Soil Phys.Cond.Plant Growth,Jpn,68,15~24,1993

Original

Potassium Status and Release Characteristics of Twelve Floodplain Soils of Bangladesh.

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ABSTRACT

An introductory investigation on soil conditions in relation to K status and release characteristics of twelve soils reveal that the physical and chemical properties of the studied soils varied considerably with the variation of soil parent material, hydrology and climatic conditions. The texture of the soils varied from sandy to clay,organic matter content was rather low(6.9-19.8g kg^{-1}).Except for Sara soil,the pH(1 : 1,water)of the soils ranged between 4.7 and 5.3,indicating that the soils are acidic. Sara soil contained about 60 g kg^{-1} $CaCO_3$ and had an alkaline pH(8.2).Among the twelve soils,seven soils had exchangeable K^+ of more than 0.20 cmol(+)kg^{-1},which can be considered as the critical level of K for these soils.The exchangeable K^+/exchangeable Mg^{2+} ratio of the soils varied from 0.05 to 0.14.The structural K was about 93 to 99% of the total K,while exchangeable(0.26-1.02%)and non-exchangeable (1.07-8.33%)K comprised a small percentage of the total K.Non-exchangeable K in the soils determined by 0.7M H_2SO_4 and 1M HNO_3 methods varied from 0.11 to 3.26 and 0.44 to 3.94 cmol(+)kg^{-1}, respectively.

Rate of release of K from the soils was very high in the first extraction by both the 1M CH_3COONH_4 (1.02-3.07mmol kg^{-1})and 0.3M NaCl(0.90-2.47 mmol kg^{-1})solutions.With 1M CH_3COONH_4,the release of K was drastically reduced on the second day and virtually stopped on the third day of extraction.With 0.3M NaCl extraction,the rate of release of K was reduced gradually and even on the 11th day of extraction the release of K was considerable.Only K released with 0.3M NaCl showed a significant positive(r=0.70**)correlation with the non-exchangeable K.

Key words : acidic soils,critical level of soil K,exchangeable and non-exchangeable K,exchangeable K^+ /exchangeable Mg^{2+} ratio,release of soil K.

INTRODUCTION

The role of K in soils is prodigious. This prodigy mainly depends on the dynamic nature of different forms of soil K under various soil conditions.Soil K can be divided into solution,exchangeable,non-exchangeable,fixed and structural K[33].Literature providing information about different forms of soil K in the tropics and subtropics is not very abundant and very much scanty in the developing countries of South-east Asia.Moreover,most of the literatures have dealt only with the available fraction,which,by and large,has considered to be the exchangeable K^+, but non-exchangeable K content has not been emphasized[21].The importance of non-exchangeable K in relation to K release characteristics is even greater[3] than indicated by the previous investigations[2,14,27].Moreover, the rate at which non-exchangeable K is released from soil minerals has been found to be important in assessing the degree to which K is supplied to the soil solution or growing plants[21,35]. The K^+ removed by plants exceeded the initial exchangeable K^+ levels by considerable amounts[14].In soils containing little amount of non-exchangeable K,the exchangeable K^+ may be the predominant phase with respect to availability.Conversely,many soils of temperate regions contain little K^+ in the exchange phase,and

Table 1 Soil series name with location, hydrological and climatic conditions of the study area.

