Potassium release and fixation capacity 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 potassium release and fixation capacity. The K-fixation in different soils ranged from 78.80 mg kg^{-1} (Kurkum series of A.R.S., Vadgaon-Maval) to 276.40 mg kg^{-1} (Koregaon series of A.R.S., Karad). From the mean values, it was observed that Vertisols showed highest K fixation capacity followed by Inceptisols and Entisols. All the soil series were categorized as very low in step K except Koregaon series of A.R.S., Karad of Vertisols. The sub-surface horizon showed higher cumulative step K release than the surface horizon. The step K and constant rate K was highest in Vertisols followed by Inceptisols and Entisols.

Key words: Potassium release and fixation, step K, constant 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. Potassium availability in soil depends on the total content and release characteristics from its different forms as influenced by the soil characteristics. In addition, through its influence on drainage, runoff, leaching, erosion, vegetation and physiography also affects potassium availability to plants. The present studies were, therefore, undertaken to evaluate the potassium release and fixation capacity of 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 analysed for K fixation capacity and K release capacity i.e., step K and constant K. K fixation capacity was determined by the wetting and drying method as described by Volk (1934); step K and constant rate K were undertaken in the laboratory by using 1 *N* HNO_3 extractant (Hyalock, 1956) to assess long term behaviour of potassium under intensive cropping and to judge the availability of non-exchangeable K to field crops under intensive cropping. Potassium estimation in the extracts was carried out with the help of a flame photometer.

RESULTS AND DISCUSSION

The horizon wise K fixation capacity, step K and constant K release in different soil series of Entisols,

Table 1: Potassium fixation, Step K and Constant K release from Entisol soil series (K mg kg^{-1})

Sr. No.	Horizon	Depth (cm)	K Fixation	Step K release					Cummulative Step K release	Constant K release
				1	2	3	4	5		
			(mg kg^{-1})							
I	**Ahmedpur series - A.R.S., Karad (Lithic ustorthents)**									
	Ap	0-21	114.80	746.00	522.20	242.00	122.60	94.45	1618.73	108.53
	A1	21-45	132.60	850.00	552.20	264.00	130.80	103.60	1783.40	117.20
	Mean		123.70	798.00	537.20	253.00	126.70	99.03	1701.06	112.86
II	**Kurkum series – R.S. and J.R.S., Kolhapur (Lithic ustorthents)**									
	Ap	0-22	110.40	766.00	384.40	245.00	118.60	96.45	1502.93	107.53
	A12	22-50	99.80	836.00	467.70	256.00	127.80	102.60	1674.90	115.20
	A13	50-80	118.60	773.00	414.40	224.00	136.40	113.30	1536.25	124.85
	A14	80-107	107.40	748.00	509.90	319.00	168.40	184.45	1753.33	176.43
	A15	>107	112.00	942.00	697.70	342.00	124.80	128.60	2108.40	126.70
	Mean		109.64	813.00	494.82	277.20	135.20	125.08	1715.16	130.14
III	**Sathesai series – N.A.R.P.(S.Z), Shendapark (Lithic ustorthents)**									
	Ap	0-25	86.80	658.00	361.10	200.00	120.20	88.45	1323.43	104.33
	A1	25-50	97.40	674.00	383.30	212.00	132.40	99.30	1385.15	115.85
	A2	>50	91.20	645.00	336.60	194.00	105.66	93.60	1275.23	99.63
	Mean		91.80	659.00	360.33	202.00	119.42	93.78	1327.94	106.60
IV	**Kurkum series - Agriculture college, Kolhapur (Lithic ustorthents)**									
	Ap	0-18	96.80	588.00	342.20	226.00	108.60	94.75	1257.88	101.68
	A1	18-30	101.40	634.00	384.40	253.00	116.40	105.30	1382.25	110.85
	Mean		99.10	611.00	363.30	239.50	112.50	100.03	1320.06	106.26
V	**Kurkum series - A.R.S., Vadgaon–Maval (Lithic ustorthents)**									
	Ap	0-20	78.80	567.00	324.40	165.00	98.40	77.90	1144.55	88.15
	A1	20-45	84.60	672.00	376.60	184.00	106.40	89.30	1330.45	97.85
	A2	>45	80.20	714.00	353.30	203.00	124.20	104.60	1384.70	114.40
	Mean		81.20	651.00	351.43	184.00	109.67	90.60	1286.57	100.13
Avg. Mean			101.09	706.40	421.41	231.14	120.70	101.70	1470.18	111.20
Range			78.80 - 114.80	567.00 - 942.00	324.40 - 697.70	165.00 - 342.00	98.40 - 168.40	77.90 - 184.45	1144.55 - 2158.13	88.14 -176.43

