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# Increasing Growth and Production of Green beans (*Vigna radiata* L.) by Providing Organic Fertilizers with Goat Manure and Variations in Planting Spacing

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## ABSTRACT

Green bean is a food ingredient that is extensively consumed by the general public and is categorized as having a high frequency of use. This study seeks to determine the effect of organic goat manure on the growth and yield of green beans (Vigna radiata L). It will also examine the impact of plant spacing and the interaction between the two factors. This investigation utilized a factorial randomized block design (RBD) with two regimens and three replications. The first variable was the amount of goat manure organic fertilizer applied to each plot: 0 kg/plot, 2 kg/plot, 4 kg/plot, and 6 kg/plot. The second factor is the variation of the different spacing sizes, which are 20 x 40 cm, 25 x 40 cm, 30 x 40 cm, and 35 x 40 cm. In this study, the following parameters were observed: plant height, number of productive branches, number of pods per sample, number of pods per plot, pod production per sample, pod production per plot, and 100 seed weight per sample. The study's results indicated that the application of goat manure organic fertilizer, the assessment of different plant spacings, and the interaction between the two treatments had no significant effect on any of the parameters. Include plant height, number of productive branches, number of pods per sample, number of pods per plot, pod production per sample, pod production per plot, and 100 seed weight per sample.

Keywords: *Growth, Production, Green beans, Goat Manure, Planting Spacing*

## 1. INTRODUCTION

Green bean is a food ingredient that is extensively consumed by the general public and is categorized as having a high frequency of use. Cultivating green beans is relatively simple and has numerous potential applications; therefore, it is anticipated that it will generate agricultural economic opportunities. Demand for mung legumes is rising, but local production is insufficient. Domestic demand for green beans is primarily driven by the feed or animal feed industry, with some demand also deriving from food and industrial applications. In addition to meeting domestic requirements, domestic green bean production has the potential to supply a sizable portion of the global green bean market and increase the country's foreign exchange earnings (Baruse *et al.*, 2014).

In 2020, Indonesia will require an average of 350,000 tons of green beans per year, but only 311,658 tons will be produced, which is insufficient to meet demand. The annual demand for animal nutrition, such as food and seeds, is 1.27 kilograms. During this period, the value of Indonesia's exports decreased by 10.37%, with an average annual decline of 24,019 tonnes. Meanwhile, the import market increased by 6.83%, or a yearly average of 42,655 tonnes (Alfandi, 2015).

One way to increase green bean production is by fertilizing. Fertilization will increase soil fertility, which will increase green bean yields. Fertilizers are separated into two categories: organic fertilizers and inorganic fertilizers, depending on the ingredients they are made of. Soil structure and porosity can be improved by using organic fertilizers produced from the remains of living organisms which include macronutrients (N, P, K) and micronutrients (Ca, Mg, Fe, Mn, Bo, S, Zn, and Co) (Syaiful, 2020).

Goat manure fertilizer is one of the organic fertilizers that can combat soil fertility. Although goat manure is readily available in the environment, it has not been extensively used to improve soil fertility. Other than that, goat manure functions similarly to other forms of fertilizer. The difficult decomposition of goat manure's particles affects nutrients' supply and decomposition phases (Afrilliana, 2017). The application of 15 tons/ha of goat manure resulted in 95.34 pods, 9556.67 grains, 79.99 gr/plant, and 17.7 g/100 seeds (Banda et al., 2021), so researchers wished to examine the effects of various dosages.

In addition to providing the proper organic fertilizer, one method to affect the development and yield of plants is by adjusting the spacing between plants, which can increase the production of green beans. Proper spacing allows for maximum yield, but if plants are too close together, there will be increased competition for nutrients and light. Several factors must be considered when cultivating plants, including soil fertility, balanced fertilization, and appropriate spacing (Mistaruswan, 2014).

To prevent plant growth from being hindered by plant competition, the land used to cultivate plants must be nutrient-rich and have adequate spacing between plants. This is connected to competition for the utilization of food, water, light, and space for growth. Depending on the cultivar, planting density requirements vary. The planting distance is adjusted based on the plant's characteristics and the prevailing environmental conditions to achieve optimal results. Increasing planting density to the maximum level will increase production per unit area, whereas increasing planting density above this level will maximize the reduction in crop yield (Iwan, 2013). According to research, a spacing of 40 cm x 25 cm can increase green bean production because the density of the spacing affects the appearance and yield of plants (Salmiah, 2013). This study examined the disparities between various spacing combinations and previous studies.