Parent material[a]	Soil Series	Hydrological condition[b]	Location	Rainfall[c](mm)	Drought condition[d]
Pleistocene–Terrace	1. Belabo	Well drained highland	Andharkota, Mitha–pukur, Rangpur.	2500	Slight
(Madhupur clay)	2. Amnura	Poorly drained highland	Gagusu, Tanore, Rajshahi.	1500	Very Severe
	3. Lauta	Deeply flooded land	Pakuria, Singra, Natore.	1700	Severe
	4. Ekdala	Poorly drained highland	Eankai, Dhupchan–cia, Bogra.	1800	Severe
Tista Alluvium	5. Domar	Well drained highland	Kaniakhata, Nilphamari.	2600	Slight
	6. Gangachara	Poorly drained highland	Kismat Parul, Pir–gachha, Rangpur.	2500	Slight
	7. Kaunia	Shallowly flooded land	Gorai, Ulipur, Kurigram.	3000	Slight
	8. Farabari	Shallowly flooded land	Gobindapur, Gaibandha.	2500	Slight
	9. Laskara	Shallowly flooded land	Nilkantapur, Gabin–daganj, Gaibandha.	2500	Slight
	10. Uttargaon	Deeply flooded land	Aguniatair, Sona–tala, Bogra.	1800	Severe
Ganges–Alluvium	11. Sara	Well drain highland	Haldigachi, Char–ghat, Rajshahi.	1500	Very Severe
Old Himalayan–Piedmont Alluvial Plain	12. Baliadangi	Poorly drained highland	Bara Balia, Thakurgaon.	2300	Less Moderate

Source : [a,c] FAO–UNDP[12]. [b] Master Plan Organization(MPO)report[22];and Land and Soil Resources Utilization Guide[30]. [d]Karim,et al.[18].

K availability depends on transformation from the non–exchangeable forms to replenish the exchangeable or solution phases upon depletion[9]. The K–supplying power of a soil depends not only on content and kind of K–bearing minerals in the soil but also on the rate at which structural and fixed K becomes available to plants[32]. Moreover, the sequence of the rates of K release varies with the release mechanisms [32]. Therefore, the nature of K reserves and rate of K release are very important to study potash chemistry of the soils in relation to crop response.

Accordingly, we considered some K problem soils in the semi–arid regions of Bangladesh where K fertility and fertilizers do not respond well. The present study is therefore, an introductory investigation on the physico–chemical conditions of the soils with respect to K chemistry, and on the K release characteristics of the soils as assessed by using different analytical techniques.

MATERIALS AND METHODS

Study site :

The study area is located between latitude 1377.1 rad or 24°2′N and longitude 5107.3 rad or 89°8′E. The site selection was made on the basis of different parent material and hydrological conditions of the soils(Table 1).

Climate : On the basis of the distribution of temperature over the year, the study area has two distinct seasons – the cool and the warm. Mean annual temperature(MAT) of the area is 25.3℃[20]. The mean winter(December to February) and mean summer(April to July) temperatures are 19.0 and 28.8℃, respectively. The summer maxima of the study area ranges from 33 to 36℃ in April and the minimum temperature of 6℃ is reached in January. Temperature regime can, therefore, be classed[31] as hyperthermic (MAT=>22.5℃).

The mean annual rainfall over the entire country is about 2300mm[22]. The distribution of total annual rainfall in the study areas vary considerably and ranges between 1500 and 3000mm(Table 1). In the recent years, drought have been so severe in April and May that rainfed agriculture has been severely affected and signs of desertification has become apparent. The study area can be classified into 4 categories(Table 1) on the basis of drought conditions[18].

The mean annual evaporation of the study area is about 1280mm[20]. Total annual evaporation is smaller than total annual rainfall but the evaporation exceeds rainfall during the dry seasons. Therefore, the existence of seasonal moisture surplus and deficit is prominent[17].

Soil samples : A laboratory experiment was conducted using 12 floodplain soils obtained from semi−arid regions of Bangladesh during 1990−91. Bulk soil samples (0−15cm depth) of Belabo, Domar, Gangachara, Kaunia, Baliadangi, Farabari, Laskara, Amnura, Lauta, Sara, Ekdala and Uttargaon series were collected for these studies. Sampling occurred in areas in which no K fertilizer had been applied for at least one year. The samples were air−dried and gently crushed to pass a 2.0mm sieve and sub−samples were obtained by passing through 1.0 and 0.25mm sieves as required.

