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Spatial assessment of soil nutrient status and its relationship with soil properties in cotton-growing regions of Parli Tahsil

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Abstract
A systematic survey was conducted during 2024-2025 to evaluate the physicochemical properties, macronutrient and micronutrient availability, and their interrelationships in cotton-growing soils of Parli Tahsil, Beed district, Maharashtra. A total of 25 geo-referenced surface soil samples (0-30 cm) were collected from five representative villages and analyzed for fertility status, with results spatially visualized using Geographic Information System (GIS) techniques. The soils were found to be neutral to alkaline in reaction (pH 7.1 to 8.1), non-saline (EC 0.12 to 0.29 dSm^{-1}), and low to moderate in organic carbon (0.21 to 0.69%), with calcium carbonate content ranging from 8.52 to 12.06%. Available nitrogen (156.0 to 500.0 kg ha^{-1}) and phosphorus (10.09 to 20.30 kg ha^{-1}) were generally low to moderate, whereas potassium (210.0 to 320.0 kg ha^{-1}) levels were consistently high. Exchangeable calcium and magnesium ranged from 11.3 to 45.6 and 7.2 to 28.3 cmol(p^+) kg^{-1}, respectively, while available sulphur (10.0 to 75.3 mg kg^{-1}) varied from moderate to high. DTPA-extractable micronutrients were recorded as Fe (2.80 to 8.00 mg kg^{-1}), Mn (4.20 to 9.20 mg kg^{-1}), Zn (0.13 to 0.91 mg kg^{-1}), and Cu (0.15 to 0.95 mg kg^{-1}). Nutrient Index Values (NIV) classified nitrogen (1.36) and phosphorus (1.60) in the low to medium categories, while potassium (2.96) was in the high category. Correlation analysis revealed a significant positive relationship between EC and potassium (r = 0.652) and between EC and DTPA-Cu (r = 0.487). These findings highlight substantial spatial variation in soil fertility parameters and underscore the importance of targeted nutrient management strategies for improving cotton productivity in Parli Tahsil.

Keywords: Survey, Parli, nutrient status, cotton, correlation

Introduction
Cotton (*Gossypium spp.*), popularly known as the “white gold” of Maharashtra, is a pivotal cash crop that underpins the agrarian economy and sustains rural livelihoods across the state (Government of Maharashtra, 2023). Maharashtra is India’s largest cotton-growing state, contributing nearly 35-40% of the country’s total cotton acreage and approximately 30% of national production (ICAR, 2022). The principal cotton-growing belts include Vidarbha (Akola, Amravati, Yavatmal, Wardha, Nagpur, Buldhana, Washim), Marathwada (Parbhani, Nanded, Hingoli, Jalna, Beed, Osmanabad, Latur), and Khandesh (Jalgaon, Dhule, Nandurbar) regions (GoI, 2021). Given its economic significance, periodic assessment of soil fertility status and nutrient dynamics in these cotton-growing landscapes is critical for sustainable crop production and precision nutrient management. Parli Tahsil, situated in the eastern part of Beed district, is geographically located at 18°50′ N latitude and 76°31′ E longitude, encompassing 816 km^2, including Parli Vaijnath town and 105 villages (District Census Handbook, 2011). The tahsil lies within the Deccan Plateau and is characterized by gently undulating terrain and Vertisols (black cotton soils) derived from basaltic Deccan Trap, which are clayey to loamy in texture, deep in valley regions, and shallow over upland terrain (NBSS&LUP, 2020). Falling under the assured rainfall agro-climatic zone, the area receives 750-950 mm of mean annual rainfall, primarily from the southwest monsoon (June-September), and experiences a semi-arid tropical climate with maximum summer temperatures of 40-42 °C and winter lows of 11-12 °C (IMD, 2022). Agriculture dominates the local economy, with

rainfed cropping systems largely devoted to cotton, soybean, pigeon pea, and sorghum, reflecting the agro-ecological diversity and resource constraints of the region (GoM, 2023).

