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Effect of Organic Fertilizers on Soil Fertility and Peanut Yields

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ABSTRACT

To support environmentally sound agricultural practices, this study assessed the effectiveness of a single type of organic fertilizer applied at different dosage levels in optimizing the yield of groundnut (*Arachis hypogaea* L.). The methodology involved a Completely Randomized Design (CRD) field trial structured around four treatments: a control and three compost dosage levels, each executed in triplicate. Key performance indicators included plant morphological traits (height and number of pods) and harvest parameters (fresh pod weight and yield per hectare). Data analysis confirmed that all organic fertilizer applications led to statistically significant increases in groundnut growth and yield when compared to the untreated control. The highest dosage treatment (30 tons/ha) produced the most favorable outcome, with a fresh pod yield of 615 g/m². These improvements are attributed to the compost's ability to enhance soil physical, chemical, and biological properties. This research supports the use of organic fertilizer as a sustainable strategy to improve groundnut productivity while maintaining environmental quality.

Keywords: groundnut; organic fertilizer; yield; plant growth; sustainable agriculture

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1. Introduction

Sustainable agriculture has become an increasingly important and globally adopted paradigm in modern farming. This approach aims to meet the continuously growing global demand for food while protecting environmental quality and conserving natural resources. Within this framework, effective soil fertility

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management is one of the most critical elements. Fertile soil plays a fundamental role in increasing agricultural productivity, as it serves as the primary source of essential nutrients that support optimal plant growth. Among various strategies to improve soil fertility, the application of organic fertilizers is widely recognized as both an effective and environmentally friendly method. Derived from natural sources such as compost, animal manure, and crop residues, organic fertilizers have been proven to improve soil quality in physical, chemical, and biological aspects [2].

Organic fertilizers are increasingly used as a key alternative in sustainable agricultural systems due to their important role in improving soil health and crop productivity. These fertilizers, which consist of natural materials such as animal waste, compost, and other organic matter, provide dual benefits: they supply essential nutrients for plant growth and simultaneously enhance soil physical, chemical, and biological properties. The adoption of organic fertilizers also has strong potential to reduce dependence on synthetic chemical fertilizers, which are often associated with long-term soil degradation and environmental pollution [1].

Healthy and fertile soil has the capacity to optimally supply nutrients for plant growth, which directly supports higher productivity. Organic inputs contribute to this condition by improving soil structure and increasing the activity of beneficial soil microorganisms that play a key role in nutrient cycling. Increased soil organic matter content leads to higher cation exchange capacity (CEC), improved soil aeration, and more stable soil pH, all of which are essential factors in supporting sustainable agricultural production [3].

Peanut (*Arachis hypogaea L.*) is an important agricultural commodity with high economic value and significant nutritional content, particularly as a source of vegetable protein. Therefore, increasing peanut productivity remains a major concern in efforts to meet growing food demand. One effective approach to improving peanut yield is through the enhancement of soil fertility using organic fertilizers. Several previous studies have reported that organic fertilizer application can significantly increase peanut yield, both in terms of pod number and seed weight. However, the effect of organic fertilizers on soil fertility and peanut yield is not uniform and can be influenced by several factors, including the type and dosage of fertilizer as well as soil characteristics. Based on this background, this study aims to analyze the effect of

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different organic fertilizer dosages on soil fertility and peanut yield, as well as to determine the correlation between soil fertility parameters and peanut production.

2. Materials and Method

Research Design and Approach

This investigation employed a field experimental design utilizing a quantitative methodology to rigorously assess the impact of organic fertilizer application on both soil fertility parameters and peanut yields. The experiment was structured based on a Completely Randomized Design (CRD). It incorporated four distinct treatment levels, each replicated three times, resulting in a total of 12 individual experimental units or plots.

Site and Duration

The field work was conducted within a lowland agricultural area characterized by a silty clay loam soil texture and determined to have moderate initial fertility. The entire study spanned one complete growing season, covering approximately 90 days from the initial planting date up to the final harvest.