After treatment with 30% H_2O_2, particle size distribution was determined by the pipette method[8]. Moisture at field capacity was determined by gravimetric method after oven drying at 105℃[4]. Organic matter content was determined by wet combustion with $K_2Cr_2O_7$[24]. Soil pH was measured for 1 : 1 suspension of air−dried soils in water, 1M KCl and 0.01M $CaCl_2$ using a Corning pH meter Model 7[16]. Cation exchange capacity (CEC) was determined by saturation with 1M CH_3COONH_4 (pH 7.0), ethanol washing, NH_4^+ displacement with acidified 10% NaCl solution, and subsequent analysis by steam (Kjeldahl method) distillation[6]. Exchangeable Na^+, Ca^{2+} and Mg^{2+} were extracted with 1M CH_3COONH_4 at pH 7.0. The modified $BaCl_2$−triethanolamine method[26] was used for the determination of exchangeable H^+.

Several availability indexes were used to evaluate the K status of these soils : exchangeable K by 1M CH_3COONH_4 buffered at pH 7.0[6]; non−exchangeable K by 0.7M H_2SO_4 and hot 1M HNO_3[19], and total K by HF digestion[5]. Structural K contents were estimated by subtracting the 0.7M H_2SO_4 and 1M HNO_3 extractable K from total K. The rate of release of K from soils were determined by using two (method I and II) methods[15]. In method I, triplicate 2.5 g portions of each soil (≦2mm sieved) were placed in 50cm³ centrifuge tubes and 25ml of 1M CH_3COONH_4 (pH 7.0) was added. The stoppered tubes were shaken for 24 hours and centrifuged. The supernatent liquids were analyzed for K. In method II, triplicate 5g portions of each soil were suspended in 50 ml of 0.3M NaCl in centrifuge tubes and supernatents were collected. The processes (Methods I and II) were repeated with the same soil for about 30 days till a plateau of K was reached.

RESULTS AND DISCUSSION

Soil Characteristics :

The physical parameters along with chemical and mineralogical characteristics are the most obvious criteria to recognize and use the soils for soil−plant−water relationship. Sand and clay fractions of the soils ranged from 24 to 63 and 17

Table 2 Physical and chemical properties of the studied soils (size = <2mm, depth= 0 −15cm) on oven dry basis.

Soil Series	Particle size* (%)			Textural Class*	Field capacity (kg kg⁻¹)	Soil pH (1:1)			Organic matter	Total N	C/N ratio
	Sand	Silt	Clay			H_2O	1M KCl	0.01M$CaCl_2$	<—($g\ kg^{-1}$)—>		
Belabo	48	32	20	Loam	0.24	4.9	4.1	4.0	7.4	0.6	7.2
Domar	63	20	17	Sandy loam	0.32	4.8	4.0	3.7	8.8	0.7	7.3
Gangachara	43	37	20	Loam	0.39	5.0	4.2	4.1	9.6	0.9	6.3
Kaunia	32	35	33	Clay loam	0.38	53.0	4.6	4.4	10.8	0.7	9.0
Baliadangi	53	24	23	Sandy clay	0.26	4.7	4.0	3.7	10.8	0.8	7.9
Farabari	24	41	35	Clay loam	0.42	4.9	4.1	3.9	11.7	0.9	7.6
Laskara	28	27	45	Clay	0.26	5.2	4.1	3.8	18.4	1.5	7.1
Amnura	38	33	29	Clay loam	0.35	5.3	3.9	3.8	6.9	0.6	6.7
Lauta	26	23	51	Clay	0.35	5.3	4.0	4.0	12.4	0.8	9.0
Sara	56	25	19	Sandy loam	0.29	8.2	7.4	7.0	6.5	0.3	12.7
Ekdala	40	35	25	Loam	0.32	4.9	4.1	4.0	19.8	1.1	10.5
Uttargaon	25	38	37	Clay	0.31	5.1	4.1	4.2	10.8	1.0	6.3

* Particle size and textural class according to the international system.

Table 3 Cation exchange capacity, exchangeable cations and potassium status of the studied soils.

