EFFICIENCY OF EXTRACTION METHODS BASED ON "AVAILABILITY-UPTAKE" RELATIONSHIP OF THE NUTRIENTS WITH REFERENCE TO PADDY IN SOME SOILS OF BANGLADESH. I. NITROGEN

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Abstract

N NaCl and acidified *N* NaCl (pH1) extractable N were found to be highly correlated with the plant uptake out of the six extractants used in the study. *N* NaCl extractable N seemed to be better related with the plant uptake than the latter. Nevertheless, the regression analyses showed that both the extractants ranked equal in predicting the available nitrogen in all the soils studied. Although Morgan's extractant proved effective for two soils only, the remaining methods failed to give any significant result.

Introduction

Better crop production and a good soil management need a sound information about the availability of nutrients especially, N, P, K, Ca and Mg. The selection of suitable nutrient extractants is a serious problem which the workers in this line face in determining the availability of nutrients in soils by chemical methods.

Correlation obtained between the nutrients estimated by different methods and crop yield is far from satisfactory. This indicates that, as the chemical nature of the nutrient elements in the soil is not well known, the nature of the extracting solution must be determined by trial and error for the assessment of the availability of the elements for a particular crop in a particular group of soils.

Attempts in this line have been made in the recent past by Anam *et al.* (1975, 1976, 1977) for some representative soils of the country. The present work is a further extension of the previous works with more of the representative soils of the country with some different extractants.

Materials and Methods

Five representative soil tracts *viz.*, (i) Piedmont plain (Uttarsur, Sylhet); (ii) Hill Tracts (Bhaorabari, Sylhet); (iii) Surma flood plain (Moulavibazar, Sylhet); (iv) Lower Meghna tidal flood plain (Sudharam, Noakhali) and (v) Lower Meghna estuarine flood plain (Chandpur,

Comilla) were included in the study. Henceforth, the soils will be designated as S-1, S-2, S-3, S-4 and S-5, respectively. The soils were collected from 0-6″ from the surface. Some of the soil characters are presented in Table I.

Table 1. Some of the soil characters.

Soils	pH	% sand	% silt	% clay	% O.C.	% total nitrogen
S—1	4.7	66.34	12.26	21.40	0.914	0.077
S—2	5.1	54.64	16.40	28.96	0.795	0.041
S—3	4.9	43.64	25.30	31.06	1.56	0.099
S—4	7.8	21.44	54.20	24.36	0.867	0.092
S—5	6.2	52.64	32.20	15.16	0.501	0 025

Greenhouse experiment : BR-3 paddy (*Oryza sativa*) designated as BRJ27 (IR 506-I-133 × Latishail) was taken as the indicator plant. The experiment was arranged in a randomized block design in triplicates. 12 lb air-dried samples of each of the soils were taken in earthen ware pots of 15 lb capacity. The pots were divided into two sets ; one of them was kept absolute control while the others were treated with urea T. S. P. and M. P. at the rates of 210, 160 and 180 pounds per acre, respectively. The seeds were germinated outside the pots in distilled water and 7 days old seedlings were transplanted at the rate of 20 plants per pot at a regular distance from each other. The plants were thinned to 12 per pot. The pots remained wet throughout the growing period. Plant samples (with roots) were collected at random from each pot at the vegetative (8 weeks old) and post blossom (14 weeks old) stage.

The extractants used and the extraction procedures : The different extractants used and the extraction procedures followed are presented in Table 2. In all the cases the soil : extractant ratio was I : 10.

Table 2. The extraction methods used for the estimation of available nutrients in soils.

Extractants	Author/s name/designation of the methods	Time of shaking*
N NaCl	Hissink(1923)	24 hrs
N NaCl (pH– 1)	Modification of Olsen's (1929) method	30 minutes
N NaOAc (pH – 8)	Bower *et al.* (1952)	24 hrs
10% CH_3COONa+ 3% CH_3COOH (pH – 4.8)	Morgan (1937)	5 minutes
0.3N HCl	Nelson *et al.* (1951)	2 hrs
0.5M $NaHCO_3$(pH – 8.5)	Olsen *et al.* (1954)	30 minutes

* After being shaken for the required time the supernatant was filtered.

The available nitrogen ($NH_4^+ + NO_3^-$, NH_4^+ and NO_3^-) was determined by semi-micro distillation method using MgO and Devarda's alloy (as and when required) as described in "Methods of Soil Analysis Vol. II" (edited by C. A. Black, 1965). The plant nitrogen was determined by Kjeldahl's method (Jackson 1958).

