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Nutrient Uptake and Yield of Peanuts (*Arachis hypogaea* L.) under Different NPK Forms and Doses

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Abstract

Fertilization is important in peanut cultivation through the use of fertilizers tailored to crop requirements. This study aimed to determine the effects of NPK fertilizer form and dosage on nutrient uptake and peanut yield. The experiment was arranged in a Randomized Block Design with a 2 × 2 factorial pattern and eight replications, resulting in 32 experimental units. The treatments consisted of two factors: the first was fertilizer form, with granular and blended options. The second factor was NPK fertilizer dosage, with two levels: 200 kg ha^{-1} and 250 kg ha^{-1}. The results showed a significant interaction between fertilizer form and dosage on plant height at 25 days after planting and net pod weight. The highest plant height reached 14.8 cm in the blending form treatment and a dose of 250 kg ha^{-1}, while the best net pod weight was 2,681.8 kg ha^{-1}, obtained from blending fertilizer at a dosage of 200 kg ha^{-1}. In the blended fertilizer form, N and K nutrient uptake were higher than in the granular form. Uptake of P tended to be similar across both fertilizer forms and dosages. Fertilizer dosage significantly affected crop productivity, with the highest yield obtained at 250 kg ha^{-1}.

1. Introduction

Peanut (*Arachis hypogaea* L.) is an important legume crop that plays a vital role in food security by providing sources of protein and fat at both local and national levels. Based on data from the Center for Agricultural Data and Information Systems (PDSIP, 2022a), the supply of peanuts in Indonesia during the 2018–2021 period declined significantly, from 8.02 tons to 6.99 tons. This data is consistent with the average export statistics of peanuts, which also showed a decrease of 595 tons over the same period (PDSIP, 2022b). One factor contributing to low peanut productivity is nutrient deficiency (Sumarno et al., 2013).

Studying nutrient uptake across various NPK fertilizer application rates is essential for assessing plant nutrient utilization efficiency. Nutrient losses and element imbalances are common in Inceptisols, so increasing fertilizer doses does not always equate to increased uptake. This study is necessary to determine optimal NPK doses, improve fertilizer efficiency, and support sustainable soil management and crop production. Inceptisols are soils with an early stage of profile development, so their physical and chemical properties vary widely and are heavily influenced by their parent material and land management. Therefore, soil characterization is important to determine the initial fertility conditions, particularly pH, organic matter content, and nutrient availability, as a basis for evaluating the soil's response to fertilizer treatments.

The availability of nutrients in the soil is closely correlated with crop productivity. One effort to increase peanut productivity is to maintain stable nutrient availability in the soil, which can be achieved through intensification programs that use fertilization. Fertilization is an essential factor in nutrient supply, as plant growth and development are influenced by nutrient availability. Peanut productivity is greatly affected by the availability of macronutrients (N, P, K) and proper fertilizer management. Although legumes have the ability to fix nitrogen, the need for other nutrients besides N (including P and K), as well as the supply of N in the pod zone, still determines plant growth, pod formation, and final yield (Li et al., 2024).

The form (source and formulation) and dosage of NPK fertilizer influence nutrient availability in the soil profile, fertilizer use efficiency (NUE), and nutrient uptake by plants. Recent studies have shown that targeted fertilization can enhance nutrient absorption and yield without excessively increasing the total N dosage (Zhu et al., 2023). In addition to dosage, the method of application (granular/compost fertilizer, solution/fertigation, foliar application, polymer/slow-release fertilizer, nano-fertilizer) has also been proven to affect the absorption efficiency of P and K (Liu et al., 2023).

Fertilization is the process of providing additional nutrients to plants to increase the nutrient content in the soil (Masnang and Wibaningwati, 2023). The primary nutrients required by plants are macronutrients, namely nitrogen (N), phosphorus (P), and potassium (K). Specifically formulated plant-based fertilizers can be an ideal choice for fertilization, as they enhance the effectiveness and efficiency of nutrient application by providing balanced proportions tailored to crop requirements within a single growing season. Although efficient in application, the dosage of compound fertilizers still needs to be adjusted. According to Prayuda (2015), fertilizer dosage can increase nutrient availability in the soil. Applying fertilizer at the proper dosage is crucial to achieving optimal plant growth. Furthermore, to maximize the benefits of fertilizers, selecting the appropriate fertilizer form is essential for ensuring optimal nutrient absorption by plants (Masnang et al., 2022). According to Marella et al. (2020), the smaller or finer the fertilizer particles, the higher their reactivity to water, which allows nutrients to be absorbed more efficiently and become readily available to support plant growth and development. One method to produce fine-grained fertilizer is by grinding, in which the fertilizer is not granulated. This fine-structured fertilizer is known as a blending fertilizer. The objective of this study was to determine the effects of NPK fertilizer form and dosage, and their interaction, on nutrient uptake and yield of peanut plants.

