

Growth and Production of Young Pods of Purple Winged Bean with Different Doses of Chicken Manure

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ABSTRACT

The winged bean (*Psophocarpus tetragonolobus* L) is a tropical plant that all parts of the plant can be utilized and are relatively easy to cultivate. A purple winged bean is a varietal group that has high antioxidant activity. One way to optimize the growth and productivity of winged beans is by fertilizing them with organic fertilizers as an alternative to the inorganic fertilizer. This research was conducted to investigate to the effect of chicken manure on the growth and productivity of the winged bean Sandi IPB variety. The experiment was conducted from July to November 2022 in the Organic Field of the IPB Experimental Station in Cikarawang, Bogor. This study used a completely randomized block design (RCBD) with a single factor, namely chicken manure doses consisted of 0, 10, 20, and 30 tons ha⁻¹. The results showed that increasing the dose of chicken manure increased the growth characteristics of winged bean plants, namely plant height, leaf number, leaf area, leaf potassium content, as well as yield components included fresh weight, dry weight, pod size, pod weight per plant, pod weight per plot, number of pods per plot, and productivity of young pods of winged bean. The relationship between manure rates and yield is linear, therefore the optimum dose of chicken manure cannot be determined yet. From the extrapolation, it can be predicted that the optimum chicken manure rate is 31.4 ton ha⁻¹.

Keywords: Anthocyanin; Carotene; Organic; *Psophocarpus tetragonolobus* L.; Sandi IPB

Introduction

Psophocarpus tetragonolobus L., or commonly known as the winged bean, is a tropical plant that is relatively easy to cultivate. The winged bean plant is widely known by the public because the young pod is commonly consumed as a vegetable. Currently, the winged bean is one of the legume plants that are still under-cultivated, even though it has many benefits. All parts of the plant, from seeds, young pods, leaves, and flowers to tubers can be consumed. Based on their nutritional composition, winged bean is not inferior to soybeans, because they contain almost the same proportion of protein, oil, minerals, vitamins, and essential amino acids (Amoo et al. 2011). Each 100 g young winged bean pods contain 1.9-4.3 g protein, 0.1-3.4 fat, 0.9-3.1 fiber, vitamin A 300-900 IU, potassium 205-381 and several other nutrients (Handayani et al. 2013). Winged pods also contain the bioactive compounds particularly vitamin A, vitamin C, calcium, iron, sioflavons and phenolics (Khalili et al. 2013).

The yield potential of winged bean pods is at 2,58-8,94 tons ha⁻¹. An effort to obtain high yield of crop plants is the selected high yielding varieties. Several winged bean varieties that have been released and registered with the Ministry of Agriculture Republic Indonesia are Melody IPB, Fairuz IPB, and Sandi IPB. Sandi IPB is a winged bean variety that has purple pods and high antioxidant activity (Calvindi et al. 2020). Another thing that needs attention to optimize the growth and yield of winged bean plants is the need for fertilizer (Handayani et al. 2015).

There are two types of fertilizers on the market, namely synthetic fertilizers and organic fertilizers. Synthetic fertilizers are fertilizers produced from chemical, physical, and/or biological processes and are industrial products or fertilizer manufacturing plants. Organic fertilizers are mostly or wholly composed of plant residues produced in solid or liquid form and or organic matter obtained from animals. This fertilizer provides organic matter and improves the soil's physical, chemical, and biological properties (Simanungkalit et al. 2006). One of the best types of manure for plants is chicken manure. Chicken manure has a fairly low C/N ratio so the decomposition process doesn't take a long time. Besides that, chicken manure has a high N content so it is very beneficial for plants (Setiawan 2007). Better effects of poultry manure than other organic manures on plant growth was also reported, for instance on okra (Adekiya et al. 2020) and soybean (Oktabriana 2018).

A healthy lifestyle with the slogan "Back to Nature" is a new lifestyle for the world community. Many people realize that the use of synthetic fertilizers, pesticides, growth hormones, and other chemicals in agricultural production harms human health and the environment (Roidah 2013). According to research conducted by Chrysanthini et al. (2017), the main reason why many consumers switch to consuming organic vegetables is that organic vegetables have a higher nutritional content compared to conventional vegetables, with the main consideration being the quality of the product and the health benefits it provides. Seeing this, the cultivation of organic vegetables including winged beans very likely to be cultivated by farmers. However, information on winged bean cultivation and organic cultivation is still limited. Therefore, it is necessary to carry out further research on winged bean cultivation, especially in determining the dosage of fertilizers in organic cultivation systems.

