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# Impact of Soil Physicochemical Properties on Crop Productivity in Jaipur's Peri-Urban Ecosystems

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## Abstract

The nutrients found in the soil are the most crucial components needed for soil fertility and plant growth. Plants need these nutrients in sufficient amounts. This study aimed to assess the chemical characteristics of a few chosen soil ecosystems in Jaipur's outlying regions, including those associated with agriculture, organic farming, forests, and industries. The following factors were examined to determine the soil fertility status: pH, EC, OC, N, P, and K. According to the study, the pH of the soil samples ranged from 7.01 to 7.41 and was somewhat alkaline, but still within the recommended range of 6.5 to 8.5 for crops, except forest soil, which had a lower value. The EC values, which ranged from 0.2 dSm-1 to 0.503 dSm-1, suggested lower salinity in the soil samples. The organic carbon content readings were consistent across all soil samples. Except for organic farming, nitrogen and phosphorus concentrations had a negative influence on all soil samples. Potassium levels are optimal in organic and forest soil samples, but lower in industrial and chemically treated soils.

**Keywords**: Chemical characteristics, soil nutrients, soil health, forest, organic carbon, EC

## Introduction

According to *Velayutham and Bhattacharya* (2000), soil is a naturally occurring substance that is created by pedogenic processes through the weathering of rocks. It has a mineral and organic content as well as specific mineralogical, chemical, physical, and biological qualities that make it an ideal medium for plant growth. In addition to being an essential part of the ecosystem and a major source of food, water, and energy for humans, soil also supports life through a variety of processes such as water purification, biomass production, pollution remediation, ecosystem restoration, and the cycling of carbon, nitrogen, sulfur, and water (*Gaur*, 1997) [9]. Given that agriculture and related industries rely heavily on soil resources, it is the most significant natural resource for humans and other living things. One of the most crucial elements in crop production is soil, which is a thin layer of organic matter on the surface of the earth that also contains nutrients, water, air, and other organic matter that work together to support plant growth. Farmers need to understand that measuring fertility levels is necessary to determine soil fertility, which can lead to increased productivity and profitability.

The world's soil resources are finite and quickly deteriorating due to a variety of anthropogenic activities in natural systems, which causes agricultural land to be used for non-agricultural purposes (Lal, 1998) [13]. Degradation of soil is a serious problem that can be accelerated by salinization, erosion, changes in the soil's organic matter content, loss of plant nutrients, and structural alterations. Soil health is negatively impacted by intensive agricultural practices and excessive use of chemical fertilizers in farming practices for food production. Soil health deteriorated as a result of heavy pesticide use and tainted irrigation water from industrial wastewater (Rayment et al., 2002; Kaur et al., 2014) [17, 11]. As per the report by the Indian Council of Agricultural Research (2010), 37 percent of India's total land area is affected by different types of land degradation, such as acidity, salinity, alkalinity, mining, and industrial waste. These factors have a direct impact on crop productivity throughout the nation. The depleted organic matter needs to be replenished, the degraded soils and ecosystem need to be improved, and food needs need to be met both now and in the future. Food, fuel, water, fiber, herbal, and pharmaceutical items all depend on healthy soils. Physical fertility, chemical fertility, and biological fertility are the three primary components of soil fertility (Christopher Johns et al. 2017) [5].

The ability of plants to absorb nutrients and water is significantly influenced by the physical and chemical characteristics of the soil (B.S. Griffith, 2010) [2]. The size, shape, pore spaces, texture, organic matter, and nutritional composition of the soil are all considered aspects of physical fertility. The soil's pH, electrical conductivity, organic content, and different mineral composition are among its chemical characteristics. Working with various soil ecosystems necessitates an awareness of their various levels of physical and chemical properties. When working with a specific soil, understanding its physical and chemical qualities aids in the soil management methods (N. Brady, 2002) [15]. In addition, the forest provides essential soil ecosystem services that keep terrestrial systems functioning (Abson et al., 2014: Chazdon et al., 2009). [1, 4]. The functions include fuel and fiber (Rojstaczer et al., 2001: Vitousek et al., 1986), as well as products and services required to sustain human populations (Matson, 1997) [14]. [16, 20]. Additionally, they can assist pollination services and regulate pest control (Bale et al., 2008; Kremen et al., 2002). [12]. It's critical to stay current with knowledge regarding the many qualities of soil in order to maximize productivity from any soil ecosystem (B.S. Griffith, 2010). [2]. Soil fertility must be kept at its ideal level in order to improve yields, lower pollution, and implement sustainable agricultural methods (Diaccono & Montemuroo, 2010). [7].

