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Dahule DD
Assistant Professor, Soil Science and Agricultural Chemistry Department, Kewalramji Harade College of Agriculture chamorshi, Maharashtra, India

Kadu PR
Associate Professor, Soil Science and Agricultural Chemistry and Resistrar, Dr. Panjabrao Deshmukh Krushi Vidyapeeth Akola, Maharashtra, India

Pathare IS
Student, College of Agriculture Nagpur, Maharashtra, India

Tembhurkar RA
Student, College of Agriculture, Nagpur Maharashtra, India

Corresponding Author:
Dahule DD
Assistant Professor, Soil Science and Agricultural Chemistry Department, Kewalramji Harade College of Agriculture chamorshi, Maharashtra, India

Potassium fractionation of mandarin growing soil of katol tahsil in Nagpur

Dahule DD, Kadu PR, Pathare IS and Tembhurkar RA

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Abstract
The present investigation entitled "potassium fractionation of mandarin growing soil of Katol tahsil of Nagpur" was conducted on farmer's field at Katoltahsil, Dist. Nagpur during Kharif 2017-18. Seven locations viz., Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba and Baravha were selected to determine the different fractions of soil potassium and its correlation with soil properties. 35 surface soil samples (5 soil samples each from one location) were taken from 0-20 cm depth over the field of Nagpur mandarin orchards. The results revealed that the contribution of different K fractions at surface level was in order of lattice K > non exchangeable K > exchangeable K > water soluble K. Available K bears highly significant and positive correlation with water soluble K (r=0.813**) and exchangeable K (r=0.998**). Lattice K showed negatively significant correlation with available K (r= -0.377*), water soluble K (r= -0.422*), exchangeable K (r= -364*) and non-exchangeable K (r= -0.524*). Water soluble K shows highly positive and significant correlation with exchangeable K (r= 0.998**) and it shows negatively significant correlation with lattice K (r= -0.422*).

Keywords: Potassium fractions, correlation, exchangeable K,Non-exchangeable K, total K, lattice K, water soluble K

Introduction
Potassium exists in soil in different forms, *viz.*, water soluble-K, which is taken up directly by plants; exchangeable-K, held by negative charges on clay particles and is available to plants and fixed-K, which is trapped between layers of expanding lattice clays. The knowledge of various forms of K *viz.*, water soluble, exchangeable and non-exchangeable and an understanding of conditions controlling the availability to growing crops is important for the appraisal of the available K in the soil. The available K constitutes only 1-2 per cent of total K and exists in soil in two forms *i.e.* water soluble and exchangeable K, adsorbed on soil colloidal surface (Brady and Weil, 2002). These forms remain in a dynamic equilibrium with one another. The readily available or water-soluble K has been reported to be a dominant fraction in the initial stage while exchangeable and nonexchangeable K contribute more in the later stages of plant growth (Sharma *et al.* 2009) [16]. Under intensive cultivation, readily available and exchangeable K is removed by crops. This is followed by further release of exchangeable K from non-exchangeable forms. Dynamic equilibrium affected when applied K is either taken up by plants or leached into the lower soil horizons or converted into unavailable form. Under this situation, non-exchangeable-K plays an important role by releasing K to exchangeable and solution forms. The dynamics of K in soil depends on the rate of application and mining of K from the system (Singh and Bansal, 2009) [17].

Materials and methods
The soil were selected by surveying the mandarin orchards of Katoltahsil of Nagpur district and therefore total 35 fields were selected for the present study. during 2017-2018. The one sample were collected from each field, sampling was done from 0-20 cm depth having common management practices. The soil samples were collected from 0 to 20 cm depth for physical and chemical analysis as per standard procedure. About 1-1.5 kg representative soil samples from the zone of maximum feeder root concentration at 0 to 20 cm depth were collected in cloth bag for laboratory characterization. The bulk soil samples were allowed to air dry in shade and then weighed soil aggregates were passed through 2 mm and 0.5 mm

sieve. Soil material passing through the sieve was placed in labelled polythene bags and again weighed. A small portion of 0.2 mm sample was ground to pass sieve for organic carbon determination.