Soil Series	CEC	Exchangeable bases Na$^+$	K$^+$	Ca^{2+}	Mg^{2+}	Total bases	Exch. H$^+$	Base saturation (%)
	cmol(+)kg^{-1}							
Belabo	10.0	0.28	0.24	2.48	1.70	4.70	5.30	47.0
Domar	10.2	0.53	0.19	2.02	2.80	5.54	5.66	54.5
Gangachara	12.2	0.54	0.18	4.31	3.17	8.20	4.00	67.2
Kaunia	12.8	1.16	0.18	5.72	2.74	9.80	3.00	76.6
Baliadangi	11.6	0.34	0.18	2.42	2.12	5.06	8.54	44.0
Farabari	14.9	0.50	0.20	5.08	3.22	9.00	5.90	60.4
Laskara	17.5	0.37	0.46	5.38	3.43	9.64	7.86	55.1
Amnura	13.7	0.29	0.18	5.70	3.14	9.30	4.40	67.9
Lauta	24.9	0.44	0.43	11.0	5.03	15.6	9.33	62.5
Sara	14.7	0.29	0.25	10.9	3.17	14.6	0.00	98.8
Ekdala	13.9	0.46	0.28	5.07	2.13	7.94	5.96	57.1
Uttargaon	17.3	0.47	0.20	7.25	4.32	12.2	5.06	70.7

.........continued

Table 3 Continued.

Soil Sereis	[a]Exch.K/[b]Non-exch.K ratio	[a]Exch. K percentage[c]	[b]Non-exch. K percentage[c]	Exch.K$^+$/Exch.Mg^{2+} ratio
Belabo	0.44	0.57	1.30	0.14
Domar	0.05	0.40	8.33	0.07
Gangachara	0.05	0.27	5.56	0.06
Kaunia	0.10	0.26	2.65	0.07
Baliadangi	0.22	0.26	1.20	0.08
Farabari	0.13	0.27	1.99	0.06
Laskara	0.26	0.60	2.29	0.13
Amnura	0.40	0.43	1.07	0.06
Lauta	0.90	1.02	1.14	0.09
Sara	0.14	0.44	2.99	0.08
Ekdala	0.64	0.71	1.12	0.13
Uttargaon	0.13	0.27	2.18	0.05

[a]Exchangeable K by 1M CH_3COONH_4. [b]Non-exchangeable K by hot 1M HNO_3. [c]Percentage of the total K.

to 51%, respectively (Table 2). The texture of the soils ranged from sandy loam to clay. Five textural classes were recognized within the soils, such as sandy loam (Domar and Sara soils), sandy clay (Baliadangi soil), loam (Ekdala, Gangachara and Belabo soils), Clay loam (Uttargaon, Amnura and Kaunia soils), and clay (Lauta and Laskara soils). The field capacity of the soils ranged from 0.24−0.42kg kg^{-1}.

The pH(H_2O) ranged from 4.7 to 5.3 (Table 2) except for Sara soil, indicating that the soils are acidic. Only Sara had alkaline pH (pH 8.2) and contained about 60g kg^{-1} $CaCO_3$. When pH was determined in 1M KCl and 0.01M $CaCl_2$, there was a drop in pH in all the soils, and the drop of pH was large in all the soils with 0.01M $CaCl_2$ solution.

Organic matter content in the soils was rather low, ranging from 6.9 to 19.8g kg^{-1} (Table 2). Only Ekdala and Laskara soils had about 20g kg^{-1} organic matter, and Uttargaon, Lauta, Farabari, Baliadangi and Kaunia soils had about 10g kg^{-1} organic matter. The rest soils had less than 10g kg^{-1} organic matter. Total nitrogen content was low as in the case of organic matter and ranged from 0.3 to 1.5g kg^{-1}. The optimum (about 10) carbon−nitrogen (C/N) ratio was found only with Ekdala soil and the other soils had C/N ratio below the this level (Table 2).

The cation exchange capacity of the soils ranged from 10 to 18 cmol(+)kg^{-1} (Table 3), except for Lauta soil (25cmol(+)kg^{-1}). A positive correlation was obtained between CEC and organic matter ($r=0.34^*$), and between CEC and clay contents ($r=0.87^{**}$). The content of exchangeable Na^+ varied from 0.28 to 0.54 cmol(+)kg^{-1}, except for Kaunia soil which contained 1.16 cmol(+)kg^{-1}.

