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Comparing poultry manure and cow dung on *Arachis hypogaea* growth in savanna environment

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Abstract. *Mahmud AA, Abdulrahman MD. 2025. Comparing poultry manure and cow dung on* Arachis hypogaea *growth in Savanna environment. Nusantara Bioscience 17: 21-29.* The study investigated the effects of poultry manure and cow dung on the growth of *Arachis hypogaea* L. (groundnut) in a controlled experimental setup at the botanical garden of Department of Plant Science and Biotechnology, Federal University Dutsin-Ma, Katsina State, Nigeria. The experiment followed a Completely Randomized Block Design (CRBD) with two organic fertilizer as treatments; poultry manure cow dung, and a control sample with no fertilizer. Two groundnut seeds varieties; pure red and light tan mixed each separately with cow dung, and poultry manure, and were subjected to viability test before planting. Growth parameters, including the number of leaves and plant height, were measured monthly for five months. The data obtained were analyzed using SPSS statistical software version 21, and significant differences were identified with Duncan's multiple range tests at a 5% probability level. Results indicated a significant impact of organic fertilizers on the growth parameters. The results revealed that cow dung promotes early growth while poultry manure contributes more to reproductive success and yield. The control group showed significantly lower leaf development, with an average of (43.4) leaves. The findings highlight the role of organic fertilizers in enhancing plant leaf production, as they provide essential nutrients that are often deficient in untreated soils. In terms of plant height, the light tan variety treated with cow dung achieved the greatest average height (16.53 cm), surpassing both the control (15.4 cm) and the pure red variety treated with poultry manure (13.45 cm). Overall, the study emphasizes the importance of using organic fertilizers like poultry manure and cow dung to improve groundnut growth, reduce dependence on synthetic fertilizers, and enhance soil health. These organic amendments are beneficial for sustainable agricultural practices, contributing to improved crop yield and environmental sustainability.

Keywords: *Arachis hypogaea*, cow dung, groundnut growth, organic fertilizer, poultry manure

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), also known as peanut, is a vital legume crop grown widely across tropical and subtropical regions due to its nutritional and economic value. It serves as a key source of protein, oil, and income for many farmers, particularly in Sub-Saharan Africa, where it is cultivated on small and large scales (Ramatsetse et al. 2023). Groundnut plays a significant role in improving soil fertility through nitrogen fixation, making it an essential crop in various agricultural systems. However, its productivity is often hindered by inadequate soil nutrients, particularly in regions where synthetic fertilizers are either unaffordable or unavailable to smallholder farmers. As a result, there has been increasing interest in the use of organic fertilizers as a sustainable alternative to synthetic inputs (Ramatsetse et al. 2023). Organic fertilizers, such as poultry manure and cow dung, have been widely recognized for their ability to enhance soil fertility, improve plant growth, and contribute to sustainable agricultural practices (Ke et al. 2024). These organic amendments contain essential nutrients, including nitrogen, phosphorus, and potassium, which are vital for plant development. Additionally, they improve soil structure, water retention, and microbial activity, all of which contribute to healthier plant growth (Leopold 2022). The use of organic fertilizers can also reduce reliance on chemical fertilizers, which are known to degrade soil quality and pose environmental risks when overused. In this context, understanding the effects of different organic fertilizers on crop performance is crucial for promoting sustainable farming practices, especially for crops like groundnut that are widely cultivated.

Numerous studies have highlighted the benefits of organic fertilizers in enhancing crop productivity, these studies include that of (Bergstrand 2022; Govindasamy et al. 2023; Sathiparan et al. 2023). Cow dung, for instance, has been found to significantly increase plant growth due to its high nutrient content and rapid nutrient release (Shalaby et al. 2022). It improves soil organic matter, boosts microbial activity, and provides a steady supply of nutrients, making it particularly effective for enhancing leaf production and overall plant vigor. Similarly, cow poultry, though slower in nutrient release compared to poultry manure, improves soil texture and water-holding capacity, and contributes to long-term soil fertility. These benefits make both poultry manure and cow dung valuable inputs for groundnut cultivation, where improved growth metrics such as leaf number and plant height are critical indicators of productivity (Ho et al. 2022). Despite the documented benefits of organic fertilizers, their effects can vary depending on several factors, including the type of fertilizer, crop variety, and local environmental conditions (Gao et al. 2023). Different groundnut varieties may respond differently to specific fertilizers due to variations in their nutrient requirements and growth habits (Abebe et al. 2022). Therefore, it is important to investigate the comparative effects of organic fertilizers on different groundnut varieties to determine the most effective fertilization strategy for maximizing growth and yield.

