CHOICE OF EXTRACTION METHODS IN ASSESSING AVAILABLE NUTRIENTS. II. PHOSPHORUS AND POTASSIUM.

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Abstract

Few extraction methods were tried to estimate the availability of phosphorus and potassium with respect to BR-3 paddy grown undergreen house condition. 1N NaCl method was found to be the best in estimating the availability of phosphorus at flowering stage. Phosphorus extracted by 2N KCl was also found to be significantly correlated with plant uptake (BR-3) flowering at stage. In case of potassium all the extractants were found to be positively significant at flowering stage. Among them Morgan's reagent was the best and 1N NaCl method was found to be suitablenext to Morgan's reagent,

Introduction

With the possible exception of nitrogen, no other element has been as critical in the growth of plants in the field as phosphorus. Lack of this element is doubly serious, since it may prevent other nutrients that are present in soil from being acquired by plants. Phosphorus occurs in soil in inorganic and organic forms, the relative proportion of which varies with orghnic matter content, but usually the organic forms predominate. This element tends to accumlate in the finer fractions of soil and thus increases as the clay content increases.

The presence of adequate available potassium in the soil has much to do with the general tone and vigor of plant growth. A large part of the potassium in soils is present as a portion of the crystalline structure of primary and secondary minerals such as micas, feldspar, and illite. Information about the available quantity of these two elements is of prime significance in the field of agriculture in assessing the fertilizer requirement. These information can only be obtained through chemical and biological testing of soils.

Dean (1937) attempted the dilute sulphuric acid extraction of soils to separate calcium phosphates. Ghani (1943) modified Deans procedure by extracting first with acetic acid to remove mono-, di-, and tri-calcium phosphates, then with sodium hydroxide to remove organic, aluminium and iron phosphates and finally with dilute sulphuric acid to dissolve apatites.

Available potassium can be separated into that immediately available which is the water-soluble and exchangeable, and potentially available or 'fixed'. Since the amount of K exchanged from the soil depends on the nature of the replacing cation the exchangeable K is defined more specifically as that which is extracted with neutral **1N** NH40Ac minus the water-soluble K. Evans and Attoe (1948) noted that exchangable form of K is readily available to plants, makes up only a small portion of the total potassium is soil. Very few works has been reported for Bangladesh soils in this regard. Attempts have been made in the field in recent years by Anam et al. (1978) to develop suitable methods for the assessment of available phosphorus and potassium. The pressent work is a continuation of the previous works in this line and aims at finding out reliable extractants for determining available phosphorus and potassium status of Dantmara Rubber soils, Chittagong in relation to plant uptake (BR-3). Five extraction methods were studied in the present investigation,

Materials and Methods

The soils with which the present work were carried out include six composite soil samples of Dantmara, Chittagong, under the plantation area of Bangladesh Rubber Planting Project. The soil samples were collected from two different topographic positions, e. g. top and basin of four different gardens of 1972, 1973, 1978 and 1979 plantation years. The soils were collected at a depth of 0-15 c.m. from the surface and were dried, ground and passed through a 2mm sieve. Some of the physical and chemical properties of the soils are given in Table-1.

Green house experiment

Two and half pounds air-dried soil was taken in each earthenware pot for green house experiment. Soil containing in all pots were treated with N,P_2O_5 and K_2O at a uniform rate of 40 Kg/hectre in the form of urea, triple superphosphate and muriate of potash respectively.

The pots were arranged in completely randomized desing in triplicate. Two weeks old seedlings of BR-3 were transplanted at the rate of twelve plants per pot at a regular distance from each other. After one week the plants were thinned to six plants per pot. The plants in the pot were kept wet throughout the whole growing period. The plant samples were collected (with roots) at random from each pot at the flowering stage (eight weeks old) and all the remaining plant samples were collected at the harvesting stage (fourteen weeks old).

Laboratory methods

Particle size distribution was determined by hydrometere method, and the textural classes were determined according to the U.S.D.A. system (1951). pH was determined by a glass electrode pH meter at a soil : water ratio of 1 : 2.5. Organic carbon was determined by wet oxidation method (Walkley and Black, 1934). Total nitrogen was determined by semi-micro steam distillation method as described by Black (1965). The available phosphorus was determined by using a Colman junior II spectrophotometer after the development of vanad-omolydophosphoric yellow colour method, in nitric acid system (Jackson, 1658). Available potassium was determined by using a EEL flame photometer.

