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Availability of N.P.K under low intensity of soil survey of Northern District of Madhya Pradesh (India)

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Abstract
This study investigates the soil macronutrient composition across various land use types (agricultural, forest, and riverside) in five northern districts of Madhya Pradesh, India (Shivpuri, Gwalior, Morena, Bhind, and Datia). A total of 30 soil samples were collected from both surface (0-15 cm) and subsurface (15-30 cm) depths to assess key soil parameters, including pH, Electrical Conductivity (EC), Organic Carbon (OC), Nitrogen (N), Phosphorus (P), and Potassium (K). The results revealed that the soil pH ranged from neutral to slightly alkaline across the districts, with the highest pH values observed in the Datia district. EC levels were found to be low to medium, with the highest values recorded in Shivpuri. Organic carbon content was generally low to medium, with Gwalior and Datia exhibiting higher organic carbon concentrations in forest and riverside areas. Nitrogen content varied from low to medium, with Datia exhibiting the highest nitrogen levels, particularly in forested areas. Phosphorus was found to be low to medium, with the highest concentrations in the Morena district under agricultural use. Potassium levels also showed variation, with the highest cross all land use categories. This study provides a comprehensive assessment of the soil nutrient status in the region, contributing valuable insights for sustainable land management practices and soil fertility optimization.

Keywords: Soil macronutrients, pH, electrical conductivity, organic carbon, nitrogen, phosphorus, potassium, land use, Madhya Pradesh

Introduction
A low-intensity soil survey in Northern Madhya Pradesh provides valuable insights into the region's soil types, fertility levels, and nutrient availability, which are crucial for understanding the suitability of different cropping systems. Northen M.P., with its diverse primarily black soils (Regur), red soils, alluvial soils, and kankar requires an analysis of how these soil properties interact with local cropping patterns. Black soils, with their high clay content, excellent water retention, and rich organic matter, are well-suited for crops like cotton, soybean, and pulses, commonly cultivated in the region.

Based on the findings of a low-intensity soil survey in Northern Madhya Pradesh, it is clear that the region's diverse soil types require tailored cropping systems to maximize agricultural productivity and promote sustainable land use. The soil survey revealed various soil types, including black soils, red soils, alluvial soils, and kankar soils, each with unique characteristics that influence their suitability for different crops. To enhance soil fertility, optimize water usage, and ensure long-term agricultural sustainability, cropping systems must be chosen to match the specific soil properties of each area.

Materials and Methods
The Sample was selected based on the Surface & Sub-Surface soil of the farmer's field from different areas of different districts. It was sampled randomly to a depth of 0-15 and 15-30 cm in a V shape with the help of khurpi & auger from different districts. The Soil sample was mixed thoroughly and about a half kilogram of composite samples from farmer fields in various areas was taken for analysis. After that Soil samples were brought into the laboratory and dried in the shade at room temperature. Air-dried soil samples were crushed with the help of a wooden roller and sieved through a 2 mm sieve.

Finally, dried soil samples were kept in a polythene bag for further physio-chemical analysis. All the soil samples were processed to analyze pH, EC, organic carbon, nitrogen, phosphorus, and potassium. All soil analysis was carried out in the Department of Soil Science and Agricultural Chemistry laboratory, I.T.M. University Gwalior M.P India. Available macronutrients i.e. available Nitrogen (N), Phosphorus (P) and potassium (K) were estimated by the methods suggested by Subbiah and Asija (1926) [18] and Bray and Kurtz (1945) [2], available potassium, by the ammonium-acetate method described by Jackson (1973) [8].

The Nitrogen estimated by the available nitrogen was determined by distilling the soil with an alkaline potassium permanganate solution of 0.32% Subbiah and Asija (1956) [18] which oxidizes and hydrolyses the organic matter present in the soil. The liberated ammonia was absorbed in the boric acid, titrated the distillate against 0.02 N sulphuric acids, and taken in the burette until a pink color appeared. The phosphorus was estimated by Available phosphorus was determined by using Olsen's extractant (0.5 N sodium bicarbonate solution of pH 8.5 (Olsen *et al.,* 1954) [12], and the potassium was estimated by the available potassium content of the soil was determined by the method described by Hanway and Heidel (1952) [7].

