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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. II. PHOSPHORUS AND POTASSIUM

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Abstract

$NaHCO_3$ appeared to be the best method for all the soils in extracting available P. This was established both by the correlation, coefficient and regression analyses. The other method that correlated significantly with P uptake was NaCL. As for potassium, most of the methods gave unsatisfactory and puzzling results in predicting its availability. All the methods except NaCI (pH-1), were either insignificantly or negatively correlated. Though the degree of correlation for NaCL (pH-I) extractable K was not so strong yet, the regression lines suggested that this method was suitable for K availability assessment in three soils only.

Introduction

The present work is a continuation of the work in this line (Anam *et al.* unpublished) in the quest of choosing a suitable extract for interpreting the availability of P and K in some representative soils of the country in relation to plant growth. More representative soils and some different types of extractants than those of the previous ones have been included in the present work.

Materials and Methods

The materials and methods, green-house experiment and the extractants used have been described in part I (Anam *et al.* 1977). The available P was determined by using a Coleman Junior II spectrophotometer after the development of molybdophosphoric blue colour in HCI system (Jackson 1958) at a wavelength of 660 millimicron. Available K was determined by using a NIL digital flame photometer.

Results and Discussions

The amounts of P and K as extracted by different extractants from different soils are presented in Table 1 (a & b) and the corresponding uptake of the elements at the two stages of growth under the two soil conditions are presented in Table 2 (a & b).

Table 1. Available phosphorus and Potassium contents in soils before cropping as determined by different extractants (in ppm).

(a) Phosphorus

Soils	NaCI	NaCI (pH-I)	NaOAc	Method of Morgans' reagent	Extraction 0.3N HCI	$NaHCO_3$
S-I	4.4	7.9	2.4	4.0	13.8	9.8
S-2	1.2	1.9	0.6	1.5	5.85	3.2
S-3	4.2	7.4	2.2	3.2	12.5	8.6
S-4	2.1	42.0	2.2	3.5	79.0	4.2
S-5	2.76	17.44	1.88	2.96	35.63	6.28

(b) Potassium

S-1	40	31	31	32	45.6	46
S-2	30	21	17	22	30.8	34
S-3	36	28	28	29	38.1	42
S-4	40	29	30	31	68.2	58
S-5	55	50	40	40	62.9	44

Phosphorus : It is apparent from Table 1(a) that the amount of P extracted by the different extractants differed widely from soil to soil. The P removing capacities of the extractants may be arranged as :

0.3N HCI > NaCI (pH-I) > $NaHCO_3$ > Morgan's reagent > NaCI > NaOAc

Higher uptake of phosphorus was recorded in the treated soils at the vegetative stage of the plants (Table 2a).

Table 2. Amounts of phosphorus and potassium in rice plants (in per cent).

(a) Phosphorus

Soils	Vegetative stage Control	Vegetative stage Treated	Post blossom stage Control	Post blossom stage Treated
S-1	0.232	0.270	0.122	0.139
S-2	0.078	0.120	0.092	0.110
S-3	0.212	0.240	0.115	0.130
S-4	0.112	0.154	0.111	0.125
S-5	0.158	0.200	0.100	0.122

Table 2. (contd.)
(b) Potassium

Soils	Vegetative stage Control	Treated	Post blossom stage Control	Treated
S-1	2.262	2.250	1.46	1.37
S-2	1.850	2.070	1.24	1.18
S-3	2.030	2.090	1.31	1.24
S-4	1.833	1.950	1.22	1.16
S-5	2.350	2.420	1.52	1.42

The correlation, coefficients between the P uptake by paddy plants and its availability as measured by different methods revealed that NaCI and $NaHCO_3$ extractable P was significantly correlated with its uptake at the vegetative stage.

Table 3. Coefficients of correlation between phosphorus contents of plant and the corresponding available amount of it in soils as determined by different methods of extractions.

(a) Simple correlation

Methods	'r' values Vegetative stage Control	Treated	Post blossom stage Control	Treated
NaCI	0.9490**	0.9204**	0.9140*	0.9098*
NaCI(pH-I)	-ve	-ve	-ve	-ve
NaOAc	0.7269	0.7380	0.8695*	0.8787*
Morgan's reagent	0.7180	0.7236	0.9293**	0.9269**
0.3N HCI	-ve	-ve	-ve	-ve
$NaHCO_3$	0.9883***	0.9832***	0.8400*	0.9022*

