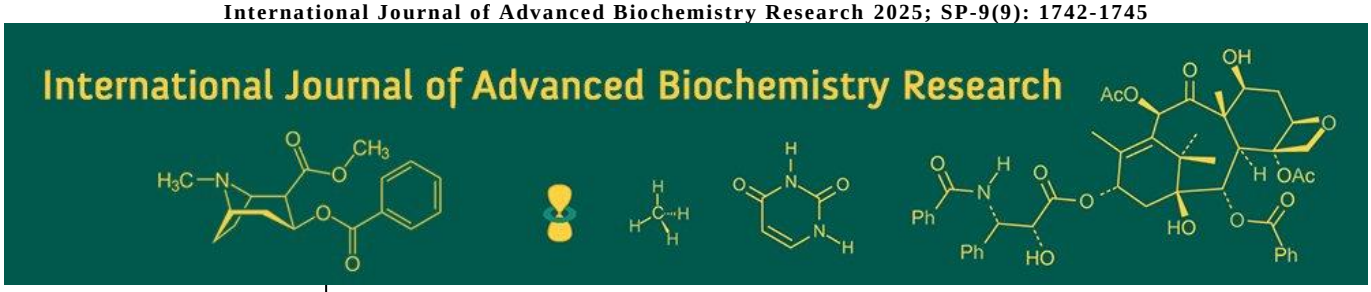

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Evaluation of soil nutrient status of village Albaras, district Durg, Chhattisgarh

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Abstract
The study conducted on village Albaras district Durg Chhattisgarh on GPS-based surface soil samples (0-15 cm) and fertilizer recommendation for major crop. The soil pH, EC and OC of research area varied from 5.87 to 7.85 (mean 6.91), 0.11 to 0.26 dS/m (mean 0.17 dS/m) and 0.37 to 0.75% (mean 0.56%) respectively. The available nitrogen content in the soils of the study area ranged from 100.35 to 263.42 kg/ha, with a mean value of 175.52 kg/ha. Phosphorus availability varied from 9.19 to 30.67 kg/ha, with an average of 17.87 kg/ha. Potassium levels ranged from 168.54 to 637.41 kg/ha, averaging 385.04 kg/ha. Sulphur content ranged between 11.03 and 32.51 kg/ha, with an average of 19.17 kg/ha. As for the available micronutrients, Iron (Fe), measured through DTPA extraction, ranged from 5.79 to 29.78 mg/kg with a mean of 17.34 mg/kg. Manganese (Mn) levels ranged from 4.94 to 29.14 mg/kg, with an average of 13.34 mg/kg. Copper (Cu) concentrations ranged from 0.56 to 2.88 mg/kg, averaging 1.61 mg/kg. and zinc (Zn) content ranged from 0.22 to 1.96 mg/kg, with a mean of 0.78 mg/kg. In the study region the soil fertility status was evaluated by using Nutrient Index Value. Overall ratings were assessed as low (1.00), medium (1.84) and high (2.62) in available N, available P and available K, respectively based on NIV was reported. As for available S and micronutrients, sulfur and boron recorded as low (1.19) and (1.06) respectively, and Zn was medium (1.87) while Fe, Mn and Cu were in high category of NIV (2.87, 2.86 and 3.00, respectively). As a whole, available N, S, and B are the major nutrient constraints in the study area.

Keywords: Soil nutrient status, Albaras, Durg, Chhattisgarh, soil pH

Introduction
Soil is one of the most essential resources forming the foundation of agricultural development. It is a natural entity formed through the action of environmental forces on natural materials. Typically, soil is structured into distinct horizons made up of varying layers of mineral and organic matter. These layers differ from the underlying parent material in terms of their appearance, physical and chemical properties, composition, and biological characteristics. Soil fertility refers to the natural ability of soil to supply essential nutrients in the right amounts and proportions needed for the growth and development of specific plants. It focuses on delivering these nutrients in sufficient quantity and proper balance, assuming other growth conditions such as light, water, temperature, and soil structure are suitable. Fertile soil contains all the essential elements needed for healthy plant growth. These include primary macronutrients (nitrogen, phosphorus, potassium), secondary macronutrients (calcium, magnesium, sulfur), and micronutrients (iron, copper, zinc, manganese, boron). The overall amount of available nutrients in the soil provides an indication of how accessible each nutrient is to plants. A deficiency in any of these elements can significantly hinder plant development. Soil fertility evaluation illustrates the soil system's nutrient supplying capacity. A serious threat arouses due to practice of intensive cropping that necessity the evaluation of nutrient status. Soil testing helps in providing information regarding available nutrient content in soil which is the basis for fertilizer recommendations for achieving maximum crop yields. Soil testing program is advantageous for formulating specific fertilizer recommendations.

