# Effects of pineapple peel liquid organic fertilizer and quail manure on the growth and yield of Peanut Plants (Arachis hypogaea L.)

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**ABSTRACT**

Peanuts (*Arachis hypogaea* L.) are important food legumes whose productivity is strongly influenced by soil fertility, nutrient availability, and the balance between vegetative and generative growth. This study evaluated the effects of pineapple peel liquid organic fertilizer (POC) and quail manure on peanut growth and yield. The experiment was conducted at the Al Azhar University Experimental Farm, Medan, from April to August 2025 using a factorial randomized block design with two factors: pineapple peel POC at 0, 35 and 70 ml L-1 and quail manure at 0, 1, 2, and 3 kg plot-1, with three replications. Observed parameters included plant height, stem diameter, number of pods per plant, and 100-seed weight. Analysis of variance followed by Duncan's Multiple Range Test showed that pineapple peel POC and quail manure significantly increased plant height and 100-seed weight, but did not significantly affect stem diameter or the number of pods per plant. No significant interaction was detected for any parameter. The highest plant height was recorded at N2 (58.31 cm) and P3 (59.28 cm), while the highest 100-seed weight was recorded at N2 (70.50 g) and P2 (68.22 g). These findings indicate that pineapple peel POC and quail manure can improve peanut performance mainly by supporting vegetative growth and seed filling, although their effects were independent rather than synergistic.



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## 1. INTRODUCTION

Peanuts (Arachis hypogaea L.) are a food legume crop of economic importance, as their seeds are used as a source of plant protein, oil, and processed food ingredients. Peanut productivity is greatly influenced by the quality of the growing medium, nutrient availability, soil microbial activity, and the balance between vegetative and generative growth. In legume crops, an insufficient supply of nutrients can limit biomass formation and seed filling, while unbalanced nitrogen management can affect nodulation and the efficiency of biological nitrogen fixation (G. Zhang et al., 2023).

Organic fertilization is one strategy for improving soil fertility, reducing dependence on chemical fertilizers, and supporting sustainable agriculture. Various studies indicate that organic matter can increase soil organic carbon content, water-holding capacity, enzyme activity, nutrient availability, and soil microbial composition that supports plant growth (Chen et al., 2018; Y. Liu et al., 2024; G. Zhang et al., 2023). In peanuts, the application of organic fertilizer has been reported to improve growth, yield components, and soil environmental quality, including increases in total nitrogen, available phosphorus, available potassium, and porosity, as well as a decrease in bulk density (Liu et al., 2023).

One local organic material with potential for development as a liquid organic fertilizer (POC) is pineapple peel waste. Pineapple peels are often considered agro-industrial and household waste, even though they contain organic matter, sugar, carbohydrates, and minerals that can be utilized as a fermentation substrate. Mandasari et al. (2025) demonstrated that pineapple peel waste can be fermented using EM4 as a bioactivator to produce POC containing nitrogen, phosphorus, potassium, and organic carbon. Kuswardina and Abror (2023) also reported that pineapple peel POC affects the growth and yield of red lettuce. This indicates that pineapple peel has potential as a source of liquid organic fertilizer, although its effectiveness is highly influenced by fermentation quality, application concentration, and plant type.

Poultry manure also has potential as a source of macro- and micronutrients. Poultry manure generally contains nitrogen, phosphorus, potassium, and organic matter that mineralizes relatively faster than some other types of manure. Research on groundnuts indicates that poultry manure can improve growth and yield, while the combination of chicken manure with Rhizobium inoculation increases biomass, nodules, pod weight, fresh yield, oil content, and seed protein (Chuong, 2023; Mahmud & Abdulrahman, 2025). Syamsiah et al. (2025) demonstrated that the application of organic matter combined with quail manure can increase organic carbon, cation exchange capacity, available phosphorus, ammonium, nitrate, potassium, calcium, and several other soil chemical indicators. Thus, quail manure has the potential to serve as both a slow-release nutrient source and a soil conditioner.

The combination of pineapple peel POC and quail manure can theoretically provide complementary benefits. Pineapple peel POC serves as a source of soluble nutrients and simple organic compounds resulting from fermentation, while quail manure provides solid organic matter that undergoes a more gradual mineralization process. The combination of liquid and solid inputs is expected to improve nutrient availability during the vegetative phase while supporting seed filling during the generative phase.