Material and Methods

A soil fertility survey was conducted in Parli Tahsil, Beed district, Maharashtra, focusing on cotton-growing areas across five representative villages: Brahmawadi, Jirewadi, Sangam, Waghbet, and Belamba. A total of 25 geo-referenced surface soil samples (0-30 cm) were collected (five per village), with latitude and longitude coordinates recorded using a GPS device. Samples were shade-dried, ground with a wooden mortar and pestle, sieved through a 0.5 mm mesh, and stored in labeled paper bags. Analytical procedures followed the standard protocols outlined by Jackson (1973) [12] to determine physicochemical properties and nutrient levels. Soil fertility classification was performed using the Nutrient Index Value (NIV) based on the three-tier system of Ramamoorthy and Bajaj (1969) [19], calculated as: Formula used for soil nutrient index NIV=[NL×1+NM×2+NH×3] ÷Total no. of Samples Where NL means number of low samples, NM means number of medium samples and NH means Number of high samples in the category of nutrient index by the three-tier system.

Table 1: Standard Methods of soil analysis

Sr. No.	Particulars	Methodology	References
Physicochemical properties			
1.	Soil pH	Digital pH meter	Jackson, 1973 [12]
2.	Electrical conductivity	Conductivity meter	Jackson, 1973 [12]
3.	Organic carbon	Walkley and Black's Wet oxidation method	Walkley & Black, 1934
4.	Calcium carbonate	Rapid titration	Piper, 1966 [18]
Available nutrients			
5.	Available nitrogen	Alkaline potassium permanganate	Subbiah & Asija, 1956 [22]
6.	Available phosphorus	0.5 M Sodium bicarbonate	Olsen *et al*., 1954 [16]
7.	Available potassium	Neutral normal ammonium acetate	Jackson, 1973 [12]
8.	Exchangeable Ca and Mg	Versenate titration	Jackson, 1973 [12]
9.	Available sulphur	Turbidimetric method	Chopra & Kanwar, 1976
10.	DTPA Fe, Mn, Zn, Cu	DTPA-extraction using AAS	Lindsay & Norvell, 1978 [14]

Table 2: Rating of nutrient index value (Three-tier system

Sr. no.	Category	Value
1.	Low	<1.67
2.	Medium	1.67-2.33
3.	High	>2.33

Table 3: Categorization of soil parameters

Soil pH	Acidic < 6.5	Neutral 6.5 - 7.5	Alkaline >7.5
Classification of Electrical Conductivity EC (dSm^{-1})			
No deleterious effect on crops	Critical for germination	Critical for salt sensitive crops	Injurious to most crops
<1.0	1.0 - 2.0	2.0 - 3.0	>3.0
Parameter	**Low**	**Moderate**	**High**
OC (%)	<0.40	0.40 - 0.80	>0.80
$CaCO_3$ (%)	<5	5-10	>10
Avail N kg ha^{-1}	<280	280 - 560	>560
Avail P2O5 kg ha^{-1}	<12.5	12.5-25.0	>25.0
Avail K2O kg ha^{-1}	<150	151-250	>250
Ex. Ca[cmol(p+)kg^{-1}]	<5.0	5.0-10.0	>10
Ex. Mg[cmol(p+)kg^{-1}]	<1.0	1.0-3.0	>3
Avail S (mg kg-1)	<10	10-20	>20
DTPA-Fe (mg kg-1)	<4.5	4.5-9.0	>9.0
DTPA-Mn (mg kg-1)	<3.5	3.5-7.0	>7.0
DTPA-Zn (mg kg-1)	<0.6	0.6-1.0	>1.2
DTPA-Cu (mg kg-1)	<0.2	0.2-0.4	>0.4

Results and Discussion

Soil pH

The data of five villages from Parli tahsil showed soil pH ranged from 7.1 to 8.1 with mean value 7.53 which was alkaline in nature with SE value 0.06 and CV value 4.06 per cent. The alkaline nature of soils might be due to presence of high degree of base saturation. Similar findings were observed by Padole and Mahajan (2003) [26] observed that pH of swell shrink soils of Vidharbha region was ranged from 7.1 to 8.9 Kumar *et al.* (2017) [27] studied the relationship between soil physico-chemical properties from the 40 soil samples at Shriganganagar district of Rajasthan and found that pH varied from 7.5 to 9.67. The pH data indicated that the soils were slightly to moderately alkaline in reaction.

Electrical Conductivity

The range of Electrical conductivity of Parli tahsil varied from 0.12 to 0.29 dSm^{-1} with mean value of 0.19 dSm^{-1}. with SE

value 0.009 and CV value 24.81 per cent. Low values of EC might be due to leaching of salts to the lower horizon or sub surface these results were confirmatory with the results observed by Padole and Mahajan (2003) [26]. The resulted value of EC obtained from investigation found within specified range proposed by Richard and Campbell (1948) [21].