Treatment Application

The experimental treatments consisted of varying application rates (doses) of a single organic fertilizer type, defined as follows:

Table 1. Organic Fertilizer Application Rates Used in the Experiment

Treatment Code	Description	Dosage Rate
P0	Control group (no fertilizer application)	0 tons/ha
P1	Low dose application	10 tons/ha
P2	Medium dose application	20 tons/ha
P3	High dose application	30 tons/ha

The organic fertilizer utilized in this research was a compost derived from a mixture of plant residues and well-decomposed livestock manure. This material was

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applied uniformly across the respective plots and thoroughly incorporated into the soil structure one week prior to the actual sowing of the peanut seeds.

Observed Parameters (Measured before and after treatment):

Soil Fertility Parameters

- Soil Organic Matter (SOM, %)
- Total Nitrogen (N-total, %)
- Available Phosphorus (P-available, ppm)
- Exchangeable Potassium (K-available, me/100g)

Plant Growth and Yield Parameters:

- Plant height (cm)
- Number of pods per plant
- Yield per square meter (g/m^2)

Data Analysis

The collected data were subjected to both descriptive and inferential statistical analysis. Analysis of Variance (ANOVA) was initially performed to determine whether the applied treatments had a statistically significant effect on the measured variables. Where significant differences were identified (i.e., the null hypothesis was rejected), Duncan's Multiple Range Test (DMRT) was subsequently employed for post-hoc mean comparison at a 5% level of significance (α=0.05). Furthermore, Pearson correlation analysis was carried out to quantify the strength and direction of the linear relationship between key soil fertility parameters and the resulting peanut yield.

3. Result

Initial Soil Characteristics

The initial laboratory analysis revealed that the experimental site soil is classified as a Latosol with a near-neutral pH (6.7). The nutrient status was generally poor: the soil exhibited a low organic matter content (1.2%), and total nitrogen and available phosphorus levels were measured at 0.08% and 15 ppm, respectively. Furthermore, the available potassium content was determined to be 0.15 me/100g. Collectively, these baseline characteristics suggest that the soil possessed a moderate-to-low

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fertility level, indicating a significant potential for improvement through appropriate organic fertilizer application.

Table 1. Initial Soil Characteristics Before Treatment

Parameter	Unit	Value	Soil Fertility
Soil pH (H_2O)	-	6.7	Neutral
Organic Matter Content	%	1.2	Low
Total Nitrogen (N)	%	0.08	Low
Available Phosphours (P)	ppm	15	Medium
Available Potassium (K)	Me/100g	0.15	Low

Effect of Organic Fertilizer on Soil Fertility

The application of organic fertilizer across the different dosage treatments resulted in a significant positive increase in several key soil fertility parameters upon post-treatment analysis. The following table details the changes in soil chemical properties after the treatment period:

Table 2. Effect of Organic Fertilizer on Soil Fertility Parameters

Treatment	Organic Matter (%)	Total N (%)	Available P (ppm)	Available K (me/100g)
Control (P0)	1.2	0.08	15	0.15
P1 (Low Dose)	1.7	0.10	19	0.19
P2 (Medium Dose)	2.1	0.13	24	0.23
P3 (High Dose)	2.5	0.15	27	0.28

The data clearly illustrate a correlation: higher doses of organic fertilizer consistently led to greater enhancements in the content of organic matter, total nitrogen (N-total), available phosphorus (P-available), and available potassium (K-available) in the soil. Specifically, the substantial rise in organic matter content, from 1.2% in the control (P0) to 2.5% in the high dose (P3), underscores the vital role of the organic amendment in ameliorating soil chemical conditions. This positive change

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directly translated into higher availability of essential macronutrients (N, P, and K) critical for plant sustenance.