This study aimed to evaluate the effects of two organic fertilizers; poultry manure and cow dung mixed each separately with two varieties of groundnut seeds (pure red and light tan), focusing on evaluating key growth parameters such as the number of leaves and plant height. The experiment was carried out in Completely Randomized Block Design (CRBD) at the botanical garden of the Department of Plant Science and Biotechnology, Faculty of Life Science, Federal University Dutsin-Ma, Katsina State, Nigeria. The two groundnut seeds varieties were subjected to viability tests before planting, and growth parameters were measured monthly for five months. Data obtained were analyzed using SPSS statistical software version 21, and significant differences between the treatments were identified using Duncan's multiple range tests at a 5% probability level. By comparing the effects of poultry manure and cow dung on different groundnut varieties, this study provides valuable insights into the role of organic fertilizers in promoting groundnut growth. Understanding these effects is essential for smallholder farmers seeking sustainable alternatives to synthetic fertilizers, as organic inputs offer both economic and environmental benefits. The findings of this research are expected to contribute to the broader knowledge of organic fertilization strategies for groundnut cultivation and offer practical recommendations for farmers to improve crop yield through sustainable agricultural practices.

MATERIALS AND METHODS

Study area

The study was conducted within five-month period at the botanical garden of the Department of Plant Science and Biotechnology, Federal University Dutsin-Ma, Katsina State. Dutsin-Ma is situated at a longitude of 7°11'14.86" East of the Greenwich Meridian and a latitude of 7°28'51.39" North. Katsina State lies within the derived Savanna Zone. In Dutsin-Ma, the growth of groundnut (*A. hypogaea*) is influenced by several environmental factors such as; temperature, rainfall and soil texture. Groundnuts thrive in warm temperatures, with an ideal range between 25-30°C. Dutsin-Ma's climate typically supports groundnut growth, as it experiences warm temperatures for much of the year. High temperatures, however, can stress the plant, especially if they exceed 35°C consistently. In terms of rainfall, groundnuts require moderate rainfall, with an optimal range of 500-700 mm during the growing season. Dutsin-Ma has a semi-arid climate with a rainy season between May and September, which provides a suitable amount of water for groundnut cultivation.

However, irregular rainfall patterns and prolonged dry spells can impact yields, making supplementary irrigation beneficial. Whereas in terms of soil texture, groundnuts grow best in well-drained sandy or sandy-loam soils. Dutsin-Ma has predominantly sandy to loamy soil, which is suitable for groundnut cultivation as it facilitates good root development and easy penetration for pods to develop underground. Proper soil management is essential to ensure adequate nutrient availability, particularly for nitrogen and phosphorus (Mahmud et al. 2023). These conditions collectively support groundnut growth in Dutsin-Ma (Mahmud et al. 2023), but careful management practices are necessary to optimize yields and address any limitations in climate or soil quality.

Procedures

Sample collection

Two dry groundnut seeds varieties were purchased from Dutsin-Ma market and transported to the laboratory of the Department of Biological Sciences for analysis. The organic fertilizers (cow dung and poultry manure) were sourced from the animal farm of the Faculty of Agriculture, Federal University Dutsin-Ma, Katsina State, Nigeria.

Experimental design

The experiment was carried out in Completely Randomized Block Design (CRBD) (Figure 1). A polythene bag filled with two organic fertilizer treatments separately (manure and cow dung) and a control sample were randomly placed on the fertilized plots. The control sample received no manure treatment (Figure 2). The two groundnut seeds varieties: pure red and light tan were mixed separately with both poultry manure and cow dung and the control variety was randomly planted in polythene bags (Azad et al. 2022). The experiment was conducted in triplicate.

Viability test

For the viability test, the seeds that floated were discarded, while the viable ones were used for planting (Pradhan et al. 2022).

Seeds planting

The viable groundnut seeds were sown separately in each polythene bag containing soil mixed with either poultry manure, cow dung, or only soil (without fertilizer which served as control) (Chowdary et al. 2022).

Measurement of growth parameters

Growth parameters, including the number of leaves per plant and plant height, were recorded throughout the planting trial (Paradiso and Proietti 2022).

Numbers of leaves

The number of leaves for each replicate was counted weekly, and the average leaf count was recorded from each organic fertilizer treatment and groundnut variety (Sapre et al. 2022).