## Materials and Methods

The study sites are located in the city-outer part of Jaipur. The composite soil samples were collected from four regions - local forest region, soil with chemically fertilized, soil with organically fertilized soil, and industrial area soil. Three duplicates of the composite soil samples (0–15 cm) were gathered and transported to the lab in tiny, sterile, low-density polythene bags. After being air-dried, the soil samples were run through a 2 mm filter to examine their chemical composition. The soil samples that were treated were utilized to measure pH and In 1:2 soil, electrical conductivity was measured using the conductivity bridge method (Jackson, M.L. 1977) [10] and the potentiometric method (Jackson, M.L. 1977) [10]. Wet digestion was used to measure the organic carbon (Walkley and Black, 1934) [22]. According to Subbaiah and Asija (1956) [18], the alkaline permanganate method is used to evaluate the total nitrogen nutrients level. Available potassium was determined using ammonium acetate extract, and available phosphorus was measured in the Olsen's extract using ascorbic acid (Watanabe and Olsen, 1965) [21].

| S. No | Parameters | Methods |
|---|---|---|
| 1 | pH | 1:2.0 soil water suspension by Using pH meter. |
| 2 | Electrical conductivity | 1:2 soil water suspension by using Conductivity bridge. |
| 3 | Organic Carbon | Walkley and Black's oxidation method (Walkely, a and Black, I.A. 1934) [22] |
| 4 | Total Nitrogen | Alkaline permanganate method (Subbaiah and Asija, 1956) [18] |
| 5 | Available Phosphorus | Olsen's extraction method (Olsen, S.R. 1954) |
| 6 | Available Potassium | Ammonium acetate extract method (Mervin and Peach, 1951) |

The Chemical analysis of the four soil samples was done in triplicates and the data is presented as Mean ± Standard Error. Statistical analysis was done with the help of Microsoft Excel computer software programs.

The term " pH " describes how acidic and alkaline the soil is. Significant changes in the chemical and biological properties of the soils have been demonstrated to occur with slight variations in the pH of the soils. The current study demonstrates that the pH of two agricultural stations was within the ideal range of 6.5 to 8.5, which is needed for crops. The data also revealed that the industrial and forest stations' paddy crops were rather acidic, with the industrial soil having an acidity level of 7.4 and the forest station's 6.15. The soil forest location had the lowest pH value out of the four soils, and organic soil had the highest average value.

According to the results, the pH values of the organic and agricultural soils were similar, and this is roughly in line with past research on the rhizosphere of paddy soil that revealed a pH of 7.23 (*Madhavilatha et al*., 2015) and (Madhavi et al., 2018) [8]. The woodland had a lower pH of 6.12, according to the current data. According to Charman and Murray (2007) [3].

**Results**

One of the main indicators of salinity or salt content in soil is the electrical conductivity (EC) of the soil. The range of EC values recorded was 0.2 to 0.5 dS m-1, with agriculture exhibiting the greatest average value. Being a measurable part of organic matter, soil organic carbon plays a significant role in soil biological function. The majority of organic matter is made up of decomposing or dead components. The findings revealed moderate in significant quantities in all soil samples. Continuous cultivation, the removal of crop residue without return, and the effects of wind and water erosion, which preferentially remove soil colloids, including the organic components, are all responsible for the low OC.

The three main macronutrients of soil—nitrogen, phosphorus, and potassium—are crucial for plant growth. An essential component of chlorophyll that promotes protein content during vegetative development is nitrogen. A lack of nitrogen causes plants to grow slowly, while too much nitrogen in the soil can also cause problems for plants, as evidenced by their delayed maturity and increased vulnerability to pests and illnesses. The amount of nitrogen in the soil usually indicates fertility and accessible nitrogen ranges from 139.2 kg/acre (organic soil) to 927 kg/acre (industrial). Due to the lack of a nitrogen source, a similar pattern was seen in the forest. Extensive use of chemically fertilized agriculture practices may result in high nitrogen concentration in agricultural soil that exceeds restrictions for this location.

