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Growth and Production Responses of Cabbage (*Brassica oleracea* L.) after Various Bat Guano Fertilizer Application Doses in Lowlands

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Abstract

Cabbage is a popular horticultural commodity in the community with great potential development in highlands and lowlands. Nutrient fulfillment is a factor that supports optimal cabbage growth and production. This study aimed to determine the effect of different bat guano fertilizer doses on the growth and production of cabbage in lowlands. The cabbage type used was a suitable variety at lowlands called *Grand 22*. This study was performed in the experimental land of the Faculty of Agriculture, UNCP at 2 masl on September – December, 2021, through a randomized group design with six treatments and four replications. The treatments included: P0 = Control (without bat guano treatment), P1 = 30 g of bat guano per crop, P2 = 60 g of bat guano per crop, P3 = 90 g of bat guano per crop, P4 = 120 g of bat guano per crop, and P5 = 150 g of bat guano per crop. The results indicate that bat guano significantly affects all observed parameters. The 150 g of bat guano per crop provides the best effect on the cabbage height (27.75 cm), leaf width (27 cm), crop-forming age (36.5 days), and crop weight (1106.5 g).

Keywords: lowlands, *Grand 22*, bat guano, cabbage

A. Introduction

Cabbage is one of the popular horticultural commodities and is generally cultivated in the highlands. Cabbage plants are usually cultivated at 800-1000 masl (Destiwarni, et al., 2021). Although generally grown in the highlands, cabbage plants can also be cultivated in the lowlands. In the lowlands, cabbage plants have great potential for development and have high enough economic value to become a commodity with promising prospects (Hartono, et al., 2019). Cabbage plants can grow in the lowlands at 0-200 masl (Destiwarni, Sari, Astarina, &

Umar, 2021). Suitable varieties for lowland cultivation are *Grand 22*, *Green Coronet*, *Green Helmet*, *KK-Cross*, *Gloria Osena*, and *Green Autumn 2055* (Hartono, Kartinaty, Sunardi, & Marsusi,, 2019).

Cabbage contains many vitamins and minerals required by the human body. Vitamins in cabbage include vitamins A, B, C, and E. In addition, the minerals in cabbage are potassium, phosphorus, sodium, and iron (Akbar, 2015). High Vitamin C content in cabbage can prevent the acute mouth ulcers (Patty, 2012). Cabbage can also deactivate toxicants in the human body by triggering glutathione formation (Destiwarni, et al., 2021).

Cabbage production in Indonesia has fluctuated in 2015-2019. In 2015, cabbage production in Indonesia reached 1,433,227 tons, then increased to 1,513,326 tons in 2016. Cabbage production decreased to 1,442,624 tons in 2017, then continued to decrease in 2018 (1,407,932 tons) and in 2019 (1,413,060 tons) (BPS, 2020). The Central Bureau of Statistics recorded that cabbage production in Indonesia was 1.40 million tons in 2022. This number decreased by 2.08%, compared to the previous year, which reached 1.43 million tons (BPS, 2022).

Many factors can cause decreased production in a cultivation business. Planting media is an important component for optimal plant growth and production. The planting media has a role in supplying nutrients to plants. Fertilization is an effort to fulfill the nutrient requirements in plants to support their growth and production (Dewanto, Londok, Tuturoong, & Kaunang, 2013). Organic fertilizer is a widely-recommended fertilizer that can be applied to plants. Besides supplying nutrients, organic fertilizer can also improve the soil structure, thus supporting the development of plant roots. Organic fertilizers are also rich in microorganisms, which can increase soil nutrients and organic matter (Hartatik, Husnain, & Widowati, 2015); (Siswanto, Sugiyanta & Melati, 2015); (Haryadi, Yetti, & Yosefa., 2015).

Bat guano is an under-utilized organic fertilizer widely, although containing abundant nutrient contents for soil nutrient requirements. Bat guano fertilizer has macronutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur (Tangguda, Valentine, Hariyadi, & Sadiarsa, 2022). The bat guano fertilizer can also improve the soil structure and act as a biological fungicide due to containing organic material, bacteria, and microflora (Hariyadi, 2014).

Based on Hayanti, Yuliani & Fitrihidayati (2014), applying bat guano at 3.96 g per polybag could increase the growth of peanut plants. In addition, the combination of bat guano and urea could increase the growth and production of green bean plants (Taofiq, Setiati, & Purnama, 2018). Based on the description above, organic fertilizer from bat guano can be applied as a source of nutrients for cabbage cultivation in lowlands. This study aimed to determine the effect of various bat guano doses on the growth and production of cabbage plants at lowlands.

B. Methology

1. Experimental Design

This study was performed in the experimental land of Faculty of Agriculture, University of Cokroaminoto Palopo, Palopo at 2 masl on September – December, 2021. The materials used in this study were *Grand 22* cabbage seeds, bat guano, bamboo, raffia fiber, board, and water. The equipment included hoes, shovels, machetes, a camera, stationery, books, rulers, and scales.

