

PHYSICO-CHEMICAL CHARACTERIZATION OF AGRICULTURAL SOILS OF MORADABAD DISTRICT, U. P., INDIA

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ABSTRACT

Soil is a complex mixture of minerals, gases, liquids, and creatures that serve as the foundation for life. Physicochemical parameters are fundamental to soil research because they influence soil and crop health. Physicochemical characteristics studied, (from April 2022 to July 2023) were pH, E.C, W.H.C, soil temperature, O.C, N, P, and K. 10 surface (0-15 cm) composite soil samples were collected from different 8 administrative blocks (Bhagatpurtanda, Mundapandey, Chhajlet, Moradabad, Bilari, Kunderki, Thakurdwara and Dilari) and analysed by using standard laboratory techniques at Moradabad soil and culture laboratory. pH of soil across the sampling sites ranged between 7.03 to 7.40 and minimum pH was reported from Bhagatpurtanda and Mundapandey as 7.03 that represent neutral status and maximum reported from Chhajlet and Mundapandey as 7.40 with little alkaline nature. E.C. ranged from 0.40 - 0.88 dSm⁻¹ that represents the minimum value for seed germination in district. Available nitrogen content varied from 71.24 to 103.56 kg ha⁻¹, available phosphorus content varied from 13.66 to 23.50 kg ha⁻¹ and the potassium content was 159.10 to 217.91 kg ha⁻¹. Phosphorus ranged represents the low soil status of the district and potassium content range showed as the medium status of soil. The organic carbon values fluctuated from 0.26 to 0.51 % that represents the low value status of district soil profile. W.H.C. of the different blocks was ranged from 22.85 to 54.28% and soil temperature ranged from 10.1 to 25.2°C. The findings suggest that more development is required to enhance soil quality by using improved cropping strategies rather than continuous cropping. Soil in Moradabad was nutrient imbalanced in all the blocks. It can be restored by providing enough amounts of certain nutrients and controlling the use of chemical fertilisers in the soil. The use of organic manure instead of chemical fertilisers can improve soil health and boosts nitrogen concentrations.

(Key words: Electrical conductivity, macronutrient, pH, physicochemical analysis)

INTRODUCTION

Soil is crucial for agriculture, and its physicochemical study is vital as its physical and chemical properties significantly influence its production. Soil is crucial for crop development and nutrient storage, and its health is vital for maintaining agricultural productivity. Soil is a thin layer on the earth's crust that provides life support for biotic components (More, 2022). Soil is crucial for various ecological services, including stimulating plant growth and regulating water, nutrients, and contaminants movement (Kumar *et al.*, 2016; Scholes and Scholes, 2013). Crop production is heavily influenced by the physicochemical qualities of soil (Gairola and Soni, 2010). The soil resource database must be updated in order to apply fertiliser efficiently and choose crops suitable for a specific region (Nayak *et al.*, 2022). Soil's physical properties, including depth, porosity, water holding capacity, texture, crusting, and aggregation, influence root growth, seedling

development, and water transport between particles (Yadav and Verma, 2019). Soil contains intrinsic and dynamic properties, including vertical and horizontal geographical fluctuations (Potdar *et al.*, 2020). Soil fertility is crucial for plant growth, influenced by the levels of N, P, K, micronutrients, and water in organic and inorganic materials. Variability of nutrition availability is a natural phenomenon; certain locations may have enough nutrients, while others may be deficient. The availability of nutrients and organic matter in the soil influences plant development (Yadav and Verma, 2019). Depending on the hydrological qualities of the soil, there may be some variability within it (Kumar *et al.*, 2013). Farmers tend to apply more nitrogen fertiliser for a greener crop and use sub-optimal amounts of phosphorus or completely disregard its administration, resulting in uneven nutrient application and consequently decreasing nutrient utilisation efficiency (Sapkota *et al.*, 2014). N, P, and K are known as soil's key macronutrients, and they are needed for the health and performance of plants (Tewari *et al.*, 2016).

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MATERIALS AND METHODS

The research region is located in Western Uttar Pradesh's Moradabad district (28°-21' to 28°-16' north latitude and 78°-4' to 79° east longitude).

Soil sampling

Between April 2022 and July 2023, 80 surface soil (0-15 cm) samples were collected from agricultural fields. Soil samples were obtained from eight administrative blocks in Moradabad district, each representing a different agro-ecosystem. The entire study area was divided into four different sub-divisions: Sub-division-I Moradabad (Blocks i.e. Moradabad, Mundapandey, Bhagatpur Tanda), Sub-division-II Bilari (Blocks i.e. Bilari, Kunderki), Sub-division-III Kanth (Block i.e. Chhajlet), and Sub-division-IV Thakurdwara (Blocks i.e. Thakurdwara and Dilari), and 10 soil samples were collected from each administrative block, using the conning and quartering technique. The samples were transferred to clean polythene bags and tagged. The process involved removing unwanted items, shattering clods, sieving samples, and analyzing their physical and chemical characteristics using a 2 mm sieve and aluminium tag.

