Soil Quality Assessment Based on Physicochemical Parameters in the Career Point University Kota Rajasthan

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ABSTRACT

The objective of this research was soil testing to ensure soil quality, soil health, and nutrient management in CARRER POINT UNIVERSITY CAMPUS ALNIYA KOTA. Here in this research article we are presenting preliminary studies of physicochemical properties of soil across the Career Point University campus, Kota in winter season. The chemical analysis of soil is based on a number of factors such as pH, electrical conductivity, organic carbon, macronutrient and micronutrients. Soil pH and Electric conductivity plays a significant role in regulating the availability of nutrients to plants. Organic carbon enhances soil structure, increases moisture retention, and supports beneficial microbial activity. Macronutrients were analyzed due to their vital roles in plant physiology. Micronutrient required in small quantities, these elements are essential for enzyme function, chlorophyll formation, and overall metabolic processes in plants.

Soil testing is only way to determine available nutrient status in campus soil and this research article provide detailed information about properties of soil across the Career Point University campus and find out any deficiency of minerals from the soil. The soil across Career Point University exhibits good fertility and is generally well-suited for both cultivation and ornamental landscaping.

Keywords

Physicochemical analysis, soil fertility, soil properties, pH, electrical conductivity (EC) macronutrient, micronutrients, Alaniya Kota Rajasthan.

INTRODUCTION

Soil is an important system of terrestrial ecosystem. Organic matter stimulates the microbial growth and increases the enzymatic activity in soil. The fertility of the soil in the natural ecosystem depends on the microbial processes such as mineralization of organic matter, sulfur (S), Potassium(K) and phosphorus(P) **(Joniec, 2018).**

The chemical properties of soil largely depend on the size of particles that soil is composed the properties are porosity, soil water, soil air and capillary. Acidity and alkalinity of the soil are more importance for growth and distribution of plants various kinds of bacteria and fungi are present in soil for maintaining fertility dark color substance that is humus is present in the soil. This is formed by decomposition of dead animals' plants and microorganism. It is more importance to plant, crops both chemically and physically. It increases soil fertility and provide nutrients for growth of plants and other microorganisms including nitrogen fixing bacteria which also increase the availability of minerals in dissolved state to the plants. It can retain high amount of water and also increases the aeration and percolation of water ***(Gupta et al.2018).***

Soil health deals with both inherent and dynamic soil quality. The inherent soil quality relates to the natural (genetic) characteristics of the soil (e.g., texture), which are the result of soil forming factors. On the other hand, dynamic soil quality component is readily affected by management practices and relates to the levels of compaction, biological functioning, root proliferation, etc. The dynamic component is of more interest to growers because good management allows the soil to come to its full potential ***(Lal, R., et al.2023)***. For example, in an agricultural field, the capacity of a soil to function at sustaining crop. Growth would depend on several soil characteristics including bulk density, soil moisture, infiltration, and biological activity, to name a few. Many of these properties can be changed by management (e.g., infiltration and organic matter content) and soil quality can be improved according to its function. There are several criteria to consider soil health and soil quality indicators In general appropriate indicators should be easy to access, able to measure changes in soil function both at plot and landscape scales, assessed in time to make management decisions, accessible to many farmers, sensitive to variations in agro-ecological zone, representative of physical, biological or chemical properties of soil and assessed by either qualitative or quantitative both approaches ***(Schoonover and Crim, 2015)***

