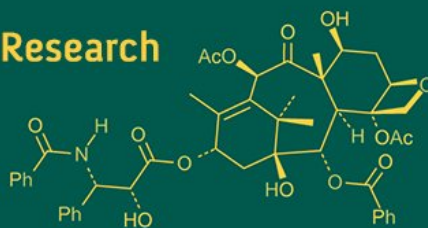
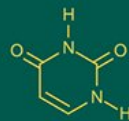
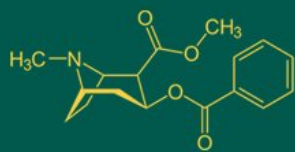


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 1119-1126
www.biochemjournal.com
Received: 26-06-2026
Accepted: 29-07-2026

Nikhil Pravin Wankhade
PG Scholar, Department of
Soil Science, Post Graduate
Institute, Akola, Dr. PDKV,
Akola, India

Dr Nilam M Kanase
Assistant Professor,
Department of Soil Science,
Dr. PDKV, Akola, India

Dr DV Mali
Assistant Professor,
Department of Soil Science,
Dr. PDKV, Akola, India

Dr BA Sonune
Assistant Professor,
Department of Soil Science,
Dr. PDKV, Akola, India

Dr SM Bhojar
Professor, Post Graduate
Institute and Associate dean,
College of Agriculture, Dr.
PDKV Akola, India

Dr SS Karhale
Assistant Professor,
Department of Agriculture
Engineering, Dr. PDKV,
Akola, India

Dr DS Kankal
Assistant Professor,
Department of Soil Science,
Dr. PDKV, Akola, India

Dr SD Jadao
(CAS) Professor, Head,
Department of Soil Science,
Dr. PDKV, Akola, India

Corresponding Author:
Dr Nikhil Pravin Wankhade
PG Scholar, Department of
Soil Science, Post Graduate
Institute, Akola, Dr. PDKV,
Akola, India

Soil fertility assessment and nutrient indexing of pdkv adopted mohammadpur model village in yavatmal district

Nikhil Pravin Wankhade, Nilam M Kanase, DV Mali, BA Sonune, SM Bhojar, SS Karhale, DS Kankal and SD Jadao

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7Sn.9186>

Abstract

The present investigation was undertaken to assess the fertility status of soils of Dr. PDKV adopted Mohammadpur Model village in Yavatmal district of Maharashtra during 2024-25. Seventy-three surface soil samples of Mohammadpur village were taken and analysed for various chemical properties. The soils under the study were observed moderately alkaline in nature (pH 7.66 to 8.32), non-saline hazard of soluble salts (EC 0.12 to 0.55 dS m⁻¹), and moderate to highly calcareous (CaCO₃ 1.98 to 9.62%). Organic carbon at different sites varied between very low and very high (0.31 to 0.95 %), available nitrogen (150.6-216.2 kg ha⁻¹) and phosphorus (14.32-20.80 kg ha⁻¹) was observed low and medium. Whereas, available potassium was found moderately high to very high (229.92-435.12 kg ha⁻¹). The available sulphur content was low to medium (5.37-14.41 mg kg⁻¹). Among the micronutrients, both the zinc (0.11-0.95 mg kg⁻¹) and iron (4.39-5.93 mg kg⁻¹) content indicated in between low to medium level, whereas copper levels were very high (1.29-3.02 mg kg⁻¹). Manganese (4.14-8.60 mg kg⁻¹) was generally present at moderately high to high levels. The nutrient index value for soils were found to be moderately high for organic carbon. It is reported high for calcium carbonate and available K, for available N low NIV is reported. The nutrient index value reported for available P, available S and iron is moderate. Micronutrient NIVs showed very high and moderately high values for copper and manganese, whereas moderate for iron and low for zinc.

Keywords: GPS, Mohammadpur Model Village, Nutrient Index Value. And Soil Fertility Assessment

Introduction

Soil is a living and very critical natural resource that meets human and livestock requirements in the form of food, fodder, fuel and fibre. Land is a scarce resource and the demands posed by the mass population, urbanization, industrial activities, and intensive farming have helped to degrade the soil. It is thus important to retain its soil health to maintain sustainable agricultural productivity, food security and long-term land use productivity. Proper, location specific data on the nutrient status of soils are important in making informed decisions on fertilizer application and good management of soils. These kinds of data can be acquired by carrying out regular assessments of fertility of soils, which augur knowledge on the physical, chemical, and biological characteristics of the soils. Some of the important indicators of soil quality are agriculture productivity since soil quality influences the crop productivity and also the fertility of the land (Wankhede *et al.*, 2021) [24]. Assessment of the physical, chemical and nutrient properties of soil is important in determining its fertility and thus a management plan of the land to be on the lines of sustainable agriculture (Shanmugasundaram *et al.*, 2019) [21]. Balanced fertilization and conservation of organic matter by applying appropriate soil management practices are required to improve carbon sequestration in soil, in addition to boosting agriculture productivity with different types of agro-climatic conditions (Bhattacharyya *et al.*, 2009) [1]. Based on this, this study was undertaken to assess the level of soil fertility of Mohammadpur Village in Yavatmal district in order to further boost agricultural performance.