2. Research Methods

2.1. Research Location

This study was conducted from December 2023 to April 2024 at the experimental field of the Research Department of PT Pupuk Kujang Cikampek, Karawang Regency, at an altitude of approximately 46 meters above sea level.

2.2. Research Implementation

The tools used in this research included stationery, a camera, label paper, a sprayer, a SPAD chlorophyll meter (Soil Plant Analysis Development), and other agricultural production equipment. The materials used in this study consisted of peanut seeds of the Garuda Biga variety, NPK-specific fertilizer in granular and blended forms with a 1:2:3 formulation, pesticides, and laboratory tools and materials for analyzing nutrient status and uptake.

The parameters observed in this study are as follows: 1) Analysis of soil nutrient status at the beginning and end of the experiment, 2) Germination test was conducted at 8 DAP 3) Nutrient uptake, observed by taking plant samples at the age of 25 DAP, and 40 DAP from each replication, which were then composited into one sample, 4) Chlorophyll index, observed using SPAD devices at the age of 25 DAP and 40 DAP, 5) Plant agronomics (plant height and number of branches) at the age of 25 DAP, and 40 DAP, 6) Productivity was conducted by observing the pod weight of sample and non-sample plants at 90 DAP, then determining the net pod weight, finding the estimated productivity in hectares (ha) with a correction factor of 75% and germination test according to the data obtained in each plot.

The research was conducted using a Randomized Block Design (RBD) with a 2 x 2 factorial pattern with 8 replications, of which 5 replications were for productivity observation and 3 replications were for nutrient uptake analysis (destructive), resulting in 32 experimental units, consisting of two treatment factors, namely; the first factor, the form of fertilizer consisting of granular (B1) and blending (B2). The second factor was the dose of NPK fertilizer, consisting of two factors, namely 200 kg ha^{-1} (D1) and 250 kg ha^{-1} (D2).

The initial soil nutrient status analysis aimed to determine the appropriate treatments during soil preparation to achieve soil homogenization and minimize potential bias in the study. Based on the results of the initial soil nutrient analysis, it was decided to add soil ameliorants. The materials added included dolomite at 600 kg ha^{-1} and cattle manure at 20 t ha^{-1} to increase organic carbon content, neutralize soil pH, and improve the soil's physical, chemical, and biological properties. Raised beds were formed, and a systemic insecticide/nematicide with carbofuran as the active ingredient was applied. After bed formation, drip tape was installed to support a drip irrigation system, ensuring uniform, measured water distribution across all plants. The drip tape used had a width of 16 mm, a thickness of 200 microns (0.2 mm), and an emitter spacing of 40 cm. It could work at a pressure of 0.2-1.2 bar and an average flow rate of 2 L h^{-1}, with two lines per bed installed between plant rows. The fertilizers used were in granular and blended forms, applied using the *tugal* (dibble stick) system along each planting row. This method required precise adjustment of fertilizer dosage for each plant, which was then multiplied by the number of plants in one row to obtain the total fertilizer dose per row. This technique was applied because it is efficient in application and ensures that each plant receives an equal amount of fertilizer (Table 1).

Table 1. Dosage of fertilizer used

Notation	Dosage kg ha^{-1}	Population ha^{-1}	Dosage g plant^{-1}	Dosage g raw^{-1}
	(a)	(b)	(c)=(a/b*1000)	(d)=(c*16)
B1D1	200	101470	1.97	31.52
B1D2	250	101470	2.46	39.36
B2D1	200	101470	1.97	31.52
B2D2	250	101470	2.46	39.36

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}. The plant population was determined based on the planting spacing; the effective land area yielded 16 plants per row.

Each treatment unit consisted of 64 plants arranged in four rows, with 16 plants per row. Therefore, the fertilizer dose per plant was multiplied by 16 to obtain the fertilizer dose per row. Once the dose per row was known, the next step was to prepare the fertilizer by weighing it according to the specified amount. The next step was to prepare the fertilizer by weighing it according to the specified dosage. The fertilizer was then placed in plastic bags and labeled according to the treatment notation (Figure 1).

