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Analysis of Soil Fertility Status Prayagraj district's Chaka block, Uttar Pradesh, India

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ABSTRACT

The current study was conducted at the lab of the United University Faculty of Agriculture and Allied Sciences. 15 soil samples were colleted for this study on November 1, 2024, from five distinct villages in the Prayagraj district of Chaka block. Three soil samples were taken from each village, and their physico-chemical properties were examined using normal laboratory procedures. Seventy to eighty percent of the soil samples fell into the low to medium range for nitrogen (N) (51-648 kg ha^{-1}), phosphorus (P) (0-48 kg ha^{-1}), and potassium (K) (78.4-392 kg ha^{-1}) based on the essential limitations of soil nutrients. The Chaka block was determined to be in the medium category for organic carbon (2.25), nitrogen (1.70), phosphorous (2.29), and manganese (1.70) based on the Nutrient Index Values. Potassium was in the low category (1.37). The findings indicated that better cropping patterns, organic waste decomposition, mulching, and tillage techniques are needed to increase soil fertility and quality.

Key word- *soil health, soil fertility, nutrient status, essential nutrient, nutrient index*.

1. INTRODUCTION

Soil is one of the natural resources that must be used scientifically to raise the nation's level of production and economic standing. The thin coating on the earth's surface that existed before human civilization developed is called soil, and it controls nutritional status, which in turn affects the socioeconomic state of any biosphere. Soil health is the ability of soil to support humans, animals, and plants as a living ecosystem. The five main functions of healthy soil are to: regulate water, snowmelt and irrigation water movement, sustain living organisms and buffer potential pollutants, and cycle nutrients such as nitrogen, phosphorous, carbon, and other nutrients are stored and transformed (USDA U.S. Salinity Laboratory Staff).

Healthy soil also provides us with clean air and water, crops and forests, grazing lands, diverse wildlife, and a magnificent landscape. The combined effects of physical, chemical, and biological processes make soil fertility management a useful technique for boosting the production of agricultural soil with a high degree of spital viability. While nitrogen, phosphorus, and potassium are the main soil nutrient elements that regulate soil fertility and crop yields, the fertility state of an area or region's soils is a significant factor for sustainable agricultural output. Plant growth requires 16 key nutrients; if any one of these is lacking, crop yield will suffer. The macro and micro nutrients such as N, P, K, Ca, Mg, S, and Cu, Fe, Mn, B, Zn, etc. are categorized as essential plant nutrients. Nitrogen can be found in soil as N_2O, NO, NO_2, and NH_3. It is a necessary component of all living things, including protein, chlorophyll, protoplasm, and nucleic acids. It is also present in other substances involved in plant metabolism, such as alkaloids, phosphates, nucleotides, enzymes, hormones, vitamins, and more. A limiting component in the soil that is used for fixation, phosphorus is essential for photosynthesis, respiration, energy storage, cell division, cell elongation, and the early development and growth of roots. The charges on the acidic molecules of organic acid and phosphoric acid, which are harmful to plants, are neutralized in large part by calcium. Magnesium is a mineral component of chlorophyll and an element found in chromosomes and polyribosomes. Since sulfur is a component of several amino acids, which serve as the building blocks of proteins, it plays a significant role in the production of plant protein.

The Ganga system's rivers have spread a thick layer of alluvial soil over the majority of Uttar Pradesh. Alluvial soils range in fertility from sandy to clayey loam, with the soil in the southern region of Uttar Pradesh being a mixture of red and black or red-to-yellow. Uttar Pradesh's 29,441 hectares of land are divided among various soil orders, with 415 ha belonging to vertosols, 83 ha to mollisols, 1,793 ha to alfisols, 21,490 Inceptisols, 4,813 Entisols, and 848 ha to other soil orders. Rivers are valuable natural features that are essential to the organization and integration of the landscape. The Yamuna is an important river in India and the second greatest tributary of the Ganga. It was formed by the Yamunotri glacier in Uttar Kansi. It passes through the states of Uttar Pradesh, Delhi, and Haryana before joining the Ganga at Triveni Sangam in Prayagraj. With a total drainage area of 366,220 square kilometers, the river is approximately 1,370 kilometers long. In the entire Yamuna basin, 12.3 million hectares are irrigated, with 49% of the land being irrigated from surface water, and around 57 million people rely on the river for their basic needs.