2. Materials and Methods

The Mohammadpur village is situated in 78.16 E longitude and Latitude 20.55 N in Babhulgaon Tehsil of Yavatmal district with annual ainfall of 1364.8 mm. The total geographical area of Mohammadpur village is 390.97 ha out of which 388.29 ha is cultivable and 230.0 ha is under irrigation. The total population of the village is 780. The soils of the region are medium to deep black and shallow coarse in origin. These soils are deep, sticky and clay loam in texture and moisture retentive. The samples were collected from the fields of different farmers during 2024 – 25. In Mohammadpur village, 73 samples (0-20cm) were taken and their positions in the field were noted on GPS and the sample were then analysed for chemical parameters (pH, electrical conductivity, organic carbon, calcium carbonate), available macronutrients (N, P, K and S) and micronutrients (Fe, Cu, Mn and Zn). A 1:2.5 soil-water suspension was used to determine the pH and electrical conductivity of the soil (Jackson, 1973) [8, 9]. Soil organic carbon was measured by wet oxidation method described by Walkley and Black (1934) [23] whereas, calcium carbonate was estimated using rapid titration method described by Piper (1966) [17, 18].

The available nitrogen was estimated through alkaline permanganate method as suggested by Subbiah and Asija (1956) [22]. Available P was extracted calorimetrically using Olsen method (Watanabe and Olsen, 1965) [16]. Available K was estimated by flame photometer after extraction with neutral normal ammonium acetate (pH 7.0) as suggested by Knudsen and Peterson (1982) [11]. The available micronutrients (Fe, Mn, Cu, and Zn) was extracted using DTPA (Lindsay and Norvell, 1978) [14]. The nutrient index value (NIV) was determined on the basis of the six scale method of Ramamoorthy and Bajaj (1969) [19, 20] as given below:

$$NI = \frac{[NVL \times 0.5 + NL \times 1 + NM \times 1.5 + NMH \times 2 + NH \times 2.5 + NVH \times 3]}{\text{Total number of samples}}$$

Where, NVL, NL, NM, NMH, NH and NVH are the number of samples in very low, low, medium, moderately high, high and very high classes of nutrients as per six tier system.

Table 1: Rating of Nutrient Index Value (Six tier system)

Sr. No.	Category	Value
1	Very low	0.5 to 0.75
2	Low	0.76 to 1.25
3	Moderate	1.26 to 1.75
4	Moderately High	1.76 to 2.25
5	High	2.26 to 2.75
6	Very High	2.76 to 3.00

3. Results and Discussion

3.1 Soil properties

The soils of Mohammadpur were found to be slightly alkaline in reaction, with pH values ranging from 7.66 to 8.32 (mean 8.04). The EC of the soils ranged from 0.12 to 0.55 dS m⁻¹, with a mean value of 0.24 dS m⁻¹ indicating non-saline and within the safe limit.

The organic carbon status of the Mohammadpur village varied from 0.31 to 0.95 %, with a mean value of 0.68 %. The 97.27 percent soil samples were medium to very high in category. The CaCO₃ contents of soils were ranging from 1.98 to 9.62 % and a mean value of 6.28% indicating soil is calcareous with moderately high to high percentage.