Figure 1. Fertilizer form and packaging.

The seed variety used is Garuda Biga, which has undergone peeling, sorting, and grading. Planting was carried out simultaneously with fertilizer application, with each planting hole filled with one peanut seed to ensure adequate growing space and reduce nutrient competition between plants. Seeds were planted at a depth of approximately 4 cm, sufficient to protect them from surface disturbance and provide ideal conditions for germination. Planting was carried out with a spacing of 17 cm between planting holes within rows and 30 cm between rows.

Samples were obtained from five planting locations, while samples for the final soil (Inceptisol) nutrient status analysis were obtained from each replication unit, then composited into soil samples based on treatment. The test parameters included N, P, K, pH, organic carbon content, and soil texture. The analysis was conducted in PT's Research Department laboratory. *Pupuk* Kujang uses electrometry, Kjeldahl, spectrophotometry, pipette, selective sequential extraction (SSA), and atomic absorption spectroscopy (AAS) methods.

Germination is a non-destructive test conducted to determine the percentage of seeds that germinate and grow (Equation 1). This test aims to determine the percentage of seed germination by comparing the number of seeds planted with the number that germinated 8 days after planting. Germination provides information on the viability of seeds used in planting. In this study, the germination percentage obtained was 90%.

$$\text{Germination Test} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds planted}} \times 100\ \% \quad (1)$$

Nutrient uptake was measured destructively by taking samples at 25 and 40 days after planting (DAP), with four plants per experimental unit. Parameters analyzed included the N, P, and K content of the plant samples. Nutrient uptake analysis was conducted in the Research Department's laboratory at PT. Pupuk Kujang uses the Kjeldahl, Spectrophotometry, Selective Sequential Extraction (SSA), and Gravimetry methods.

The chlorophyll index is measured using a SPAD (Soil Plant Analysis Development) tool (Figure 2). Measurements are made on three actively photosynthesizing leaves. High chlorophyll levels indicate good plant health and optimal photosynthetic ability, while low chlorophyll levels indicate problems with plant growth.

Figure 2. Observation of chlorophyll index using a SPAD meter.

Plant height and number of branches were measured at 25 and 40 days after planting. Productivity was calculated as the number of pods and seeds produced by sample and non-sample plants. The number of harvested pods was recorded, and pod quality was analyzed by grouping them into large, empty, and neutral pods. Next, the weight and number of each category were recorded. Productivity was expressed in kg ha^{-1} and used to evaluate the treatment's effectiveness.

2.3. Data Analysis

Observation data on peanut plants were statistically analyzed using STAR (Statistical Tool for Agricultural Research) software version 2.0.1 to determine analysis of variance (ANOVA) using a factorial Randomized Block Design (RBD). This was followed by a Least Significant Difference (LSD) test to identify significantly different treatments.

3. Results and Discussion

3.1. Soil Nutrient Status

Soil analysis results showed changes in several parameters from the initial to the final measurement (Table 2). This is suspected to be due to the addition of ameliorants, such as chemical fertilizers, manure, dolomite, or combinations of these materials.

Table 2. Analysis of soil nutrient status

Parameter Analysis	Unit	Analysis Result						Criteria
		Initial		Final				
		Result	Criteria	B1D1	B1D2	B2D1	B2D2	
pH (H_2O)	-	6.3	Slightly Acidic	7,1	7,1	6,7	6,7	Neutral
N-Total	%	0,18	Low	0,12	0,13	0,13	0,12	Very Low
P_2O_5	ppm	408	Very high	47	63	55	69	Very High
K_2O	mg $100g^{-1}$	11	Low	23	23	24	24	Moderate
C-Organic	%	1,3	Low	1,3	1,5	1,4	1,4	Low
Texture	% Sand	21						
	% Silt	30						
	% Clay	49			Clay			

Source: Pusat Penelitian Tanah, 1983

Based on the initial and final soil nutrient analysis, changes in nutrient status were identified in several parameters. Soil pH at 6.3 is slightly acidic. After the application of the amelioration technique, an increase in soil pH to 6.7-7.1 indicates a shift toward neutral conditions. This increase in soil pH is one of the factors that causes the P_2O_5 parameter, or the source of P in the soil, to decrease. Although the initial analysis had a very high criterion of 405 ppm, this value decreased to 47-69 ppm in the final analysis.

