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Effect of manure and compound npk fertilizer application on the growth and yield of peanuts (*Arachis hypogaea* L.) In Siwalubanua II Village Gunungsitoli Idanoi District

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ABSTRACT

Peanuts (*Arachis hypogaea* L.) are a nutritious and economically valuable food crop; however, their productivity in Indonesia, including the Nias Islands, remains low, necessitating proper soil fertility management and the provision of appropriate nutrients. This study aimed to determine the effects of pig manure and compound NPK fertilizer, as well as their interaction, on the growth and yield of peanuts in Siwalubanua II Village, Gunungsitoli Idanoi District. The study employed a factorial randomized block design (RBD) with two factors: pig manure treatments K0 (no fertilizer), K1 (3 kg/plot), K2 (4 kg/plot), and K3 (5 kg/plot), as well as NPK 16:16:16: N0 (no fertilizer), N1 (22 g/m²/application), and N2 (32 g/m²/application), with three replicates. The observed parameters included plant height, number of branches, flowering age, number of pods per sample, fresh weight of pods per sample, and fresh weight of pods per plot. The data were analyzed using ANOVA and the BNJ test at the 5% level. The results showed that pig manure and NPK 16:16:16 produced different responses for each parameter. K3 (5 kg/plot) yielded the highest values for plant height at 2–3 MST, number of branches at 2 and 5 MST, earlier flowering, and fresh pod weight per sample. K2 (4 kg/plot) produced the highest plant height at 4–5 MST, the highest number of branches at 3–4 MST, the highest number of pods per sample, and the highest fresh pod weight per plot. N2 (32 g/m²) produced the highest numerical values for most parameters. The interaction between the two factors did not have a significant effect in some early observations but began to have a significant to highly significant effect in subsequent observations and on several yield components. The K3N2 combination produced the highest numerical values for several parameters but was not always significantly different from other treatment combinations based on the 5% BNJ test.

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1. INTRODUCTION

Peanuts (*Arachis hypogaea* L.) are an important food commodity with high economic value and nutritional content, particularly protein and fat, resulting in steadily rising demand in line with

population growth and the needs of the food industry. However, this increasing demand has not been matched by optimal productivity. Domestic peanut production remains insufficient to meet national needs, leaving Indonesia dependent on imports. This situation indicates that increasing peanut productivity remains a key challenge in the development of this commodity. Low productivity at the farmer level is linked, among other factors, to the suboptimal application of cultivation technologies, poor land management, and inadequate provision of plant nutrients to meet crop requirements (Qibtiyah *et al.,* 2021 ; *et al.,*2023) .

One of the key factors determining the growth and yield of peanuts is soil fertility and the availability of nutrients. Improper fertilization and the continuous use of chemical fertilizers without balancing them with organic matter can degrade soil quality and disrupt the balance of the soil's physical, chemical, and biological properties (Darmasandi *et al.,* 2025)). Therefore, the application of proper and balanced fertilization through a combination of organic and inorganic fertilizers is necessary to improve soil conditions while meeting the plants' nutrient needs. Organic fertilizers can increase organic matter content and improve soil properties, while inorganic fertilizers provide nutrients that are more readily available to plants (Hapsoh *et al.,* 2023) .

These productivity issues are also evident at the regional level. North Sumatra is one of the regions where peanuts are cultivated, but productivity remains fluctuating and relatively low. In the Nias Islands, peanut productivity was recorded at 11.39 kw/ha in 2019; there was no production in 2020; and it subsequently increased to 12.37 kw/ha in 2021 and 12.59 kw/ha in 2022 (BPS, 2023). These conditions indicate that productivity still needs to be improved through cultivation technologies adapted to local environmental conditions and resources.

One local resource with potential for utilization is swine manure. The village of Siwalubanua II has swine farming activities that generate a significant amount of manure. Preliminary research findings indicate that manure production from adult pigs averages approximately 5 kg per head per day, with an estimated total of around 210 metric tons per year. This waste has not yet been optimally utilized and has the potential to cause environmental problems if not properly managed. Pig manure can be utilized as a source of organic matter because it contains macro- and micronutrients and plays a role in improving soil conditions (Ririn *et al.,* 2022)). Utilizing this material as fertilizer is one alternative for reducing livestock waste while simultaneously providing a source of organic matter for the soil.