2. MATERIALS AND METHODS

2.1 Study Area

Chaka is a 98-meter (322-foot) block in the Prayagraj district of the Indian state of Uttar Pradesh, which is located in the southern region. Another major city in the Indian state of Uttar Pradesh is Prayagraj. It is 102 meters above mean sea level and can be found at 25.450 N and 81.840 E. According to data from 1991, the district's total size is 5437.2 square kilometers. Agroclimatic Zone IV, Middle Gangetic Plains Zone V, and Upper Gangetic Plains Zone VIII are the three agroclimatic zones that Prayagraj falls under. There are 1472 Gram panchayats, 218 Nyaya panchayats, 20 locks, and 7 Tehsils in the Prayagraj district. The area has a humid subtropical climate with yearly rainfall of 981 mm with winter temperatures ranging from 100 to 280 degrees Celsius and summer temperatures from 230 to 420 degrees Celsius. Jowar, wheat, barley, and paddy are the main crops cultivated.

2.2 Analys is of Physico-chemical Parameters

Eight distinct villages provided a total of 24 surface soil composite samples, with three surface soil samples taken from each village at various locations in the Chaka Block of the Prayagraj District of Uttar Pradesh. Initially, the sampling area was cleared of stones, debris, and twigs. The soil was then excavated to a depth of 15 cm using a soil auger. In a zigzag pattern, four to six representative sub-samples were taken from each field. To make the soil homogenous, a sample of around 3–4 kg of dirt was gathered, spread out on a broad sheet, and mixed. After the mixing was complete, any remaining root twigs were removed, and the sample was reduced to 1 kg using the quadratic approach. After that, the soil was placed in poly bags, and the bags were taken to the lab with the sample number, location, area, farmer, crop, and date of sampling written on them. The soil samples were physically crushed with a mallet and shade-dried in the lab before being sieved through a 2 mm sieve mash. After sieving, 500 g of soil was recovered; this soil sample was then kept in a sterile jute bag. The chemical, macronutrient, and micronutrient properties of the samples that were gathered were examined. A 1:2.5 soil water suspension was used to determine the pH using the potentiometric method, while a digital EC meter was used to assess the EC. The wet-oxidation method was used to determine organic carbon. The alkaline potassium permanganate method was used to measure the amount of nitrogen present in an 800 ml Kjeldhal flask. Using a spectrophotometer, the colorimetric approach was used to determine phosphorus. Using a neutral ammonium acetate solution, a flame photometer was used to measure the available K.

3. RESULTS AND DISCUSSIONS

Table 2 displays the findings of the macro-chemical characteristics of soil samples from several villages in the Chaka Block of the Prayagraj district.

With a mean value of 289.9, standard deviation of 184.7, and coefficient of variation of 63.7%, the accessible nitrogen content of soil samples varies from 51 to 648 kg ha-1 for each sample. Out of all the soil samples, 41.6% had low nitrogen content, 45.8% had medium nitrogen content, and 12.5% had high nitrogen content, according to the parameters proposed by Muhr et al. With Patel et al., similar outcomes were noted. From 6 to 48 kg ha-1, the phosphorus concentration of the soil samples varied with a mean of 23.08, standard deviation of 11.47, and coefficient of variation of 49.7%. Of the total soil samples, 33.3% were in the high range of phosphorus, 62.5% were in the medium range, and 4.16% were in the low range. With Yurembam et al., similar outcomes were noted.

The mean potassium content of soil samples is 144.6, with a range of 78.4 to 392 kg ha-1. According to the limits proposed by Muhr et al. 66.6% of all soil samples fell into the low potassium range; this could be because the soils lacked elite-rich potassium minerals. The remaining 29.1% fell into the medium range, and 4.1% fell into the low potassium range. Comparable outcomes were noted with.

Soil Nutrient Index

A single value for each nutrient has to be obtained in order to compare the soil fertility levels of different areas. The computed values for the Organic Carbon, Nitrogen, Phosphorus, and Potassium Index are displayed in Table 1. The formula provided by Muhr et al. [13]1963 is used to determine the nutritional index.

$$\text{Nutrient Index (N.I.)} = \frac{NL \times 1 + NM \times 2 + NH \times 3}{NT}$$

Where, NL: Indicates number of samples falling in low class of nutrient status

NM: Indicates number of samples falling in medium class of nutrient status

NH: Indicates number of samples falling in high class of nutrient status

NT: Indicates total number of samples analyzed for a given area.