## 2. MATERIAL AND METHODS

This investigation was conducted at an altitude of 27 meters above sea level on Paya Bakung St., Serbajadi IV Village. This study will be conducted between June and October of 2022. This research will utilize green bean seedlings of the variety Vima 1, goat manure, soil topsoil, and water. This investigation on green bean plants will use a tape measure, hoes, sprinkler, scales, bamboo or wood, signs, stationery, and various other tools.

Using a factorial randomized block design (RBD) comprised of 2 treatment factors, namely the application of organic goat manure (0 kg/plot, 2 kg/plot, 4 kg/plot, and 6 kg/plot) and variations in plant spacing (20 x 40 cm, 25 x 40 cm, 30 x 40 cm, 35 x 40 cm), 16 treatment combinations, and 3 replicates to obtain a total of 48 treatment plots were planned for this investigation. The research data were analyzed with a factorial randomized block design (RBD) utilizing variance, and then Duncan's significant difference test was performed.

Implementation of activities includes land preparation, plot creation, application of goat manure, sowing, maintenance, determination of sample plants, and harvesting. Plant height, the number of productive branches, the number of pods per sample, the number of pods per plot, pod production per sample and pod production per plot, and the weight of 100 seeds per sample were observed as parameters.

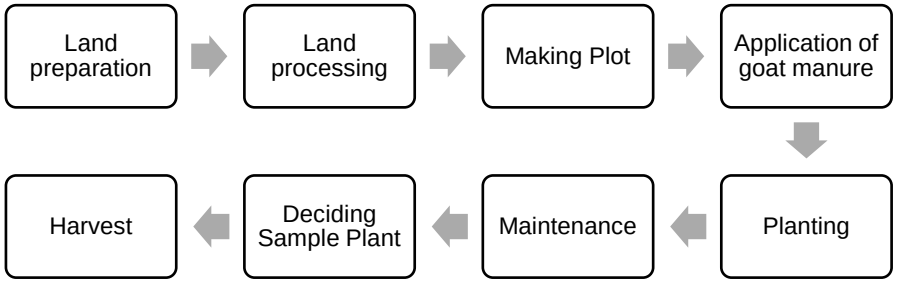


Figure 1. Research flowchart

## 3. RESULT AND DISCUSSION

### Plant Height (cm)

According to the results of the analysis of variance, the application of goat manure organic fertilizer, the variation in plant spacing, and the interaction between the two treatments had no significant effect on the parameter of plant height (cm) of green bean plants at ages 2, 4, and 6 WAP in Table 1.

Table 1. Average Height of Green bean Plants (cm) Against Goat Manure Organic Fertilizer and Variation of Planting Spacing at 2, 4 and 6 WAP.

| Treatment | Plant Height (cm) | | |
|---|---|---|---|
| | 2 MST | 4 MST | 6 MST |
| Goat Manure Organic Fertilizer (K) | | | |
| 0 kg/plot | 6,33 a | 19,89 a | 41,19 a |
| 2 kg/plot | 6,49 a | 21,19 a | 41,92 a |
| 4 kg/plot | 6,81 a | 21,54 a | 43,56 a |
| 6 kg/plot | 7,60 a | 22,09 a | 46,24 a |
| Planting Spacing Variation (J) | | | |
| 20 x 40 cm | 6,61 a | 20,66 a | 41,28 a |
| 25 x 40 cm | 6,72 a | 20,91 a | 42,64 a |
| 30 x 40 cm | 7,08 a | 22,00 a | 45,20 a |
| 35 x 40 cm | 6,83 a | 21,13 a | 43,79 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level.

The application of 6 kilograms of goat manure organic fertilizer per plot resulted in the tallest green bean plants, measuring 46.24 centimeters in height, according to Table 1. However, statistically, it was not substantially different from the other treatments. Applying organic fertilizer derived from goat manure had no discernible effect on plant height parameters. It was hypothesized that the N nutrient in goat manure organic fertilizer was insufficient, thereby hindering the growth of green bean plants, as goat manure organic fertilizer contained relatively low N elements. The root nodules of green beans can absorb N from the soil. If nitrogen levels are below 28%, the formation of roots and stems will not be optimal in green bean plants. Goat manure contains 1.41 percent nitrogen, which can promote vegetative growth, specifically plant height. This process entails the production of proteins that plants obtain as organic matter from the soil in their environment (Gardner *et al*. 2012).

