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Effect of Guano and KCl Fertilizer Application on the Growth and Yield of Peanut (*Arachis hypogaea* L.)

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Abstract:
Heavy reliance on chemical fertilizers limits sustainable peanut (*Arachis hypogaea* L.) production in Indonesia. This study evaluated the effects of guano and KCl fertilizer doses and their interaction on the growth and yield of peanut. A field experiment was conducted from June to October 2025 in Jember, East Java, using a factorial randomized block design with three replications. The first factor was guano dose (0, 5, 10, and 15 t/ha), and the second was KCl dose (75 and 100 kg/ha). Data were analyzed by ANOVA and Duncan's multiple range test. Guano had a highly significant effect on the number of branches; 15 t/ha produced 6.31 and 8.39 branches at 28 and 42 days after planting (DAP), 29.0% and 35.5% more than without guano, although 5 t/ha was equivalent at 42 DAP. KCl at 100 kg/ha increased the number of filled pods (23.53 pods) and dry biomass (38.31 g) by 11.6% and 15.7%. The guano × KCl interaction affected plant height and number of leaf stalks at 28 DAP and 100-seed weight, with the highest values under 0 t/ha guano and 75 kg/ha KCl. Pod and seed weights were unaffected. Guano promotes branching, whereas 100 kg/ha KCl improves pod filling.

Keywords:
bat guano, organic fertilizer, potassium, pod filling, peanut

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INTRODUCTION

Peanut (*Arachis hypogaea* L.) is the second most important legume crop in Indonesia after soybean and is an important source of vegetable protein and oil for food and feed. Demand for peanuts has increased steadily due to population growth, greater nutritional awareness, food diversification, and the expansion of the food and feed industries. National production, however, has not kept pace with this demand, and the gap has been filled largely by imports. Increasing productivity per unit area is therefore a priority, and nutrient management is one of the factors most directly under the farmer's control. Studies on groundnut in other tropical regions show that imbalanced and inadequate fertilization is one of the main reasons for low yields, and that yields respond strongly when nutrient supply is matched to crop demand (Naveen and Senthilkumar, 2021; Mohanty et al., 2022). In East Java, including Jember Regency, peanuts are commonly grown on dryland and in paddy fields after rice, and farmers depend mainly on chemical fertilizers, rarely returning organic matter to the soil. Under such conditions, soil organic carbon tends to decline, nutrient retention becomes weaker, and the efficiency of applied fertilizers decreases. Fertilization strategies that maintain soil quality while supplying the nutrients needed for pod formation are therefore required.

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Potassium (K) is the nutrient that peanuts require in the second largest quantity after nitrogen. It regulates stomatal opening, photosynthesis, enzyme activation, protein synthesis, and the transport of assimilates from leaves to developing organs (Hasanuzzaman et al., 2018). In peanut, K deficiency reduces photosynthetic capacity and yield (Liu et al., 2023), whereas adequate K supply increases the number and mass of marketable pods (Abreu et al., 2024). Potassium chloride (KCl) is the most widely used K source in Indonesia, and its dose and timing affect pod formation in legumes (Alfy and Handoyo, 2022). The response of peanut to K fertilizer is not constant; it depends on soil K status, plant density, and production environment (Cordeiro et al., 2023). Under high soil fertility, additional KCl may offer little benefit, while repeated use of chemical fertilizers without organic inputs can contribute to declines in soil organic matter and overall soil quality.

Combining organic and inorganic nutrient sources is widely recommended to maintain soil fertility and sustain crop yields. In groundnut-based systems, integrated nutrient management that combines organic manures with reduced rates of chemical fertilizers improved soil organic carbon, soil biological activity, and system productivity, and saved about 25% of chemical fertilizers (Bana et al., 2024). Organic manures, combined with inorganic phosphorus, also increased groundnut nutrient uptake and yield (Sharma et al., 2020). Among organic fertilizers, bat guano is of particular interest because it is rich in nitrogen, phosphorus, potassium, calcium, and other nutrients (Abd Rahman et al., 2023). Application of bat guano has been reported to increase the cation exchange capacity, macronutrient content, and pH of soil (Karagöz and Hanay, 2020), and guano harbors diverse bacterial communities that may contribute to nutrient cycling (Newman et al., 2018).