Materials and Methods

The study was conducted on "Evaluation of soil nutrient status of village Albaras, district Durg, Chhattisgarh". The conducted study involved the collection and chemical analysis of 180 soil samples. The analysis of collected soil samples was carried out in the laboratory of Department of Soil Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. The study area was located in 21º05′ 571.7″ N latitude and 81º24′75.8" E longitude with altitude ranging from 317m above the mean sea level. The soils in the study area are mainly dominated by Inceptisols (Matasi) and Vertisols (Kanhar). Inceptisols are medium-textured, moderately fertile, and well-drained, found on gently sloping lands, suitable for pulses, oilseeds, and cereals. Rice, Lathyrus are the major crops in the study area, other important crops are minor *viz*. mustard, chickpea and field pea. Inceptisols and vertisol are present in the study area. The collected soil samples were air dried and soil samples were crushed by wooden hammer and sieved through a 2 mm sieve. Standard analytical methods were employed for soil parameter estimation, including the glass electrode method for measuring (pH), the salt-bridge technique for electrical conductivity (EC), the Walkley and Black method for determining organic carbon, and the Subbiah and Asija procedure for assessing available nitrogen. Available phosphorus was analyzed using Olsen's method, while potassium was measured through the ammonium acetate extraction technique. Sulphur content was determined using the turbidimetric method. For micronutrient analysis, the DTPA extraction method was used to assess available iron (Fe), copper (Cu), manganese (Mn), and zinc (Zn), and boron was estimated using the hot water extraction method.

The Nutrient Index values and Fertility Classes

Nutrient index value (Parker,1952) for the various soil parameters was calculated from the number or proportion of samples under low, medium and high available nutrient status and categorized in different fertility classes as per the method explained by Ramamoorthy and Bajaj (1969) [11].

$$NIV = \frac{1 \times PL + 2 \times PM + 3 \times PH}{} 100$$

Where,
NIV = nutrient index value
PL=% samples fall under low category.
PM=% sample as fall under medium category.
PM =% sample as fall under high category.

Table 1: Nutrient index values for nutrients

NIV for the nutrients	Fertility class (based on NIV)		
N, P, K and S Fe,	Low	Medium	High
Mn, Zn and Cu	1.33	1.34 -2.33	>2.33

Results and Discussion

- **Soil pH:** Analysis of the collected soil samples revealed that the pH values ranged from 5.86 to 7.85, with an average of 6.91. This indicates that the soils in the study area range from slightly acidic to slightly alkaline. Out of the 180 samples analyzed, 13.33% were found to be slightly acidic, 76.67% were neutral, and the remaining 10% were slightly alkaline. Similarly, Kumar *et al.* (2021) evaluated the macro- and micronutrient status of soils at the College of Agriculture and Research Station, Kurud, in Dhamtari district, Chhattisgarh. Their results showed a soil pH range of 6.50 to 7.30, which also reflects a neutral soil reaction.
- **EC (dS/m):** The total soluble salt content in the soils of the study area was assessed by measuring electrical conductivity (EC) using a 1:2.5 soil-to-water suspension. The EC values of all 180 soil samples ranged from 0.11 to 0.26 dS/m, with an average value of 0.17 dS/m. Based on these results, 100% of the soil samples fell under the 'good' category in terms of electrical conductivity. Similarly, Kumar M. *et al.* (2023) assessed the soil fertility status of the Jabalpur block in Jabalpur district, Madhya Pradesh, where the EC values ranged between 0.07 and 0.12 dS/m, with an average of 0.09 dS/m.
- **Organic Carbon (%):** The organic carbon content in the soil samples ranged from 0.37% to 0.75%, with an average value of 0.56%. A majority of the samples 78.33% fell under the medium category, while 21.67% were classified as low. Overall, the organic carbon status in the study area is considered to be in the medium range. Similar results were reported by Meher *et al.* (2020) [7], who found that the organic carbon content in the soils of the KVK farm at Pahanda, Durg, ranged from 0.27% to 0.71%, with an average of 0.48%, reflecting the fertility status of the soil.
- **Available Nitrogen (kg/ha):** The available nitrogen content in the soil samples varied from 100.35 to 263.42 kg/ha, with an average value of 175.52 kg/ha. All soil samples (100%) from the study area were classified as low in available nitrogen., it recovers only oxidizable N fraction of dry soil N pool. It can be noted that the whole area seems N deficient which might be due to the fact that these soils were very poor organic C content which is biggest source of N. It can also be due to the extensive leaching and runoff losses of various form of N a tropical environment is its high temperature which leads to rapid loss of soil organic matter due to volatilization. Similar findings were reported by Sahu *et al.* (2023) [13], who evaluated the soil fertility status at the research farm of the College of Agriculture and Research Station, Katghora, Korba, Chhattisgarh. Their analysis showed that available nitrogen levels ranged from 150.53 to 263.16 kg/ha, with an average of 224.28 kg/ha. Most of the soil samples were categorized as low in available nitrogen content.
- **Available Phosphorus (kg/ha):** The available phosphorus content in the soils of the study area ranged from 9.19 to 30.67 kg/ha, with an average value of 17.87 kg/ha. Out of the total samples analyzed, 22.22% were classified as low, 71.11% as medium, and 6.67% as high in available phosphorus content. Overall, the majority of the samples fell into the medium category. Similar results were reported by Motghare *et al.* (2019) [8], who assessed the soil fertility status in the Arang block of Raipur district, Chhattisgarh. Their findings showed that available phosphorus levels ranged from 5.37 to 39.42 kg/ha, with an average of 19.79 kg/ha.
- **Available potassium (kg/ha):** The available potassium content in the study area ranged from 168.54 to 637.41 kg/ha, with an average value of 385.04 kg/ha. Out of the 180 soil samples analyzed, 37.78% were categorized as medium, while 62.22% fell under the