Soil physicochemical analysis

All physicochemical analyses of soil were carried out at Moradabad Soil and Culture Laboratory. Moisture (%) is determined using the weighting method. Water retention capacity (%) was calculated using the method described by (Trivedy and Goel, 1984). The organic carbon (%) in soil samples was determined using the fast titration method developed by (Walkley and Black, 1934). Phosphorus (kg ha^{-1}), availability in soil is determined by bicarbonate test (Olsen, 1954). The potash (kg ha^{-1}) concentration of the soil was measured using a flame photometer (Aines, 1951). The alkaline potassium permanganate method was used to determine the amount of nitrogen (kg ha^{-1}) extracted from soil samples (Subbiah and Asija, 1956). The pH and electrical conductivity (EC) (dSm^{-1}) of soil samples in soil water suspension were measured using a glass electrode in a digital pH meter and a systronics electrical conductivity meter, respectively (Jackson, 1973).

RESULTS AND DISCUSSION

Water holding capacity and soil temperature

W.H.C. (%) of soil ranged from 22.85% to 54.28% (Table 1). Minimum W.H.C. (22.85%) was reported from Bhagatpurtanda and Kunderki block and maximum (54.28%) from Bilari. In the context of sub-division level minimum value (22.85%) from Moradabad and Thakurdwara while maximum from Bilari (Table 3). These variances were caused by clay, silt, and O.C. (%), whereas sandy soils had low W.H.C. due to high sand and low clay content. In all samplings, the average W.H.C. was found to be higher in fields located distant from the banks of rivers at all sites

tested. W.H.C. increases with higher organic carbon levels and soil silt and clay particles due to their larger surface area for water storage (Tewari *et al.*, 2016). Verma *et al.* (2019) reported that the water holding capacity in Allahabad district of Uttar Pradesh soils ranged from 45.71 to 66.66%. Soil temperature of soils ranged from 10.1 to 25.2°C (Table 1). Lower organic matter in the region might be attributed to the high temperature and adequate aeration in the soil, which accelerates the rate of oxidation of organic matter content (Kumar *et al.*, 2013).

Soil pH

pH is an essential physicochemical property of soil because it influences the activity of microorganisms. The solubility of most nutrients changes with pH (Singh *et al.*, 2016). Soil pH in Moradabad district ranged from 7.03 to 7.40, indicating neutral to alkali character. At block level minimum pH (7.03) was reported from Bhagatpurtanda and Mundapandey while maximum (7.40) from Chhajlet and Moradabad (Table 1). Yadav and Verma (2019) reported that the pH in Bareilly district of Uttar Pradesh soils ranged from 6.50 to 7.80. Kumar *et al.* (2015) found that the pH in subtropical Uttar Pradesh soils ranged from 4.36 to 8.57. Amritanshu *et al.* (2023) reported that the pH in Dehradun district of Uttarakhand soils ranged from 5.38 to 7.88. Verma *et al.* (2019) reported that the pH in Allahabad district of Uttar Pradesh soils ranged from 7.35 to 8.12.

Electrical conductivity (dSm^{-1})

Soil electrical conductivity (EC) is a measurement that connects with soil qualities and influences soil texture, cation exchange capacity, drainage conditions, organic matter level, salinity, and sub-soil features (Solanki and Chavda, 2012). Furthermore, electrical conductivity is an excellent indicator of dissolved solids (Singare *et al.*, 2011). The EC of surface soil samples from the study site was 0.40 to 0.88 it was less than 1dSm^{-1} (Table 1). Block Mundapandey represents the minimum value (0.40dSm^{-1}), and Thakurdwara as maximum (0.88dSm^{-1}). Sharma *et al.* (2008) found similar results in Amritsar soils with EC values ranging from 0.10 to 1.00dSm^{-1} . Yadav and Verma (2019) reported that the EC in Bareilly district of Uttar Pradesh soils ranged from 0.40 to 0.80. Amritanshu *et al.* (2023) reported that the EC in Dehradun district of Uttarakhand soils ranged from 0.11 to 0.44dSm^{-1} . Verma *et al.* (2019) reported that the EC in Allahabad district of Uttar Pradesh soils ranged from 0.48 to 0.54dSm^{-1} .