Guano has been shown to improve the growth of various crops, including cassava (Linn and Myint, 2018), water spinach (Maisarah and Fitriah, 2022), fenugreek (Simon et al., 2024), and tomato, for which its effects were comparable to those of farmyard manure and chemical fertilizers (Singh et al., 2025). In peanut, guano application increased plant height, number of branches, number of pods, and pod weight (Risnayanti et al., 2025), and a combination of 10 t/ha guano with 75 kg/ha NPK gave the highest pod yield of 2.98 t/ha (Amir et al., 2022). In contrast, Yeri et al. (2023) found that the treatment without guano performed as well as or better than guano treatments for several growth variables, indicating that the response to guano depends on the site and the accompanying fertilizers. These contrasting results show that the benefit of guano cannot be assumed and should be tested under the specific soil and management conditions in which it is to be used. The optimum dose also has practical importance, because guano is applied at several tonnes per hectare and its cost and transport represent a considerable part of the production budget for smallholder farmers.

Although guano and KCl have each been studied, information on how guano doses interact with KCl doses in peanut is limited. Because guano also supplies K, its application may alter the amount of KCl the crop needs, and the combination that yields the best growth and yield cannot be predicted from single-factor studies. Farmers also lack clear recommendations on the appropriate doses of guano and KCl for peanut. Therefore, this study aimed to evaluate the effects of guano dose, KCl dose, and their interaction on peanut growth and yield, and to identify the most effective dose combination. We hypothesized that guano would improve vegetative growth and that the effect of KCl on yield components would depend on the guano dose.

METHOD

The field experiment was conducted from June to October 2025 in Krajan Hamlet, Slawu Village, Patrang District, Jember Regency, East Java, Indonesia. The soil at the site was soil

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type/texture, determined from a composite sample taken at 0–20 cm before planting. Rainfall and air temperature during the growing season. The experiment was arranged in a factorial randomized block design (RBD) with two factors and three replications. The first factor was guano dose (K), with four levels: K0 = 0 t/ha (without guano), K1 = 5 t/ha, K2 = 10 t/ha, and K3 = 15 t/ha. The second factor was KCl dose (T), with two levels: T1 = 75 kg/ha and T2 = 100 kg/ha. The combination of the two factors produced eight treatments (Table 1), giving 24 experimental plots. Blocking was used to control field variation in soil fertility and moisture. Blocks were arranged perpendicular to the slope/soil gradient of the field, and treatments were assigned at random to plots within each block.

Table 1. Treatment combinations of guano and KCl doses

Guano dose	T1 (KCl 75 kg/ha)	T2 (KCl 100 kg/ha)
K0 (0 t/ha)	K0T1	K0T2
K1 (5 t/ha)	K1T1	K1T2
K2 (10 t/ha)	K2T1	K2T2
K3 (15 t/ha)	K3T1	K3T2

Note: Each treatment combination was replicated three times, giving 24 experimental plots.

The data were analyzed according to the linear model of a two-factor factorial RBD: $Y_{ijk} = \mu + \rho_k + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$, where Y_{ijk} is the observation in the *k*-th block receiving the *i*-th guano dose and the *j*-th KCl dose, μ is the general mean, ρ_k is the effect of the *k*-th block, α_i is the effect of the *i*-th guano dose, β_j is the effect of the *j*-th KCl dose, $(\alpha\beta)_{ij}$ is the interaction effect, and ε_{ijk} is the random error. The land was cleared, plowed, and harrowed, and raised plots were prepared with 50 cm between plots and 100 cm between blocks. Guano was spread evenly on each plot according to the treatment and incorporated into the topsoil 7 days before planting. KCl was applied at planting in furrows beside the planting rows together with the basal fertilizers. Seeds were sown at two seeds per hole at a spacing of 40 cm × 15 cm and thinned to one plant per hole. Plants were irrigated as needed to maintain adequate soil moisture. Weeding and earthing up were carried out at DAP, and pests and diseases were controlled when necessary. Plants were harvested at physiological maturity, when most pods had a dark inner pericarp and the leaves had turned yellow.