Data analysis

The collected data were analyzed using One-Way Analysis of Variance (ANOVA), and significant differences were identified through Duncan's Multiple Range Test (DMRT) at a 5% significance level. The data analysis was performed using the SPSS statistical software, version 21.

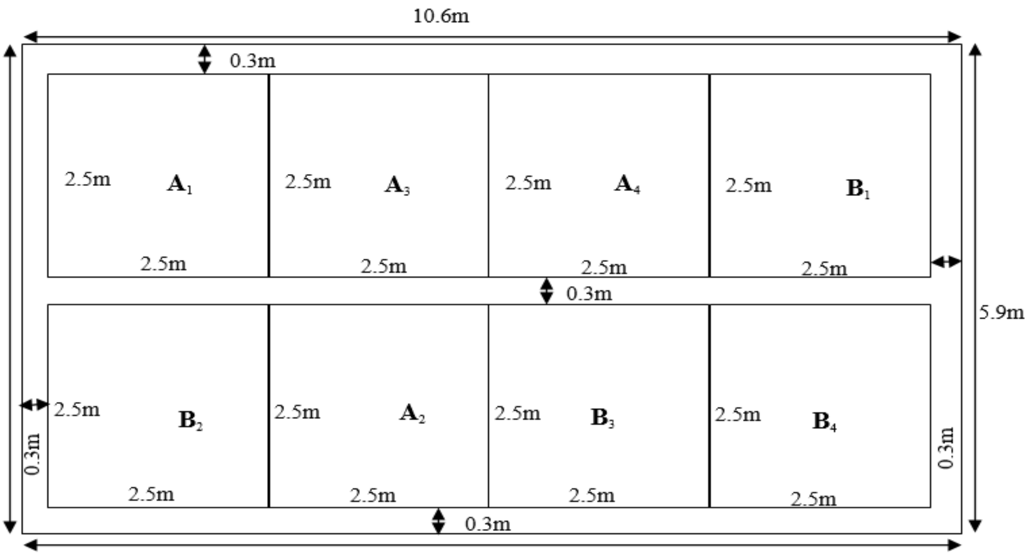

Figure 1. Complete randomized block design illustrating the plot configuration in Dutsin-Ma, Katsina State, Nigeria

Figure 2. Groundnut seeds treated with cow dung and poultry manure

RESULTS AND DISCUSSION

Yield analysis was conducted to assess flowering and pod development. Table 1 summarizes the flowering time and pod development across various treatments. Poultry manure-treated plants exhibited the earliest flowering and highest pod count, with a significant difference ($p < 0.05$) compared to cow dung-treated and control plants.

The yield analysis revealed significant differences among the treatments. Poultry manure-treated plants exhibited the highest yield (2,800 kg/ha), significantly outperforming cow dung-treated plants (2,200 kg/ha) and the control group (1,400 kg/ha). The gradual nutrient release from poultry manure likely contributed to its superior performance during the reproductive phase, resulting in more pods and higher pod weight. In contrast, cow dung provided a rapid nutrient boost, which favored early vegetative growth but was less effective in sustaining yield. These results are consistent with previous studies, such as those by Ho et al. (2022) and Shalaby et al. (2022), which demonstrated the benefits of organic fertilizers in enhancing crop productivity. The findings emphasize the importance of choosing fertilizers that match the crop's nutrient requirements at different growth stages. The yield analysis indicated that poultry manure provided a significant advantage in pod number and weight compared to cow dung and control. The gradual nutrient release of poultry manure likely contributed to these long-term benefits. In contrast, cow dung facilitated rapid vegetative growth, which may explain its early advantages in plant height and leaf production.

On the other hand, following the procedure of Ho et al. (2022), a post-harvest soil analysis revealed significant improvements in soil quality in plots treated with organic fertilizers compared to the control. Poultry manure-treated soils showed the highest levels of organic matter (3.0%), nitrogen (0.18%), phosphorus (20 ppm), and potassium (150 ppm). These improvements reflect the gradual nutrient release and superior nutrient density of poultry manure. Cow dung-treated soils also exhibited notable enhancements, particularly in organic matter (2.5%) and potassium (120 ppm), though to a lesser extent than poultry manure. Control plots, lacking any fertilizer, had the lowest nutrient levels, underscoring the necessity of organic amendments for soil fertility in the savanna environment (Table 2).

