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Physico-chemical Characterization of Soil Samples from Agra District

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ABSTRACT
The physical and chemical qualities of the soil determine its potential for crop production. Soil is an essential natural resource for growing plants. In this study, soil samples were collected from different locations of Agra district. The study's goals were to ascertain the soil's physico-chemical characteristics. The soil's physico-chemical makeup has been studied using several parameters, including pH, electrical conductivity (EC), total organic carbon, available nitrogen (N), and available phosphorus(P), available potassium (K) and some micronutrients (Zn, Fe, Cu and Mn). This research helped us to determine how many nutrients are present in the soil in various study areas of Agra. Soil pH may affect how well nutrients are absorbed by plants and how they grow. All samples were found to be slightly acidic to moderately alkaline (pH 6.9 - 7.9), salt free to slightly saline (EC 0.47 – 7.21 dS m^{-1}), low in organic carbon (0.11 – 0.42 %). The soils have low levels of accessible N (98.0 to 218.0 kg / ha^{-1}), low to medium in available P (4.1 – 11.4 kg ha^{-1}) and medium in available K (138.0 – 276.0 kg / ha^{-1}). However, the soils were adequate in available Fe and Mn but low in available Zn and Cu content. The results showed that increased EC of the soil may cause a salinity problem. The findings indicated that all the areas in Agra district have low levels of several parameters like OC, N, P, K Zn and Cu except EC, Fe and Mn. Farmers can use this information to determine how much fertilizer to give to the soil in order to solve problems linked to soil nutrients.
Keywords: *Soil, Agra District, Physico-chemical Analysis.*

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INTRODUCTION

The 4027 square kilometre Agra district is in the South-West semi-arid region of Uttar Pradesh. It is situated at a longitude of 77.90 east and an altitude of 27.20 north. The region has 750 mm of yearly rainfall on average. District behind M.P. is divided by the river Chambal, which forms the district's southern boundary. In the north, Agra is bordered by the districts of Firozabad and Etawah. The district consists of 15 blocks, 904 villages and six tehsils. Sandy loam ravines, and wasteland make up the district's soils. The soil's fertility status ranges from poor to extremely poor (https://agra.kvk4.in/district-profile.html). The average max. temperature of the district recorded 34.85 degree celsius and average min. temperature 16.2 degree celsius.

An essential part of the earth's system is the soil that regulates different geochemical cycles and it provides goods, resources, and services to humanity [1]. Soil is a diverse natural entity whose characteristics result from the interaction between biotic activity and climate [2]. In general, there is a direct correlation between crop quality and soil health. It comprises measures of soil nutrient quality and soil health that can be evaluated. Healthy soils are directly linked to nutrition and food security, quality of water, public health, climate change etc. [3]. A greater understanding of the geographical variability of soil qualities is crucial for enhancing sustainable land use and agricultural management techniques [4]. The reason for variance in crop productivity as described by management approaches may also be explained by an awareness of the roles played by various soil qualities together with their interactions. With a greater understanding of the characteristics of soil and soil quality, soil health and quality have steadily improved. Analysis of soil is carried out for the studies of various parameters phosphorus (P_2O_5), potassium (K_2O), available nitrogen (N), organic carbon (OC), pH, electrical conductivity, soil texture, moisture content percentage and some micronutrients (Zn, Cu,Mn and Fe). In addition to being a potential carbon dioxide sink, soil organic carbon is essential to the global carbon cycle. Agricultural management approaches can promote carbon sequestration, which provides possible strategies for removal while also enhancing overall soil quality. The concentration of N, P, K, organic and inorganic elements, and conductivity all affect the soil's fertility.

Potassium is needed for blooming as well as for protein synthesis, photosynthesis, fruit quality and the prevention of disease, while phosphate is necessary for plant root growth. Nitrogen is a component of plant proteins, chlorophyll and nucleic acids and is necessary for plant growth[13-16].
The current study aims to determine the physical and chemical analysis of the soil samples from various areas of Agra district. Seven representative soil samples were collected from various regions of the Agra district. Farmers can use this information in order to make their produce profitable.

MATERIAL AND METHODS

Soil Sample Collection

For the study sterile tools were used to gather soil samples. Before collecting soil samples from the layer of soil immediately beneath the surface of the soil (0-20 cm), the top layer of plants, surface litter etc. were scraped away. Because just a small section of the huge soil mass is examined, obtaining a correctly representative soil sample of the area is essential. The soil samples were placed in a zip-lock container and transported to a lab for study. The study covered agricultural lands in various regions of the Agra district.