In addition to manure, plant nutrient requirements can be met using a 16:16:16 compound NPK fertilizer, which provides nitrogen (N), phosphorus (P), and potassium (K) simultaneously. Nitrogen plays a role in supporting vegetative growth, phosphorus in root development and flowering, while potassium plays a role in the formation and filling of crop yields (Suryaningtyas *et al.,*2023) . The combined use of organic and NPK fertilizers can theoretically complement each other, as manure plays a role in providing organic matter and improving soil conditions, while NPK provides mineral nutrients that are relatively quickly available to plants. Previous studies have shown that applying NPK to peanut crops can enhance growth, nutrient uptake, and productivity, while combining NPK with organic fertilizer can also yield positive effects on plant growth and yield. Riyansyah *et al.*(2026) reported that applying NPK at a rate of 200–250 kg ha^{-1} affects peanut productivity, while Febri *et al.*(2026) showed that a combination of manure and NPK can increase peanut growth and yield. These results indicate that the combined use of organic and inorganic nutrient sources has the potential to increase nutrient availability while improving the plant's growing environment.

However, the specific response of groundnut plants to a combination of manure derived from pig manure and 16:16:16 compound NPK fertilizer remains unknown, particularly under the soil and cultivation conditions in Siwalubanua II Village. Previous studies have primarily used different types of organic materials and NPK formulations; therefore, it is not yet known directly how groundnuts respond to the use of pig manure combined with 16:16:16 NPK, nor whether these two types of fertilizers interact to affect plant growth and production. Furthermore, the optimal application rates of pig manure and NPK that yield different growth and production responses under these local conditions remain unknown. These conditions underscore the need to test combinations of these two nutrient sources at various application rates to obtain information relevant to local conditions.

This study used pig manure at rates of 3, 4, and 5 kg/plot and NPK 16:16:16 fertilizer at rates of 22 g/m² and 32 g/m² as graded treatment rates. This dose range was selected to test the plants' response to increased application of organic and inorganic nutrient sources. Based on a plot area of 1.54 m², the manure doses of 3, 4, and 5 kg/plot are equivalent to 19.48, 25.97, and 32.47 metric tons/ha, respectively, while the 16:16:16 NPK fertilizer was applied at 22 g/m² per application and 32 g/m² per application in treatments N1 and N2, respectively. With two applications, the cumulative doses for each treatment were 44 g/m² (440 kg/ha) and 64 g/m² (640 kg/ha). This dose range was used as a factorial design to obtain information on the growth and yield response of peanuts to

increased applications of organic matter and mineral fertilizer, not as a general recommendation. The use of multiple dose levels also allowed for testing the potential interaction between pig manure and NPK in influencing plant growth and yield.

Based on this, the combination of pig manure and compound NPK fertilizer has the potential to provide a more balanced nutrient supply, improve soil conditions, and support peanut growth and yield. This study was conducted to determine the effects of pig manure, 16:16:16 compound NPK fertilizer, and their interaction on the growth and yield of peanut plants in Siwalubanua II Village.

2. METHOD

2.1 Research Location and Schedule

This study was conducted in Siwalubanua II Village, Hamlet III, Gunungsitoli Idanoi Subdistrict, Gunungsitoli City, North Sumatra, at coordinates 1.1831841° N and 97.6842123° E. The study site is located in a lowland area at an elevation of approximately ±51 m above sea level. The study was conducted over approximately 5 months, from February through June 2026.

2.2 Research Materials and Equipment

The materials used included “Spanish” variety peanut seeds, Nativo and Curacron pesticides, black soil, 90 kg of dried pig manure, 3 kg of rice bran, 10 kg of burnt rice husks, 200 ml of EM4, 200 g of brown sugar, approximately ±5–8 L of water, and 16:16:16 NPK fertilizer. Research equipment consisted of a hoe, a machete, a measuring tape, a watering can, plastic rope, sample signs, scissors, a digital scale, a pH meter, a sprayer, observation sheets, and a camera.