Growth variables were recorded on five sample plants selected at random from the inner rows of each plot, excluding border plants. Plant height was measured from the soil surface to the tip of the main stem, and the number of leaf stalks (petioles) and primary branches was counted at 14, 28, and 42 days after planting (DAP). At harvest, the number of filled and empty pods, pod weight per sample, dry seed weight per sample, and dry biomass per sample were recorded. Pod weight per plot was determined from all plants in the net plot, and 100-seed weight was obtained by weighing 100 randomly selected seeds from each plot. Pods and seeds were sun-dried to a moisture content before weighing, and biomass was oven-dried at 70 °C for 48 h. The observed variables are summarized in Table 2.

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Table 2. Observed variables, units, and time of observation

Variable	Unit	Basis	Time
Plant height	cm	Sample plants	14, 28, 42 DAP
Number of leaf stalks	stalks	Sample plants	14, 28, 42 DAP
Number of branches	branches	Sample plants	14, 28, 42 DAP
Number of filled and empty pods	pods	Per sample	Harvest
Pod weight	g	Per sample and per plot	Harvest
Dry seed weight	g	Per sample	Harvest
100-seed weight	g	Per plot	Harvest
Dry biomass	g	Per sample	Harvest

Note: DAP = days after planting

Statistical Analysis

Data were tested for normality and homogeneity of variances before analysis. The data were subjected to two-way analysis of variance (ANOVA) according to the factorial RBD model. When the F-test showed a significant effect ($p < 0.05$), means were separated using Duncan's multiple range test (DMRT) at the 5% level, and highly significant effects ($p < 0.01$) were separated at the 1% level. When the interaction was significant, simple effects were compared: KCl doses within each guano dose and guano doses within each KCl dose. Main effects were compared only when the interaction was not significant. Analyses were performed using statistical software. In addition, the relative difference between the best and the lowest treatment for each significant variable was calculated as (best − lowest)/lowest × 100%. This value was used only to describe the magnitude of the response and not as a statistical test. Because yield components were measured per sample, pod weight per plot was used to represent yield at the field scale, and the ANOVA coefficient of variation (CV) was examined to assess experimental precision.

RESULTS

The ANOVA summary is presented in Table 3. Guano dose had a highly significant effect on the number of branches at 28 and 42 DAP. KCl dose had a significant effect on the number of filled pods and dry biomass. The interaction between guano and KCl was significant for plant height, number of leaf stalks at 28 DAP, and 100-seed weight. None of the factors significantly affected plant height and number of leaf stalks at 14 and 42 DAP, number of branches at 14 DAP, number of empty pods, pod weight per sample, pod weight per plot, or dry seed weight per sample.

Plant Height and Number of Leaf Stalks

At 28 DAP, the response of plant height to KCl depended on the guano dose (Table 4). Without guano, plants receiving 75 kg/ha KCl were 4.43 cm (42.7%) taller than those receiving 100 kg/ha KCl, whereas at 5, 10, and 15 t/ha guano the two KCl doses did not differ. At 75 kg/ha KCl, plants without guano were taller than those receiving 5 t/ha guano, while at 100 kg/ha KCl, guano dose had no effect.

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Table 3. Summary of analysis of variance (F-values) for the effects of guano and KCl on peanut growth and yield

No.	Observed variable	Age	Guano (K)	KCl (T)	K × T
1	Plant height	14 DAP	1.32 ns	0.15 ns	0.61 ns
		28 DAP	0.46 ns	0.51 ns	4.88 *
		42 DAP	0.13 ns	0.00 ns	0.98 ns
2	Number of leaf stalks	14 DAP	0.18 ns	0.00 ns	1.29 ns
		28 DAP	1.76 ns	0.00 ns	5.01 *
		42 DAP	0.69 ns	0.35 ns	1.54 ns
3	Number of branches	14 DAP	1.10 ns	1.80 ns	1.70 ns
		28 DAP	7.00 **	3.50 ns	0.70 ns
		42 DAP	22.80 **	0.70 ns	0.90 ns
4	Number of filled pods	Harvest	2.40 ns	5.70 *	0.64 ns
5	Number of empty pods	Harvest	1.13 ns	0.01 ns	3.29 ns
6	Pod weight per sample	Harvest	1.99 ns	2.17 ns	1.15 ns
7	Pod weight per plot	Harvest	1.14 ns	2.80 ns	0.90 ns
8	Dry seed weight per sample	Harvest	0.05 ns	0.03 ns	2.29 ns
9	100-seed weight per plot	Harvest	2.97 ns	0.12 ns	3.38 *
10	Dry biomass	Harvest	0.25 ns	4.90 *	0.84 ns

Note: ** = highly significant ($p < 0.01$); * = significant ($p < 0.05$); ns = not significant; DAP = days after planting.

