

GROWTH RESPONSE OF BOK CHOY (*Brassica rapa L.*) DUE TO THE DIFFERENT DOSE AND TIMES OF GIVING BOKASHI

I Wayan Merta and Ahmad Raksun,

Biology Education Department, FTTE, University of Mataram, Mataram, Indonesia
Email: wayanmerta.fkip@unram.ac.id

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Abstract: Bok choy is one of the commodities favored by the Indonesian people. The presence of nutrients around the plant root system significantly affects the growth of bok choy. The availability of nutrients can be increased by fertilization. Fertilization of plants can be done by using bokashi organic fertilizer. A study on the growth response of bok choy due to differences in dose and time of giving bokashi was conducted to determine: (1) the growth response of bok choy to bokashi treatments, (2) the growth response of bok choy to the difference in time of giving bokashi, (3) The growth response of bok choy due to interaction between dose and time of giving bokashi. Two factors that completely randomized design with three replications were used in the study. The bokashi treatment consisted of 5 stages, while the time of giving bokashi consisted of 4 steps. The growth data measured were plant height, number of leaves, and leaf length of the bok choys. This study showed that: (1) plant height, number of leaves, and leaf length had a positive response to bokashi treatment with the best bokashi dose of 15 tons per hectare; (2) plant height, number of leaves, and leaf length responded positively to the giving time of bokashi. The highest growth parameters were found in the 30-day-after-planting bokashi treatment; (3) plant height, the number of leaves, and leaf length were not significantly different due to the interaction between dose and time of giving bokashi.

Keywords: *bokashi dose, bok choy growth*

INTRODUCTION

Bok choy is one of the commodities that the Indonesian people are interested in. This plant is one of the important vegetables in Asia. Bok choy has a tap root system (*radix primaria*) and root branches that are elliptical (cylindrical), spreading in all directions. These roots function to absorb water and nutrients from the soil and strengthen the position of plant stems. The stem (*caulis*) of bok choy is very short and segmented (almost invisible). This stem functions as a tool for forming and supporting the leaves. Bok choy plant height can reach 15-30 cm. The leaves of the bok choy plant have stalks, oval in shape, glossy dark green, do not form a crop, arranged in a tight spiral, and grow slightly upright or half horizontal. The petiole is white or light green, thick, and fleshy. Mustard plants are generally easy to flower and seed naturally, both in the highlands and lowlands. The mustard seeds are small round brown or blackish brown [1].

The presence of nutrients around the plant root system is one of the most decisive factors for bok choy growth. Fertilization is needed to increase the amount of nutrients around the root system of bok choy plants. Fertilization using organic and inorganic fertilizers has been widely used in vegetable cultivation. The use of organic fertilizers can be a good alternative considering the increasingly high price of chemical fertilizers [2]. The use of organic fertilizers has various advantages over chemical fertilizers, including regulating soil properties and acting as a buffer for the supply of nutrients for plants so that this fertilizer can restore soil fertility [3]. One of the organic fertilizers that

can increase the availability of nutrients around the plant root system is bokashi. Bokashi is a compost produced by fermentation with an agricultural EM4 activator. Bokashi can improve the physical and chemical properties of soil because it is made from organic waste. Bokashi-based organic waste such as goat manure, manure, and cow manure contains N, P, K, Ca, and Mg nutrients [4].

Mustard plants are very beneficial for health because of their high fiber content that can facilitate digestion in the body. Mustard plants are rich in vitamin A, vitamin B, vitamin C, vitamin E, and vitamin K. Mustard plants also contain protein, carbohydrates, and fats, which are helpful for body health. In addition, mustard plants also contain minerals. The minerals contained in the mustard plant are potassium, manganese, phosphorus, and iron minerals [5]. Fertilization with the right dose is needed to increase the growth of bok choy. [6] Increasing the productivity of vegetable production can be done in various ways, one of which is applying fertilizers with the right type, dose, and method.

Based on the descriptions above, a study was conducted on the response of bok choy growth due to differences in dose and time of giving bokashi. This study was conducted in Terong Tawah Village, Labuapi District, West Lombok Regency. The purpose of this study was to obtain information about: (1) bok choy growth response due to bokashi treatment, (2) bok choy growth response due to differences in bokashi treatment time, and (3) bok choy growth response due to the interaction between dose and time of giving bokashi.