Physico-chemical Analysis of Soil Samples

A healthy soil has chemical, physical and biological qualities that promote animal, plant, and human health while also protecting the environment. The importance of soil physico-chemical research cannot be overstated. Electrical conductivity, pH, moisture content, temperature, available nitrogen, organic matter, potassium, phosphorus, and microelements (Zn, Fe, Mn, and B) are some of the factors used in the physico-chemical analysis. This understanding assists us in comprehending the state of the soil as well as those who are interested in the agricultural area. Different analytical techniques were used to characterize the soil's physiochemical composition. Soil physical properties such as soil texture analysis was done by hydrometer method [6]. The moisture content of soil samples was done by a weighing method. Water holding capacity was measured by oven drying method [7]. A solution's pH tells if hydrogen ions are present. To determine the soil sample's pH digital electronic pH meter [8] was used. Electrical conductivity (EC) provides a precise estimate of the number of soluble salts in the soil by indicating the presence of ions in a solution that are directly proportional to the soil's current carrying capacity. Using a Digital Electrical Conductivity Meter [9], the electrical conductivity of soil samples was measured. The amount of organic content in the soil is necessary for the plants to maintain a healthy physical condition. The breakdown of leftover plant and animal debris, as well as living and dead microbes, is what makes organic matter in the soil available. It helps with soil fertility, structure, and water-holding capacity. Organic matter not only enhances the soil's physicochemical characteristics but also encourages microbial growth and raises enzymatic activity [10]. The Walkley and Black wet oxidation method [8] was used to measure soil organic carbon (OC). Kjeldahl distillation was used to estimate the amount of available nitrogen (N) [16]. It was discovered that the phosphorus present in soil is present in many configurations and types as orthophosphate, but that some of it might only be accessible to plants. Olsen's approach was used to determine the amount of available phosphorus [12]. Within the overall non-exchangeable form (unalterable K) of potassium present in soil samples, a tiny amount (accessible K) is held in exchangeable form. According to Jackson [5], available potassium (K) was extracted using a 1N ammonium acetate solution at pH 7 and measured using a flame photometer. Micronutrients such as iron, zinc, copper, manganese etc. are needed in extremely little quantities, yet they are crucial for plant health because they help plants' metabolisms more quickly. They are typically present in the mineral portion of the soil, Lindsay and Norvell's work (Lindsay and Norvell, 1978) is frequently used to determine the number of accessible micronutrients in soil samples. The method was used to analyse micronutrients including Zn, Mn, Cu and Fe in soil samples.

RESULTS AND DISCUSSION

Seven standard soil samples were taken from various sites within the Agra district for investigation. Sample 1 was taken from Saiyan, sample 2 from Kheragarh, sample 3 from Shamshabad, sample 4 from Fatehabad, sample 5 from Bichpuri, and sample 6 and 7 from Achnera and Fatehpur Sikri, respectively, for analysis. A site-specific balanced fertiliser recommendation can be created utilising GPS data to determine the available nutrients in the soil and to analyse the geographical and temporal trends in soil fertility. The GPS locations of the sample collection sites are given in **Table 1**.

Table 1. GPS locations of collected soil samples.

Sample Code	Place	Latitude	Longitude
S1	Saiyan	26057’7” N	77056’26” E
S2	Khairagarh	26056’47” N	77048’57” E
S3	Shamshabad	2700’33” N	7806’46” E
S4	Fatehabad	2701’34” N	78017’9” E
S5	Bichpuri	27010’32” N	77053’35” E
S6	Achnera	27010’23” N	77045’54” E
S7	Fatehpur Sikri	2706’22” N	77040’50” E

The physicochemical parameters of soil samples collected from different area were analysed and are given in **Table 2** and **Table 3**. The results are also represented by graphs as given in **Figure 1**.

Table 2. Results of studies various Physico-chemical parameters of various soil samples

Samp le	pH	Tem p (0C)	Soil texture	Moisture (%)	WHC (%)	EC (dS/m)	(OC) (%)	P (kg/ha)	K (kg/ha)	N (kg/ha)
S1	6.9	28	Clay	28	46	6.28	0.21	9.6	149	196
S2	7.9	31	Sand	21	21	7.21	0.26	14	276	218
S3	7.6	30	Sand	29.7	19	3.88	0.19	4.1	254	209
S4	7.6	28	Sand	28.5	23	5.64	0.32	11.4	138	173
S5	7.8	33	Clay	32.2	50	1.3	0.42	7.9	162	98
S6	7.3	29	Silt	34.9	49	0.47	0.37	5.66	156	154
S7	7.6	31	Clay	31.78	48	2.33	0.11	8.2	141	127

Table 3. Results of micronutrient analysis of the soil samples.

