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Micronutrient Status of Soil in Barshitakli Tahsil of Akola District

Akanksha D. Chiliwant[1], Alpana Kumhare[2], Yagini Tekam[3*], Kailash Kumar[4], Neetu Kokode[5] and Mrunal R. Gedam[1]

[1]Department of Soil Science and Agricultural Chemistry, College of Agriculture, Nagpur, Dr. PDKV, Akola (Maharashtra), India.
[2]Department of Agronomy, College of Agriculture, RVSKVV, Gwalior (Madhya Pradesh), India.
[3]Department of Soil Science and Agricultural Chemistry, College of Agriculture, JNKVV, Jabalpur (Madhya Pradesh), India.
[4]Department of Forestry, College of Agriculture, JNKVV, Jabalpur (Madhya Pradesh), India.
[5]Department of Soil Science and Agricultural Chemistry, College of Agriculture, Indore, RVSKVV, Gwalior (Madhya Pradesh), India.

(Corresponding author: Yagini Tekam)*
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ABSTRACT: The investigation in relation to the "Micronutrient status of soil in Barshitakli tahsil of Akola district" was undertaken during 2020–21. Through this investigation, observations were taken of the soil's physico-chemical properties and the major and micronutrient status of surface soils. Sustainable food production and the health of the soil are dependent on micronutrients. The soils under study were slightly to moderately alkaline in reaction, and the EC values for these soils were within the safe limit. The organic carbon content in these soils showed a medium to moderately high status. The free $CaCO_3$ content of these soils ranged from moderately to high calcareous in nature. Barshitakli tahsil soils had a range of micronutrient cation contents; available Zn content was between 0.17 and 0.69 mg kg^{-1}, and available Fe content was between 1.1 and 3.75 mg kg^{-1}, Mn content varies from 0.97 to 4.93 mg kg^{-1}, Cu content varied from 0.25 to 3.12 mg kg^{-1}. Results show that these soils are well supplied with Mn and Cu and low to marginal in Zn and Fe. The correlation study reveals that the availability of major nutrients and micronutrients decreases with an increase in pH. The increase in organic carbon leads to an increase in Zn, Fe, Mn, and Cu. The soil fertility index worked out for major and micronutrients and showed that, as per the six-tier system, iron (Fe) comes under the very low category, zinc comes under the low category, manganese comes under the moderate category, and Cu comes under the very high category. The rapid depletion of available micronutrients from the soil has been exacerbated by the current intense cropping of high-yielding varieties (HYV) with the application of micronutrient-free, high-responsive fertilisers to increase food grain production. Each crop must be designed with a specialized fertilizer formulation technology for optimal production and productivity under certain agro-ecological conditions. Satisfying the increasing population nowadays requires appropriate policies to create apprehension amongst the farming community for determining micronutrient deficiency precisely and maintaining balanced fertilization, which is especially required to maintain the health of the soil along with crop sustainability.

Keywords: Calcareous, Micronutrient, Organic carbon, Soil fertility, Sustainability.

INTRODUCTION

Soil is the most precious and natural resource of any nation. To meet the growing demand for food, fibre, fuel, and fodder, soils are maintained in an excellent state of health. There are seventeen essential plant nutrients that are required for proper plant growth and development, each one of which is equally important to the plants, and they are required in vastly different amounts. Micronutrients consist of eight essential elements required by plants, *viz*., zinc (Zn), iron (Fe), copper (Cu), manganese (Mn), molybdenum (Mo), boron (B), nickel (Ni), and chlorine (Cl).

These elements occur in very small amounts both in soils and plants, but their role is equally vital as that of primary or secondary plant nutrients. They are constituents of enzymes and coenzymes. A deficiency of one or more of the micronutrients can lead to severe depression in growth, yield and crop quality. The lack of micronutrients has become a major barrier in sustainable crop productivity in soils, and now important to know the spatial variability of nutrients of the soil (Katkar *et al.,* 2018). In such cases, supplemental micronutrient application in the form of commercial fertilizers and foliar sprays or the application of appropriate microbial inoculants in the soil becomes highly essential. During the initial years of the introduction of high-yielding varieties (HYVs), micronutrient deficiencies were subsequently noticed in many pockets of the globe owing to the high yield potential and high nutrient requirements of this germplasm (Rattan *et al.*, 2009).

Micronutrients are not only important for better crop productivity but also essential for sustaining human and animal health. Micronutrients are needed by plants in significantly lesser amounts in comparison to macronutrient elements. To ensure optimum agriculture production, it is imperative to know the basic facts about our soils and their management to achieve sustainable production.