Based on the above discussion, research on the combination of pineapple peel POC and quail manure is relevant because it combines a liquid nutrient source derived from fruit waste with a solid nutrient source derived from poultry manure. Recent studies on peanut and other legumes also indicate that organic and organic-biological fertilizers can improve soil fertility, physiological growth, yield, and seed quality when application rates are appropriate (Darmasandi et al., 2025; Li et al., 2024). However, plant responses to this combination have not always been consistent, particularly regarding generative parameters such as pod number and seed weight. Therefore, this study aims to determine the effects of pineapple peel POC, quail manure, and their interaction on the growth and production of groundnuts. The results of this study are expected to serve as a basis for utilizing local organic waste as a more economical and environmentally friendly agricultural input.

## 2. METHOD

### 2.1. Place and Time of Research

The study was conducted at the Al Azhar University Experimental Farm in Medan Johor District, Medan City, North Sumatra Province, at an elevation of approximately 25 meters above sea level, from April to August 2025. The research site is located in a lowland area, making it suitable for peanut cultivation provided that drainage and soil moisture are properly managed.

### 2.2. Tools and Materials

The materials used in this study included Gajah variety peanuts, topsoil, quail manure, pineapple peel waste as a POC ingredient, water, brown sugar, EM4, plastic rope, research signs, buckets, and a watering can. The tools used included a measuring tape, a hoe, a machete, scissors, a digital scale, a calculator, a camera, a blender, writing utensils, and equipment for processing POC.

### 2.3. Production of Pineapple Peel POC

Pineapple peel POC is produced through a simple fermentation process. The pineapple peels are washed, cut into small pieces, and then pureed using a blender. For each fermentation batch, 3 kg of fresh pineapple peels were washed, chopped, and blended with 3 L of clean water. The slurry was mixed with 150 g brown sugar as a microbial energy source and 100 mL EM4 as a bioactivator, transferred into an airtight plastic container, and fermented anaerobically for 21 days at room temperature. The container was opened briefly every two days to release gas, stirred gently, and resealed. At the end of fermentation, the mixture was filtered through a clean cloth, and the filtrate was used as the POC stock solution. The POC stock was diluted with water immediately before application according to the treatment concentrations of 0, 35, and 70 mL L-1.

### 2.4. Research Methodology

This study employed a factorial randomized block design (RBD) with two treatment factorsThe first factor was pineapple peel liquid organic fertilizer (N), with three levels: N0 = 0 ml/L of water (control), N1 = 35 ml/L of water, and N2 = 70 ml/L of water. The second factor was the dose of quail manure (P), which consisted of four levels: P0 = 0 kg/plot (control), P1 = 1 kg/plot, P2 = 2 kg/plot, and P3 = 3 kg/plot. Thus, there were 12 treatment combinations, and each treatment was repeated three times, resulting in 36 experimental units. Quail manure was air-dried, crushed, and incorporated evenly into the topsoil one week before planting according to the assigned dose. Each experimental unit was arranged as a 1 m x 1 m plot with a planting distance of 25 cm x 25 cm, resulting in 16 planting holes per plot. Two seeds were sown per hole and thinned to one healthy plant per hole at 2 weeks after planting, so each plot contained 16 plants. Four central plants were selected as sample plants to reduce border effects. Pineapple peel POC was applied by soil drenching around the root zone at 250 mL plant-1 application-1 at 2, 4, and 6 weeks after planting. The application was carried out in the morning to reduce evaporation and minimize direct leaf exposure.

The observed parameters included plant height (cm), measured during the vegetative phase up to 6 Weeks After Planting (WAP); stem diameter (cm), measured during the vegetative phase; number of pods per plant, measured after harvest; and 100-seed weight (g), measured after the seeds were dried to a condition suitable for weighing. Plant height and stem diameter represent vegetative responses, while the number of pods and the weight of 100 seeds represent generative responses and yield components.

### 2.5. Data Analysis

The observational data were analyzed using analysis of variance (ANOVA) based on a factorial RBD model. The mathematical model used is:

$$Yijk = \mu + \rho i + Nj + Pk + (NP)jk + \varepsilon ijk \quad (1)$$

where Yijk = observed value, μ = overall mean, ρi = effect of the i-th group, Nj = effect of the j-th level of pineapple peel POC, Pk = effect of the k-th level of quail manure, (NP)jk = interaction effect of pineapple peel POC and quail manure, and εijk = experimental error.
If the results of the analysis of variance indicate a significant effect, the analysis is continued with the Duncan Multiple Range Test (DMRT) at the 5% level, as required for interpretation.