This study used a randomized group design with six treatments and four replications, thus, the total treatment units were 24 units with 2 plant samples, so there were 48 observed plants. The dose treatments included: P0 = Control (without bat guano), P1 = 30 g of bat guano per crop, P2 = 60 g of bat guano per crop, P3 = 90 g of bat guano per crop, P4 = 120 g of bat guano per crop, and P5 = 150 g of bat guano per crop.

2. Research procedures

The experiment was started by processing and cleaning the land from weeds or remnants of previous plantings with hoes and machetes. Then, the soil tillage was performed by 30 cm depth. After processing, beds were made with 80 cm x 50 cm size, a distance of 30 cm and a height of 30 cm. This design was aimed as a walking path and drainage.

Furthermore, a nursery was conducted to prepare the seeds for planting, reducing the mortality risk. In this process, the seeds were sown in the prepared containers, with a 1:1 planting medium, namely 1 kg of compost and 1 kg of soil. The nursery was carried out for 2 weeks until the seedlings were ready to be transferred to the field. Seedlings with 3-4 leaves were soon transferred to the experimental land for planting. Seedlings were planted in the afternoon by inserting them into the holes of the prepared beds. Each planting hole was filled

with one seedling and covered with soil to support growth. The bat guano was applied only once, namely before planting and by hole immersion, based on the doses applied in each treatment. The parameters observed in this study were plant height, leaf width, crop-forming age, and crop weight.

Data from the observation results were analyzed using an analysis of variance (F-test) at 1% and 5% confidence levels. The analysis results with a significant difference were further tested with an Honest significance test (HST) at 5% for a significantly different value and 1% for a very significantly different value.

C. Result

Plant Height (cm)

Based on the analysis of variance results, different bat guano doses showed a very significant effect on the average cabbage plant height cultivated in lowlands. The average cabbage plant height at 8 Week After Planting (WAP) can be shown in Figure 1.

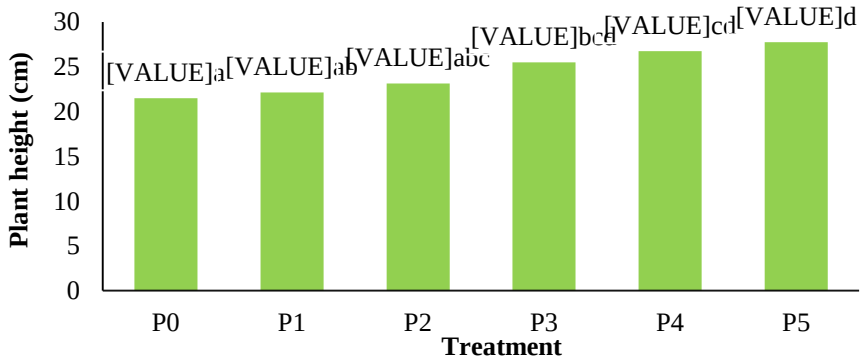

Figure 1. Average of cabbage plant height after different bat guano doses at 8 WAP. Notations behind numbers are the results of HST at a 1% confidence value. Numbers followed by the same notation have no significant difference.

Based on Figure 1, the P0 (control) treatment was insignificantly different from the P1 (30 g of bat guano per crop) and P2 (60 g of bat guano per crop) treatments, but showing a significant difference with the P3 (90 g of bat guano per crop), P4 (120 g of bat guano per crop), and P5 (150 g of bat guano per crop) treatments. The best treatment was obtained from the P5 with the cabbage plant height of 27.75 cm. The P0 treatment obtained the lowest plant height compared to other treatments.

Leaf Width (cm)

Based on the analysis of variance results, various bat guano doses significantly affected the average cabbage leaf width in lowlands. The average leaf width of cabbage plants at 8 WAP can be seen in Figure 2.

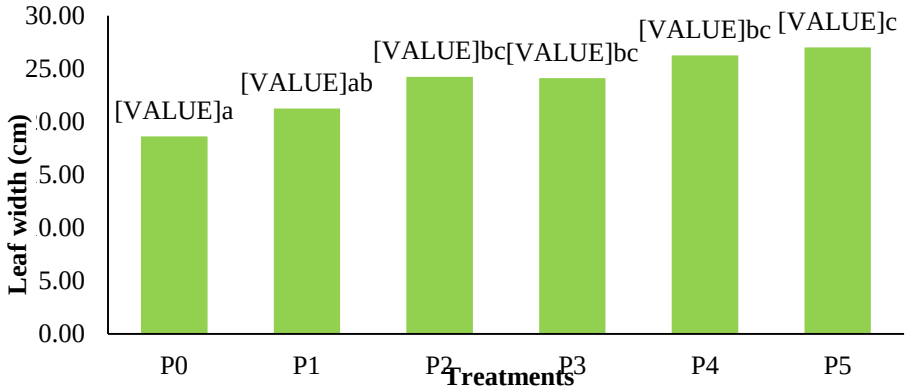

Figure 2. Average of cabbage leaf width after different bat guano doses at 8 WAP. Notations behind numbers are the results of HST at a 1% confidence value. Numbers followed by the same notation have no significant difference.