Table 2: chemical properties of soils in Mohammadpur village in Yavatmal District

Sample No.	pH (1:2.5)	Ec (dSm ⁻¹)	OC (%)	CaCO ₃ (%)
1	7.81	0.36	0.46	6.87
2	7.66	0.55	0.65	6.00
3	7.91	0.41	0.63	4.37
4	8.03	0.39	0.65	3.75
5	8.12	0.44	0.58	2.50
6	7.86	0.46	0.79	1.98
7	7.95	0.33	0.69	3.75
8	7.78	0.27	0.70	5.00
9	8.04	0.2	0.72	2.50
10	8.26	0.35	0.65	4.37
11	8.21	0.29	0.49	6.25
12	8.06	0.31	0.37	3.37
13	8.11	0.24	0.58	6.87
14	7.91	0.41	0.66	3.75
15	8.15	0.31	0.55	3.75
16	8.02	0.26	0.67	3.50
17	8.08	0.34	0.46	3.37
18	8.12	0.3	0.54	5.62
19	8.15	0.32	0.54	3.75
20	8.12	0.41	0.74	6.25

21	7.99	0.31	0.66	5.00
22	8.13	0.46	0.76	5.62
23	8.00	0.16	0.31	7.00
24	7.81	0.24	0.74	6.12
25	8.17	0.29	0.69	2.50
26	8.21	0.22	0.67	7.12
27	8.31	0.16	0.71	3.50
28	8.16	0.27	0.77	4.37
29	8.20	0.19	0.63	6.25
30	8.13	0.2	0.74	4.37
31	8.05	0.25	0.68	5.62
32	8.12	0.17	0.66	6.87
33	8.32	0.25	0.71	2.00
34	8.25	0.21	0.55	5.37
35	8.10	0.25	0.63	3.75
36	7.91	0.17	0.80	5.12
37	8.21	0.23	0.69	5.87
38	8.12	0.25	0.95	4.12
39	8.02	0.23	0.72	6.75
40	7.94	0.19	0.75	7.62
41	8.17	0.16	0.79	7.75
42	8.13	0.21	0.70	6.75
43	8.01	0.19	0.68	7.75
44	8.12	0.23	0.69	6.75
45	8.20	0.16	0.67	7.25
46	8.12	0.14	0.66	8.00
47	8.26	0.19	0.76	7.25
48	8.02	0.23	0.74	8.12
49	8.11	0.15	0.78	9.00
50	8.21	0.17	0.70	8.75
51	8.03	0.13	0.65	5.87
52	7.91	0.15	0.63	6.50
53	7.83	0.14	0.77	7.87
54	7.96	0.12	0.74	7.37
55	7.99	0.18	0.78	8.25
56	8.12	0.13	0.65	9.25
57	8.02	0.18	0.72	8.37
58	7.86	0.23	0.76	9.00
59	7.92	0.2	0.79	9.62
60	8.05	0.21	0.81	7.25
61	7.91	0.17	0.74	9.12
62	7.82	0.23	0.71	8.00
63	8.03	0.19	0.69	9.12
64	7.81	0.17	0.71	9.62
65	8.11	0.27	0.75	8.37
66	7.91	0.19	0.72	7.37
67	8.22	0.21	0.68	8.25
68	8.02	0.20	0.71	9.00
69	7.93	0.19	0.77	8.00
70	7.78	0.30	0.79	7.50
71	7.93	0.17	0.76	8.25
72	8.15	0.2	0.74	9.12
73	7.83	0.21	0.69	7.50
Mean	8.04	0.24	0.68	6.28