This decrease in P is thought to result from more effective phosphorus release as soil pH increases. At neutral pH, P release is better because there is no formation of poorly soluble phosphate compounds, such as calcium phosphate in alkaline soils or aluminum phosphate in acidic soils. This reduces P fixation, making phosphorus more readily available and absorbed by plants. The decrease in P can also be attributed to increased phosphorus uptake by plants during the growing period and the possible fixation of phosphorus in secondary mineral forms (Dong et al., 2022; Wang and Chu, 2015). Despite the positive changes in soil pH that increased phosphorus availability, the total N content in the soil actually decreased, although it remained within the low criterion. N decreased from 0.18% in the initial analysis to 0.12%-0.13% in the final analysis. This decrease indicates that during cultivation, there was an interaction between the N element and the plants, affecting soil nitrogen levels.

Analysis of potassium (K_2O) showed that the initial K content was low, at 11 mg $100g^{-1}$, but increased to 23-24 mg $100g^{-1}$ in the final analysis, resulting in a moderate level. This is likely due to the use of fertilizers with the highest K content relative to other elements, which maintained soil K balance. Potassium is a macronutrient that is readily soluble and rapidly absorbed by plants, but can also be retained in the soil if bound by clay minerals or stable organic matter (Oze et al., 2019; Meyer et al., 2023). Furthermore, balanced application of NPK fertilizers can increase the availability of K in the soil because nutrient synergy affects microbial activity and cation exchange (Velasco-Sánchez et al., 2024; Leon-Chang et al., 2022). The organic carbon content increased from 1.3% to 1.5%, although it remained low. This was partly due to the manure's stable rate of decomposition. Overall, the applied ameliorant material successfully neutralized the soil pH but was not effective at increasing soil organic carbon.

3.2. Nutrient Uptake

The results of the nutrient uptake analysis show the accumulation and distribution of nutrients in plants at 25 and 40 days after planting. Comparing nutrient uptake data can provide an overview of treatment effectiveness. Plant uptake of nitrogen (N), phosphorus (P), and potassium (K) varied because soil nutrient availability was influenced by the treatment, as shown in Figure 3a, 3b, and 3c.

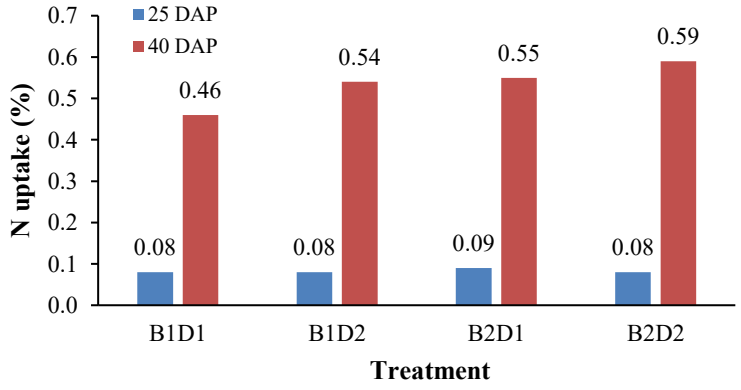

Figure 3a. Plant uptake of nitrogen (%).

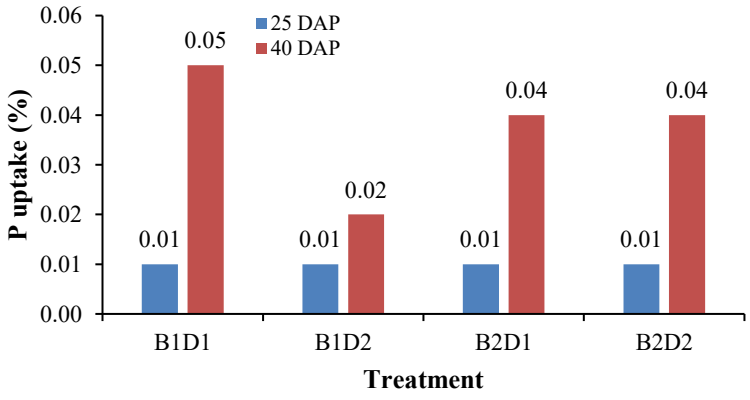

Figure 3b. Plant uptake of phosphorus (%).

