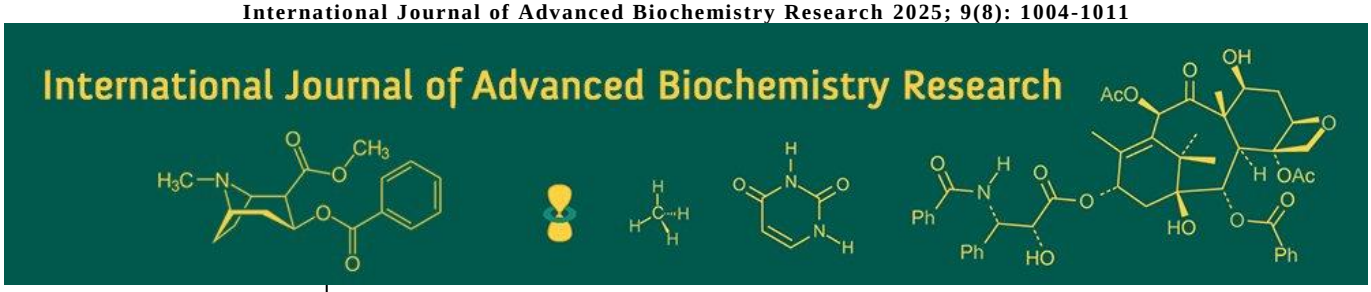

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Soil fertility assessment and nutrient indexing of PDKV adopted Hirapur model village in Gadchiroli district

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Abstract
The present investigation was undertaken to assess the fertility status of soils of Dr. PDKV adopted Hirapur Model village in Gadchiroli district of Maharashtra during 2024-25. Seventy-five surface soil samples of Hirapur village were taken and analysed for various chemical properties. The soils under the study were observed slightly acidic to neutral nature (pH 5.90 7.50), non-saline hazard of soluble salts (EC 0.05 0.16 dS m^{-1}), and moderately calcareous ($CaCO_3$ 0.70 6.50%). Organic carbon at different sites varied between very low and very high (0.32 to 1.31 %), available nitrogen and phosphorus was also between very low and medium. Whereas, available potassium was found low to very high (143-487 kg ha^{-1}). The available sulphur content was low to medium (3.25-15.98 mg kg^{-1}). Among the micronutrients, zinc content (0.11-0.95 mg kg^{-1}) indicated deficiency, whereas iron levels were high (5.62-31.78 mg kg^{-1}). Manganese (4.15-23.29 mg kg^{-1}) and copper (0.73-2.87 mg kg^{-1}) were generally present at medium to very high levels. The nutrient index value for soils were found to be moderately high for organic carbon and calcium carbonate, low for available N, P and K and high for available K. Micronutrient NIVs showed low values for zinc, high for iron, and very high for manganese and copper.

Keywords: GPS, Hirapur model village, nutrient index value. and soil fertility assessment

1. 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) [23]. 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) [20]. 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 Hirapur Village in Gadchiroli district in order to further boost agricultural performance.

2. Materials and Methods
The Hirapur village is situated in 79.77 E longitude and Latitude 21.53 N in Gadchiroli Tehsil of Gadchiroli district with annual ainfall of 1432.8 mm. The total geographical area of Hirapur village is 519.11 ha out of which 178.64 ha is cultivable and 98.64 ha is under irrigation. The total population of the village is 814. The soils of the region are yellowish brown to grey and lateritic in origin due to relatively higher rainfall in the region.

These soils are chiefly derived from mixed rocks like granite, gneiss and schists. The samples were collected from the fields of different farmers during 2024 - 25. In Hirapur village, 75 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]. Soil organic carbon was measured by wet oxidation method described by Walkley and Black (1934) [22] whereas, calcium carbonate was estimated using rapid titration method described by Piper (1966) [17]. The available nitrogen was estimated through alkaline permanganate method as suggested by Subbiah and Asija (1956) [21]. Available P was