Organic carbon (%)

Soil organic carbon serves a crucial function in preserving soil integrity and providing plant nutrients (Solanki and Chavda, 2012). Crop waste, animal manure, green manure, and organic fertilisers are some of the sources of organic carbon in soil. In our findings organic carbon percentages ranged from 0.26% to 0.51% (Table 1). Block Chhajlet represents the minimum value (0.26%) and Thakurdwara with maximum (0.51%) organic carbon. Soil OC showed an increasing trend with time in all the residue incorporation (Ladha *et al.*, 2004). Meena *et al.* (2006)

discovered that the OC content ranged from 0.19 to 0.90%, with a mean value of 0.45% in Tonk, Rajasthan soils. Yadav and Verma (2019) reported that the OC in Bareilly district of Uttar Pradesh soils ranged from 0.15% to 1.20%. Amritanshu *et al.* (2023) reported that the OC in Dehradun district of Uttarakhand soils ranged from 0.27 to 1.16%. Verma *et al.* (2019) reported that the OC in Allahabad district of Uttar Pradesh soils ranged from 0.84 to 1.51%. Organic matter improves water retention capacity, making water more available in sandy and loamy soils (Yadav and Verma, 2019).

Available nitrogen in soil (kg ha⁻¹)

Nitrogen appears to have the quickest and most dramatic impact among the macro and micro nutrients often employed in chemical fertilisers, therefore it is regarded as a potent nutrition element that must not only be converted but also appropriately maintained (Kumar *et al.*, 2013). The majority of N in the soil is affected by the O C present in the soil (Baruah and Barthakur, 1997). In our results available N, concentration of soil samples ranged from 71.24 to 103.56 kg ha⁻¹, as shown in Table 1. Findings represents that minimum nitrogen value (71.24 kg ha⁻¹) reported from Bilari and maximum (103.56 kg ha⁻¹) from Thakurdwara. Kumar *et al.* (2013) reported the range of Nitrogen from 99.32 to 398.97 kg ha⁻¹ in different soil samples of Muzaffarnagar District of U. P., India, along with Ganga canal command area. Low nitrogen status in soils might be related to a lack of organic carbon in the soils, and variable rainfall has a significant influenced on nitrogen availability.

Available phosphorus in soil (kg ha⁻¹)

Phosphorus, the “Master Key to Agriculture,” is crucial for maintaining plant nutrient balance and ensuring appropriate crop growth, despite low crop output often attributed to phosphorus shortages. The available P in soils of our study ranged from 13.66 to 23.50 kg ha⁻¹ in different soil, mentioned in Table 1. Block Thakurdwara represents minimum value (13.66 kg ha⁻¹) and maximum value (23.50 kg ha⁻¹) from Bhagatpurtanda. Kumar *et al.* (2013) reported the range of phosphorus from 11.17 to 52.61 kg ha⁻¹ in different soil samples of Muzaffarnagar District of U. P., India, along with Ganga canal command area. These findings are consistent with Singh *et al.* (2016), who showed that phosphorus levels varied from medium to high in the

Kapurthala area of Punjab. Ganorkar *et al.* (2013) reported phosphorus in the range of 18.5 to 25 kg ha⁻¹ of soil in Rajura Bazar in Amravati District of Maharashtra India. Yadav and Verma (2019) reported that the phosphorus in Bareilly district of Uttar Pradesh soils ranged from 4.50 to 13.50 kg ha⁻¹. Amritanshu *et al.* (2023) reported that the phosphorus in Dehradun district of Uttarakhand soils ranged from 3.15 to 50.96 kg ha⁻¹.

Available potassium in soil (kg ha⁻¹)

Potassium is an essential nutrient that promotes plant development and the synthesis of amino acids and proteins (Aziz *et al.*, 2010). The available K in soils of Moradabad district ranged from 159.10 to 217.91 kg ha⁻¹, minimum from Thakurdwara block and maximum from Bhagatpurtanda (Table 1). Singh and Pathak (2018) reported that available K was higher in top soil than sub soil. Athokpam *et al.* (2013) observed that the extractable potassium ranged from 55.60 to 359.11 kg ha⁻¹, with an average of 208.06 kg ha⁻¹ in the soils of Manipur’s Senapati district. Yadav and Verma (2019) reported that the potash in Bareilly district of Uttar Pradesh soils ranged from 134 to 179 kg ha⁻¹.