Estimation of various parameters

Fractions of potassium

Water soluble Kextracted by shaking soil and water suspension (1:5) for 1 hour and K determined on Flame Photometer as described by USLE (1954).Exchangeable K**.**extracted by using 1N neutral ammonium acetate, K on exchangeable complex determined with Flame Photometer (Knudsen *et al*, 1982).Non–exchangeable K determined by treating with 1 N HNO_3 in 1 : 10 ratio and boiling for 10 minutes and K estimated with the help of Flame Photometer as described by (Wood and Deturk, 1941). Lattice K calculated by subtracting the sum of above three fractions from the total potassium content (Ranganathan and Satyanarayana,1980). Total K extracted by HF digestion method and K determined on Flame Photometer (Jackson, 1967).

Result and discussion

Distribution of different forms of soil potassium

The different forms of potassium are quite important to know the potassium status of the soil. As such potassium is not rapidly available to plants but it is an important reservoir of slowly available K. potassium from minerals is gradually released to more available forms. About 1 to 10% of total K is present in non-exchangeable form which is slowly available (fixed) because of its fixation by soil colloids.

Water soluble K (mg kg^{-1})

The water-soluble potassium is the fraction of soil potassium that can be readily ascribed by plants. Nevertheless, this is very small fraction of total potassium and even in the fertile soil this form cannot supply the major requirements of the plants. Water soluble K is taken up directly by plants but is usually found in low quantities in soils. The data on water soluble potassium of soils in the study area is presented in table-2. The data revealed that, the mean value of water-soluble potassium were recorded from 22.99 to 25.64 mg kg^{-1} in surface layer soil, where Nagpur mandarin orchards grown on Vertisol. The water-soluble potassium in surface level stated not many variations among the different locations. The lowest value of WSK (19.9 mg kg-1) was recorded in Silli location, while highest value (28.3 mg kg^{-1}) was also recorded at same location. Dhakad *et. al* (2017) [6] reported that, the average values observed for water soluble-K, exchangeable-K, non-exchangeable-K, lattice-K and total K were: 15.1, 230.5, 548.4 mg kg^{-1}, 1.403% and 1.482%, respectively. The readily available or water-soluble K has been reported to be a dominant fraction in the initial stage while exchangeable and non-exchangeable contribute more in the later stages of plant growth (Sharma and Bansal, 2009) [16].

Exchangeable K (mg kg^{-1})

The exchangeable K is readily available to the growing plant. Exchangeable K is the popular index for soil fertility so far consisting to 0.9-2% of the total K in soils. The data present in table-2 showed that, exchangeable potassium ranges from 125.71 to 195.64 mg kg^{-1}, 142.7 to 177.35 mg kg^{-1}, 126.35 to 164.26 mg kg^{-1}, 131.35 to 205.35 mg kg^{-1}, 122 to 193.64 mg kg^{-1}, 125 to 188.68 mg kg^{-1} and 143.71 to 199 mg kg^{-1} in locations of Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba, Baravha, respectively. The lowest value of exchangeable K 121.79 mg kg^{-1} was recorded in Savangi. Whereas highest value i.e. 205.35 mg kg^{-1} was observed in Silli location. In the present study, the exchangeable K constitute between 1.49 to 1.70 per cent of the total K.

Non exchangeable K (mg kg^{-1})

In the study area, 2.86 to 3.81 per cent of total K is present in non-exchangeable form which is slowly available because of its fixation by soil colloids. The nonexchangeable potassium content varried in location and ranged from 279.65 to 464.65 mg kg^{-1}, 326 to 438.7 mg kg^{-1}299.85 to 404.29 mg kg^{-1}, 305.65 to 420.65 mg kg$^{-1,}$ 229.65 to 375.65 mg kg^{-1}, 284.29 to 423 mg kg^{-1} and 255.32 to 322.05 mg kg^{-1} in Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba, Baravha, respectively. The lowest value (229.65 mg kg^{-1}) was recorded under orchards of Savangi and the highest value (464.65 mg kg^{-1}) was recorded at Niravha.