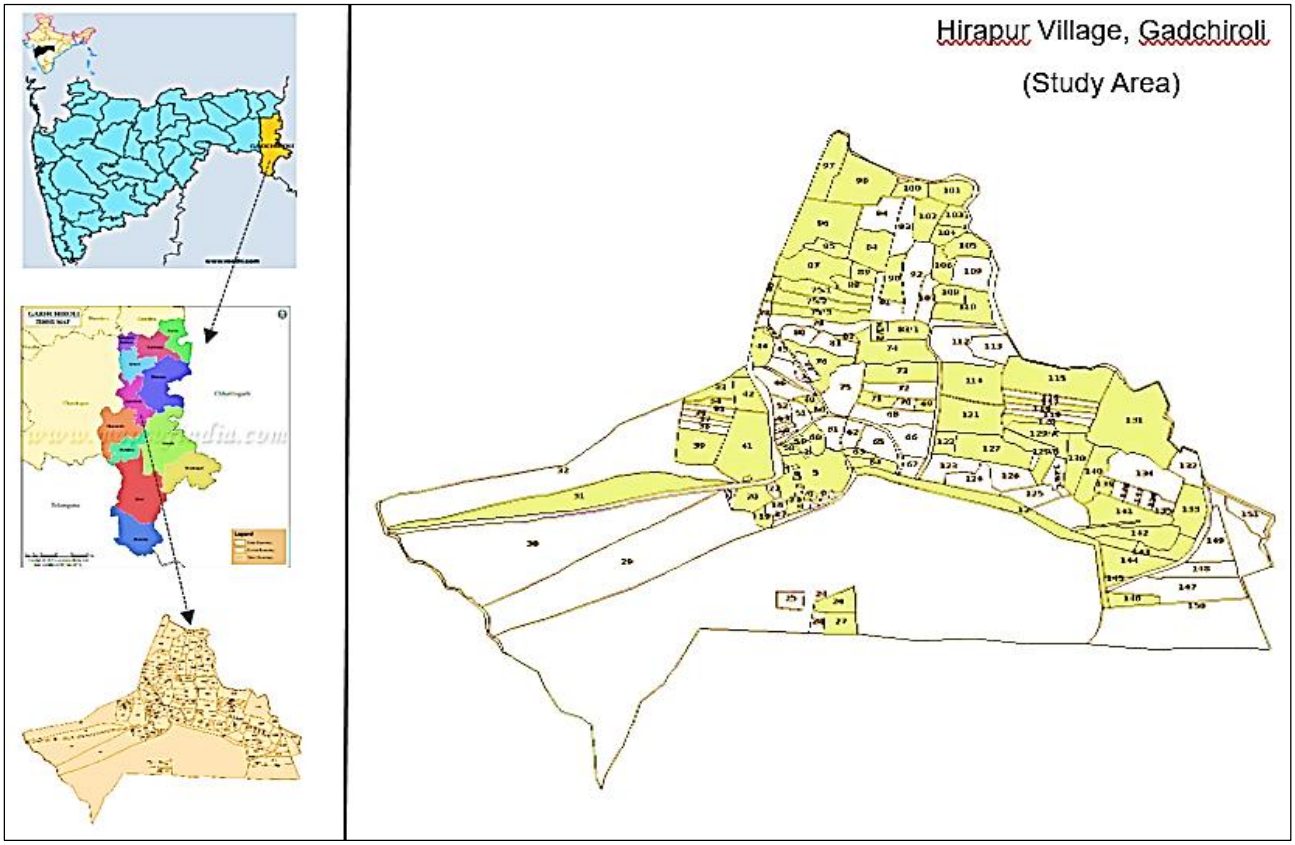


Fig 1: Location map of Hirapur Village in Gadchiroli district

extracted calorimetrically using Olsen method (Watanabe and Olsen, 1965). Available K was estimated by flame photometer after extraction with neutral normal ammonium acetate (pH 7.0) as suggested by Knudsen and Peterson (1982). The available micronutrients (Fe, Mn, Cu, and Zn) was extracted using DTPA (Lindsay and Norvell, 1978) [13]. The nutrient index value (NIV) was determined on the basis of the six scale method of Ramamoorthy and Bajaj (1969) [19] as given below:

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

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 Hirapur were found to be moderately acidic to neutral in reaction, with pH values ranging from 5.90 to 7.50 (mean 6.79). The EC of the soils ranged from .05 to 0.16 dS m^{-1}, with a mean value of 0.098 dS m^{-1} indicating non-saline and within the safe limit. The organic carbon status of the Hirapur village varied from 0.32 to 1.37 %, with a mean value of 0.73 %. The 87 percent soil samples were medium to very high in category. The CaCO3 contents of soils were ranging from 0.70 to 6.50 % and a mean value of 3.30% indicating non-calcareous with low to high.

