Forms of potassium of representative soil series of sub-montane zone of Maharashtra

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ABSTRACT

The representative soil series of order Entisols, Inceptisols and Vertisols collected from agriculture college Kolhapur and different research stations of Sub-montane zone of Maharashtra were assessed for different forms of potassium and its distribution. The water soluble K, Exchangeable K, non-exchangeable K and lattice K contributed 0.23, 2.87, 8.97 and 87.81 per cent of total K, respectively. From the mean values, highest water soluble K, exchangeable K, non-exchangeable K, lattice K and total K were noticed in Vertisols followed by Inceptisols and Entisols. The water soluble k and exchangeable K were found higher in surface layer than sub-surface layer. There was no any specific trend noticed with respect to depth wise distribution of different forms of potassium. These representative soil series of Sub-montane zone of Maharashtra were categorized as medium to high in status for non-exchangeable K and low to moderate in status for total K.

Key words: Water soluble K, exchangeable K, non-exchangeable K, lattice K, total K and Sub-montane zone

Potassium is one of the three major plant nutrient elements. Its importance in Indian agriculture has increased with intensification of agriculture. 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 (Mengel and Krikby, 1987). Over sixty enzymes require K for their activation. In soils, potassium exists in different forms viz. water soluble, exchangeable, and non-exchangeable 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. It can 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.

MATERIALS AND METHODS

Horizon-wise twelve profile samples from representative soil series of order Entisols, Inceptisols and Vertisols from agriculture college, Kolhapur and different research stations of Sub-montane zone of Maharashtra were collected. The collected soil samples were analyzed for different forms of K. Water soluble K was determined in a 1:5 soil: water extract (USSLS, 1954); exchangeable K by Knudsen *et.al* (1982); non-exchangeable K by boiling 1 *N* HNO_3 (Wood and De Turk 1941); lattice K was calculated by subtracting 1 *N* HNO3 extractable K from total K. Total K was determined by extracting soil with H_2SO_4, $HClO_4$ and HF mixture in platinum crucible at 220-225^oC (Jackson 1973), Potassium estimation in the extracts was carried out with the help of a flame photometer.

RESULTS AND DISCUSSION

The horizon wise distribution of different forms of K in different soil series of Entisols, Inceptisols and Vertisols presented in the Table 1, 2 and 3.

Table 1: Forms of K of Entisol soil series

Sr. No.	Horizon	Depth (cm)	Water soluble K		Exchangeable K		Non-Exchangeable K		Lattice K		Total K (mg kg^{-1})
			mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	
I	**Ahmedpur series - A.R.S., Karad (Lithic ustorthents)**										
	Ap	0-21	11.03	0.24	113.40	2.46	396.36	8.61	4079.21	88.68	4600
	A1	21-45	9.45	0.22	128.52	3.06	413.48	9.84	3648.55	86.87	4200
	Mean		10.24	0.23	120.96	2.76	404.92	9.23	3863.88	87.77	4400
II	**Kurkum series – R.S. and J.R.S., Kolhapur (Lithic ustorthents)**										
	Ap	0-22	10.50	0.25	97.02	2.31	322.32	7.67	3770.16	89.76	4200
	A12	22-50	8.93	0.23	124.74	3.28	406.56	10.70	3259.77	85.78	3800
	A13	50-80	7.88	0.17	116.82	2.54	394.86	8.58	4080.44	88.7	4600
	A14	80-107	8.40	0.19	104.94	2.38	361.06	8.20	3925.60	89.22	4400
	A15	>107	8.93	0.20	100.98	2.29	346.40	7.87	3943.69	89.63	4400
	Mean		8.93	0.21	108.90	2.56	366.24	8.60	3795.93	88.62	4300
III	**Sathesai series – N.A.R.P.(S.Z), Shendapark (Lithic ustorthents)**										
	Ap	0-25	8.40	0.26	90.34	2.82	287.40	8.98	2813.86	87.93	3200
	A1	25-50	6.30	0.22	103.76	3.58	333.24	11.49	2456.70	84.71	2900
	A2	>50	7.35	0.19	97.28	2.56	306.68	8.07	3388.69	89.18	3800
	Mean		7.35	0.22	97.13	2.99	309.11	9.51	2886.42	87.27	3300
IV	**Kurkum series - Agriculture college, Kolhapur (Lithic ustorthents)**										
	Ap	0-18	8.93	0.23	104.94	2.76	321.79	8.47	3364.34	88.53	3800
	A1	18-30	7.88	0.18	118.42	2.75	360.54	8.38	3813.16	88.68	4300
	Mean		8.41	0.21	111.68	2.75	341.17	8.42	3588.75	88.60	4100
V	**Kurkum series - A.R.S., Vadgaon–Maval (Lithic ustorthents)**										
	Ap	0-20	8.93	0.25	105.84	2.94	318.78	8.85	3166.45	87.96	3600
	A1	20-45	7.35	0.17	115.96	2.63	382.46	8.69	3894.23	88.50	4400
	A2	>45	8.40	0.20	94.50	2.25	343.82	8.19	3753.28	89.36	4200
	Mean		8.22	0.20	105.43	2.61	348.35	8.58	3604.65	88.61	4100
Avg. Mean			8.63	0.21	108.82	2.71	353.96	8.85	3547.93	88.12	4000
Range			6.30 – 11.03	0.17 – 0.26	90.34 – 128.52	2.25 – 3.58	287.40 – 413.48	7.67 – 11.49	2456.7 – 4080.44	84.71 – 89.76	2900 – 4600

