Eco. Env. & Cons. 20 (3) : 2014; pp. (1269-1272)
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ISSN 0971–765X

Dynamics of potassium in representative soil series of navsari district of South Gujarat

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(Received 20 May, 2014; accepted 1 July, 2014)

ABSTRACT

The present study on "Dynamics of potassium in representative soil series of Navsari district of South Gujarat" was carried out during the year 2013. Five locations are randomly selected from each series and from each location, two samples, i.e. 0-15cm and 15-30cm are collected. Thus, total 120 numbers of soil samples were collected separately from soil series of Navsari district. The results revealed that various forms of k, viz., water soluble potassium, available K, exchangeable K, non-exchangeable K, Total K and mineral K of Navsari district varying from 0.026 to 0.064 cmol/kg, 0.16– 0.43 cmol/kg, 0.39 -1.11cmol/kg, 0.69 – 1.33 cmol/kg, 18.96–29.54 cmol/kg and 17.25 – 27.70 cmol/kg, respectively in surface layer (0-15 cm) while 0.02 to 0.055 cmol/kg, 0.25 - 0.83 cmol/kg, 0.21 - 0.78 cmol/kg, 0.65 – 1.34 cmol/kg, 20.33 – 31.30 cmol/kg and 19.02–29.78 cmol/kg (15-30 cm), respectively in sub-surface layer. The results also revealed that the available K showed positively significant relationship (0.998) with exchangeable K. Total K positively significant with mineral K in 0-15 cm, while in 15-30 cm, the available K showed significantly and positively correlated (0.998) with exchangeable K.

Key words : *Potassium in soil, Fractions of potassium, South Gujarat*

Introduction

Potassium is the most extensively researched nutrient next only to nitrogen. Its status in the soils is uniquely dynamic and elusive and its functions in the plants are complex. Of the total potassium present in soils, more than 98% occurs in primary and secondary minerals and the rest occurs in either fixed or non-exchangeable or exchangeable (adsorbed) form or in soil solution (Ramanathan, 2011). Q/I studies showed that surface layer had more potassium supplying power than the sub-soil. The amounts of water soluble, exchangeable and non-exchangeable forms of potassium are used to evaluate the potassium supplying power of soil. One way of expressing the available potassium, *i.e.* labile pool (Q) and soluble potassium is the Quantity/Intensity (Q/I) relationship (Beckett). Beckett (1964_a ,1964_b) had shown that a joint consideration of quality factor ("K), the intensity factor (AR^k) and potential buffering capacity (PBC) gives a clear picture of the K characteristics of soil system. The general aim of potassium-dynamics is to explain the movement of potassium in soil-solution-plant systems. Keeping all the points in view, a research programme has been carried out for assessing the dynamics of potassium in representative soil series of Navsari district of Gujarat.

Materials and Methods

The district lies between latitude and longitude of 20.57^0 to 20.95^0 N and 72.56^0 to 72.93^0 E, respectively. Soil samples from surface (0-15cm) and sub-surface (15-30cm) were collected from twelve soil series namely Jalalpore, Mandir, Eru, Bodali, Kabilpor,

Sisodra, Onjal, Bilimora, Att, Dandi, Gadat and Amalsad of Navsari district. Five locations were randomly selected in each series of the district. These soil samples after preparation were analysed for different forms of potassium, i.e. exchangeable K extracted with 1 N NH_4OAC pH 7.0 (Jackson 1979), water soluble K (Richards 1983) and HNO_3 soluble K (Wood and De Trunk method) by flame photometrically, The non -exchangeable K was analysed by difference of HNO_3 soluble K and available K (Grewal and Kanwar 1966). The total K was analysed by HF-$HClO_4$ digestion method (Pratt 1988), while the mineral K was analysed by difference of total-K and HNO_3 soluble K.

Results and Discussion

Different forms of Potassium

The average value of the different from of the potassium in the surface and sub-surface soils for each series are presented in Table 1.

