International Journal of Advanced Research and Development
ISSN: 2455-4030
Impact Factor: RJIF 5.24
www.advancedjournal.com
Volume 2; Issue 6; November 2017; Page No. 480-482

Assessment of distribution of different forms of potassium in soil

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Abstract
Potassium is essential for various metabolic activities of living cell, transformation of carbohydrates, reduction of nitrates, synthesis of protein and normal meristematic activities where it acts as a catalyst or as a co-factor in enzymatic reaction of living cells. In the present study, the various soil samples were studied. The amount of water soluble, exchangeable, available, non-exchangeable, lattice and total-K in soil samples; ranged from 0.008 - 0.051, 0.251 - 0.975, 0.266 - 1.012, 0.625 - 2.987, 21.818 - 45.883 and 23.515 - 49.640 me/100g with the mean value of 0.019, 0.550, 0.569, 1.463, 32.522 and 34.574 me/100g respectively. Results of the study indicated that all the forms of potassium found higher in black soils compared to red soils. The water soluble and exchangeable K was higher in surface sample compared to sub surface in both the soil type. Whereas, non-exchangeable, lattice and total K was higher in sub surface than the surface in both the soil types.

Keywords: potassium, soil, distribution, forms

Introduction
Potassium (K), is an essential element for plant growth which exists in soil in four forms, Viz. Water soluble K, which is taken up directly by plant; exchangeable - K, held by negative charges on clay particles and is available to plant; fixed - K which is trapped between layers of expanding lattice clays; and lattice-K and integral part of primary K bearing minerals. Potassium is one of the three major plant nutrient elements. Its importance in Indian agriculture has increased with intensification of agriculture (Schroeder, 1978) [9]. Potassium is an essential nutrient element for all living organisms including plants and animals. It is a univalent cation found in the largest concentration in the plant cell sap and so it is called a "master cation". Potassium is ionic (K+), free (not bound to any constituent) and mobile in plants. Potassium plays a vital roles in enzyme activation, water relations (osmotic regulation), energy relations, translocation of assimilates, photosynthesis, protein and starch synthesis (Singh *et al.*, 2001) [10]. Over sixty enzymes require K for their activation. In soils, potassium exists in different forms viz. water soluble, exchangeable, nonexchangeable and lattice potassium. The water soluble and exchangeable together constitutes the plant available potassium. The information on vertical distribution of potassium in agricultural soils is important because it indicates the distribution of potassium with respect to depth of soils (Bhaskar *et al.*, 2001) [1]. It also indicate the depletion as well as accumulation pattern of potassium, if any within the profile. The present studies were, therefore, undertaken to evaluate the distribution of different forms of K for the representative soil series of Sub-montane zone of Maharashtra. Since, there is no information available regarding the different forms of K and their inter relationship with some soils properties in soil of Mumbai region. Hence the attempt was carried out to investigate the distribution of different forms of K in surface soil

Materials and Methods
Collection and preparation of soil sample
Over all 10 surface soil samples (0-15 cm) were collected from 250 different field of Mumbai city. To evaluate the depth distribution of K in soil profile sample were collected up to 75 cm with an interval of 15 cm. These soil samples were air dried, crushed in wooden mortal and pastel passed through 2 mm sieve for physico-chemical properties using following standard procedures.

Mechanical composition of soil
The percentage of particles of different sizes that is sand, silt and clay was determined by mechanical analysis of soil. All the collected samples were analyzed by Bouyoucos Hydrometer method (1927).

Analysis of different forms of K
Water soluble K: Water soluable potassium was estimated in 1:5, soil: water suspension as described by Black (1965). The results were expressed in me 100 g-1.

Exchangeable K: Exchangeable potassium was determined by flame photometer using 1N neutral ammonium acetate extraction in 1:5 ratios as described by Black (1965). The results were expressed in me 100 g-1.

Non-exchangeable K: 1 N boiling HNO3 extractable potassium was estimated flame photometerically in 1:10, soil: acid suspension boiled for 10 minutes as described by Black (1965) and the results were expressed in me 100 g-1.

Total K: Total potassium was estimated flame photometerically by digestion with hydrofluoric (48%) and perchloric (70-72%) acid in platinum crucible by the method outlined by Black (1965) and the results were expressed in me

100 g-1.