Soil Sample	Mn (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
S1	10.91	11.09	0.43	0.59
S2	12.38	15.39	0.51	0.61
S3	11.57	13.4	0.36	0.13
S4	12.41	14.18	0.44	0.36
S5	10.48	15.61	0.49	0.21
S6	9.51	12.9	0.53	0.11
S7	11.7	13.91	0.28	0.47

The Interpretation of Soil Properties is based on criteria as given in ‘Methods Manual, Soil Testing in India (2011)’ and the results of analysis are discussed with the possible reasons behind it.

pH: The pH of the soil is a measurement of the soil's acidity or alkalinity and is expressed as a pH unit. According to Methods Manual [9], seven categories of soil reactions are identified based on soil pH values, they are Extremely acid (<4.6), Strongly acid (4.6-5.5), Moderately acid (5.6-6.5), Slightly acid (6.6-6.9), neutral (7.0), Moderately alkaline (7.1-8.5) and strongly alkaline (>8.5). Most of the soils under investigation were found to be slightly acidic to moderately alkaline with pH levels ranging from 6.9 to 7.9. In soil sample S1, the minimum pH (6.9) was found, indicating that the soil in this area was slightly acidic in comparison to other areas. Most soils in Agra District have a pH greater than 7. Low levels of leaching and build-up of bases may be responsible for soils' higher pH. Soil sample S2 had the highest pH (pH-7.9).

Electrical Conductivity: The soil EC is a gauge of the number of ions from water-soluble salts present in soils. The electrical conductivity of a material is frequently expressed as dS m-1 or millimhos centimetre-1 (mmhos cm-1). A dS/m equals one mmhos/cm. Electrical conductivity (E.C.) readings from various locations revealed that soils’ E.C. values were ranging from 0.47 to 7.21 mmhos/cm. The soil sample from Achnera had the lowest E.C. value (0.47 mmhos/cm), while the soil sample from Khairagarh had the highest E.C. value (7.21 mmhos/cm). As a result of the soil samples' EC measurement, most of them were found to be slightly saline (According to Methods Manual, 2011). The research area's increased level of soluble salts may be related to the semi-arid climate.