high category for available potassium. The similar observations were supported by Tarar *et al.* (2023) [15], who evaluated the soil fertility status at the research farm of IGKV in Raipur district. The available potassium content in their study ranged from 277.31 to 484.96 kg/ha.

- **Available Sulphur (kg/ha):** The available sulphur content in the soil ranged between 11.03 and 32.51 kg/ha, with an average value of 19.17 kg/ha. A significant proportion of the soil samples approximately 80.56%were categorized as low in available sulphur, while the remaining 19.44% fell under the medium category. The study area had low to medium status of S due to the poor organic C reserve along with the leaching and runoff losses of sulphate ions. Majority of soil samples were found to be deficient in sulphur because use of low amount of sulphate fertilizers like SSP and imbalanced fertilizer. These findings are consistent with the study by Meher *et al.* (2020) [7], who assessed soil fertility at the KVK farm in Pahanda, Durg district, Chhattisgarh, and reported sulphur levels ranging from 11.20 to 39.60 kg/ha, with an average of 27.27 kg/ha.
- **Available iron (mg/kg):** The concentration of available iron in the soil samples ranged between 5.79 and 29.78 mg/kg, with an average value of 17.34 mg/kg. Based on the analysis, all soil samples (100%) were categorized as sufficient in iron content. The study region, has a high accessible Fe concentration. This is due to the rice growing there, which is caused by prolonged submergence in conjunction with decreasing circumstances. Since the soils' Fe-bearing minerals release the necessary quantity of Fe for crops, the soils in the research area do not have a deficiency in Fe. Similarly, Sahu *et al.* (2023) [13], in their study conducted at the research farm of CARS, Katghora, Korba (Chhattisgarh), also reported that the available iron levels in the soil fell under the high fertility class.
- **Available Manganese (mg/kg):** The concentration of available manganese in the soil samples ranged from 4.94 to 29.14 mg/kg, with an average of 13.34 mg/kg. All samples 100% were classified as sufficient in manganese content. Similarly, the result supported by Sahu *et al.* (2023) [13], in their assessment of soil fertility at the research farm of CARS, Katghora, Korba, Chhattisgarh, also categorized the available manganese in the soil samples under the high fertility class.
- **Available Copper (mg/kg):** The available copper content in the soils of the study area ranged from 0.56 to 2.88 mg/kg, with an average value of 1.61 mg/kg. All the soil samples (100%) were found to be sufficient in available copper. A similar trend was observed by Sahu *et al.* (2023) [13], who evaluated the soil fertility status at the research farm of the College of Agriculture and Research Station, Katghora, Korba, Chhattisgarh. Their analysis showed that the available copper (Cu) content ranged between 0.38 and 3.58 mg/kg, with a mean value of 1.82 mg/kg. Based on these findings, the soil samples were categorized within the high fertility class for copper.
- **Available Zinc (mg/kg):** The available zinc content in the soil samples varied from 0.22 to 1.96 mg/kg, with an average value of 0.78 mg/kg. The results indicated two distinct fertility categories: 22.78% of the samples were classified as deficient, while 77.22% fell into the sufficient category for available zinc. The Zn deficiency increased with increase in pH. Similarly, Sahu *et al.* (2023) [13], in their assessment of soil fertility at the research farm of the College of Agriculture and Research Station, Katghora, Korba, Chhattisgarh, found that available zinc ranged from 0.48 to 1.29 mg/kg, with an average of 0.82 mg/kg, and concluded that zinc levels were generally sufficient.
- **Available Boron (mg/kg):** The available boron content in the soils of the research farm ranged from 0.14 to 0.55 mg/kg, with an average value of 0.30 mg/kg. A majority of the samples (93.33%) fell into the deficient category, while only 6.67% were classified as sufficient. The findings of the present study are supported by those of Sahu *et al.* (2023) [13], who assessed soil fertility at the research farm of the College of Agriculture and Research Station, Katghora, Korba, Chhattisgarh. Their analysis revealed that the available boron content ranged from 0.14 to 0.91 mg/kg, with an average value of 0.48 mg/kg, and the soils were categorized as having low boron fertility. Similar results were reported by Tarar *et al.* (2023) [15] at the research farm of IGKV in Raipur district, Chhattisgarh, where boron levels were also found to be deficient.