2.4 Chaka Block, Prayagraj, Uttar Pradesh: Correlation Matrix between Soil Physicochemical Parameters

The information on the correlation matrix between the physical and chemical characteristics of the soil in several communities in The following table lists the Chaka block in Prayagraj, Uttar Pradesh: - 3. There is a negative, non-significant correlation between the bulk density of the soil and its water-holding capacity (r = -0.070), phosphorus (r = -0.082), organic carbon (r = -0.538), nitrogen (r = -0.546), porosity (r = 0.001), pH (r = 0.366), EC (r = 0.166), and potassium (r = 0.106). There is a negative, non-significant correlation between the soil's particle density and its capacity to hold water (r = -0.289), pH (r = -0.130), EC (r = -0.133), organic carbon (r = -0.317), and nitrogen (r = -0.199). potassium, where r is - 0.360 strongly but not substantially connected with phosphorus (r = 0.277) and porosity (r = 0.942). Phosphorus (r = 0.259) and sulphur (r = 0.185), pH (r = -0.252), EC (r = -0.219), organic carbon (r = -0.189), nitrogen (r = -0.036), and potassium (r = -0.449) all have favourably significant correlations with the soil's porosity. Positive non-significant correlations have been found between the soil's water-holding capacity and pH (r = 0.145), EC (r = 0.359), organic carbon (r = 0.304), nitrogen (r = 0.200), phosphorus (r = 0.176), and potassium (r = 0.308). There is a considerable negative correlation between potassium and soil pH (r = -0.038). EC (r = -0.016), organic carbon (r = -0.207), nitrogen (r = -0.154), and phosphorus (r = -0.436) all have a negative, non-significant correlation with each other. There was a substantial positive correlation between nitrogen and the soil's EC. positively non-significantly connected with potassium (r = 0.797) and phosphorus (r = 0.370) (r = 0.607).

Table 1: Chaka lock's nutrient index scores in Uttar Pradesh's Prayagraj district

Sl. No	Available nutrients	Nutrient index values	Category
1	Organic carbon	2.25	Medium
2	Nitrogen	1.708	Medium
3	Phosphorus	2.291	Medium
4	Potassium	1.375	Low

Table 2: Soil quality metrics for various villages in Prayagraj, Uttar Pradesh's Chaka block

Sample No	Name of the Village	pH	EC (d S m^{-1})	OC (%)	N (Kg ha^{1})	P (Kg ha^{1})	K (Kg ha^{1})
S_1	Arail	7.41	0.21	0.84	385	16	155.8
S_2	Arail	7.37	0.22	0.43	166	26	171.2
S_3	Arail	7.43	0.32	0.73	404	41	251.6
S_4	Dewrakh	7.35	0.23	0.55	127	17	222.0
S_5	Dewrakh	7.62	0.24	0.49	179	23	391.0
S_6	Dewrakh	7.75	0.23	0.39	132	21	281.0
S_7	Mawaiya	7.65	0.18	0.33	128	20	90.6
S_8	Mawaiya	7.65	0.14	0.62	389	27	79.4
S_9	Mawaiya	7.70	0.15	0.52	290	19	110.8
S10	Lawayan	7.70	0.16	0.85	412	18	120.8
S11	Lawayan	7.41	0.17	0.52	481	19	122.0
S12	Lawayan	7.50	0.14	0.54	302	16	98.6
S13	Chat Kalana	8.63	0.18	0.11	321	13	92.6
S14	Chat Kalana	7.70	0.16	0.53	310	17	102.0
S15	Chat Kalana	7.64	0.17	0.45	432	16	120.8

4. CONCLUSION

According to the results of the current study conducted in the Chaka Block of the Prayagraj District of Uttar Pradesh, the soil is neutral to alkaline. All soil samples (100%) fall inside the acceptable EC range for the majority of crops. Because of the low and high temperatures and the slower rate of organic matter decomposition, 58.3% of the soil samples had a medium-high organic carbon content. While potassium and sulfur are in the low range, over 50% of soil samples have medium levels of nitrogen and phosphorus. Because of their inverse association with pH—that is, a rise in pH results in a decrease in availability—zinc, manganese, and iron are insufficient, whereas copper is within an adequate range. Potassium, sulfur, zinc, and iron have low nutrient index ranges, while organic carbon, nitrogen, potassium, and manganese have medium nutrient index ranges, according to the soil nutrient index. These studies could assist farmers in maintaining appropriate nutrient management to produce high-quality goods with a high yield. Cropping patterns, organic waste decomposition, mulching, and tillage techniques can all be improved.

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