Table 2: Forms of K of Inceptisol soil series

Sr. No.	Horizon	Depth (cm)	Water soluble K		Exchangeable K		Non-Exchangeable K		Lattice K		Total K (mg kg^{-1})
			mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	
I	**Kankauli – A.R.S., Radhanagari (Typic haplusterts)**										
	Ap	0-20	12.85	0.30	139.86	3.33	335.58	7.99	3711.71	88.37	4200
	B21	20-45	8.93	0.19	113.40	2.46	360.56	7.84	4117.11	89.50	4600
	B22	45-75	10.50	0.20	117.18	2.30	425.11	8.33	4547.21	89.16	5100
	B23	75-90	8.40	0.18	124.74	2.65	382.41	8.14	4184.45	89.03	4700
	B24	90-115	7.35	0.17	103.62	2.41	374.63	8.71	3814.40	88.71	4300
	Mean		9.61	0.21	119.76	2.63	375.66	8.20	4074.98	88.95	4600
II	**Bamburdi series - Agriculture college, Kolhapur (Typic ustochrepts)**										
	Ap	0-15	14.70	0.29	207.64	4.07	430.99	8.24	4446.67	87.19	5100
	B21	15-30	9.45	0.17	174.32	3.17	407.89	8.33	4908.34	89.24	5500
	B22	30-46	12.60	0.21	192.40	3.15	520.45	8.32	5374.55	88.11	6100
	B23	46-64	10.50	0.18	186.12	3.26	496.20	8.36	5007.18	87.84	5700
	B24	>64	8.40	0.16	176.22	3.45	447.09	8.29	4468.29	87.61	5100
	Mean		11.13	0.20	187.34	3.42	460.52	8.31	4841.01	88.00	5500
III	**Bamburdi series –A.R.S., Vadgaon–Maval (Typic ustochrepts)**										
	Ap	0-20	13.65	0.26	144.54	2.73	415.80	8.32	4726.01	89.17	5300
	B21	20-45	9.45	0.20	106.94	2.23	396.36	8.32	4287.25	89.32	4800
	B22	45-75	10.50	0.19	153.76	2.79	436.78	8.32	4898.96	89.07	5500
	B23	75-90	8.93	0.16	101.68	1.78	511.07	8.31	5078.32	89.09	5700
	B24	90-105	7.88	0.15	146.52	2.76	473.58	8.32	4672.02	88.15	5300
	Mean		10.08	0.19	130.69	2.46	446.72	8.32	4732.51	88.96	5300
Avg. Mean			10.27	0.20	145.93	2.84	427.63	8.28	4549.50	88.64	5100
Range			7.35 – 14.70	0.15 – 0.30	101.68 – 207.64	1.78 – 4.07	335.58 – 520.45	7.84 – 8.71	3711.71 – 5374.55	87.19 – 89.50	4200 – 6100