(b) Multiple correlation

Methods	'r' values Vegetative stage	Post blossom stage
NaCI	0.9593**	0.9686**
NaCI (pH-I)	0.4366	0.0774
NaOAc	0.7867	0.8912*
Morgan's reagent	0.7826	0.9280**
O.3N HCI	0.4953	0.1019
$NaHCO_3$	0.9892***	0.9148*

*, **, *** indicate significant at 5, 1 and 0.1 per cent level respectively.

the value of 'r' being higher for $NaHCO_3$ (Table 3a). The values are 0.9883 and 0.9832 (0.9587 being significant at 0.1% level) for the controlled and treated conditions respectively. The NaCI extractable P has been found to be significant at the 5% level with the values of 'r' being 0.9409 and 0.9204 for the two soil conditions respectively. The NaOAc and Morgan's reagent extractable P correlated insignificantly with its uptake at the vegetative stage. However, P extracted by the above four extractants correlated significantly with plant uptake at the post blossom stage. The remaining two extractants yielded negative values at both the stages of plant growth for the two soil conditions.

The coefficient of multiple correlation showed that a highly significant relationship exists between NaCI extractable P and its uptake by paddy plants at both the stages of growth (Table 3b). $NaHCO_3$, that gave the highest value for 'r' at the vegetative stage did not show the same trend at the post blossom stage. Though NaOAc and Morgan's reagent extractable P gave poorly significant values at the post blossom stage, they were insignificantly correlated at the vegetative stage.

The methods deserve to be considered for predicting P availability in the soils are NaCI and $NaHCO_3$ as significant relationship were obtained between uptakes and availability of P at both the stages of growth. Though NaOAc and Morgan's reagent extractable P showed significant relationship with its uptake at the post blossom stage, they are regarded to be of little importance due to their insignificant relationship at the vegetative stage.

To further substantiate this, regression lines were drawn for the two methods *viz.*, NaCI and $NaHCO_3$ and it showed that the observed values for $NaHCO_3$ extractable P oriented more closely around the regression line than that for NaCI extractable P in both the stages of growth (Fig. 1).

This confirmed the superiority of $NaHCO_3$ in predicting the available P of the soils under investigation. This is in accordance with the findings of Cooke (1967) and Tamehane and Subbiah (1962).

Potassium : Little difference were found in the removing capacity of the extractants in assessing the available K of the soils. However, 0.3N HCI was found to extract the highest amount of K while NaOAc the lowest (Table 1b).

The K content of plant tissue at the vegetative stage was found to be as high as 1.5 times than that at the post blossom stage (Table 2b). Very little increase in the uptake of potassium was observed at the vegetative stage due to fertilization. It is likely that the soils had sufficient reserve of the element to meet the demand of the growing plants. K contents in plants were found to decline at the post blossom stage in the treated soils. This might be due to the fact that, at the post blossom stage growth of plants are at its maximum and