Research Method

The materials used in this study were topsoil, bok choy seeds, compost made from organic waste, Furadan, anthracol, transparent paper, woven bamboo fence, iron nails, raffia rope, label paper, bamboo, and water. The tools needed were hand sprayers, saws, machetes, sickles, hoes, shovels, buckets, scales, measuring cups, and Arco. The study was conducted in the following stages: (1) preparing the necessary tools and materials, (2) processing organic waste into compost, (3) cleaning the experimental land from wild plants and garbage, (4) hoeing the experimental land and making beds with 1-meter width and 15-meter length, (5) mixing compost with a topsoil layer of soil on the experimental land, (6) planting bok choy plants, (7) irrigating the experimental land with river water, (8) weeding the experimental land by removing the existing weeds/wild plants on the experimental land, (7) eradicating pests and plant diseases, (8) measuring the growth parameters of bok choy, and (9) conducting data analysis.

This study was conducted with a 4 x 5 factorial experiment arranged in a completely randomized design with three replications. Based on the design, it was obtained 4 x 5 x 3 = 60 experimental units. The first factor is the *bokashi* treatment which consists of 5 levels: B₀ = 0 kg *bokashi*, B₁ = 0.5 kg *bokashi* treatment, B₂ = 1.0 kg

bokashi treatment, B₃ = 1.5 kg *bokashi* treatment and B₄ = 2.0 kg *bokashi* treatment. The second factor is the time of giving *bokashi* which consists of 4: *bokashi* treatment 0 days before planting (W₀), *bokashi* treatment 10 days before planting (W₁), *bokashi* treatment 20 days before planting (W₂), and *bokashi* treatment 30 days before planting (W₃). The growth parameters measured were stem height, number of leaves and leaf length, *bok choy* plants. The *bok choy* growth parameter data were analyzed by analysis of variance [7] [8].

Results and Discussion

Height of Plants

This study was conducted for 5 months, from July to November 2020. The parameters of *bok choy* growth measured were plant height, number of leaves, and leaf length of *bok choy* plants. The average height measurement of *bok choy* plants conducted 30 days before planting can be seen in table 1.

Table 1 shows that the lowest *bok choy* plant height was 18 cm, found in the W₀B₀ experiment in the unit that was not given *bokashi* treatment (control treatment). On the other hand, the highest *bok choy* plant was 25 cm, found in the W₃B₃ experiment in the unit treated with 1.5 kg of *bokashi* given 30 days before planting. The diversity analysis results of the effect of dose and time of *bokashi* treatment on *bok choy* plant height are shown in the following table.

Table 1. Data of *Bok choy* Plant Height (cm) in Each Treatment Combination

Treatments	Plant Heights	Treatments	Plant heights
W ₀ B ₀	18	W ₂ B ₀	19
W ₀ B ₁	19	W ₂ B ₁	20
W ₀ B ₂	20	W ₂ B ₂	22
W ₀ B ₃	20	W ₂ B ₃	23
W ₀ B ₄	18	W ₂ B ₄	22
W ₁ B ₀	18	W ₃ B ₀	21
W ₁ B ₁	19	W ₃ B ₁	22
W ₁ B ₂	21	W ₃ B ₂	23
W ₁ B ₃	22	W ₃ B ₃	25
W ₁ B ₄	21	W ₃ B ₄	24

Table 2. The Results of the High Diversity Analysis of *Bok choy* Plants

SK	DB	JK	KT	F. Hit.	F. Tab. 5%
<i>Bokashi</i> (B)	4	88,82	20,21	20,76	2,62
Time (W)	3	45,73	15,24	14,24	2,85
B x W	12	17,26	1,44	1,35	1,99
Error	38	40,75	1,07		

The diversity analysis showed that the treatment of *bokashi* organic fertilizer had a very significant effect on the plant height of *bok choy*. The timing of giving *bokashi* also had a very substantial effect on the plant height of *bok choy*. *Bok choy* plant height data did not show significant differences due to the interaction of dose and

treatment time of *bokashi* organic fertilizer. *Bokashi* is an organic compost fertilizer whose manufacturing process is accelerated by using an EM4 activator. *Bokashi* treatment can support growth and plantation. The compost is organic material that has been weathered [9]. The administration of organic compost functions serves

as a source of nutrients in the soil, improves the content of soil organic matter, improves the structure of the soil, and encourages the micro-organisms of soil. In addition, organic fertilizer compost can improve the physical properties of soil, such as land permeability, soil porosity, groundwater retaining power, and land cation.

