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EVALUATION OF THE SUITABILITY OF THE METHODS FOR ASSESSMENT OF NUTRIENTS OF DATMARA SOILS WITH RESPECT TO RUBBER PLANT

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Abstract

Out of different extraction methods used in the study to evaluate the availability of nutrients of Datmara soil with respect to rubber plants, Morgan's reagent, 0-5M. $NaHCO_3$ and acidified 1 N.NaCl (pH—1·0) were found to be suitable for phosphorus, potassium and calcium respectively.

Introduction

The estimation of the nutrient elements in soil is very important. Usually the availability of nutrients are measured by using different chemical extractants. The suitability of any chemical method for assessing soil nutrient status depends on their ability to extract nutrients from soil in relation to their uptake by plants. No one method is likely to be suitable for all the nutrients present in soils and plants.

However, the relationship between the extractability of a nutrient by various extractants and plant availability there of, may be studied and statistical interpretation of the results may suggest a method best suitable for the purpose. Many research workers have tried in the past and are trying to develop suitable chemical methods to assess the nutrient status in soils with respect to different crops. Still from time to time many workers like Dyer (1894), Tyrin (1934), Bower *et al.* (1952), Troug (1954) and Richard *et al.* (1960) tried to correlate between the nutrient status as measured by chemical methods and crop response to fertilizer or uptake of nutrient elements by plants. These efforts have resulted in varying degrees of failure and success. Attempts have been made to evaluate the nutrient status of some soils of Bangladesh by Islam and Chowdhury (1967), Islam *et al.* (1975) and Anam *et al.* (1976,

1977 and 1980). However, information about the nutrient availability with respect to rubber is scanty. In the present investigation different extraction methods were used as tool for the determination of the nutrient supplying power of a rubber garden soil with respect to rubber plant.

Materials and methods

Four rubber gardens in the district of Chittagong were selected for the study. The entire study area belongs to Datmara series. The gardens were planted in the years of 1972, 1973, 1978 and 1979 respectively. Four composite soil samples from 0–15 cm surface soil and rubber leaves from respective areas were collected from two different topographic positions (top and basin) of 1972 and 1973 gardens. Two composite soil samples were collected from 1978 and 1979 gardens. After air-drying and processing some of the physical and chemical properties were determined (Table 1). pH was measured by a glass electrode pH meter at a soil : water ratio of 1 : 2.5. Particle size distribution was determined by hydrometer method and texture was determined following U.S.D.A. (1951) method. Organic carbon was determined by wet oxidation method (Walkley and Black, 1934). Total and available nitrogen were determined by Kjeldahl's method (Black, 1965). Phosphorus was determined through vanadomolybdophosphoric yellow colour method in nitric acid system and making use of Coleman Junior spectrophotometer (Jackson, 1958). Potassium was determined by flame photometer and calcium and magnesium were determined by E. D. T. A. method (Black, 1965).

Collected rubber leaves were washed with distilled water and then dried to constant weight in an oven at 75°C for few hours. Then the samples were ground to fine powder with the help of a micro-grinder. Wet washing of plant samples were made according to the procedure described by Jackson (1958).

Extractants used were : 1N.NaCl (Hissink, 1923), acidified (pH—1.0) 1N.NaCl (Olsen, 1929), Morgan's reagent (Morgan, 1937), water extraction (Nelson, 1951), 2N.KCl (Olsen, 1927) and 0.5M.$NaHCO_3$ (Olsen *et al.* 1954).

Results and discussion

Physical and chemical characteristics of the soils are shown in Table-1. It can be seen from the table that all the soils were acidic in nature and

have sandy loam texture. Total carbon and nitrogen contents of the 1973 garden were slightly higher than the other gardens. Nutrient contents of rubber leaves are shown in Table 2.

Table 1. Some physical and chemical characteristics of the soils.

