Biological Forum
an International Journal 17(7): 36-39(2025)
ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Studies on Macro and Micronutrient Status in Vertisols of Northern Tehsils of Jalgaon District of Maharashtra, India

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(Received: 12 April 2025; Revised: 22 May 2025; Accepted: 19 June 2025; Published online: 07 July 2025)
(Published by Research Trend)

ABSTRACT: The soil samples were collected from Northern Jalgaon district of Maharashtra including Jalgaon, Bhusawal, Raver, Yawal and Muktainagar Tehsil and analyzed at College of Agriculture, Muktainagar, Dist. Jalgaon, MS, India during summer season of 2024. This study investigated to know the status of different types of available macro (N, P and K) and micronutrients (Cu, Fe, Mn and Zn) in soil. As Jalgaon district is located in the northwest region of Maharashtra, India at location Between 20° and 21° North latitudes and 74° 55′ to 76° 28′ East longitudes surrounded by Satpuda Hills to the north, Aurangabad and Nashik district to the south, Madhya Pradesh state and Buldhana district to the east, and Dhule district to the west with total geographical area of 11,765 sq km. This region is well known for Banana crop production, continuous use of fertilizers and high yielding varieties of Banana crop have led to depletion of natural soil nutrients and soil fertility. Total 25 soil samples randomly collected and analyzed for the basic parameters viz. pH, EC, OC and $CaCO_3$. The macro nutrients N, P and K also the micro nutrients like Cu, Fe, Mn and Zn were analyzed by using atomic absorption spectrophotometer. Analysis revealed that the soils were medium to deep black in colour, poor to medium drained, with slightly alkaline pH, medium in organic carbon and average range in EC suitable for crop production. Also found insufficient amount of macro and micro nutrient in soil. The findings suggest that, this information could aid in decision making for application of plant nutrients (macro and micro nutrients) for higher monetary returns to the farmers and extension functionaries in northern part of Jalgaon district of Maharashtra.

Keywords: Jalgaon District, Tehsil, Macro and Micro nutrients, Vertisols, Soil fertility.

INTRODUCTION

Jalgaon is rich in volcanic soil which is well suited for cotton production. It is a major business center for tea, gold, pulses, cotton and bananas. Jalgaon is known as the "Banana Capital" of India, and is the world's seventh largest banana producer contributing 16% of the India's banana production. Jalgaon's climate is hot semi-arid, with an average annual rainfall of 690 mm. The district experiences hot summers and is generally dry throughout the year, except during the southwest monsoon season from June to September. Most part of the study area is covered by Deccan traps except few strips of alluvial land on both sides of the Tapi River (Patil *et al.,* 2015). The district accounts for 69% of Maharashtra's banana production area and 61% of its production. Management of soil resources on scientific principle is essential to maintain the present level of soil productivity and prevent soil degradation. In recent years, crop quality and productivity have declined due to the overuse of chemical fertilizers, pesticides, and insecticides. The soil fertility has also decreased due to the continuous sowing of the same crop year after year and reduced manure application. Jalgaon is one of the districts contributing major share of production of cereals (e.g. wheat, sorghum, rice, maize and bajra), pulses (e.g. Tur, Mung and Udid), fruits (e.g. Banana and Sugarcane), Cotton, Legumes and Oilseeds (e.g. Groundnut, Sesame, Sunflower, Soybean, Caster Seed, Safflower, Rapeseed and Mustard), Vegetables and many others. This call for comprehensive knowledge on soil resources in terms of soil type, their physical, chemical properties and limitations of capabilities, remote sensing technology has emerged as a powerful tool for studying soil resources because it helps in studying soil resources in spatial domain in time and cost-effective manner (Das, 2007; Deb *et al.,* 2012). Soil resources information and use of fertilizers planning options are useful to this area, keeping this in mind; the present investigation was taken to characterize the soils of this district using analysis method of soil parameters and also used for achieving sustainable crop production (Brady and Weil 2007).