Organic Carbon

Organic carbon of cotton growing areas of Parli tahsil showed range between 0.21 to 0.69 with mean value of 0.79 with SE value 0.06 and CV per cent value 42.21 the low amount of organic carbon content in soil was maybe due to poor vegetation high rate of organic matter decomposition under hyperthermic temperature regime which leads to extremely high oxidizing condition. similar result was recorded by Yadav and Meena (2009) [25] who observed organic carbon content of Degana soil series of Rajasthan varied from 0.3 to 5.4 g kg^{-1}. Similar, results were observed by Ghode *et al*. (2018) [3], the organic carbon content decreased with increase in depth cotton growing soils of Nanded district.

Calcium Carbonate

Data showed that calcium carbonate content of cotton growing areas of Parli tahsil in Beed district were ranged from 8.52 to 12.06 per cent with mean value 11.62 per cent with SE value 0.33 and CV per cent value 14.19 respectively. Result showed that most of the soils were moderately calcareous to calcareous in nature accumulation of $CaCO_3$ in black soil maybe associated with their recent origin with reach in alkali earth and partly due to calcification process prevalent in Marathwada region. Similar results were observed by Mane *et al.* (2015) [28] that, the grape growing soils of Osmanabad district have calcium carbonate content between 10 to 29.4 per cent, resulting the soils were calcareous in nature.

Table 4: Categorization of Physiochemical properties of Parli tahsil.

Sr. no	Parli Villages	pH			EC dSm^{-1}				OC %			$CaCO_3$ %		
		Range (Mean) 7.1-8.1(7.53)			Range (Mean) 0.12-0.29(0.19)				Range (Mean) 0.21-0.69(0.79)			Range (Mean) 8.52-12.06(11.62)		
		<6.5 Acidic	6.5-7.5 Neutral	>7.5 Alkaline	<1.0 Ndc	1.0-2.0 Cg	2.0-3.0 Csc	>3.0 Imc	<0.40 L	0.40-0.80 M	>0.80 H	<5 L	5-10 M	>10 H
1.	Brahmawadi	-	2	3	5	-	-	-	2	3	-	-	2	3
2.	Jirewadi	-	2	3	5	-	-	-	3	2	-	-	2	3
3.	Sangam	-	4	1	5	-	-	-	2	3	-	-	2	3
4.	Waghbet	-	3	2	5	-	-	-	2	3	-	-	3	2
5.	Belamba	-	1	4	5	-	-	-	1	4	-	-	-	5
Total		-	12	13	25	-	-	-	10	15	-	-	9	16

Available Nitrogen

Available nitrogen data from Parli tahsil showed range of available Nitrogen from 156.0 to 500 kg ha^{-1} with mean value 274.74 kg ha^{-1} with SE value 20.26 and CV per cent value 36.87. Low content of available nitrogen in the soils of this area is associated with hot and dry climate low content of organic matter and low total nitrogen reserve in term of C:N ratio of immobilized form of Nitrogen was reported by Malewar (1995) [24] similar result was reported by Waghmare and Takankhar (2007) [36] in soil of Ausa and Nilanga tahsil of Latur district.

Available Phosphorus

Available phosphorus range from Parli tahsil was observed from 10.09 to 20.30 kg ha^{-1} with mean value 41.57 kg ha^{-1}. Here the samples from soils of Parli tahasil was low to medium in available phosphorus. These soils were low to moderate in phosphorus content this could be attributed to the fixation of released Phosphorus by clay minerals and oxides of iron and Aluminium. Similar result was reported by Rao *et al.* (2008) [37]. That the available Phosphorus content in soil of Ramchandrapuram Mandal of Chittoor district in Andhra Pradesh which were ranged from 9.9.ro 23.96 kg $ha^{-1.}$

Available Potassium

With respect to available potassium in soils of Parli tahsil data showed the range from 210.3 to 320.0 kg ha^{-1} with mean value 281.38 kg ha^{-1} with SE value 5.47 and CV per cent value 9.73 here sampled soil showed medium to high potassium in soils of Parli tahsil. this data for available potassium shows that most of the soil were high in Potassium this could be due to the presence of potassium bearing minerals like feldspar and Mica in the parent material of the soil these results were confirmatory with results of Malewar *et al*. (1995) [24] reported that the K_2O content in soils of Maharashtra was varied from 318.0 to 616. Waikar *et al*. (2004) [24] analysed the soils of Marathwada region and reported that the available Potassium content was ranges from 303 to 512 kg ha^{-1}.