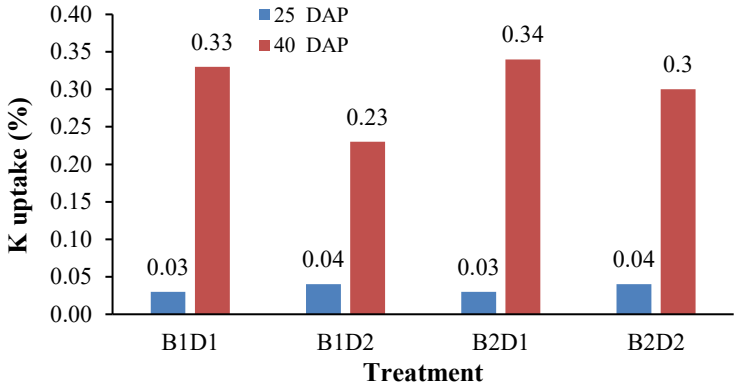

Figure 3c. Plant uptake of potassium (%).

Based on nutrient absorption data at the age of 25 DAP and 40 DAP, there are changes in nutrient absorption by plants. At the age of 25 DAP, nitrogen (N) absorption per plant ranges from 0.08% to 0.09%. In contrast, at 40 DAP nitrogen absorption increases to between 0.46% to 0.59%, this shows that the plant's need for N elements is needed more in the 40 DAP phase and the combination of treatments tends to be better in the two forms (blending) because of the characteristics of blending fertilizers which have high reactivity to water, while for phosphorus (P) absorption per plant at 25 DAP is constant at 0.01% and increases to between 0.02% to 0.05% at 40 DAP In addition, potassium (K) absorption per plant at 25 DAP ranges from 0.03% to 0.04%. In comparison, at 40 DAP, it increases to between 0.23% and 0.34%. The increase in K absorption is caused by the fertilizer formulation, which is rich in K, making it more readily available in the soil. Overall, this increase in nutrient absorption and accumulation indicates that plants absorb more nutrients as they grow, a pattern influenced by the treatment.

Nutrient uptake analysis showed increased N, P, and K uptake from 25 DAP to 40 DAP across all treatments, consistent with nutrient accumulation during the vegetative phase towards the beginning of the reproductive phase in peanut plants. According to Yu et al. (2019), the increase in N and K uptake mainly reflects the increased biomass requirements and higher uptake efficiency at the next plant age, indicating faster nutrient accumulation around 30–40 DAP. The low percentage of phosphorus (P) uptake relative to N and K indicates limited P availability or plant P uptake efficiency—a common phenomenon in peanuts due to P binding to the soil and dependence on root morphology and P acquisition mechanisms. According to Ding et al. (2022), efforts to increase P efficiency through improved acquisition (e.g., development of root morphology, assistance from phosphate-solubilizing microbes) or through fertilizer management (organic + NPK combination, and specific dose recommendations) have been shown to increase P uptake and fertilizer efficiency in peanuts. The statistical analysis showed that neither the interaction between NPK fertilizer form and fertilizer dose nor the main factors significantly affected seed germination (Table 3).

Table 3. Germination test

Treatment	Germination (%)
B1D1	90.0
B1D2	90.2
B2D1	88.4
B2D2	93.8

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}.

The results of the statistical test showed that although none of the treatments were statistically significantly different, the B2D2 treatment had the highest germination value, namely 93.8, indicating the best plant growth performance among the treatments during this observation period. The B1D2 treatment showed a higher germination value (90.2) than B1D1, while B2D1 had the lowest germination value (88.4), though still within a relatively similar range. The difference in germination values between these treatments can be attributed to the effect of the combination of fertilizer form and dosage on nutrient availability and plant absorption efficiency. Increasing the fertilizer dosage to the optimum limit can improve the availability of macro- and micronutrients, ultimately affecting plant vegetative growth. However, when differences between treatments are not statistically significant, this is often due to uniform environmental conditions or good plant adaptation to the treatment. In addition, plant physiological factors can also contribute to relatively uniform results between treatments.

According to Nugraha and Islami (2021), peanut plants can adapt to variations in NPK fertilizer dosage, primarily due to their symbiotic relationship with Rhizobium bacteria, which aid nitrogen fixation and maintain nutrient balance. Therefore, although the difference was not significant, the high germination rate in the B2D2 treatment indicates that this combination of fertilizer form and dosage provided the most favorable conditions for plant growth during this observation period. Based on the results of the analysis of variance in Table 4, the chlorophyll index at 25 and 40 days after planting did not significantly differ between fertilizer types and dosage levels.