Rajasthan is located on the north-western side of India. The state covers an area of 3, 42,239 square kilometers or 10.4 percent of the total geographical area of the country. Out of the total geographical area in the State, even 50 percent is not cultivable and within cultivable land, soil fertility varies considerably across districts. The wide differences in land productivity indicate the variation in soil health across districts in the State. The south east and eastern part of Aravali range is productive for agriculture purposes having clay loam soil type. Kota district is situated in the southeastern part of Rajasthan and comes under Agro climatic zone V. Kota is also known as education city of Rajasthan. It is the third largest city of Rajasthan after Jaipur and Jodhpur with an area of 5217 km2. The district has six Tehsils namely Ladpura, Digod, Pipalda, Ramganjmandi, Sangod & Kanwas. Out of which first three Tehsils comes under Chambal Command Area whereas last three Tehsils comes under noncommand area. Precipitation in Kota region happens amid the southwest monsoon and the upper east rainstorm season. The region gets higher precipitation from the southwest monsoon. The average annual rainfall of the district varies from 650 to 1000 mm. The total cultivated area of the district is 3.4 lac ha out of which 2.1 lac ha is irrigated. Though a big part of Rajasthan is in the form of desert, but because of Chambal River, Kota along-with its 3 adjoining districts, altogether known as Hadoti region, is a productive and bio diversifying

Study Area

Career Point University is located at 25.2068° N latitude and 75.8682° *E longitude in Kota, Rajasthan. This semi-arid region experiences a hot climate with an average annual rainfall of About 93% of the annual rainfall is received during the South West monsoon season. The average annual rainfall of the district varies from 650 to 1000 mm. The average minimum temperature was recorded 10.6°C in winters and maximum 42.6°C in summers. Soil sampling was done from total four locations, namely sport ground (site 1), open field area (site 2) Faculty Garden (site3) and Botanical Garden (site 4). The soil properties are influenced by the region's low water availability, high temperatures, and varying levels of organic matter content. Understanding the soil's physical and chemical properties is crucial for designing appropriate land management practices that can maximize the use of available water resources and ensure long-term soil fertility.The four sample locations within the campus were selected to represent a range of land uses:

Location 1 (Sports Ground): An open area used for recreational activities, typically well-maintained with minimal vegetation.

Location 2 (Open Field Area): A less developed, open area that is more exposed to natural weathering and erosion.

Location 3 (Faculty Garden): An area dedicated to small-scale farming and plant research.

Location 4 (Botanical Garden): A landscaped area that hosts a variety of plants, with significant organic matter input from horticultural activities.

METHODOLOGY

A total of 16 soil samples were collected from different site using soil auger, screw auger and khurpi at the depth of 0-15cm, 15-30 cm and 30-45 cm. in laboratory. The exact quantity of the soil sample was 100gm which was adequate for laboratory testing, with an emphasis on reliable outcomes. Soil samples were collected from each of the four locations at a depth of 5 to 30 cm, which is the most active layer for root growth. A composite sample was formed by collecting soil from multiple spots within each location to account for variability within the site.

The soil was homogenized before being sent to the laboratory for analysis. A total of four composite samples were collected for this study, one from each location. The chemical parameters include pH, Electrical conductivity, Organic Carbon, Macro-Nutrients (N, P, K, Ca, Mg, S) and Micronutrients (Fe, Cu, Zn, Mn). pH was estimated with the help of Digital pH meter after making 1:2 soil water suspension ***(Ghosh et al.,1983).***

Electrical Conductivity was estimated with the help of Digital Conductivity meter **(Richards, 1954)**. Percent Organic Carbon was estimated by Wet Oxidation Method **(Walkley and Black, 1934).** Available Nitrogen was estimated by Alkaline Potassium Permanganate method, using Kjeldahl apparatus **(Subbiah and Asija, 1956)**.Available Phosphorus was estimated by Olsen's extraction followed by Spectrophotometric method ***(Olsen et al., 1954)*** , available Potassium was estimated by Neutral normal Ammonium Acetate extraction followed by Flame photometric method **(Toth and Prince, 1949),** Exchangeable Ca2+ and Mg2+ were estimated by Normal Ammonium Acetate saturation method **(Cheng and Bray, 1951)**, available Sulphur was estimated by Turbidimetric method followed by Spectrophotometric analysis **(Chesnin and Yien, 1950)**. Available Fe, Cu, Zn and Mn were estimated by DTPA extraction followed by AAS analysis **(ChengandBray,1951)**