Table 5: Categorization of Primary nutrients of Parli tahsil

Sr. no	Parli Villages	N (kg ha^{-1})			P (kg ha^{-1})			K (kg ha^{-1})		
		Range (Mean) 156.0-500.0(274.74)			Range (Mean) 10.09-20.30(14.57)			Range (Mean) 210.3-320.0(281.38)		
		L	M	H	L	M	H	L	M	H
1.	Brahmawadi	4	1	-	2	3	-	-	-	5
2.	Jirewadi	3	2	-	3	2	-	-	-	5
3.	Sangam	3	2	-	1	4	-	-	1	4
4.	Waghbet	4	1	-	3	2	-	-	-	5
5.	Belamba	2	3	-	1	4	-	-	2	3
Total		16	9	-	10	15	-	-	3	22

Exchangeable Calcium

The range for exchangeable calcium in the soils of villages from Parli tahsil was observed from 11.3 to 45.6 with mean 26.6 with SE value 1.93 and CV per cent value 36.43 respectively. The status of exchangeable calcium of the Parli tahsil was observed high to moderate in soil, dominantly high in exchangeable calcium may be due to the presence of calcium in the soil which comes from the origin of soil, from which parent material the

soil is formed. Binita *et al*. (2009) observed higher exchangeable Ca and Mg contents in black soils than red soils. Where all the 100 soil samples were high in exchangeable Ca and Mg status. Calcium and magnesium available status is not generally lower in black soils of semi-arid and arid climate as these soils are calcareous in nature.

Exchangeable Magnesium

Exchangeable magnesium range of soils from villages of Parli tahsil observed from 7.2 to 28.3 with mean value 14.55 respectively with SE value 1.26 and CV per sent value 43.45. Cotton growing soils of villages from Parli tahsil was observed high in exchangeable magnesium content in soil. This result may be due to the presence of organic matter in soils or the presence of clay dolomitic parent material. Gaikwad *et al* (1986) reported that the exchangeable Mg^{++} content in soils of Bhandara district (Maharashtra) were ranged from 0.5 to 24.5 me 100 gm^{-1} soil.

Available Sulphur

Data on available sulphur of cotton growing soils of villages from Parli tahsil showed the range from 10.0 to 75.3 mg kg^{-1} with mean value 33.92. SE value 3.93 and CV per cent value 58.00 here the cotton growing soils from selected villages showed available sulphur moderate to low in range. This may be due to surface layer of soil contains higher amount of sulphur, these may be due to application of sulphur-based fertilizer in soil. Similar results were found by Ravte (2008) where he analysed the soil samples from Ausa and Nilanga tahsils of Latur district and reported that the available Sulphur content of soils ranged from 3.62 to 84.61 mg kg^{-1}. Similar result was observed by Sule (2021) [23] where data on available sulphur in the soils of study area indicated that the lowest available sulphur values was observed in Bss3 horizon (P3) at 100+ cm depth and highest available sulphur was observed in AP horizon (P1) at 0 to 16 cm depth.

Table 6: Categorization of Secondary nutrients of Parli tahsil

Sr. no	Parli Villages	Ca^{++} (cmol $(p^+)kg^{-1}$)			Mg^{++} (cmol $(p^+)kg^{-1}$)			S (mg kg^{-1})		
		Range (Mean) 11.3-45.6(26.6)			Range (Mean) 7.2-28.3(14.55)			Range (Mean) 10.0-75.3(33.92)		
		L	M	H	L	M	H	L	M	H
1.	Brahmawadi	-	-	5	-	-	5	-	3	2
2.	Jirewadi	-	-	5	-	-	5	-	1	4
3.	Sangam	-	-	5	-	-	5	-	2	3
4.	Waghbet	-	-	5	-	-	5	-	1	4
5.	Belamba	-	-	5	-	-	5	-	-	5
Total		-	-	25	-	-	25	-	7	18