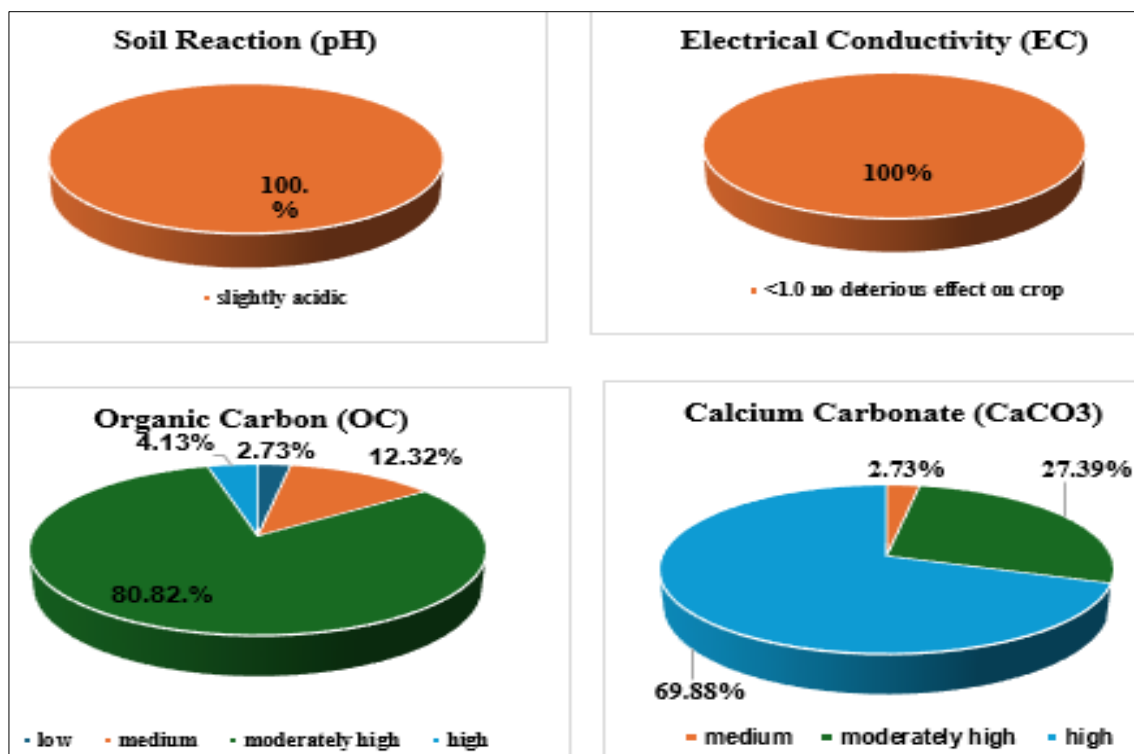


Fig 2: Chemical properties of soils in Mohammadpur village in Yavatmal District

3.2 Status of macro nutrients

The result showed that the status of available nitrogen in the soils of Mohammadpur village in Yavatmal district was ranged from 150.60 to 216.2 kg ha⁻¹, with a mean value of 191.62 kg ha⁻¹. The 100 % soil samples were found in low category, respectively. The available phosphorus in the soils of the study area ranged from 14.32 to 20.80 kg ha⁻¹, with a mean value of 17.40 kg ha⁻¹. All the 100 % soil samples were found in medium category. A wide variation in the contents of available potassium was noticed in the soils of the study area ranging from 229.36 to 435.12 kg ha⁻¹, with mean value of 298 kg ha⁻¹. Overall, 10.95 % soil samples were in the moderately high category, 46.57% in high, 42.48% in very high category of available potassium. For available sulphur, the per cent samples in low and medium categories were 45.20 and 54.80 %, respectively. The available sulphur ranged from 5.37 to 14.41 mg kg⁻¹ with mean value of 10.22 mg kg⁻¹.

3.3 Status of micro nutrients

In the soils of Mohammadpur village in Yavatmal district, the available iron (Fe) content ranged from 4.39 to 5.93 mg kg⁻¹, with an average value of 4.90 mg kg⁻¹. Based on fertility classification, 4.10 % of the samples were in the low category, while remaining 95.90% in the medium category. Available manganese (Mn) content varied between 4.14 and 8.60 mg kg⁻¹, with a mean value of 6.80 mg kg⁻¹. The distribution showed that 87.67 % of the samples were moderately high and 12.33% were in the very high category. Available zinc (Zn) levels ranged from 0.41 to 0.78 mg kg⁻¹, with an average of 0.58 mg kg⁻¹. On an average, 57.53 % samples was in low category and 42.47 % into the medium category. Available copper (Cu) concentrations in the soils ranged from 1.29 to 3.02 mg kg⁻¹, with an average value of 2.00 mg kg⁻¹. Among the samples, all of the 73 (100%) were in the very high category.

Table 3: Available macronutrient (N, P, K, S) and Micronutrient (Fe, Mn, Zn, Cu) status of soils in Mohammadpur Village in Yavatmal District

Sample No.	N	P ₂ O ₅	K ₂ O	S	Fe	Mn	Zn	Cu
		(kg/ha)				(mg/kg)		
1	183.25	16.49	299.92	11.71	5.14	6.46	0.55	1.04
2	190.4	19.71	329.36	11.15	5.54	5.09	0.64	0.98
3	195.2	15.05	246.96	11.26	5.25	6.55	0.61	0.96
4	208.52	20.8	254.08	10.33	5.93	6.48	0.7	0.96
5	183.5	18.06	229.36	8.24	5.31	8.18	0.56	0.84
6	198.4	16.38	270.48	8.78	4.89	7.84	0.47	1.92
7	205.7	16.99	286.96	10.36	5.25	6.24	0.71	0.86
8	213.6	17.48	323.44	8.28	4.39	7.74	0.61	0.94
9	188.6	19.42	241.12	12.22	4.75	7.8	0.59	0.96
10	178.6	15.35	252.88	6.70	4.83	7.7	0.72	1.11
11	195.25	16.26	299.92	7.31	4.82	7.62	0.43	1.46
12	203.6	17.49	241.12	7.87	5.22	8.2	0.71	0.78
13	198.4	16.99	323.44	9.87	4.71	6.14	0.63	1.05