2.3 Research Method

This study used a factorial randomized block design (RBD) with two factors. Factor K was pig manure, consisting of K0 = 0 kg/plot, K1 = 3 kg/plot, K2 = 4 kg/plot, and K3 = 5 kg/plot. Factor N consisted of NPK 16:16:16, namely N0 = 0, N1 = 22 g/m²/application, and N2 = 32 g/m²/application. The combination of the two factors resulted in 12 treatments. Each combination was replicated three times, so the entire experiment consisted of 36 experimental units.

2.4 Research Procedure

2.4.1 Land Preparation

The land was first cleared of weeds and crop residues using a machete and a hoe. Before tilling, the pH was measured using a pH meter and found to range from 5.3 to 5.6. Subsequent tilling was performed by hoeing the soil until it was sufficiently loose to ensure that aeration and soil structure supported root development. The soil at the study site is of the podzolic type with an acidic reaction.

2.4.2 Plot Preparation

Thirty-six research plots, each measuring 140 cm × 110 cm, were established. The experiment consisted of three replicates, each containing 12 plots. The distance between replicates was set at 50 cm, while the distance between plots was 30 cm, with a plot height of 25 cm. This arrangement was used to separate the experimental units so that treatments could be applied according to the design and to minimize the influence between experimental units.

2.4.3 Preparation of Pig Manure Fertilizer

The manure was prepared from 90 kg of pig manure that had been cleaned of impurities. The manure was then mixed with 3 kg of rice bran and 10 kg of charred rice husks until evenly distributed. An activator solution was prepared by dissolving 200 mL of EM4 and 200 g of brown sugar in 5–8 L of water; this solution was then sprayed onto the mixture while stirring until the moisture content was suitable for fermentation (Tukan *et al.,* 2024) . Fermentation was carried out for 14–21 days in a sealed container, and the material was turned every 3–4 days to maintain aeration. The compost is considered mature when it is dark brown to black in color, has a crumbly texture, its temperature is close to ambient, and the pungent odor has diminished or disappeared (Lica *et al.,* 2025) . Once mature, the compost is air-dried and then weighed according to the K0, K1, K2, and K3 levels for application two weeks before planting.

2.4.4 Application of Pig Manure

Pig manure was applied according to the treatment levels: K0 = 0, K1 = 3 kg/plot, K2 = 4 kg/plot, and K3 = 5 kg/plot. The manure was mixed evenly into the soil two weeks before planting to allow time for mineralization and nutrient release.

2.4.5 Determining Planting Spacing

Planting distances were determined before the seeds were planted. After the base fertilizer was applied, the planting distance was set at 40 cm × 20 cm using stakes or string to ensure uniform plant spacing and growing space in each plot.

2.4.6 Planting

Seeds were planted in holes approximately 3–5 cm deep, each containing 2 seeds, spaced at 40 cm × 20 cm. After the seeds were placed, the holes were lightly covered with soil and watered to maintain moisture during germination. Each plot contained 20 plants, resulting in a total of 720 plants across 36 plots. Sample plants were selected using a zig-zag pattern along the planting rows in each plot. This method was used to ensure that the sample locations were distributed throughout the plot and could represent plant conditions more evenly, while also reducing the potential for sampling bias (Wang *et al.,*2024) . The number of samples was set at 6 plants per plot, for a total of 216 sample plants.

2.4.7 Attaching Research Labels

Labels were attached to all plants designated as sample plants, for a total of 216 labels.

2.4.8 Application of NPK Fertilizer

A 16:16:16 compound NPK fertilizer was applied twice, at 7 DAP and 30 DAP. For each application, the full treatment dose was applied: N0 (no NPK), N1 at 22 g/m² per application, and N2 at 32 g/m² per application. Thus, the cumulative dose during the study was 44 g/m² for N1 and 64 g/m² for N2. The fertilizer was spread evenly around the plants, ensuring that it did not come into direct contact with the stems.

2.4.9 Plant Maintenance

Maintenance included watering, weed control, hilling, and pest control. Watering was performed in the morning and evening, twice a day, taking weather conditions into account. Weeds were pulled manually as needed based on field conditions. Hilling was carried out at 38 days after sowing (DAS) by carefully adding soil to the base of the plants. Pest and disease control was conducted through routine monitoring; Curacron was applied at 36 DAS, while Nativo was applied at 59 DAS following the recommended dosage.