## 3. RESULTS AND DISCUSSION

### 3.1. Plant Height

The analysis of variance showed that pineapple peel POC and quail manure each had a highly significant effect on peanut plant height at 6 weeks after planting (Table 1). The highest mean for the pineapple peel POC factor was found in N2, while the highest mean for the quail manure factor was found in P3. This indicates that increasing the concentration of POC and the dose of quail manure tends to improve the vegetative growth of the plants to a certain extent.

**Table 1.** Average peanut plant height (cm) at 6 weeks after sowing following the application of pineapple peel organic liquid fertilizer and quail manure

| N | P0 | P1 | P2 | P3 | Average N |
|---|---|---|---|---|---|
| N0 | 51.33 | 54.73 | 53.87 | 59.53 | 54.87 b |
| N1 | 52.73 | 54.97 | 52.77 | 59.33 | 54.95 a |
| N2 | 58.20 | 57.87 | 58.20 | 58.97 | 58.31 a |
| Average P | 54.09 b | 55.86 a | 54.94 a | 59.28 a | |

Note: Numbers followed by different letters in the same row or column indicate significant differences according to Duncan's test. Lowercase letters indicate the 5% level, while uppercase letters indicate the 1% level. N = pineapple peel POC, P = quail manure, N0 = 0 ml/l, N1 = 35 ml/l, N2 = 70 ml/l, P0 = 0 kg/plot, P1 = 1 kg/plot, P2 = 2 kg/plot, and P3 = 3 kg/plot

Table 1 shows that the highest mean plant height for pineapple peel POC was obtained at N2 (58.31 cm), which formed the same statistical group as N1 but was higher than N0. For quail manure, P3 produced the highest numerical mean (59.28 cm) and was significantly higher than P0. This response can be explained through the mineralization process of organic inputs. Quail manure supplies organic N, P, K, and other nutrients that become available after microbial decomposition, whereas fermented pineapple peel POC provides more soluble nutrients and readily degradable carbon compounds. The released nitrogen may support chlorophyll formation and photosynthetic capacity, thereby increasing plant height, while the added organic carbon can stimulate microbial activity in the rhizosphere and improve nutrient cycling. This interpretation is consistent with reports that organic fertilization in peanut can increase chlorophyll, net photosynthetic rate, nodulation, and yield (Zhang et al., 2023), and that organic fertilizer affects soil bacterial communities and enzyme-related processes involved in nutrient transformation (Zhang et al., 2024). The role of nitrogen in maintaining chlorophyll pigments and vegetative performance is also supported by Muhammad et al. (2022).