MATERIALS AND METHODS

The study was conducted in Jalgaon district is located in east side of Nasik division. It is 20° and 21° North latitudes and 74° 55′ to 76° 28′ East longitudes and it is 3.76 % of Maharashtra state. The average rainfall ranges from 600 to 750 mm. Climate of Jalgaon district are hot semi-arid. The district experiences hot summers and is generally dry throughout the year, except during the southwest monsoon season from June to September. The macro and micro nutrients govern the soil fertility and control the yield of crops. The soil fertility evaluation of an area or region is an important aspect in context of sustainable agricultural production, particularly for semi-arid region. Where cropping depends on rain water and the farmers having less land. Random soil samples from 0 to 20 cm. depth were collected from one village of Jalgaon, Bhusawal, Raver, Yawal and Muktainagar Tahasil.

Five samples from each village were collected; about 25 representative soil samples were analyzed for important physico-chemical properties by following standard methods. The pH and EC of soils were estimated by using soil suspension (1:2.5), organic carbon (OC) by method of Walkley and Black (wet oxidation method) method revised by Mylavarapu *et al.* (2014) P_2O_5 estimated by Olsen *et al.* (1954). K_2O in soil using flame photometer and micronutrients were obtained by DTPA- method with the help of atomic absorption spectrophotometer (AAS) (Berger and Truog 1939; Lindsay and Norvell 1978).

Soil Site: The 25 representative soil samples were collected from the villages of five tahasil viz; Jalgaon- Nashirabad, Bhusawal- Sakegaon, Raver- Dasnur, Yawal- Bamnod and Muktainagar- Anturli selected randomly. Generally, vegetation from that area was Cotton, Banana, Maize, Jowar, Bajra and Wheat.

RESULT AND DISCUSSION

Table 4 displays the significant and pertinent soil properties and features. The pH values of the soils in Jalgaon were between 7.3 and 7.8 with a pooled mean value of 7.63, Bhusawal was between 7.60 and 8.30 with a pooled mean value of 8.01, Raver was between 7.52 and 8.34 with a pooled mean value of 7.98, Yawal was between 7.60 and 8.50 with a pooled mean value of 8.14, and Muktainagar was between 7.89 and 8.34 with a pooled mean value of 8.06. About 80% of those samples exhibited an alkaline soil response, while 20% displayed a neutral one. This suggests that soils are generally neutral to alkaline in nature and that they are formed from basaltic parent material, which is naturally rich in basic cations.

Approximately 100% of the samples had normal EC (<1.0 dS^{-1}). Sixty percent of the soil samples were non-calcareous, and forty percent were calcareous. This would eventually result in high soil salinity and lower crop yields if there was not enough natural drainage, like in water-logged soils and if there was no appropriate leaching and drainage program to remove salts. While low concentrations of $CaCO_3$ improve soil structure and are usually good for crop productivity, greater concentrations can cause iron shortage and when cemented, reduce the soil's ability to store water.

Available Major/ Macro Nutrients: Table 2 lists the macro nutrients- N, P, and K—as well as their average values in the soils in the northern Jalgaon region. These soil samples' organic content (OC) was evaluated as low to medium in terms of organic carbon. The low availability of nitrogen status in soils is also reflected in this. High temperatures and adequate aeration in these soils accelerated the pace at which organic matter oxidized, lowering the amount of soil organic carbon (Singh *et al.*, 2007). Patil *et al.* (2015) also observed that the reduced amount of organic matter in these soils was ascribed to similar conditions. 10% have high nitrogen content, 40% have a medium nitrogen concentration, and 40% have low nitrogen content. Low nitrogen indicates a low level of organic matter in the soil sample. Poor vegetation and a rapid rate of organic matter decomposition under a hyper-thermic temperature regime are the causes of the low content, which results in exceptionally high oxidizing conditions. According to the limitations suggested by Muhr *et al.* (1963), the accessible phosphorus in soils varied from 22.8 $kgha^{-1}$ to 26.3 $kgha^{-1}$, with a mean value of 24.9 $kgha^{-1}$. All soil samples included a large range of available phosphorus. Excessive fertilizer usage, the addition of organic matter, and plant and animal manure all contribute to the high phosphorus content of soils. Higher P fertilizer dosages or phosphorus fixation on clay minerals or $CaCO_3$ surfaces throughout the period of time between fertilizer application and crop absorption might be the cause of this. With a combined value of 141.6 $kgha^{-1}$, the available potassium content ranged from 123.8 $kgha^{-1}$ to 173.7 $kgha^{-1}$. The medium K concentration of all the soil samples suggests that the clay minerals, such as Montmorillonite, are abundant in the Jalgaon district's soils.

