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Effectiveness of Goat Manure and Inorganic Phosphate Fertilizers on the Growth and Yield of Mung Bean (*Vigna radiata L.*)

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Abstract:
The availability of phosphate in the soil is generally low, especially in soils with minimal organic matter content. This study aims to evaluate the effect of applying goat manure and inorganic phosphate fertilizer on the growth and yield of mung bean plants (*Vigna radiata* L.). The research was conducted in Antirogo Village, Sumbersari District, Jember Regency, East Java, from June to September 2024, using a factorial randomized block design (RBD) with two factors and three replications. The first factor was the dose of goat manure at 0 tons/ha, 10 tons/ha, 20 tons/ha, and 30 tons/ha, while the second factor was the dose of inorganharvested area for potatoes in 2014 was 76,291 ha, with a production of 1,347,815 tons and a productivity of 17.67 tons/ha; in 2015, the harvested area weight, dry seed weight, shoot biomass, root biomass, and weight of 100 seeds. The results showed that the interaction of 20 tons/ha of goat manure and 200 kg/ha of inorganic phosphate produced the highest dry seed weight per plot (565.67 g), while the combination of 20 tons/ha of goat manure and 100 kg/ha of phosphate fertilizer increased shoot biomass (8.75 g). The application of 20 tons/ha of goat manure also had a significant effect on plant height (30.10 cm). This increase is thought to be due to the improved availability of phosphate because of adsorption by organic matter, allowing nutrients to be more easily absorbed by the plants.

Keywords:
growth, organic fertilizer, synthetic fertilizer, Vigna radiata L, yield

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INTRODUCTION

Mung bean is the third most important legume crop after soybean and peanut, and it can be cultivated in tropical regions. However, the production of this commodity declined from 2020 to 2022, decreasing from approximately 222,629 tons/ha in 2020 to 132,539 tons/ha in 2022 (Central Bureau of Statistics, 2023). One factor contributing to this decline is improper fertilization. Imbalanced fertilization, particularly in excessive amounts, can degrade soil fertility, resulting in lower mung bean productivity.

Manure is an organic fertilizer that can provide macro- and micronutrients while also improving soil properties. According to Peni et al. (2023), goat manure has a C/N ratio of 20–25% and undergoes effective decomposition, making its nutrients more available to plants. Thus, the application of goat manure is considered effective in improving soil quality by enhancing its physical, chemical, and biological properties, and it also supports the absorption of nutrients, particularly phosphorus (P), from TSP fertilizer.

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One type of phosphorus-containing fertilizer is TSP, which has a P_2O_5 content of 48–54%. Phosphorus (P) is essential for mung bean plants during seed formation and contributes to complete seed development. It also helps accelerate fruit ripening and enhances the plant's resistance to drought (Syafria, 2013). However, phosphorus is prone to leaching, which further limits its availability to plants. Moreover, the low organic matter content in the soil further restricts phosphorus availability, despite organic matter's role in releasing bound phosphorus. Therefore, adding manure, such as goat manure, can help reduce phosphorus leaching, allowing phosphorus in the root zone to be better utilized by mung bean plants. This study aims to evaluate the effect of goat manure and inorganic phosphate fertilizers on mung bean yield.

METHOD

This research was conducted on agricultural land at the State Polytechnic of Jember, located in Kaliurang Village, Sumbersari District, Jember Regency, East Java Province. The site is situated at an altitude of approximately 146 meters above sea level with an average temperature ranging from 23°C to 32°C. The study was carried out during the dry season, from June to September 2024.

The experiment was arranged in a Factorial Randomized Complete Block Design (RCBD) with two treatment factors and three replications. The first factor was goat manure fertilizer with four treatment levels: 0, 10, 20, and 30 tons/ha. The second factor was inorganic phosphate fertilizer with three levels: 0 kg/ha, 100 kg/ha, and 200 kg/ha.

The mung bean seeds used were of the Vima 5 variety, planted at a spacing of 40 x 20 cm in plots measuring 2 x 1 meters, for a total of 36 plots. Planting was done using the dibble method, with two seeds per planting hole. Crop maintenance included weeding and thinning between 7–14 days after planting (DAP), replanting between 7–14 DAP, watering, and fertilizing. Goat manure was applied one week before planting, while inorganic phosphate fertilizer was applied at planting using the dibble method. Basal fertilization was given at 7 DAP using urea, followed by an additional application of urea and KCl at 35 DAP. Other practices included hilling, pest and disease control, and harvesting at 56 DAP.