Table 2: Potassium fixation, Step K and Constant K release from Inceptisol soil series (K mg kg^{-1})

Sr. No.	Horizon	Depth (cm)	K Fixation	Step K release					Cumulative Step K release	Constant K release
				1	2	3	4	5		
			(mg kg^{-1})							
I	**Kankauli - A.R.S., Radhanagari (Typic haplusterts)**									
	Ap	0-20	114.80	784.00	524.40	274.00	105.66	80.30	1675.38	92.98
	B21	20-45	128.60	714.00	464.40	292.00	112.60	84.45	1568.93	98.53
	B22	45-75	117.60	684.00	518.80	242.00	109.13	81.75	1540.24	95.44
	B23	75-90	121.40	654.00	574.40	368.00	108.60	79.45	1690.43	94.03
	B24	90-115	126.00	638.00	496.60	212.00	120.20	74.30	1443.85	97.25
	Mean		121.68	694.80	515.72	277.60	111.24	80.05	1583.76	95.64
II	**Bamburdi series - Agriculture college, Kolhapur (Typic ustochrepts)**									
	Ap	0-15	135.30	924.00	586.60	288.00	122.00	92.60	1905.9	107.30
	B21	15-30	140.80	954.00	698.80	318.00	134.80	99.90	2088.15	117.35
	B22	30-46	129.20	868.00	584.40	264.00	124.80	93.60	1825.60	109.20
	B23	46-64	125.60	934.00	618.80	324.00	138.60	105.60	1998.90	122.10
	B24	>64	114.80	842.00	512.20	252.00	114.80	86.60	1706.90	100.70
	Mean		129.14	904.40	600.16	289.20	127.00	95.66	1905.09	111.33
III	**Bamburdi series –A.R.S., Vadgaon–Maval (Typic ustochrepts)**									
	Ap	0-20	133.40	979.00	565.50	278.00	116.10	93.60	1927.35	104.85
	B21	20-45	138.60	954.00	576.60	312.00	144.80	114.30	1972.15	129.55
	B22	45-75	127.60	928.00	582.20	324.00	132.40	105.60	1953.20	119.00
	B23	75-90	119.80	1074.00	667.70	338.00	142.40	122.45	2212.13	132.43
	B24	90-105	117.20	1024.00	608.80	356.00	168.60	132.15	2139.18	150.38
	Mean		127.32	991.80	600.16	321.60	140.86	113.62	2040.80	127.24
Avg. Mean			126.05	863.67	572.01	296.13	126.37	96.44	1843.22	111.40
Range			114.80 - 140.80	638.00 - 1074.00	464.40 - 698.80	212.00 - 368.00	105.66 - 168.60	74.30 - 132.15	1443.85 - 2212.13	92.98 - 150.38

Table 3: Potassium fixation, Step K and Constant K release from Vertisol soil series (K mg kg^{-1})