Overall inference of current study at blocks levels reveals that, pH value ranged from 7.03 to 7.40 shows that neutral to little alkaline nature of the soil. In the context of electrical conductivity status of soil in different blocks represents that electrical conductivity ranged from 0.40 to 0.88 dSm⁻¹, and it is less than 1 dSm⁻¹, not optimum for seed germination. Organic carbon ranged from 0.26 to 0.50%, and it represents that low value of the organic carbon in all the blocks except block Thakurdwara (0.51%) and showed medium value. Nitrogen ranged from 71 to 103.56 kg ha⁻¹. In the context of phosphorus status block Bhagatpurtanda represents medium value (22.13 to 23.50 kg ha⁻¹) remaining all blocks showed low value. K status in the soil of Moradabad represents that medium value (159.10 to 217.91 kg ha⁻¹) in all the administrative blocks of four subdivisions. The study suggests that improving soil quality through improved cropping practices and limiting chemical fertilizers, as well as using organic manure, can restore nutrient balance in Moradabad’s soil.

Table 1. Blocks wise physicochemical analysis of soil from Moradabad District, Uttar Pradesh, India

Sr. No.	Soil Parameters	BT-JSP-1		MP-JSP-2		CH-JSP-3		MO-JSP-4		BL-JSP-5		KN-JSP-6		TK-JSP-7		DL-JSP-8	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1.	pH	7.03	7.18	7.03	7.10	7.21	7.40	7.30	7.40	7.29	7.30	7.31	7.32	7.10	7.12	7.07	7.14
2.	Temp. °C	10.10	19.10	11.30	20.20	10.40	22.00	12.20	21.00	11.30	25.20	12.10	21.40	12.00	20.10	11.50	21.40
4.	W.H.C. (%)	22.85	45.71	25.71	48.50	34.28	42.80	34.28	51.42	25.71	54.28	22.85	51.42	34.28	48.50	22.85	45.71
5.	E.C. (dSm ⁻¹)	0.42	0.84	0.40	0.52	0.41	0.53	0.59	0.63	0.65	0.65	0.70	0.73	0.85	0.88	0.87	0.88
6.	O.C. (%)	0.44	0.47	0.46	0.50	0.26	0.35	0.36	0.36	0.33	0.36	0.38	0.43	0.45	0.51	0.45	0.45
7.	N (kg ha ⁻¹)	86.96	100.81	82.54	84.13	81.83	88.08	82.37	83.33	71.24	75.15	83.04	85.00	102.49	103.56	101.75	103.50
8.	P (kg ha ⁻¹)	22.13	23.50	20.29	20.91	18.72	18.76	19.53	19.71	17.28	18.03	16.52	16.76	13.66	13.9	14.14	14.61
9.	K (kg ha ⁻¹)	210.00	217.91	179.63	216.10	175.78	189.46	170.39	172.94	182.42	187.29	161.98	170.9	159.10	159.31	159.15	167.70

BhagatpurTanda BT-JSP-1, Mundapandey MP-JSP-2, Chhajlet CH-JSP-3, Moradabad MO-JSP-4, Bilari BL-JSP-5, Kunderki KN-JSP-6, Thakurdwara TK-JSP-7, Dilari DL-JSP-8

Table 2. Fertility categories of soil as per soil and culture lab, Moradabad, Uttar Pradesh, India

Sr.No.	Soil Parameters	Minimum value	Low value	Medium value	High value
1	pH	0 – 6.5 acidic soil	6.5- 8.5 normal soil	> 8.5 alkaline	-
2	E.C. (dSm ⁻¹)	< 1.0 normal	1-2 optimums for seed germination.	2-3 salt active, optimum for crop	>3 harm full for more crops
3	O.C. (%)	<0.20	0.21 - 0.50	0.51-0.80	>0.81
5	P (kg ha ⁻¹)	0 - 10.0	10.1-20.0	20.1-40.0	>40.0
6	K (kg ha ⁻¹)	0 - 50.0	51 - 100	101-250	>250

Table 3. Sub-division wise physicochemical properties of soil in Moradabad district, Uttar Pradesh, India

Soil Division	pH		Temp. °C		W.H.C.(%)		E.C.(dSm ⁻¹)		O.C.(%)		N (kg ha ⁻¹)		P (kg ha ⁻¹)		K (kg ha ⁻¹)	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Moradabad	7.03	7.40	10.10	21.0	22.85	51.42	0.4	0.84	0.36	0.50	82.37	100.81	19.53	23.50	170.39	217.91
Bilari	7.30	7.32	11.30	25.2	22.85	54.28	0.65	0.73	0.33	0.43	71.24	85.00	16.52	18.03	161.98	187.29
Kanth	7.21	7.40	10.40	22.0	34.28	42.80	0.41	0.53	0.26	0.35	81.83	88.08	18.72	18.76	175.78	189.48
Thakurdwara	7.07	7.14	11.50	21.4	22.85	48.50	0.85	0.89	0.45	0.51	101.75	103.58	13.66	14.61	159.15	167.70

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