown by several previous workers. In the water culture experiments reported here it was observed that there was considerable loss of nitrogen from culture solutions under rice. When there was no crop there was little or no loss from culture solutions. Of the total loss under rice roughly about 50% was recovered in the plant. The remaining 50% was lost probably as elemental nitrogen. This was true whether nitrate or ammonia was present in the culture solutions. Further experiments were carried out to determine the extent of this loss at various stages of the plant growth. The results were as follows :—

During	Loss of nitrogen, probably as elemental nitrogen, as per cent of total loss from culture solution.
Seedling Stage	46.1
Active Vegetative Stage	6.4
Flowering Stage	21.5
Ripening Stage	60.9

It is clear that the loss of nitrogen from the culture solutions is very great during the seedling and ripening stages. The result is of obvious importance as it demonstrates the advisability of increasing the available nitrogen status of the soil, if so desired, by top dressing of soluble nitrogenous fertilisers only during the active vegetative stage and in the beginning of the flowering stage.

4. Manuring of a lateritic paddy field with niciphos.

For this experiment 72 plots were laid out in three blocks of 24 plots each in the Government Farm, Dacca. The soil is of a lateritic type and poor in organic matter and nitrogen status. Twelve treatments consisting of various combinations of lime, potash, and magnesium were distributed in 36 plots. The remaining 36 plots received the same 12 treatments plus niciphos at the rate of 130 lbs. per acre given in two doses as top dressings—one at the end of the seedling stage and the other during the middle of the active vegetative stage. Experiments have now been carried out for about 5 years in these two sets of 36 plots receiving no nitrogen and niciphos respectively. The results show that the increase in the grain yield due to niciphos is statistically significant but the increase even in a year of favourable weather conditions averages to only 21 per cent over the yield of the plots receiving no nitrogen.