Table 2: chemical properties of soils in Hirapur village in Gadchiroli District

Sample No.	pH (1:2.5)	Ec (dSm^{-1})	OC (%)	$CaCO_3$ (%)
1	7.20	0.16	0.92	5.50
2	6.90	0.15	0.46	3.60
3	6.50	0.11	0.52	4.50
4	7.20	0.13	0.78	2.20
5	7.10	0.09	0.42	3.80
6	6.70	0.10	0.49	4.60
7	7.00	0.08	0.39	3.20
8	6.80	0.16	0.29	1.70
9	7.20	0.07	0.27	3.80
10	6.90	0.08	0.21	4.80
11	7.30	0.06	0.33	5.40
12	7.50	0.12	0.36	3.20
13	6.74	0.15	0.57	3.70
14	6.80	0.16	0.68	2.70
15	6.70	0.08	0.82	2.10
16	6.80	0.12	1.02	1.50
17	6.45	0.06	1.08	1.70
18	6.80	0.04	0.91	0.80
19	6.20	0.07	0.52	1.60
20	7.20	0.09	0.39	3.60
21	7.40	0.15	1.03	3.80
22	6.90	0.12	0.70	2.10
23	6.70	0.10	0.53	1.60
24	6.30	0.13	0.67	3.80
25	6.80	0.14	0.47	5.70
26	7.30	0.07	0.32	3.30
27	7.10	0.10	0.95	4.10
28	7.20	0.08	0.88	5.50
29	6.90	0.10	0.38	4.60
30	6.80	0.12	0.81	3.00
31	6.50	0.14	1.02	4.50
32	6.70	0.15	0.59	2.30
33	7.00	0.17	0.46	4.80
34	5.90	0.13	1.12	2.70
35	7.10	0.08	0.91	1.50
36	7.30	0.09	0.56	3.50
37	7.10	0.13	0.95	3.10
38	6.80	0.11	1.00	3.00
39	6.20	0.11	0.73	3.30
40	7.20	0.05	1.13	3.10
41	6.50	0.08	1.08	4.00
42	6.30	0.04	0.67	4.10
43	6.40	0.06	0.80	3.10
44	6.60	0.07	0.91	3.30
45	6.30	0.04	0.47	2.60
46	6.10	0.08	1.02	3.00
47	7.40	0.13	1.14	4.10
48	6.90	0.1	1.09	3.30
49	6.50	0.12	0.66	4.10
50	6.90	0.15	0.63	3.10
51	6.40	0.08	0.89	3.40
52	6.30	0.10	0.57	4.50
53	6.20	0.06	1.18	0.70
54	5.90	0.05	1.24	1.00
55	7.10	0.13	0.57	1.80
56	7.20	0.17	1.16	2.10
57	6.90	0.08	0.57	3.80
58	6.50	0.07	1.00	3.00
59	7.10	0.07	0.81	5.10
60	6.40	0.10	0.28	5.60
61	6.80	0.06	0.18	3.00
62	6.90	0.06	0.39	4.10
63	7.10	0.07	0.73	3.30
64	7.20	0.12	1.03	4.10
65	6.70	0.05	1.09	3.10
66	7.10	0.11	1.03	3.40

67	7.40	0.07	0.60	4.50
68	6.40	0.14	0.49	0.70
69	6.50	0.11	0.88	1.00
70	6.30	0.07	0.99	1.80
71	6.40	0.12	1.13	2.10
72	6.80	0.07	0.52	3.80
73	7.10	0.1	0.47	3.00
74	7.30	0.05	0.55	5.10
75	6.80	0.09	1.37	5.60
Mean	6.79	0.098	0.73	3.30