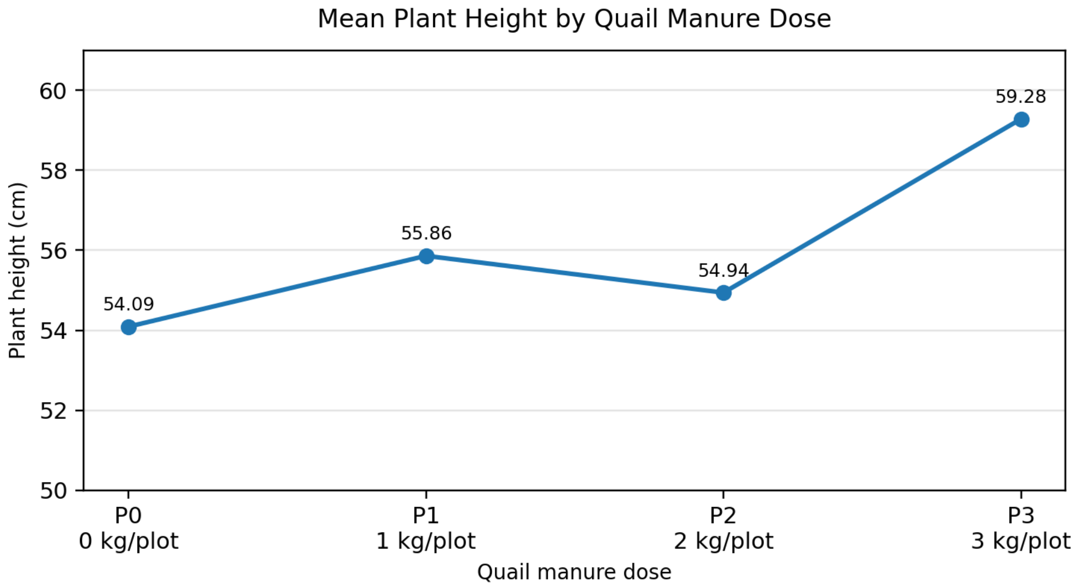


**Figure 1.** Main-effect trend of quail manure dose on peanut plant height at 6 WAP

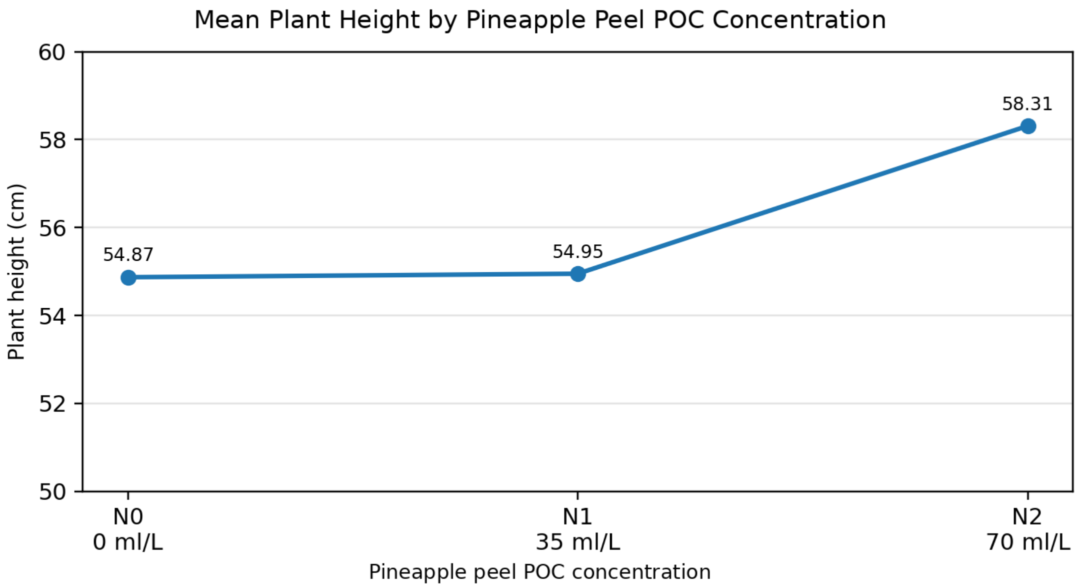


**Figure 2.** Main-effect trend of pineapple peel POC concentration on peanut plant height at 6 WAP

Figures 1 and 2 strengthen this interpretation. Figure 1 shows that the response to quail manure was not strictly linear: P1 and P2 produced only modest increases compared with P0, whereas P3 showed a clearer increase in plant height. This suggests that a greater amount of solid organic matter was required to elicit a visible vegetative response during the observation period. Figure 2 shows a clearer concentration-dependent response for pineapple peel POC, with a relatively small difference between N0 and N1 but a stronger increase at N2. The absence of a significant N x P interaction indicates that the two inputs improved plant height mainly through independent main effects rather than a synergistic effect. POC release was rapid while the manure mineralization was gradual, the timing of the three POC applications did not fully coincide with nutrient release from quail manure, or the initial soil condition was sufficient to buffer treatment contrasts.

### 3.2. Stem Diameter

The analysis of variance showed that pineapple peel POC, quail manure, and their interaction did not significantly affect peanut stem diameter (Table 2). Although the means tended to increase from the control toward N2 and P3, the magnitude of the difference was small, ranging only from 0.59 to 0.63 cm in the main-effect means.

