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CHOICE OF EXTRACTION METHODS IN ASSESSING AVAILABLE NUTRIENTS OF SOME BANGLADESH SOILS. I. NITROGEN

K. ANAM, S. M. IMAMUL HUQ, M. AMIRULLAH and J. AKHTAR
Department of Soil Science, University of Dacca, Bangladesh.

Abstract

Normal NaCl appeared to be the best among the five extractants used for the extraction of available nitrogen from six soils of the country. Acidified N NaCl (pH 1) ranked second in superiority. The uptake of nitrogen by paddy plants in relation to its availability as assessed by N NaCl was significantly correlated both at the flowering and harvesting stages under controlled and fertilized conditions, the values of 'r' being 0.813 (0.05) and 0.821 (0.05) at the flowering stage and 0.836 (0.01) and 0.888 (0.01) at the harvesting stage for the two conditions respectively.

Introduction

The knowledge of available nutrient status of soils is of the out most importance for the efficient use of fertilizers. This necessitates the determination of the availability of different nutrients present in the soil. Many research workers have tried and still are trying to correlate the uptake of nitrogen by green house plants with chemical methods used for determination of available nitrogen (Dyer 1894, Tyrin 1934, Morgan 1937, Richard *et al.* 1960, Anam *et al.* 1975, Enayetullah 1975). Their efforts have resulted in varying degrees of failure and success as the uptake of nutrients by plants from soil is controlled by a series of reactions which are governed by the soil, the plants and the nature of the extractants. The chemical methods for interpreting the nutrient status of soils are somewhat arbitrary. It is not possible to extract from a soil sample the amount of nutrient or even constant proportion thereof in a few minutes which a plant will absorb from the soil during the entire period of its growth.

No single method or a number of methods have so far been developed that can accurately measure the extent of contribution of each of these factors to interpret the availability of nutrients to plants. However, the relationship between the extractability of nutrient element by different extractants and plant availability thereto may be studied and a statistical interpretation of the results may suggest a method best suitable for the purpose. Attempts in this line have been made by the authors (1975) and others (Enayetullah 1975) during the recent past with some soils of

Bangladesh. The present work is a further extension of the previous works with more samples of representative soils of the country and with some different extractants.

Materials and Methods

Six surface (0-15 cm) soil samples from different localities in the country with varying physical and chemical properties (Table I) were included in the study. The mechanical analyses of the soils were done by the hydrometer method as described by Piper (1966) and the textural classes were determined by the USDA (1951) method. The pH of the soils were determined by using a Corning glass electrode pH meter at a soil : water ratio of 1 : 2.5. Organic carbon was determined volumetrically by wet oxidation method (Walkley and Black 1934). Total nitrogen was determined by Kjeldahl's method as outlined by Jackson (1958). NH_4^+—N was alkali distilled in a micro distillation apparatus.

Table 1. Some of the soil characteristics

Soils (localities)	Soil Type	Texture	pH	Organic carbon (%)	Total nitrogen (%)	C/N ratio
Thakurgaon	Old Himalyan piedmont plain	Loam	5.2	0.9067	0.0552	16.42
Gaibandha	Tista flood plain	Loam	6.2	0.5655	0.0427	13.24
Serajganj	Jamuna flood plain	Loam	7.3	0.3581	0.0320	11.19
Daudkandi	Meghan estuary flood plain	Clay loam	5.0	1.0050	0.0800	12.57
Kotowali (Comilla)	Acid basin clay	Clay loam	5.2	0.8618	0.0552	15.61
Hathazari	Brown hill soil	Sandy loam	6.3	0.3770	0.0406	9.26

Green House Experiment

The green house experiment was arranged in a completely randomized design in triplicate. 12 pounds of each of the soils (air dry) were taken in earthenware pots. The pots were divided into two sets ; one of them were kept controlled and the others were treated with fertilizers. Healthy seedlings of 200 lbs of N/A, 100 lbs P_2O_5/A and 100 lbs of K_2O/A respectively. Healthy seedlings of BR-3 variety of paddy were sown at the rates of 10 seedling per pot. The pots were watered at the rate of 138 acre-inches so that 2-3 inches of water remained on the top of the soil in the pots. Half of the plants were harvested with roots at the flowering stage

(80 days old) and the rest at the harvesting stage (110 days old) when almost all the grains were ripe.

Methods of Extraction :

The extractants used during the investigation and the extraction procedure adopted are presented in a tabular form (Table 2). In all the cases the soil : extractant ratio was maintained at 1 : 10.

Table 2. The different extractants used and the extraction procedure for the present study.