Table 4. Interaction effect of guano and KCl doses on plant height (cm) at 28 DAP

Guano dose	T1 (KCl 75 kg/ha)	T2 (KCl 100 kg/ha)
K0 (0 t/ha)	14.80 A a	10.37 B a
K1 (5 t/ha)	11.07 A b	12.77 A a
K2 (10 t/ha)	12.87 A ab	12.99 A a
K3 (15 t/ha)	12.12 A ab	12.96 A a

Note: Means followed by the same uppercase letter in the same row (KCl doses within a guano dose) and the same lowercase letter in the same column (guano doses within a KCl dose) are not significantly different according to DMRT at the 5% level.

A similar interaction was observed for the number of leaf stalks at 28 DAP (Table 5). The highest values were obtained with 0 t/ha guano and 75 kg/ha KCl (34.89 stalks) and with 5 t/ha guano and 100 kg/ha KCl (34.06 stalks). The response to KCl was therefore reversed between these two guano doses: without guano, 75 kg/ha KCl was better, whereas at 5 t/ha guano, 100 kg/ha KCl was better. At 10 and 15 t/ha guano, KCl dose had no significant effect.

Table 5. Interaction effect of guano and KCl doses on the number of leaf stalks at 28 DAP

Guano dose	T1 (KCl 75 kg/ha)	T2 (KCl 100 kg/ha)
K0 (0 t/ha)	34.89 A a	28.17 B b
K1 (5 t/ha)	27.61 B b	34.06 A a
K2 (10 t/ha)	28.78 A b	28.39 A b
K3 (15 t/ha)	32.11 A ab	32.44 A ab

Note: Letter notation as in Table 4 (DMRT, 5%).

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Number of Branches

Guano significantly increased the number of branches at 28 and 42 DAP (Table 6). At 28 DAP, guano rates of 10 and 15 t/ha produced more branches than the control, whereas 5 t/ha was intermediate. At 42 DAP, all guano doses produced significantly more branches than the control and did not differ from each other. The increase relative to the control was 27.5% at 5 t/ha and 35.5% at 15 t/ha, indicating that most of the effect was already achieved at the lowest guano dose.

Table 6. Effect of guano dose on the number of branches at 28 and 42 DAP

Guano dose	28 DAP	42 DAP	Change vs. K0 at 42 DAP (%)
K0 (0 t/ha)	4.89 b	6.19 b	–
K1 (5 t/ha)	5.94 ab	7.89 a	+27.5
K2 (10 t/ha)	6.08 a	8.03 a	+29.7
K3 (15 t/ha)	6.31 a	8.39 a	+35.5

Note: Means followed by the same letter in the same column are not significantly different according to DMRT at the 1% level. Change was calculated from the treatment means.

Yield Components and Biomass

KCl at 100 kg/ha significantly increased the number of filled pods per sample and dry biomass compared with 75 kg/ha (Table 7). The increases were 2.45 pods (11.6%) and 5.21 g (15.7%), respectively. Guano dose and the interaction did not affect these variables.

Table 7. Effect of KCl dose on the number of filled pods and dry biomass per sample

KCl dose	Number of filled pods (pods per sample)	Dry biomass (g per sample)
T1 (75 kg/ha)	21.08 b	33.10 b
T2 (100 kg/ha)	23.53 a	38.31 a
Change T2 vs. T1 (%)	+11.6	+15.7

Note: Means followed by the same letter in the same column are not significantly different according to DMRT at the 5% level.