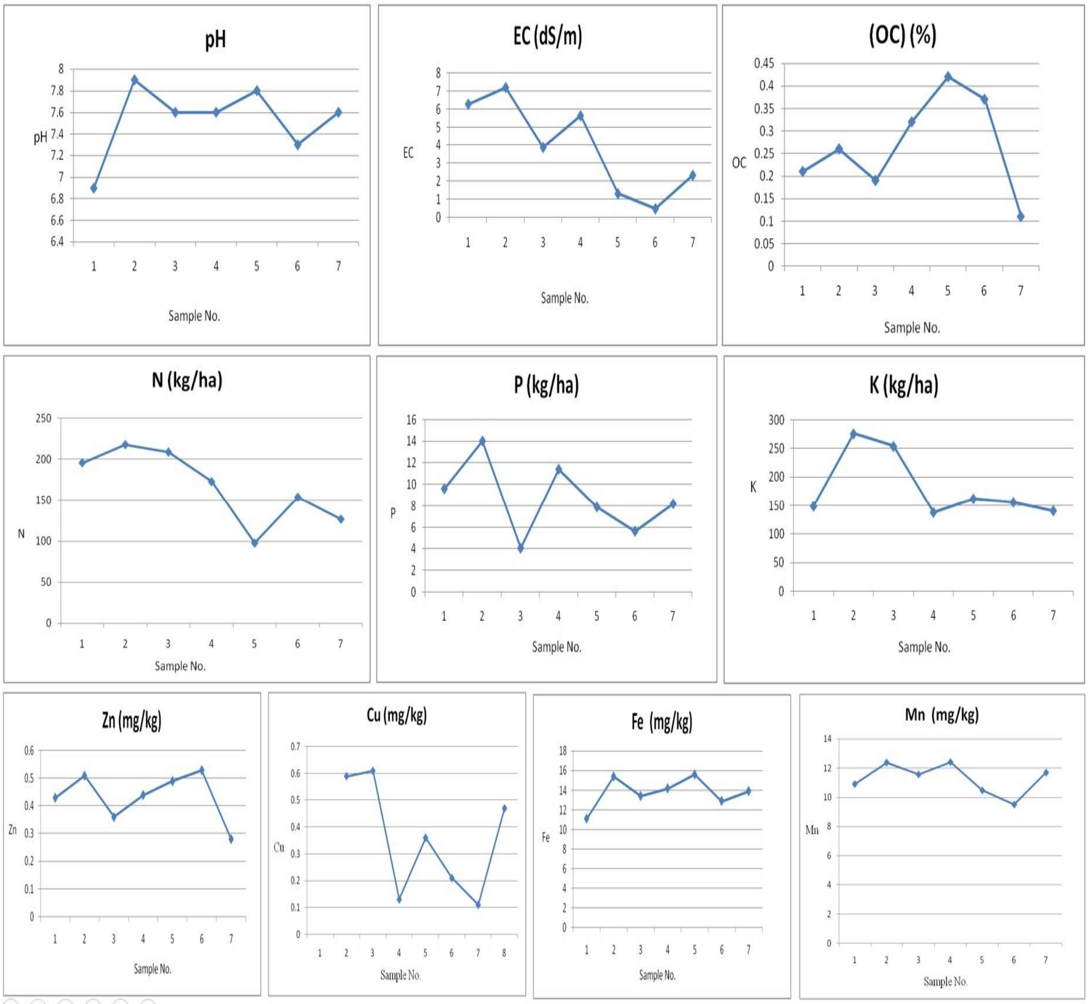

Figure 1. Graphical representation of the various parameters of the analysed soil samples.

Organic Carbon: It was discovered that practically all samples had low levels (<0.5, Methods manual - 2011) of organic carbon ranges between 0.11 percent to 0.42 percent (Table 2). Less organic matter means the soil does not have the microflora and fauna that produce organic matter. The quick burning of organic matter caused by the region's high average temperatures is what causes the soils in these areas have little organic carbon. It was observed that Bichpuri had the highest O.C. (0.42 percent), while Fatehpur Sikri had the lowest (0.11 percent).

Nitrogen: The available nitrogen in soils of the Agra District ranged from 98 to 218. The highest total nitrogen (218 kg ha-1) was found in a soil sample from Kheragarh, while the low content was found in a soil sample from Bichpuri (98 kg ha-1). All the soil samples had a low amount of accessible nitrogen in lined with Methods Manual, [9] (<280 is considered low, 280-560 is considered medium, and > 560 is high). Low levels of organic carbon may be the main factor influencing the availability of nitrogen [13].

Phosphorous: The available P concentration in various soils in the study area ranged from 4.1–14 kg per ha. The soil sample from Kheragarh contained the highest phosphorus (14 kg per ha), whereas the soil sample from Shamshabad contained the least (4.1 kg per ha). According to Methods Manual (2011), most soils have low (<10 kg per ha) level of useable phosphorus followed by medium (10-24.6 kg per ha). The status of soil samples in the available phosphorus ranged from low to medium [9].

Potassium: The findings revealed that the potassium content was between (138-276) kg per ha (Table 2). With 276 kg per ha, Kheragarh's soil sample has a highest potassium content among all the samples. The prevalence of K-rich micaceous and feldspar minerals in the parent material may be responsible for the soil of Kheragarh's greater accessible K content. Mustafa *et. al.* (2011) had similar findings. Methods Manual, 2011 considers soils with a potassium content of <108 kilogram per ha as low, 108-280 kg per ha as medium and >280 kg per ha as high. It was discovered that the soil samples from S3 also had high potassium usable status [9].

Zinc: All soil samples had zinc concentrations between 0.28 and 0.53 parts per million. The availability of Zn in the soil is often represented as parts per million (ppm) or mg/kg. A ppm equals one mg/kg. Sample S6 contained the highest amount of Zn in soil. According to Methods Manual [9], in all areas under consideration, the zinc concentration was discovered to be found under critical limits range (very low to low). The main causes of zinc deficiency may be the parent material, the coarse soil texture, the poor usage of organic matter, and fertilisers that include soil micronutrients. Zinc levels were determined to be below the range of deficits in all regions.

Copper: According to the findings of the soil analysis, it indicated that copper content varied spatially in the Agra district. There was a very low to medium range of copper content Methods Manual, [9] in various study areas, revealing almost 0.11 – 0.61 ppm. Mustafa *et. al.* [10] also observed low status of available copper in soil of Kheragarh.

Iron: Iron levels in soil were 13.78 ppm on average. Comparing S5 to other samples, the iron level was much greater, this could be influenced by the amount of organic matter in the soil. In general, it was discovered that as organic carbon levels rose, iron availability rose dramatically as well. All the soil samples taken from the Agra district had very high iron contents [9].

Manganese: The available Manganese content of the research areas was very high and ranged from 9.51 to 12.38 mg kg-1 with average value 11.28, indicating that there was enough manganese in these Agra District's soils.

CONCLUSION

It was concluded that different soil locations had an impact on the physicochemical properties of the soils since they displayed varying values depending on where they were. The soil samples from the study area contained little organic carbon. Most soil samples show low levels of accessible nitrogen, phosphorous, copper and zinc; yet most soils have alkaline pH values. In order to manage alkaline soils in the research region and stop future deterioration, prompt action is required. Farmers and policy makers can use the obtained nutrient status information as a useful tool to develop site-specific nutrient management methods. One type of such activity is the addition of the necessary quantity of fertilisers / biofertilizers to raise the nutritional value of the nutrients and improve soil quality.

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