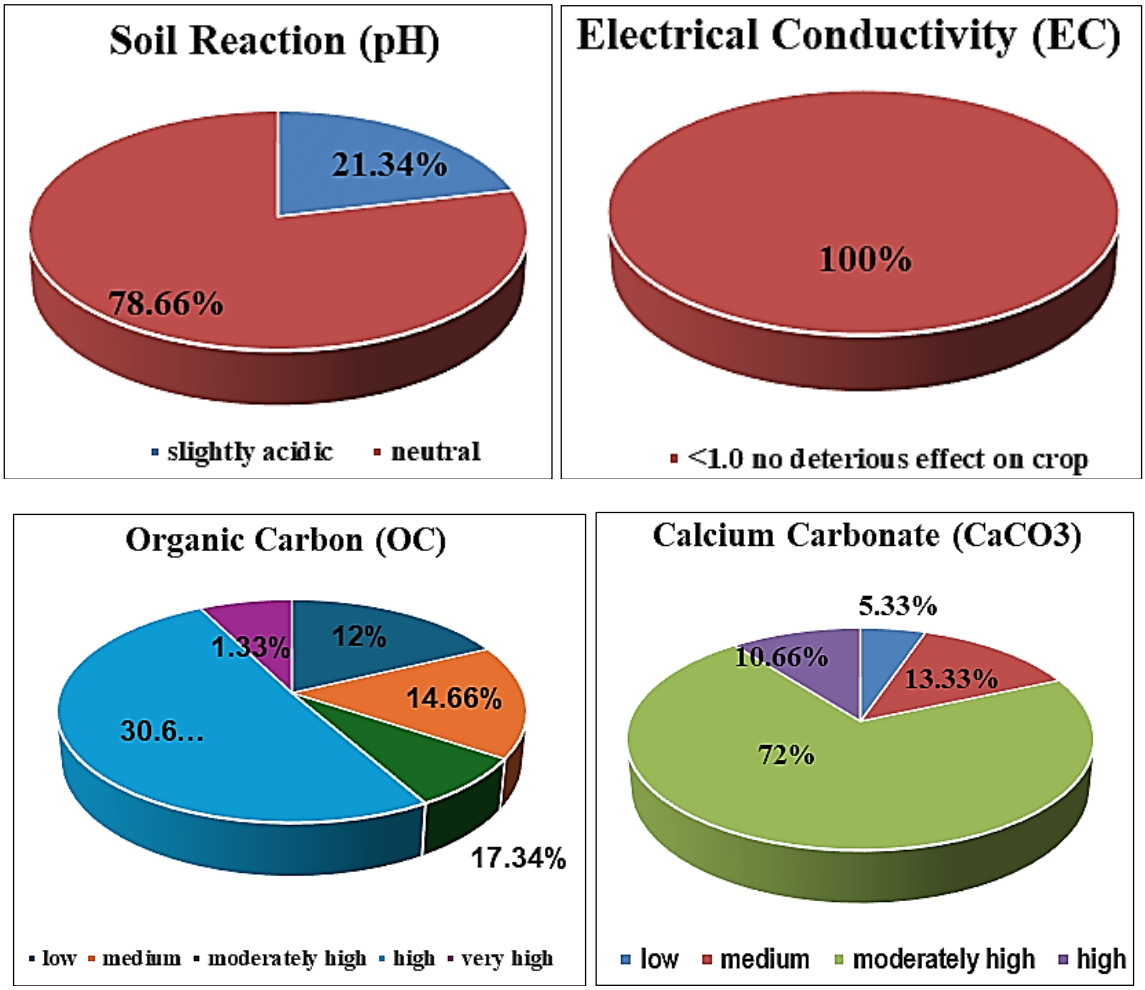


Fig 2: Chemical properties of soils in Hirapur village in Gadchiroli District

3.2 Status of macro nutrients

The result showed that the status of available nitrogen in the soils of Hirapur village in Gadchiroli district was ranged from 118 to 373 kg ha^{-1}, with a mean value of 241 kg ha^{-1}. The 76 and 21.34 % soil samples were found in low and medium category, respectively. The available phosphorus in the soils of the study area ranged from 12.80 to 68.44 kg ha^{-1}, with a mean value of 30.38 kg ha^{-1}. The 4 and 46.66 % soil samples were found in very low and low category while, 44 and 5.34 % of the soil samples were found in the medium and moderately high category, respectively. A wide variation in the contents of available potassium was noticed in the soils of the study area ranging from 143 to 487 kg ha^{-1}, with mean value of 350 kg ha^{-1}. Overall, 6.66 % soil samples were in the low category, 17.34% in medium, 16% in moderately high, 22.66% in high and 37.34% in the very high category of available potassium. For available sulphur, the per cent samples in very low, low, medium, moderately high, and very high categories were 14.67, 62.67, 20 and 2.66 %, respectively. The available sulphur ranged from 3.25 to 15.98 mg kg^{-1} with mean value of 7.94 mg kg^{-1}.

