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Research Article

Study of Soil Chemical Properties, Available Sulphur and Micronutrients Status of Soils in Solapur District of Maharashtra

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ABSTRACT

The aim of this study was to evaluate available sulphur and micronutrients (Zn, Fe, Cu, Mn and B) status of soils. The present study mainly focused on testing of soil samples in Solapur District in Maharashtra to determine their level of micronutrients and to provide information to farmers and extension functionaries. A survey was conducted in 2019-20 by All India Co-ordinated Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants under Department of Soil Science & Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, (M.S.) in a view to have proper assessment of secondary and micronutrient status in soil of the district. In the present investigation different chemical properties, available sulphur and micronutrients status was assessed in GPS based three hundred seven surface soil samples (0-20 cm) from 11 blocks in Solapur district of Maharashtra. The pH, EC, OC and $CaCO_3$ of soils collected from the study area varied from 6.30 to 8.75, 0.02 to 0.59 dS m^{-1}, 1.75 to 17.75 g kg^{-1} and 2.67 to 13.37 percent, respectively. Results further indicated that the 45.60, 76.55, 95.44, 70.03, 9.12 and 0.65 per cent soil samples were found to be deficient in S, Zn Fe, Mn, Cu and B, respectively. The nutrient index values are low for zinc (1.27), iron (1.05) and manganese (1.32), medium for sulphur (1.84) and whereas high nutrient indices were observed for copper (2.48) and boron (2.77). The results obtained in the present study clearly showed a large variability in chemical properties of soil across the Solapur district. This information could aid in decision making for application of plant nutrients for higher monetary returns to the farmers.

Keywords: *Micronutrients status, Available sulphur, GPS, Nutrient Index.*

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INTRODUCTION

Soil is a vital resource in which proper use depends on the country and the socio-economic development of its people. Overexploitation of productive lands with increasing population pressure creates serious problem of lowering the fertility status of soil and it leads to deterioration of soil. Micronutrients in soils are very important for plant growth, soil fertility, animal nutrition and productivity (Renwick & Walkar, 2008). The deficiency of nutrients directly effects on the growth of crops and crop response become poor (Jagtap et al., 2018). Hence, for sustainability of the present agricultural system and for management of our soil resources, database regarding the fertility status of soils is required. Application of fertilizers by the farmers in fields without prior knowledge of soil fertility status might result in adverse effects on soils as well as crops both in terms of micronutrient deficiency and toxicity either by inadequate or overuse of fertilizers. With the invent of modern technologies of remote sensing, GIS and GPS, it is now possible to monitor the soil fertility and crop health through systematic surveys. This will be helpful to monitor the changes in fertility status of the studied area site specific nutrient requirement of the crop. It is anticipated that with higher yields and more intensive agriculture the secondary and micronutrient deficiency will increase both in amount and extent (NAAS, 2018). Imbalanced and inadequate use of fertilizers coupled with low use efficiency of other inputs led to decline in the response efficiency of chemical fertilizer nutrients under intensive agriculture in recent years. Keeping this in view, present study was taken up in Solapur district of Maharashtra.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY AREA

Solapur district of Maharashtra is situated between 17° 10’ to 18° 32’ North latitude and 74° 42’ to 76° 15’ East longitude. Total geographical area of the district is 14,895 ha and is divided into Eleven talukas (Barshi, Mohol, North Solapur, South Solapur, Akkalkot, Pandharpur, Mangalvedhe, Sangole, Malshiras, Madha and Karmala). It is bounded from the North by Osmanabad district and Ahmednagar district, on the North-Eash by Satara district and at the South & East it has common boundary of Karanataka state. The rivers like Bhima, Sina, Man, Nira, Bhogawati and many other smaller tributaries drain in the district. Banana, cotton, jawar, sugancane, grapes, bajari, wheat are the main crops of district.

SOIL SAMPLING AND ANALYSIS

GPS based three hundred seven surface soil samples (0-20 cm) were collected from eleven talukas of Solapur district during the year 2019-20. The sampling villages were selected using stratified random method. The soil samples were processed and analyzed for pH and EC in soil: water suspensions (1:2.5 w/v) as described by Jackson (1973). Organic carbon was determined by Wet oxidation method described by Walkley and Black (Nelson and Sommers, 1982) and free $CaCO_3$ was determined by Rapid titration method (Piper, 1966). Available S was estimated by turbidimetric method (Chesnin & Yien, 1951). Soil samples were extracted with 0.005M diethylene triamine penta acetic acid (DTPA) for estimation of available Zn, Fe, Cu and Mn using Atomic Absorption Spectrophotometer (Lindsay & Norvell, 1978). Available boron was determined by 0.01 M $CaCl_2$ extract with Azo-methine method (Berger & Troug, 1939). The nutrient indices were calculated by using the formula given by Parker et al. (1951) and categorized into low (<1.66), medium (1.66 – 2.33) and high (> 2.33).