Table 4. Average chlorophyll index

Treatment	Chlorophyll Index	
	25 DAP	40 DAP
B1D1	38.06	41.06
B1D2	37.76	41.14
B2D1	38.38	41.54
B2D2	38.90	41.90

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}.

The chlorophyll index analysis showed that the B2D2 treatment consistently produced the highest value, reaching 38.90 at 25 DAP and increasing to 41.90 at 40 DAP. Conversely, at 25 DAP, the lowest chlorophyll index was recorded in the B1D2 treatment with a value of 37.76, and at 40 DAP. The lowest value was recorded in the B1D1 treatment with a chlorophyll index of 41.06. These results indicate that the B2D2 treatment had the most positive impact on increasing chlorophyll during the two growth phases, while B1D2 and B1D1 showed lower values in each phase. The chlorophyll index in leaves is influenced by nitrogen, and fertilizer solubility is strongly related to nitrogen uptake in plants.

The results of the N nutrient uptake analysis (Figure 3a) show that treatments that focused on fertilizer formulations with factors B2 and D2 resulted in a higher percentage of chlorophyll absorbed by plants. This is due to the high reactivity of blended fertilizers with water, which makes nutrients quickly available to plants. This results in increased nitrogen uptake efficiency by plants, which in turn increases chlorophyll production. The increase in the chlorophyll index in the B2D2 treatment can be attributed to improved nitrogen (N) availability (Figure 3a), as N is a key component of chlorophyll formation and plays a crucial role in this process (Zhang et al., 2021). The availability of P and K also supports chlorophyll synthesis by increasing the efficiency of energy metabolism and ion transport in leaf tissue.

The results of the analysis of variance showed that the treatments significantly differed in plant height at 25 DAP. Based on Table 5, at 25 DAP, the B2D2 treatment had the highest average plant height (14.8 cm), while B1D2 had the lowest (12.6 cm). At 40 DAP, the B1D1 treatment achieved the highest growth, with an average plant height of 38.2 cm, followed by B1D2 and B2D1 at 35.8 cm, and B2D2 at 35.2 cm. The combination of fertilizer forms and doses significantly differed in plant height in the final vegetative phase (25 DAP). The use of a granular fertilizer at a dose of 200 kg ha^{-1} (B1D1) resulted in the best growth, with an average height of 38.2 cm, as this combination effectively met nutrient requirements, particularly nitrogen (N).

Table 5. Average plant height

Treatment	Plant Height (cm)	
	25 DAP	40 DAP
B1D1	14.2 a	37.0 a
B1D2	12.6 b	35.5 a
B2D1	14.2 a	37.0 a
B2D2	14.8 a	35.5 a

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}. Numbers followed by the same letter in the same column indicate no significant difference at the 5% level.

Nitrogen plays a crucial role in stimulating vegetative growth, including stem and leaf growth. Furthermore, nitrogen is needed to form important compounds like chlorophyll, nucleic acids, and enzymes, all of which

contribute to plant growth. Nitrogen deficiency in the soil disrupts plant growth and development, reducing yields by inhibiting chlorophyll formation, which is crucial for photosynthesis (Sartini, 2020).

Based on the results of the analysis of variance in Table 6, the interaction between fertilizer form and dose did not significantly affect the number of branches of peanut plants (*Arachis hypogaea* L.). In observations at 25 and 40 DAP, the highest number of branches was recorded in the B2D1 treatment, with a value of 6.8 at 25 DAP and increased to 8.2 at 40 DAP, while the lowest number of branches was in the B1D2 treatment, namely 6.4 at 25 DAP and 7.8 at 40 DAP.

Table 6. Average number of branches

Treatment	Number of branches	
	25 DAP	40 DAP
B1D1	6.6	8.0
B1D2	6.4	7.8
B2D1	6.8	8.2
B2D2	6.6	8.0

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}.

Observations of net pod weight showed that the treatments significantly affected it, as shown in the analysis results in Table 7. The combination of fertilizers, in terms of form and dosage, significantly affected the net weight of peanut pods. B2D1 treatment (blending fertilizer at a dose of 200 kg ha^{-1}) yielded the highest net weight of 1475.50 g. The lowest weight in the B1D1 treatment (granular fertilizer with a dose of 200 kg ha^{-1}) was significantly different from other treatments because the dose used was below the recommended dose, and the form of granular fertilizer was characterized by not being easily dissolved because its reactivity to water was low, so it was not quickly available to plants.