Water soluble-K

Water soluble potassium ranged from 0.026 to 0.064 cmol/kg in surface and 0.02 to 0.055 cmol/kg in the sub-surface soils. These finding are in good agreement with the observation of Ahmed and Walia (1999) and Padmaja and Sreenivasa (1999). The highest value was recorded in the Gadat series (0.064 cmol/kg). Relatively higher concentration of water soluble K in surface layer as compare to sub-surface layer is likely due to the application of potassic fertilizer or higher organic matter content or vegetation in the surface soil.

Exchangeable K

The exchangeable K was found in the range of 0.39 -1.11 cmol/kg in 0-15 cm while in 15 -30 cm, it was found in the range of 0.21 - 0.78 cmol/kg. The maximum value was recorded in the Sisodra series while minimum in Onjal series. The variation among soil series might be due to the variation in clay content with organic carbon having some additive effect. (Das *et al.* 2000).

Non-exchangeable K

The Non exchangeable K was found in the range of 0.69– 1.33 cmol/kg and 0.65–1.34cmol/kg in 0-15 cm and 15 -30 cm, respectively. The contents were found to be maximum in Onjal series and minimum in Bilimora series in surface layer soil samples and in sub-surface layer, it was maximum in Amalsad and minimum in Gadat series. The variation in depth wise distribution pattern of this fraction might be due to change in particle size distribution in various horizons.

Mineral-K

The content of mineral-K in soil series ranged from 17.25 to 27.70 cmol/kg with mean value of 21.80 cmol/kg in surface soil, while in sub- surface soil ranged from 19.02 to 29.78 cmol/kg with a mean value of 24.11 cmol/kg. The mineral K was found

Table 1. Average value of depth wise distribution of different forms of K in soil series of Navsari. (cmol/kg)

Series name	Water soluble K		Exchangeable K		NonExchangeable K		Mineral K	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
Eru Series	0.028	0.025	0.59	0.53	0.86	0.69	18.67	22.63
Jalalpur Series	0.027	0.023	0.71	0.62	1.09	1.01	27.70	28.17
Amalsad Series	0.026	0.020	1.06	0.75	1.19	1.34	21.48	23.37
Mandir Series	0.034	0.030	0.69	0.57	1.08	1.07	19.34	21.69
Bodali Series	0.029	0.025	0.59	0.40	1.09	0.88	17.25	19.02
Sisdora Series	0.057	0.048	1.11	0.78	1.22	1.16	25.05	25.96
Onjal Series	0.039	0.035	0.39	0.21	1.33	1.27	26.52	29.78
Aat Series	0.041	0.033	0.47	0.26	1.19	1.29	22.51	25.38
Dandi Series	0.041	0.034	0.54	0.34	0.74	0.65	18.10	21.02
Bilimora Series	0.037	0.029	0.48	0.31	0.69	0.68	22.98	26.58
Gadat Series	0.064	0.055	0.82	0.69	1.13	0.65	20.26	22.67
Kabilpor Series	0.049	0.039	0.58	0.53	1.30	1.12	21.76	23.06
Maximum	0.064	0.055	1.11	0.78	1.33	1.34	27.70	29.78
Minimum	0.026	0.020	0.39	0.21	0.69	0.65	17.25	19.02
Mean	0.039	0.033	0.67	0.50	1.08	0.98	21.80	24.11

maximum in Jalalpore series and minimum in Bodali series. It was also found to be lower in the majority of the surface soils possibly due to more intense weathering of K-bearing mineral of surface soils. Das *et al.* (2000).

Correlation between various form of potassium

The forms of potassium and their relative proportion in soils are usually influenced by various soil properties. From correlation Tables, exchangeable K showed significant and positive correlation (0.986) with available K and total K showed positively significant (0.979) with mineral K in 0-15 cm soil samples. The various forms of potassium were poorly correlated indicating difficulty in replenishment of available form of K from non-exchangeable and mineral K once, available pool of K is depleted. While in 15-30 cm, the available K showed significantly and positively correlated (0.998) with exchangeable K and total K showed positively significant with mineral K. These finding are in good agreement with the observation of Pharande and Sonar (1996) and Mishra and Srivastava (1991).