The soil categorization as low, medium and high followed in Maharashtra state in case of micronutrients is depicted in Table 1.

RESULTS AND DISCUSSION

SOIL PROPERTIES

Data pertaining to physic-chemical properties of soils in study area is depicted in Table 2. Investigated soils are neutral to alkaline in reaction with pH varied from 6.30 – 8.75

across the district. Neutral to alkaline pH may be attributed to the reaction of applied fertilizer material with soil colloids, which resulted in the retention of basic cations on the exchangeable complex of the soil. Maximum soil samples were found slightly to moderately alkaline in nature. The electrical conductivity (EC) gives an indication about salt concentration of the soil and it varied from 0.02 to 0.59 dS m^{-1} at 25^0C with an average value of 0.14 dS m^{-1}. All the soils were non-saline in nature and suitable for healthy plant growth. The organic carbon content in soils ranged from 2.67 to 13.37 g kg^{-1}. Calcium carbonate content in soils of the district varied from 1.75 to 17.75 per cent, High calcium carbonate is harmful; it reduces the concentration of micronutrient cations in soils to such a level that the sensitive plant suffers from deficiency of micronutrients (Deb et al., 2012).

SULPHUR STATUS

The available sulphur varied from very low to very high (1.13 to 31.56 g kg^{-1}) as presented in Table 3 and 4. Majority of the are showed low in available sulphur (45.60 %). Low amount of available sulphur at surface soil samples is mainly because of intensive cultivation of crops and application of fertilizers devoid of sulphur (Katkar et al., 2018). The application of balanced nutrition to the crops under intensive cultivation is essential for maintaining the soil fertility and sustainable productivity.

MICRONUTRIENTS STATUS

Data pertaining to micronutrient status and percent sample deficient of the study area is depicted in Table 3 and Table 4, respectively. DTPA-Zn of Solapur district as a whole, varied from 0.10 to 2.50 mg kg^{-1} indicating 76.55 per cent deficiency. The highest deficiency of zinc was observed in Madha taluka followed by North Solapur. Under alkaline soil condition (pH higher than 7.0) the micronutrient cations are changed largely to their oxides and hydroxides which ultimately reduced their availability (Deb et al., 2012). DTPA-Fe content showed slight variation (0.11 to 13.74 mg kg^{-1}) in the soils of Solapur district. Considering 4.5 mg kg^{-1} as critical limit of available iron, the distribution of soil samples under deficient category was 95.44%. Increased removal of micronutrients as a consequence of adoption of high yielding varieties and intensive cropping together with a shift towards the use of high analysis NPK fertilizers which might have caused decline in the level of micronutrients in the soil below the critical level which are required for normal productivity of crops (Zende, 1987). The DTPA extractable Cu in the soils of ranged from 0.10 to 3.95 mg kg^{-1}. 9.12 % soil samples in Solapur district were found deficient in Cu content. The DTPA-Mn status of soils ranged from 0.20 to 11.98 mg kg^{-1} with only 70.03 % deficiency. Available boron in soils of all the blocks ranged from 0.35 to 2.82 mg kg^{-1} with a mean value of 1.40 mg kg^{-1}. The range of available boron in soils of different states of India varied from traces to 12.2 mg kg^{-1} (Das, 2007). Nearly all soil samples (99.35 %) are found sufficient in Boron.

NUTRIENT INDICES

Nureint index values (NIV) representing the available nutrients present in the soils was calculated utilizing the formula suggested by Parker et al. (1951) and classified as low (<1.67), medium (1.67-2.33) and high (>2.33).

$NI = [(NLx1) + (NMx2) + (NHx3)] / NT$

Where

NL, NM and NH are the number of soil samples falling in low, medium and high categories for nutrient status and are given weightage of 1, 2 and 3, respectively NT is the total number of soil samples.