In contrast, the control plots exhibited poor soil quality, with low organic matter and nutrient levels. This reinforces the need for organic fertilizers to maintain soil fertility and achieve sustainable agricultural production in nutrient-depleted soils common in the savanna region. The study underscores the need to select fertilizers based on crop growth stages. Cow dung is more effective during the vegetative phase, providing immediate nutrient availability. However, poultry manure excels in sustaining growth and yield, as supported by previous studies (Ho et al. 2022; Shalaby et al. 2022).

Table 1. Yield analysis values

Treatment	Time to first flowering (days)	Number of pods	Yield (kg/ha)
Cow dung	42	20	2,800
Poultry manure	38	25	2,200
Control	50	12	1,400

Table 2. Soil analysis values

Parameter	Control	Cow dung	Poultry manure
Organic matter (%)	1.2	2.5	3.0
Nitrogen content (%)	0.05	0.12	0.18
Phosphorus (ppm)	8	20	20
Potassium (ppm)	70	150	150
Soil pH	6.2	6.8	6.8

Table 3. Number of leaves per groundnut samples

Sample	1st Month	2nd Month	3rd Month	4th Month	5th Month	Total mean
Pac	18.75 ± 1^{d}	30.25 ± 1^{c}	35 ± 1^{c}	42.00 ± 1^{b}	53.5 ± 1^{a}	35.9 ± 1^{ba}
Pap	18.0 ± 1^{d}	24.75 ± 1^{c}	29.75 ± 1^{c}	33.75 ± 1^{b}	55.75 ± 1^{a}	32.0 ± 4^{b}
Lac	18.5 ± 1^{d}	26.25 ± 1^{c}	32.25 ± 1^{c}	34.25 ± 1^{b}	48.00 ± 1^{a}	31.0 ± 85^{c}
Lap	15.0 ± 1^{d}	23.75 ± 1^{c}	28.0 ± 1^{c}	33.00 ± 1^{b}	49.00 ± 1^{a}	29.0 ± 75^{d}
Control	12.0 ± 1^{d}	21.00 ± 1^{b}	27.6 ± 1^{b}	31.4 ± 1^{a}	43.40 ± 1^{a}	$27.\pm085^{e}$

Note: Data presented as a mean variable ± standard error of the mean; PAC: pure red + cow dung, Pap: pure Red + Poultry droppings, Lac: Light tan + Cow dung; Lap: Light tan + Poultry droppings

From Table 3, a detailed progression of leaf development in *A. hypogaea* (groundnut) samples treated with poultry manure, cow dung, and a control (sample with no fertilizer) over a five-month period. The data provides insights into how different organic fertilizers impact plant growth, revealing patterns of early development and sustained growth benefits. Two groundnut seeds varieties were used for planting; pure red and light tan. These two varieties were mixed each with cow dung and poultry droppings individually as follows; pure red groundnut treated with cow dung (Pac), pure red groundnut treated with poultry droppings (Pap), light tan groundnut treated with cow dung (Lac), light tan groundnut treated with poultry droppings (Lap), and finally, an untreated control variety.

In the first 1st month, the pure red variety treated with cow dung (Pac) shows the highest number of leaves (18.75), followed closely by light tan treated with cow dung (Lac) with 18.5 leaves. These two groups outperformed both the poultry manure-treated groups and the control group, which had the lowest leaf count (12 leaves). This early dominance of cow dung-treated plants suggests that cow dung may release essential nutrients more rapidly, providing an initial growth boost. Conversely, the poultry manure-treated groups (Pap and Lap) lag behind with 18 and 15 leaves, respectively, indicating a slower release of nutrients from this fertilizer in the early growth stage. The control group, unsurprisingly, shows the slowest growth, with only 12 leaves, emphasizing the impact of organic amendments in enhancing early leaf development.

In the 2nd month, all samples show notable growth, but the pattern from 1st month persists. Pac continues to lead with 30.25 leaves, while Lac follows with 26.25 leaves. The poultry droppings-treated samples, Pap and Lap, maintain a slower growth trajectory, with 24.75 and 23.75 leaves, respectively. The control group shows moderate progress, with 21 leaves.

This phase of growth suggests that cow dung-treated plants maintain their early advantage, likely due to its faster nutrient release and better soil amendment properties. Poultry manure, however, remains behind in the initial phases of growth, highlighting its slower, more gradual nutrient availability. The control group, while progressing, continues to be significantly less vigorous, reinforcing the value of organic fertilizers in promoting leaf production. This is in line with the study of Oritsejafor et al. (2022).