**Table 2.** Mean peanut stem diameter (cm) resulting from the application of pineapple peel POC and quail manure

| N | P0 | P1 | P2 | P3 | Average N |
|---|---|---|---|---|---|
| N0 | 0.57 | 0.60 | 0.59 | 0.64 | 0.60 |
| N1 | 0.59 | 0.59 | 0.61 | 0.63 | 0.60 |
| N2 | 0.60 | 0.63 | 0.63 | 0.63 | 0.62 |
| Average P | 0.59 | 0.61 | 0.61 | 0.63 | |

Note: Numbers without superscripts indicate that the differences between treatments are not significant based on the results of the analysis of variance. N = pineapple peel POC, P = quail manure, N0 = 0 ml/l, N1 = 35 ml/l, N2 = 70 ml/l, P0 = 0 kg/plot, P1 = 1 kg/plot, P2 = 2 kg/plot, and P3 = 3 kg/plot

Table 2 shows that the absence of a significant stem-diameter response is related to the timing of observation, genotype-dependent stem architecture, and the relatively limited treatment gap during early growth. Unlike plant height, stem diameter may require a longer period of assimilate accumulation before treatment differences become evident. In this experiment, the main-effect means ranged narrowly from 0.59 to 0.63 cm, indicating that the treatments were not strong enough to alter radial stem growth. Part of the absorbed nutrients was likely allocated first to leaf expansion, shoot elongation, root development, and reproductive preparation rather than to stem thickening. Pineapple peel POC is also expected to contain relatively modest concentrations of macronutrients compared with inorganic fertilizers; therefore, its effect may be more visible in parameters directly linked to nutrient uptake, chlorophyll formation, and photosynthetic performance than in structural thickening of the stem (Suryani et al., 2022). This result is consistent with reports that fruit-waste-based liquid organic fertilizers may influence certain growth parameters but not all vegetative traits equally (Cristina et al., 2022). The non-significant interaction also suggests that the combination of liquid and solid organic inputs did not create an additive physiological effect on stem diameter within the measured growth period.

### 3.3. Number of Pods per Plant

The analysis of variance indicated that pineapple peel POC, quail manure, and their interaction did not significantly affect the number of pods per plant. The highest mean for pineapple peel POC was recorded at N2 (40.38 pods), whereas the highest mean for quail manure was recorded at P2 (40.14 pods).

**Table 3.** Mean number of pods per plant resulting from the application of pineapple peel POC and quail manure

| N | P0 | P1 | P2 | P3 | Average N |
|---|---|---|---|---|---|
| N0 | 37.07 | 39.07 | 39.17 | 39.40 | 38.68 |
| N1 | 39.17 | 39.20 | 40.63 | 40.27 | 39.82 |
| N2 | 40.53 | 40.50 | 40.63 | 39.87 | 40.38 |
| Average P | 38.92 | 39.59 | 40.14 | 39.84 | |

Note: Numbers without superscripts indicate that the differences between treatments are not significant based on the results of the analysis of variance. N = pineapple peel POC, P = quail manure, N0 = 0 ml/l, N1 = 35 ml/l, N2 = 70 ml/l, P0 = 0 kg/plot, P1 = 1 kg/plot, P2 = 2 kg/plot, and P3 = 3 kg/plot

Table 3 shows that the pod formation in peanuts is determined by flowering success, gynophore development, gynophore penetration into the soil, soil moisture, calcium availability around the pegging zone, and nutrient availability during the reproductive stage. The narrow range of pod-number means (38.68-40.38 pods per plant for pineapple peel POC and 38.92-40.14 pods per plant for quail manure) suggests that the treatments did not create sufficient physiological or environmental contrast to alter pod initiation. This may occur when organic inputs improve the overall nutrient status of plants but do not specifically affect reproductive events that determine pod number. In addition, the application schedule of POC at 2, 4, and 6 WAP may have contributed more to early vegetative growth than to the critical period of gynophore penetration and pod setting. The lack of interaction may also indicate that nutrient release from quail manure and soluble nutrients from pineapple peel POC were not synchronized enough to increase the number of reproductive sinks. However, the increase in seed weight observed later indicates that the organic inputs were more influential during seed filling than during pod formation. Similar variability in peanut responses to liquid organic fertilizer has been reported by Dasumiati et al. (2024), where treatment effects differed among growth and yield components.

### 3.4. Weight of 100 Seeds

The results of the analysis of variance indicate that pineapple peel POC and quail manure have a highly significant effect on the weight of 100 seeds, whereas the interaction between the two treatments has no significant effect. The weight of 100 seeds is an important indicator because it reflects the plant's ability to fill seeds and accumulate assimilates during the generative phase.