Available Micronutrients: The levels of accessible micronutrients, or DTPA-Cu, Fe, Mn, and Zn, in these soil samples were measured and the results are displayed as follows. With a mean value of 0.78 mg kg^{-1}, the critical limits of accessible Cu vary from 0.62 $mgkg^{-1}$ to 1.00 $mgkg^{-1}$ (Kaul *et al.*, 2010). The availability of copper is influenced by the properties of the soil; it rises with organic matter but falls with soil pH and $CaCO_3$ concentration. According to critical limitations, 60% of soil samples had medium levels of copper and 40% had adequate levels. The mean value of DTPA-Fe in the soil samples was 0.39 $mgkg^{-1}$, with a range of 0.35 $mgkg^{-1}$ to 0.52 $mgkg^{-1}$. As pH and $CaCO_3$ increased, the amount of accessible Fe dramatically reduced. All soil samples had a Fe deficiency based on the critical limits of accessible Fe (Malewar, 2005). With a pooled mean of 6.47 $mgkg^{-1}$, the DTPA-Mn in these soil samples varied from 6.14 $mgkg^{-1}$ to 6.75 $mgkg^{-1}$. The main factors influencing manganese availability are soil moisture, organic matter, and pH. 100% of the soil samples were deemed medium based on the critical limits of the available Mn. With a mean value of 0.54 $mgkg^{-1}$, the amount of zinc present in these soil samples ranged from 0.48 $mgkg^{-1}$ to 0.62 $mgkg^{-1}$, meaning that about 100% of the soils

were found to be zinc deficient. The amount of zinc in soil is determined by the parent material, organic matter, OC, $CaCO_3$, and the amount of zinc that is accessible when pH rises (Marathe and Somani 2014).

Table 1: Chemical properties of soils in different tahsils of northern Jalgaon district.

Sr. No.	Name of Tahasil	pH (1:2.5)		EC (dSm^{-1})		$CaCO_3$ (%)		Organic carbon (%)	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Jalgaon	7.36-7.89	7.63	0.21-0.31	0.26	2.08-2.92	2.54	0.58-0.69	0.64
2	Bhusawal	7.64-8.31	8.01	0.21-0.37	0.27	2.84-3.59	3.16	0.42-0.54	0.48
3	Raver	7.52-8.34	7.98	0.21-0.36	0.28	3.07-5.15	3.92	0.41-0.63	0.54
4	Yawal	7.62-8.45	8.14	0.09-0.22	0.15	2.82-4.77	3.78	0.58-0.70	0.63
5	Muktainagar	7.89-8.34	8.06	0.19-0.32	0.24	2.25-2.82	2.54	0.50-0.64	0.57

Table 2: Available macronutrient status (kg ha^{-1}) in soils of different tahsils of northern Jalgaon district.

Sr. No.	Name of Tahasil	Available N		Available P		Available K	
		Range	Mean	Range	Mean	Range	Mean
1.	Jalgaon	176.4-194.5	186.2	24.7-28.3	26.3	119.5-141.8	132.2
2.	Bhusawal	159.6-180.4	171.7	19.9-27.5	22.8	132.7-151.1	141.9
3.	Raver	152.9-176.1	166.4	22.2-29.8	25.6	162.0-186.2	173.7
4.	Yawal	161.2-182.3	171.6	19.5-26.8	23.9	112.6-164.2	136.5
5.	Muktainagar	158.2-173.4	166.2	22.8-29.3	26.2	115.2-131.0	123.8

Table 3: Available micronutrient status (mg kg^{-1}) in soils of different tahsils of northern Jalgaon district.