By the 3rd month, there is a more distinct divergence in growth patterns. Cow dung-treated plants, Pac (35 leaves) and Lac (32.25 leaves), continue to show superior growth. The poultry manure-treated plants, Pap (29.75 leaves) and Lap (28 leaves), display gradual but consistent improvement, closing the gap with the cow dung-treated samples. The control group, although growing, lags behind with 27.6 leaves. This stage demonstrates the sustained effect of cow dung in maintaining higher growth rates, whereas poultry manure starts to exert its influence, especially in Pap, which shows gradual improvement. The steady growth of the control sample reflects the slower progress in nutrient-deficient soil, underscoring the critical importance of fertilizers in ensuring optimal growth conditions (Bashir et al. 2022).

4th month marks an interesting shift where the gap between cow dung-treated and poultry manure-treated plants begins to narrow. Pap, previously behind Pac, now shows a significant leap with 33.75 leaves compared to Pac's 42 leaves. Similarly, Lap catches up with Lac (33 versus 34.25 leaves). This indicates that the poultry manure, while slower to release nutrients initially, begins to provide sustained growth benefits in the later stages of development. Cow dung continues to support steady growth, but its early advantage diminishes as poultry manure-treated plants gain momentum. The control group shows continued growth (31.4 leaves), but remains behind the fertilized plants, reinforcing the consistent trend of underperformance in untreated soil. This findings disagrees with Janani and Jebakumar (2023) where they reported an opposite case.

Through the 5th month, the poultry manure-treated plants (Pap and Lap) demonstrate strong growth, with Pap reaching the highest number of leaves (55.75), surpassing even the Pac sample (53.5). This is as indicated by Okpanachi et al. (2022) that poultry manure, despite a slower start, ultimately supports more robust leaf production than cow dung. Lap also outperforms its cow dung-treated counterpart (49 leaves versus 48 leaves), confirming the long-term benefits of poultry manure in enhancing leaf production. The control group, which received no organic treatment, ends with 43.4 leaves, significantly lower than the fertilized plants. This outcome underscores the critical importance of organic fertilizers in maximizing leaf growth and overall plant vigor.

The total mean leaf count reflects the cumulative growth trends over the five-month period. Pac, treated with cow dung, leads with a mean of 35.9 leaves, followed by Pap (32.4 leaves), Lac (31.85 leaves), and Lap (29.75 leaves). The control group has the lowest total mean of 27.08 leaves, highlighting its consistent underperformance throughout the study. This data suggests that cow dung promotes faster early-stage growth, making it an effective organic amendment for plants that require a quick start. However, poultry manure, while slower in the initial stages, provides more sustained benefits, leading to superior leaf production in the long term. This makes poultry manure a better option for crops that require gradual nutrient availability over time.

The observed trends show clear differences in the effects of cow dung and poultry manure on the growth of groundnut leaves. Cow dung appears to have a faster nutrient release rate, leading to more immediate growth benefits in the first few months. This rapid response could be beneficial for crops that need a strong initial boost. However, as the development progresses, poultry manure-treated plants begin to outperform cow dung-treated plants, particularly in terms of leaf count, suggesting that poultry manure might offer more sustained and consistent nutrient availability. The control group's consistently lower performance throughout the study reinforces the necessity of organic fertilizers for maximizing crop growth. Untreated soils, as shown by the control group's slower growth, are less capable of supporting robust plant development, particularly in terms of leaf production, which is a key indicator of overall plant health.

We deduced from the above data that, both cow dung and poultry manure positively influence leaf development in groundnut plants, but their effects vary over time. Cow dung is more effective in promoting early growth, while poultry manure leads to greater long-term benefits, particularly in terms of leaf production. This data highlights the need for farmers to consider not only the type of fertilizer but also the growth stage of the plant when selecting organic amendments for optimal results. It is paramount to note that, while cow dung-treated plants led in leaf count, poultry manure have supported other metrics such as pod yield and overall plant health

Table 4 captures the growth patterns of various plant samples across five weeks, represented by the height measurements (in centimeters) of each sample group; Pac, Pap, Lac, Lap, and a Control group. As we examined this data month by month, we recorded a clear progression in growth as well as significant differences between the samples in terms of their overall performance.

In the 1st month, all samples demonstrate relatively low growth, which is expected as plants are in the early stages of establishment. The heights are close to each other across the samples: Pac (4.32 cm) shows the highest initial height, indicating early vigor, while Pap (4.08 cm) and Control (3.48 cm) follow closely behind.