3.3 Status of micro nutrients

In the soils of Hirapur village, Gadchiroli district, the available iron (Fe) content ranged from 5.62 to 31.78 mg kg^{-1}, with an average value of 22.13 mg kg^{-1}. Based on fertility classification, 1.34 % of the samples were in the medium category, 14.66 % in the moderately high category, 66.66 % in the high category, and 17.34 % in the very high category. Available manganese (Mn) content varied between 4.15 and 23.29 mg kg^{-1}, with a mean value of 16.53 mg kg^{-1}. The distribution showed that 4 % of the samples were moderately high, 32 % were high, and 64 % were in the very high category. Available zinc (Zn) levels ranged from 0.11 to 0.95 mg kg^{-1}, with an average of 0.58 mg kg^{-1}. On an average 8 % of samples were found to be highly deficient, 38.66 % samples was in low category and 53.34 % into the medium category. Available copper (Cu)

concentrations in the soils ranged from 0.73 to 2.87 mg kg^{-1}, with an average value of 1.92 mg kg^{-1}. Among the samples, 1.34 % soil samples were classified as moderately high, 5.33 % as high, and a majority of 93.33 % were in the very high category.

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

Sample No.	N	P_2O_5	K_2O	S	Fe	Mn	Zn	Cu
	(kg/ha)			(mg/kg)				
1	293	31.16	337	6.05	17.69	8.81	0.95	2.15
2	187	58.99	387	9.20	18.32	10.14	0.62	2.35
3	227	43.96	311	15.98	10.19	8.01	0.68	1.62
4	247	33.77	345	8.94	15.15	11.23	0.54	1.73
5	160	11.74	160	4.72	17.39	16.18	0.50	1.33
6	198	21.70	227	5.03	27.23	20.13	0.40	1.73
7	190	37.76	312	5.81	25.12	14.13	0.56	1.45
8	123	17.81	224	3.73	5.62	4.15	0.37	1.30
9	167	26.72	216	9.29	21.67	13.12	0.33	1.01
10	173	18.36	249	7.12	24.22	10.18	0.65	1.62
11	161	12.80	308	5.03	10.88	4.18	0.32	1.24
12	176	21.16	342	5.65	12.10	6.19	0.41	1.41
13	258	18.54	328	3.25	12.18	8.41	0.57	1.62
14	231	34.16	314	10.62	18.92	16.15	0.61	1.12
15	333	16.14	332	6.68	13.95	8.04	0.62	2.05
16	273	23.93	304	8.16	27.96	22.28	0.66	1.88
17	264	19.60	446	6.25	21.16	19.16	0.66	1.89
18	287	32.83	475	8.77	23.79	20.16	0.91	1.74
19	254	34.51	376	12.33	24.04	21.76	0.83	2.83
20	201	40.62	335	9.20	24.12	20.17	0.62	2.41
21	278	30.61	484	7.45	23.22	19.14	0.41	2.02
22	273	17.93	369	5.64	18.16	17.62	0.65	2.41
23	259	17.24	410	5.42	20.18	15.69	0.77	2.02
24	233	22.67	370	6.56	21.69	21.25	0.64	2.19
25	229	21.16	487	5.46	31.12	21.16	0.42	2.10
26	186	33.96	361	11.20	30.19	21.86	0.76	1.32
27	260	23.26	340	8.99	22.44	19.16	0.81	1.81
28	287	47.86	448	10.16	23.05	19.18	0.76	1.49
29	253	38.40	443	5.13	26.13	20.16	0.58	2.24
30	226	48.41	330	15.72	18.28	16.23	0.96	2.41
31	326	40.55	402	11.28	23.37	20.31	0.82	2.41
32	240	21.52	454	5.94	21.37	17.86	0.70	2.34
33	224	26.72	406	10.17	26.32	20.80	0.60	2.20
34	267	35.42	406	9.46	16.56	13.14	0.70	2.31
35	260	36.18	329	11.37	22.03	21.71	0.89	2.87
36	187	15.02	451	3.98	22.66	19.61	0.31	2.42
37	248	43.55	398	13.02	24.60	21.87	0.78	2.41
38	293	40.96	355	6.51	28.22	14.10	0.63	2.21
39	240	20.90	432	8.54	21.17	14.04	1.02	2.34
40	317	28.57	374	10.15	21.93	18.18	0.85	2.01
41	160	35.15	355	12.24	22.13	21.76	0.74	1.62
42	207	27.04	426	10.29	16.14	15.82	0.68	2.60
43	313	62.33	482	9.29	20.14	18.17	0.58	2.10
44	246	42.84	338	7.38	21.10	17.84	0.62	2.00
45	240	23.93	459	8.33	19.10	12.18	0.83	2.21
46	326	50.65	402	7.03	24.14	21.10	0.64	1.94
47	257	37.92	454	6.33	23.16	18.16	0.51	2.60
48	297	28.94	406	15.98	26.13	19.94	0.83	1.24
49	206	21.70	406	8.22	30.40	20.46	0.57	1.24
50	209	19.67	329	6.46	21.40	16.76	0.53	1.29
51	304	22.25	451	7.38	17.21	10.08	0.65	2.86
52	253	15.77	398	5.85	18.42	10.33	0.49	1.28
53	353	37.39	355	6.51	22.63	15.03	0.42	0.73
54	326	37.28	432	6.16	28.08	18.18	0.61	0.93
55	220	39.29	374	6.51	26.20	18.80	0.39	1.42
56	248	68.44	355	7.29	18.82	8.11	0.31	2.44
57	226	36.66	426	15.62	20.13	17.61	0.84	2.15
58	280	42.22	482	8.77	21.84	18.14	0.43	2.14
59	200	34.30	338	13.63	30.02	11.72	0.63	1.62
60	118	23.38	459	6.63	28.32	20.31	0.59	1.73