Sr. No.	Horizon	Depth (cm)	K Fixation	Step K release					Cumulative Step K release	Constant K release
				1	2	3	4	5		
			(mg kg^{-1})							
I	**Koregaon series - A.R.S., Karad (Typic haplusterts)**									
	Ap	0-24	229.40	1092.00	708.80	438.00	176.40	121.45	2387.73	148.93
	A12	24-54	237.00	1065.00	685.50	404.00	184.20	143.90	2318.55	164.05
	A13	54-85	255.40	1023.00	656.60	448.00	108.60	83.60	2223.70	96.10
	A14	85-108	276.40	1098.40	690.00	431.00	215.35	169.45	2411.80	192.40
	A15	>108	246.40	1108.40	678.80	446.00	201.56	156.30	2412.13	178.93
	Mean		248.92	1077.36	683.94	433.40	177.22	134.94	2350.78	156.08
II	**Shiware series - R.S. and J.R.S., Kolhapur (Typic haplusterts)**									
	Ap	0-24	147.00	943.60	582.20	326.00	140.88	112.30	1978.39	126.59
	B21	24-54	159.60	915.00	501.10	271.00	176.10	136.45	1843.38	156.28
	B22	54-85	175.40	907.30	524.40	315.00	154.20	109.60	1878.60	131.90
	B23	85-108	142.80	852.40	586.60	286.00	140.65	105.60	1848.13	123.13
	AC	>108	156.40	958.00	598.80	269.00	198.40	147.15	1998.58	172.78
	Mean		156.24	915.26	558.62	293.40	162.05	122.22	1909.41	142.13
III	**Koregaon series - A.R.S., Gadhinglaj (Typic haplusterts)**									
	Ap	0-23	223.60	1058.00	656.60	396.00	164.60	108.60	2247.20	136.60
	B1	23-55	229.60	1035.20	525.50	357.00	178.20	116.30	2064.95	147.25
	Bss1	55-85	244.20	998.60	541.10	412.00	103.00	78.75	2042.58	90.88
	Bss2	85-105	269.60	1064.40	602.20	404.00	205.88	150.45	2248.77	178.17
	AC	>105	236.40	1036.00	655.50	410.00	196.36	138.15	2268.76	167.26
	Mean		240.68	1038.44	596.18	395.80	169.61	118.45	2174.45	144.03
IV	**Donoli series - Agriculture college, Kolhapur (Udic haplusterts)**									
	Ap	0-20	143.60	972.00	542.20	264.00	148.88	105.60	1905.44	127.24
	A12	20-55	176.40	946.00	564.40	276.00	176.20	133.15	1941.08	154.68
	A13	55-90	155.40	924.00	504.40	252.00	124.80	93.60	1789.60	109.20
	A14	90-105	159.60	841.00	596.60	296.00	156.88	112.60	1868.34	134.74
	A15	>105	164.60	1092.00	672.20	398.00	174.20	132.15	2315.38	153.18
	Mean		159.92	955.00	575.96	297.20	156.19	115.42	1963.97	135.81
Avg. Mean			201.44	996.52	603.68	354.95	166.27	122.76	2099.65	144.51
Range			142.80 - 276.40	841.00 - 1108.40	501.00 - 708.00	252.00 - 448.00	103.00 - 215.35	78.55 - 169.49	1789.60 - 2412.13	90.88 - 192.40
Overall series Mean			142.86	855.53	532.37	294.07	137.78	106.97	1804.34	122.37
Overall series Range			78.80 - 276.40	567.00 – 1108.40	324.40 – 708.00	165.00 – 448.00	98.40 – 215.35	77.90 – 169.49	1114.55 – 2411.80	88.15 – 192.40

Inceptisols and Vertisols presented in the Table 1, 2 and 3. The K-fixed in different soils ranged from 78.80 mg kg^{-1} (Kurkum series of A.R.S., Vadgaon-Maval) to 276.40 mg kg^{-1} (Koregaon series of A.R.S., Karad). From the mean values, it was observed that Vertisols showed highest K fixation capacity followed by Inceptisols and Entisols. The values of K fixation capacity of soils are in conformity with the results of Srinivasa Rao Ch. *et al*. (2000) for the soils of India.

The cumulative step K release in different soils ranged from 1114.55 mg kg^{-1} (Kurkum series of A.R.S., Vadgaon-Maval) to 2411.80 mg kg^{-1} (Koregaon series of A.R.S., Karad). The constant K in different soils series ranged from 88.15 mg kg^{-1} (Kurkum series of A.R.S., Vadgaon-Maval) to 192.40 mg kg^{-1} (Koregaon series of A.R.S., Karad). According to Subba Rao *et al.* (1993) all the soil series except koregaon, A.R.S., Karad were categorized under very low step K were as koregaon series, A.R.S., Karad under low step K category.

CONCLUSION

The present study revealed K fixation capacity and K release 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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