Table 1 reveals that the spacing of 30 cm x 40 cm produced the tallest green bean plants, at 45.20 cm, although statistically, it was not substantially different from the other treatments. This is due to the fact that the spacing used does not result in competition between plants during the height-growth period. When green bean plants are appropriately spaced, they do not compete with other plants for nutrients, water, and sunlight. The availability of N, P, and K nutrients can increase meristem cell division, which influences the height growth of plants (Fajrin and Sucipto, 2015).

**Number of Productive Branches (Branch)**

Table 2 displays that the application of goat manure organic fertilizer, variations in plant spacing, and their interaction had no significant effect on the number of productive branches (branches) of green bean plants

Table 2. Average Number of Productive Branches of Green bean Plants (branches) Against Goat Manure Organic Fertilizer and Variation of Planting Spacing.

| Treatment | Number of Productive Branches (Branch) |
|---|---|
| Goat Manure Organic Fertilizer (K) | |
| 0 kg/plot | 4,45 a |
| 2 kg/plot | 4,57 a |
| 4 kg/plot | 4,78 a |
| 6 kg/plot | 5,42 a |
| Planting Spacing Variation (J) (J) | |
| 20 x 40 cm | 4,49 a |
| 25 x 40 cm | 4,68 a |
| 30 x 40 cm | 5,28 a |
| 35 x 40 cm | 4,77 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level.

The application of 6 kg of goat manure organic fertilizer per plot resulted in the greatest number of productive branches on the green bean plant, namely 5.42 branches. However, statistically, it was not substantially different from the other treatments. This indicates that the nutrients in the goat manure organic fertilizer applied to the soil were insufficient to meet the nitrogen requirements of the green bean plants. Nitrogen is not always present in the soil as a nutrient. As one of the fundamental plant nutrients, nitrogen is essential for plant growth and development. Suppose the soil cannot meet the plant's nitrogen requirements. In that case, a fertilizer that can provide nitrogen availability is

required, because if it is not met, the process of a plant's growth and development, particularly the formation of branches, is disrupted. Due to competition for photosynthetic results between stems and branches, plant height influences the number of branches that develop, so an increase in plant height will dominate branch growth. Additionally, the research environment, which influences plant growth and development, also affects the increase in the number of productive branches. In addition to nutrients provided by fertilizers, growth can also be affected by climate, sunlight, soil, and genetics (Muliawan, 2012).

The spacing of 30 cm x 40 cm produced the greatest number of productive green bean branches, namely 5.28 branches, although statistically it was not substantially different from the other treatments. This is believed to occur between plants during the extraction of nutrients, resulting in an uneven distribution of nutrients. The distance between plants influences how much sunlight and mineral nutrients are absorbed. Compared to close spacing, wide spacing reduces the likelihood of plants competing for nutrients and water. Based on Sitompul and Guritno (2012), spacing provides adequate room for plant development so that their physiological systems can function optimally. The efficacy with which plants utilize light and the competition between plants for water and nutrients have a substantial effect on the yield of these plants. When plants are grown at low densities, they do not compete with one another, resulting in superior growth compared to plants grown at high densities. Plants will compete for light, water, and nutrients at large densities, ultimately affecting yield.

**Number of Pods Per Sample (g)**

Based on the results of the analysis showed that the application of goat manure organic fertilizer and variations in plant spacing and the interaction of the two treatments had no significant effect on the parameter number of pods per sample (pods) of green bean plants.

Table 3. The average number of pods per sample of green bean plants (pods) on applying organic fertilizer by goat manure and variations in plant spacing.

| Treatment | Number of Pods Per Sample (pods) |
|---|---|
| Goat Manure Organic Fertilizer (K) | |
| 0 kg/plot | 16,78 a |
| 2 kg/plot | 17,16 a |
| 4 kg/plot | 17,77 a |
| 6 kg/plot | 18,52 a |
| Planting Spacing Variation (J) | |
| 20 x 40 cm | 16,94 a |
| 25 x 40 cm | 17,29 a |
| 30 x 40 cm | 18,35 a |
| 35 x 40 cm | 17,66 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level

The application of 6 kg/plot of organic goat manure resulted in the greatest number of pods per sample of green bean plants, 18.52 pods. However, statistically, this did not differ significantly from the other treatments. This is due to internal factors, such as the local temperature and a paucity of carbohydrates derived from photosynthesis, as only a small portion is used to produce pods.