RESULTS AND DISCUSSION

Soil pH and Electrical Conductivity (EC): -Soil pH is a measure of alkalinity and acidity in soil. The pH value was found to be 7.8, which is slightly alkaline, suggesting that the soil is suitable for a wide range of crops but may need amendments for acid-loving plants. The EC value was 4.6388 ds/m, indicating that the soil has moderate salinity. This needs to be considered when irrigating, as excess salts may hinder plant growth. Soils with EC values less than 1 dS/m are considered non-saline, which is ideal for plant growth. Given that none of the locations exceeded 0.50 ds/m, the soils are unlikely to pose any salt stress problems for vegetation types cultivated at the university

Table: -1Assesment of chemical properties of soil from CARRER POINT UNIVERSITY KOTA

Site name	Soil pH	Electrical conductivity(ds/m)	Organic matter %
1A	8.0	0-17	0.32
1B	8.0	0-08	0.29
1C	7.9	0-13	0.27
1D	8.1	0-10	0.30
2A	8.0	0-13	0.30
2B	8.1	0-12	0.27
2C	8.2	0-12	0.24
2D	8.2	0.137	0.30
3A	8.0	0-14	0.33
3B	8.1	0-13	0.29
3C	8.1	0-15	0.30
3D	8.2	0.147	0.33
4A	7.9	0-10	0.36

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4B	7.8	0-10	0.33
4C	7.9	0-09	0.38
4D	7.8	0-11	0.35

For site 1a 1b 1c and 4c

Parameters	Mean	Standard deviation	Error
Soil Ph	**8.0**	**0.07**	**0.035**
Electrical conductivity	**0.12**	**0.034**	**0.017**
Organic Metter	**0.295**	**0.018**	**0.009**

For site 2a 2b 3c 4c

Parameters	Mean	Standard deviation	Error
Soil Ph	**8.125**	**0.0083**	**0.0415**
Electrical conductivity	**0.12675**	**0.0072**	**0.0036**
Organic Metter	**0.2775**	**0.0249**	**0.0124**

For site 3a 3b 3c 4c

Parameters	Mean	Standard deviation	Error
Soil Ph	**8.1**	**0.0707**	**0.0354**
Electrical conductivity	**0.141**	**0.0077**	**0.00385**
Organic Metter	**0.3125**	**0.0179**	**0.00895**

For site 4a 4b 4c and 4d

Parameters	Mean	Standard deviation	Error
Soil Ph	**7.85**	**0.05**	**0.025**
Electrical conductivity	**0.10**	**0.0071**	**0.0035**
Organic Metter	**0.355**	**0.0218**	**0.0109**

Macronutrient Status: -

Organic Carbon: -Organic carbon content was determined using the Walkley-Black method, which involves oxidation of organic matter and titration with a standard solution. Organic carbon is vital for maintaining soil structure, water retention, and nutrient cycling.

Organic carbon levels ranged from 0.24% to 0.38%, indicating moderate organic matter content. Organic carbon is vital for improving soil structure, water retention, and nutrient cycling. The Faculty Garden average (0.313%) could benefit from additional organic amendments to improve soil quality, while the Botanical Garden (0.355%) had the highest organic carbon content.

Potassium (K): - Potassium levels were measured using a flame photometer, mechanical shaker and pH meter detects the concentration of potassium in the soil solution. Potassium content varied from 158 to 242mg/kg. Potassium is essential for water regulation, enzyme activation, and stress tolerance in plants.

Potassium is a vital nutrient in agriculture that supports overall plant health and productivity. It enhances crop quality by improving fruit size, color, and taste, and helps extend shelf life. Potassium also strengthens plant resistance to diseases and pests by reinforcing cell walls. It plays a key role in regulating water movement within plants, improving drought tolerance.

Phosphorus (P): -Phosphorus plays a critical role in agriculture, primarily because it is an essential nutrient for plant growth. Phosphorus is a key component of ATP (adenosine triphosphate), which is the primary energy carrier in plants.

