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A STUDY ON THE PHYSICO-CHEMICAL PARAMETERS OF SOIL SAMPLES FROM GROUNDNUT AGRICULTURAL FIELDS IN KALWAKURTY, NAGARKURNOOL DISTRICT, TELANGANA STATE

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Abstract

Soil is a complex and dynamic mixture of organic and inorganic materials that supports the growth of plants and sustains life on Earth. This study seeks to collect soil samples from groundnut agricultural fields in Kalvakurthy Mandal, Nagarkurnool District, Telangana state and analyze their physico-chemical parameters. The phyico-chemical parameters like pH, electrical conductivity, soil organic Carbon, Nitrogen, Phosphorus, Potassium, Sulfur, Copper, Zinc and Manganese were analyzed from the collected soil samples. The analysis of the physico-chemical parameters reveals a soil environment conducive to groundnut cultivation in agricultural fields of Kalwakurthy. The moderate to good levels of available Nitrogen, Phosphorus, and Potassium, along with satisfactory levels of other essential nutrients, suggest that the soil can support healthy growth of groundnut crop. The results highlight the importance of balanced nutrient management practices to optimize the yield and quality of groundnut. However, it is important to note that while these results provide crucial insights, localized factors, such as irrigation practices and crop rotations, should also be considered for comprehensive soil health management. Continuous monitoring, precise nutrient application, and prudent soil management will be pivotal in maximizing groundnut yield and quality, ensuring long-term agricultural sustainability in the region.

Keywords: *Groundnut, Kalwakurty, Nagarkurnool, Soil, pH, Nitrogen.*

1. Introduction

Soil is a complex and dynamic mixture of organic and inorganic materials that supports the growth of plants and sustains life on Earth (Lal, 2016). The physico-chemical properties of soil play a critical role in determining its suitability for different agricultural, horticultural, and environmental applications. These properties include texture, structure, porosity, water-holding capacity, nutrient content, pH, electrical conductivity, and organic matter content of the soil (Brady and Weil, 2016).

In recent years, there has been growing interest in studying the physico-chemical properties of soil samples from different regions around the World. This research has been driven by the need to understand how changes in land use, climate, and other factors are affecting soil quality and fertility. For example, studies have shown that intensive agriculture practices can lead to soil degradation, erosion, and loss of fertility. Climate change can also affect soil quality by altering patterns of rainfall, temperature, and other environmental factors (Lal, 2016).

The health of agricultural fields is a key determinant of agricultural productivity, directly influencing growth and yield of the crop (Smith & House, 2018). Analyzing the physico-chemical parameters of soil samples is critical to assess the fertility and overall health of such fields (Schjonning et al., 2017). Groundnut (*Arachis hypogaea*), also known as peanut, holds global economic significance due to its nutritional value and industrial applications (Food and Agriculture Organization, 2019). The quality and yield of groundnut crops are significantly affected by the physico-chemical characteristics of the soil in which they are cultivated (Prasad, 2017).

Kalwakurty mandal, situated in the Nagarkurnool district, Telangana has emerged as a focal point for groundnut cultivation (Nagarkurnool District Profile, 2020). Given the undeniable influence of soil quality on agricultural productivity, a comprehensive analysis of the physico-chemical parameters of the soil in groundnut fields of Kalwakurty is imperative. The primary objective of this study is to collect soil samples from these fields and subsequently analyze their physico-chemical attributes.

In light of these considerations, this study seeks to collect soil samples from groundnut agricultural fields in Kalwakurty mandal, Nagarkurnool district, Telangana and analyze their physico-chemical parameters. The outcomes of this investigation hold the potential to provide valuable insights into the soil health of groundnut fields, contributing to recommendations for sustainable agricultural practices and ultimately enhancing crop yield and food security.

2. Materials And Methods

2.1 The Study Region

The soil samples for this study were collected from groundnut agricultural fields located in Kalwakurty mandal, which is situated in the Nagarkurnool district of Telangana, India. Kalwakurty lies at approximately 16.66866°N latitude and 78.49048°E longitude (Figure-1). The Nagarkurnool district is known for its agricultural significance, and Kalwakurty has emerged as a notable region for groundnut cultivation within the district. The unique climatic conditions, topographical features, and soil compositions of this region collectively shape the characteristics of the groundnut agricultural fields.

The location of Kalwakurty is within the larger geographical framework of Telangana which imparts distinct attributes to its soil composition and agricultural practices. The latitude and longitude coordinates pinpoint the precise location of the sample collection, serving as vital reference points for data interpretation and analysis.