The observed variables included plant height (measured at 14-42 DAP), number of productive branches (measured at 35 and 45 DAP), fresh pod weight per sample, dry seed weight per sample, dry seed weight per plot, 100-seed weight, shoot biomass, and root biomass. The collected data were analyzed using ANOVA. If significant or highly significant differences were found, further analysis was conducted using Duncan's Multiple Range Test (DMRT) at the 5% or 1% significance level.

RESULT

Based on the study's results, eight observation variables were obtained: plant height, number of productive branches, fresh pod weight per sample, dry seed weight per sample, dry seed weight per plot, 100-seed weight, shoot biomass, and root biomass. The collected data were analyzed using ANOVA. The analysis of variance results is presented in the table below:

Plant Height

Based on the ANOVA test, the application of goat manure at 28 days after planting (DAP) showed a significant difference. Therefore, further analysis was conducted using Duncan's Multiple

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Range Test (DMRT) at the 5% significance level. The results of the DMRT analysis are shown in Table 1.

Table 1. Plant Height of Mung Bean Plants in Response to Goat Manure Application

Goat Manure Dose (kg/plot)	Plant Height (cm)	DMRT Score
0	29.86a	-
2	29.64a	1,68
4	26.72b	1,76
6	30.10a	1,82

Note: Numbers followed by different lowercase letters indicate a significant difference based on the 5% DMRT (Duncan's Multiple Range Test).

Based on the plant height variable, the results showed a significant difference. The K3 treatment had the highest average height at 6 kg/plot (30.10 cm), followed by the control (29.86 cm) and 2 kg/plot (29.64 cm). The lowest result was observed in the 4 kg/plot treatment, which measured 26.72 cm. The 4 kg/plot treatment (26.72 cm) was significantly different from the control (29.86 cm), 2 kg/plot (29.64 cm), and 6 kg/plot (30.10 cm).

Number of Productive Branches

Observations on the number of productive branches were carried out twice, at 35 and 45 days after planting (DAP). The average number of productive branches showed no significant difference (ns) in the single factor of goat manure fertilizer (K), the single factor of inorganic phosphate (N), or in the interaction between goat manure and inorganic phosphate (KxN). Therefore, no further analysis was required for this observation variable

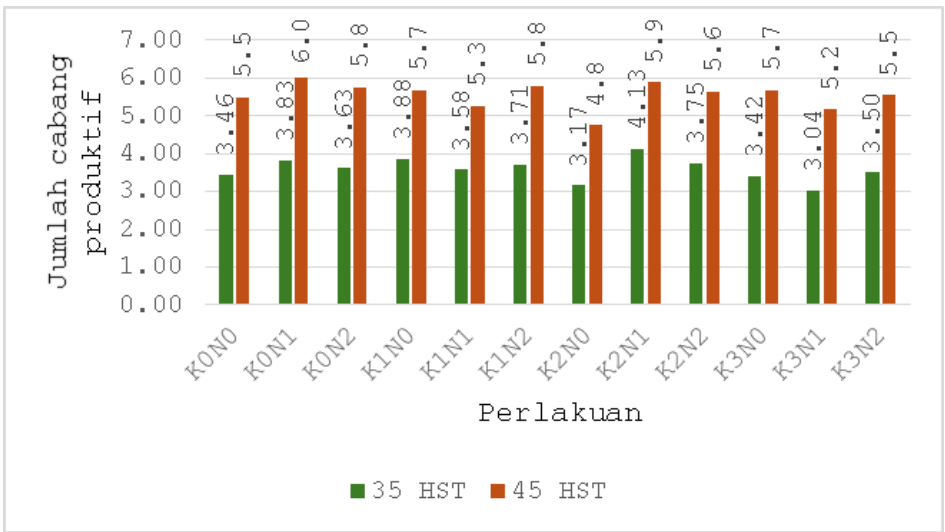


Figure 1. Data on the number of productive branches at 35 and 45 days after planting (DAP)

Shoot Biomass Weight

Based on the ANOVA, the interaction between goat manure and inorganic phosphate fertilizers was significant. Therefore, further analysis was carried out using Duncan's Multiple Range Test (DMRT) at the 5% significance level. The results of the DMRT analysis are presented in Table 2.