14	183.5	20.39	317.52	9.24	4.58	7.98	0.78	0.82
15	179.6	16.51	304.56	10.93	4.42	7.5	0.68	1.19
16	208.4	19.85	324.36	7.50	4.96	6.18	0.58	0.87
17	201.1	16.99	256.96	12.40	4.72	7.26	0.73	0.91
18	173.5	18.21	341.04	10.00	5.04	7.98	0.54	1.13
19	193.6	16.75	258.72	12.56	4.61	6.26	0.61	1.85
20	203.4	20.06	256.96	9.65	5.27	6.95	0.52	0.89
21	178.4	15.78	317.52	9.81	5.24	8.1	0.67	2.04
22	203.8	19.79	329.36	11.20	4.67	8.28	0.53	1.09
23	160.4	19.42	317.60	11.37	4.83	6.86	0.58	0.95
24	206.6	17.72	323.44	7.22	5.23	7.68	0.41	1.09
25	185.8	19.36	299.92	6.98	4.59	6.68	0.61	0.90
26	188.6	17.02	294.00	6.20	5.08	7.82	0.59	1.73
27	190.6	19.22	299.92	9.63	4.52	8.2	0.52	0.83
28	168.7	20.15	341.04	8.61	5.04	7.98	0.47	0.76
29	192.6	17.65	435.12	9.63	4.62	8.28	0.58	1.15
30	175.7	16.26	323.44	8.61	5.01	4.762	0.72	0.91
31	201.1	20.09	324.56	11.02	4.98	4.834	0.49	0.80
32	188.6	17.23	276.40	8.89	4.85	7.38	0.64	1.07
33	203.6	15.59	294.00	9.02	4.63	6.68	0.58	0.92
34	216.2	17.23	264.64	10.46	4.55	4.14	0.65	0.87
35	173.5	16.81	252.88	5.37	4.76	5.666	0.53	0.77
36	206.4	17.32	317.52	5.74	4.89	6.02	0.56	0.82
37	185.97	18.45	311.68	9.1	4.87	7.51	0.62	1.18
38	177.5	16.51	376.32	10.93	4.60	7.68	0.57	1.57
39	210.88	19.91	341.68	8.06	4.75	6.98	0.63	0.81
40	203.5	16.41	264.64	8.47	4.56	8.3	0.68	1.02
41	150.6	14.32	329.36	9.53	4.96	7.32	0.59	1.07
42	208.6	16.99	246.96	11.23	4.63	7.28	0.55	0.89
43	191.6	18.98	274.40	11.74	4.61	7.94	0.6	0.88
44	178.5	19.18	299.92	10.93	4.53	7.3	0.53	1.19
45	201.1	15.34	323.44	11.64	4.85	7.96	0.68	0.88
46	198.5	17.38	264.64	8.74	4.54	7.76	0.52	0.97
47	208.6	18.41	311.68	8.86	4.70	4.48	0.49	0.96
48	175.97	15.29	423.36	11.20	5.83	6.48	0.58	0.86
49	201.1	16.55	270.48	10.13	4.94	8	0.47	1.04
50	175.8	18.69	241.12	9.36	5.52	4.59	0.61	0.91
51	163.6	19.95	288.16	12.08	4.57	4.832	0.57	1.15
52	213.6	17.41	329.36	8.78	4.63	7.78	0.7	1.12
53	180.4	15.09	294	11.02	4.92	6.58	0.57	0.95
54	188.6	14.80	246.96	12.69	5.57	4.668	0.45	1.08
55	201.1	17.48	323.44	11.88	4.69	6.737	0.62	1.12
56	193.6	15.68	399.84	12.3	4.92	7.52	0.54	1.06
57	215.23	15.78	299.92	12.87	5.16	6.02	0.57	1.08
58	188.6	17.62	288.16	12.1	5.26	7.86	0.65	1.12
59	201.1	18.21	311.68	10.19	5.18	5.96	0.58	0.99
60	198.4	17.04	317.60	13.22	5.24	4.16	0.47	1.67
61	204.1	15.86	311.68	9.17	4.83	4.836	0.66	1.09
62	175.97	17.41	288.16	14.41	4.43	8.6	0.59	0.91
63	200.1	14.84	246.96	11.30	4.71	7.26	0.68	1.28
64	213.6	17.96	258.72	12.53	4.89	6.42	0.61	1.08
65	188.6	20.61	294	12.6	4.57	5.04	0.54	1.56
66	176.4	16.26	329.36	11.20	5.65	6.96	0.63	1.64
67	192.16	15.11	288.16	12.87	5.29	7.05	0.51	1.86
68	186.6	16.55	299.92	13.80	4.63	7.76	0.43	0.78
69	203.6	14.81	270.48	11.39	5.04	7.08	0.47	2.14
70	185.6	15.59	311.68	9.08	4.97	6.56	0.61	2.28
71	166.45	18.69	258.72	11.27	4.52	7.02	0.52	0.85
72	173.5	16.79	288.16	10.65	4.97	6.74	0.62	1.17
73	183.08	17.04	264.64	12.87	4.69	8.2	0.46	0.79
75	150.60-216.20	14.32-20.80	229.36-435.12	5.37-14.41	4.39-5.93	4.14-8.60	0.41-0.78	0.76-2.28
Mean	183.25	16.49	299.92	11.71	5.14	6.46	0.55	1.04