Plantation year	Soils	pH	Texture	% organic carbon	% Total nitrogen	C/N ratio	C. E.C. me/100gm
1972	Top	5.15	Sandy loam	0.87	0.077	10.67	12.10
	Basin	5.0	Sandy loam	0.85	0.058	14.10	14.90
1973	Top	4.77	Sandy loam	1.02	0.079	10.20	10.15
	Basin	4.75	Sandy loam	1.10	0.122	9.30	11.64
1978	Plain	4.65	Sandy loam	0.85	0.074	11.83	18.40
1979	Plain	4.50	Sandy loam	0.93	0.060	16.02	11.75

Table 2. Nutrient contents in rubber leaves collected from different gardens of Datmara.

plantation year	Plant's leaves of	Nitrogen %	Phosphorus %	Potassium %	Calcium %	Magnesium %
1972	Top	2.45	0.17	0.163	0.77	0.216
	Basin	2.45	0.20	0.209	0.90	0.138
	Average	2.45	0.185	0.186	0.835	0.177
1973	Top	3.05	0.15	0.219	0.745	0.096
	Basin	2.72	0.17	0.176	0.712	0.582
	Average	2.885	0.16	0.1975	0.7285	0.339

Nitrogen

All the extraction methods used in this study were found to be quite effective when their available nitrogen removing capacity is considered. Maximum quantities of nitrogen have been extracted from all the soils by Morgan's reagent. On the basis of this method, all the soils contained about 0.0023% available nitrogen. The basin soils of 1972 garden and top soils of 1973 garden contained comparatively larger amounts of available nitrogen. However, no significant correlation was found between the nitrogen contents of rubber leaves and available soil nitrogen extracted by different methods.

Table 3. Available nitrogen ($NH_4^+ + NO_3^-$) contents (%) of soils as extracted by different extractants.

Plantation year	Soils	Water extraction	1N.NaCl	1N.NaCl (pH—1)	Morgn's reagent	O.5M $NaHCO_3$	$HF + HClO_4$ treatment.
1972	Top	0.02932	0.0150	0.0142	0.0220	0.0160	0.0230
	Basin	0.00832	0.0200	0.0152	0.0280	0.0130	0.0210
1973	Top	0.01000	0.0174	0.0200	0.0275	0.0180	0.0168
	Basin	0.01000	0.0174	0.0093	0.0225	0.0100	0.0172
1978	Plain	0.00536	0.0120	0.0120	0.0210	0.0100	0.0165
1979	Plain	0.00402	0.0107	0.0120	0.0200	0.0100	0.0135

Phosphorus

The amount of available phosphorus in different soils as extracted by different methods used in this study varied widely (Table-4). This reveals the difference in extracting capacity among the different methods. Maximum quantities of available phosphorus were extracted from all the soils by Morgan's method. This method extracted about 4 times more phosphorus than 1N.NaCl and 2N. KCl methods. On the basis of Morgan's method, basin soils of 1972 garden contained maximum amount (60 ppm) of available phosphorus. Other gardens contained more or less equal amounts (50 ppm) of available phosphorus.

The coefficient of correlation between phosphorus contents of rubber leaves and the availability of soil phosphorus measured by different methods reveals that only Morgan's reagent and 1N. NaCl methods were statistically significant. Phosphorus contents extracted by Morgan's reagent and 1N. NaCl method were found to be significant at 0.1% level ($r = +0.9958$) and 2% level ($r = +0.8874$) respectively. Other methods did not show any significant correlation with uptake.

Islam *et al.* (1975) have found 2N. KCl and Morgan's reagent to extract relatively larger amounts of available phosphorus. But in this study Olsen's method extracted only about one-fifth of available phosphorus extracted by Morgan's reagent. This anomaly could be explained assuming these soils to contain calcium phosphate as "alkaline solution can hydrolyze iron and aluminium phosphates but not dissolve calcium phosphate (Chang and Juo, 1963)." The efficiency of Morgan's reagent for the assessment of available phosphorus also supports the findings of Anam *et al.* (1976, 1977 and 1978).

From the regression line (Figure-1a) for Morgan's extractable phosphorus and its uptake by plants, it seems that all the observed values (uptake) fall

Table 4. Available Phosphorus and Potassium contents (PPm) of soils as extracted by different extractants.

Plantation year	Soils	Water extraction		1 N. NaCl		1N.NaCl (pH–1.0)		Morgan's reagent		2N. KCl	0.5 $NaHCO_3$
		P	K	P	K	P	K	P	K	P	K
1972	Top	22.0	38.2	11.26	85.3	50.0	90.4	52.0	108.4	11.75	107.3
	Basin	18.0	20.9	16.25	79.5	40.0	86.2	60.0	103.2	10.75	114.5
1973	Top	25.0	18.6	11.25	75.1	40.0	72.1	48.0	100.8	10.0	112.1
	Basin	12.0	17.0	13.75	70.4	45.0	60.8	52.0	92.5	11.25	107.0
1978	Plain	16.25	11.9	10.62	70.3	42.5	61.8	48.0	86.3	10.0	93.2
1979	Plain	12.50	9.3	10.0	53.5	25.0	52.9	47.5	68.6	9.37	73.5

Table 5. Available calcium and magnesium contents (ppm) of soils as extracted by different extractants.