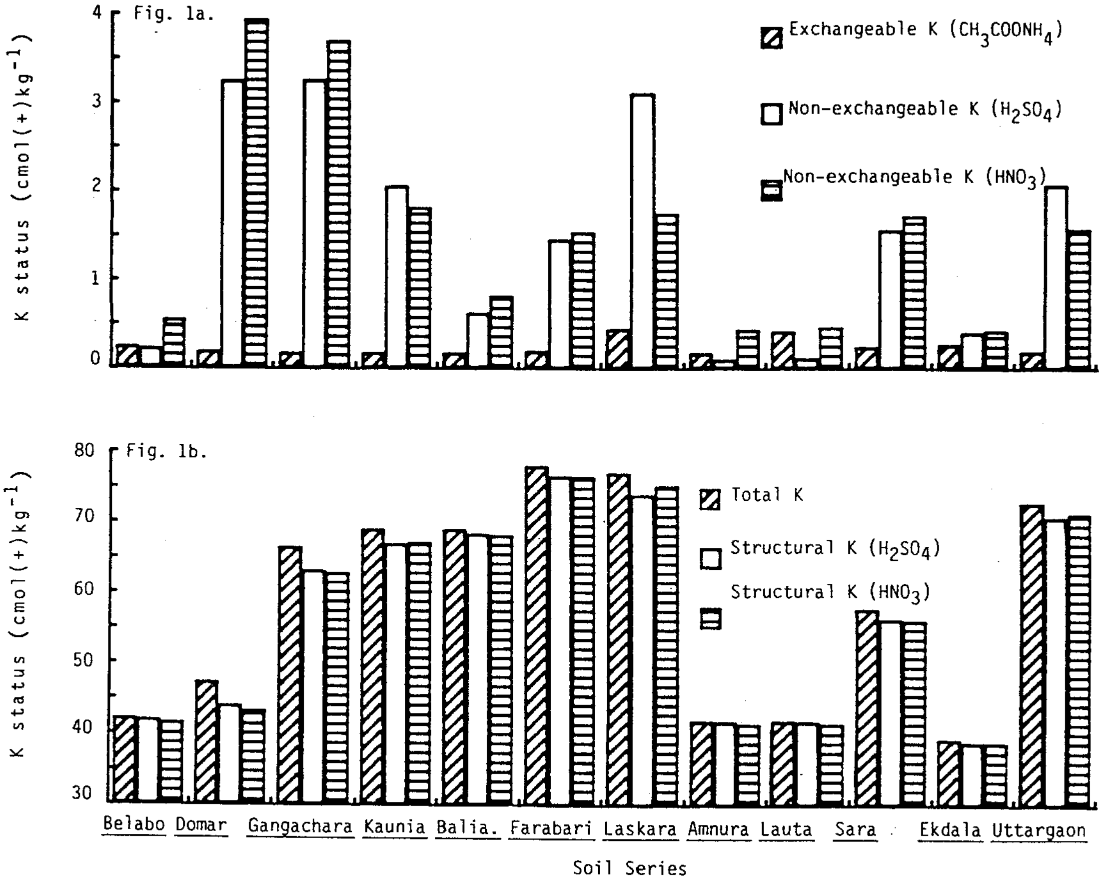

Fig. 1 Exchangeable and non-exchangeable K (a), total and structural K (b) status of the studied soils.