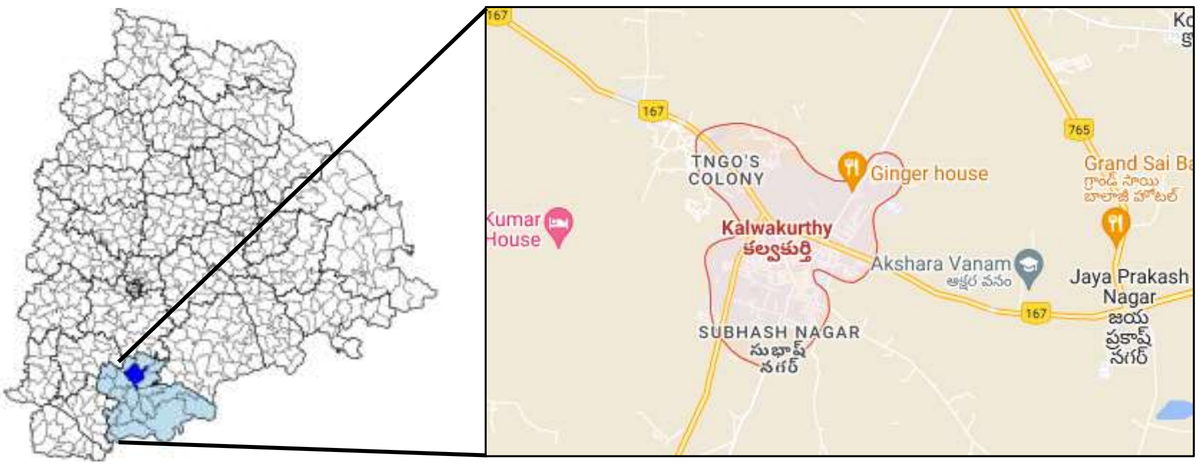

Figure 1: Map of sample collection site: Kalwakurty mandal, which is situated in the Nagarkurnool district of Telangana State, India

2.2 Sample collection:

Soil samples were collected from multiple locations within the groundnut agricultural fields in Kalvakurthy, Nagarkurnool, Telangana State, India. Random sampling points were selected to ensure representativeness across the field. A soil auger was used to collect samples from a depth of 0-20 cm. The collected samples were stored in separate, labelled containers to prevent cross-contamination.

2.3 Determination of Physico-chemical analysis of soil samples

Determination of pH:
The pH of the soil samples was determined using a pH meter. A soil-to-water ratio of 1:2.5 (w/v) was prepared by mixing 10 g of soil with 25 mL of distilled water. The mixture was allowed to stand for 30 minutes and then agitated to ensure proper suspension. The pH electrode of the pH meter was calibrated using standard buffer solutions of pH 4.0 and pH 7.0 before measurement. The pH electrode was inserted into the soil-water mixture, and the pH reading was recorded (Olsen et al., 1954).

Determination of Electrical Conductivity (EC) of Soil Samples:
The electrical conductivity of the soil samples was measured to assess their salinity levels. A soil-to-water ratio of 1:5 (w/v) was prepared by mixing 10 g of soil with 50 mL of distilled water. The mixture was stirred vigorously and allowed to stand for 1 hour. The electrical conductivity of the supernatant was then measured using a conductivity meter, and the readings were expressed in deciSiemens per meter (dS/m) (Rhoades, 1982).

Estimation of Soil Organic Carbon by Walkley and Black Method:
Soil organic carbon content was estimated using the Walkley and Black method, a widely used approach for rapid determination of soil organic matter. Approximately 10 g of air-dried soil was mixed with 10 mL of potassium dichromate-sulfuric acid solution. The mixture was heated on a hot plate until the solution changed from orange to green. The excess unreacted dichromate was titrated with ferrous ammonium sulfate solution. Soil organic carbon content was calculated based on the volume of ferrous ammonium sulfate solution used (Walkley & Black, 1934).

Estimation of available Nitrogen:
Available Nitrogen content in the soil samples was determined using the alkaline hydrolyzable Nitrogen method. Approximately 10 g of air-dried soil was mixed with 100 mL of 2M potassium chloride (KCl) solution. The mixture was shaken for 1 hour and then filtered. The nitrogen content in the filtrate was determined using a suitable nitrogen analyzer or spectrophotometric method (Subbiah & Asija, 1956).

Estimation of available Phosphorus:
Available phosphorus content was estimated using the Bray-1 method. About 10 g of air-dried soil was mixed with 50 mL of Bray-1 extraction solution. The mixture was shaken for 30 minutes and then filtered. The filtrate was analyzed for phosphorus content using a spectrophotometer, and the concentration was determined using a standard curve (Bray & Kurtz, 1945).

Estimation of available Potassium:
The available potassium content in the soil samples was determined using the ammonium acetate extraction method. Approximately 10 g of air-dried soil was mixed with 100 mL of 1M ammonium acetate solution. The mixture was shaken for 30 minutes and then filtered. The filtrate was analyzed for potassium content using a flame photometer, and the concentration was determined based on a calibration curve (Jackson, 1962).