Plantation Year	Soils	Water extraction		I N. NaCl		I N. NaCl (pH-1.0)		2N. KCl		Exchangeable	
		Ca	Mg	Ca	Mg	Ca	Mg	Ca	Mg	Ca	Mg
1972	Top	64.0	27.2	220.0	132.6	206.0	22.8	272.0	138.4	122.0	34.8
	Basia	25.8	12.4	220.0	76.2	272.0	61.2	256.0	128.0	128.0	12.0
1973	Top	94.2	21.6	240.0	91.8	159.0	49.2	122.0	97.2	122.0	34.8
	Basin	57.8	17.2	200.0	61.8	177.0	37.2	220.0	128.4	110.0	54.8
1978	Plain	47.9	11.7	216.0	60.0	155.0	40.8	129.0	85.2	64.0	62.4
1979	Plain	32.4	8.7	194.0	58.2	148.0	38.4	128.0	48.0	76.0	70.8

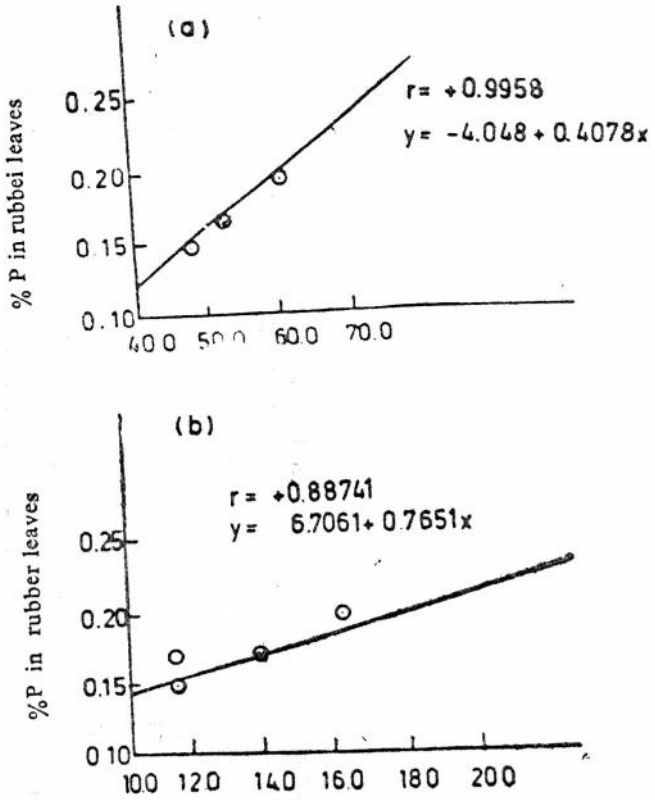

Fig 1. Regression line of available P (a. Morgan's method and b. NaCl method) on the P content of rubber leaves.

very close to the regression line. Hence, it may be suggested that Morgan's reagent may be used for the extraction of available phosphorus from these soils, while 1N. NaCl method (figure-1b) deserves to be counted as a favourable method.

Potassium

Out of five extraction methods used, 0.5M.$NaHCO_3$ and water extraction methods have been found to extract maximum and minimum amounts of available potassium respectively from all the soils. As regards the available potassium content, 1972 and 1973 gardens were superior to the other two gardens and contained 111 and 109 ppm available potassium (average of top and basin soils) respectively on the basis of 0.5M.$NaHCO_3$ method.

1978 and 1979 gardens contained 93 and 73 ppm available potassium respectively. The higher amounts of available potassium in these soils may be due to the immature nature of the soils containing easily weatherable minerals.

A better correlation was obtained between the uptake of potassium by the rubber plants and the availability measured by 0.5M.$NaHCO_3$ method. The coefficient of correlation was found to be significant at 2.0% level ($r = +0.8848$). Other methods failed to show any significant correlation with the uptake.