Table 2: Salient Findings of soil Properties Analysis

S.N.	Parameters	Range	Mean	Standard Deviation
1	pH	5.86 - 7.85	6.91	0.41
2	EC ($dSm^{-1)}$	0.11 -0.26	0.17	0.034
3	OC (%)	0.37 - 0.75	0.56	0.092
4	Available N (kg/ha)	100.35 - 263.42	175.52	41.85
5	Available P (kg/ha)	9.19 - 30.67	17.87	4.90
6	Available K (kg/ha)	168.54 - 637.41	385.04	116.96
7	Available S (kg/ha)	11.03 - 32.51	19.17	4.82
8	Available B (mg/kg)	0.14 - 0.55	0.30	0.096
9	Available Fe (mg/kg)	5.79 - 29.78	17.34	6.45
10	Available Mn (mg/kg)	4.94 - 29.14	13.34	4.87
11	Available Cu (mg/kg)	0.56 - 2.88	1.61	0.56
12	Available Zn (mg/kg)	0.22 – 1.96	0.78	0.32

Table 3: The overall fertility status based on the NIV

So. no.	Soil	Range	Mean	% samples category			NIV	Fertility class
				Low	Medium	High		
1	pH	5.86 -7.85	6.91	13.33	76.67	10	1.96	Medium
2	EC (dS/m)	0.11 - 0.26	0.17	100	0	0	1	Low
3	OC (%)	0.37 - 0.75	0.56	21.67	78.33	0	1.78	Medium
4	N (kg/ha)	100.35 - 263.42	175.52	100	0	0	1	Low
5	P (kg/ha)	9.19 - 30.67	17.87	22.22	71.11	6.67	1.84	Medium
6	K (kg/ha)	168.54 - 637.41	385.04	0	37.78	62.22	2.62	High
7	S (kg/ha)	11.03 - 32.51	19.17	80.56	19.44	0	1.19	Low
8	Fe (mg/kg)	5.79 - 29.78	17.34	0	12.22	87.78	2.87	High
9	Mn (mg/kg)	4.94 - 29.14	13.34	0	13.89	86.11	2.86	High
10	Cu (mg/kg)	0.56 - 2.88	1.61	0	0	100	3	High
11	Zn (mg/kg)	0.22 - 1.96	0.78	22.78	66.67	10.55	1.87	Medium
12	B (mg/kg)	0.14 - 0.55	0.30	93.33	6.67	0	1.06	Low

Conclusion

A detailed soil analysis carried out in Albaras village, located in the Durg district (C.G.), reveals important features related to agricultural productivity. The soil pH in the region ranges from slightly acidic to neutral and slightly alkaline, while the electrical conductivity remains below 1 dS/m, suggesting favorable conditions for a variety of crops. Organic carbon levels are generally found to be in the low to medium range.

In terms of nutrient status, nitrogen content is classified as low, whereas phosphorus ranges from low to medium and high status of available potassium. Sulphur levels fall within the low category. Among micronutrients, iron (Fe), manganese (Mn), and copper (Cu) are present in sufficient quantities, and B and Zn were sufficient and deficient in some area.

Soil N status was evaluated as low status hence 25% extra application of general recommendation dose can be suggested for nitrogenous fertilizer. 80.56% soil was low for Sulphur status hence, an application of 20 to 40 kg/ha of elemental sulphur is recommended, along with the use of organic manure and the standard NPK fertilizer and also recommended use of SSP in place of DAP**.** In case of micronutrient, Boron status was recorded as low category hence borax powder at the rate of @10 kg/ha is recommended.

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