Results and Discussion

The results of the macronutrients, a total of 30 soil samples were collected from different districts under different areas in the region, representing a range of land uses (agricultural, forest, and riverside). The results achieved from the present investigation are presented in this chapter in the following heads:

The available pH was estimated in various Northern Districts of M.P (Shivpuri, Gwalior, Morena, Bhind, Datia) represented in the Table was found neutral to slightly alkaline in range in surface and subsurface based on the rating suggested by USDA (2017). Under the Cropped area, the maximum pH was found at Datia district in a range from 8.65 to 8.58 at a depth of 0-15cm and 15-30 cm respectively. While the minimum pH was found at Morena district in a range from 7.41 to 7.35 at a depth of 0-15cm and 15-30 cm. Under the Forest area, the maximum pH was found in Datia district in a range from 7.78 to 7.72at a depth of 0-15cm and 15-30 cm. While the minimum pH was found at Shivpuri district in a range from 7.01 to 6.86 at a depth of 0-15cm and 15-30 cm. While under the Riverside area, the maximum pH was found in the Datia district in a range from 8.96 to 8.88 at a depth of 0-15cm and 15-30 cm. While the minimum pH was found in the Gwalior district in a range from 7.74 to 7.72 at a depth of 0-15cm and 15-30 cm.

The Electrical Conductivity (EC)was estimated in various Northern Districts of M.P (Shivpuri, Gwalior, Morena, Bhind, Datia) represented in the Table and was found low to medium in range in surface and subsurface based on the rating suggested by Shilewant *et al*., (2021) [16].

Under the Cropped area the maximum EC was found at Shivpuri district in a range from 0.68 to 0.66dSm^{-1} at a depth of 0-15cm and 15-30 cm respectively. The minimum EC was found at Datia district in a range from 0.22 to 0.21 dSm^{-1} at a depth of 0-15cm and 15-30 cm and under the forest area, the maximum EC was found at Shivpuri district in a range from 0.74 to 0.72 dSm^{-1} at a depth of 0-15cm and 15-30 cm. The minimum EC was found at Datia district in a range from 0.34 to 0.32 dSm^{-1} at a depth of 0-15cm and 15-30 cm. While under the Riverside area, the maximum EC was found at Shivpuri district in a range from 0.86 to 0.85 dSm^{-1} at a depth of 0-15cm and 15-30 cm. The minimum EC was found at Datia district in a range from 0.46 to 0.45 dSm^{-1} at a depth of 0-15cm and 15-30 cm.

The organic carbon was estimated in various Northern Districts of M.P (Shivpuri, Gwalior, Morena, Bhind, Datia) represented in Table No 4.6was found low to medium in range in surface and subsurface based on the rating suggested by Yeasmin *et al.,* (2023) [20]. Under the Cropped area, the maximum OC was found at the Gwalior district in a range from 0.55 to 0.52% at a depth of 0-15cm and 15-30 cm respectively. While the minimum OC was found at Bhind district in a range from 0.26 to 0.24% at a depth of 0-15cm and 15-30 cm. Under the Forest area, the maximum OC was found in the Datia district in a range from 0.94 to 0.92%at a depth of 0-15cm and 15-30 cm. The minimum OC was found at Morena district in a range from 0.491 to 0.488% at a depth of 0-15cm and 15-30 cm. While under the Riverside area, the maximum OC was found in the Datia district in a range from 0.53 to 0.51% at a depth of 0-15cm and 15-30 cm. While the minimum OC was found at Shivpuri district in a range from 0.38 to 0.36% at a depth of 0-15cm and 15-30 cm.

The available nitrogen was estimated in various Northern Districts of M.P (Shivpuri, Gwalior, Morena, Bhind, Datia) represented in Table No 1 was found low to medium in range in surface and subsurface based on the rating suggested by Yeasmin *et al.,* (2023) [20]. Under the Cropped area, the maximum nitrogen was found at Datia district in a range from 272.7 to 270.5 kg ha^{-1} at a depth of 0-15 cm and 15-30 cm respectively. The minimum nitrogen was found in the Bhind district in a range from 170.3 to 168.8 kg ha^{-1} at a depth of 0-15cm and 15-30 cm.Under the Forest area, the maximum nitrogen was found in Datia district in a range from 352.2 to 350.6 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While the minimum nitrogen was found at Morena district in a range from 191.6 to 190.7 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While under the Riverside area, the maximum nitrogen was found in Datia district in a range from 251.1 to 250.6 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While the minimum nitrogen was found in the Morena district in a range from 188.8 to 187.2 kg ha^{-1} at a depth of 0-15cm and 15-30 cm.