Materials and methods

The research was carried out from July to November 2022 in the Organic Field of the IPB Experimental Station in Cikarawang, Dramaga, Bogor Regency at an altitude of 250 m asl with rainfall of 3300 mm per year and has latosol type soil. Observation of biomass was carried

out at the Post-Harvest Laboratory and Testing Lab of the Department of Agronomy and Horticulture, Faculty of Agriculture, IPB University. The materials used in this research were winged bean seeds variety Sandi IPB, chicken manure, agricultural lime, and raffia rope. Other supporting materials are silver-black mulch, seedling trays, and bamboo stakes.

This experiment used a completely randomized block design (RCBD) with four treatments and three replications, so there were 12 experimental units. The treatments tested were fertilizer doses of 0, 10, 20, and 30 tons of chicken manure ha⁻¹.

Land preparation was done two weeks before planting, then 2 tons ha⁻¹ of lime is applied. Beds are made with a size of 0.8 m x 3.3 m, then covered with plastic mulch. The planting holes with a spacing of 40 cm x 30 cm on plastic mulch. Manure was applied one week before planting with half (1/2) of the treatment dose, then the rest at the beginning of the generative phase (\pm 8 WAT). Manure is applied directly in the planting hole for initial fertilization and for subsequent fertilization, it is applied to plants by dissolving the manure according to the treatment in water at a dose of 5 liters/bed. The seeds are sown first on the seedling tray with the amount of 1 seed per hole. The seedling medium used was a mixture of soil, husks, and manure with a ratio of 1:1:1. Transplanting is done when the seedlings have 3 full leaves or approximately 14 days after sowing. Furthermore, the seedlings are planted with a spacing of 40 cm x 30 cm.

At 4 Weeks After Transplanting (WAT), winged bean plants are supported with 2 m bamboo stakes and every four stakes are tied with a rope. Watering, weed cleaning, and pest control are carried out as needed. Harvesting the young pods is done when the color of the winged bean pods is fully purple. Harvesting is done carefully then put in the plastic. According to Handayani (2013), harvesting young winged bean pods can be done from 12 WAT.

The experimental observations included soil analysis before planting, manure analysis, leaf nutrient analysis, young pod pigment analysis, growth characteristics, and young pod production. The soil was taken compositely and analyzed for pH, C-organic content, CEC, total N, total P and available P, total K, and available K content. Manure analysis was carried out on pH, CEC, moisture content, C-organic content, N, P, and K. Leaves were taken from two plants (excluding sample plants) per plot and analyzed for N, P, and K content. Pigment analysis in young pods was performed on one sample from each plot and analyzed for chlorophyll, anthocyanin, and carotene content. Observations on plant growth characteristics were carried out including stem length, leaf number, leaf area, leaf NPK levels (at 10 weeks after transplanting), and days to 50% flowering. Observations on young pod production

included pod fresh weight, pod length, pod width, pod dry weight, pod weight per plant and plot, pod number per plant and per plot, and young pod productivity.

The data were analyzed using SAS for Academics, and Microsoft Excel. Data were analyzed by F-test (analysis of variance). If the analysis shows a significant effect, then a further test will be carried out using Duncan's Multiple Range Test (DMRT) at the 5% level. The determination of the optimum dose is based on the results of the regression test.

Results and Discussion

Plant Height and Leaf Number

The plant height and leaf number of winged beans began to show significant differences between treatments at 6 and 8 Weeks After Transplanting (WAT). The application of chicken manure resulted higher plant height and leaf number, but there is not significant difference among doses of manure (Figures 1). Chicken manure as organic fertilizer plays a role in improving biological, physical, and chemical properties of soil. High amount of manure application (10-30 tons ha⁻¹) in the experiment can also provide nutrient directly to the soil. The chicken manure applied in this experiment contains 15.4% organic, 1.97% total N, 6.35% total P, and 2.54% total K. The effect of doses of chicken manure on the performance of several types of plants has also been reported by several previous researchers.

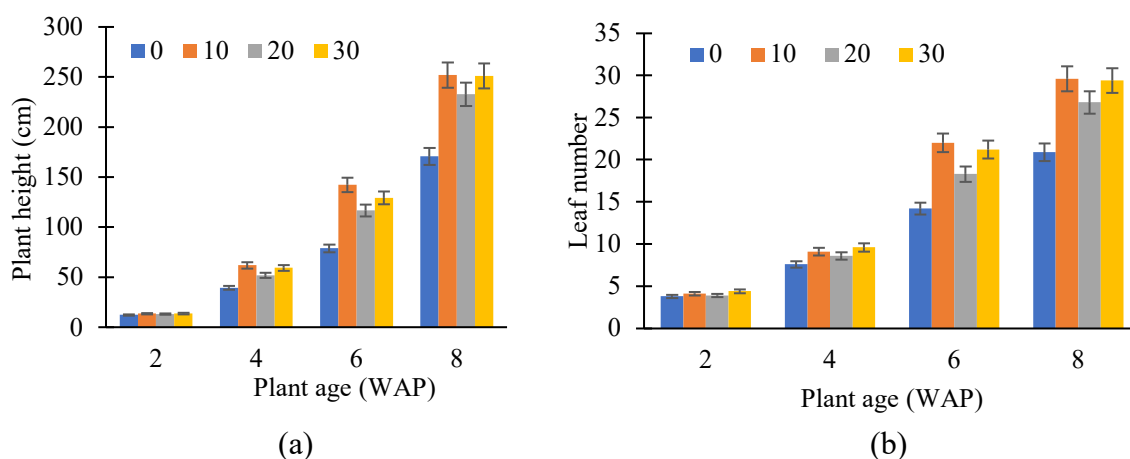


Figure 1. Plant height (a) and leaf number (b) with different chicken manure doses