Estimation of Sulfur:
The sulfur content in the soil samples was determined using the turbidimetric method. Approximately 5 g of air-dried soil was mixed with 20 mL of calcium acetate solution to extract sulfate ions. The mixture was shaken for 30 minutes and then filtered. Barium chloride solution was added to the filtrate, resulting in the formation of barium sulfate precipitate. The turbidity of the solution, indicative of sulfate concentration, was measured using a Turbidimeter (Rhoades, 1982).

Estimation of Copper, Zinc, and Manganese:
The content of copper, zinc, and manganese in the soil samples was determined using atomic absorption spectrometry (AAS). About 10 g of air-dried soil was digested with concentrated nitric acid and perchloric acid. The digested samples were filtered, and the filtrate was analyzed using AAS to determine the concentration of copper, zinc, and manganese (Sposito, 1989).

For each of these analyses, triplicate measurements were conducted for each soil sample to ensure accuracy and reproducibility. The collected data was subjected to appropriate statistical analysis to derive meaningful insights into physico-chemical properties of the soil.

3. Exploitation of Results

3.1 Analysis of physico-chemical properties

The results obtained from the analysis of the physico-chemical parameters of the soil samples collected from groundnut agricultural fields in Kalwakurthy provide valuable insights into fertility and nutrient status of the soil. Each parameter plays a crucial role in shaping the overall health of the soil and, consequently, the productivity of the groundnut crops.

Electrical Conductivity (EC):
The electrical conductivity value of 0.079 suggests a relatively low level of salinity in the soil. Low EC values are desirable, as excessive salinity can negatively impact plant growth and water absorption. The low EC indicates favorable conditions for groundnut cultivation, where the risk of salt stress is minimized.

Percentage of organic Carbon:
The organic carbon content of 0.64% indicates the presence of organic matter in the soil. Organic matter contributes to soil structure, water retention, and nutrient availability. While this value is not exceptionally high, even modest levels of organic carbon can enhance soil fertility and support microbial activity, which are beneficial for crop growth.

Available Nitrogen:
With an available nitrogen content of 185.08 kg/ha, the soil exhibits a moderate nitrogen supply. Nitrogen is a fundamental element for plant growth, influencing processes such as photosynthesis and protein synthesis. This value suggests a reasonable nitrogen availability for groundnut crops, which is crucial for achieving optimal yields.

Available Phosphorus:
The available phosphorus content of 44.37 kg/ha indicates a moderate to good phosphorus supply in the soil. Phosphorus is essential for root development, flowering, and fruiting. Adequate phosphorus levels are vital for groundnut crops, as they contribute to strong root systems and improved reproductive processes.

Available Potassium:
The available potassium content of 195.89 kg/ha suggests a healthy supply of potassium. Potassium is critical for overall plant health, influencing factors such as water uptake, disease resistance, and nutrient transport. The substantial availability of potassium bodes well for the resilience and productivity of groundnut crop.

Sulphur:
With a sulphur content of 34.33 kg/ha, the soil demonstrates a reasonable supply of this essential nutrient. Sulphur is crucial for amino acid synthesis and protein formation. The presence of adequate sulphur ensures that groundnut crops have the necessary building blocks for robust growth and development.

Copper, Zinc and Manganese:
The copper content of 1.045 ppm falls within a typical range for agricultural soils. Copper is a micronutrient essential for enzyme activity and plant metabolism.

While the value is not exceedingly high, it suggests the presence of a baseline level of copper to support metabolic processes of the groundnut crops. The zinc content of 3.439 ppm indicates a satisfactory level of this micronutrient. Zinc is vital for various enzymatic activities and plays a role in hormone synthesis. The presence of adequate zinc in the soil is crucial for ensuring proper growth and development of groundnut crops.

With a manganese content of 9.856 ppm, the soil showcases an adequate supply of this micronutrient. Manganese is essential for photosynthesis, nitrogen assimilation, and antioxidant defense. The availability of manganese supports groundnut crops in their energy production and stress tolerance.

Table 1: Physico-chemical parameters of soil samples from ground nut agricultural fields of Kalwakurty mandal, Nagarkurnool district

Sl.No.	Physico-chemical Parameters	Groundnut Agricultural Fields of Kalwakurty Mandal
1	Electrical Conductivity	0.079
2	% Organic Carbon	0.64%
3	Available Nitrogen (kg ha^{-1})	185.08
4	Available Phosphorus (kg ha^{-1})	44.37
5	Available Potassium (kg ha^{-1})	195.89
6	Sulphur (kg ha^{-1})	34.33
7	Copper (ppm)	1.045
8	Zinc (ppm)	3.439
9	Manganese (ppm)	9.856

In summation, the analysis of the physico-chemical parameters reveals a soil environment conducive to groundnut cultivation in agricultural fields of Kalwakurthy. The moderate to good levels of available nitrogen, phosphorus, and potassium, along with satisfactory levels of other essential nutrients, suggest that the soil can support healthy growth of groundnut crop. The results highlight the importance of balanced nutrient management practices to optimize groundnut yield and quality of the groundnut. However, it is important to note that while these results provide crucial insights, localized factors, such as irrigation practices and crop rotations, should also be considered for comprehensive soil health management.