61	147	21.16	218	4.42	22.14	17.13	0.39	1.33
62	293	24.48	202	8.07	31.78	23.16	0.40	2.41
63	212	24.38	267	5.55	19.37	13.42	0.58	2.30
64	236	34.09	271	4.34	25.16	14.48	0.12	2.10
65	320	17.45	274	5.03	30.22	20.16	0.68	1.01
66	347	28.46	250	6.86	31.14	21.56	0.38	1.62
67	160	16.14	210	4.60	22.39	19.22	0.62	2.11
68	267	17.81	302	4.77	22.18	17.83	0.11	2.83
69	160	32.40	319	10.48	25.57	23.29	0.24	1.73
70	233	33.96	196	11.24	29.38	20.14	0.22	2.21
71	373	27.27	281	9.20	16.20	12.18	0.63	2.16
72	253	32.83	479	8.85	18.96	11.06	0.42	2.22
73	233	35.61	162	3.99	24.17	20.21	0.68	1.65
74	147	12.80	165	4.16	24.10	21.38	0.18	2.19
75	213	45.09	143	4.34	26.70	18.54	0.26	1.94
Mean	241	30.38	350	7.94	22.13	16.53	0.58	1.92

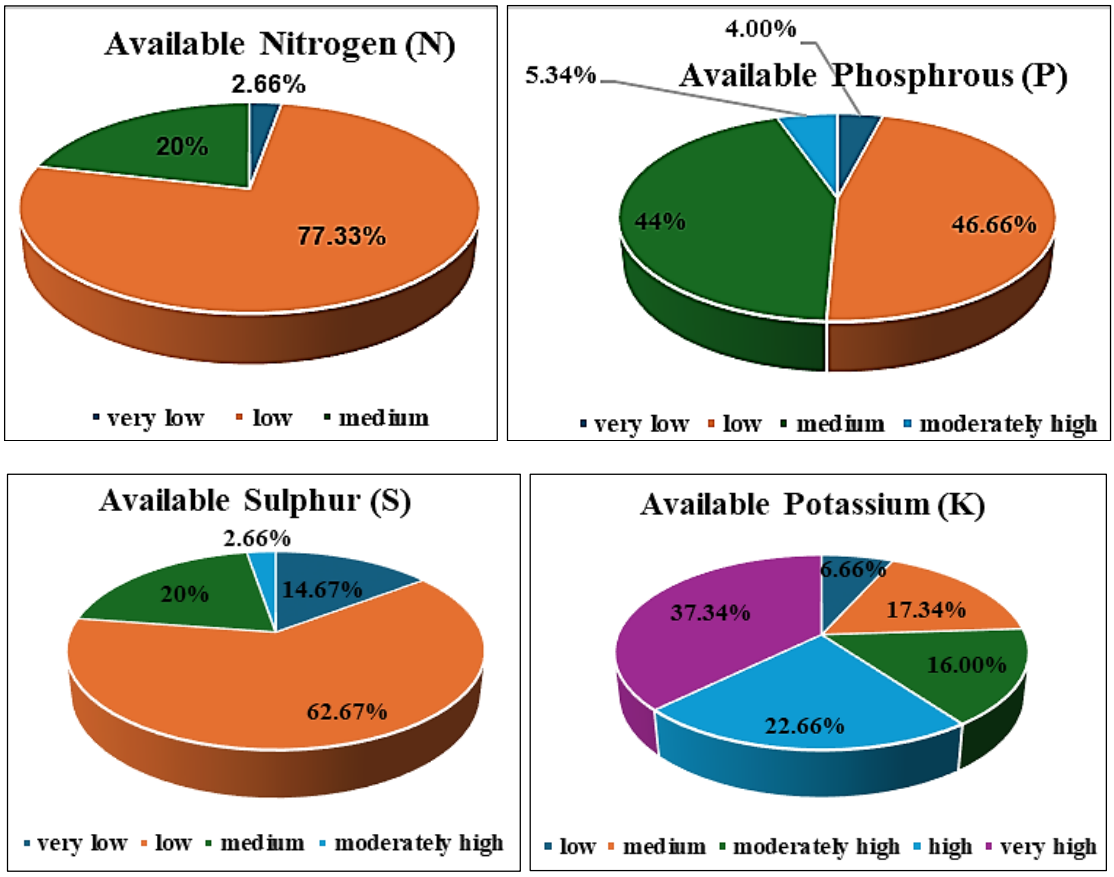
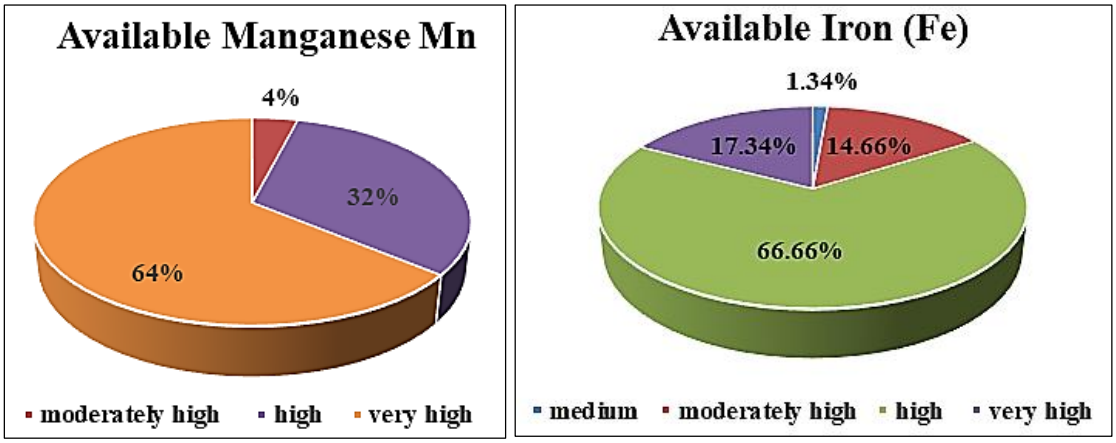


Fig 3: Available macronutrient (N, P, K, S) of soils in Hirapur village in Gadchiroli District