Considering the concept of 'Soil Nutrient Index' the soils of the study area as presented in Table 5 were found in the category of 'low fertility status' for zinc (1.27) and iron (1.05) and manganese (1.32), 'medium' with respect to sulphur (1.84) and 'high' for copper (2.48) and boron (2.77) considering whole district as one unit. In nutshell, overall fertility rating for micronutrients in the soils of Solapur district revealed low in Zn, Fe and Mn, marginal in S and high in Cu and B status. The areas where the status of nutrients are high, may show

deficiency in near future if the due care will not be taken for addition of organic manures and inorganic micronutrient fertilizers based on soil testing by the cultivators in the solapur district for intensive cultivation of different crops (Malewar, 2005).

Table 1: Categorization of soil parameters and nutrients

Sr. No.	Parameters	Low	Medium	High
1	pH (1:2.5)	<6.5 (Acidic)	6.5-7.5 (Neutral)	>7.5 (Alkaline)
2	EC (dS m^{-1})	<1.0	1-2	>2.0
3	O.C. (g kg^{-1})	<4.0	4-8	>8.0
4	$CaCO_3$ (%)	<3.0	3-8	>8.0
5	S (mg kg^{-1})	<10.0	10-20	>20.0
6	Zn (mg kg^{-1})	<0.60	0.6-1.80	>1.80
7	Fe (mg kg^{-1})	<4.50	4.50-18.0	>18.0
8	Cu (mg kg^{-1})	<0.20	0.20-0.80	>0.80
9	Mn (mg kg^{-1})	<2.0	2.0-8.0	>8.0
10	B (mg kg^{-1})	<0.50	0.50-1.0	>1.0
11	Mo (mg kg^{-1})	<0.10	0.10-0.40	>0.40

Table 2: Chemical properties of soils in different blocks across Solapur District

S. N.	Name of Block	Total No. of samples	pH (1:2.5)		EC (dS m^{-1})		$CaCO_3$ (%)		Organic carbon (g kg^{-1})	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Barshi	30	7.65-8.30	7.92	0.02-0.23	0.11	2.50-16.00	6.57	2.97-7.87	5.17
2	Mohol	30	7.35-8.36	7.89	0.02-0.43	0.12	6.13-13.50	9.29	2.67-7.13	4.62
3	Solapur (N)	19	7.70-8.18	7.95	0.06-0.23	0.11	6.52-16.75	10.38	3.71-9.50	7.39
4	Solapur (S)	18	7.69-7.99	7.83	0.07-0.17	0.12	4.25-17.75	11.67	8.02-13.37	10.5
5	Akkalkot	31	7.38-8.24	7.93	0.07-0.44	0.14	6.38-17.75	11.07	5.79-10.99	8.37
6	Pandharpur	31	7.64-8.45	8.00	0.09-0.59	0.16	4.13-10.38	6.98	5.94-10.84	8.70
7	Mangalvedhe	25	7.62-8.71	8.07	0.04-0.28	0.10	3.63-11.0	8.33	4.31-10.84	7.92
8	Sangole	34	7.76-8.51	8.01	0.06-0.28	0.12	5.38-11.50	8.84	4.60-12.03	7.99
9	Malshiras	29	7.56-8.75	8.05	0.06-0.57	0.18	3.63-7.38	5.27	4.64-13.22	7.47
10	Madha	29	7.16-8.59	7.93	0.07-0.25	0.15	1.75-6.38	4.23	3.56-10.98	6.65
11	Karmala	31	6.30-8.17	7.83	0.09-0.29	0.17	3.13-8.88	5.87	3.71-9.28	6.94
District average		**307**	**6.30-8.75**	**7.95**	**0.02-0.59**	**0.14**	**1.75-17.75**	**7.87**	**2.67-13.37**	**7.33**

Table 3: Available sulphur and micronutrient status (mg kg^{-1}) of soils in different blocks across Solapur District