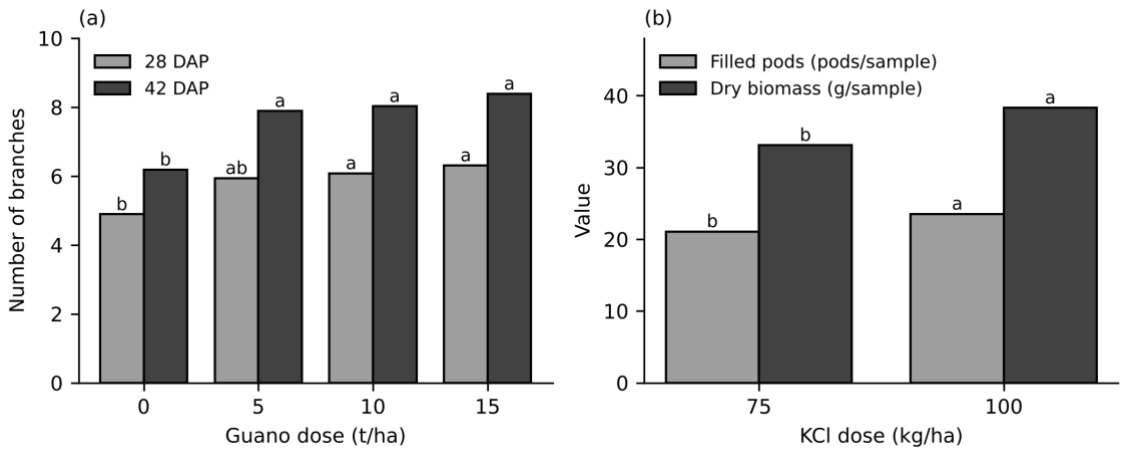

Figure 1. Effect of (a) guano dose on the number of branches at 28 and 42 DAP and (b) KCl dose on the number of filled pods and dry biomass per sample. Bars followed by the same letter within the same variable are not significantly different according to DMRT.

The contrasting responses of branching to guano and of pod filling and biomass to KCl are illustrated in Figure 1. The figure shows that the increase in branch number between 28 and 42 DAP

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was greater in guano-treated plots than in the control, and that the effect of KCl was more pronounced on biomass than on the number of filled pods.

The 100-seed weight was affected by the interaction between guano and KCl (Table 8). The heaviest seeds were obtained with 0 t/ha guano and 75 kg/ha KCl (80.00 g), which was 13.2% higher than without guano at 100 kg/ha KCl. At 75 kg/ha KCl, all guano treatments produced lighter seeds than the control, whereas at 100 kg/ha KCl, guano dose had no significant effect.

Table 8. Interaction effect of guano and KCl doses on 100-seed weight (g)

Guano dose	T1 (KCl 75 kg/ha)	T2 (KCl 100 kg/ha)
K0 (0 t/ha)	80.00 A a	70.67 B a
K1 (5 t/ha)	66.67 A b	74.00 A a
K2 (10 t/ha)	66.00 A b	68.67 A a
K3 (15 t/ha)	69.33 A b	32.44 A a

Note: Letter notation as in Table 4 (DMRT, 5%). The value for K3T2 in the original data (32.44 g) is inconsistent with its letter notation and with the other treatments and must be verified by the authors.

Overview of Treatment Responses

Table 9 summarizes the best treatment for each significantly affected variable and the magnitude of the response. The relative difference between the best and the lowest treatment ranged from 11.6% for the number of filled pods to 42.7% for plant height at 28 DAP. Guano mainly influenced branching, KCl mainly influenced pod filling and biomass, and the interaction effects were limited to 28 DAP and to seed weight.

Table 9. Best treatment and relative response for variables significantly affected by guano, KCl, or their interaction

Variable	Source of effect	Best treatment (value)	Lowest value	Relative difference (%)
Plant height 28 DAP (cm)	K × T	K0T1 (14.80)	10.37 (K0T2)	+42.7
Leaf stalks 28 DAP	K × T	K0T1 (34.89)	27.61 (K1T1)	+26.4
Branches 28 DAP	Guano	15 t/ha (6.31)	4.89 (0 t/ha)	+29.0
Branches 42 DAP	Guano	15 t/ha (8.39)	6.19 (0 t/ha)	+35.5
Filled pods (pods per sample)	KCl	100 kg/ha (23.53)	21.08 (75 kg/ha)	+11.6
Dry biomass (g)	KCl	100 kg/ha (38.31)	33.10 (75 kg/ha)	+15.7
100-seed weight (g)	K × T	K0T1 (80.00)	66.00 (K2T1)	+21.2

Note: Relative difference = (best − lowest)/lowest × 100%, calculated from the treatment means in Tables 4–8. The unverified K3T2 value for 100-seed weight was excluded.