Exchangeable K^+ contents of the soils varied from 0.18 to 0.46 cmol(+)kg^{-1} and non−exchangeable K, when determined with 0.7M H_2SO_4 and 1M HNO_3 methods, ranged from 0.11 to 3.26 and 0.44 to 3.94 cmol(+)kg^{-1}, respectively (Figure 1a). Of the above two extractants, hot 1M HNO_3 extracted a little higher amounts of non−exchangeable K in the most of the soils, while for Kaunia, Laskara, Uttargaon soils, 0.7M H_2SO_4 extracted the higher amounts of non−exchangeable K. Among the twelve soils, seven soils had exchangeable K^+ of more than 0.20 cmol(+)kg^{-1}. According to Munson[23], this value (0.20 cmol(+)kg^{-1}) can be considered as the critical level of K for these soils and these soils may be considered to contain sufficient K in the labile form (Fig.1). However, these values are quite low as compared with the modal concentration (0.7 cmol(+)kg^{-1}) for tropical and subtropical acid soils[1]. The soils contained relatively small amounts of exchangeable Na^+ and K^+. Calcium was the dominant exchangeable cation and the highest amount of exchangeable Ca^{2+} was obtained from Lauta (11.0) and Sara (10.9 cmol(+)kg^{-1}) soils (Table 3). The exchangeable Ca^{2+} of the rest soils ranged from 2.02 to 7.25 cmol(+)kg^{-1}. Magnesium was ranked second among the exchangeable cations and varied from 1.70 to 5.03 cmol(+)kg^{-1}. The K^+ and Mg^{2+} have physiological antagonism[3]. Thus, with respect to plant uptake, the exchangeable K^+/Mg^{2+} ratio may be more important. These ratios for the studied soils ranged between 0.05 and 0.14 (Table 3). For the lower ratio soils, K availability might be hindered by higher Mg content of the soils. Therefore, K^+/Mg^{2+} ratio of the soil should be considered before predicting K availability. Exchangeable H^+ content was high and ranged between 3.00 and 9.33 cmol(+)kg^{-1}, except Sara soil where exchangeable H^+ was not found. The soil pH, percentage of base saturation and exchangeable H^+ content of the soils indicating that the most of the soils are acidic, except for Sara soil (Tables 2 and 3). Sara soil contained $CaCO_3$ (about 60 g kg^{-1}) in it and the percentage of base saturation was very high (98.8%), indicating that the soil was alkaline.

Kaolinite and illite were the dominant clay minerals in all the studied soils[29]. Illite content was comparatively higher in the Pleistocene terrace (Belabo, Amnura, Lauta and Ekdala soils) and Ganges alluvial (Sara) soils than Tista alluvial (Domar, Gangachara, Kaunia, Farabari, Laskara and Uttargaon) soils, but kaolinite content was high in Tista alluvial soils. The large amounts of occurrence of interstratified (0.7nm/1.0nm, 1.0nm/1.4nm) clay minerals in the soils of Pleistocene terrace has been reported[10,13]. In the sand fraction of Pleistocene terrace soils, the dominant mineral was quartz, while feldspars and mica content was low[11]. The Ganges and Tista alluvium soils contain relatively high quantities of mica than the soils of Pleistocene terrace[29].

The above results demonstrate that the soils varied considerably in their physical and chemical characteristics with the variations of their parent material, hydrology and climatic conditions (Tables 1−3).

Potassium Chemistry Studies :

Most of the soils contained large quantities of total K (Fig. 1b), even though there were some soils containing high quantities of sand. The quantity of total K was found maximum (78.0 cmol(+)kg^{-1}) in Farabari soil and minimum (39.3 cmol(+)kg^{-1}) in Ekdala soil (Fig. 1b), which may be due to the variation of parent material, hydrology and climatic conditions of the soils. However, these quantities of total K can be compared with those in some acid soils of Himachal Pradesh of India, which were sandy clay − loam − silt loam and contained 32.1 to 53.5 cmol(+)kg^{-1} of total K, and had a low amount of available K but did not respond to K application[7]. These quantities of total K are also within the range of typical temperate region soils[3], and considerably higher than those found in Atlantic Coastal Plain soils in Virginia[34] and Florida[36]. This may be due to the presence of higher amounts of K−bearing minerals in the soils. The quantities of exchangeable (0.26−1.02%) and non−exchangeable (1.07−8.33%) K comprised a small percentage of the total K (Table 3). The exchangeable and non−exchangeable K were 0.2 and 1.5%, respectively of the total K in the soils of Himachal Pradesh[7], which are quite similar in status with the exchangeable K of the studied soils but different in the non−exchangeable K content.