S. N	Name of Block	S		DTPA-Zn		DTPA-Fe		DTPA-Cu		DTPA-Mn		B	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Barshi	1.13-20.34	6.51	0.54-1.75	1.51	0.21 – 1.67	0.73	0.51 – 2.94	1.16	0.20 – 3.88	1.22	0.89 – 2.03	1.31
2	Mohol	1.14-28.88	12.43	0.11-2.50	1.16	0.27 – 7.19	1.86	0.28 – 2.85	0.95	0.21 – 4.75	1.51	0.66 – 2.53	1.74
3	Solapur (N)	23.90-30.98	27.49	0.10-2.42	0.61	0.20 – 2.87	1.48	0.11 – 3.02	0.82	0.23–11.72	1.60	0.63 – 2.82	1.85
4	Solapur (S)	21.24-31.56	27.96	0.11-2.40	0.94	0.77 – 3.09	1.87	0.10 – 1.24	0.28	1.49 – 3.23	2.47	0.55 – 2.51	1.55
5	Akkalkot	1.25-20.63	6.94	0.10-1.60	0.57	0.67 –13.74	3.90	0.39 – 3.25	1.16	0.21–11.60	2.56	0.35 – 2.25	1.44
6	Pandharpur	3.73-28.11	10.27	0.10-2.37	0.63	0.11 – 4.25	1.89	0.12 – 2.41	0.65	0.46 – 5.09	1.71	0.69 – 2.51	1.85
7	Mangalvedhe	21.09-30.86	28.44	0.12-1.44	0.48	0.77 – 4.83	2.11	0.11 – 1.47	0.52	0.24 – 3.71	1.15	0.61 – 1.71	1.10
8	Sangole	2.99-30.43	17.01	0.10-2.21	0.57	0.12 – 4.23	1.82	0.20 – 2.96	1.04	0.36 – 2.07	1.10	0.60 – 2.35	1.29
9	Malshiras	3.28-22.99	10.27	0.12-1.27	0.58	0.32 – 1.92	1.01	0.94 – 3.62	1.87	0.29 – 3.62	1.33	0.52 – 1.89	1.23
10	Madha	4.46-18.82	10.26	0.29-0.92	0.57	0.25 – 1.96	0.75	0.48 – 3.00	1.86	0.24 – 2.95	0.83	0.50 – 1.88	1.04
11	Karmala	1.94-17.77	9.79	0.22-2.24	0.75	0.23 – 9.88	1.27	0.61 – 3.95	2.25	0.20–11.98	3.93	0.53 – 1.80	1.21
District average		**1.13-31.56**	**14.06**	**0.10-2.50**	**0.76**	**0.11 -13.74**	**1.71**	**0.10 –3.95**	**1.19**	**0.20-11.98**	**1.76**	**0.35 – 2.82**	**1.40**

Table 4: Percent samples deficient for available sulphur and micronutrients of soils in different blocks across Solapur District

S. No.	Name of Block	Percent of samples deficit for available sulphur and micronutrients					
		Sulphur	DTPA-Zn	DTPA-Fe	DTPA-Mn	DTPA-Cu	Boron
1	Barshi	83.33	3.33	100.00	80.0	00	00
2	Mohol	53.33	46.67	90.00	66.67	00	00
3	Solapur (N)	00	94.74	100.00	68.42	15.79	00
4	Solapur (S)	00	61.11	100.00	16.67	72.22	00
5	Akkalkot	87.10	90.33	70.97	51.61	00	6.45
6	Pandharpur	58.06	87.10	100.00	77.42	12.90	00
7	Mangalvedhe	00	92.00	96.00	92.00	32.00	00
8	Sangole	38.24	91.17	100.00	97.06	00	00
9	Malshiras	41.38	93.10	100.00	79.31	00	00
10	Madha	51.72	100.00	100.00	89.66	00	00
11	Karmala	45.16	83.87	96.77	32.26	00	00
District average		**45.60**	**76.55**	**95.44**	**70.03**	**9.12**	**0.65**

Table 5: Status of nutrients and nutrient indices of soils in different blocks across Solapur District

Nutrients	Percent samples			Nutrient index
	Low	Medium	High	
S	45.60	24.76	29.64	1.84
Zn	76.55	19.22	4.23	1.27
Fe	95.44	4.56	00	1.05
Mn	70.03	27.69	2.28	1.32
Cu	9.12	34.20	56.68	2.48
B	0.65	21.50	77.85	2.77

CONCLUSION

The present study revealed that there is wide variation in micronutrient status is soils of Solapur district in Maharashtra. The soils are low in available zinc, iron and magnase, medium in available sulphur and high in available copper and boron. Deficient nutrients have to be restored through chemical fertilizers and / or organic manures to maintain soil health. The current status of available sulphur and micronutrients in soils of Solapur district will be helpful to suggest the efficient ways and methods of balanced nutrient application for enhancing the yields by using recommended quantities of organic manures and inorganic fertilizers in the areas of major and micro-nutrients deficiency.

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