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Table 2. Shoot Biomass Weight of Mung Bean Plants at Each Dose of Goat Manure and Inorganic Phosphate Fertilizer

Goat Manure Dose (kg/plot)	TSP Fertilizer Dose (g/plot)		
	0 g	20	40
0	6.1 B b	6.8 A b	7.8 A a
2	8.5 A a	7.0 B b	7.7 A b
4	6.2 A b	8.8 A a	7.7 B b
6	6.8 B a	7.0 A b	8.5 A a

Note: Values followed by the same uppercase letter in the same row and values followed by the same lowercase letter in the same column are not significantly different based on the 5% DMRT test.

Table 2 presents the observation results of shoot biomass weight in mung bean plants in response to the application of goat manure and inorganic phosphate fertilizers. Based on the DMRT 5% post-hoc test, the interaction between goat manure and inorganic phosphate (K×N) showed a significant difference. The highest treatment was K2N1 (4 kg/plot + 20 g/plot) with a weight of 8.75 grams, while the lowest was K0N0 (Control + Control) with a weight of 6.13 grams. The most favorable result was obtained from treatment K2N0 (2 kg/plot + Control) with a weight of 8.5 grams.

DISCUSSION

The observation variable for plant height shows that goat manure application had a significant effect, increasing plant height at 28 days after planting (DAP). This indicates that varying doses of goat manure influence the growth of mung bean plants. This type of manure offers several benefits, including the ability to fix nitrogen from the air, enhance plant growth through the activity of microorganisms it contains, and help dissolve bound phosphate in the soil. In addition, goat manure also plays a role in breaking down complex organic compounds into simpler forms (Suhwayono, 2011). Nitrogen is an essential nutrient for plants, especially during the vegetative growth phase. Ramadhan (2022) states that to achieve optimal plant height, soil nutrient availability must be sufficient in both quantity and balance.

The number of productive branches was not significantly affected by either the single factors or their interaction. This may be due to heat stress or high temperatures, which can inhibit mung bean plant growth and cause flower drop, resulting in suboptimal pod formation—both fresh and dry. Basu et al. (2019) explain that during the summer season, mung bean plants experience stress, particularly during the reproductive stage. This condition may lead to reduced anthesis, lower pollen viability, increased flower fertilization and flower drop, and a shorter seed filling period. Altogether, these effects lead to decreased mung bean yield. Heat stress also significantly affects plant growth and development. High temperatures can influence flowering time, reduce branching, and potentially cause deformities in floral organs (Zinn et al., 2010).

The observation variable for shoot biomass weight showed a significant interaction between goat manure and inorganic phosphate fertilizers. This is because photosynthates are first directed to the leaves, then to the stems to strengthen their structure, and finally to the roots to aid nutrient uptake, which positively affects shoot biomass yield and overall plant growth. According to Hanafiah (2014), the application of organic fertilizer increases soil nitrogen (N) content, which is essential during the vegetative growth stage and supports increased dry matter content in plants. Meanwhile, inorganic phosphate fertilizers stimulate the activity of potassium and nitrogen, both of which are critical for plant metabolic needs. The products of photosynthesis are also used in cell division,

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especially in the stems and leaves, which contribute to the increase in shoot biomass accumulation in mung bean plants.

CONCLUSION

The single treatment of goat manure at 20 tons/ha had a significant effect on plant height, with the highest average value of 30.10 cm. The combination of 20 tons/ha of goat manure and 100 kg/ha of phosphate fertilizer effectively increased shoot biomass. These results indicate that combining organic and inorganic fertilizers can effectively enhance the growth and yield of mung bean plants. On the other hand, phosphate fertilizer applied as a single treatment had no significant effect on any of the observed variables. It is recommended to use the K2N0 combination treatment, consisting of goat manure at 40 tons/ha and inorganic phosphate fertilizer at 0 kg/ha (control), as it was found to be more efficient than other dosage combinations.

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