Table 3: Forms of K of Vertisol soil series

Sr. No.	Horizon	Depth (cm)	Water soluble K		Exchangeable K		Non-Exchangeable K		Lattice K		Total K (mg kg^{-1})
			mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	mg kg^{-1}	% of Total K	
I	**Koregaon series - A.R.S., Karad (Typic haplusterts)**										
	Ap	0-24	19.70	0.35	241.92	4.32	629.02	11.23	4709.36	84.10	5600
	A12	24-54	17.88	0.34	219.24	4.14	577.54	10.90	4485.34	84.63	5300
	A13	54-85	16.80	0.28	230.58	3.91	680.09	11.53	4972.53	84.28	5900
	A14	85-108	18.30	0.29	223.02	3.48	718.83	11.23	5439.85	85.00	6400
	A15	>108	15.85	0.22	215.46	2.95	646.52	8.86	6422.17	87.97	7300
	Mean		17.71	0.30	226.04	3.76	650.40	10.75	5205.85	85.20	6100
II	**Shiware series - R.S. and J.R.S., Kolhapur (Typic haplusterts)**										
	Ap	0-24	19.70	0.34	219.24	3.85	586.94	10.30	4877.02	85.56	5700
	B21	24-54	17.88	0.29	200.34	3.23	531.02	8.56	5454.99	87.98	6200
	B22	54-85	16.80	0.28	192.78	3.27	558.76	9.47	5133.76	87.01	5900
	B23	85-108	18.30	0.28	204.12	3.19	643.96	10.06	5536.07	86.50	6400
	AC	>108	15.85	0.24	196.20	2.93	580.58	8.66	5910.62	88.22	6700
	Mean		14.72	0.29	202.54	3.29	580.25	9.41	5382.49	87.05	6200
III	**Koregaon series - A.R.S., Gadhinglaj (Typic haplusterts)**										
	Ap	0-23	18.30	0.33	238.14	4.33	591.33	10.75	4652.23	84.59	5500
	B1	23-55	17.24	0.28	204.12	3.35	566.90	9.29	5311.74	87.08	6100
	Bss1	55-85	16.80	0.29	223.02	3.91	665.77	11.68	4794.41	84.11	5700
	Bss2	85-105	17.88	0.30	234.36	3.97	686.32	11.63	4961.44	84.09	5900
	AC	>105	15.85	0.26	215.46	3.53	643.47	10.55	5225.22	85.66	6100
	Mean		17.21	0.29	223.02	3.82	630.76	10.78	4989.01	85.11	5900
IV	**Donoli series - Agriculture college, Kolhapur (Udic haplusterts)**										
	Ap	0-20	15.85	0.26	154.98	2.54	464.38	7.61	5464.79	89.59	6100
	A12	20-55	13.65	0.25	142.30	2.59	454.55	8.26	4889.5	88.90	5500
	A13	55-90	12.60	0.20	136.08	2.16	511.07	8.11	5640.25	89.53	6300
	A14	90-105	14.70	0.23	124.74	1.92	558.08	8.58	5802.48	89.27	6500
	A15	>105	11.03	0.17	117.18	1.86	531.02	8.43	5640.77	89.54	6300
	Mean		13.57	0.22	135.06	2.21	503.82	8.20	5487.56	89.37	6100
Avg. Mean			15.80	0.28	196.66	3.27	591.31	9.79	5266.23	86.68	6100
Range			11.03 - 19.70	0.17 – 0.35	117.18 - 241.92	1.86 – 4.33	454.55 - 718.83	7.61 – 11.68	4485.34 – 6422.17	84.09 – 89.59	5300 – 7300
Overall series Mean			11.57	0.23	150.47	2.87	457.63	8.97	4454.55	87.81	5100
Overall series Range			6.30 – 19.70	0.15 – 0.35	90.34 - 241.92	1.78 – 4.33	287.40 - 718.83	7.61 – 11.68	2456.70 – 6422.17	84.68 – 89.76	2900 – 7300

The average mean value of water soluble K in different pedons is 11.57 mg kg^{-1}. It contributed 0.23 percent of total K. In general, most of the soil series showed comparatively higher water soluble K in surface horizon than sub-surface horizon. This variation might be due to nature and intensities of cropping pattern, clay content, weathering stages of K bearing minerals and organic matter content in soil. Similar results were reported by Subba Rao *et al.* (1991) and Raskar and Pharande (1997). The average mean value of exchangeable K in different soil series was 150.47 mg kg^{-1} and it contributed 2.87 per cent of total K. The exchangeable K status in surface horizon was comparatively higher than sub surface horizons. The higher exchangeable K status of surface layer could be due to application of K fertilizers, crop residue, high organic carbon content and higher biological activities. These findings corroborated with the results observed by Raskar and Pharande (1997) for black soils of Maharashtra. The average mean value of non-exchangeable K in different soil series was 457.63 mg kg^{-1} and it contributed 8.97 per cent of total K. Most of the soil series showed comparatively low non-exchangeable K status in surface horizon than subsurface horizon. As per the categorization proposed by Subba Rao *et al.* (1993) for non-exchangeable potassium reserve in all the soil series showed medium to high in non-exchangeable K status. The medium content of non-exchangeable K-status might be due to low content of K bearing minerals such as muscovite, biotite and illite in clay fractions. The higher status of non-exchangeable K in some soil series might be due to higher pedochemical weathering of K bearing minerals in soil and transformation into illite and vermiculite. The values of non-exchangeable K obtained were in agreement with those reported by Bhosale *et al.* (1992). The average mean value of lattice K in different soil series was 4454.55 mg kg^{-1} and it contributed 87.81 per cent of total K. The lattice K values of different soil series was low in surface horizon than sub surface horizon. The average mean value of total K in different soil series was 5100 mg kg^{-1}. Surface horizon of most of the soil series showed lower total K than sub surface horizon indicating pedochemical weathering of K bearing in surface horizon than subsurface horizons. On the basis of total K status proposed by Subba Rao *et al.* (1993), from the mean values, it was observed that the total K content of Vertisols and Inceptisols soil order were medium. Whereas, the soil series of Entisols soil order was low to medium in total K status. The values of total K were in agreement with the values reported by Kadrekar and Kibe (1972), Murthy (1988) and Sharma and Dubey (1988).

CONCLUSION

The present study revealed considerable variation in the distribution of different forms of K in the horizons of the different soil samples collected from the representative soil series of sub-montane zone of Maharashtra. The study pointed out the need of integrated use of organic manures and K fertilizers for ensuring steady supply of K to crops to sustain production in the long run.

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