The qualities of the soil need to be looked at because the natural resources are being overexploited. The soils of Maharashtra state are categorized as poor to moderate in fertility and they vary widely in genetic, morphological, physical, chemical, and biological characteristics. Intensively cultivated soils are being depleted with available nutrients, especially secondary and micronutrients. Therefore, an assessment of the fertility status of soils that are being intensively cultivated with high-yielding crops needs to be carried out.

Micronutrients are important for maintaining soil health and also for increasing crop productivity. The deficiency or excess presence of the micronutrients may produce synergetic and antagonistic effects in plants. This causes a decline in the productivity of crops. Due to the importance of micronutrients in crop productivity and quality, it is imperative that we recognise the factors that lead to micronutrient deficiencies and affect overall crop growth and development.

MATERIALS AND METHODS

The study was conducted with an objective to assess the micronutrient status and to identify and delineate area of micronutrient deficiencies in Barshitakli tahsil of Akola district. The research work entitled "Micronutrient status of soil in Barshitakli tahsil of Akola district" conducted during the year 2020-21. Barshitakli tahsil lies between Latitude [N] N 20° 16′-N 21 ° 17′E Longitude [E] 76°38′-E 77° 38′. The district has recorded a minimum temperature of 2 °C while a maximum of 47.7 °C. The normal annual rainfall over the district varies from about 740 mm to 860 mm.Out of 159 villages of Barshitakli block, 10 villages selected on the basis of GPS griding at 5 km interval so as to cover all area of Barshitakli tehsil. Surface soil samples (0-20 cm) taken from 10 different villages and from each village 10 soil samples (from farmer's field) collected (100 soil sample) at 5 km grid interval from Barshitakli tahsil of Akola district. The soil pH was determined by digital pH meter using glass electrodes and 1:2.5 soil: water ratio as described by Jackson (1973). Electrical conductivity (EC) was determined with conductivity meter using 1:2.5 soil: water suspension as described by Jackson (1973). Organic carbon was determined by Walkley and Black (1934) method as described by Jackson (1973). Calcium carbonate was estimated by rapid titration method using phenolphthalein indicator as described by Piper (1966). Available Micronutrients i.e. DTPA (0.005 M) extractable Fe, Mn, Zn and Cu was determined as the procedure outlined by Lindsay and Norvell (1978) using atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

A. Soil pH and Electrical Conductivity

The pH of soils of Barshitakli tahsil was in the range of 6.7 to 8.4 which was slightly alkaline to moderately alkaline with the mean value of 7.83. Similar results reported by Priyanka *et al.* (2018). The electrical conductivity of all soils of the farmers field was 0.121-0.389 dS m^{-1} which was under the safe limit (<0.51 dSm^{-1}) with the average value of 0.222. Similar results were reported by Hadole *et al*. (2019).

B. Organic Carbon and Calcium carbonate

The variation in organic carbon content in this soil was from 3.9 to 7.5 mg kg^{-1} with a mean value of 6.05 g kg^{-1} (Table 1). Lowest value of organic carbon was found in Ujaleshwar village (3.9 g kg^{-1}) and highest organic carbon found at Kanherisarap, Donad and Yeranda village (7.5 g kg^{-1}). In general, the organic carbon status of soils in Barshitakli tahsil was medium to moderately high. Similar result found by Raut *et al.* (2017). Shind *et al*. (2019) studied the fertility status of highway of the central research station Dr. PDKV Akola, they revealed that nutrient index value of Highway block calculated for organic content in soils is 1.37 g kg^{-1}The calcium carbonate content data revealed that, the soils under study have $CaCO_3$ in a range of 3.55-6.6 per cent with average value of 4.95 per cent (Table 1). The highest $CaCO_3$ (6.7%) content was observed in Ujaleshwar village whereas the lowest was in Kanherisarap and Yeranda village (3.55%). It indicates that, the soils are moderately calcareous to calcareous in nature. Similar finding were reported by Katkar *et al.* (2013).

Table 1: Range and mean of physico-chemical properties of soil.

Village	pH		EC (dS m^{-1})		$CaCO_3$ (%)		OC (g kg^{-1})	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
KanheriSarap	7.1-8.4	7.81	0.137-0.331	0.215	3.55-6.05	4.78	4.2-7.5	6.52
Barshitakli	7.3-8.2	7.76	0.156-0.273	0.207	3.90-5.65	4.82	4.5-7.2	6.06
Sindkhed	7.8-8.2	8.06	0.200-0.356	0.228	3.65-5.40	4.43	4.8-7.2	6.29
Sukali	7.6-8.2	7.88	0.145-0.295	0.228	3.95-6.10	4.90	4.4-7.2	5.9
Sarav	6.7-8.1	7.64	0.179-0.345	0.225	4.20-6.10	5.46	4.8-7.2	6.68
Dhaba	7.5-8.2	7.73	0.157-0.269	0.216	4.15-6.10	5.31	4.8-7.5	6.05
Ujaleshwar	7.7-8.2	8.05	0.122-0.390	0.211	3.80-6.70	5.16	3.9-7.3	5.2
Alanda	7.4-8.3	7.91	0.179-0.388	0.245	3.95-6.05	4.82	4.3-7.2	5.73
Donad	7.4-8.2	7.80	0.174-0.319	0.219	3.95-5.80	4.99	4.4-7.3	6.21
Yeranda	7.1- 8.3	7.64	0.123-0.389	0.222	4.25-5.85	4.81	4.2-7.5	6.01