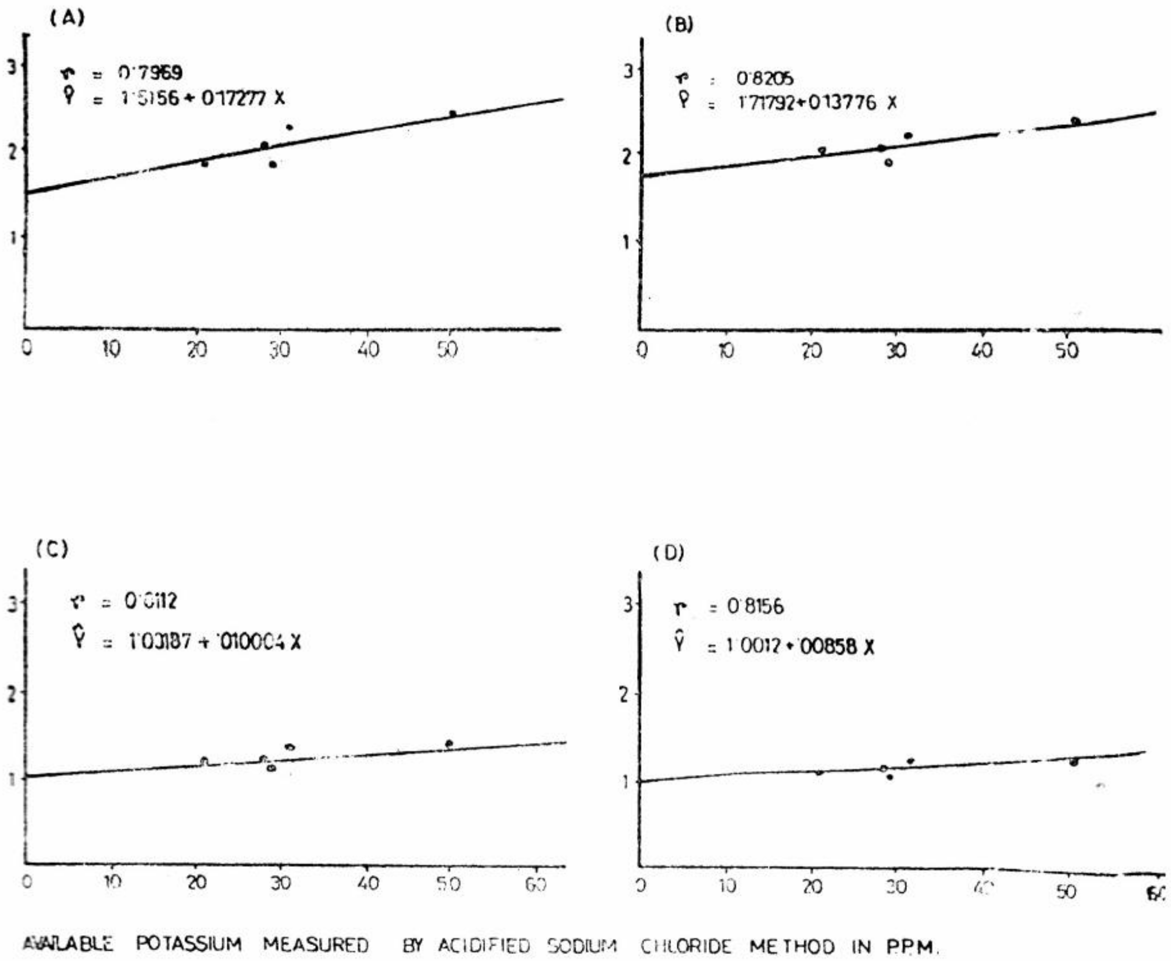

Fig. 1. Relationship between available phosphorus in soil and phosphorus content in plant tissue at various stages of growth : (A) 8 weeks old plant, untreated; (B) 8 weeks old plant, treated; (C) 14 weeks old plant, untreated; (D) 14 weeks old plant, treated.

fertilization might have accentuated the growth more and consequently the amount of the element in the plant tissue is not at par.

The correlation coefficients (Table 4a) between the uptake of K and the available form of it as measured by different extractants showed that the values are sporadic in nature excepting for the $NaHCO_3$ extractable one, which is negatively correlated.

Table 4. Coefficient of correlation between potassium contents of paddy plants and the corresponding available amount of it as measured by different extractant.

(a) Simple correlation

Methods	'r' values			
	Vegetative stage		Post blossom stage	
	Control	Treated	Control	Treated
NaCI	0.8040	0.7560	0.9080*	0.7650
NaCI(pH-I)	0.7969	0.8205*	0.8115*	0.8156*
NaOAc	0.7637	0.6645	0.7542	0.7477
Morgan's reagent	0.7846	0.8159*	0.7871	0.7778
$NaHCO_3$	-ve	-ve	-ve	-ve
0.3N HCI	0.2290	0.1440	0.2260	0.2913

(b) Multiple correlation

Methods	'r' values	
	Vegetative stage	Post blossom stage
NaCI	0.7676	0.7707
NaCI(pH-I)	0.8227*	0.8161*
NaOAc	0.7854	0.5655
Morgan's reagent	0.7901	0.8290*
$NaHCO_3$	0.8887*	0.6634
0.3N HCI	0.2659	0.5295

* indicates significant at 5 per cent level.

For example, NaCI extractable K is significantly correlated with its uptake at the post blossom stage only in the control soils (Table 4a). It gave insignificant values in all other instances. The Morgan's reagent extractable K is insignificantly correlated with the uptake except at the vegetative stage in the treated soils. Compared to others, NaCI (pH-I) extractable K was found to give better relationship. Except for the control soils at the vegetative stage, the NaCl (pH I) extractable K was found to give significant values.