Correlation coefficient between forms of potassium and chemical properties of soils of Katol tahsil

Soil of different locations of Katol area was studied to assess potassium fractions of soils. 35 soil samples of mandarin orchards from seven villages under common management practices with high potassium status of soil were selected. From the correlation data presented in table-5. Exchangeable potassium showed highly significant and positive relationship with available potassium (0.998**). Similarly, correlation was also reported by Saini and Grewal (2014), the values of correlation coefficient of exchangeable potassium was positively correlated with pH (r=-0.548*), EC (r=0.324*). Jatav and Dewangan (2012) also noticed that, the soil pH showed positive and significant correlation with exchangeable K. Organic C exhibited significant and positive correlation with exchangeable K. water soluble potassium did not showed any correlation with soil properties except major nutrient and available potassium. water soluble potassium showed highly significant and positive correlation with available potassium (r=0.813**), and it showed positively significant correlation with exchangeable magnesium (r=0.345*).

Correlation coefficient amongst the forms of potassium of soils of Katol tahsil

The available potassium was showed highly positive significant correlation with water soluble potassium (r=0.813**) in mandarin growing soil. Similarly, it shows positive significant correlation with exchangeable potassium (r=0.998**). Available potassium showed negative correlation with lattice potassium (r=-0.377*). Behera and Chaitanya (2015) [4] reported that, available and exchangeable K were strongly positively correlated (r=1.00), available K was positively correlated with OC (r=0.623), water soluble K (r=0.459).

Exchangeable potassium showed highly positive significant correlation with available potassium (r=0.998**) in mandarin growing soil. Similarly, it showed significant correlation with water soluble potassium (r=-0.775**). also showed negative correlation with non-exchangeable potassium (r=-0.255).

Water soluble potassium showed highly positive and significantly correlated with available potassium (r=0.813**) in mandarin growing soil. Similarly, it showed positively significant correlation with exchangeable potassium (r=0.775**). Behera *et. al.*, (2015) [4] reported that the water-soluble K content of Saripbasa soil series was significantly positively correlated with Exchangeable K (r=0.431), and Available K (r=0.459)

Lattice potassium showed negatively significant correlation with available potassium (r=-0.377*) in mandarin growing soil of study area. Lattice potassium showed negatively significant correlation with water soluble potassium (r=-0.422*), exchangeable potassium (r=-0.364*) and nonexchangeable potassium (r=-0.524*). However, lattice potassium showed positive and highly significant correlation with total potassium (r= 0.876**). (Sharma and Bansal 2009) [16]. Lattice-K has showed highly significant and negative correlation with total K (r=-0.99**). Gongopadhyay *et al.*, 2005 [9]. showed significant positive correlation with non-exchangeable K (r= 0.65**) and total K (r= 0.99**)