Table 2: Range and means of micronutrient content in soils of Barshitakli tahsil.

Village	Zn (mg kg^{-1})	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})	Cu (mg kg^{-1})
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
KanheriSarap	0.29-0.65	0.48	1.84-5.47	2.78	1.78-4.72	4.28	1.75-3.12	3.29
Barshitakli	0.21-0.59	0.43	1.13-5.14	2.33	0.99-2.97	3.33	1.25-3.10	2.04
Sindkhed	0.15-0.32	0.48	2.11-4.86	2.44	2.18-4.93	4.38	1.71-2.97	3.30
Sukali	0.27-0.68	0.48	2.36-5.75	2.19	2.67-4.38	3.63	1.22-2.92	3.80
Sarav	0.42-0.67	0.56	2.02-5.52	2.67	1.60-4.37	4.35	2.09-2.98	3.78
Dhaba	0.33-0.58	0.45	2.97-4.97	2.29	3.15-4.77	3.80	0.25-3.03	3.79
Ujaleshwar	0.30-0.69	0.53	2.08-5.37	2.24	1.54-4.24	3.71	1.49-2.95	3.10
Alanda	0.32-0.61	0.47	2.34-5.60	2.33	1.78-4.24	4.17	1.43-3.09	3.25
Donad	0.17-0.62	0.40	2.46-5.49	2.19	1.54-4.23	4.66	0.96-3.04	2.94
Yeranda	0.29-0.63	0.53	3.11-5.70	2.33	1.92-4.77	4.13	1.69-3.02	3.62

C. Available micronutrient status in soil of Barshitakli tahsil

(i) Available Zn. As per the given data in Table 2 the Zn availability in soils of Barshitakli tahsil was ranged from 0.17 to 0.69 the lowest value i.e. 0.17 mg kg^{-1} was found in soil sample from Donad village and the highest in Ujaleshwar village soils i.e. 0.69 mg kg^{-1}. The mean available Zn content in soils of Barshitakli tahsil was 0.48 mg kg^{-1}. Among all soil samples from Barshitakli tahsil, 24 soil samples were very low, 50 soil samples were low and 26 samples were medium in available Zn content (Table 3). The spatial variability classes of available Zn shows that available Zn content categorized between very low to medium. This may be due to alkaline pH and high $CaCO_3$ which causes zinc to be precipitated as hydroxides and carbonates under alkali pH range. Therefore, their solubility and mobility may be decreased. In well drained aerated calcareous soil zinc exists in oxidized state and its availability become low. The results were in conformity with the finding of Bhagat (2012). Hadole *et al*. (2020) also analyzed the soil samples in Solapur District in Maharashtra to determine their level of micronutrients and to provide information to farmers and extension functionarie. They evaluated that, 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).

(ii) Available Fe. The highest DTPA Fe was observed in soil of Sukali village i.e., 5.75 mg kg^{-1} and the lowest was observed in Barshitakli village i.e.,1.13 mg kg^{-1}. The mean value of available Fe of soils in Barshitakli tahsil is 4.04 g kg^{-1}. The DTPA-Fe in Vertisols ranges from 0.70-14.50 mg kg^{-1}. The available iron in Vertisols was ranging from 1.14 to 10.46 mg kg^{-1} as reported by Dhamak *et al.* (2014). Range and mean of available Fe content in soils from different village are presented in (Table 2). The spatial variability classes of available- Fe of Barshitakli tahsil showed that the available Fe content ranged from very low to low category (Table 3).

(iii) Available Mn. The available Mn status of soil from different villages showed that the lowest value i.e. 0.97 mg kg^{-1} recorded in soils of Barshitakli village and the highest i.e. 4.93 mg kg^{-1} in Sukali, Ujaleshwar village soils. The mean value of available Mn of soils in Barshitakli tahsil was 4.11 mg kg^{-1}. Among all soil samples, 14 samples were low, 58 samples were medium and 28 soil samples were moderately high in available Mn content. Thus, most of the soil samples were sufficient in Mn content (Table 3). Similar results were observed by Waikar *et al.* (2014). The range and mean of available Mn of soils from different villages are presented in (Table 2). The spatial variability classes of available-Mn of Barshitakli tahsil shows that the available Mn content varies from low to moderately high category (Table 3). The findings of Ikhe *et al.* (2017) on different soils in Buldana district of Maharashtra revealed

that the soils are high in Mn followed by Fe, Cu and Zn.