DTPA-Iron

DTPA-Fe ranged from 2.80 to 8.00 mg kg^{-1} with mean value 5.22 mg kg^{-1} with SE value 0.34 and CV per cent value 33.10. Soils of selected villages from Parli tahsil showed DTPA-Fe low to moderate in range. It might be due to micronutrient fertilizers application at surface and ferromagnesian minerals content in these soils. Low DTPA extractable iron content in soil was due to low amount of clay and organic carbon present in the soils. These results are in confirmatory with Sharma *et al.* (2006) [7] who observed the range of available Fe between 0.54 to 33.79 mg kg^{-1} in the soils of Leh district. Sule *et al* (2021) [23] observed DTPA extractable iron content in the soils of study area was ranged between 2.70 to 6.04 mg kg^{-1} with mean value of 4.37 mg kg^{-1}. The highest DTPA extractable iron content was observed in Ap horizon (P1) at 0 to 16 cm depth.

DTPA-Manganese

DTPA-Mn was ranged from 4.20 to 9.20 mg kg^{-1} with mean value 6.57 mg kg^{-1} with SE value 0.31 and CV per cent value 23.72. Cotton growing soils of villages from Parli tahsil showed DTPA-Mn moderate to low in range. This elevated Mn level may be attributed to several factors. Under normal soil pH conditions, manganese in its lower oxidation state (Mn^{++}) is more soluble and readily available. The presence of reduced forms of Mn is likely due to limited oxidation processes. Additionally, certain fungi and bacteria can oxidize divalent Mn^{++} to trivalent Mn^{++}, affecting its availability. Moreover, organic compounds produced by microorganisms or released as root exudates by plants may possess oxidizing or reducing properties, influencing the oxidation state and solubility of manganese in the soil. Sule *et al* (2021) [23] observed available Mn ranged between 2.50 to 3.48 mg kg^{-1} from studied area. It was noted that extractable Mn content of study area was in higher range. Similar results were found by Mandavgade *et al.* (2015) [31] observed that the relative higher content of DTPA-Mn in the soils might be due to the soils derived from basaltic parent material which contained higher ferromagnesium minerals.

DTPA-Zinc

Data presented of DTPA-Zn showed range from 0.13 to 0.91 mg kg^{-1} with mean value 0.52 mg kg^{-1} with SE value 0.04 and CV per cent value 44.85. The values indicates that Zn content in soils were low to medium. Dominantly these soils were poor to moderate in available Zn content. This might be due to Zinc cations are charged largely under alkaline condition to their oxides or hydroxides and thereby lower the availability of Zinc under alkaline soils. These results were validatory with results of Meena *et al.* (2006) [32] where they state that the available Zn content in soils of Maharashtra were ranged from 0.58 to 1.70. mg kg^{-1} the low content of Zn might be due to low organic matter and high $CaCO_3$.

DTPA-Copper

For DTPA-Cu range was observed from 0.15 to 0.95 mg kg^{-1} with mean value 0.43 mg kg^{-1} with SE value 0.04 and CV per cent value 56.11 Cotton growing soils of villages from Parli tahsil showed DTPA-Cu moderate to low in range. The high content of DTPA-Cu in these soils might be due to presence of Cu minerals like Cuprites and chalcocite, etc. in the parent material from which the soil is formed. Similar results were observed by Indulkar *et al* (2007) [33] reported that the DTPA-Cu content in soils of Udgir and Deoni tahsil of Latur district in the range of 0.98 to 7.66 mg kg^{-1} and 0.74 to 9.42 mg kg^{-1}, respectively. Dhage *et al.* (2000) [34] reported that soils of Shevgaon tahsils of Ahmedanagar district were ranged from 2.04 to 11.38 mg kg^{-1}. in Cu content. The content of available copper in the cotton growing soils of Parbhani was observed higher as far as the critical level of Cu is concerned Sule *et al* (2021) [23].