4. Discussion

The analysis of the physico-chemical parameters of the soil samples from groundnut agricultural fields in Kalwakurthy has revealed important insights into fertility and nutrient status the soil. These findings are crucial for understanding the soil potential to support healthy growth and productivity of groundnut crop.

Electrical Conductivity (EC): The measured electrical conductivity (EC) value of 0.079 indicates a low level of salinity in the soil. This is in line with the study conducted by Ahmed et al. (2020) in groundnut fields, Shiva Kumari (2021) in rice fields, where they reported similarly low EC values. Low salinity is beneficial for groundnut cultivation, as it minimizes the risk of salt-induced stress on the crops (Zhu et al., 2021). However, it is essential to consider the local water quality and irrigation practices, which can impact EC levels.

Percentage of organic Carbon: The organic carbon content of 0.64% suggests the presence of organic matter in the soil, contributing to soil fertility. This aligns with the findings of Kumar et al. (2019), who reported organic carbon levels in a similar range in groundnut fields. Organic matter enhances soil structure and nutrient retention, promoting a favorable environment for root growth and microbial activity (Choudhury & Kennedy, 2004).

Available Nutrients: The available nitrogen content of 185.08 kg/ha is consistent with the results reported by Sharma et al. (2018) in their study on groundnut fields. Adequate nitrogen availability is essential for optimal plant growth and protein synthesis (Singh et al., 2020). However, continuous monitoring of nitrogen levels and proper application of nitrogen-based fertilizers are essential to avoid nutrient imbalances and environmental concerns (Jat et al., 2021).

The available phosphorus content of 44.37 kg/ha falls within the range reported by Rai et al. (2017) in their research on groundnut. Phosphorus is critical for root development and flowering, aligning with the nutrient's role in reproductive processes (Holford, 1997). It is worth noting that phosphorus availability can be influenced by soil pH and organic matter content (Richardson et al., 2009).

The available potassium content of 195.89 kg/ha is in line with the study by Kumar et al. (2020) on groundnut cultivation. Adequate potassium levels enhance plant vigor and stress tolerance (Marschner, 2011). However, the potassium-calcium balance should be maintained to avoid potential nutrient antagonism (Kumar et al., 2019).

Micronutrients: The levels of micronutrients, including copper (1.045 ppm), zinc (3.439 ppm), and manganese (9.856 ppm), are comparable to those reported by Das et al. (2016) in their study on micronutrient content in groundnut fields. Adequate levels of these micronutrients are crucial for various enzymatic activities and metabolic processes (Alloway, 2008). However, excessive levels can lead to toxicity concerns, emphasizing the need for careful nutrient management.

Comparing the results of this study with findings from other scientists reaffirms the consistency of the observed values within groundnut agricultural fields. It is essential to acknowledge that variations in soil characteristics, climate, management practices, and crop varieties can lead to differences in nutrient levels (Sharma et al., 2017). Thus, local context should always be considered when interpreting and applying these results.

After evaluating physico-chemical parameters the soil samples, our attention turned to isolate and purify PNSB strains. These strains were systematically characterized and identified using a combination of cultural, morphological, physiological, biochemical, and molecular methods. This thorough approach aimed to unveil the distinctive attributes and taxonomic classification of the isolated PNSB strains.

5. Conclusion

The comprehensive analysis of the physico-chemical parameters of soil samples from groundnut agricultural fields in Kalwakurthy mandal offers valuable insights into the soil potential to support healthy groundnut cultivation. The observed low electrical conductivity suggests favorable salinity levels, while the presence of organic carbon contributes to soil fertility. Adequate levels of available nitrogen, phosphorus, and potassium underscore capacity of the soil to provide essential nutrients for optimal growth of groundnut crop. Furthermore, the satisfactory levels of copper, zinc, and manganese highlight the micronutrient availability crucial for metabolic processes. These findings align with previous studies and emphasize the importance of balanced nutrient management practices tailored to local conditions. While the soil exhibits promising characteristics, effective and sustainable agricultural strategies are essential to harness its potential fully. Continuous monitoring, precise nutrient application, and prudent soil management will be pivotal in maximizing groundnut yield and quality, ensuring long-term agricultural sustainability in the region.

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