Plant analysis

The harvested rice plants were washed and cleaned with distilled water with roots and flowers and then dried in an oven at 60-70·C and were ground to fine powder. Wet ashing of plant samples were made by means of HNO_3-$HClO_4$-H_2SO_4 mixture (ternary mixture in the ratio of 10 : 4 : 1) as described by Jackson (1958). Once the stock solution was prepared by wetoxidation, the determination of phosphorus and potassium were done according to the procedure as described for the determination of P and K in soils.

The different extractants and the procedure adopted in the study are presented in the table – 2.

Results and Discussion

The amount of available phosphorus and potassium extracted by different methods are presented in Table-3 (a and b) and the amount of the corresponding elements in the rice plant (BR-3) are presented in Table-4.

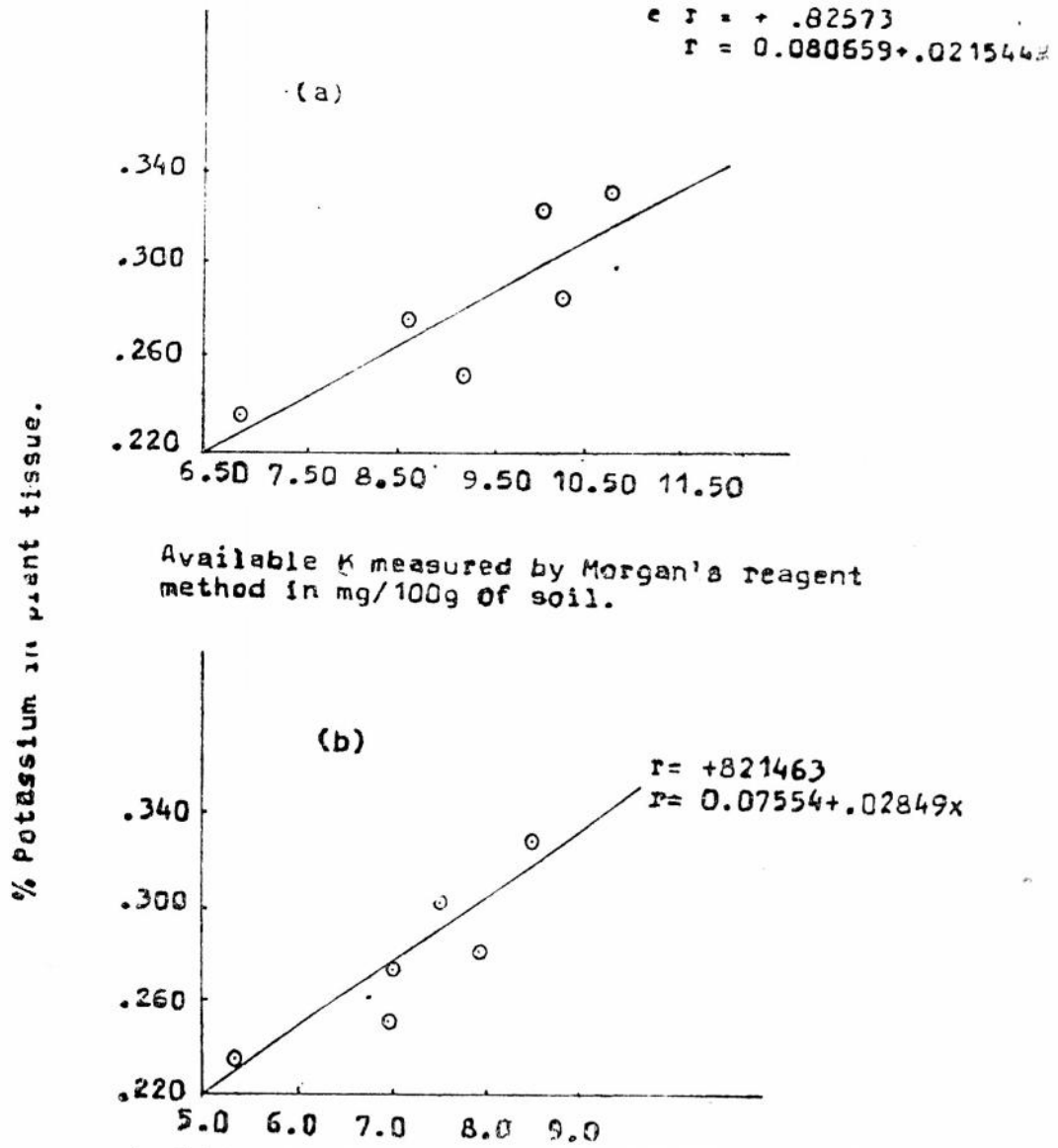


Fig. 1. Regression line of available P on the P content of plant tissue.

