Agropedology, 1998, **8**, 90-93

Forms of Potassium in some soils of Arunachal Pradesh

*S.P. Singh, Jagat Ram, Nanak Singh and A.K. Haldar**

National Bureau of Soil Survey & Land Use Planning, Regional Centre, New Delhi 110 012, India

* National Bureau of Soil Survey & Land Use Planning, Regional Centre, Calcutta 700 091, India

Abstract

The results of study on different forms of K and their relationship with soil characteristics in twenty nine soil series belonging to Entisols, Inceptisols, Alfisols and Mollisols occurring on various landforms in the state of Arunachal Pradesh indicated that nearly 12.4 per cent of the total K was present in the HCl soluble form, 1.8 per cent in the non-exchangeable form and 0.9 per cent in the available form. The average contribution of water soluble and exchangeable K towards available K was 9.3 and 90.7 per cent, respectively. Total and HCl soluble K were positively correlated with silt and clay, respectively. Water soluble, exchangeable and available K maintained a positive relationship with organic carbon.

Additional Keywords: Total potassium, available potassium.

Introduction

Potassium availability in soils depends on the total K content and release characteristics from its different forms as influenced by the soil characteristics. In addition, through its influence on drainage, runoff, leaching, erosion and vegetal cover, physiography also affects potassium availability to plants. For a critical appraisal of potassium supplying capacity of soils, a knowledge of different forms of potassium and conditions controlling their availability is essential. Though adequate information is available on the forms of potassium and its availability in the soils of adjoining state of Mizoram (Singh *et al.* 1989; Singh and Datta 1986) and Assam (Basumatary and Bordoloi 1992) very little is known about this nutrient in the soils of Arunachal Pradesh. The present investigation was, therefore, undertaken to evaluate various forms of potassium as affected by soil characteristics in this hilly and mountainous state of the north-east India.

Material and methods

Situated in the extreme north-east of India (26°30' to 29°28'N latitudes and 91°25' to 97°24' E longitudes), Arunachal Pradesh is characterised by humid to perhumid sub-tropical climate. The mean annual rainfall varies from 1380 to 5500 mm whereas the mean annual soil temperature ranges between 18°C to 22°C with a length of growing period exceeding 270 days in a year. The soil moisture and temperature regimes of this region are udic and thermic, respectively (Sehgal and Mandal 1995). The terrain is extremely hilly and mountainous but for some narrow inter-hill valleys and foot hill slopes. Geologically, the region is characterised by the presence of sedimentary and metamorphic rocks of various epochs starting from the Palaeozoic to Recent formations.

One hundred and fifteen surface soil samples representing twenty nine soil series belong to Entisols (six), Inceptisols (seven), Alfisols (ten) and Mollisols (six), occurring on different landforms were collected, processed and analysed for their physical and chemical properties by standard procedures (Jackson 1977). Total potassium was extracted with HF-$HClO_4$ mixture and available K by leaching the soil with 1*N* NH_4OAc (Jackson 1977). Water soluble K was extracted by shaking in 1:5 soil-water ratio (Grewal and Kanwar

1966). The water soluble K was subtracted from available K to get the exchangeable fraction. HCl soluble and non-exchangeable K were determined according to the methods outlined by Piper (1966) and Graley *et al.* (1960), respectively. The estimation of K in all the extracts was done with the help of a flame photometer.

Results and discussion

Some characteristics of the soils and the content of different forms of potassium are presented in table 1. In general, the soils were strongly acidic in reaction (pH 4.0 to 5.9).

Table 1. Some characteristics and forms of potassium (mean value) in the different soil series