Results and Discussions

The amounts of available nitrogen ($NH_4^+ + NO_3^-$) extracted by

Table 3. Available nitrogen ($NH^+ + NO_3^-$) content of soils before cropping as determined by different extractants (mg/100gm soil).

Soils	NaCl	NaCl (pH 1)	Methods of extraction		
			NaOAc	Morgan's reagent	O.3N HCl
S—1	5.928	6.840	5.472	5.016	5.472
S—2	5.244	5.928	5.928	4.560	5.928
S—3	4.012	5.016	4.560	3.876	5.472
S—4	4.332	5.700	5.928	3.192	5.016
S—5	3.648	4.560	6.384	3.055	4.104

different extractants before cropping are presented in Table 3. All the extractants except $NaHCO_3$ have been found to be more or less effective when their nitrogen removing capacities are considered. As the $NaHCO_3$ method totally failed to provide with any detectable amount of nitrogen in all the soils any further discussions about it is redundant. The other extractants may be arranged in the following order with respect to their nitrogen extracting capacity :

NaOAc > NaCl (pH-1) > 0. 3*N* HCl > NaCl > Morgan's reagent

The plant analyses results revealed that the plants at the vegetative stage in all the soils contain higher amounts of nitrogen than that at

Table 4. Amount of nitrogen in plant tissue (per cent) and dry matter yield (gm).

Soils	Vegetative stage				Post blossom stage			
	Control		Treated		Control		Treated	
	N cont.	D.M.	N cont.	D.M.	N cont.	D.M.	N cont.	D.M
S—1	2.44	4.36	2.60	10.88	1.90	10.41	2.00	17.35
S—2	2.17	5.53	2.33	11.98	1.68	12.25	1.79	20.36
S—3	1.84	2.65	1.98	6.47	1.52	6.34	1.68	11.40
S—4	1.90	2.36	2.17	5.40	1.62	5.29	1.73	8.64
S—5	1.68	3.56	1.90	7.93	1.35	7.79	1.52	13.59

the post blossom stage (Table 4). Increased nitrogen content in the plant tissue irrespective of the stages of growth, have been obtained due to the application of fertilizers.

The coefficients of correlation between uptake of N by plants from the controlled and treated soils and the corresponding availability of it as determined by NaCl are 0.9955*** and 0.9882*** at the vegetative stage and 0.966*** and 0.952*** at the post blossom stage for the two soil conditions respectively (Table 5a). The 'r' values between the uptake of N and its availability as determined by acidified NaCl (pH-I) have been found to be highly significant at both the stages of growth for the two soil conditions. The Morgan's reagent extractable N also correlated significantly with its uptake at both the stages of plant growth for the two soil conditions, but not as strongly as for the former two extractants

Table 5. Coefficients of correlation between available nitrogen as determined by various extractants and N uptake by plants. (a) simple correlation ; (b) multiple correlations.

(a) Simple correlation coefficient values.

Extractants	Value of 'r'			
	Vegetative stage		Post blossom stage	
	Control	Treated	Control	Treated
N NaCl	0.9955***	0.9822***	0.9660**	0.9521**
NaCl (pH-1)	0.9650**	0.9399**	0.9930***	0.9808***
NaOAc	−ve	0.6929	−ve	−ve
Morgan's reagent	0.9468**	0.8518**	0.8387*	0.9261***
0.3N HCl	0.6868	0.7258	0.6418	0.6855

(b) multiple correlation coefficient values

Extractants	Values of 'r'	
	Vegetative stage	Post blossom stage
N NaCl	0.9968***	0.9574**
NaCl (pH-1)	0.9910***	0.9968***
NaOAc	0.6683	0.7330
Morgan's reagent	0.9977***	0.8901**
0.3N HCl	0.7653	0.6864

*, **, *** indicate significant at 5.1 and 0.1 per cent level.

(Table 5a). 0.3*N* HCl extractable N correlated insignificantly while NaOAc extractable N negatively correlated with its uptake by the paddy plants.