2.4.10 Observation Parameters

Plant height was measured once a week from 14 DAP to 35 DAP. Measurements were taken from the soil surface to the highest growing point on the sample plants in each plot. Number of branches was determined by directly counting all branches developing from the main branch on the sample plants. Observations were conducted weekly from 14 DAP to 35 DAP. Flowering age is determined based on the time the first flower appears on the sample plant. Observations are made daily from 16–27 days after sowing (DAS), and the results are expressed in DAS. At harvest, all pods formed on each sample plant are counted. The count includes both filled and unfilled pods. Fresh weight of pods per sample indicates the mass of fresh pods obtained from each sample plant. This value is used as a measure of yield, which is influenced by genetic factors, cultivation techniques, and nutrient availability. Fresh weight of pods per plot is calculated from all fresh pods harvested in a single plot and is used to describe the yield per unit area of the experiment. Weighing is performed when the plants reach physiological maturity using an analytical balance.

2.4.11 Data Analysis

Growth and yield data for peanuts (Arachis hypogaea L.) were analyzed using analysis of variance (ANOVA) based on a factorial design. This analysis was used to test the effects of pig manure, NPK 16:16:16, and the combination or interaction of both on all observed parameters.

$$Yijk = \mu + \rho k + \alpha i + \beta j + (\alpha\beta)ij + \varepsilon ijk \quad (1)$$

Notes:

Yijk = Observed value for the i-th pig manure treatment and the j-th NPK fertilizer treatment in the k-th replicate

μ = The value representing the overall average condition of the observed data

ρk = Effect of group or the kth replicate

αi = Effect of the pig manure treatment at level i.

βj = Effect of the compound NPK fertilizer treatment at level j.

(αβ)ij = Effect of the interaction between pig manure at level i and compound NPK fertilizer at level j on the observed parameter

Eijk = Experimental error for the pig manure treatment at level i , the NPK fertilizer at level j , and group k , i.e., the variation that cannot be explained by either the treatment or group factors.

If the ANOVA results indicate a significant or highly significant effect, the analysis proceeds with the Honest Significant Differences (HSD) test at the 5% level. This test is used to compare treatment means and determine which treatment groups are significantly different and which are not.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The ANOVA analysis showed that manure had a highly significant effect on plant height at all observation times (2–5 MST). NPK had no significant effect at 2 MST but began to show a highly significant effect at 3–5 MST. The interaction between manure and NPK was also not significant at 2–3 MST, became significant at 4 MST, and highly significant at 5 MST. The lack of response early in growth is thought to be related to ongoing root development and the plants' ability to utilize food reserves from the seed before nutrient uptake from the growing medium becomes more optimal (Hodiyah & Milati, 2022).

Table 1. Results of the Follow-Up Test with 5% BNJ at Plant Heights of 2 MST–5 MST

Treatment	2 MST	3 MST	4 MST	5 MST
K0	14.62bc	20.67b	29.34b	38.53c
K1	14.56c	21.70a	31.43a	42.26b
K2	15.48ab	22.18a	32.66a	44.33a
K3	16.16a	22.54a	31.42a	44.11a
N0	15.13a	21.49b	30.54b	41.47b
N1	15.24a	21.35b	30.58b	41.68b
N2	15.24a	22.48a	32.53a	43.78a
K0N0	14.80ab	20.53d	28.57e	39.03e
K0N1	14.47ab	20.43cd	29.60cde	38.23e
K0N2	14.60ab	21.03bcd	29.87cde	38.33e
K1N0	13.90b	21.17bcd	30.53bcde	40.53de
K1N1	15.03ab	21.33abcd	30.63abcde	41.93cd
K1N2	14.73ab	22.60abc	33.13ab	44.30bc
K2N0	15.37ab	21.67abcd	31.83abcd	43.17bc
K2N1	15.20ab	22.87abc	32.73abc	44.37bc
K2N2	15.87ab	23.10ab	33.40ab	45.47ab
K3N0	15.77ab	22.60abcd	31.23abcde	43.13bcd
K3N1	16.27a	20.77abcd	29.33de	42.17cd
K3N2	16.43a	23.17a	33.70a	47.03a

Note: Numbers followed by the same letter in the mean row indicate no significant difference, while values with different letters indicate a significant difference based on the BNJ test results at the 5% level (α = 0.05).