ATP is required for nearly all cellular processes, including growth, photosynthesis, and nutrient uptake. Phosphorus deficiency in plants can result in several growth issues, including stunted development, poor root formation, and yellowing of older leaves, particularly at the tips and edges.

Sulphur: -Sulfur is an essential element for plants, animals, and microorganisms, important roles in agriculture. Plants use sulfur to synthesize essential amino acids (like cysteine and methionine) and proteins, as well as vitamins (such as biotin and thiamine). Sulfur has natural fungicidal and pesticidal properties. It is often used in agricultural settings to control fungal diseases like powdery mildew and other plant pathogens.

Table: -2 Assessment of primary nutrients in soil of Career Point University kota

Site name	**Potassium (K)**	**phosphorus**	**Sulphur**
1A	181	43	42.6
1B	196	45	27.0
1C	205	32	26.25
1D	158	54	22.5
2A	202	44	22.0
2B	210	45	22.5
2C	214	22	24.75
2D	242	30	26.25
3A	201	35	37.65
3B	220	50	33.6
3C	194	22	34.2
3D	179	35	28.05
4A	196	34	34.5
4B	180	45	35.55
4C	223	50	36.3
4D	192	22	34.5

For site 1a 1b 1c and 4c

Parameters	Mean	Standard deviation	Error
Potassium	185	18.93	9.47
Phosphorus	43.5	8.77	4.39
Sulphur	29.34	8.55	4.28

For site 2a 2b 2c and 2d

Parameters	Mean	Standard deviation	Error
Potassium	204.5	8.99	4.50
Phosphorus	33.25	10.11	5.06
Sulphur	26.69	5.97	2.98

For site 3a 3b 3c and 3d

Parameters	Mean	Standard deviation	Error
Potassium	209.5	14.20	7.10
Phosphorus	39.25	13.50	6.75
Sulphur	35.44	1.88	0.94

For site 4a 4b 4c and 4d

Parameters	Mean	Standard deviation	Error
Potassium	197.45	18.15	9.08
Phosphorus	37.75	12.45	6.22
Sulphur	35.21	0.88	0.44

Micronutrients: -Micronutrients, though required in small amounts, are essential for healthy plant growth and development in agriculture. These nutrients include iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu), Each plays a specific role in plant physiological functions such as enzyme activation, photosynthesis, hormone regulation, and nutrient transport.

Zinc (Zn): - Zinc plays a critical role in enzyme activation, protein synthesis, and the regulation of growth processes. One of zinc's most important functions is its involvement in the formation of auxins, which are key plant hormones that control cell elongation and division, directly influencing plant structure and growth. Zinc deficiency is more common in high pH, sandy, or phosphorus-rich soils where zinc availability is limited.

Copper (Cu): -Copper is necessary for lignin synthesis. Lignin is important for strengthening cell walls, providing structural support, and increasing disease resistance. Copper is also crucial for reproductive development, contributing to pollen viability and seed formation.

Iron (Fe): - Iron plays a central role in the synthesis of chlorophyll. Iron is also vital for electron transport in both photosynthesis and respiration. Additionally, iron is important for nitrogen fixation, particularly in leguminous plants, where it supports the activity of nitrogenase enzymes in root nodules. Iron deficiency commonly appears as interveinal chlorosis, where young leaves turn yellow while the veins remain green.

Manganese (Mn): -Manganese is heavily involved in enzyme activation, particularly those related to photosynthesis, respiration, and nitrogen metabolism. One of manganese's key roles is in the oxygen-evolving complex of photosystem II, where it participates in water splitting and oxygen production during photosynthesis.