In line with the results of the above research, the treatment of compost organic fertilizers could increase the height of rice plants, the availability of nitrogen, the number of saplings per clump, and rice plants (the number of grain per tassel and the number of grain contents per tassel [10]. The application of *bokashi* organic fertilizer can increase the height of the stem, leaf length, leaf width, and diameter of the stem of spinach. *Bokashi* application with 1.6 kg per 10 kg of land is the best dose for spinach plants [11]. Furthermore, the study results showed that the treatment of *bokashi* had a very significant effect on the high vertical elephant grass at 4, 6, and 8 weeks after planting [12]. The difference in the median value showed that the treatment of 30 tons per hectare gave the most significant number of saplings (7.95 saplings). It is because *bokashi* contains several nutrients and organic matter that can improve soil's physical,

chemical, and biological properties and provide nutrients such as nitrogen, phosphorus, and potassium needed by plants. Nitrogen, phosphorus, and potassium are macronutrients needed in significant quantities by plants. The application of organic fertilizer in manure and compost was able to increase the height of the stem of water spinach and hydroponics at 2, 4, and 6 weeks after planting [13]. The *Bokashi* application significantly increases the height of the 15-day sweet corn stem [14]. Research on the long bean plants was also concluded that *bokashi* applications could increase plant length and total fruit weight per plant. *Bokashi* treatment of 20 tons per hectare produced the highest total weight of fruit per plant [15].

Number of Leaves

The number of *bok choy* leaves found in each treatment combination showed a difference in the levels of *bokashi* applied. The least set of *bok choy* leaves is 10 leaves, found in the 0 kg *bokashi* treatment. The largest collection of *bok choy* leaves was 15, found in W3B3 treatment with 1.5 kg *bokashi* treatment applied 30 days before planting. Data on the number of *bok choy* leaves can be seen in Table 3.

Table 3. Data of Number of *Bok choy* Plant Leaves in Each Treatment Combination

Treatments	Number of Leaves	Treatments	Number of Leaves
W0B0	10	W2B0	11
W0B1	10	W2B ₁	12
W0B2	11	W2B2	12
W0B3	12	W2B3	14
W0B4	11	W2B4	13
W1B0	10	W3B0	12
W1B ₁	11	W3B ₁	122
W1B2	12	W3B2	13
W1B3	13	W3B3	15
W1B4	12	W3B4	14

From table 3, it is known that the number of leaves of the *bok choy* plant varies according to the level and time of *bokashi* application. The highest number of *bok choy* leaves was 15 strands, found in W3B3 treatment (treatment of 1.5 kg *bokashi* applied 30 days before planting). The least number of leaves was 10 leaves found on plants without *bokashi* treatment. The diversity analysis showed that the number of leaves had a positive response to the dose of *bokashi* applied. Total leaf has a positive response to the time of *bokashi* application. Total leaves were not significantly different due to the interaction between dose and time of *bokashi* application. The result of the diversity analysis is presented in Table 4.

The increase in total *bok choy* leaves due to *bokashi* treatment was caused by an increase in the nutrient content of the growing media due to the

application of *bokashi*. [16] explained that the mineralization process of organic matter would release complete plant nutrients such as N, P, K, Ca, and Mg in uncertain amounts. Furthermore, [17] found that the application of *bokashi* organic fertilizer with increasing doses could increase the pH (from 5.11 to 5.36) depending on the control. Moreover, the application of *bokashi* with increased doses was also able to increase potassium and magnesium nutrients. The *bokashi* fertilizer treatment of vegetable waste had a significant effect on soil-nitrogen parameters [18]. Besides increasing soil nitrogen, vegetable waste *bokashi* can also significantly increase plant height and fruits per plant. The highest nitrogen absorption in plant tissue was found in the treatment of 55 tons per hectare with 0.007g per plant.