The 5% BNJ results show a highly significant effect of manure on plant height at 2–5 MST. K3 produced the tallest plants at 2–3 MST, while K2 produced the tallest plants at 4–5 MST, and K0 yielded the lowest values. The effect of NPK became highly significant starting at 3 MST; N2 yielded heights of 22.48 cm, 32.53 cm, and 43.78 cm at 3–5 MST. Among the treatment combinations, K3N2 yielded the highest numerical values, namely 16.43 cm; 23.17 cm; 33.70 cm; and 47.03 cm at 2–5 MST, while K0N0 yielded the lowest. This pattern indicates that the simultaneous use of both fertilizer sources supports greater plant height growth than the unfertilized condition.

Greater height growth in plants receiving fertilizer highlights the importance of adequate nutrient supply for vegetative tissue formation. Manure not only contributes nutrients but also increases organic matter content, which can improve soil aggregation, porosity, aeration, and water-holding capacity. These improvements in the root environment can aid root development and nutrient uptake. These results are consistent with Vaclav *et al.,*(2021) regarding the relationship between organic matter and soil properties, and Homer *et al.,*(2024) , which reported increased growth and peanut yield following compost application.

The increasingly evident effect of NPK at 3–5 MST indicates a rising nutrient requirement as the roots and canopy develop. Nitrogen is associated with the formation of vegetative tissue and chlorophyll; phosphorus supports root development and energy transfer; while potassium is related to metabolic processes and plant physiological functions. These results are consistent with Asis *et al.,*(2022) and Rahmadi *et al.,*(2024) , which discuss the response of groundnuts to NPK. The taller plants in the K3N2 treatment indicate that soil improvement through organic fertilizer, combined with the supply of mineral nutrients, can create conditions more conducive to growth. These results are also consistent with Yunanda *et al.,*(2022) , regarding the role of organic fertilizer in improving soil properties and groundnut production.

3.2 Number of Branches

ANOVA showed that manure had a highly significant effect on the number of branches at 2–5 MST. NPK did not have a significant effect at 2 MST, but its effect became highly significant at 3–5 MST. The interaction between the two factors was not significant at 2 MST and began to show a significant effect at 3–5 MST. In general, branching was higher in plants treated with fertilizer, with K3N2 yielding the highest value and K0N0 the lowest.

Table 2. Results of the 5% BNJ Post-hoc Test for Number of Branches at 2 MST–5 MST

Treatment	2 MST	3 MST	4 MST	5 MST
K0	1.22b	2.20b	3.28b	3.87c
K1	1.33ab	2.56a	3.93a	5.06b
K2	1.41a	2.80a	4.17a	5.39a
K3	1.46a	2.72a	4.04a	5.48a
N0	1.32a	2.38b	3.65b	4.67c
N1	1.38a	2.49b	3.82b	4.92b
N2	1.38a	2.85a	4.08a	5.26a
K0N0	1.28abc	2.11c	3.22e	3.78e
K0N1	1.17c	2.22c	3.33de	3.89de
K0N2	1.22bc	2.28c	3.28de	3.94de
K1N0	1.33abc	2.39bc	3.61cde	4.61cd
K1N1	1.39abc	2.28c	3.94abcd	5.06bc
K1N2	1.28abc	3.00ab	4.22abc	5.50ab
K2N0	1.28abc	2.45bc	3.83abcde	5.06bc
K2N1	1.50ab	2.94ab	4.28abc	5.67ab
K2N2	1.44abc	3.00ab	4.39ab	5.72ab
K3N0	1.39abc	2.56abc	3.95abcd	5.22abc
K3N1	1.44abc	2.50abc	3.72bcde	5.06bc
K3N2	1.56a	3.11a	4.44a	5.89a

Note: Numbers followed by the same letter in the mean row indicate no significant difference, while values with different letters indicate a significant difference based on the BNJ test results at the 5% level (α = 0.05).