Quantity –Intensity parameter of potassium dynamics

The mean value of the analytical results of the equilibrium solutions and parameters of the potassium Q/I for different soil series are presented in Table 3. From the Table, Equilibrium Activity Ratio (AR^k_e), potassium potential, potassium buffering capacity (PBC) and non specific potassium etc, Q/I param-

Table 2. Coefficients of correlation among various K forms in surface and sub-surface soil-:

	Water soluble K	Available K	Exchangeable K	Non Exch. K	Total K K	Mineral K
			Surface Soil			
Water soluble K	1.000					
Available K	0.285	1.000				
Exchangeable K	0.236	0.986	1.000			
Non Exch. K	0.252	0.268	0.258	1.000		
Total K	0.110	0.164	0.160	0.471	1.000	
Mineral K	0.079	0.084	0.081	0.407	0.979	1.000
			Sub-Surface Soil			
Water soluble K	1.000					
Available K	0.259	1.000				
Exchangeable K	0.208	0.998	1.000			
Non Exch. K	-0.137	0.073	0.081	1.000		
Total K	0.056	-0.088	-0.093	0.466	1.000	
Mineral K	0.053	-0.160	-0.164	0.390	0.994	1.000
At two tail (r) = ± 0.574						

Table 3. Q/I parameters of potassium for different soil series

Soil series	ARK $(mol\ L^{-1})^{1/2}$	k Potential $cmolkg^{-1}/(mol\ L^{-1})^{-1/2}$	PBC (cmol/kg)	Non Specific K (cmol/kg)
Eru Series	0.0025	1.4160	23.6000	0.0600
Jalalpur Series	0.0039	3.1130	28.3000	0.1100
Amalsad Series	0.0025	0.9900	19.8000	0.0500
Mandir Series	0.0048	3.5490	27.3000	0.1300
Bodali Series	0.0022	3.7170	41.3000	0.0900
Sisdora Series	0.0057	3.4440	24.6000	0.1400
Onjal Series	0.0032	1.1100	18.5000	0.0600
Aat Series	0.0047	3.6140	27.8000	0.1300
Dandi Series	0.0084	4.2750	22.5000	0.1900
Bilimora Series	0.0028	1.3020	21.7000	0.0600
Gadat Series	0.0023	2.8160	35.2000	0.0800
Kabilpor Series	0.0039	4.3810	33.7000	0.1300

eters were discussed.

Equilibrium Activity Ratio (ARK_e)

It is the value at which soil neither gains or losses potassium *i.e.* ±"K=0. The value of AR^k_e ranged from $2.2^* 10^{-3}$ to 8.4^*10^{-3} (mol $L^{-1})^{1/2}$. Maximum values of AR^k_e were observed in Dandi series while minimum values of AR^k_e were found in Bodali series.

Potassium potential (K-potential)

It is the quantity and intensity relationship in a single parameter and was more closely related with the non-specific K and PBC. The potassium potential were observed maximum as 4.38 cmolkg^{-1}/(mol $L^{-1})^{-1/2}$ in Kabilpore series and minimum value is 0.99 cmolkg^{-1}/(mol $L^{-1})^{-1/2}$ in Amalsad series.

Potassium buffering capacity (PBC)

This is a measure of the ability of soil to maintain the intensity of soil solution potassium. It denotes the rate of change of quality (Q) with intensity (I) and is represented by the gradient of the curve. It was observed maximum in Bodali series (41.3 cmol/kg) and minimum in Onjal series (18.5 cmol/kg).

Non specific potassium

It gives an indication of the potassium adsorbed to non specific sites. It was found that the maximum non specific potassium was observed in the Dandi series (0.19 cmol/kg) and minimum in Amalsad series. (0.05 cmol/kg).

Conclusion

From this study, it can be concluded that comprehensive knowledge about the forms of potassium and their relationship among themselves help in assessing the status of potassium and its availability in soil. The surface soils contained normally more amount of all forms of K than sub-surface soils except mineral and total K. The different forms of K in soil showed a definite pattern of variation.

Q/I isotherm provides a better overview of K dynamics in soils. It is useful method to assess the K supplying power of soils to plant. The higher K intensity and activity lead to a lower PBC, which is a better indicator of the ability of soil to maintain K intensity. It could be inferred that in the soils studied, higher values of quantity parameters will give higher intensity of K, which will require low energy for the removal of the K from the exchange sites.

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