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Characteristics and properties of mandarin growing soils of Katol tahsil in Nagpur

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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 Katol tahsil, Dist. Nagpur during Kharif 2017-18. Seven locations *viz*., Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba and Baravha were selected to study the characteristics of soils under Nagpur mandarin. 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 soil reaction of study area exhibited slightly alkaline in nature. In all locations, there is no much variations in electrical conductivity of soil and these soils are non-saline in nature. The values of soil organic carbon found (4.0–8.9 g kg^{-1}) comes under low to moderately high content. Soils under study area were low to medium in available nitrogen and available phosphorus in soils found to be low to moderately high. All the soils of Katol tahsil were found high to very high in available potassium status. The DTPA extractable micronutrients soils (Zn, Fe, Cu and Mg) in these were observed sufficient except Zn which was found deficit by 48.57 per cent among 35 surface soil samples.

Keywords: Potassium fractions, soil charactaristics, alkaline, phosphorous, micronutrients, extrctable**.**

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 (Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019) [19, 20, 21, 22, 23, 24, 25, 26, 27]. 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) [1]. The soils being neutral to alkaline with high alkaline earth bases, Ca^{2+},K^{+} exchange is an important driving force of K^{+} availability. The picture of crop response to K in India has been changing with time as more and more soils are showing signs of K depletion due to use of N and P without progressive increase in K. On the other hand, in spite of high K status in swell-shrink soil, crop responded to applied K.

Materials and Methods
The soil were selected by surveying the mandarin orchards of Katol tahsil 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

Soil pH: It was determined in 1:2.5 soils water suspension with the help of Glass Electrode using pH meter (Jackson, 1973) [7]. Electrical conductivity (EC) of the soil was determined in 1:2.5 soil water supernant using ELICO Conductivity Bridge (Jackson, 1973) [7]. Organic carbon, (g kg^{-1}): It was determined by oxidizing soil organic matter by chromic acid using heat of dilution sulphuric acid by Wet Oxidation method. (Walkley and Black, 1934) [34]. available nitrogen, (kg ha^{-1}) available nitrogen was estimated using Alkalinepotassium permanganate method (Subbiah and Asija, 1956) [29]. Available phosphorus, (kg ha^{-1}) It was determined by using Olsen's method (Jackson, 1973) [7]. Available potassium, (kg ha^{-1}) available potassium in soil was extracted by Neutral Normal Ammonium Acetate solution and potassium was determined using flame photometer (Jackson, 1973) [7].

determination of Exchangeable Cation, (Cmol (p^+) kg^{-1}): Ca and Mg: exchangeable calcium and magnesium were determined by using 1N KCL triethanolamine buffer solution (pH 8.2) and titrating the leachate with standard EDTA solution using murroxide and EBT as an indicator (Jackson 1973) [7]. Na and K: exchangeable sodium and potassium were determined by leaching the soil with 1N ammonium acetate (pH 7.0) solution. Na+ and K+ from the leachate were estimated by using atomic absorption spectrophotometer (Jackson, 1973) [7]. Determination of Zn, Fe, Cu and Mn, (mg kg^{-1}): It was determined by DTPA extract using atomic absorption spectrophotometer method given by Lindsay and Norvell (1978) [12].

Result and Discussion

Chemical Properties of Soil

Soil pH

The data pertaining to soil pH and electrical conductivity is presented in table-1. Soil pH is an important intrinsic property of soil which usually does not change easily. Soil reaction as indicated by soil pH which is an approximate measure of the active fraction of hydrogen ions present in soil phase. It determines salinity, alkalinity, nutrient availability, microbial activity, physical condition of soil and its intrinsic relationship with other soil constituents.

The pH of saturated soils of selected locations of Nagpur mandarin orchards of Katol tehsil of Nagpur district ranged from 7.5 to 8.27 under the common practices of nutrient management of inorganic and integrated manner. The lowest value of soil pH 7.50 in surface layer was recorded at Iratni location whereas the maximum values of soil pH registered 8.27 at Savangi location. The mean value of soil pH ranges from 7.95 to 8.15 amongst different locations of Nagpur mandarin growing orchards of Katol tehsil indicating their slightly alkaline in nature. Dhawan *et al* (1957) reported similar in their finding that, safe limit of soil pH was 7.6 to 8.5 for citrus. Surwase (2016) [31] also reported soil pH ranged from 6.5 to 8.6 in Katol and Kalmeshwar tehsil of Nagpur district for Nagpur mandarin orchards.

