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EFFICIENCY OF EXTRACTION METHODS BASED ON "AVAILABILITY UPTAKE" RELATIONSHIP OF THE NUTRIENTS WITH REFERENCE TO PADDY IN SOME SOILS OF BANGLADESH. III. CALCIUM AND MAGNESIUM

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Abstract

All the six extractants were found to be highly efficient in assessing calcium and magnesium availability status of majority of the soils excepting those having higher extractable calcium and magnesium.

Introduction

Attempts have already been made during the recent past in evaluating a suitable method of extraction for some soils of the country (Anam *et al.* 1977). The present work is a further extension of the previous works with some different extractants and more of the representative soils of the country.

Materials and Methods

The materials and methods, green-house experiment and the extractants used are the same as in part I.* The available Ca and Mg of the soils and that of plants were determined volumetrically by EDTA titration.

Results and Discussions

The amounts of available Ca and Mg extracted by different methods and their amounts in the paddy plants at the flowering and post blossom stages are presented in Tables 1 (a and b) and 2 (a and b) respectively.

It appears from the Tables 1a and 1b that acidic methods are more powerful in extracting the Ca and Mg from the soils. Their relative efficiency in removing the elements may be arranged as :

0.3N HCl> NaCl (pH-I)> Morgan's reagent> NaCl> NaOAc> $NaHCO_3$ (for Ca) and 0.3N HCl> NaCl (pH1)> $NaHCo_3$> Morgan's reagent> NaCl> NaOAc (for Mg).

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Table 1. Available Ca and Mg contents of soils before cropping as determined by different extractants (mg/100g of soil).

(a) Calcium

Soils	Methods of extraction NaCl	NaCl(pH-1)	NaOAc	Morgan's reagent	0.3N HCl	$NaHCO_3$
S-1	19.2	15.8	16.8	10.8	12.8	15.4
S-2	22.5	16.8	19.2	15.0	13.0	18.2
S-3	33.0	28.0	30.6	24.2	24.0	28.2
S-4	87.0	267.4	82.8	143.2	300.0	84.0
S-5	79.6	127.4	80.0	75.4	144.4	75.2
(B) Magnesium						
S-1	3.72	4.08	3.60	7.56	3.84	3.60
S-2	12.96	12.96	11.52	11.88	15.12	11.88
S-3	4.56	4.92	4.08	4.32	5.76	4.44
S-4	37.30	61.20	37.93	38.04	91.90	58.40
S-5	84.12	94.80	62.40	90.00	94.80	87.60

All the extractants removed very high amount of Ca and Mg from the soils S-4 and S-5. The uptake of Ca and Mg by plants (Tables 2a and 2b) is more or less uniform in all the soils irrespective of their availability as assesed by different extraction methods. Contrary to the expectations, the plants grown

Table 2. Amount of Ca and Mg. in paddy plants (in per cent)

(a) Calcium

Soils	Vegetative stage Control	Treated	Post blossom stage Control	Treated
S-1	0.356	0.375	0.240	0.2506
S-2	0.368	0.392	0.249	0.2621
S-3	0.380	0.412	0.261	0.3600
S-4	0.324	0.336	0.248	0.2504
S-5	0.344	0.352	0.276	0.2540
(b) Magnesium				
S-1	0.1920	0.1968	0.1680	0.1848
S-2	0.1896	0.2040	0.1584	0.1752
S-3	0.2280	0.2324	0.1990	0.2124
S-4	0.2200	0.2420	0.1390	0.1520
S-5	0.2500	0.2760	0.1730	0.1870

on the soils S-4 and S-5 used relatively lesser amounts of Ca and Mg. It is assumed that the extractants over estimated the available Ca and Mg in these soils. Moreover, compared to other extractants, the acidic ones estimated more Ca and Mg from these soils.

The coefficient of simple and multiple correlation between available Ca and Mg and their subsequent uptake by plants at different stages of growth were found to be negative when all the soils were considered together. However, excluding the two soils having larger amounts of Ca and Mg, positive and significant relationships were obtained between availability and uptake.