Table 4. Diversity Analysis of the Total *Bok choy* Leaves

SK	DB	JK	KT	F. Hit.	F. Tab.5%
<i>Bokashi</i> (B)	4	22,23	5,56	13,24	2,62
Time (W)	3	16,34	5,45	12,98	2,85
B x W	12	4,33	0,36	0,86	1,99
Error	38	15,92	0,42		

Research on other plants found that the application of *kirinyuh* leaf *bokashi* can increase the number of mustard leaves. In addition, the application of *kirinyuh* leaf *bokashi* also significantly increased plant height, leaf width, root weight, and fresh weight per plant. The application of *bokashi* dose of 20 tons per hectare produced the highest number of leaves (9.63 leaves) and gave the best results for all parameters measured [19]. The application of organic *bokashi* fertilizer had a significant effect on the total parameters of candlenut leaves [20]. The application of *bokashi* also had a significant effect on the total leaves of *kawali* varieties of sorghum [21] and total leaves of elephant grass [22].

Leaf Length

Bok choy leaf length was measured from the base to the tip of the leaf. *Bok choy* leaf length varies

depending on the time of application of *bokashi* and the high and low levels of *bokashi* applied. The lowest leaf length was 16 cm found in mustard plants that were not treated with *bokashi*. Furthermore, the highest leaf length was 21 cm, found in the application of 1.5 kg *bokashi* 30 days before planting. The average leaf length of the *bok choy* plant is presented in the following table.

The diversity analysis showed that the difference in *bokashi* doses had a significant impact on the length of the *bok choy* leaves. *Bok choy* leaf length showed a significant difference due to differences in *bokashi* application time. *Bok choy* leaf length was not significantly different due to the interaction between different doses and application time. Analysis of the diversity of *bok choy* leaf length in all treatment combinations can be seen in Table 6.

Table 5. Data of *Bok choy* Leaf Length in Each Treatment Combination

Treatments	Averages of Leaf Length (cm)	Treatments	Averages of Leaf Length (cm)
W0B0	16	W2B0	17
W0B1	178	W2B ₁	18
W0B2	1718	W2B2	19
W0B3	18	W2B3	20
W0B4	17	W2B4	19
W1B0	17	W3B0	18
W1B ₁	17	W3B ₁	18
W1B2	181	W3B2	19
W1B3	19	W3B3	21
W1B4	17	W3B4	19

Table 6. Analysis of *Bok choy* Leaf Length Diversity in Each Treatment Combination

SK	DB	JK	KT	F. Hit.	F. Tab. 5%
<i>Bokashi</i> (B)	4	41,07	10,27	14,26	2,62
Time (W)	3	13,78	4,59	6,38	2,85
B x W	12	6,13	0,51	0,71	1,99
Error	38	27,52	0,72		

Bokashi organic fertilizer can increase the availability of macronutrients such as nitrogen, sulfur, and potassium in the growing media. The application of *bokashi* can increase plant growth, such as leaf length growth, stem height growth, and wet weight and dry weight of the plant. Research on *Ipomoea reptans poir* plant showed that the application of *bokashi* could increase leaf length [23]. Furthermore, research on *Cucumis melo* plants also found that the application of *bokashi* can

significantly increase leaf length [24]. Not only increasing leaf length, *bokashi* application can also increase plant weight. [25] concluded that the application of *bokashi* together with *NPK* fertilizer could increase cucumber fruit weight. Beneficial microorganisms found in *bokashi* can increase the diversity and activity of microorganisms in the soil to increase the availability of nutrients and support plant growth.

CONCLUSION

Based on the study conducted, it can be concluded that: (1) plant height, leaf number, and leaf length had a positive response to *bokashi* treatment with the best *bokashi* dose of 15 tons per hectare; (2) plant height, the number of leaves and leaf length of *bok choy* responded positively to the time of giving *bokashi* with the highest growth parameters were found in the *bokashi* treatment 30 days before planting; and (3) plant height, leaf number and leaf length were not significantly different due to the interaction between dose and time of giving *bokashi*.

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