The ratio of 1M CH_3COONH_4 extractable to 1M HNO_3 extractable K of five soils ranged from 0.22 to 0.64 (Table 3), suggesting that the exchangeable and non−exchangeable K levels of these soils were reasonable in relation to K release characteristics [25]. But the rest of the soils had higher amounts of non−exchangeable K, except for Lauta soil. The amount of exchangeable K was relatively high as with the amounts non−exchangeable K in the Lauta soil suggesting that the soil may not be respond well to K−fertilization. The rather low amounts of exchangeable plus non−exchangeable K in Belabo, Baliadangi, Amnura and Ekdala soils suggesting that some crops may respond to applied K.

Figure 1b shows that structural K occupied the principal fraction of the total potassium in the studied soils, and its content ranged from 38.9 to 76.5 cmol(+)kg^{-1}. The structural K was about 93−99% of the total K and the similar quantities of structural K has also been noticed in the soils of Atlantic Coastal Plain[25]. The amounts of the structural K show that the reserve of K in the soils was very high that could be supplying K over a period of time to plants and could thus account for the lack of crop response to applied K. Now a question can be posed; what is the rate of K release from these soils? Accordingly, the

Table 4 Rate of release of potassium from the soils by extraction with 1M CH_3COONH_4 (soil : solution= 1 : 10).

Soil Series	K released by 1M CH_3COONH_4 (mmol kg^{-1}) Days 1	2	3	4	5	Total K released (cmol kg^{-1})	% K* released
Belabo	1.66	0.22	0.00	0.00	0.00	0.19	0.45
Domar	1.28	0.13	0.00	0.00	0.00	0.14	0.30
Gangachara	1.12	0.51	0.00	0.00	0.00	0.16	0.25
Kaunia	1.02	0.13	0.00	0.00	0.00	0.12	0.17
Baliadangi	1.15	0.16	0.00	0.00	0.00	0.13	0.19
Farabari	1.50	0.26	0.00	0.00	0.00	0.18	0.23
Laskara	3.07	0.48	0.00	0.00	0.00	0.35	0.46
Amnura	1.15	0.19	0.00	0.00	0.00	0.13	0.32
Lauta	2.49	0.26	0.00	0.00	0.00	0.27	0.65
Sara	1.53	0.19	0.00	0.00	0.00	0.17	0.30
Ekdala	2.05	0.19	0.00	0.00	0.00	0.22	0.57
Uttargaon	1.28	0.22	0.00	0.00	0.00	0.15	0.21

*Per cent K (% K) released=(amount of total K released/amount of total K in the initial soil) x 100.

Table 5 Rate of release of potassium from the soils by extraction with 0.3M NaCl (soil : solution=1 : 10).

Soil Series	K released by 0.3M NaCl (mmol kg^{-1}) Days 1	2	3	4	5	6	7	8	9	10	11	Total K released (cmol kg^{-1})	% K* released
Belabo	1.43	0.40	0.28	0.26	0.15	0.13	0.13	0.13	0.13	0.19	0.06	0.33	0.78
Domar	1.39	0.77	1.00	1.23	1.24	1.28	1.53	1.32	1.24	1.32	1.28	1.36	2.87
Gangachara	1.04	0.47	0.26	0.26	0.26	0.21	0.24	0.26	0.26	0.26	0.26	0.37	0.56
Kaunia	0.96	0.40	0.30	0.30	0.19	0.15	0.13	0.13	0.13	0.13	0.13	0.29	0.43
Baliadangi	1.02	0.32	0.21	0.21	0.13	0.06	0.06	0.13	0.13	0.13	0.13	0.25	0.37
Farabari	1.28	0.51	0.26	0.26	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.32	0.41
Laskara	2.47	0.83	0.26	0.26	0.26	0.21	0.19	0.21	0.13	0.13	0.13	0.51	0.66
Amnura	0.90	0.26	0.13	0.13	0.13	0.06	0.03	0.03	0.03	0.03	0.03	0.17	0.41
Lauta	1.39	0.60	0.38	0.26	0.26	0.13	0.13	0.13	0.13	0.13	0.08	0.36	0.86
Sara	1.28	0.55	0.38	0.34	0.30	0.26	0.26	0.26	0.26	0.26	0.19	0.43	0.75
Ekdala	1.53	0.45	0.26	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.63
Uttargaon	0.96	0.38	0.26	0.26	0.13	0.13	0.13	0.13	0.13	0.13	0.11	0.27	0.37