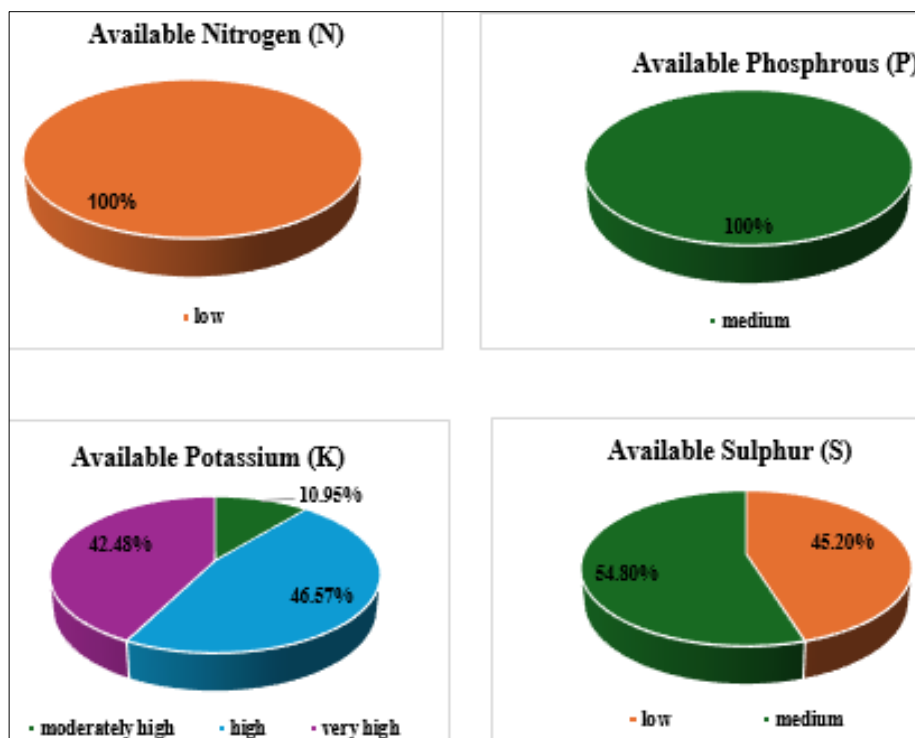


Fig 3: Available macronutrient (N, P, K, S) of soils in Mohammadpur village in Yavatmal District