Sr. No.	Name of Tahasil	DTPA - Cu		DTPA - Fe		DTPA - Mn		DTPA - Zn	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
1.	Jalgaon	0.73-1.31	1.00	0.29-0.48	0.36	5.63-7.10	6.38	0.34-0.61	0.48
2.	Bhusawal	0.68-1.25	0.93	0.26-0.49	0.38	4.95-7.64	6.75	0.37-0.71	0.50
3.	Raver	0.58-0.91	0.73	0.23-0.50	0.36	5.08-7.44	6.14	0.46-0.75	0.62
4.	Yawal	0.48-0.93	0.66	0.26-0.48	0.35	5.26-7.64	6.57	0.39-0.70	0.53
5.	Muktainagar	0.46-0.83	0.62	0.37-0.61	0.52	4.78-7.92	6.52	0.34-0.79	0.59

Table 4: Rating of macronutrients in soil.

Sr. No.	Nutrients	Low	Medium	High
1.	Organic carbon %	< 0.5	0.5 - 7.5	> 0.75
2.	Available Nitrogen kg ha^{-1}	< 240	240- 480	> 480
3.	Available Phosphorous kg ha^{-1}	< 11	11 – 22	> 22
4.	Available Potassium kg ha^{-1}	< 110	110-280	> 280

Table 5: Rating of micronutrients in soil (ppm or mg kg^{-1}).

Sr. No.	Parameters	Low	Medium	High
1.	Copper (Cu)	< 0.2	0.2- 1.0	> 1.0
2.	Iron (Fe)	< 4.5	4.5- 10.0	> 10.0
3.	Manganese (Mn)	< 5.0	5.0- 10.0	> 10.0
4.	Zinc (Zn)	< 0.8	0.8- 2.0	> 2.0

Table 6: Availability of micronutrients affected by other macro and micronutrients in soil (Antagonism).

Sr. No.	Elements	Availability reduced by
1.	B	Organic nitrogenous fertilizers and high levels of phosphorus
2.	Mn	High levels of potassium, phosphorus, iron, copper, and zinc
3.	Cu	High levels of zinc, nitrogen, and phosphorus
4.	Fe	High levels of copper, manganese, zinc, and phosphorus
5.	Mo	High levels of manganese and nitrate-nitrogen fertilizer
6.	Zn	High levels of copper and phosphorus

CONCLUSIONS

Based on the findings of the study, it can be said that the primary factors influencing the availability of macronutrients and micronutrients are the pH, EC, OC, and $CaCO_3$ of the soil. Although there is deficit of iron among the micronutrients, zinc is a key problem and has to be used with fertilizers to increase crop productivity. In terms of soil reactivity, these soils were neutral to alkaline, and their salinity was within an acceptable range. Low to medium organic carbon concentration, calcareous to non-calcareous, with certain soil samples having a high calcareous content. Phosphorus is abundant and available nitrogen is quite limited, necessitating organic compost with a low K content.

Authors' Contributions. Corresponding author contributed to the conceptualization and design of the study, data collection, data analysis, interpretation of the results. Third author drafted the manuscript, critically revised the manuscript for important

intellectual content and supervised the study. All authors read and approved the final manuscript.

FUTURE SCOPE

For high and healthy, nutrient-dense food productivity and sustainable agriculture, the soils need to be monitored for soil health on a regular basis and integrated nutrient management techniques.

Acknowledgement. I would like to thank all co-authors for their extraordinary support in this research. I am grateful for the invaluable support provided by the College of Agriculture, Muktainagar Dist- Jalgaon throughout the research process. The facilities and resources offered were extremely helpful and have been instrumental in completing this research successfully. Finally, I would like to thank all those who have contributed to the success of this research.
Conflicts of Interest. None.

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How to cite this article: Ravindra Jadhav, Prasad Margal and Nihal Titirmare (2025). Studies on Macro and Micronutrient Status in Vertisols of Northern Tahasils of Jalgaon District of Maharashtra, India. *Biological Forum, 17*(7): 36-39.