It is apparent that the amounts of phosphorus and potassium extracted from a particular soil by different extractants as well as by a particular extractant from different soils differed appreciably. The content of phosphorus in the plants at harvesting stage was higher than that at the flowering stage while potassium was higher at the flowering stage. However, there is a great variation in these nutrient contents of the paddy plants (BR-3) at both the stages grown in different soils of this experiment which is presumably related to this difference in the fertility status of the soil.

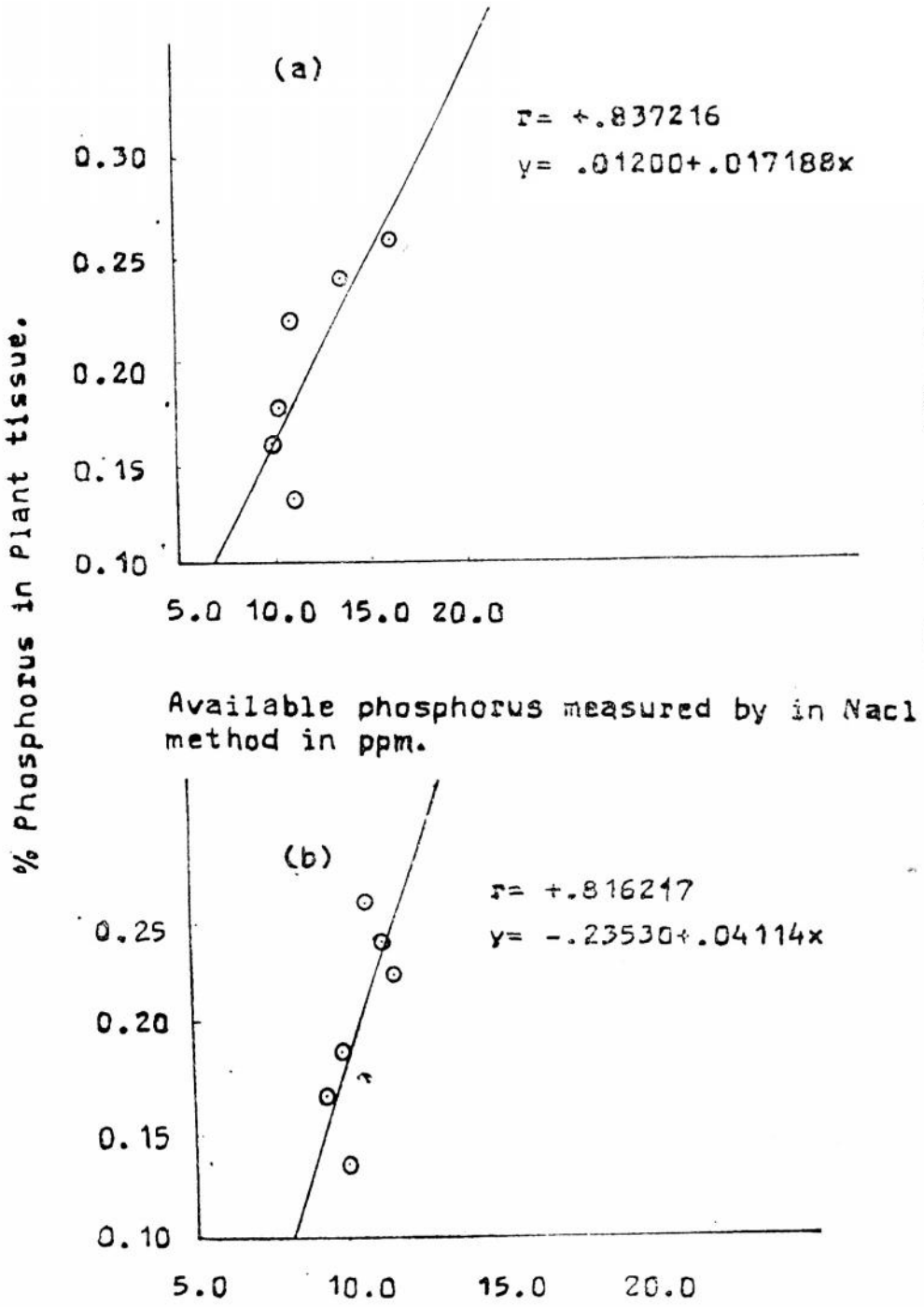
The correlation of phosphorus content of rice plant at flowering stage with the availability as measured by 1N NaCl and 2N KCl methods in the soils were found to be significant at 1.0% level ($r = +0.8$) and 2.0% ($r = +0.82$) respectively. The remaining three methods such as 1N NaCl (pH-1), water extraction and Morgan's method found to be insignificant at flowering stage in relation to phosphorus availability (table-5a) ;