Based on Figure 2, the P0 (control) treatment was insignificantly different from the P1 (30 g of bat guano per crop) treatment but significantly different from the P2 (60 g of bat guano per crop), P3 (90 g of bat guano per crop), P4 (120 g of bat guano per crop), and P5 (150 g of bat guano per crop) treatments. The P1 treatment was insignificantly different from the P2, P3, and P4 treatments but significantly different from the P5 treatment. The best treatment was shown in the P5 treatment with an average cabbage leaf width of 27 cm. The P0 treatment showed the lowest average leaf width, compared to other treatments.

Crop forming-age

Based on the analysis of variance results, different bat guano doses had a significantly different effect on the average crop-forming age of cabbage cultivated at lowlands. The average crop-forming age in cabbage can be seen in Figure 3.

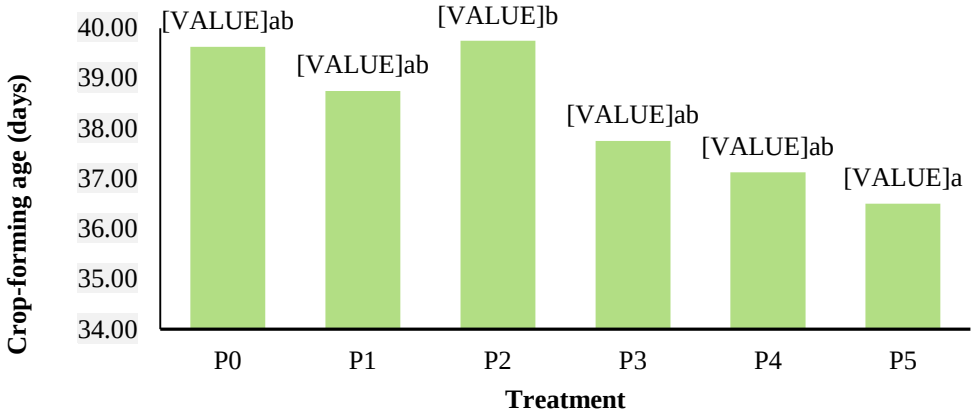

Figure 3. Average crop-forming age in cabbage after different bat guano doses at 8 WAP. Notations behind numbers are the results of HST at a 1% confidence value. Numbers followed by the same notation have no significant difference.

Based on Figure 3, the P0 (control) treatment was insignificantly different from the P1 (30 g of bat guano per crop), P3 (90 g of bat guano per crop), P4 (120 g of bat guano per crop), and P5 (150 g of bat guano per crop) treatments, but significantly different from the P2 (60 g of bat guano per crop) treatment. The P1 treatment was insignificantly different from the P2, P3, and P4 treatments but significantly different from the P5 treatment. The best treatment was obtained from the P5 treatment with an average crop-forming age in cabbage at 36.5 days. Cabbage plants administered with 150 g of bat guano formed crops faster than other treatments. The P2 treatment showed the longest crop-forming age compared to other treatments.

Crop Weight

Based on the analysis of variance results, different bat guano doses had a significantly different effect on the average crop weight of cabbage cultivated in lowlands. The average crop weight of cabbage can be seen in Figure 4.

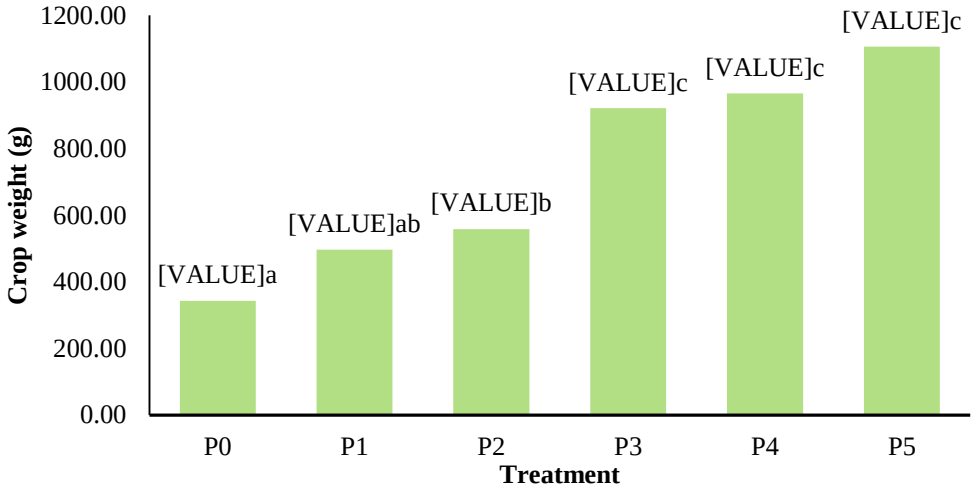

Figure 4. Average of cabbage crop weight after different bat guano doses at 8 WAP. Notations behind numbers are the results of HST at a 1% confidence value. Numbers followed by the same notation have no significant difference.