Leaf Area and Leaf Nutrient Content

The chicken manure dose treatment had a significant effect on the area of ten leaves but did not affect leaf nutrient content. Manure application resulted in higher areas of the 10-leaf by 43-68% compared to control (Table1), but there was no significant difference among manure

doses. These results are similar to the research conducted by Gole et al. (2019), who revealed that the application of manure doses to mustard plants increased leaf area according to the increased dose of manure given.

The concentrations of leaf N, P, and K were not significantly different among treatments although with a dose of 20 tons ha⁻¹ of manure resulted in higher N, P, and K compared to the other doses. The N content in winged bean leaf have similar level, but P, K content in the current experiment were lower than those of Tustiyani et al. (2023).

Table 1. Area of ten leaves and leaf nutrient content in winged bean at 10 WAT with different doses of chicken manure

Chicken manure doses (ton)	Area of 10 leaves	N total (%)	P (%)	K (%)
0	851.47±148.73b	5.06±0.39	0.29±0.02	0.80±0.07b
10	1220.69±232.82ab	5.12±0.16	0.32±0.01	1.00±0.08ab
20	1432.63±228.41a	5.28±0.40	0.33±0.01	1.42±0.25a
30	1277.30±300.67ab	5.12±0.12	0.30±0.01	1.33±0.19a

Notes: Numbers followed by the same letter in the same column are not significantly different based on DMRT ($\alpha = 0,05$); \pm = standard error of means (n=3).

Days to Flowering and Days of Pods Turn Purple

Plants with chicken manure application flowering faster (6 weeks after planting/WAT) than those without fertilization (7 WAT). Harvesting the young pods is done when the pods are fully purple. Winged bean plants without fertilization produced full purple young pods faster (13 days after anthesis/DAA) than winged bean plants that were given fertilization with a difference of 2 days (15 DAA). According to Susanti (2022), the addition of the harvesting age of the young winged bean pods of the Sandi IPB variety causes the pods to become more intense purple and evenly distributed throughout the pods. The current study, however, found that the older the plant, the more fibrous the young pods with a full purple color.

Pod Size

The application of chicken manure causes differences in the length and width of the young pods (Figure 2). Plants with a dose of 30 tons ha⁻¹ produced the longest young pods, but not significantly different when compared to doses of 10 and 20 tons ha⁻¹ with an average length of about 26 cm, while plants without chicken manure only produced young pods 21 cm long. In line with the length of the pods, plants with a fertilizer dose of 30 tons ha⁻¹ also produced the widest young pods when compared to other doses. Differences in the width of young pods between treatments showed significantly different results.

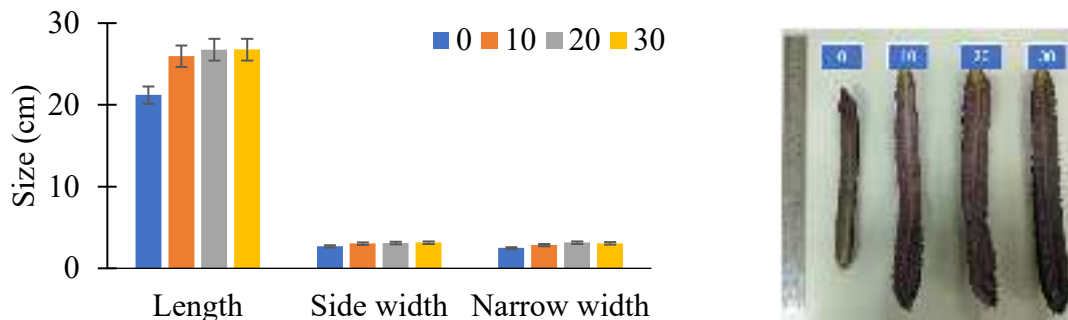


Figure 2. Sizes of winged bean young pod (a) and winged bean performance (b) with various doses of chicken manure

Pigmen Levels

Pigment levels of young pods, both chlorophyll, anthocyanin, and carotene from each treatment did not show significant differences (Table 2). This is because the pigment analysis was carried out when the pods of each treatment were already purple. The more purple the color of the pods, the higher the carotene content. On the other hand, the older the harvest, the less chlorophyll and anthocyanin content of the pods will decrease.