Table 3 above displays the spacing of 30 cm x 40 cm produced the greatest number of pods per sample of green bean plants, 18.35 pods, although statistically it was not substantially different from the other treatments. The ability of plants to assimilate nutrients and

light depends on their spacing. The greater the number of plants in a field, the more intensive the competition for nutrients, and the lower the yield per plant. Wide plant spacing will also allow more light to permeate, increasing evaporation and reducing crop yields if the spacing is too wide.

**Number of Pods Per Plot (g)**

Based on the data analysis results, the application of organic fertilizer goat manure, variations in spacing, and the interaction of the two treatments had no significant effect on the parameter number of pods per plot (pods) of green bean plants. It can be seen in Table 4.

Table 4. Average Number of Pods Per Plot of Mung Bean Plants (pods) Against Goat Manure Organic Fertilizer and Variation of Planting Spacing.

| Treatment | Number of Pods Per Plot (Pod) |
|---|---|
| Goat Manure Organic Fertilizer (K) | |
| 0 kg/plot | 304,83 a |
| 2 kg/plot | 311,56 a |
| 4 kg/plot | 320,56 a |
| 6 kg/plot | 337,03 a |
| Planting Spacing Variation (J) | |
| 20 x 40 cm | 305.08 a |
| 25 x 40 cm | 311,06 a |
| 30 x 40 cm | 338,81 a |
| 35 x 40 cm | 319,03 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level.

The application of 6 kg of goat manure organic fertilizer per plot resulted in the greatest number of pods per plot of green bean plants, 337.03 pods. However, statistically, it was not substantially different from the other treatments. Sihotang et al. (2012) demonstrated that temperature is an environmental factor affecting embryo development. Because increased evaporation from arid soil and high temperatures can have an impact on soil moisture and plant nutrient absorption, drought can reduce soil moisture and impede nutrient transport.

Table 4 displays that 30 cm x 40 cm spacing produced the greatest number of pods per sample of green bean plants, 338.81 pods. However, statistically, this was not substantially different from the other treatments. Jumin (2012) demonstrates that density and spacing cannot be separated from a parcel of land's yield. Plant production results from reproductive factors and vegetative development, and the relationship between spacing and competition and yield between plants for sunlight and nutrients required for plant growth is close.

**Production of Pods Per Sample (g)**

The application of goat manure organic fertilizer, the variation in plant spacing, and the interaction between the two treatments had no significant effect on the pod production parameters per sample (g) of green bean plants, as shown in Table 5.

Table 5. Average Pod Production Per Sample of Green Bean Plants (g) Against Goat Manure Organic Fertilizer and Variation of Planting Spacing.

| Treatment | Production of Pods Per Sample (g) |
|---|---|
| Goat Manure Organic Fertilizer (K) | |
| 0 kg/plot | 29,26 a |
| 2 kg/plot | 29,41 a |
| 4 kg/plot | 29,93 a |
| 6 kg/plot | 30,57 a |
| Planting Spacing Variation (J) | |
| 20 x 40 cm | 28,75 a |
| 25 x 40 cm | 29,24 a |
| 30 x 40 cm | 31,05 a |
| 35 x 40 cm | 30,12 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level.

The application of 6 kg/plot of organic goat manure resulted in the highest pod production per sample of green bean plants, 30.57 g. However, statistically, it was not substantially different from the other treatments. This is due to the insufficient nutrient content of the fundamental fertilizer used during the green bean production stage. According to Sutopo (2010), the availability of the proper nutrients in the soil will affect the capacity of plants to translocate and assimilate nutrients into seeds, indirectly affecting their growth and altering seed weight. This will affect optimal plant metabolism and biological activity.

Table 5 displays that 30 cm x 40 cm spacing produced the greatest number of pods per sample of green bean plants, 31.05 g. However, statistically, it was not substantially different from the other treatments. Greater spacing will increase yield per plant. Large populations must be adequately spaced for optimal production. Even with a large population, yields can be high if the assimilation of nutrients and sunlight during the growing season is not disrupted.