**Table 4.** Mean weight of 100 peanut seeds (g) resulting from the application of pineapple peel POC and quail manure

| N | P0 | P1 | P2 | P3 | Average N |
|---|---|---|---|---|---|
| N0 | 50.83 | 53.90 | 63.30 | 61.33 | 57.34 b |
| N1 | 66.33 | 73.20 | 65.50 | 67.37 | 68.10 a |
| N2 | 61.97 | 77.30 | 75.87 | 66.87 | 70.50 a |
| Average P | 59.71 b | 68.13 a | 68.22 a | 65.19 a | |

Note: Numbers without superscripts indicate that the differences between treatments are not significant based on the results of the analysis of variance. N = pineapple peel POC, P = quail manure, N0 = 0 ml/l, N1 = 35 ml/l, N2 = 70 ml/l, P0 = 0 kg/plot, P1 = 1 kg/plot, P2 = 2 kg/plot, and P3 = 3 kg/plot

Table 4 shows that pineapple peel POC increased 100-seed weight from 57.34 g in N0 to 68.10 g in N1 and 70.50 g in N2. The Duncan grouping indicates that N1 and N2 were significantly higher than N0, while N2 was numerically the highest treatment level. For quail manure, P2 produced the highest mean 100-seed weight (68.22 g), followed closely by P1 (68.13 g) and P3 (65.19 g), all of which were higher than P0 (59.71 g). The highest numerical treatment combination was N2P1 (77.30 g), but because the interaction was not significant, it should not be concluded as the statistically best combination. The stronger response in 100-seed weight than in pod number suggests that the treatments mainly enhanced assimilate accumulation and seed filling rather than increasing pod initiation. From a source-sink perspective, organic inputs may have improved source strength through better chlorophyll development, leaf area, and photosynthetic activity, while the number of pods as sinks remained relatively stable. Phosphorus and potassium released from quail manure are particularly relevant during seed filling because phosphorus supports energy transfer and assimilate metabolism, while potassium contributes to carbohydrate transport and water regulation. The lower numerical mean at P3 compared with P1 and P2 indicates that a higher manure dose does not necessarily produce a proportional increase in seed weight, possibly because excessive vegetative demand, nutrient-release imbalance, or local changes in root-zone conditions can reduce the efficiency of assimilate partitioning to seeds. These findings are consistent with Zhang et al. (2023), who reported that organic fertilizer in peanut systems can increase net photosynthetic rate, leaf area index, nodulation, 100-kernel weight, and yield, and with Liu et al. (2023), who reported improved peanut yield and soil environmental quality after organic fertilizer application.