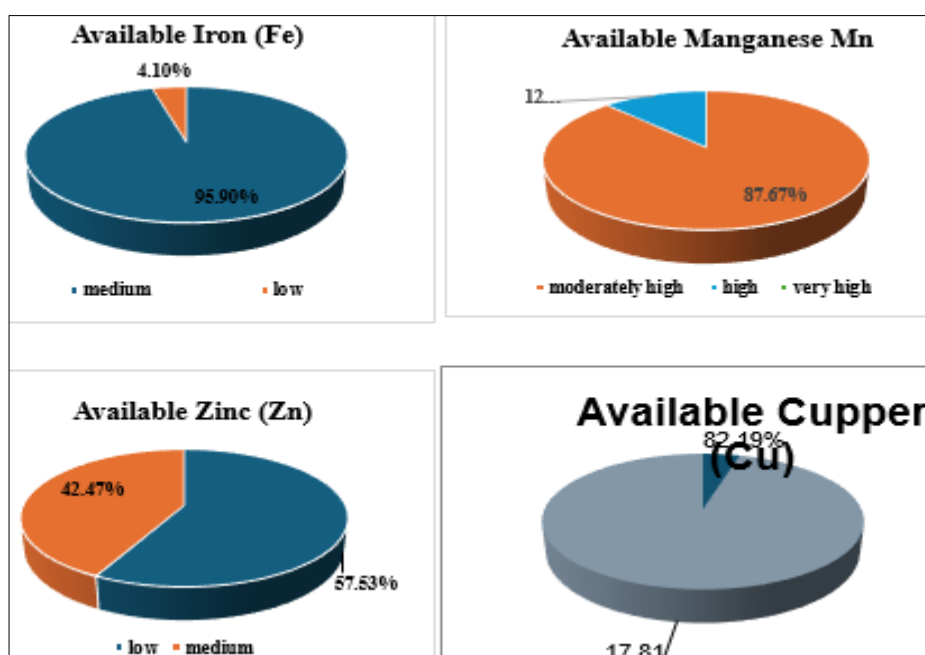


Fig 4: Available micronutrient (Fe, Mn, Zn, Cu) of soils in Mohammadpur village in Yavatmal District

3.4 Nutrient Value Index (NIV)

The Nutrient Index Values (NIV) of the studied soils revealed a varied fertility status across different parameters. Organic carbon and calcium carbonate exhibited moderately high and high levels, with values of 1.96 and 2.33 respectively. In contrast, the soils were found to be deficient in available nitrogen (1.00) and phosphorus (1.50) reflecting a low status

for these essential nutrients, whereas sulphur (1.27) showed moderate status. Potassium, recorded a high status with an NIV of 2.65. The Nutrient Index Value of Micronutrients, soils showed a low status for zinc (1.21) and iron (1.47). Manganese (2.06) and copper (2.58) exhibited moderately high and high status, indicating their abundant presence in the soils.

Table 4: Soil nutrient index of Mohammadpur village of Yavatmal district.

Nutrient	Nutrient index value	Category
Organic carbon	1.96	Moderately high
Calcium carbonate	2.33	High
Available N	1.00	Low
Available P	1.50	Moderate

Available K	2.65	High
Available S	1.27	Moderate
Available Fe	1.47	Moderate
Available Mn	2.06	Moderately high
Available Zn	1.21	Low
Available Cu	2.58	High

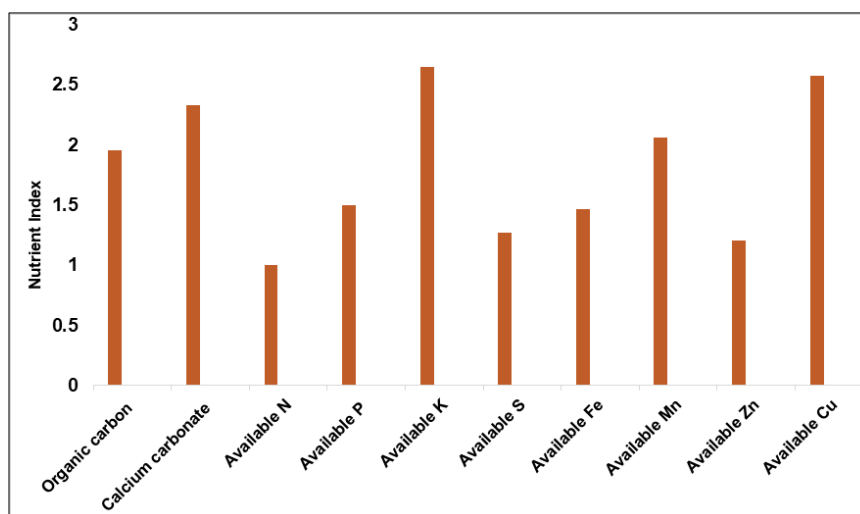


Fig 5: Nutrient index values of soils of Mohammadpur village in Yavatmal district.

4. Conclusion

Based on the current study, it can be concluded that the soils of Mohammadpur village are slightly alkaline, non-saline and highly calcareous, and they have medium-high organic carbon. Whereas potassium, manganese, copper and iron are sufficiently abundant, nitrogen, phosphorus, sulphur and zinc are deficient in the soils. All these nutrient imbalances suggest the relevance of specific nutrient management especially supplementing N, P, S and Zn as a way of enhancing the overall fertility of the soils and making them sustainable with crop production.

5. Acknowledgement

The authors are highly grateful to the Head, Department of Soil Science, Dr. PDKV, Akola for providing necessary facilities to carry out this work.