Multiple correlation coefficients were calculated to determine the relationships among the three variables viz., availability as determined by various extractants, uptake from controlled soils and uptake from treated soils (Table 5b). It is clear from Table 5b that both NaCl and NaCl (pH1) gave strong significant correlation values with N uptake at the two stages of growth for available nitrogen. Though the value for

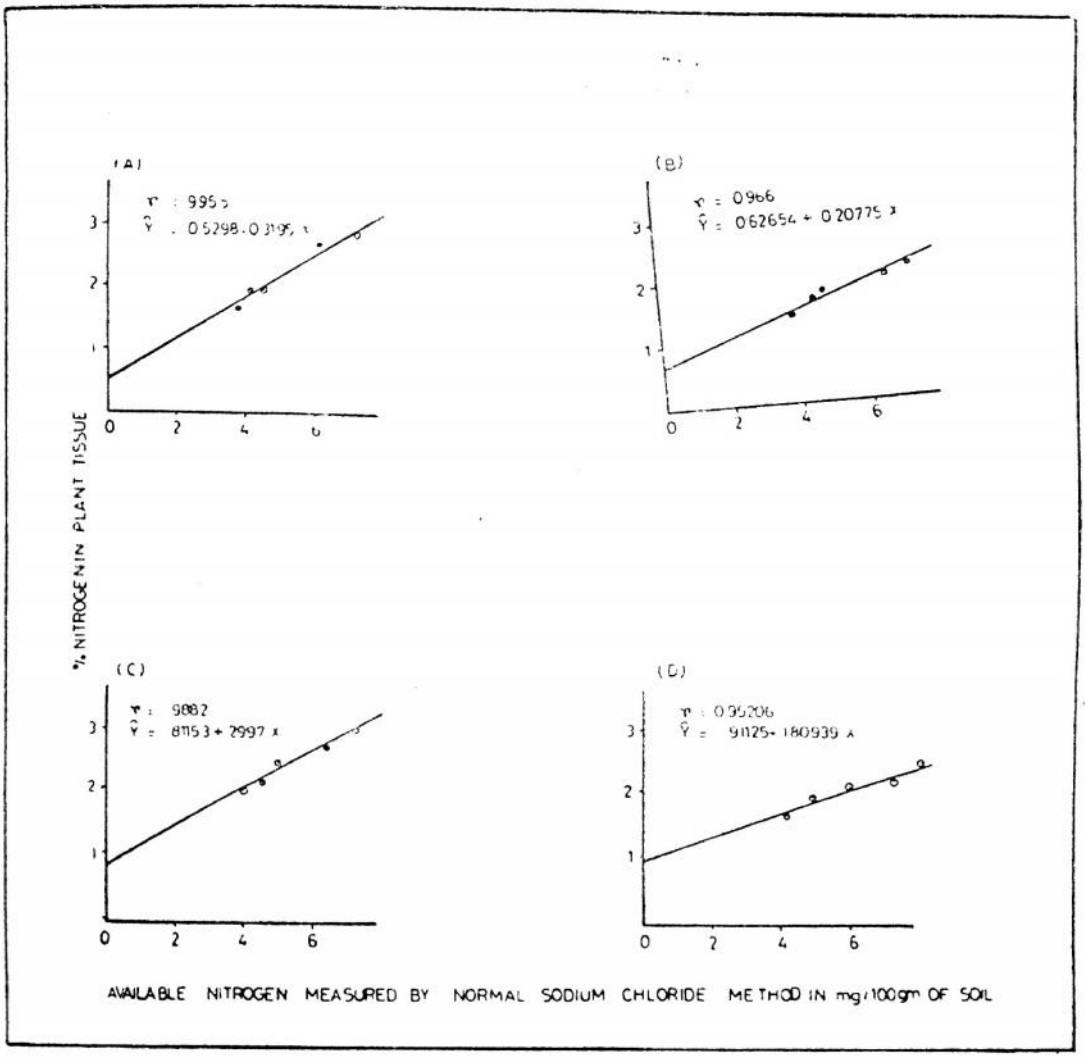

Fig. 1. Relationship between available nitrogen in soil and nitrogen content in plant tissue at various stages of growth, (a) 8 weeks old plant, untreated; (b) 14 weeks old plant, untreated (c) 8 weeks old plant, treated; (d) 14 weeks old plant, treated.

Morgan's reagent extracted N was significant at the vegetative stage, the degree of correlation at the post blossom stage was not as strong as those for NaCl or acidified NaCl (pH 1). The other methods gave insignificant relationships.

To further substantiate the observations, linear regression lines were drawn (Fig. 1) to see the distribution of observed plant uptake of N in relation to soil N as extracted by the different extractants. It has been observed that the NaCl extractable N and its uptake by plants are more closely related to the expected values in the vegetative as well as post blossom stage for both the soil conditions. The acidfied NaCl (pH 1) extractable nitrogen ranked next to it.

It can, therefore, be suggested that NaCl may be used as a suitable extractant for assessing the available nitrogen of the soils under investigation. This corroborates the findings of Anam *et al.* (1975) with some other groups of soils of Bangladesh.

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