Calcium : The coefficient of simple correlation (Table 3a) between Ca uptake by paddy plants from the three soils and its available amount determined by the different extractants revealed that NaCl, Morgan's reagent and $NaHCO_3$ extractable Ca were significantly correlated with its uptake at the vegetative stage. But at the post blossom stage, Morgan's reagent extractable Ca gave the highest correlation coefficient values (r=0.9940 and 0.997 for the control and treated soils respectively) thereby putting this method as the superior to all the other extractants.

Table 3. Coefficient of correlation between Ca contents of plants at the two stages of growth and the corresponding available amount of it as determined by the different extraction.

(a) Simple correlation — Coefficient of correlation values

Methods of extraction	Vegetative stage		Post blossom stage	
	Control	Treated	Control	Treated
N NaCl	0.9560*	0.9778*	0.9760*	0.9910**
NaCl(pH-1)	0.9005	0.9198	0.9330	0.9997***
NaOAc	0.9358	0.9410	0.9610*	0.9980**
Morgan's reagent	0.9770*	0.9864*	0.9940**	0.9970**
0.3N HCl	0.8337	0.8955	0.8518	0.9960**
$NaHCO_3$	0.9510*	0.9645*	0.9760*	0.9935**

(b) Multiple correlation

Methods	Vegetative stage	Post blossom stage
N NaCl	0.9999***	0.9999***
NaCl(pH-1)	0.9999***	0.9999***
NaOAc	0.9990***	0.9999***
Morgan's reagent	0.9999***	0.9999***
0.3N HCl	0.9990***	0.9999***
$NaHC0_3$	0.9999***	0.9999***

*, **, *** Significant at 5, 1, and 0.1% level respectively.

Though Ca extracted by all the other methods correlated positively with its uptake at various levels of significance at this stage of growth, the 0.3N HCl extractable Ca was found to be insignificantly correlated.

Significantl correlations were obtained for NaCl, Morgan's reagent and NaOAc extractable Ca and its uptake at both the stages of plant growth. On the other hand, multiple correlation values (Table 3b) showed that Ca extracted by the methods related significantly with its uptake at both the stages of plant growth.

Regression equations obtained for all the six methods seem to be more or less equally suitable in predicting Ca avilability in the soils S-1, S-2 and S-3. The distribution patterns of the observed values in case of the three soils about the regression lines have been found to be almost identical for all the methods. Regression line for NaCl (Fig. 1) is being presented here as an example.