Phosphorus is a crucial component that aids in cell division, promotes the growth and creation of roots, and supplies ATP, the biological energy that increases a plant's resistance to disease, drought, and cold. Phosphorus availability is influenced by both organic carbon and pH. While organic soil is assigned a lower value, forest soil has the highest value. All soil samples do, however, generally contain significant amounts in the area.

**Table 1. Physicochemical properties of different Soil (Mean ± SE)**

| S.No. | Parameters | Agriculture | Organic | Forest | Industrial |
|---|---|---|---|---|---|
| 1 | pH | 7.1 ± 0.048 | 7.1 ± 0.010 | 6.15 ± 0.012 | 7.40± 0.126 |
| 2 | EC (ds $m^{-1}$) | 0.504 ± 0.015 | 0.237 ± 0.015 | 0.205 ± 0.005 | 0.307 ± 0.065 |
| 3 | Organic carbon | 0.69 ±0.008 | 0.72 ±0.014 | 0.75 ±0.007 | 0.76 ± 0.024 |
| 4 | Nitrogen (kg/acre) | 872.3 ± 1.45 | 124.2 ± 0.68 | 842.6± 1.169 | 917 ± 3.214 |
| 5 | Phosphorus (kg/acre) | 67.8 ± 0.435 | 49.45 ± 0.33 | 74.21 ± 0.76 | 57.70 ± 0.20 |
| 6 | Potassium (kg/acre) | 30.03 ± 0.688 | 71 ± 0.577 | 52.86 ± 0.35 | 41.5 ± 0.692 |