Based on the results of the 5% BNJ test, manure had a highly significant effect on the number of branches at all observation ages (2–5 MST). Treatment K3 yielded the highest numerical values at 2 MST and 5 MST, with 1.46 and 5.48 branches, respectively, while at 3 and 4 MST, the highest values were observed in treatment K2, at 2.80 and 4.17 branches. Regarding the NPK factors, the effect was not significant at 2 MST but became highly significant at 3–5 MST, with N2 yielding 2.85, 4.08, and 5.26 branches. The interaction was not significant at 2 MST but became significant starting at 3 MST. The K3N2 combination produced the highest numerical value for the number of branches, but it was not significantly different from several other treatment combinations based on the 5% BNJ test. Increased branching is related to the availability of nutrients that support cell and tissue formation. N supports vegetative growth, P is associated with root development and energy transfer, while K supports enzyme activity and metabolism. These results are consistent with Rahmadi *et al.,*(2024) regarding the importance of N, P, and K availability for peanut growth and production.

A greater number of branches has the potential to expand leaf formation and the photosynthetic area. Thus, photosynthetic products can be used to support vegetative growth while also providing photosynthates for the formation of generative organs. The combination of manure and NPK fertilizer can provide complementary functions: organic fertilizer improves the soil environment, while NPK supplies mineral nutrients that are more readily available. These findings are consistent with the studies by Yunanda *et al. (* (2022) and Putra *et al. (* (2024) regarding the benefits of organic fertilizers and organic-inorganic fertilizer combinations on soil conditions and crop production.

3.3 Flowering Age

The results of the ANOVA analysis showed that both manure and NPK had a highly significant effect on flowering time. The interaction between the two factors also showed a significant effect on the timing of flowering.

Table 3. Results of the 5% BNJ Post-hoc Test for Flowering Duration (HST)

Treatment	Flowering Duration (HST)
K0	22.98a
K1	21.78ab
K2	21.52b
K3	19.35c
N0	22.28a
N1	21.60a
N2	20.35b
K0N0	22.45ab
K0N1	23.56a
K0N2	22.95a
K1N0	23.33a
K1N1	22.17ab
K1N2	19.84bc
K2N0	23.61a
K2N1	21.17abc
K2N2	19.78bc
K3N0	19.72bc
K3N1	19.50bc
K3N2	18.83c

Note: Numbers followed by the same letter in the mean row indicate no significant difference, while values with different letters indicate a significant difference based on the BNJ test results at the 5% level (α = 0.05).

Based on the results of the 5% BNJ test, manure had a highly significant effect on flowering time. K3 produced the earliest flowering, at 19.35 HST, while K0 was the latest at 22.98 HST. Among the NPK treatments, N2 resulted in the earliest flowering time ( ) at 20.35 HST, and N0 resulted in the latest at 22.28 HST. The interaction between the two factors was significant; K3N2 resulted in flowering at 18.83 HST, while K2N0 was the combination with the latest flowering time, at 23.61 HST.

Faster flowering indicates that the plants obtained sufficient nutrient conditions to enter the generative phase. Manure can help create a better root environment and support nutrient uptake, while NPK supplies the elements needed for metabolic processes and growth phase transitions. These results are consistent with Astuti *et al.,*(2022) , which highlight the importance of managing organic and phosphorus nutrient sources to support peanut growth.

Phosphorus plays a role in energy transfer and root development, while potassium supports enzyme activation, water balance, and the distribution of photosynthates. When N, P, and K are adequately available, the transition to the generative phase can proceed more effectively, potentially leading to earlier flowering. This is supported by Juliawati *et al.,*(2024) and Purbajanti *et al.,*(2024) , which emphasize the roles of phosphorus, nitrogen, and potassium in peanut growth and productivity. The K3N2 results indicate that flowering is influenced by a combination of growing medium conditions and the availability of mineral nutrients. However, early flowering does not automatically guarantee high yields, as the formation of gynophores, pods, and pod filling remain the determining factors for the final yield.

3.4 Number of Pods per Sample

ANOVA results showed that manure and NPK each had a highly significant effect on the number of pods per sample. The interaction between the two factors was also highly significant. In general, fertilization treatments increased the number of pods, with K3N2 yielding the highest value and K0N0 the lowest.