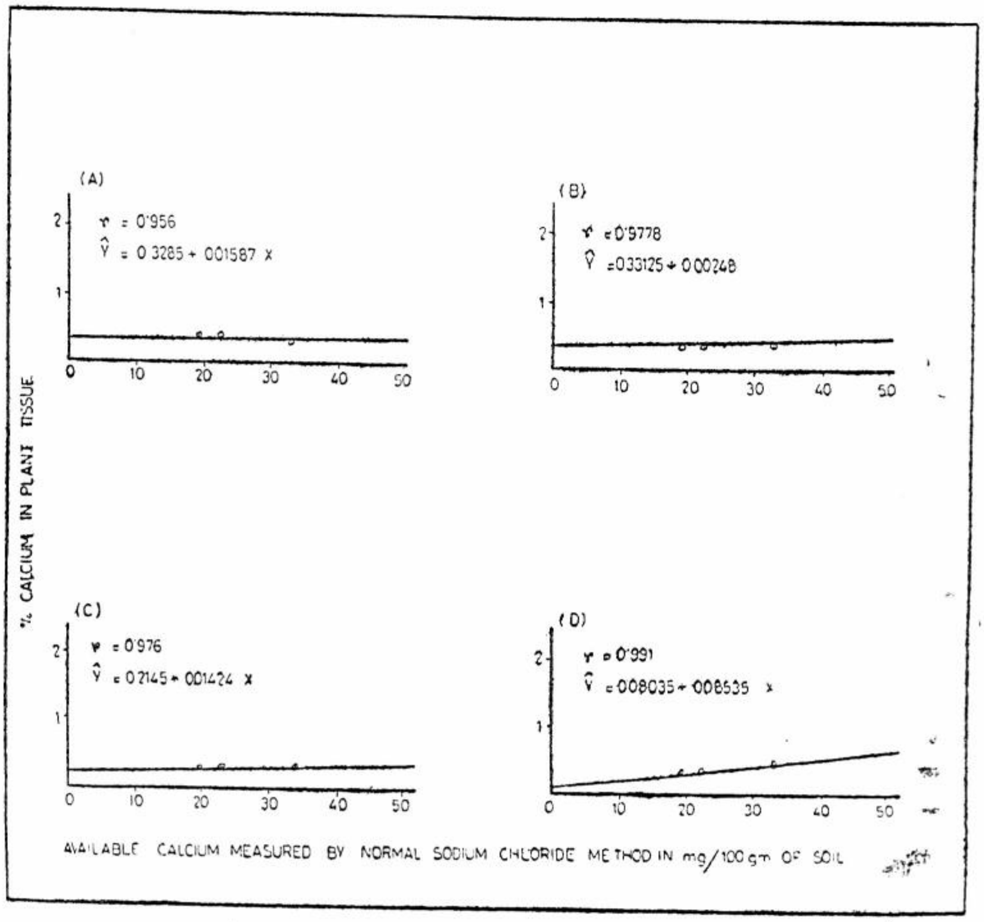

Fig. 1. Relationship between available calcium in soil and calcium content in plant tissue at various stages of growth. (a) 8 weeks' old plant, untreated ; (b) 8 weeks' old plant, treated (c) 14 weeks' old plant, untreated ; (d) 14 weeks' old plant, treated.

It can, therefore, be concluded that any one of the methods under study could be used for the determination of available Ca of the soils S-1, S-2 and S-3.

Magnesium: Coefficient of simple correlation (Table 4a) between Mg extracted by different extractrants and the uptake of it by paddy plants at different stages of growth under two soil conditions revealed that only the NaOAc extractable Mg retained the harmony of relationship throughout the phases of growth. The values of 'r' being 0.9939 and 0.9903 (significant at 1% level) at the vegetative stage and 0.9604 and 0.9540 (significant at 5% level) at the post blossom stage for the two soil conditions respectively. The NaCl and NaCl (pH-1) extractable Mg correlated significantly at 1% level at the vegetatiue stage for the two soil conditions while the same was significant at 5% level at the post blossom stage for the control soils only. 0.3N HCI and $NaHCO_3$ extractable Mg have been found to be significantly correlated with uptake at the vegetative stage, but were insignificantly related when the plants grew older. Multiple correlation coefficient values (Table 4b) showed that Mg extracted by all the methods were significantly related at 0.1% level at both the stages of growth.

Table 4. Coefficient of correlations between Mg contents of plants at two stages of growth and the corresponding available amount of it as determined by the different extraction methods.

(a) Simple correlation — Coefficient of correlation values

Methods of extraction	Vegetative stage		Post blossom stage	
	Control	Treated	Control	Treated
N NaCl	0.9904**	0.9939**	0.9522*	0.9350
NaCl(pH-1)	0.9900**	0.9942**	0.9513*	0.9440
NaOAc	0.9939**	0.9903**	0.9604*	0.9540*
Morgan's reagent	0.9793**	0.8905	0.9916**	0.9995***
0.3N HCl	0.9864**	0.9994***	0.9523	0.9160
$NaHCO_3$	0.9890**	0.9947**	0.9490	0.9410

(b) Multiple correlation

Methods	Vegetative stage	Post blossom stage
N NaCl	0.9999***	0.9999***
NaCl(pH-1)	0.9999***	0.9999***
NaOAc	0.9999***	0.9999***
Morgan's reagent	0.9999***	0.9999***
0.3N HCl	0.9999***	0.9999***
$NaHCO_3$	0.9999***	0.9999***

*, **, *** significant at 5,1, and 0.1% level respectively.