**Fig 1: $P^H$ values observed in different soil types**

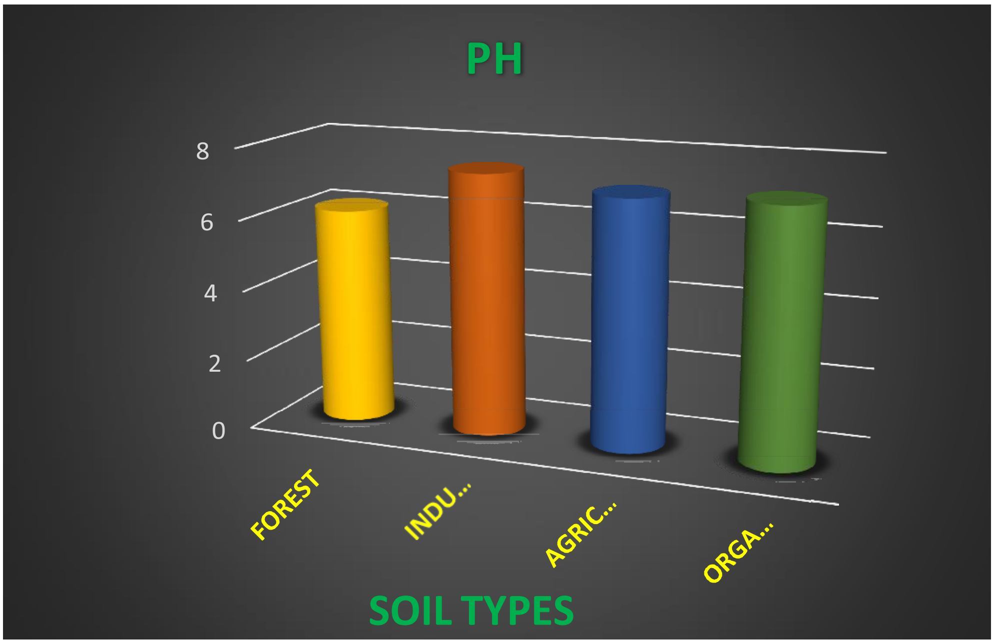



**Fig 2. The EC values present in different soil types**

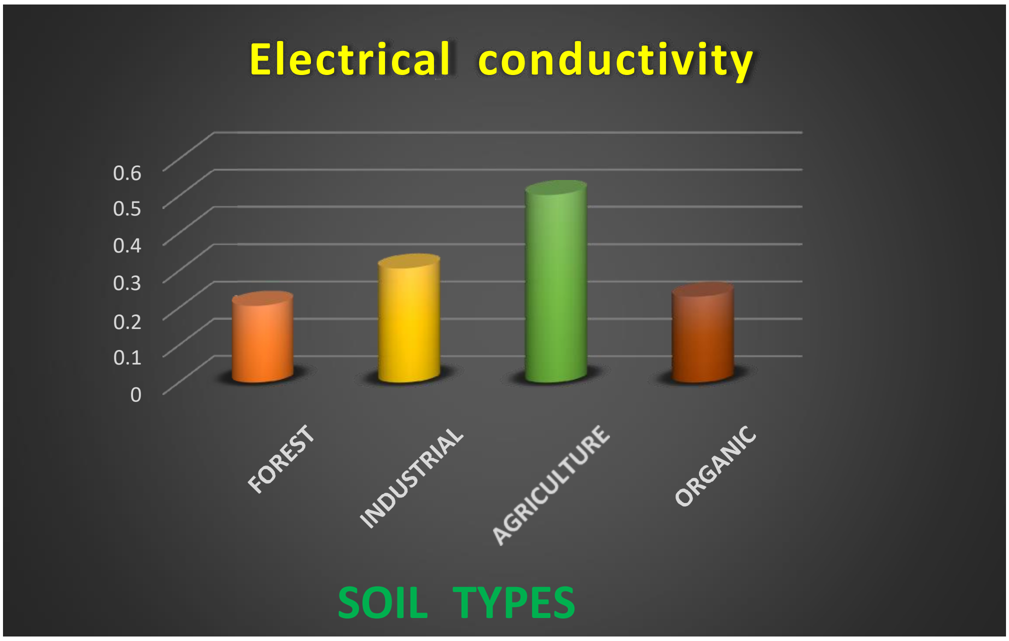
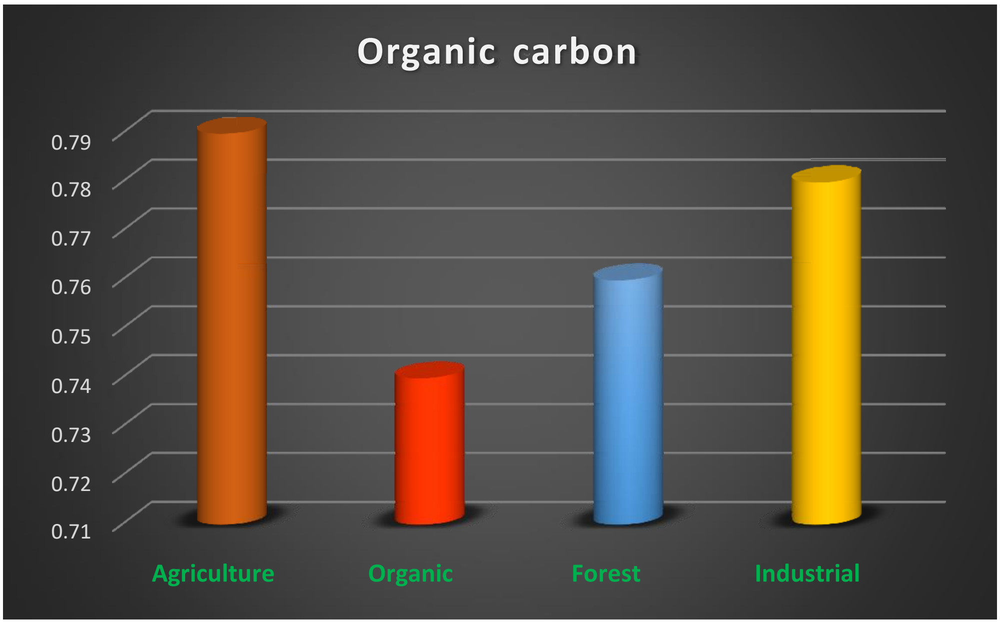


**Fig 3. Organic carbon content in different soils**




## Conclusion

According to the study, soil chemical features such as accessible phosphorus and nitrogen have a detrimental impact on industrial, agricultural, and forest systems, except organic farming soil systems, where phosphorus is the only factor affecting the soil. The soil system's high levels of accessible phosphorus, organic carbon (forest), and nitrogen suggest that it has a significant influence on nutrient build-up and accumulation by lowering losses from soil erosion and leaching brought on by high litter formation. Farmers can benefit from this study, which is the first from Jaipur outside regions. Adopting more environmentally friendly agricultural practices is necessary for sustainable output, and proper soil management techniques can assist in maintaining the health of the soil. To understand the microbial profiles in each of the four soil ecosystems and how they relate to soil management techniques, more research is necessary.

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