Based on Figure 4, the P0 (control) treatment was insignificantly different from the P1 (30 g of bat guano per crop) treatment but significantly different from the P2 (60 g of bat guano per crop), P3 (90 g of bat guano per crop), P4 (120 g of bat guano per crop), and P5 (150 g of bat guano per crop) treatment. The P1 treatment was insignificantly different from the P2 treatment but significantly different from the P3, P4, and P5 treatments. The P3, P4, and P5 treatments were insignificantly different. The best treatment was obtained from the P5 treatment with an average crop weight of 1106.50 g. The P0 treatment showed the lowest average crop weight compared to other treatments.

D. Discussion

Based on the study results, the application of bat guano at 150 g per crop obtained the best effect compared to other treatments for all observation parameters, including plant height (cm), leaf width (cm), crop-forming age (days), and crop weight (grams). The unfertilized cabbage plants showed the lowest growth and production responses among all treatments. This indicates that applying bat guano can increase the growth and production of cabbage plants in lowlands. The nutrient contents in the bat guano were thought to meet the nutrient requirements of cabbage plants.

Bat guano has high nitrogen, phosphorus, and potassium content. Based on test results, bat guano compost added with straw, husks, and bran contained 4.89% nitrogen, 1.65% phosphorus, and 1.89% potassium (Hayanti, et al., 2014). Bat guano is an organic fertilizer rich in nitrogen and phosphorus contents. Bat guano also contains ammonia, phosphoric acid, oxalic acid, and carbonic acid. In addition, bat guano has a good cation exchange ability, so plants can easily absorb nutrients useful in fertilizers. Furthermore, bat guano was also rich in organic matter, thus improving the soil structure (Syahbudin & Budiyanto, 2019).

The availability of macronutrients, especially nitrogen, phosphorus, and potassium in organic fertilizer will stimulate plant growth and production. The nutrient requirements of plants for nitrogen, phosphorus, and potassium will activate the cell division, specifically cells in meristem tissues for faster plant growth (Gardner, Brent, & Mitchell, 1991). Nitrogen is required by plants to stimulate the formation of plant vegetative organs, such as roots, stems, and leaves, in addition to assisting the formation of chlorophyll which plays an important role in absorbing solar radiation as an energy source for photosynthesis. Phosphorus plays a role in stimulating root development, flowering, fruit and seed formations. Meanwhile, potassium plays a role in forming proteins and carbohydrates in plants and increases the plant's resistance to biotic and abiotic stresses (Fachawati, 2020).

Nutrients that have been fulfilled will make plants grow optimally. A well-formed vegetative organ may cause the plants to enter the generative phase more quickly, whereas the 150 g of bat guano per plant formed a crop more quickly than other treatments. The fulfilled phosphorus requirement will accelerate plant maturity and stimulate the formation of generative organs, such as flowers, fruits, and seeds. Better plant growth will accelerate crop formation in cabbage plants (Sihaloho, Purba, Halolo, 2020).

Plant growth will affect its production. Plants that grow well will produce maximum production. Based on the study results, 150 g of bat guano per plant could increase the crop weight of cabbage plants. Rondonuwu, Paulus, & Pinaria (2016) stated that the provision of nutrients largely determined the crop weight of cabbage plants. The cabbage crop weight is affected by plant growth. Cabbage plants that were administered with the highest fertilizer concentration had a more optimal growth response and affected greater crop weight. The macronutrients in bat guano could meet the plant nutrient requirements, resulting in a high production level (Hasan, Lewar, Lehar & Duan, 2018). According to Hasan, et al. (2018), applying bat guano at 150 ml/L to kale plants obtained the best results compared to plants administered with bat guano at lower concentrations. High phosphorus content in bat guano supports the growth and development of the plant's vegetative and generative organs. Phosphorus is needed by plants for the formation of energy sources (ATP and ADP) (Winarti, et al., 2023).

E. Conclusion

Based on the study results, various bat guano doses significantly affect all observed parameters in cabbage plants cultivated at lowlands. The best treatment is found in 150 g of bat guano per plant, based on the cabbage height (27.75 cm), leaf width (27 cm), crop-forming age (36.5 days), and crop weight (1106.5 g).

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