Regression line for extracted potassium as measured by 0.5M. $NaHCO_3$ method is shown in Figure-2. The regression line reveals that 0.5M. $NaHCO_3$

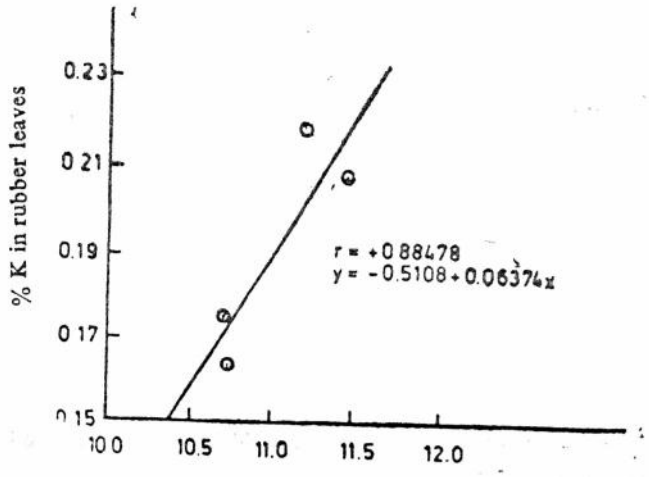

Fig. 2. Regression line of available K (0.5M $NaHCO_3$ method) on the K content of rubber leaves.

method may be employed for the extraction of potassium from top soils of 1972 and basin soils of 1972 garden.

Calcium

The amounts of calcium as extracted by different methods have been found to vary widely (Table 5). 1N.NaCl and 2N.KCl methods extracted comparatively more calcium than other methods and soils of 1972 gardens contained more calcium than soils of other gardens (272 and 256 ppm of calcium wore extracted from top and basin soils of 1972 gardens respectively by 2N.KCl method). In all the cases minimum amounts of calcium

were obtained through water extraction. Higher amounts of calcium in the 1972 garden may be attributed due to less acidic nature of this soil.

The correlation coefficient between calcium contents of rubber leaves and the available calcium in soils as extracted by acidified 1N. NaCl (pH-1.0) method was found to be significantly correlated at 1.0% level ($r = +0.9431$). The remaining methods did not show any significant correlation.

Regression line for acidified 1N. NaCl (pH—1.0) method is shown in Figure 3.

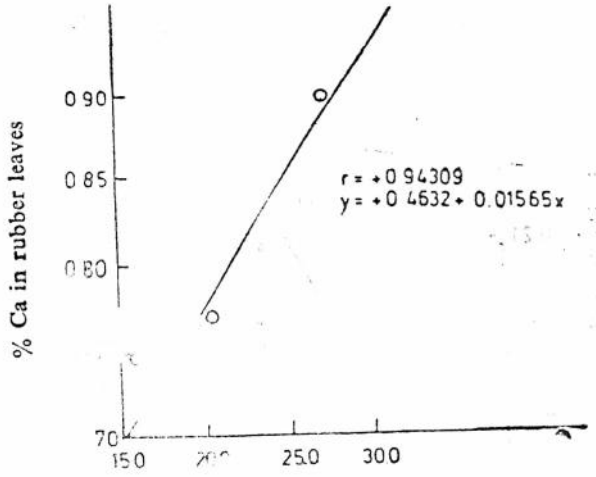

Fig. 3. Regression line of available Ca (acidified IN.NaCl method) on the Ca content of rubber leaves.

The regression line shows that calcium as extracted by acidified 1N. NaCl (pH—1.0) method may be considered as suitable for all the soils under study except for the soils of 1973 garden.

Magnesium

The amount of magnesium extracted varied widely within the soils and within the methods of extraction. 2N. KCl extracted maximum amounts of magnesium while water extraction gave minimum amounts of magnesium in case of all soils. 138 and 128 ppm of magnesium were extracted by 2N. KCl method from top and basin soils of 1972 garden which were the highest values among all the soils. Higher amounts of magnesium in soils of this garden may be attributed due to less acidic nature of these soils.

EVALUATION OF THE METHODS OF NUTRIENT ASSESSMENT

All the extraction methods used in this study reflected their poor capability to show significant correlation between the available magnesium contents of the soils as extracted by different methods and the uptake by rubber plants. So, further research work is necessary to find out a suitable extraction method for the assessment of available magnesium in soils of Datmara series.

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