Lac (3.38 cm) and Lap (3.25 cm) display the lowest heights, suggesting these samples may be slower to establish their root systems or have faced some form of early stress. This initial stage is critical because it lays the foundation for how well the plants can absorb nutrients and grow in the subsequent months (Bigatton et al. 2024). By the 2nd month, there is a noticeable increase in height for all samples, signaling the onset of accelerated growth. Pap (7.8 cm) exhibits the most significant growth spurt, jumping from 4.08 cm to 7.8 cm, reflecting favorable conditions or better nutrient uptake during this stage. Lac (6.1 cm) and Lap (6.1 cm) also show significant improvements, nearly doubling their heights, while Pac (4.93 cm) shows more moderate growth. Interestingly, Control (4.02 cm) grows the least in the 2nd month, hinting at possible constraints, such as nutrient limitation or less favorable conditions compared to the treated samples. This stage is crucial because it highlights the different growth potentials, with Pap emerging as the frontrunner, showing the highest growth increment. In the 3rd month, growth remains steady across all samples, although the rates vary between them. Pac (5.2 cm), Pap (9.5 cm), Lac (8.23 cm), and Lap (9.13 cm) continue to grow, but Pap remains ahead in terms of overall height. This consistent performance suggests it has more favorable growing conditions or genetic advantages. This consistence performance of pap was also reported by Abdelghany et al. (2022) in their study. Control (8.96 cm), on the other hand, experiences a sudden growth burst, surpassing Pac and nearly matching Lap. This could indicate delayed but robust growth once the plant has overcome any initial constraints. The comparative performance of Pac lags slightly behind, which might suggest that, although it had an early lead in the 1st month, its growth is now plateauing compared to other samples. This month showcases a leveling-off for some samples while others, particularly Pap and Control, are catching up or surpassing the initially strong performers.

Table 4. Plant height per groundnut samples

Sample (cm)	1st	2nd	3rd	4th	5th	Mean
Pac	4.32±0.4[d]	4.93±0.4[c]	5.2±0.4[b]	8.5±0.4[b]	13.65±0.4[a]	7.0±32[a]
Pap	4.08±0.4[d]	7.8±0.4[c]	9.5±0.4[b]	9.75±0.4[b]	13.45±0.4[a]	8.0±92[b]
Lac	3.38±0.4[d]	6.1±0.4[c]	8.23±0.4[b]	10.17±0.4[b]	16.53±0.4[a]	8.0±89[c]
Lap	3.25±0.4[d]	6.1±0.4[c]	9.13±0.4[b]	10.88±0.4[b]	14.6±0.4[a]	8.0±79[d]
Control	3.48± 0.4[d]	4.02± 0.4[c]	8.96±0.4[b]	13.04±0.4[b]	15.24±0.4[a]	8.0±95[e]

The 4th month introduces even more substantial growth for most samples. Lac (10.17 cm), Lap (10.88 cm), and Control (13.04 cm) show significant growth, with Control now taking the lead at 13.04 cm. Pap (9.75 cm) continues to perform well but doesn't match the dramatic growth observed in Control or Lap. Pac (8.5 cm) remains somewhat behind, suggesting that it may be reaching its growth capacity earlier than the others, or environmental factors may be hindering its development (Zhao et al. 2023). This month is pivotal because it illustrates how growth rates can vary, with some samples experiencing delayed but powerful spurts (as seen in control sample) while others, like Pac, may begin to slow down. By the 5th month, the plants appear to be reaching their peak growth or maturity, with clear differentiation between the samples in terms of final height: Lac (16.53 cm) shows the most substantial final height, reflecting sustained growth throughout the experiment. This indicates that Lac has benefited from optimal conditions, resulting in its peak performance. Control (15.24 cm) and Lap (14.6 cm) also exhibit strong final growth, closely following Lac, which shows that despite some variability in earlier months, these samples caught up and finished strong. Pap (13.45 cm), although it started off strong in earlier months, finishes at a lower height than Lac, Lap, and Control, which suggests that its growth rate slowed towards the end. Pac (13.65 cm), although initially a strong performer, finishes in the lower range, consistent with its slower growth from the 3rd month onward.