Electrical Conductivity

The electrical conductivity is a measure of soluble salt concentration in soil, higher amount of salts in soils restrict the nutrient uptake and thus affect the plant stand. Status of EC of soil is given in table-1. The electrical conductivity of Nagpur mandarin growing soil ranged from 0.30 to 0.36, 0.22 to 0.38, 0.27 to 0.39, 0.32 to 0.38, 0.21 to 0.29, 0.20 to 0.32 and 0.21 to 0.31 (dSm^{-1}) In Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba and Baravha, respectively in surface soil which comes under acceptable limit. This range of EC of soil shows that, all the soils found in Nagpur mandarin growing orchards were non saline in nature and suitable for healthy plant growth. Patil (1979) [17] suggested that EC of soil showed not exceed 3 dS m^{-1} for orange fruit crop. In all locations, there is no much variation in EC of soils. Low EC of soils was observed in all locations which could be ascribed to increase permeability and thus leaching of salts.

Table 1: Chemical properties of soils of Nagpur mandarin growing orchards in locations of Katol tehsil

Depth (20 cm) Sample no	pH	EC (dS m^{-1})	Organic Carbon (g kg^{-1})	Available N kg ha^{-1}	Available P Kg ha^{-1}	Available K Kg ha^{-1}
Niravha						
S-1	8.13	0.32	8.07	409.1	30.8	480.80
S-2	8.15	0.30	6.00	270.8	16.8	393.60
S-3	8.16	0.32	4.40	195.5	13.6	326.40
S- 4	8.12	0.34	7.50	402.2	26.6	482.40
S- 5	8.00	0.36	7.93	405.2	25.6	404.00
Mean	8.11	0.32	6.58	336.56	22.6	417.40
Iratni						
S-6	7.50	0.27	4.10	182.3	13.6	371.20
S-7	8.02	0.30	5.10	225.5	15.9	392.00
S-8	8.03	0.22	4.80	215.0	14.8	404.00
S-9	8.15	0.28	7.40	330.0	20.0	437.60
S-10	8.06	0.38	7.50	335.2	18.5	393.60
Mean	7.95	0.29	5.78	257.60	16.56	399.68
Botesari						
S-11	8.10	0.31	7.72	290.1	17.3	371.20
S-12	8.18	0.38	6.50	229.2	15.4	382.40
S-13	8.23	0.27	7.90	390.3	27.0	415.20
S-14	7.82	0.37	8.10	391.9	24.9	371.20
S-15	8.16	0.39	7.00	321.6	18.5	416.00
Mean	8.10	0.34	7.44	324.62	20.62	391.20
Silli						
S-16	7.75	0.34	8.90	416.6	32.4	448.80
S-17	8.17	0.32	8.60	380.6	25.5	336.80
S-18	8.07	0.38	7.20	282.2	17.6	448.80
S-19	8.02	0.33	7.90	370.6	21.5	504.80
S-20	8.22	0.32	7.70	403.5	17.6	471.20
Mean	8.05	0.34	8.06	370.70	22.92	442.08
Savangi						
S-21	8.27	0.29	7.70	423.5	21.5	480.80
S-22	7.93	0.21	7.50	356.2	31.1	324.80
S-23	7.82	0.29	4.00	155.5	35.0	426.40
S-24	7.85	0.28	8.00	330.2	20.3	415.20
S-25	7.96	0.29	6.20	308.1	18.1	481.60
Mean	7.97	0.27	6.68	314.70	25.20	425.76
Salaidhaba						
S-26	8.00	0.28	7.90	410.0	29.3	324.80
S-27	8.21	0.20	6.90	290.0	18.1	403.20
S-28	8.27	0.30	7.70	383.0	23.7	393.60
S-29	7.91	0.26	6.50	395.6	27.0	369.60
S-30	7.96	0.32	7.90	436.8	34.2	458.50
Mean	8.07	0.27	7.38	382.86	26.46	389.94
Baravha						
S-31	8.19	0.23	7.20	423.4	34.4	458.50
S-32	8.04	0.22	8.15	389.7	26.5	471.20
S-33	8.22	0.21	7.90	403.2	29.1	426.40
S-34	8.26	0.25	5.10	235.2	17.4	492.80
S-35	8.04	0.31	4.07	154.6	13.0	371.20
Mean	8.15	0.24	6.48	321.22	24.08	444.02

Organic carbon

The soil organic carbon is one of the crucial parameter in substantial agricultural production and soil health. Carbon is the chief element present in soil organic matter comprising about 56 to 58 per cent of its total weight. The result obtained of soil organic carbon in study area of Nagpur mandarin orchards ranged from 4.4 to 8.0 g kg^{-1}, 4.1 to 7.5 g kg^{-1}, 6.5 to 8.1 g kg^{-1}, 7.2 to 8.9 g kg^{-1}, 4.0 to 8.0 g kg^{-1}, 6.5 to 7.9 g kg^{-1}, 4.07 to 8.15 g kg^{-1} in Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba, Baravha, respectively.