Table 4. Results of the 5% BNJ Post-hoc Test for Number of Pods per Sample (fruits)

Treatment	Number of Pods per Sample
K0	45.91b
K1	54.70a
K2	58.01a
K3	57.42a
N0	53.21b
N1	49.30b
N2	59.53a
K0N0	44.43c
K0N1	45.97c
K0N2	47.33bc
K1N0	46.90bc
K1N1	55.23abc
K1N2	61.97ab
K2N0	64.90a
K2N1	47.10bc
K2N2	62.03ab
K3N0	56.60abc
K3N1	48.90bc
K3N2	66.77a

Note: Numbers followed by the same letter in the mean row indicate no significant difference, while values with different letters indicate a significant difference based on the BNJ test results at the 5% level (α = 0.05).

Based on the results of the 5% BNJ test, manure had a highly significant effect on the number of pods per sample. K2 yielded the highest numerical mean, namely 58.01 pods, and was not significantly different from K1 (54.70 pods) or K3 (57.42 pods); all three were significantly different from K0, which produced only 45.91 pods. Regarding the NPK factor, N2 produced 59.53 pods and differed from N0 (53.21 pods) and N1 (49.30 pods). The interaction between the two factors was also highly significant. The K3N2 combination produced 66.77 pods, while K0N0 produced 44.43 pods.

The number of pods reflects the plant's success in redirecting vegetative growth and flowering toward the formation of fruit. Higher values in the fertilization treatments indicate that soil conditions and nutrient supply support the development of flowers, gynophores, and pods. Manure primarily helps improve soil conditions, while NPK provides nutrients for growth and fruit formation. Yunanda *et al.,*(2022) also reported a relationship between organic fertilizer application and soil properties and peanut production.

Phosphorus supports root growth and energy metabolism, while potassium plays a role in transporting photosynthetic products to storage organs. Both elements are related to the processes

of gynofor formation and pod development. The findings of*et al.,*(2025) regarding manure and potassium in groundnuts can be used as a comparison in explaining the relationship between nutrient management and yield components. In the single-factor analysis, K2 produced the highest number of pods, while K3N2 yielded the highest total yield. This difference indicates that the plant's response to additional manure does not always increase in direct proportion to the dose. Once nutrient requirements approach sufficient levels, further fertilizer application does not necessarily increase yield components by the same magnitude. Therefore, the balance between organic and mineral nutrient sources is a critical factor in determining plant response.

3.5 Fresh Weight of Pods per Sample

The ANOVA results showed that manure and NPK, when applied separately, had a highly significant effect on the fresh weight of pods per sample, while the interaction between the two had a significant effect. The fresh weight tended to be higher in treatments with fertilizer. The K3N2 combination yielded the highest fresh weight, while K0N0 yielded the lowest.

Table 5. Results of the 5% BNJ Post-hoc Test for Fresh Weight of Pods per Sample (grams)

Treatment	Fresh Weight of Pods per Sample
K0	90.52b
K1	101.13ab
K2	116.20a
K3	116.94a
N0	97.76b
N1	99.08b
N2	121.75a
K0N0	89.00b
K0N1	90.89b
K0N2	91.67b
K1N0	94.39b
K1N1	95.44b
K1N2	115.00ab
K2N0	96.06b
K2N1	116.72ab
K2N2	138.06a
K3N0	111.61b
K3N1	94.72ab
K3N2	142.28a

Note: Numbers followed by the same letter in the mean row indicate no significant difference, while values with different letters indicate a significant difference based on the BNJ test results at the 5% level (α = 0.05).

Based on the results of the 5% BNJ test, manure had a highly significant effect on the fresh weight of pods per sample. K3 yielded 116.94 g and was not significantly different from K2 at 116.20 g, while both were significantly different from K0 at 90.52 g. NPK also had a highly significant effect; N2 yielded 121.75 g, higher than N0 at 97.76 g and N1 at 99.08 g. The interaction between the two factors was significant, with K3N2 yielding 142.28 g and K0N0 yielding only 89.00 g.