Series	Silt	Clay	O.C.	Water soluble K	Exchangeable K	Available K	Non-exchangeable K	HCl soluble K	Total K
	<—— (%)		——>	<——		mg kg^{-1}		——>	(%)
				ENTISOLS					
Pange	75.3	17.9	2.00	34.7	237.8	272.5	553.3	3860	3.66
Meriyang	44.3	20.7	2.52	30.9	249.1	280.0	668.0	2442	3.66
Takso	15.0	16.8	1.06	12.7	141.7	154.4	726.8	2895	1.54
Belek	36.2	14.4	2.68	30.9	250.9	281.8	536.1	386	4.82
Subsansiri	42.0	10.6	3.02	20.8	303.2	324.0	1156.0	6895	4.89
Yagging	63.6	17.3	2.25	20.4	315.9	336.3	743.7	6031	3.75
				INCEPTISOLS					
Padam	63.3	22.7	2.76	35.5	349.1	384.6	448.4	2413	3.86
Kambeng	69.3	17.1	2.10	35.4	330.4	365.8	430.0	6031	5.50
Jambo	63.7	20.0	1.97	30.9	338.0	368.9	480.0	9722	5.59
Kelleng	63.0	27.0	3.03	30.2	356.5	386.7	453.3	3136	3.66
Beko	63.8	16.0	1.40	20.3	348.6	368.9	476.1	4342	2.50
Nilleng	59.3	27.1	1.23	34.7	322.0	356.7	493.3	3377	2.70
Garu	48.6	19.0	1.19	35.0	328.6	363.6	1265.1	6574	3.08
				ALFISOLS					
Renging	68.4	12.3	3.03	30.9	320.9	351.8	638.3	4050	3.37
Lorging	65.0	21.0	2.25	26.2	362.5	384.4	743.7	3136	3.08
Lirum	64.1	20.1	2.15	20.8	349.5	370.4	605.6	6272	4.59
Gensi	70.6	23.2	2.58	31.6	336.5	368.1	631.9	4342	3.28
Pobdi	20.3	31.2	2.07	20.0	349.1	369.1	704.9	6996	4.05
Kaying	63.0	20.7	2.28	37.0	327.0	364.0	1626.0	5066	4.19
Morl	21.0	31.5	2.10	24.0	367.6	391.6	928.4	9408	3.28
Bomte	48.3	20.1	1.02	13.3	256.9	270.2	1169.8	6272	4.82
Monku	64.2	27.7	2.30	30.8	369.0	399.8	2182.0	5307	2.89
Gemotali	26.2	25.4	2.20	19.2	348.9	368.1	1367.0	5583	4.43
				MOLLISOLS					
Sipang	62.8	29.2	3.49	39.2	368.2	407.4	392.6	3375	3.28
Dalbeng	41.1	20.0	4.47	40.0	371.9	411.9	391.9	2895	3.09
Haug	66.8	19.3	5.20	71.0	377.8	448.8	381.0	5790	5.79
Puda	58.9	22.7	5.70	77.2	520.2	599.4	360.0	5548	3.86
Tale	39.0	10.2	6.23	77.2	424.6	501.8	358.2	1930	4.05
Buda	65.3	19.4	3.85	49.2	356.6	405.8	1164.2	4580	3.86

Total potassium

In general, these soils are rich in total K due to the dominance of K bearing minerals. Similar results were reported by Singh and Datta (1986) for the soils of Mizoram. Total K increased with the silt contents (r=0.45*) indicating thereby the presence of substantial quantity of K bearing minerals in the silt fraction. Earlier studies (Singh *et al.* 1989) had shown that soils with a larger proportion of silt contain more of total K. Total K was higher in the soils of the flood plains than in the soils of the piedmonts and hill slopes due to variation in the degree of weathering.

HCl soluble potassium

This fraction on an average constituted 12.4 per cent of the total K and correlated significantly with clay (r=0.40*). It showed no significant relationship with pH, organic carbon and CEC (Prakash and Singh 1985). Soils occurring on hill slopes had lesser amount of this fraction in comparison to soils of piedmont and flood plains due to shifting of the finer soil fractions from higher to lower topography.

Non-exchangeable potassium

It constituted 1.9 and 14.9 per cent of total and HCl soluble K, respectively. It was inversely related with organic carbon content. Seventy per cent decrease in fixed K due to addition of organic matter has been reported by Patel *et al.* (1980) in the soils of Western Gujarat. The piedmont and flood plain soils which are under continuous paddy cultivation contained higher non-exchangeable K (Singh and Pasricha 1985), compared to the soils developed on hill slopes.

Exchangeable potassium

It contributed 0.8 and 6.3 per cent of total and HCl soluble K, respectively. Similar values were also reported by Singh *et al.* (1989) in the soils of Mizoram. Higher values of exchangeable K were associated with high organic carbon content (r=0.65*) indicating that sizeable amount of exchangeable K may be adsorbed on the exchange sites of organic carbon (Singh and Datta 1986).

Water soluble potassium

It represented 0.01 and 0.6 per cent of total and HCl soluble K, respectively. In general, water soluble K was higher in soils containing high amount of organic carbon, partly due to the release of labile K from organic residues (Singh and Tripathi 1993) and also to the capability of organic carbon in blocking specific and non-specific K binding sites, thus reducing K fixation (Verma and Verma 1968). It had a significant correlation with exchangeable K (r=0.64*), but it had no significant relationship with other forms of K.

Available potassium

It constituted 0.9 and 6.9 per cent, respectively of total and HCl soluble K. Water soluble and exchangeable K contributed 9.3 and 90.7 per cent respectively to the pool of available K. A highly significant correlation was observed with organic carbon (r=0.74*) suggesting its dependence on organic matter (Muhr *et al.* 1965). The soils of the area are rated as 'high' in available K.

References

Basumatary, A., and Bordoloi, P.K. (1992). Forms of potassium in soils of Assam in relation to soil properties. *Journal of the Indian Society of Soil Science* **40**, 443-446.

Graley, A.M., Nicollis, K.D., and Piper, C.S. (1960). The availability of potassium in some -Tasmanian soils.1. The variability of soil K in the field and its fractionation. *Australian Journal of Agricultural Research* **2**, 750-773.

Grewal, J.S., and Kanwar, J.S. (1966). Forms of potassium in Punjab soils. *Journal of the Indian Society of Soil Science* **14**, 63-67.

Jackson, M.L. (1977). 'Soil Chemical Analysis'. (Prentice Hall of India : New Delhi).

Muhr, G.R., Datta, N.P., Sankarasubramoney, H., Leley, V.K., and Donahue, R.L. (1965). Soil testing in India. (United States Agency for International Development : New Delhi).