Regression equations showed that all the methods are equally efficient for Mg estimation in the three soils. The general feature of the regression lines for Mg were similar to those for Ca. The regression line for NaCl method (Fig. 2) is being presented as a representative one.

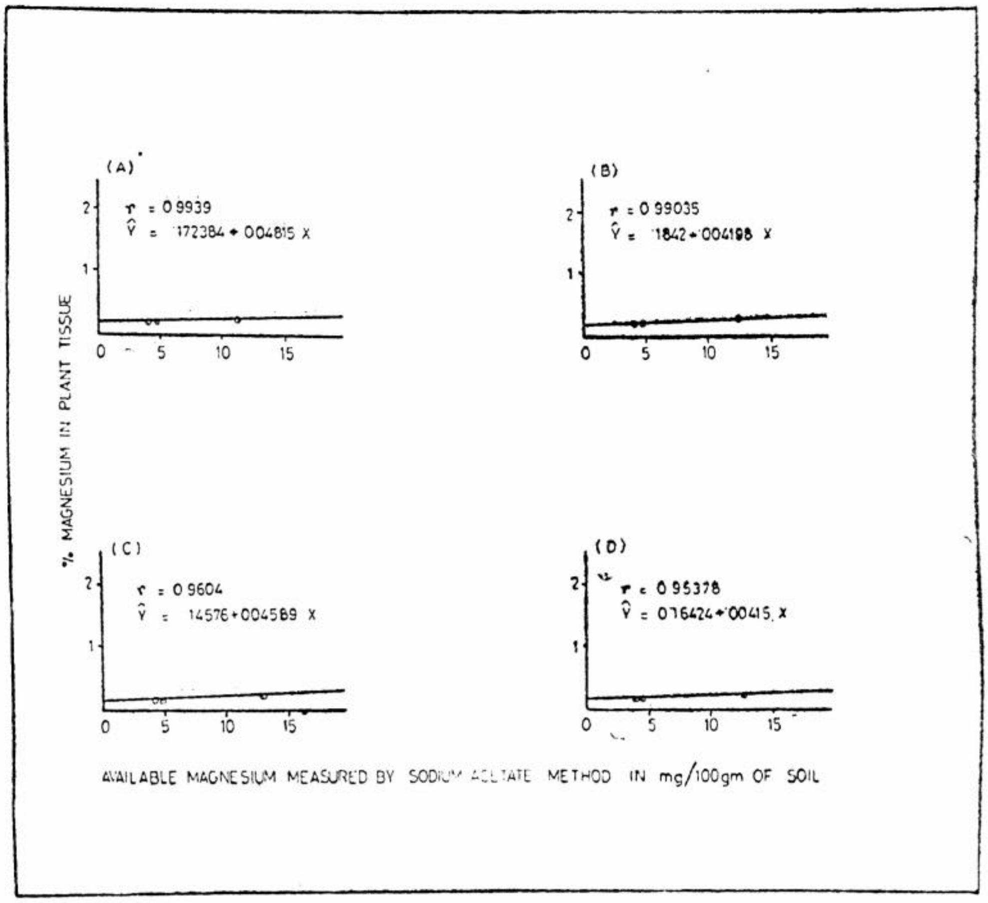

Fig. 2. Relationship between available magnesium in soil and magnesium content in plant tissue at various stages of growth. (a) 8 weeks' old plant, untreated ; (b) 8 weeks' old plant, treated ; (c) 14 weeks' old plant, untreated ; (d) 14 weeks' old plant, treated.

It is, therefore, apparent that any one of the methods may successfully be employed for the Mg availability determination of the soils S-1, S-2 and S-3.

In conclusion, it can be summerised that all the methods used in this experiment may be regarded successful in predictidg available Ca and Mg status of majority of the soils. The methods registered their inadequecy in the soils where the amounts of extracted Ca and Mg were very high.

Reference

Anam, K., S. M. Imamul Huq, M. Ahmed and N. U. Ahmed. 1977. A comparison of extraction methods to assess the available Ca and Mg in some Bangladesh soils. *Dacca Univ. Studies*, B. XXV (1) : 61-66.