Table 1: Distribution of different forms of soil potassium in Katol tahsil

Depth (20 cm) Sample no.	Potassium fractionation status in soil					
	Av. K (mg kg^{-1})	WSK (mg kg^{-1})	Ex. K (mg kg^{-1})	NEK (mg kg^{-1})	LK (mg kg^{-1})	Total K (mg kg^{-1})
Niravha						
S-1	214.64	24.2	190.44	314.16	9303.55	10047
S-2	175.71	22.1	153.58	312.69	9530.88	10195
S-3	145.71	20.2	125.53	390.29	9669.26	10351
S-4	215.36	25.5	189.86	464.65	9326.64	10222
S-5	180.36	22.9	157.47	279.65	9779.63	10420
Mean	186.36	22.99	163.38	352.29	9521.99	10247.00
Iratni						
S-6	165.71	23.0	142.69	438.70	9211.87	9982
S-7	175.00	22.9	152.11	393.40	9406.59	10150
S-8	180.36	24.7	155.68	326.00	9363.27	10050
S-9	195.36	26.1	169.24	405.05	9235.24	10031
S-10	175.71	22.3	153.38	356.69	9432.88	10141
Mean	178.43	23.81	154.62	383.97	9329.97	10070.80
Botesari						
S-11	165.71	22.9	142.99	301.49	9578.90	10212
S-12	170.71	22.2	148.51	342.89	9436.68	10121
S-13	185.36	26.1	159.29	333.94	9415.35	10120
S-14	165.71	23.2	142.54	404.29	9304.28	10040
S-15	185.71	24.9	160.87	299.85	9483.66	10155
Mean	174.64	23.85	150.84	336.49	9443.77	10129.60
Silli						
S-16	200.36	27.8	172.63	339.65	9391.57	10132
S-17	150.36	19.9	130.48	341.65	9568.62	10211
S-18	200.36	26.5	173.86	305.65	9418.64	10125
S-19	225.36	28.3	197.03	420.65	9270.64	10142
S-20	210.36	25.7	184.71	357.65	9270.64	10049
Mean	197.36	25.64	171.74	353.05	9384.02	10131.80
Savangi						
S-21	214.64	26.3	188.34	229.65	9523.06	10182
S-22	145.00	23.2	121.79	375.00	9475.00	10140
S-23	190.36	25.2	165.19	309.65	9460.64	10151
S-24	185.36	20.7	164.70	354.65	9509.64	10235
S-25	215.00	27.3	187.67	253.00	9432.00	10115
Mean	190.07	24.53	165.54	304.39	9480.07	10164.60
Salaidhaba						
S-26	145.00	20.1	124.94	423.00	9407.00	10120
S-27	180.00	25.7	154.33	300.00	9480.00	10140
S-28	175.71	22.6	153.13	284.29	9487.28	10123
S-29	165.00	23.0	143.02	367.00	9431.98	10130
S-30	204.69	26.5	178.19	355.36	9290.27	10055
Mean	174.08	23.56	150.72	345.93	9419.31	10113.60
Baravha						
S-31	204.69	27.0	177.67	255.32	9547.31	10212
S-32	210.36	27.5	182.86	322.05	9376.24	10119
S-33	190.36	23.7	166.68	309.65	9549.62	10240
S-34	220.00	25.0	194.96	286.00	9399.00	10125
S-35	165.71	22.6	143.08	282.69	9515.88	10130
Mean	198.22	25.18	173.05	291.14	9477.61	10165.20

Table 2: Correlation coefficient between forms of potassium and chemical properties of soils of Katol tahsil

	pH	EC	OC	Av. N	Av. P	Av. K	Ex Ca	Ex Mg	Ex Na
Av. K	0.222	0.015	0.24	0.288	0.160	1.000	-0.063	0.232	-0.153
WSK	0.078	-0.119	-0.012	0.254	0.242	0.813**	-0.223	0.345*	-0.173
Ex. K	0.232	0.029	0.027	0.287	0.149	0.998**	-0.045	0.217	-0.147
NEK	-0.422**	0.137	0.160	0.005	-0.013	-0.257	0.284	-0.060	0.097
TK	0.245	0.095	0.081	0.062	0.049	-0.171	0.153	-0.284	0.045
LK	0.284	-0.001	-0.024	-0.066	-0.020	-0.377*	0.002	-0.260	0.044

** significant at 1% level * significant at 5% level

Table 3: Correlation coefficient between forms of potassium and micronutrients in soils of Katol tahsil

	Zn	Cu	Fe	Mn
Available K	0.217	-0.155	-0.517	0.140
Water soluble K	0.285	-0.255	-0.336	0.293
Exchangeable K	0.205	-0.139	-0.524**	0.122
Non- exchangeable K	0.271	0.174	0.163	-0.101
Total K	0.106	-0.076	0.001	0.003
Lattice K	-0.130	-0.076	0.119	-0.005

** significant at 1% level * significant at 5% level

Table 4: Correlation coefficient amongst the forms of potassium of soils of Katol tahsil.

	Av. K	WSK	Ex. K	NEK	TK	LK
Available K	1					
Water soluble K	0.813**	1				
Exchangeable k	0.998**	0.775**	1			
Non- exchangeable K	-0.257	-0.221	-0.255	1		
Total K	-0.171	-0.309	-0.152	-0.230	1	
Lattice K	-0.377*	-0.422**	-0.364*	-0.524**	0.876**	1

** significant at 1% level * significant at 5% level

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