DISCUSSION

This study showed that guano and KCl affected different aspects of peanut growth and yield. Guano mainly increased branching, KCl mainly increased the number of filled pods and dry biomass, and their interaction was significant only for plant height, the number of leaf stalks at 28 DAP, and 100-seed weight. Pod weight and seed weight per sample and per plot were not affected by any factor. These results only partially support our hypotheses: guano improved one important vegetative trait, and the effect of KCl depended on the guano dose for some variables, but neither factor translated into higher pod yield in a single growing season.

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The increase in the number of branches is the clearest effect of guano. Branch number is a key determinant of peanut yield potential because flowers and pegs are produced in the leaf axils along the branches, so more branches provide more sites for pod formation. Guano is rich in nitrogen, phosphorus, and calcium (Abd Rahman et al., 2023), and the supply of these nutrients stimulates the development of axillary buds into lateral branches. Our results are consistent with those of Risnayanti et al. (2025), who reported that guano increased the number of branches and pods in peanut, and with the improvements in growth reported for other crops treated with guano (Maisarah and Fitriah, 2022; Simon et al., 2024; Singh et al., 2025). Notably, at 42 DAP all guano doses produced a similar number of branches, and 5 t/ha already gave 27.5% more branches than the control. From a practical perspective, this suggests that 5 t/ha guano is sufficient to stimulate branching and that higher doses provide little additional benefit for this trait.

Guano also improves soil properties that are not directly reflected in plant nutrient uptake in the short term. Bat guano increases the cation exchange capacity, macronutrient content, and pH of soil (Karagöz and Hanay, 2020), and it contains diverse bacterial communities that may stimulate microbial activity in the rhizosphere (Newman et al., 2018). However, the nutrients in organic fertilizers are released gradually through mineralization. Part of the nitrogen and phosphorus supplied by guano may therefore have become available only after the period of rapid vegetative growth, and part may remain in the soil for subsequent crops. This may explain why guano increased branching but did not significantly increase pod weight or seed weight in this study. Long-term studies in groundnut-based systems have shown that the benefits of organic inputs for soil organic carbon, soil biological activity, and productivity accumulate over several seasons (Bana et al., 2024).

KCl at 100 kg/ha increased the number of filled pods by 11.6% and dry biomass by 15.7%. Potassium is essential for photosynthesis, stomatal regulation, and the loading and translocation of sugars from leaves to developing pods and seeds (Hasanuzzaman et al., 2018). In peanuts, low K supply reduces the photosynthetic rate and nutrient accumulation, ultimately reducing yield (Liu et al., 2023), whereas adequate K increases the number of marketable pods and pod mass (Abreu et al., 2024). Higher K availability also improves leaf structure and function (Zhao et al., 2025), which may explain the greater biomass accumulation observed at 100 kg/ha KCl. Similar responses to K were reported for peanut grown on Ultisol (Susilo et al., 2019) and for green bean, where the dose of KCl affected pod number and weight (Alfy and Handoyo, 2022). The increase in filled pods without a corresponding increase in pod weight per sample suggests that the additional pods were relatively small or that the variability among plots was large. The response of peanut to K depends on soil K status and plant density (Cordeiro et al., 2023), so the benefit of increasing the dose from 75 to 100 kg/ha KCl may differ across soils with lower or higher exchangeable K.