When we examine the total mean values, the differences in long-term growth performance become clearer: Pac (7.32 cm) has the lowest total mean despite its early lead in the 1st month, indicating that it did not maintain consistent growth over time. This could be due to nutrient depletion, water stress, or other environmental factors that hampered its long-term development. Pap (8.92 cm) and Lac (8.89 cm) are close in mean height, but Pap takes a slight lead. This suggests that Pap benefited from stronger early growth, but Lac caught up due to its stronger performance in the later months. Lap (8.79 cm) and Control (8.95 cm), while both showing delayed growth in the first two months, achieved higher means in the later months, with Control surpassing even Pac and Lap in the final analysis. When connecting the dots across the months, the growth trends indicate that initial height does not always guarantee the best long-term performance (Kumar et al. 2022). For example, Pac started off with the highest 1st month height but had the lowest total mean. On the other hand, Control, which had the lowest in the 1st month height, ended up with one of the highest final heights. Lac, Lap, and Pap showed more consistent growth over the period, with Lac particularly standing out due to its significant late-stage growth that pushed its final height and mean above most of the other samples. The Control sample's growth trajectory suggests that it may have faced some initial limitations but, once those were overcome, grew robustly in the later months, culminating in a strong final height. Later growth, such as delayed nutrient uptake from inherent soil reserves has reduced competition compared to fertilized plots. While the control group showed some recovery, it did not match the overall performance of fertilized plants in yield or total leaf count.

The data suggests that while some samples (such as Pac) may have a strong initial start, their long-term performance can be outpaced by samples that exhibit more consistent and sustainable growth (such as Lac and Control). This highlights the importance of environmental factors, treatment consistency, and possibly genetic resilience in determining final plant height. The interplay of early vigor and sustained growth is key in determining overall plant performance, with later-stage growth often playing a decisive role in final outcomes. This is as implied by Zang et al. (2023) and Kamendra et al. (2023) on their studies.

Data presented as a mean variable ± standard error of the mean

Tables 5 and 6 present statistical analyses of changes in plant height and leaf count across five months period using pairwise comparisons, with significant mean differences observed in both variables as time progresses. In Table 5, plant height consistently increases, with significant changes noted across monthly intervals, especially between 1st and 5th months, where the mean height difference reaches (10.776) units. Similarly, Table 6 shows an upward trend in the number of leaves, with 5th month demonstrating a substantial increase from 1st month, reaching a mean difference of (29.194) leaves. Both tables indicate statistically significant differences ($p < 0.5$) for most month-to-month comparisons, especially between non-consecutive months, suggesting substantial growth over time. Additionally, confidence intervals support these differences, highlighting the consistent growth pattern and reliability of the findings across intervals in both plant height and leaf count.

Table 5. Dependent variable versus plant height

	(J) Time interval	Mean difference (I-J)	Std. error	Sig.[d]	95% Confidence interval for difference[d]	
					Lower bound	Upper bound
Month 1	Week 2	-1.745[*,b,c]	.872	.050	-3.488	-.002
		-3.235[*,b,c]	.872	.000	-4.978	-1.492
	(I) Time interval	-4.640[*,b,c]	.872	.000	-6.383	-2.897
	Month 5	-10.776[*,b,c]	.822	.000	-12.421	-9.131
Month 2	Month 1	1.745[*,b,c]	.872	.050	.002	3.488
	Month 3	-1.490[b,c]	.872	.093	-3.233	.253
	Month 4	-2.895[*,b,c]	.872	.002	-4.638	-1.152
	Month 5	-9.031[*,b,c]	.822	.000	-10.676	-7.386
Month 3	Month 1	3.235[*,b,c]	.872	.000	1.492	4.978
	Month 2	1.490[b,c]	.872	.093	-.253	3.233
	Month 4	-1.405[b,c]	.872	.112	-3.148	.338
	Month 5	-7.541[*,b,c]	.822	.000	-9.186	-5.896
Month 4	Month 1	4.640[*,b,c]	.872	.000	2.897	6.383
	Month 2	2.895[*,b,c]	.872	.002	1.152	4.638
	Month 3	1.405[b,c]	.872	.112	-.338	3.148
	Month 5	-6.136[*,b,c]	.822	.000	-7.781	-4.491
Month 5	Month 1	10.776[*,b,c]	.822	.000	9.131	12.421
	Month 2	9.031[*,b,c]	.822	.000	7.386	10.676
	Month 3	7.541[*,b,c]	.822	.000	5.896	9.186
	Month 4	6.136[*,b,c]	.822	.000	4.491	7.781

Note: *: The mean difference is significant at the .05 level; b: An estimate of the modified population marginal mean (I); c: An estimate of the modified population marginal mean (J)