Extractants used	Author/s	Extraction procedure	Remark
N NaCl	Hissink, D. J. 1923	Stirred occasionally and allowed to stand for 24 hrs. and filtered.	Colourless soln.
Acidified N NaCl (pH 1)	Modification of Olsen's (1929) method	Stirred in a mechanical shaker and allowed to stand for 24 hrs. and filtered.	Yellowish coloured soln.
Morgan's reagent	Morgan, M. F. 1937	Stirred for half an hour and filtered.	Colourless soln.
0.3N HCl	Nelson et al. 1952	Stirred for 2 hours and filtered.	Yellowish coloured soln.
0.028N CH_3-COOH	Spurway 1949	Stirred in a mechanical shaker for 24 hrs. and filtered.	Colourless soln.

Results and Discussion

The amount of available nitrogen ($NO_3^-$and NH_4^+) in the soils as exctracted by different methods are presented in Table 3. The corresponding values for the element in paddy plants at the flowering (80 days old) and harvesting stage (110 days old) and the rice grains are presented in Table 4.

Table 3. Available nitrogen ($NO_3^-$and NH_4^+) contents of soils before cropping as assessed by different extractants (mg/100g of soil)

Soils	N NaCl	N NaCl (pH 1)	Morgan's reagent	0.3N HCl	0.028N CH_3-COOH
Thakurgaon	4.652	5.850	4.850	4.400	3.720
Gaibandha	5.240	6.320	5.200	4.850	3.920
Serajgonj	5.120	6.220	5.120	4.650	4.120
Daudkandi	5.325	6.420	5.330	5.120	4.200
Kotowali	4.900	6.350	5.150	4.700	3.850
Hathazari	5.525	6.220	4.950	5.200	3.950

Table 4. Amount of nitrogen in paddy plant and rice grains (per cent)

Soils	Flowering stage		Harvesting stage		Rice grains	
	Cont.	Fertil.	Cont.	Fertil.	Cont.	Fertil.
Thakurgaon	2.05	2.12	1.35	1.55	1.43	1.48
Gaibandha	2.26	2.34	1.40	1.64	1.40	1.51
Serajgonj	2.25	2.33	1.40	1.52	1.40	1.49
Daudkandi	2.27	2.38	1.42	1.61	1.42	1.51
Kotowali	2·23	2.35	1.29	1.55	1.40	1.49
Hathazari	2.26	2.28	1.42	1.61	1.42	1.52

It is apparent from Tables 3 and 4 that amount of nitrogen extracted from a particular soil by different extractants as well as by particular extractant from different soils differed appreciably from each other. The amount of nitrogen in the plant at the flowering stage was higher than that at the harvesting stage. The variation in the content of nitrogen in the plants and the grains grown in different soils is presumably related to the difference in the fertility status of the soils.

The coefficient of correlation between the available nitrogen as determined by N NaCl method in all the soils and the corresponding uptake of the element from the controlled and fertilized soils was found to be significantly correlated at various levels both at the flowering and harvesting stages of its growth (Table 5). The values of 'r' being 0.821 (0.05) and 0.888 (0.01) at the flowering stage and 0.813 (0.05) and 0.836 (0.05) at the harvesting stage for the controlled and fertilized conditions respectively. The per cent content of nitrogen in the grains in relation to its availability as assessed by N NaCl was found to be highly correlated both under controlled and fertilized conditions, the values of 'r' being 0.904 (0.01) and 0.947 (0.01) respectively (Table 5).

Table 5. Coefficients of correlation between nitrogen contents of paddy plant and rice grains and the available nitrogen content in soils as assessed by different extractants.

Extractants	Coefficient of Correlation					
	Flowering Stage		Harvesting stage		Rice grains	
	Controlled	fertilized	controlled	fertilized	contr.	fertil.
N NaCl	0.821*	0.888**	0.813*	0.306*	0.904*	0.947**
N NaCl (pH 1)	0.874**	0.945**	0.284	0.391	0.967*	0.806*
Morgan's reagent	0.755*	0.827*	0.194	0.327	0.525	0.343
0.3N HCl	0.758*	0.686	0.621	0.694	0.909**	0.952 ***
0.028N CH_3COOH_3	0.735	0.725	0.640	0.135	0.529	0.445

* Indicates significance at 5 %; ** at 1 %; and *** at 0.1 % level respectively.