Table 7. Average net pod weight

Treatment	Net Pod Weight (g)
B1D1	1085.97 b
B1D2	1216.43 a
B2D1	1475.50 a
B2D2	1236.22 a

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}. Numbers followed by the same letter in the same column indicate no significant difference at the 5% level.

Table 8. Peanut productivity

Treatment	Productivity (kg ha^{-1})
B1	1371.83 a
B2	1328.75 a
D1	1221.36 b
D2	1479.23 a

Notes: B1 = granular form; B2 = blending form; D1 = dosage of 200 kg ha^{-1}; D2 = dosage of 250 kg ha^{-1}. Numbers followed by the same letter in the same column indicate no significant difference at the 5% level.

Based on Table 8 above, the dose of 250 kg ha^{-1} is statistically proven to be the best dose in increasing peanut productivity, with a yield of 1479.23 kg ha^{-1}. This productivity is significantly higher than that at the 200 kg ha^{-1} dose, which was only 1221.36 kg ha^{-1}. Thus, a dose of 250 kg ha^{-1} can be considered more effective than 200 kg

ha^{-1} in increasing peanut plant production. This occurs because a higher dose can provide a more adequate amount of nutrients, support optimal vegetative growth, and increase fertilizer absorption efficiency, ultimately increasing the number and quality of pods by better meeting the plant's nutritional needs.

4. Conclusion

There was a significant interaction effect between the form and dose of NPK fertilizer on plant height at 25 days after planting and net pod weight. The highest plant height reached 14.8 cm in the blending form treatment and a dose of 250 kg ha^{-1}, 17.5% higher compared to granular fertilizer at the same dose, and the best net pod weight was 2681.8 kg ha^{-1} in the blended fertilizer treatment at a dose of 200 kg ha^{-1}, 35.87% higher compared to using the granular form at the same dose. N and K nutrient uptake in the blended fertilizer was higher than that in the granulated fertilizer. P uptake tended to be similar across both fertilizer forms and doses. Fertilizer application at 250 kg ha^{-1} significantly increased plant productivity, yielding the highest yield.

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References

Ding, H., Zhang, Z., Zhang, G., Xu, Y., Guo, Q., Qin, F., Dai, L. 2022. Nitrogen application improved peanut yield and nitrogen use efficiency by optimizing root morphology and distribution under drought stress. Chilean Journal of Agricultural Research 82(2), 256-265. https://doi.org/10.4067/S0718-58392022000200256

Dong, Z.K., Zhang, S.Q., Li, Y.T., Gao, Q., Zhao, B.Q., Yuan, L. 2022. Effects of chelating agent on dissolution, fixation and fertisphere transformation of diammonium phosphate. Scientia Agricultura Sinica 55(21), 4225-4236. https://doi.org/10.3864/j.issn.0578-1752.2022.21.010

Leon-Chang, D.P., Bryla, D.R., Scagel, C.F., Strik, B.C. 2022. Influence of fertigation and granular applications of potassium fertilizer on soil pH and availability of potassium and other nutrients in a mature planting of Northern Highbush Blueberry. HortScience 57(11), 1377-1386. https://doi.org/10.21273/HORTSCI16747-22

Li, G., Guo, X., Sun, W., Hou, L., Wang, G., Tian, R., Wang, X., Qu, C., Zhao, C. 2024. Nitrogen application in pod zone improves yield and quality of two peanut cultivars by modulating nitrogen accumulation and metabolism. BMC Plant Biology 24, 48. https://doi.org/10.1186/s12870-024-04725-1

Liu, Y., Yan, Z., Wang, J., Zhao, J., Liu, Y., Zou, J., Li, L., Zhang, J., Wan, S. 2023. Optimizing initial nitrogen application rates to improve peanut (*Arachis hypogaea* L.) biological nitrogen fixation. Agronomy 13(12), 3020. https://doi.org/10.3390/agronomy13123020

Marella, S., Nirmal Kumar, A.R., Prasad Tollamadugu, N.V.K.V. 2020. Nanotechnology-based innovative technologies for high agricultural productivity: Opportunities, challenges, and future perspectives. In: Recent Developments in Applied Microbiology and Biochemistry: Volume 2. Elsevier, pp. 211-220. https://doi.org/10.1016/B978-0-12-821406-0.00019-9

Masnang, A., Jannah, A., Wibaningwati, D.B., Nurilmala, F., Nurhayati, L. 2022. Placement precision of organic fertilizer based on soil conservation in taro cultivation. Jurnal Teknik Pertanian Lampung 11(3), 396-404. https://doi.org/10.23960/jtep-l.v11i3.396-404