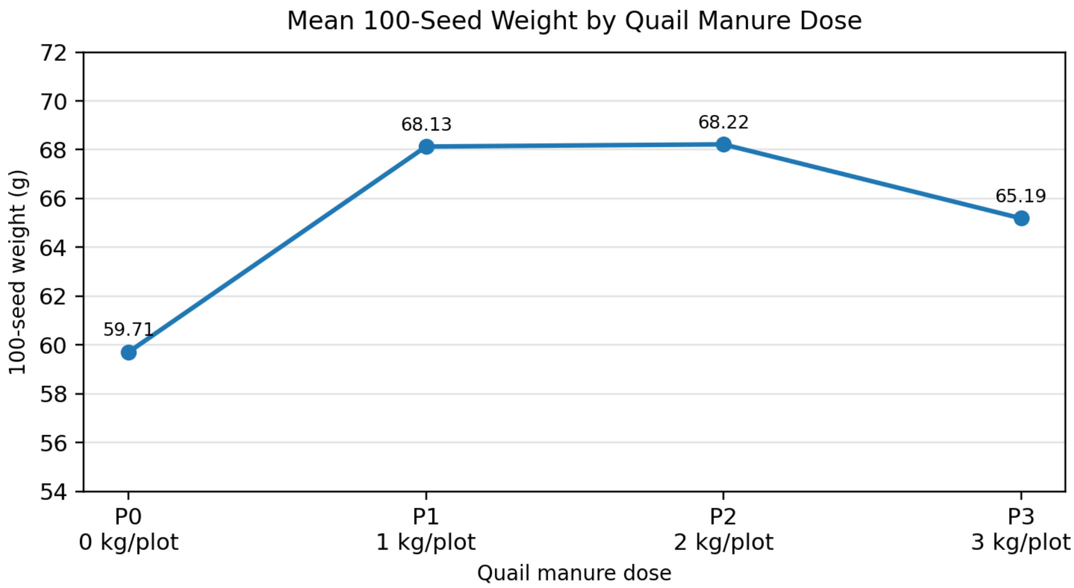


**Figure 3.** Main-effect trend of quail manure dose on 100-seed weight

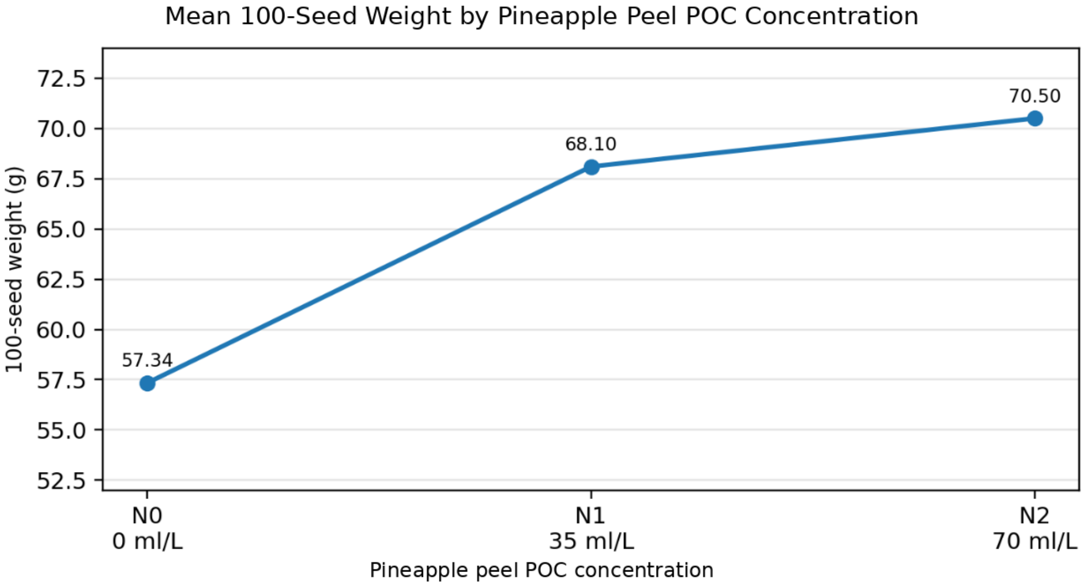


**Figure 4.** Main-effect trend of pineapple peel POC concentration on 100-seed weight

Figure 3 shows that quail manure increased 100-seed weight sharply from P0 to P1, remained almost unchanged at P2, and then declined numerically at P3. Therefore, the seed-filling response was closer to an optimum curve than to a linear dose response, suggesting that P1-P2 were more efficient for seed weight than P3 under the present conditions. Figure 4 shows a consistent increase in 100-seed weight with increasing pineapple peel POC concentration, indicating that the highest tested concentration (70 ml L-1) was still beneficial for seed filling. The non-significant interaction across all observed variables may be attributed to several agronomic factors: the POC dose may have been too low to modify the manure response, the release of nutrients from liquid and solid organic inputs may not have occurred at the same time, the POC application timing may not have fully matched the peak demand for reproductive growth, or the experimental soil may already have provided sufficient baseline fertility to reduce the chance of detecting synergy.

## 4. CONCLUSION

Pineapple peel liquid organic fertilizer and quail manure significantly improved peanut plant height and 100-seed weight, but did not significantly affect stem diameter or the number of pods per plant. The interaction between pineapple peel POC and quail manure was not significant for all observed parameters, indicating that both inputs acted mainly through independent main effects rather than synergistic effects. Under the conditions of this study, the recommended pineapple peel POC concentration is N2 (70 ml L-1), because it produced the highest plant height and 100-seed weight among the POC levels. For quail manure, P2 (2 kg plot-1) is recommended when the main objective is improving seed filling and 100-seed weight, while P3 (3 kg plot-1) may be considered when vegetative growth is prioritized. Thus, a practical yield-oriented recommendation is the use of pineapple peel POC at 70 ml L-1 combined with quail manure around 2 kg plot-1, while recognizing that this recommendation is based on main effects because the interaction was not significant. The results also show the potential of pineapple peel waste as a locally available raw material for liquid organic fertilizer, which can help reduce fruit-processing waste and provide a more economical organic input for peanut cultivation. Future studies should include soil nutrient analysis, POC nutrient characterization, and multi-season testing to determine the most efficient dose combination under different soil conditions.

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