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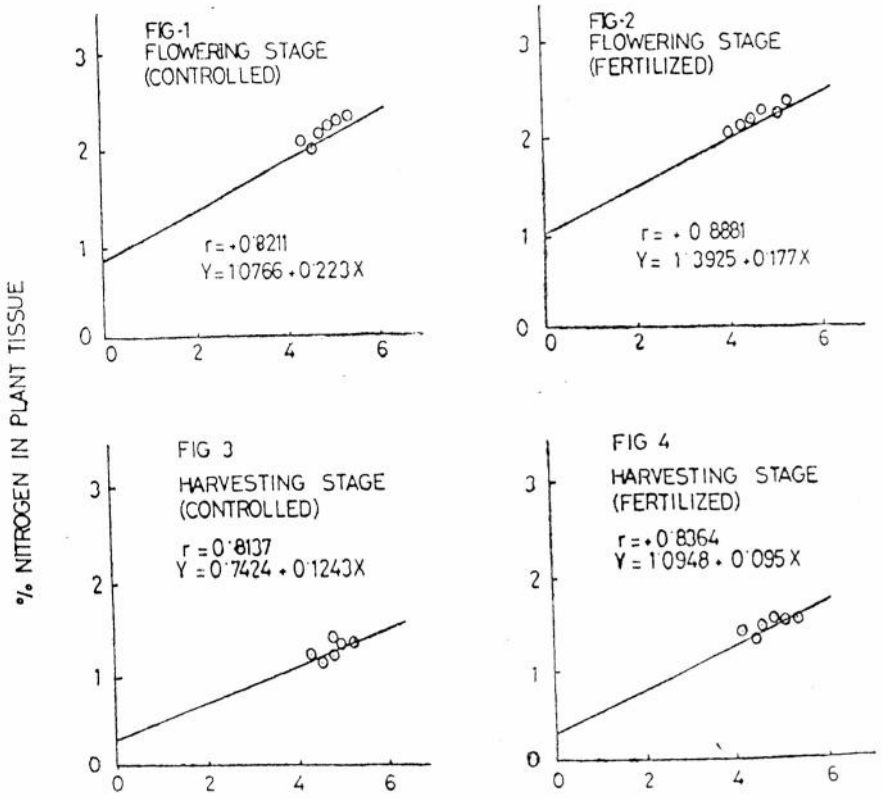
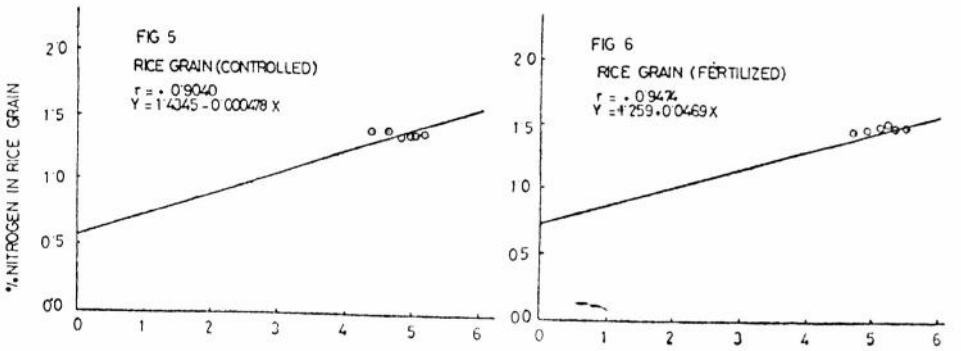
The correlation coefficients between acidified NaCl (pH 1) extractable nitrogen and the corresponding uptake by the paddy plants were found to be significant at the flowering stage only under controlled and fertilized conditions (Table 5). The nitrogen extracted by this method correlated significantly with the nitrogen content of the grains under the same conditions (Table 5). The Morgan's extractant comes next in superiority as the nitrogen extracted by this method was correlated with plant uptake at the flowering stage only under both the conditions (Table 5). The other two extractants, viz,, 0.3N HCl and 0.028N CH_3-COOH gave insignificant and inconsistent results.

Linear regression equations were calculated to see the distribution of the observed plant uptake of nitrogen in relation to the soil available nitrogen as assessed by N NaCl method. The regression lines drawn (Figs. 1-6) show that the observed values fall very close to the expected



Figs. 1—4. Relationship between available nitrogen in soil and nitrogen in plant tissue.



Figs. 5—6. Relationship between avaliable nitrogen in soil and content in rice grain.

(Available nitrogen measured by normal sodium chloride method in mg/100 g of Soil.)

values. This proximates of the values of the regression lines suggested that the relationship between N NaCl extractable nitrogen and the corresponding uptaken of it by the paddy plant was by far the best.

Results obtained in the present investigation supports the findings of Anam *et al.* (1975) and Enayetullah (1975) for some soils of the country. This finding is somewhat similar to that of Barshad (1948) who observed that Na^+ was better than K^+ for the extraction of exchangeable ammonium from the clay lattices.

It could, therefore, be suggested that N NaCl extractable nitrogen may correctly reflect the nitrogen status of the soils investigated with respect to its uptake by BR-3 variety of paddy plants.

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