The value of organic carbon of soil was observed in high range (8.9 g kg^{-1}) in surface level at location of Silli. Most of the surface soil in study area as comparatively moderately high in category of mean value of organic carbon. Improvement in soil organic status in some locations may be due to adequate incorporation of inputs, proper management practices and rapid mineralization under temperate conditions. The observed values of organic carbon of soil at surface level of location comes under low to high, low to moderately high, medium to moderately high, moderately high to high, moderately high to high, low to high and moderately high in range at Niravha, Iratni, Botesari, Silli, Savangi, Salaidhaba and Baravha, respectively with common management practices in orchards.

Prasad *et al.* (2001) [16] reported that, organic carbon in orange growing soil ranged from 2.1 to 9.9 g kg^{-1} through depth being higher in surface layer of pedon than the subsurface horizons.

Available nitrogen (kg ha^{-1})

Nitrogen is the most important major nutrient required by plant which is an essential component of all proteins and its deficiency results in stunted growth, slow growth and chlorosis in plants. The data in respect of available nitrogen of soil in Nagpur mandarin orchards grown in Vertisol is presented in table-1. In the present study, status of mean value of available nitrogen of soils in different locations of mandarin orchards were observed between 257.6 to 382.86 kg ha^{-1} The maximum available nitrogen content of soil 436.8 kg ha^{-1} was recorded in Salaidhaba fall under moderately high in category whereas very low available nitrogen of soil 154.6 kg ha^{-1} was recorded in Baravha location.

Punekar and Kuchanwar (2017) reported that available nitrogen ($KMnO_4$-N) was low (170.2-232.0 Kg ha^{-1}) in mandarin growing soils of Nagpur. The observed mean value of available N content of soils of those orchards comes under medium in category. When field of orchards treated with different common management practices. Medhiand Baruah (2007) showed that, surface soils contained higher level of available N, P, K and organic carbon reflecting their maximum accumulation than the subsurface layers.

The fertility status of soil of some locationsmight have helped in the mineralization of soil N leading to its higher build up with use of adequate amount of inputs and proper management practices.

Available Phosphorous (kg ha^{-1})

The data of available phosphorous content of soil in Nagpur mandarin orchards grown in Vertisol is presented in table-1. In the present study, mean value of available phosphorous content of soil was recorded from 16.56 to 26.46 kg ha^{-1} in surface soil under different locations falls under low in category. The lowest value of available phosphorous in soil was noticed as in Baravha (13.0 kg ha^{-1}), while highest value of available phosphorous observed in Savangi location soil (35.0 kg ha^{-1}) Dhale and Prasad (2009) [2] studied sweet orange growing soils of Jalna district of Maharashtra.

They reported that, the available N and P ranged from 68 to 313 and 9.9 to 27 kg ha^{-1}, respectively in different horizons and in general their content exhibited a decrease the nutrient. The available P status of soil of four locations comes under medium in range i.e. more than 32 kg ha^{-1}.

Medhiand Baruah (2007) reported that, surface soils contained higher level of available N, P, K and organic carbon reflecting their maximum accumulation than the subsurface layers. The fertility status of soil of some locationsmight have helped in the mineralization of soil N leading to its higher build up with use of adequate amount of inputs and proper management practices.

Table 2: Micronutrients status of soils of mandarin growing orchards in Katol tehsil