Table 2. Pigment content of young winged bean pods with various doses of chicken manure

Manure doses (ton ha ⁻¹)	Chlorophyll A (mg g ⁻¹)	Chlorophyll B (mg g ⁻¹)	Total total chlorophyll (mg g ⁻¹)	Anthocyanin (mg g ⁻¹)	Carotene (mg g ⁻¹)
0	296.33± 11.32	119.33± 10.73	415.33± 22.05	60.33± 12.39	112.33± 5.61
10	380.67± 121.39	146.33± 46.40	527.33± 167.63	49.33± 16.80	139.67± 45.71
20	374.67± 62.40	142.67± 24.42	517.67± 87.38	45.33± 8.23	133.00± 18.83
30	296.33± 53.57	136.33± 21.96	482.00± 75.50	54.33± 11.90	129.67± 19.63

Note: The mean is followed by a standard error (n=3).

Fresh Weight, Number, and Yield of Winged Bean Pod

The application of 20 and 30 tons chicken manure ha⁻¹ resulted in fresh weight of winged bean young pods which were greater than the other doses, this was following the length and width of each treatment (Figure 3). The application of organic fertilizers such as chicken manure will increase the supply and mobilization of nutrients for plants, increase microbial activity in the soil, and increase nitrogen fixation. Giving higher doses of manure will also increase the water-holding capacity of the soil, therefore the plants will get more soluble nutrients which will ultimately increase the quality and quantity of the pods (Thongbam et al. 2020).

The number of pods per plant is an important yield character, indicating treatment efficiency and influencing yield (Thongbam et al. 2020). The current experiment showed that the weight of young pods per plant was significantly different between dose treatments, but the

number of pods per plant was not significantly different. Plants with a fertilizer dose of 20 tons ha^{-1} showed the highest average yield of young pods, while the highest average young pod weight per plant was produced by plants with a dose of 30 tons ha^{-1} (Figure 3). Nurhadi (2019), reported that the application of chicken manure to black soybean plants resulted in a significant increase in the number of pods.

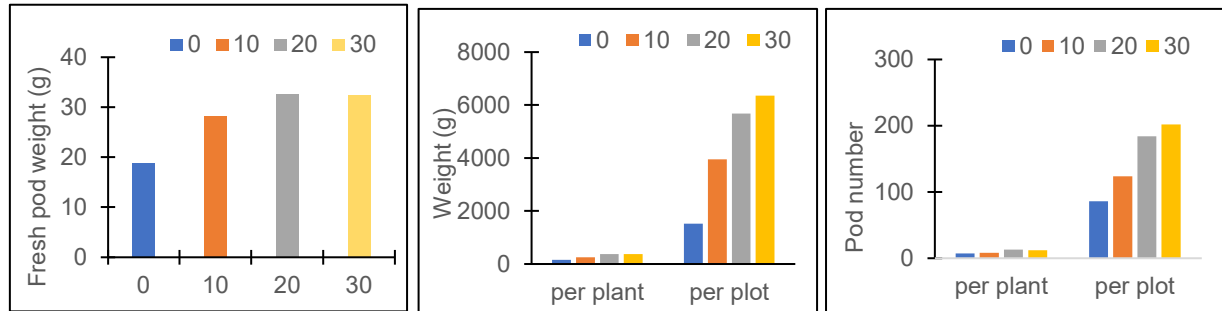


Figure 3. Number and weight of young pods

Young Pod Productivity

The number and weight of young pods per plot and yield per hectare were significantly different among treatments. The yields of winged bean pod with the dose of 0, 10, 20, and 30 tonnes ha^{-1} are 3550.65, 9209.94, 13069.00, and 14804.00 kg ha^{-1} , respectively. The highest number of young pods and pod weight per plot was produced by plants with a dose of 30 tons ha^{-1} .

Within the tested range of 0-30 tons manure ha^{-1} , the relationship between manure doses and pod yield shows a linear trend with regression equation $y=7.8x+169.43$. With the extrapolation, a quadratic regression can be obtained with the equation $y=145.14+15.107x-0.2429x^2$. From this quadratic equation, so the optimum dose from extrapolation is 31.48 tonnes ha^{-1} .

Conclusions and Suggestions

Increasing the dose of chicken manure increased the values of growth characteristics of winged bean plants, namely plant height, leaf number, leaf area, leaf potassium content, as well as yield components which included fresh weight, dry weight, young pod size, pod weight per plant, pod weight per plot, pods number per plot, and young pod productivity. The optimum dose of chicken manure has not yet been obtained because the relationship between fertilizer dose and young pod production is still linear, but from the extrapolation, the optimum dose can be predicted to be 31.5 tons chicken manure ha^{-1} .

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