But at harvesting stage Morgan's reagent and 1N NaCl (pH-1.0) extractable-P were found to be significant at 2.0% level ($r = +0.82$) and 10.0% level ($r = +0.62$) respectively. The remaining three methods in this respect were insignificant.

The co-efficient correlation between available potassium as determined by various methods and plant uptake were positive and significant. But the potassium extracted by Morgan's reagent and 1N NaCl method were found to be more strongly correlated with the uptake at flowering stage. These values were $r = +0.82$ (significant at 2.0% level) and $r = +0.82$ (significant at 2.0% level), respectively (table-5b). The co-efficient of correlation of the extractable-K from the soils by other methods namely, 1N NaCl (pH-1.0), water extraction and 0.5M $NaHCO_3$ method were $r = +0.77$ (significant at 5.0% level), $r = +0.75$ (significant at 5.0% level) and $r = +0.63$ (significant at 10.0% level) respectively at flowering stage (table-5b).

At harvesting stage only 1N NaCl (pH-1.0) and water extractable-K appeared to be significantly correlated to paddy-K at 10.0% level ($r = +0.64$) and 10.0% level ($r = +0.66$), respectively.

From the regression line (Fig.1a) it can be seen that in case of 1N NaCl extractable-P all the the observed values (uptak) fall very close to the regression line at the flowering stage, while 2N KCl



Available K measured by N NACI method in mg/100 g of soil.
Fig. 2. Regression line of available K on the K content of the plant tissue.

extractable-P (Fig.1b) deserves to be regarded as a favourable method for soils under the present investigation. Therefore, from the above study it may be concluded that 1N NaCl method may possibly be employed for the determination of available phosphorus for those soils.

For the comparison of Morgan's reagent and 1N NaCl extractable-K at flowering stage linear regression line has been shown (Fig.2). The regression line with respect to Morgan's reagent reveals that the observed values in some cases for K slightly of the line. In case of 1N NaCl method the observed values were slightly scattered than that of the Morgan's method.

The result obtained in this study is fairly in accord with the findings of Anam et al. (1976) who obtained a high degree of correlation between available potassium as measured by Morgan's reagent and 1N NaCl method and the plant uptake. So it may be concluded that Morgan's reagent and 1N NaCl method are more or less suitable for interpreting and predicting potassium supplying power of those soils.

Results obtained in the present study for the assessment of available K show that none of the methods could perhaps claim to be successful if this partial success not considered. However, for the estimation of available K of the soils of the country a suitable method is yet to be developed perhaps in accordance with the theoritical basis of availability measurement into "intensity of supply" indicating how much nutrient is available immediaetly to plant roots, and the 'pool', i.e. the total quantity of nutrient that could be used by plant.

Table—1 : Some physical and chemical properties of soils.