Depth 20 (cm)	Micronutrients status of soil			
Sample no	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})
Niravha				
S-1	0.62	5.26	5.30	1.20
S-2	0.21	7.27	1.77	0.77
S-3	0.51	8.94	3.79	1.65
S-4	0.82	4.41	3.01	1.38
S-5	0.91	6.29	4.21	1.04
Mean	0.61	6.43	3.62	1.19
Iratni				
S-6	0.38	7.07	2.09	1.69
S-7	0.43	5.21	3.86	1.48
S-8	0.32	8.38	2.21	1.14
S-9	0.62	6.27	5.84	1.86
S-10	0.76	7.40	1.78	1.57
Mean	0.50	6.87	3.16	1.55
Botesari				
S-11	0.62	5.34	5.32	1.77
S-12	0.35	5.52	2.10	1.76
S-13	0.89	8.63	9.15	0.92
S-14	0.34	6.84	1.80	1.53
S-15	0.45	6.64	2.00	1.09
Mean	0.53	6.59	4.07	1.41
Silli				
S-16	0.79	7.52	0.95	1.10
S-17	0.93	8.42	1.38	1.77
S-18	0.43	6.82	1.16	0.85
S-19	2.32	4.33	4.42	1.60
S-20	0.55	7.65	1.78	1.28
Mean	1.00	6.95	1.94	1.32
Savangi				
S-21	0.78	5.41	1.13	0.85
S-22	0.84	6.51	1.26	0.83
S-23	0.54	6.59	5.10	1.48
S-24	0.32	5.91	1.18	1.39
S-25	0.31	4.55	5.70	1.10
Mean	0.56	5.79	2.87	1.13
Salaidhaba				
S-26	0.81	9.04	1.30	1.34
S-27	0.41	7.84	10.18	1.27
S-28	0.6	6.40	1.02	1.69
S-29	0.57	8.42	5.76	1.79
S-30	0.92	5.40	3.33	1.22
Mean	0.66	7.42	4.32	1.46
Baravha				
S-31	0.61	5.55	3.95	1.97
S-32	0.64	7.26	2.79	0.92
S-33	0.41	6.82	2.54	1.07
S-34	0.32	5.93	3.42	2.16
S-35	0.59	4.55	2.97	1.92
Mean	0.51	6.02	3.13	1.61

Table 3: Exchangeable cations of soils under Nagpur mandarin growing orchards of Katoltahsil.

Depth (20 cm) Sample no.	Exchangeable cations of soil				
	Exch. Ca Cmol (P^+) Kg^{-1}	Exch. Mg Cmol (P^+) Kg^{-1}	Exch. Na Cmol (P^+) Kg^{-1}	Exch. K Cmol (P^+) Kg^{-1}	Total Cmol (P^+) Kg^{-1}
Niravha					
S-1	35.19	11.86	5.38	1.2	53.63
S-2	36.23	11.26	4.33	1.0	52.82
S-3	36.48	10.72	4.34	1.0	52.54
S-4	34.32	12.22	4.32	0.9	51.76
S-5	29.51	10.50	6.28	0.8	47.09
Mean	34.34	11.31	4.9	0.98	51.56
Iratni					
S-6	32.00	11.23	5.31	1.3	49.84
S-7	32.42	11.46	7.39	1.2	52.47
S-8	28.20	10.65	3.29	0.9	43.04
S-9	30.22	11.60	4.30	1.1	47.22
S-10	33.18	12.33	4.34	0.9	50.75
Mean	31.2	11.4	4.92	1.o8	48.66
Botesari					
S-11	28.30	12.52	5.38	0.7	46.9
S-12	25.26	11.72	6.41	0.6	43.99
S-13	34.42	11.54	6.33	0.6	52.89
S-14	30.20	10.93	7.37	1.3	49.8
S-15	31.26	10.65	5.35	1.2	48.46
Mean	29.88	11.4	6.16	0.88	48.40
Silli					
S-16	27.32	11.32	5.38	1.1	45.12
S-17	33.31	11.43	3.40	0.9	49.04
S-18	36.24	13.12	3.32	1.9	54.58
S-19	35.19	12.52	4.34	0.7	52.75
S-20	26.36	12.79	4.33	0.6	44.08
Mean	31.68	12.2	4.15	1.04	49.11
Savangi					
S-21	31.18	11.43	4.28	1.3	48.19
S-22	24.11	12.94	6.39	1.2	44.64
S-23	33.24	11.27	6.41	1.3	52.22
S-24	35.32	11.46	7.35	1.1	55.23
S-25	25.12	13.20	3.31	0.9	42.53
Mean	29.79	12.00	5.54	1.16	48.56
Salaidhaba					
S-26	37.42	10.94	3.29	0.9	52.55
S-27	32.23	12.20	4.37	0.5	49.3
S-28	26.48	11.56	2.30	0.8	41.14
S-29	29.41	13.11	5.34	2.1	49.96
S-30	30.20	13.32	5.38	1.9	50.8
Mean	31.34	12.2	4.13	1.24	48.75
Baravha					
S-31	24.12	12.52	4.42	1.3	42.36
S-32	36.42	11.94	3.40	1.2	52.96
S-33	33.18	10.13	4.32	0.9	48.53
S-34	28.31	11.59	6.41	1.3	47.61
S-35	35.16	13.17	7.39	1.2	56.92
Mean	31.43	11.87	5.18	1.18	49.676

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