Masnang, A., Wibaningwati, D.B. 2023. Effectiveness of application of organic fertilizer on plant growth and yield of taro on dry land. AIP Conference Proceedings 2583(1), 060015. https://doi.org/10.1063/5.0116537

Meyer, G., Bell, M.J., Kopittke, P.M., Lombi, E., Doolette, C.L., Brunetti, G., Klysubun, W., Janke, C.K. 2023. Mobility and lability of phosphorus from highly concentrated fertiliser bands. Geoderma 429, 116248. https://doi.org/10.1016/j.geoderma.2022.116248

Nugraha, R., Islami, T. 2021. Pengaruh dosis rhizobium dan pupuk kandang kambing pada pertumbuhan dan hasil tanaman kacang tanah (*Arachis hypogea* L.). PLANTROPICA: Journal of Agricultural Science 6(1), 21-29. https://doi.org/10.21776/ub.jpt.2020.006.1.3

Oze, C., Smaill, J.B., Reid, C.M., Palin, M. 2019. Potassium and metal release related to glaucony dissolution in soils. Soil Systems 3(4), 70. https://doi.org/10.3390/soilsystems3040070

PDSIP. 2022a. Statistik Konsumsi Pangan Tahun 2022. Kementerian Pertanian. Retrieved from https://satudata.pertanian.go.id/details/publikasi/407 (in Indonesian)

PDSIP. (2022b). Statistik Makro Sektor Pertanian 2022 Kementerian Pertanian. Retrieved from https://satudata.pertanian.go.id/details/publikasi/379 (in Indonesian)

Prayuda, C. 2015. Pengaruh Bentuk dan Dosis Pupuk NPK Majemuk Susulan pada Viabilitas Benih Kedelai (*Glycine max* (L.) *Merril*) Varietas Dering 1 Pascasimpan Tiga Bulan. Bachelor Thesis. Universitas Lampung. (in Indonesian)

Pusat Penelitian Tanah. 1983. Terms of Reference Survey Kapabilitas Kesuburan Tanah. Departemen Pertanian Bogor. (in Indonesian)

Sartini. 2020. Mengenal Pupuk Nitrogen dan Fungsinya Bagi Tanaman. Balai Penelitian Pertanian Lahan Rawa. Kementerian Pertanian.

Sumarno, S., Hartati, S., Widijanto, H. 2013. Kajian macam pupuk organik dan dosis pupuk P terhadap hasil kacang tanah (*Arachis hypogaea* L.) dl tanah Entisol. Sains Tanah - Journal of Soil Science and Agroclimatology 1(1), 1-6. https://doi.org/10.15608/stjssa.v1i1.86

Velasco-Sánchez, Á., Bennegadi-Laurent, N., Trinsoutrot-Gattin, I., van Groenigen, J.W., Moinet, G. 2024. Soil microorganisms increase Olsen phosphorus from poorly soluble organic phosphate: A soil incubation study. Soil Use and Management 40(1), 1-15. https://doi.org/10.1111/sum.12960

Wang, J., Chu, G. 2015. Phosphate fertilizer form and application strategy affect phosphorus mobility and transformation in a drip-irrigated calcareous soil. Journal of Plant Nutrition and Soil Science 178(6), 914-922. https://doi.org/10.1002/jpln.201500339

Yu, T.Y., Li, X.L., Lu, Y., Sun, X.W., Zheng, Y.M., Wu, Z.F., Shen, P., Wang, C.B. 2019. Effect of phosphorus (P) on nitrogen (N) uptake and utilization in peanut. Acta Agronomica Sinica 45(6), 912-921. https://doi.org/10.3724/SP.J.1006.2019.84107

Zhang, S., Cheng, Y.Y., Wu, H., Zheng, Q., Wang, X.B., Zhang, S.Q. 2021. Microbial biomass carbon, nitrogen and enzyme activities within aggregates of calcareous soil under biochar application. Journal of Plant Nutrition and Fertilizers 27(3), 369-379. https://doi.org/10.11674/zwyf.20500

Zhu, X., Ros, G.H., Xu, M., Cai, Z., Sun, N., Duan, Y., de Vries, W. 2023. Long-term impacts of mineral and organic fertilizer inputs on nitrogen use efficiency for different cropping systems and site conditions in Southern China. European Journal of Agronomy 146, 126797. https://doi.org/10.1016/j.eja.2023.126797