Effect of Organic Fertilizer on Peanut Growth and Yield

Observations concerning plant development confirmed that the organic fertilizer treatments exerted a **positive influence** on plant height, the number of productive branches, and the final yield components, notably the number of pods per plant. The response of peanut growth and yield to the treatments is presented below:

Table 3. Effect of Organic Fertilizer on Growth and Yield of Groundnut

Treatment	Plant Height (cm)	Pods per Plant	Fresh Yield per m² (g)
Control (P0)	32.1	18	320
P1	37.8	24	445
P2	41.0	29	530
P3	45.3	34	615

The table demonstrates that plant height, the number of pods per plant, and the final yield per square meter increased consistently as the dosage of organic fertilizer was elevated. The P3 treatment (High Dose) yielded the highest results, averaging 45.3 cm in height and a yield of 615 g/m², which represents a considerable improvement compared to the control treatment (P0) figures of 32.1 cm in height and 320 g/m² in yield. This performance differential indicates that applying organic fertilizer not only rehabilitates soil fertility but also significantly contributes to boosting the productivity of the peanut crop.

Correlations between Soil Fertility and Yields

Correlation analysis showed a strong positive relationship between soil organic matter content and groundnut yield ($r = 0.87$).

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Table 4. Correlation between Soil Fertility and Crop Yield

Parameter	Correlation Coefficient (r)
Organic Matter Content vs. yield	0.87
Total Nitrogen (N) vs. yield	0.82
Available Phosphorus (P) vs. yield	0.79
Available Potassium (K) vs. yield	0.75

Table 4 shows the correlation coefficients (r) between selected soil fertility parameters and groundnut yield. The highest correlation was observed between organic matter content and crop yield (r = 0.87), indicating that increased organic matter significantly enhances productivity. This was followed by total nitrogen (r = 0.82), available phosphorus (r = 0.79), and available potassium (r = 0.75), all of which exhibited strong positive relationships with yield performance

4. Discussion

The results of this study confirm the important role of organic fertilizer in improving soil fertility and enhancing peanut crop performance. The progressive increase in organic matter content and essential nutrients, including total nitrogen, available phosphorus, and available potassium, indicates that organic fertilizer effectively improves soil chemical quality. The increase in total nitrogen from the initial level of **0.08%** in the control to higher values at increased fertilizer doses reflects improved nutrient availability for plant growth.

The observed improvements in plant height, number of pods per plant, and fresh yield further demonstrate that organic fertilizer not only serves as a nutrient source but also enhances soil physical and biological conditions that favor root development and nutrient uptake. These findings are consistent with previous studies [5], who reported that organic inputs improve soil structure, microbial activity, and nutrient-use efficiency, thereby supporting better crop performance.

The strong positive correlations between soil fertility parameters and peanut yield further emphasize the central role of soil organic matter and nutrient balance in determining crop productivity. The highest correlation observed between organic matter content and yield (r = 0.87) indicates that soil organic matter plays a dominant role in regulating nutrient availability and supporting plant growth. This relationship

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confirms that management practices aimed at increasing soil organic matter can significantly enhance agricultural productivity.

These findings are in agreement with previous findings [3], who demonstrated that organic matter addition improves nutrient availability through slow and continuous nutrient release. The consistency between the present study and previous findings strengthens the conclusion that organic fertilizer represents a sustainable and effective alternative to synthetic fertilizers for improving soil fertility and peanut yield.

5. Conclusions

The results of this study clearly demonstrate that the application of organic fertilizer significantly enhances soil fertility and peanut crop performance. Increases in soil organic matter, nitrogen, phosphorus, and potassium levels indicate improved soil quality and nutrient availability, which in turn contribute to better plant growth—reflected in higher plant height, greater number of pods, and increased yield. The highest dosage (30 tons/ha) consistently produced the most favorable outcomes, underscoring the importance of sufficient organic nutrient supply.

Strong positive correlations between soil fertility indicators and crop yield further emphasize the crucial role of soil organic matter and nutrient balance in supporting agricultural productivity. These findings confirm that organic fertilizer is an effective and sustainable strategy for improving soil fertility, boosting peanut yield, and maintaining long-term soil health. Practically, the study suggests that farmers can adopt organic fertilizer as a viable alternative to chemical fertilizers to enhance peanut production while promoting environmental sustainability.

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