The interactions observed at 28 DAP showed an unexpected pattern. The tallest plants and the highest number of leaf stalks were obtained without guano at the lower KCl dose, and plants without guano also produced the heaviest seeds at 75 kg/ha KCl. A similar result was reported by Yeri et al. (2023), who found that peanuts without guano performed as well as guano-treated plants for several variables. Several explanations are possible. First, the soil at the experimental site may have been relatively fertile, so that the basal fertilizers and native soil nutrients were sufficient for early growth. Peanuts can also obtain a substantial portion of their nitrogen through biological fixation, thereby reducing their dependence on external nitrogen sources (Amir et al., 2022). Second, fresh organic materials with a low C/N ratio may temporarily stimulate microbial activity and immobilize nutrients during the early stage of decomposition. Third, plant height and seed size are strongly influenced by genotype, and their responses to fertilization are often smaller and less consistent than those of yield components (Febrianti et al., 2024; Yusrina et al., 2023). Because the

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interactions were not significant at 14 or 42 DAP, they appear to reflect a transient difference in early growth rather than a lasting effect on crop performance.

The 100-seed weight results should be interpreted with caution. The highest value (80.00 g) was obtained without guano at 75 kg/ha KCl, but the differences among the other treatments were small, and the values in all treatments were within the normal range for peanut. Seed weight is largely determined by genotype and by the conditions during the seed-filling period, and it is generally more stable than the number of pods (Febrianti et al., 2024). The lack of significant effects on pod weight and seed weight per sample also indicates that the yield of peanut in this study was limited by factors other than the guano and KCl doses tested, such as plant population, water supply during pod filling, or calcium availability in the pegging zone.

The timing of the experiment should also be considered. The crop was grown from June to October, which in East Java largely coincides with the dry season. Under these conditions, water availability during flowering, pegging, and pod filling is a major determinant of peanut yield, and fertilizer response may be limited if soil moisture is insufficient for nutrient uptake. Potassium contributes to stomatal regulation and osmotic adjustment, which helps plants maintain growth when water is limited (Hasanuzzaman et al., 2018). This may partly explain why KCl, rather than guano, influenced the yield components that are formed late in the season. Organic fertilizers such as guano can improve soil water retention over time, but this benefit is likely to become evident only after repeated applications. Evaluating guano and KCl in both the wet and dry seasons would therefore clarify how seasonal water supply modifies their effects.

From an agronomic perspective, the results suggest that guano and KCl play complementary roles. Guano at 5 t/ha increased branching and may improve soil properties over time, while 100 kg/ha KCl increased pod filling and biomass. The integrated use of organic and inorganic fertilizers has been shown to increase nutrient uptake, yield attributes, and pod yield in groundnut while maintaining soil fertility (Sharma et al., 2020; Naveen and Senthilkumar, 2021; Mohanty et al., 2022). A combination of a moderate guano dose with 100 kg/ha KCl may therefore be a reasonable strategy for peanut growers who wish to reduce their dependence on chemical fertilizers without sacrificing yield. Guano is also a locally available resource in many parts of Indonesia, and its use may reduce production costs (Linn and Myint, 2018; Abd Rahman et al., 2023).

This study has several limitations. It was conducted at a single location over a single growing season, so the residual effects of guano could not be evaluated. Only two KCl doses were tested, and neither a KCl-free treatment nor a fertilizer-free treatment was included, which limits the ability to estimate the full dose–response relationship. The nutrient content of the guano and the initial soil properties should be reported in detail, because guano composition varies with bat species, diet, and storage conditions (Abd Rahman et al., 2023). Future studies should include multi-season and multi-location trials, a wider range of KCl doses including a control, analysis of soil and plant nutrient concentrations, and an economic analysis to identify the most profitable combination of guano and KCl for peanut production.

CONCLUSION

Guano and KCl affected different aspects of peanut growth and yield. Guano significantly increased the number of branches, with 15 t/ha producing 6.31 and 8.39 branches at 28 and 42 DAP, although 5 t/ha was statistically equivalent at 42 DAP. KCl at 100 kg/ha increased the number of filled pods (23.53 pods per sample) and dry biomass (38.31 g per sample). The interaction between guano and KCl affected plant height and number of leaf stalks at 28 DAP and 100-seed

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weight, with the highest values under 0 t/ha guano and 75 kg/ha KCl, but no factor significantly affected pod or seed weight. A combination of 5 t/ha guano and 100 kg/ha KCl is therefore suggested as an efficient option to support peanut branching and pod filling, pending confirmation in multi-season trials.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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