Fresh pod weight is the final result of the pod formation and filling process. The increased values in fertilized plants indicate that generative organ formation and biomass accumulation occurred more effectively. Adequate canopy growth also supports photosynthesis, allowing more photosynthetic products to be redirected to the pods.

Organic matter from manure helps create soil conditions that support growth. Vaclav *et al.,*(2021) , explain the relationship between organic matter and soil properties, while Yunanda *et al.,*(2022) , report the benefits of organic fertilizer on soil properties and peanut production. NPK supplies the N, P, and K required for growth and yield formation, as supported by Asis *et al*. (2022) and Rahmadi *et al.,*(2024) . A high weight in the K3N2 treatment is also associated with a greater number of pods. Thus, the fresh weight of pods per sample is the cumulative result of vegetative growth, flowering, pod formation, and pod filling, in line with (Hapsoh *et al.,* 2023) .

3.6 Fresh Weight of Pods per Plot

Based on the results of the ANOVA analysis, it was found that manure and NPK each had a highly significant effect on the fresh weight of pods per plot, while the interaction between the two factors had a significant effect. In general, yields per plot were higher in the fertilized treatments. The K3N2 combination produced the highest weight, while K0N0 yielded the lowest weight.

Table 6. Results of the 5% BNJ Post-Hoc Test: Wet Weight of Pods per Plot (grams)

Treatment	Fresh Weight of Pods per Plot
K0	667.44b
K1	1315.11a
K2	1427.44a
K3	1349.44a
N0	986.33b
N1	1086.50b
N2	1496.75a
K0N0	615.67d
K0N1	713.00 cd
K0N2	673.67d
K1N0	971.67 cd
K1N1	1256.67abcd
K1N2	1717.00ab
K2N0	1173.33bcd
K2N1	1382.00abc
K2N2	1727.00ab
K3N0	1184.67abcd
K3N1	994.33cd
K3N2	1869.33a

Note: Numbers followed by the same letter in the mean row indicate no significant difference, while values with different letters indicate a significant difference based on the BNJ test results at the 5% level (α = 0.05).

Based on the 5% BNJ test, K2 yielded the highest fresh pod weight per plot for the manure factor, at 1,427.44 g, and this value was not significantly different from K1 (1,315.11 g) or K3 (1,349.44 g). All three treatment levels differed significantly from K0, which reached only 667.44 g. For the NPK factor, N2 yielded 1,496.75 g, while N1 and N0 yielded 1,086.50 g and 986.33 g, respectively. A significant interaction was observed between K3 and N2, yielding the highest weight of 1,869.33 g; K0N0 was the lowest combination at 615.67 g.

The fresh weight of pods per plot reflects the accumulation of yield across various stages of plant growth. Weight gain is associated with vegetative development, branch formation, flowering, pod number, and the pod-filling process. A well-developed canopy supports photosynthesis and the production of photosynthates, while P and K play a role in root development, energy metabolism, and the distribution of photosynthates to reproductive organs.

Manure supports yield by adding organic matter and improving soil conditions, while NPK provides the mineral nutrients needed by the plants. Yunanda *et al.,*(2022) reported that organic fertilizer can improve the physical and chemical properties of the soil and increase peanut production. Nugroho *et al.,*(2023) also demonstrated the relevance of using manure in combination with NPK for peanut growth and yield. In this study, K2 was the single-treatment with the highest weight, while K3N2 showed the highest numerical value among the treatment combinations. This pattern indicates that increasing the manure dose does not always result in a linear increase in weight. When the plant's nutrient requirements have been relatively met, further additions of fertilizer do not necessarily produce a proportional increase. This underscores the importance of balancing the supply of organic and inorganic nutrients.

4. CONCLUSION

Pig manure has a very significant effect on the growth and yield of groundnuts. Treatment K3 showed the highest numerical values for several growth parameters, while treatment K2 yielded the highest values for the number of pods per sample and the fresh weight of pods per plot under the manure treatment factor. NPK fertilizer had an effect starting at 3 MST and on several yield components, with N2 showing the highest numerical values for most parameters. The interaction between the two factors did not have a significant effect in some early observations but had a significant to very significant effect in subsequent observations and on several yield components. K3N2 showed the highest numerical values for several parameters but was not always significantly different from other combinations based on a 5% BNJ,

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