Lattice K: Estimated by difference between total K and sum of water soluble, exchangeable and non-exchangeable potassium

Results and Discussion

In the present study, ten surface soil samples (0-15 cm.) and five profiles were collected from Mumbai City and analyzed for different forms of potassium and for mechanical as well as physico - chemical characteristics. Results of the investigation are described under the following heads.

Different forms of potassium

Water soluble K

Water soluble K was found in the range of 0.008 – 0.051 me/100g under different farmers field with the average value of 0.019 me/100g and contributes only 0.015 to 0.24 % of total K .

Exchangeable K

Exchangeable K was observed in the range of 0.251 – 0.975 me/100g under different farmers field with the average value of 0.550 me/100g, which accounted for 1.067 to 1.96 % of total-K.

Table 1: Different forms of potassium (me/100g) of soil samples

S. No	Water soluble K	Ex. K	Avail. K	Non-ex. K	Lattice K	Total K
1	0.016	0.502	0.518	0.913	34.376	35.823
2	0.011	0.549	0.560	1.422	37.316	39.309
3	0.016	0.730	0.746	1.988	36.366	39.116
4	0.016	0.520	0.536	1.177	35.028	36.757
5	0.015	0.442	0.457	0.951	35.189	36.612
6	0.013	0.584	0.597	1.257	34.906	36.773
7	0.014	0.509	0.523	1.261	37.459	39.257
8	0.014	0.522	0.536	1.035	35.878	37.463
9	0.012	0.505	0.517	1.225	37.76	39.514
10	0.012	0.312	0.324	0.652	31.757	32.745

These relationship indicated that there exited an equilibrium between these forms of K and depletion of one is instantly replenished by one or more of the other forms of K.

During the course of discussion an effort has been made to establish that the distribution of different forms of potassium and their relationship with important physico-chemical properties of soils. However, on the basis of findings an attempt has been made in the foregoing pages to explain the possible reason of variability obtained due to physico-chemical properties of soils. Wherever necessary findings of other workers have been also been quoted to support the result of the present investigation.

Water soluble K status of soil was found in the range of 0.008 - 0.051 me/100g under different farmers field with the average value of 0.019 me/100g and contributes only 0.015 to 0.24 % of total K . Result on the same line with different soil types have also been reported by Padole and Mahajan (2003) [8] Chandrasekhara rao and Krishnamurthy (2007) and Mandal *et al.* (2011) [7]. Exchangeable K status of was observed in the range of 0.251 – 0.975 me/100g under different farmers field with the average value of 0.550 me/100g, which accounted for 1.067 to 1.96 % of total-K. Kaskar *et al.* (2001) [5] also reported that exchangeable K contributed 1.39 % towards total K in soils. Available K status of was noticed in the range of 0.266 – 1.012 me/100g under different villages with the average value of 0.569 me/100g and contributing to 1.65 % of total-K. Kaskar *et al.* (2001) [5], Padole and Mahajan (2003) [8] and Mandal *et al.* (2011) [7] also reported that available K contributed same line towards total K. Status of non-exchangeable K under different farmers field was found in the range of 0.625 – 2.987 me/100g with the average.

Status of non-exchangeable K under different farmers field was found in the range of 0.625 – 2.987 me/100g with the average value of 1.463 me/100g and contributed 2.66 to 6.02 % of total K. Chand and Swami (2000) [3] and Kaskar *et al.* (2001) [5] also reported similar results with different soil type. Lattice K was found in the range of 21.818 – 45.883 me/100g under different farmers field with the average value of 32.522 me/100g. It is clear from results that the mineral pool of K is the main source of total K which accounts more than 90% of the total –K. Kaskar *et al.* (2001) [5] and Padole and Mahajan (2003) [8] also reported that lattice K contributed same line towards total K. Total K status was found in the range of 23.515 – 49.640 me/100g under different farmers field with the average value of 34.574 me/100g. Result on the same line with different soil types have also been reported by Padole and Mahajan (2003) [8].

The results reported in foregoing pages revealed that the pH of the soil samples showed significant negative relationship with exchangeable and non-exchangeable–K. In general, clay particles of the soil showed positive relationship with all the forms of potassium indicating this fraction of soils served as the dominant sink for all the forms of K (Kumari and Kumari, 2014) [6].

Conclusion

A highly significantly and positively relationship were observed between different forms of K, These relationships indicate that there existed equilibrium between these forms of K and depletion of one is instantly replenished by one or more of the other forms of K.

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