The available Phosphorus (P) was estimated in various Northern Districts of M.P (Shivpuri, Gwalior, Morena, Bhind, Datia) represented in Table and was found low to medium in range in surface and subsurface based on rating suggested by Yeasmin *et al.,* (2023) [20]. Under the Cropped area, the maximum P was found at Morena district in a range from 24.46 to 23.60kg ha^{-1} at a depth of 0-15cm and 15-30 cm respectively. While the minimum P was found at Datia district in a range from 21.40 to 20.60 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. Under forest area, the maximum P was found in the Gwalior district in a range from 20.60 to 19.30 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While the minimum P was found at Datia district in a range from 18.22 to 17.74 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While under the Riverside area, the maximum P was found at Bhind district in a range from 23.44 to 22.64 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While the minimum P was found at Shivpuri district in a range from 20.22 to 19.77 kg ha^{-1} at a depth of 0-15cm and 15-30 cm.

The available Potassium(K) was estimated in various Northern Districts of M.P (Shivpuri, Gwalior, Morena, Bhind, Datia) represented in the Table and was found low to medium in range in surface and subsurface based on the rating suggested by Yeasmin *et al.,* (2023) [20]. Under the Cropped area, the maximum K was found at Bhind district in a range from 381.28 to 380.90kg ha^{-1} at a depth of 0-15cm and 15-30 cm respectively. While the minimum K was found in the Gwalior

district in a range from 355.68 to 354.55 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. Under forest area, the maximum K was found in Behind district in a range from 378.62 to 376.88 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. The minimum K was found in Gwalior district in a range from 350.22 to 349.70 kg ha^{-1} at a depth of 0-15cm and 15-30 cm. While under the Riverside area, the maximum K was found at Datia district in a range from 372.58 to 369.88 kg ha^{-1} at a depth of 0-15 cm and 15-30 cm. While the minimum K was found in the Gwalior district in a range from 348.12 to 347.48 kg ha^{-1} at a depth of 0-15cm and 15-30 cm.

Table 1: Available Nitrogen, Phosphorus, and Potassium variability under different locations of Northen District of M.P

District	Village	Area	Available N (Kg ha^{-1}) Depth(cm)		Available P (Kg ha^{-1}) Depth(cm)		Available K (Kg ha^{-1}) Depth(cm)	
			15	30	15	30	15	30
	Narwar	Cropping	246.7	244.6	22.40	21.90	360.66	358.90
Shivpuri	Tuki	Forest	274.5	271.7	18.60	17.46	352.40	351.76
	Raipur, Dhamkan	River side	204.6	201.5	20.22	19.77	349.52	348.27
	Manpura	Cropping	244.6	242.4	24.28	23.50	355.68	354.55
Gwalior	Bandholi	Forest	246.4	246.1	20.60	19.30	350.22	349.70
	Jakhwar	River side	233.6	231.2	22.12	21.80	348.12	347.48
	Atarsuma	Cropping	190.2	188.8	24.46	23.60	375.66	374.88
Morena	Bhanpur	Forest	191.6	190.7	18.56	17.88	372.36	371.78
	Piprai	River side	188.8	187.2	22.82	21.65	364.18	363.35
Bhind	Mau	Cropping	270.3	268.8	24.08	23.40	381.28	380.90
	Ratva	Forest	281.7	277.6	19.26	18.80	378.62	376.88
	Sukand	River side	190.6	188.4	23.44	22.64	366.44	365.77
Datia	Goraghat	Cropping	272.7	270.5	21.40	20.60	380.24	378.68
	Medpura	Forest	352.2	350.6	18.22	17.74	376.32	375.74
	Kotra	River side	251.1	250.6	20.58	19.88	372.58	369.88

Conclusion

The soil of the northern districts of Madhya Pradesh is diverse, offering a range of opportunities and challenges for sustainable agriculture. While black soils are highly fertile and support a variety of crops, red and sandy soils require more careful management to improve fertility and water retention. Soil health can be maintained and enhanced through balanced nutrient management, organic matter addition, and erosion control measures. Future efforts in soil management must focus on reducing soil degradation, enhancing organic carbon content, and improving nutrient use efficiency to ensure long-term agricultural productivity in the region.

Soil assessment provides essential data for improving land-use planning and agricultural productivity. By integrating soil health indicators with crop management strategies, it is possible to foster a more sustainable agricultural system that benefits both the environment and the farmers of northern Madhya Pradesh.

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