Table 6. Dependent variable versus number of leaves per plant

(I) Time interval	(J) Time interval	Mean difference (I-J)	Std. error	Sig.[d]	95% Confidence interval for difference[d]	
					Lower bound	Upper bound
Month 1	Month 2	-4.280[a,b]	2.150	.051	-8.581	.021
	Month 3	-7.775[a,b,*]	2.150	.001	-12.076	-3.474
	Month 4	-12.205[a,b,*]	2.150	.000	-16.506	-7.904
	Month 5	-29.194[a,b,*]	2.029	.000	-33.252	-25.135
Month 2	Month 1	4.280[a,b]	2.150	.051	-.021	8.581
	Month 3	-3.495[a,b]	2.150	.109	-7.796	.806
	Month 4	-7.925[a,b,*]	2.150	.000	-12.226	-3.624
	Month 5	-24.914[a,b,*]	2.029	.000	-28.972	-20.855
Month 3	Month 1	7.775[a,b,*]	2.150	.001	3.474	12.076
	Month 2	3.495[a,b]	2.150	.109	-.806	7.796
	Month 4	-4.430[a,b,*]	2.150	.044	-8.731	-.129
	Month 5	-21.419[a,b,*]	2.029	.000	-25.477	-17.360
Month 4	Month 1	12.205[a,b,*]	2.150	.000	7.904	16.506
	Month 2	7.925[a,b,*]	2.150	.000	3.624	12.226
	Month 3	4.430[a,b,*]	2.150	.044	.129	8.731
	Month 5	-16.989[a,b,*]	2.029	.000	-21.047	-12.930
Month 5	Month 1	29.194[a,b,*]	2.029	.000	25.135	33.252
	Month 2	24.914[a,b,*]	2.029	.000	20.855	28.972
	Month 3	21.419[a,b,*]	2.029	.000	17.360	25.477
	Month 4	16.989[a,b,*]	2.029	.000	12.930	21.047

Note: *: The mean difference is significant at the .05 level. b: An estimate of the modified population marginal mean (I). b: An estimate of the modified population marginal mean (J). d: Adjustment for multiple comparisons: Least significant difference (equivalent to no adjustments)

To conclude, the analysis of the growth patterns of the different groundnut samples over five months period reveals important insights into the effects of treatments on plant height. Based on what we observed, it was evident that while initial growth rates varied among the samples, their long-term performance was influenced by both early vigor and sustained growth. Lac emerged as the most resilient sample, showcasing substantial growth, particularly in the later weeks, which contributed to its highest final height and mean. This indicates its potential as a favorable option for cultivation where robust growth is desired. Control demonstrated the ability to overcome early limitations, achieving impressive growth in the later months. This suggests that under certain conditions, even plants that initially lag can exhibit strong recovery and growth potential. Pap and Lap displayed strong performances but experienced some variability in growth rates. While they performed well initially, their inability to maintain momentum in the later weeks highlights the need for monitoring growth conditions closely. Conversely, Pac, despite having a strong initial growth phase, concluded with the lowest total mean height. This indicates that early advantages do not guarantee long-term success and that consistent growth and resilience to stressors are crucial.

Furthermore, the study demonstrates that poultry manure and cow dung have distinct but complementary roles in enhancing groundnut growth and yield. While cow dung accelerates early growth, poultry manure provides sustained benefits, particularly for yield and soil health. Future studies should explore integrating these fertilizers over multiple growing cycles and assess their economic feasibility for smallholder farmers. Therefore, based on the results, it is recommended to prioritize Lac and Control varieties for future cultivation of groundnut due to their robust growth patterns and ability to adapt to changing conditions. These samples demonstrated not only initial growth but also sustained development over time. Farmers should implement regular monitoring of growth conditions to identify any stressors that may impede growth, especially for varieties like Pac and Pap, which showed variability in their growth rates. Adjustments in nutrient supply, water management, and pest control can significantly enhance performance. Given the importance of consistent growth, soil health and nutrient availability should be prioritized. Conducting soil tests and amending the soil based on specific nutrient deficiencies can lead to improved plant health and productivity. Following the completion of the growth period, further analysis of the plants physiological responses and root development would be beneficial. Understanding these factors can provide insights into how different samples respond to environmental stressors and can guide future planting strategies. Future studies should consider extending the growth period beyond five months to assess the long-term viability and yield potential of the different samples. Additional trials can provide more comprehensive data on growth patterns and the overall resilience of these varieties under varying environmental conditions. Encourage sustainable agricultural practices that promote plant health and reduce the need for chemical inputs. Integrating cover cropping, organic amendments, and integrated pest management can enhance the overall growth performance of these samples in the long term. It is our belief that, by following these recommendations, growers can optimize their cultivation strategies, leading to improved plant health and better yields in future growing seasons.

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