**Pod Production Per Plot (g)**

The application of goat manure organic fertilizer, the variation in plant spacing, and the interaction between the two treatments had no significant effect on the pod production parameters per plot (g) of green bean plants, as shown in Table 6.

Table 6. Average Pod Production Per Plot of Green beans (g) Against Goat Manure Organic Fertilizer and Variation of Planting Spacing.

| Treatment | Pod Production Per Plot (g) |
|---|---|
| Goat Manure Organic Fertilizer (K) | |
| 0 kg/plot | 404,25 a |
| 2 kg/plot | 410,47 a |
| 4 kg/plot | 420,14 a |
| 6 kg/plot | 437,28 a |
| Planting Spacing Variation (J) | |
| 20 x 40 cm | 395,50 a |
| 25 x 40 cm | 405,95 a |
| 30 x 40 cm | 452,22 a |
| 35 x 40 cm | 418,47 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level.

Applying 6 kg of goat manure organic fertilizer per plot resulted in the greatest pod yield per plot of green bean plants, 437.28 g. However, statistically, it was not substantially different from the other treatments. Awodun (2007) states that goat manure can increase pod weight and number of pods, whereas goat manure and urea can increase plant height, number of leaves, pod length, pod weight, and pod number in okra bean plants.

Table 6 shows spacing of 30 cm x 40 cm produced the greatest number of pods per sample of green bean plants, 452.22 g, although statistically, it was not substantially different from the other treatments. Harjadi (2014) argues that, in general, the yield per unit height is attained in large populations because the optimum use of light is attained in the early stages of development.

**Weight of 100 Seeds Per Sample (g)**

The variance results showed that the application of goat manure organic fertilizer and the variation in spacing and the interaction of the two treatments had no significant effect on the parameter weight of 100 seeds per plant sample (g), as seen in Table 7.

Table 7. Average Weight of 100 Seeds Per Sample of Green bean Plants (g) Against Goat Manure Organic Fertilizer and Variation of Plant Spacing.

| Treatment | Weight of 100 Seeds Per Sample (g) |
|---|---|
| Goat Manure Organic Fertilizer (K) | |
| 0 kg/plot | 5,32 a |
| 2 kg/plot | 5,50 a |
| 4 kg/plot | 5,72 a |
| 6 kg/plot | 6,36 a |
| Planting Spacing Variation (J) | |
| 20 x 40 cm | 5,31 a |
| 25 x 40 cm | 5,35 a |
| 30 x 40 cm | 6,51 a |
| 35 x 40 cm | 5,81 a |

Note: Numbers in the same column followed by letters that are not the same mean significantly different at the 5% level

The administration of 6 kg/plot of organic fertilizer of goat manure resulted in the highest weight of 100 seeds per sample of green bean plants, 6.36 g. However, statistically, it was not substantially different from the other treatments. It is suspected that the dosage of goat manure organic fertilizer has not had a significant effect because organic matter can act directly as a source of plant nutrients after undergoing a mineralization process and can indirectly create a more favorable environment for plant growth by increasing nutrients that support plant growth. Plant. Organic matter can improve soil's physical, chemical, and biological properties, which will improve plant growth and production. As a result, the soil will become more crumbly, and the exchange of cations and anions will speed up, allowing plants to absorb nutrients more efficiently, resulting in healthy plant growth (Hadi et al., 2015).

Table 7 above shows that the highest weight of 100 seeds per sample of green bean plants was found at a spacing of 30 cm x 40 cm, namely 6.51 g, although statistically, it was not significantly different from the other treatments. Mimbar (1990) explains that competition for light will occur if one plant or leaf overshadows another. Plant density will affect the competition between plants is the solar radiation that can be received and used efficiently.

The higher the population density, the taller the stem, the fewer the number of leaves per plant, the lower the leaf area per plant and the lower the weight of the top of the plant.

## 4. CONCLUSION

The application of organic goat manure fertilizer had no significant effect on the growth and yield of mungbean plants, as measured by plant height, number of productive branches, number of fruits per sample, number of fruits per plot, pod production per sample, pod production per plot, and weight of 100 seeds per sample.

Variation tests of various spacings on the growth and yield of mungbean plants had no significant effect on any of the observed parameters, including plant height, number of productive branches, number of fruits per sample, number of fruits per plot, pod production per sample, pod production per plot, and weight of 100 seeds per sample.

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