(iv) Available Cu. By evaluating available Cu content in soils of 10 villages in Barshitakli tahsil, it was recorded that minimum value i.e. 0.25 mg kg^{-1} in Dhaba village and maximum available Cu was observed in Kanherisarap village i.e.3.12 mg kg^{-1}. The mean value of available Cu content of soils in Barshitakli tahsil was 2.38 mg kg^{-1} which shows high status of available Cu. Near about all soil samples of the study area were under high rating for available copper content (Table 3). The higher amount of Cu in surface layer might be due to higher biological activities and chelating effect. Similar results were reported by Sharma and Chaudhary (2007). The range and mean of available Cu content in the soils of different villages are presented in (Table 2). The spatial variability classes of available Cu of Barshitakli tahsil shows that the available Cu content is in high category.

Table 3: Zn, Fe, Mn and Cu classes of soils of Barshitakli tahsil.

Class	Available Zn (mg kg^{-1})	No. of Sample	Available Fe (mg kg^{-1})	No. of Sample	Available Mn (mg kg^{-1})	No. of Sample	Available Cu (mg kg^{-1})	No. of Sample
I (Very low)	<0.30	24	<5	76	<1	00	<0.1	00
II(Low)	0.30-0.60	50	5-10	24	1-2	14	0.11-0.20	00
III(Medium)	0.60-1.20	26	10-15	00	2-4	58	0.21-0.40	01
IV(ModerateHigh)	1.20-1.80	00	15-20	00	4-8	28	0.41-0.80	00
V(High)	1.80-2.40	00	20-25	00	8-16	00	0.81-1.20	01
VI(Very High)	>2.40	00	>25	00	>16	00	>1.20	98

D. Relationship between soil chemical properties with available micronutrient

Correlation analysis between micronutrient and chemical properties is given in Table 4. The available zinc was significant and positively correlated with organic carbon (r=0.220*), significant and negatively correlated with pH (r= -0.372**), EC (r= -0.197*) and $CaCO_3$ (r= -0.127).The DTPA extractable Fe was positively correlated with organic carbon (r=0.191) and negatively correlated with pH (r=-0.151), EC (r=-0.058), and having significant negative correlation with $CaCO_3$ (r= -0.201*). Similar results were reported by Thakur *et al*. (2018). The DTPA extractable Mn was positively correlated with organic carbon (r=0.136), and negatively significantly correlated with pH (r=-0.286**), $CaCO_3$ (r= -0.118). Similar correlation was recorded by Nazif *et al*. (2006). The DTPA extractable Cu was significantly and positively correlated with organic carbon (r=0.221*) and negatively significantly correlated with pH (r=-0.325**), $CaCO_3$ (r= -0.152) and EC (r=-0.187). Similar result was reported by Meena *et al*. (2006).

Table 4: Relationship between soil chemical properties with available micronutrients.

Parameters	Ph	EC	OC	$CaCO_3$
Zn	-0.372**	-0.197*	0.220*	-0.127
Fe	-0.151	-0.058	0.201*	-0.201*
Mn	-0.286**	-0.235*	0.136	-0.118
Cu	-0.325**	-0.187	0.221*	-0.152

*Significant at 5 % level of signicance (r=0.195); **Significant at 1 % level of significance (r=0.254)

CONCLUSIONS

It can be concluded from the above results that the soils in Barshitakli tahsil in the Akola district of Maharashtra were slightly to moderately alkaline in soil reaction (pH) and soluble salt content (EC) came under the safe range. The soils were moderately to highly calcareous, and the organic carbon level was medium to very high. The available N and P in the soils were low to medium, the available S was low to high, and the available K was medium to high. While Mn and Cu were sufficient, the majority of the soil samples required Zn and Fe. The available N, P, and S as well as the micronutrients Zn, Fe, Mn, and Cu exhibit negative correlations with soil pH and EC. Organic carbon and available N, K, and S as well as the micronutrients, showed a positive and significant association.

FUTURE SCOPE

Crops show different responses to the application of different nutrients that vary from crop to crop. The study will be helpful in understanding the micronutrient status of the soil in the Barshitakli tahsil of Akola district of Maharashtra and will be helpful for future research work in that area.

Conflict of Interest. None.

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