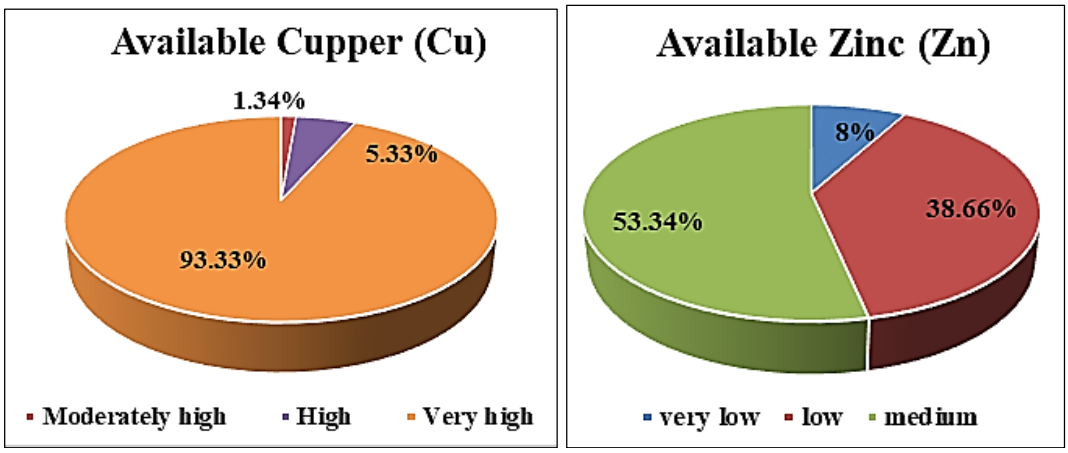


Fig 4: Available micronutrient (Fe, Mn, Zn, Cu) of soils in Hirapur village in Gadchiroli District

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 levels, with values of 2.03 and 1.96 respectively. In contrast, the soils were found to be deficient in available nitrogen (1.08), phosphorus (1.25), and sulphur (1.05), reflecting a low status for these essential nutrients. Potassium, recorded a high status with an NIV of 2.33. The Nutrient Index Value of Micronutrients, soils showed a low status for zinc (1.22), while iron levels were high (2.50). Manganese (2.80) and copper (2.96) exhibited very high status, indicating their abundant presence in the soils.

Table 4: Soil nutrient index of Hirapur village of Gadchiroli district.

Nutrient	Nutrient index value	Category
Organic carbon	2.03	Moderately high
Calcium carbonate	1.96	Medium
Available N	1.08	Low
Available P	1.25	Low
Available K	2.33	High
Available S	1.05	Low
Available Fe	2.50	High
Available Mn	2.80	Very high
Available Zn	1.22	Low
Available Cu	2.96	Very high

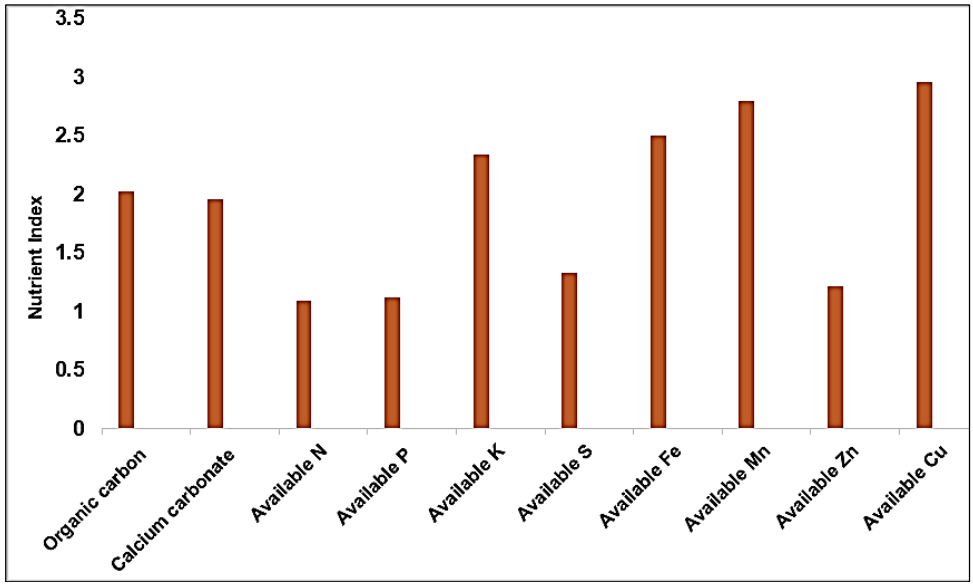


Fig 5: Nutrient index values of soils of Hirapur village in Gadchiroli district.

4. Conclusion

Based on the current study, it can be concluded that the soils of Hirapur village are moderately acidic to neutral, non-saline and generally agricultural 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.

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