Table: -3 Assessment of micronutrient in soil from CARRER POINT UNIVERSITY CAMPUS KOTA

Site name	Zn Micronutrient	Fe Micronutrient	Cu Micronutrient	Mn Micronutrient
1A	0.50	4.34	0.40	2.80
1B	0.60	4.40	0.48	2.50
1C	0.62	4.48	0.20	2.60
1D	0.84	3.80	0.24	2.64
2A	0.38	3.84	0.38	2.80
2B	0.60	4.08	0.40	2.90
2C	0.74	4.10	0.48	3.80
2D	0.40	4.20	0.20	3.00
3A	0.50	4.30	0.24	3.44
3B	0.56	4.38	0.48	2.30
3C	0.44	4.80	0.38	2.50
3D	0.44	4.30	0.40	2.52
4A	0.38	4.38	0.48	2.34
4B	0.30	4.40	0.38	2.30
4C	0.34	4.48	0.40	2.34
4D	0.40	4.50	0.48	3.00

For site 1a 1b 1c and 4c

Parameters	Mean	Standard deviation	Standard Error
Zinc	0.64	0.14	0.07
Iron	4.26	0.31	0.15
Copper	0.33	0.13	0.07
Magnise	2.64	0.12	0.06

For site 2a 2b 2c and 2d

Parameters	Mean	Standard deviation	Standard Error
Zinc	0.53	0.17	0.09
Iron	4.06	0.15	0.08
Copper	0.37	0.11	0.06
Magnise	3.13	0.46	0.23

For site 3a 3b 3c and 3d

Parameters	Mean	Standard deviation	Standard Error
Zinc	0.49	0.06	0.03
Iron	4.45	0.24	0.12

Copper	0.38	0.08	0.04
Magnise	2.69	0.51	0.25

For site 4a 4b 4c and 4d

Parameters	Mean	Standard deviation	Standard Error
Zinc	0.36	0.04	0.02
Iron	4.44	0.06	0.03
Copper	0.44	0.05	0.03
Magnise	2.50	0.34	0.17

CONCLUSION

The physicochemical analysis of the soil samples from Career Point University, Kota, revealed that the soils generally have neutral to slightly alkaline pH, low salinity, moderate organic carbon levels, and adequate cation exchange capacity.

While nitrogen, phosphorus, and potassium levels are within reasonable ranges, the organic carbon content in some areas (such as the Faculty Garden) could be improved by adding organic amendments. Furthermore, the soil texture is favorable for plant growth, although improvements in organic content could enhance nutrient retention and water-holding capacity.

To optimize soil fertility and support sustainable campus landscaping, future management strategies could include the addition of organic compost, improved irrigation practices, and targeted fertilization based on specific nutrient needs of different vegetation types.

The soil testing results provide an important insight into the fertility status of the soil in Rajasthan. Based on the data, the soil is generally suitable for growing a wide variety of crops, but attention must be given to the moderate salinity and alkaline pH.

The recommendations from the laboratory suggest that farmers can grow most crops, but those cultivating sensitive crops like pulses or some vegetables might need additional soil amendments. Soil testing should be a routine practice for farmers in Rajasthan to optimize their crop yields and ensure sustainable farming practices.

Regular monitoring of soil health and the adoption of appropriate soil management techniques will help farmers increase productivity, reduce input costs, and contribute to the long-term health of the soil. The study of physicochemical parameters of soil is important to agriculture crops, plants growth and soil management in university campus.

Recommendations

To ensure optimal crop productivity and maintain soil health, several key recommendations should be followed. Due to the slightly alkaline soil pH, the application of sulfur or other acidifying agents is advised, particularly for crops sensitive to high pH levels, as this will improve nutrient availability. Given the moderate salinity indicated by the electrical conductivity (EC) value, careful irrigation management is essential.

Practices such as alternate wetting and drying or selecting saline-tolerant crop varieties can help minimize salt stress. Fertilization should include a balanced approach using both organic and inorganic fertilizers, tailored to the specific macro and micronutrient requirements of the crops being cultivated. This supports both short-term productivity and long-term soil fertility. Regular soil testing, ideally every one to two years, is strongly recommended to track changes in pH, salinity, and nutrient levels. This enables timely adjustments to fertilization and irrigation strategies, promoting sustainable and efficient agricultural practices over time.

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