References

- Bhattacharyya R, Prakash V, Kundu S, Pandey SC, Srivastava AK, Gupta HS. Effect of fertilization on carbon sequestration in soybean-wheat rotation under two contrasting soils and management practices in the Indian Himalayas. *Aust J Soil Res.* 2009;47(6):592–601.
- Chesnin L, Yien CH. Turbidimetric determination of available sulfates. *Soil Sci Soc Am J.* 1951;15:149–151.
- Das BM, Raut M, Badge S, Mareddy N, Bhoyar K. Fertility status of rice growing soils of Gadchiroli Tehsil of Maharashtra, India in relation to available macronutrients and soil chemical properties. *Int J Plant Soil Sci.* 2022;34(24):283–289.
- Deshmukh KK, Gabhane VV, Nandeshwar DJ. Status of calcium carbonate and its influence on soil fertility in Wardha district, Maharashtra. *J Pharmacogn Phytochem.* 2019;8(1):1927–1931.
- Ekapure AS, Balapnde SS, Dongarwar U, Jadhao RV. Assessment of micronutrient content and strategies for improvement of micronutrient status in the soils of Bhandara Tehsil, Maharashtra, India. *Int J Plant Soil Sci.* 2022;34(24):863–868. DOI:10.9734/ijpss/2022/v34i242710.
- Gajare AS. Assessment of phosphorus, sulphur, and micronutrient (Fe, Mn, Zn, Cu) status and nutrient indexing in soils of soybean-growing tehsils of Latur district (Latur, Renapur, Nilanga, Ausa, Udgir, Chakur, and Ahmedpur), Maharashtra, 2009–10. [dissertation]. 2010.
- Hadole SS, Lakhe SR, Sarap PA, Kadu PR, Katkar RN, Kharche VK, *et al.* Assessment of the fertility status of different land use systems in Nagpur district. In: Ebadi MK, Tekale VS, Sarnaik SD, editors. 2020. p.47.
- Jackson ML. *Soil Chemical Analysis.* New Delhi: Prentice Hall of India Pvt Ltd; 1973.
- Jackson ML. *Soil Chemical Analysis: Advanced Course.* 2nd ed. Madison (USA): University of Wisconsin; 1973.
- Katkar RN, Lakhe SR, Hadole SS, Sarap PA. Assessment of spatial variability of major and micro nutrients in soils of Akola district of Maharashtra, India. *PKV Res J.* 2019;43(1):69–76.
- Knudsen D, Peterson GA. Available potassium. Laboratory methods. In: Page AL, Miller RH, Keeney DR, editors. *Methods of Soil Analysis, Part II.* Madison (USA): American Society of Agronomy and Soil Science Society of America; 1982. p.228–231.
- Lal R. *Soil Health and Sustainable Agriculture.* Cham: Springer; 2020.
- Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese and copper. *Soil Sci Soc Am J.* 1968;42:421–428.
- Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Sci Soc Am J.* 1978;42:421–428.
- Nalge DN, Bhoyar SM, Pardhi AA, Deshmukh PW, Mali DV, Dange NR. Nutrient status and nutrient index of different land use systems in Dharni Tehsil of Melghat region in Maharashtra state. *J Pharmacogn Phytochem.* 2020;9(6):1075–1080.

16. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Washington (DC): US Department of Agriculture; 1954. p.1–19.
17. Piper CS. Soil and Plant Analysis. Bombay: Hans Publishers; 1966. p.368–374.
18. Piper CS. Soil and Plant Analysis. 4th ed. Adelaide (Australia): University of Adelaide; 1966. p.135–200.
19. Ramamoorthy B, Bajaj JC. Available N, P and K status of Indian soils. Fertil News. 1969;14(8):24–26.
20. Ramamoorthy B, Bajaj JC. Soil fertility map of India. New Delhi: Indian Agricultural Research Institute; 1969.
21. Shanmugasundaram R, Malarkodi M, Gokila B. Continuous application of fertilizer over four decades on yield, physical and chemical properties of swell-shrink soil under finger millet–maize cropping sequence. Indian J Agric Res. 2019;53(6):687–692.
22. Subbiah BV, Asija GL. A procedure for estimation of available nitrogen in soils. Curr Sci. 1956;25:259–260.
23. Walkley AJ, Black IA. Estimation of soil organic carbon by the chromic acid titration method. Soil Sci. 1934;37:29–38.
24. Wankhede M, Dakhli R, Manna MC, Sirothia P, Rahaman MM, Ghosh A, *et al.* Long-term manure application for crop yield stability and carbon sequestration in subtropical region. Soil Use Manag. 2021;37(2):264–276.