*Per cent K (% K) released=(amount of total K released/amount of total K in the initial soil) x 100.

mechanisms of K release of these soils were studied over a 30 days period(Tables 4 and 5) by using two extractants(1M CH_3COONH_4 and 0.3M NaCl).

Release Characteristics :

The total quantity of K released by 1M CH_3COONH_4 extractant is presented in Table 4. Potassium released on the first day ranged from 1.02 to 3.07 mmol kg^{-1} of soil. On the second day, the range of K released varied from 0.13 to 0.51 mmol kg^{-1} of soil. Release on the third to fifth day was zero in all soils. Potassium released by 0.3M NaCl extractant on the first day ranged between 0.90 and 2.47 mmolkg^{-1}(Table 5). On the second day, the release was reduced by about one half in all the soils. On the third day, the release was further reduced and this reduced rate continued for about 11 days, indicating that there were still considerable K reserve after second extraction and the reserve K had a definite solubility in 0.3M NaCl but not in 1M CH_3COONH_4. The release characteristics of K in these soils differed very much depending on the extractant used. Domar soil released very large quantity of K when extracted with 0.3M NaCl even on the 30th day of extraction. The total K released by 1M CH_3COONH_4 and 0.3M NaCl methods ranged from 0.12 to 0.35 and 0.17 to 1.36 cmol kg^{-1}, respectively. The amount of K released by the 0.3M NaCl was 0.37 to 2.87% of the total K, while K released by 1M CH_3COONH_4 was 0.17 to 0.65%. Only NaCl−extractable K showed significant($r=0.70^{**}$) positive correlation with the non−exchangeable K. Of these two extractants, 0.3M NaCl method was found to extract almost double amount of K as compared with 1M CH_3COONH_4, and in some soils 0.3M NaCl−extractable K was about four−five times higher than those obtained by 1M CH_3COONH_4 method. These release characteristics of K agreed well with the findings of some researchers[28]. They found that K release increased rapidly and then began to level off as an equilibrium of K status was approached and the rate of K release varied with the mechanisms of the release[28,32].

SUMMARY

The results of the present investigation on soil conditions relating to K status and release mechanism conclude that the parent material, hydrology and climatic conditions have great influence on K−chemistry of the soils. Most of the studied soils were acidic, had moderate physical properties, and the dominant texture was loam. The 1M CH_3COONH_4 extractable K of 0.20 cmol(+)kg^{-1} was thought as the critical level of K for these soils. The exchangeable K^+/Mg^{2+} ratio of the soils varied from 0.05 to 0.14, suggesting that K availability might be hindered at the lower K^+/Mg^{2+} ratio soils. Therefore, K^+/Mg^{2+} ratio of the soils should be considered before predicting K availability. Structural K was about 93 to 99% of the total K, which indicated that the reserve of K in the soils was very high that could be supplying K over a period of time to plants and could thus account for the lack of crop response to applied K. The hot 1M HNO_3 method was found to extract a little higher amount of non−exchangeable K than 0.7M H_2SO_4.

The rate of release of K differed very much depending on the extractant used. The 0.3M NaCl extractant would be more suitable than 1M CH_3COONH_4 in order to predict the K release characteristics of the soils. Domar soil released K even on the 30th day of extraction with 0.3M NaCl. This behavior of K release by 0.3M NaCl extractant needs further investigation.

Acknowledgments :

This research was carried out under the project entitled "Potassium studies in soils and crops of Bangladesh" at the Department of Soil Science, University of Dhaka, and funded through the Subsidy in Aid for Overseas Researches of Canadian International Development Authority(CIDA) and Bangladesh Agricultural Research Council(BARC).

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(Received 23th June, 1993)