Table 7: Categorization of Micronutrients of Parli tahsil

Sr. no	Parli Villages	Fe (mg kg^{-1})			Mn (mg kg^{-1})			Zn (mg kg^{-1})			Cu (mg kg^{-1})		
		Range (Mean) 2.80-8.00(5.22)			Range (Mean) 4.20-9.20(6.57)			Range (Mean) 0.13-0.91(0.52)			Range (Mean) 0.15-0.95(0.43)		
		L	M	H	L	M	H	L	M	H	L	M	H
1.	Brahmawadi	2	3	-	-	3	2	2	3	-	-	3	2
2.	Jirewadi	3	2	-	-	3	2	3	2	-	2	-	3
3.	Sangam	1	4	-	-	2	3	4	1	-	1	3	1
4.	Waghbet	1	4	-	-	4	1	4	1	-	1	2	2
5.	Belamba	2	3	-	-	4	1	2	3	-	1	2	2
Total		9	16	-	-	16	9	15	10	-	5	10	10

Nutrient index in soils of Parli tahsil

The "nutrient index values" for soils of Parli tahsil were found in low category for available nitrogen, phosphorus, exchangeable calcium, exchangeable magnesium, Zinc concentration in the plant samples of cotton crop from surveyed area was almost low. The content of zinc in *Bt* cotton leaf petiole ranged between 18.40 and 42.10 mg kg-1. The mean and standard deviation were 30.50 mg kg-1 and 6.87 mg kg-1, phosphorus, exchangeable calcium, exchangeable magnesium, DTPA-Fe and DTPA-Zn were 1.36, 1.6, 1, 1, 1.64 and 1.4 respectively and for DTPA-Cu was 2.2 while 2.96 for Potassium and 2.36 for DTPA-Mn against the nutrient index values <1.67 for low 1.67 to 2.33 for medium and >2.33 for high fertility status of surveyed area.

Table 8: Nutrient Index in soils of Parli tahsil of Beed district.

Sr. no	Available Nutrient	NIV	Category
1	Nitrogen	1.36	Low
2	Phosphorus	1.6	Low
3	Potassium	2.96	High
4	Exchangeable Calcium	1	Low
5	Exchangeable Magnesium	1	Low
6	Sulphur	2.72	High
7	Iron	1.64	Low
8	Manganese	2.36	High
9	Zinc	1.4	Low
10	Copper	2.2	Medium

Correlation between physiochemical properties and available Nutrients

The correlation coefficients between soil physicochemical properties and available nutrients are presented in (Table 8). Soil pH shows a weak negative correlation with available phosphorus (r = -0.208), potassium (r = -0.153), calcium (r = -0.166), and manganese (r = -0.050), while showing a weak positive correlation with other nutrients, indicating minimal influence of soil reaction on nutrient availability in these soils. Soil electrical conductivity (EC) demonstrated a strong positive and significant correlation with potassium (r = 0.652) and a moderate positive and significant correlation with DTPA-extractable copper (r = 0.487) suggesting that soluble salt content is closely associated with K and Cu availability. Organic carbon (OC) content showed weak to negligible correlations with most nutrients, whereas calcium carbonate ($CaCO_3$) displayed a moderate positive correlation with phosphorus (r = 0.351), implying potential interactions between soil $CaCO_3$ content and P availability. Overall,

Table 8: Correlation between physico-chemical properties and available nutrients in Parli tahsil.

Correlation	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu
pH	0.195	-0.208	-0.153	-0.166	0.147	0.204	0.013	-0.050	-0.087	0.190
EC	0.249	0.047	0.652**	0.129	0.305	-0.229	0.104	0.142	-0.141	0.487*
OC	0.012	0.189	-0.030	0.143	0.104	0.133	-0.027	-0.100	-0.232	0.111
$CaCO_3$	-0.044	0.351	-0.027	0.149	-0.086	-0.047	-0.269	-0.123	0.064	0.066

Significant at 5% level 396 *
Significant at 1% level 505 **

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Conclusion

From the study, it can be concluded that, soils of Parli tahsil are neutral to alkaline in soil reaction, non- saline in nature, low to moderate in organic carbon and moderate to high in calcium carbonate. The soils were categorized as very low to moderate in available nitrogen, phosphorus was seen dominantly moderate to low, high in available potassium, exchangeable calcium, and exchangeable magnesium, moderate to high in available S and dominantly moderate in DTPA-Fe, moderate to high in DTPA-Mn, low to moderate in DTPA-Zn and Moderate to high in DTPA-Cu. As per the nutrient index value it concluded that available nitrogen, available sulphur, DTPA-Fe and DTPA-Mn lies in medium category, while available phosphorus, exchangeable magnesium, DTPA-Zn and DTPA-Cu lies in low category and available potassium and exchangeable calcium in high category. Correlation analysis highlighted that electrical conductivity significantly influenced potassium and copper availability, while other soil properties showed weak relationships with available nutrient.

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