Patel, M.S., Hadwani, G.J., and Yadav, B.S. (1989). Fixation of potassium in important soil groups of Western Gujarat. *Journal of Potassium Research* **5**, 134-142.

Piper, C.S. (1966). 'Soil and Plant Analysis'. (Inter-Science publication : New York).

Prakash C., and Singh, V. (1985). Forms of potassium in alluvial soils of western Uttar Pradesh. *Journal of the Indian Society of Soil Science* **33**, 11-14.

Sehgal, J., and Mandal, D.K. (1995). Soil-climatic environment in India. National Bureau of Soil Survey and Land Use Planning, Bulletin No. 58, Nagpur.

Singh, K., and Tripathi, D. (1993). Different forms of potassium and their distribution in some representative soil groups of Himachal Pradesh. *Journal of Potassium Research* **9**, 196-205.

Singh, M., and Pasricha, N.S. (1985). Release of potassium from illitic soils. In group discussion on soil testing, plant analysis and fertilizer evaluation for potassium, New Delhi, November 22-23, 1985.

Singh, O.P., and Datta, B. (1986). Forms of potassium in some soils of Mizoram. *Journal of the Indian Society of Soil Science* **34**, 187-190.

Singh, S.P., Haldar, A.K., and Singh, N. (1989). Studies on forms of potassium in relation to soil characteristics in the soils of Mizoram. *Indian Agriculturist* **33**, 55-58.

Verma, O.P., and Verma, G.P. (1968). Studies on available K in soils of Madhya Pradesh. *Journal of the Indian Society of Soil Science* **16**, 16-64.

Agropedology, 1998, **8**, 94-100

Prediction of plant available potassium in kaolinitic soils of India

*S.K. Pal**

Potash Research Institute of India, Sector-19, Gurgaon-122 001, Haryana.

Abstract

The effectiveness of five extractants, NH_4OAc, HNO_3, NaCl, AB-DTPA and Mehlich-3 was evaluated on 25 Indian soils dominated by kaolinitic clay minerals for prediction of plant available K to sorghum (*Sorghum vulgare* Pers.) grown in Neubauer technique. Total K uptake by five crops of 20 days old was used to measure plant available soil K. The average amount of K extracted were in the following order : AB-DTPA = HNO_3 < NaCl ≤ NH_4OAc ≤ Mehlich-3. The amount of K extracted by five extractants were significantly correlated with each other. The highest simple correlation with K uptake by sorghum was obtained with HNO_3-K ($r^2 = 0.945^{**}$) and the lowest with Mehlich-3-K ($r^2 = 0.636^{**}$). The K uptake was taken as the dependent variable and soil K extracted by the extractants, exchangeable Ca and Mg, organic carbon, cation exchange capacity (CEC), content of silt and clay as independent variables to develop stepwise regression model. Inclusion of soil properties improved the effectiveness of prediction except by HNO_3. In HNO_3-K model no soil properties could contribute significantly towards the improvement of prediction. However, based on the final R^2, HNO_3 is the best as a predictor of availability of K in kaolinite dominated soils.

Additional keywords: Potassium extractants, plant available K, sorghum, kaolinitic soil).

Introduction

Almost all the soil testing laboratories in India and also in abroad use 1*N* NH_4OAc solution of pH 7 as extractant to evaluate the available potassium status for making fertilizer recommendation. While evaluating the available potassium status the mineral make up vis-a-vis the ionic environment of the soils has grossly been undermined (Goswami *et al.* 1976). Various factors which can affect the availability of soil K are mineralogical characteristics, texture, CEC, organic matter, quantity/Intensity relations, interactions with other cations (Ca^{++}, Na^+, NH_4^+, Al^{+++}), moisture regime and environmental stresses (Chatterjee and Maji 1984).

Richards and Bates (1988) suggested that in addition to NH_4OAc-K, inclusion of step K (Haylock 1956) as a plant available K might improve the prediction of plant available K in Ontario soils. However, extraction of step K is time consuming exercise and not practical in routine analysis. It appears that a simple method is needed. Richards and Bates (1989) also found that 0.1*N* HNO_3 and 2*M* NaCl extractable K could explain more variation in total K uptake than did NH_4OAc. However, with inclusion of soil properties such as plant available non-exchangeable K and soil organic matter, NH_4OAc may be one of best predictors of availability of K in Ontario soils (Liu and Bates 1990).

Ammonium bicarbonate - DTPA (AB-DTPA) (Soltanpour and Schwab 1977; Soltanpour and Workman 1979) and Mehlich-3 (Mehlich 1984) used for the simultaneous extractions of number of macro and micro-nutrients in soils. Little is known about the efficiency of these multi-element extractants on Indian soils dominated by kaolinitic clay mineral.

The objective of this study was, therefore, to evaluate the effectiveness of several extractants mentioned above for prediction of the plant available K in kaolinitic soils of India.

* Present address: Dept. of Ag. Chem. & Soil Sci., N.B. Campus, B.C.K.V., Cooch Behar, West Bengal.