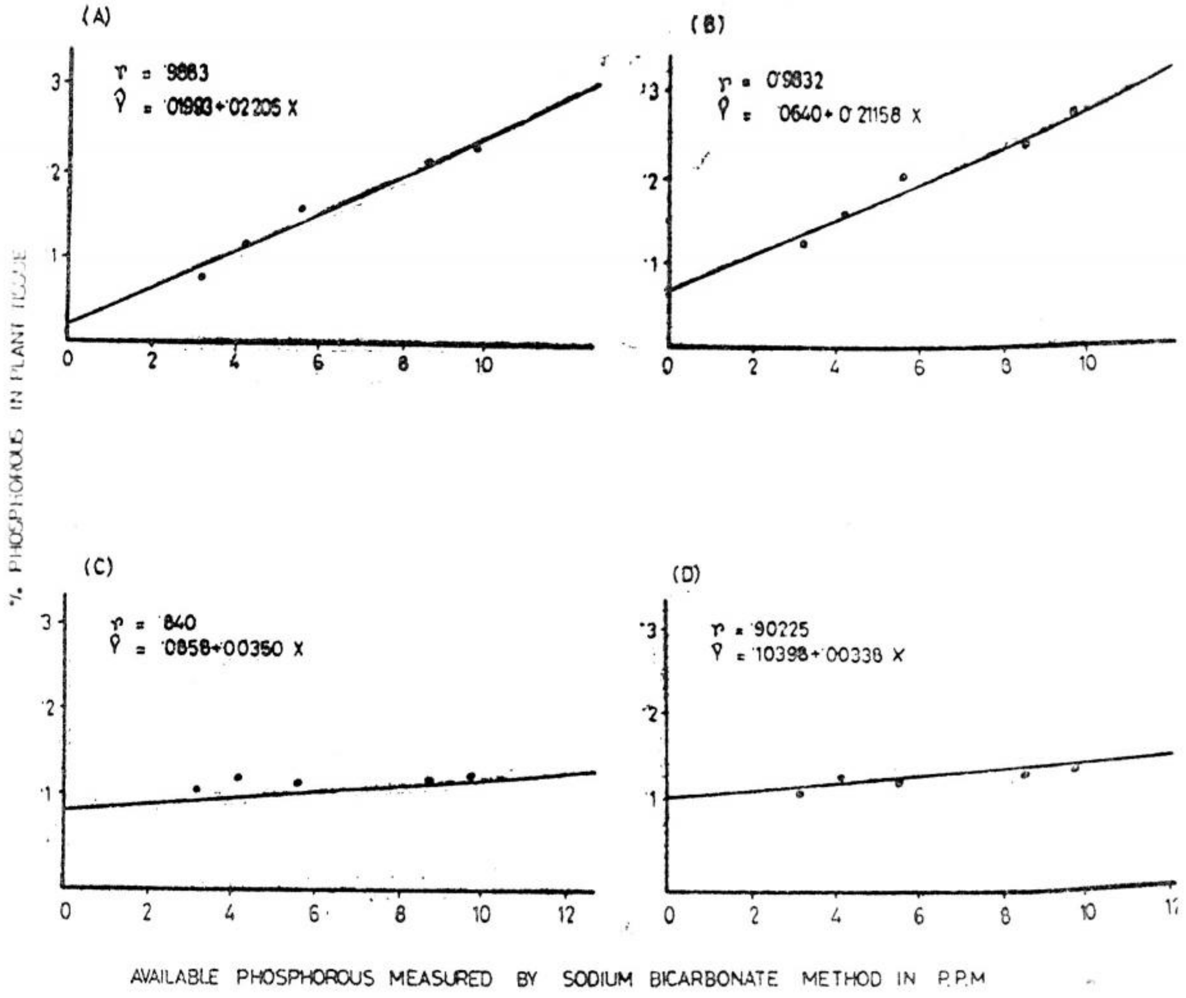

Fig. 2. Relationship between available potassium in soil and potassium content in plant tissue at various stages of growth : (A) 8 weeks old plant, untreated; (B) 8 weeks old plant, treated ; (D) 14 weeks old plant, untreated; (D) 14 weeks old plant, treated.

In the light of the above discussions as regards the simple correlation coefficient values, it may aptly be commented that all the methods are unsuitable for interpreting the available K status of the soils under study.

The multiple correlation coefficient values (Table 4b) revealed that, NaCI (pH-I) extractable K correlated significantly with its uptake at both the stages of plant growth. Rest of the methods provided insignificant values. It is apparent from the multiple correlation coefficient values that takes into account all the factors involved, that NaCI (pH-I) may reasonably, but not definitely be regarded suitable for predicting K supplying power of the soils investigated.

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To observe more closely the suitability of NaCI (pH-I) in predicting the available K of the soils studied, regression lines were drawn (Fig. 2). The distribution of the observed values about the estimated regression line showed that the values for the soils S-1, S-2 and S-3 fell very close to the regression line. So, the method is suitable for these three soils in predictingt heir K availability. Similar trends have been observed by Anam *et al.* (1978) with another group of soils of the country.

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