Plantation year	Soils	Texture	pH	Organic Carbon %	Total Nitrogen %	C/N ratio	% P	% K
1972	Top	sandy loam	5.15	0.87	0.077	10.67	0.125	0.123
	Basin	sandy loam	5.00	0 85	0.058	14.10	0.150	0.170
1973	Top	sandy loam	4.77	1.02	0.079	10.20	0.122	0.176
	Basin	sandy loam	4.75	1.10	0.122	9.30	0.120	0.129
1978	Plain	sandy loam	4.65	0.85	0.074	11.83	0.145	0.112
1979	Plain	sandy loam	4.50	0.93	0.060	16.02	0.137	0.133

Table–2: Different extractant used and the extraction procedure for the present study (Soil : extractants= 1 : 10) :

Extractants	Authors	Extraction Procedure	Remarks
IN Nact	Hissink,K.D.J. 1923.	Stirred occassionally & allowed to stand for 24 hours and filtered.	Colouress solution obtained.
Acidified 1N NaCI (pH-1.0)	Modification of 01sen's(1929) method.	Stirred in a mechanical shaker and allowed to stand for 24 hours and filtered.	Yellowish coloured solution obtained.
Morgan's reagent	Morgan,M.F. 1937.	Stirred for 5 miniutes and filtered.	Colourless soluition obtained.
Water extraction	Nelson, 1951.	Stirred in a mechanical shaker and allowed to stand for 24 hours and filtered,	Colourless solution obtained.
2N KCI	Olsen. 1929.	Stirred in a mechanical shaker and allowed to stand for half an hours and filtered.	Colourless solution obtained.
0·5M NaHCO3	Olsen,S.R., Cole,C.V., Watanable,F.S. and Dean,L.A. 1954.	Stirred occassionally and allowed to stand for 24 hours and filtered.	Colourless solution obtained.

Table—3 : Available phosphorus and potassium contents of soils as determined by different extractants. (a) Phosphoru expressed in ppm and (b) Potassium (mg/100g of soil)

(a) Phpsphorus

Plantation year	Soils	Water extraction	I N Nacl	I N Nacl (pH-1.0)	Morgan's reagent	2N Kcl
1972	Top	22.00	11.26	50.00	52.00	11.75
	Basin	18.00	16.25	40.00	60.00	10 75
1973	Top	25.00	11.25	40.00	48 00	10.00
	Basin	12.00	13.75	45.00	52.00	11.25
1978	Plain	16.25	10.62	42.50	48.00	10.00
1979	Plain	12.50	10.00	25.00	47.50	9.37
(b)	Potassium				0.5M $NaHO_3$	
1972	Top	3.82	8.53	9.04	10.84	10.73
	Basin	2.09	7.95	8.62	10.32	11.45
1973	Top	1.86	7.51	7.21	10.08	11.21
	Basin	1.70	7.04	6.08	9.25	10.70
1978	Plain	1.19	7.03	6.18	8.63	9.32
1979	Plain	0.93	5,35	5.29	6.86	7.35

Table—4 : Percent phosphorus and potassium in rice plant.

Plantation year	Soil	Phosphorus		Potassium	
		Flowering stage	Harvesting stage	Flowering stage	Harvesting stage
1972	Top	0.220	0.250	0.328	0.346
	Basin	0.260	0.270	0.281	0.262
1973	Top	0.130	0.240	0.322	0.328
	Basin	0.240	0.230	0.250	0.198
1978	Plain	0.175	0.225	0.256	0.256
1979	Plain	0.160	0.200	0.234	0.252

Table—5 : Co—efficient of correlations beetwn phosphorus and potassium contents of rice plants and the corresponding available phosphorus and potassium contents in soils as obtained by different extractants.
(a) Phosphorus and (b) Potassium.

(a) Phosphorus

Co—efficient of Correlation.

Extraction methods	Flowering stage	Harvesting stage
IN Nacl	+0.83721****	+0.47331
2N Kcl	+81621***	+0.62143
!N Nacl (pH—1.0)	+0.44455	+0.62226*
Water extraction	—Vc	+0.55562
Morgan's reagent	+0.02402	+ 0.81737***
(b) Potassium		
Morgan's reagent	+ 0.82573***	+ 0.53517
IN Nacl	+ 0.82146***	+ 0.53936
IN Nacl (pH – 1.0)	+ 0.77200**	+ 0.63976*
Water extraction	+ 0.75228**	+ 0.65951*
0.5M $NaHOG_3$	+ 0.63300*	+ 0.30371

*, **, ***, **** indicate levels of significance at the probability of 10%, 5%, 2%, and 1%, respectively.

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