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Effectiveness of Giving Bokashi and NPK Fertilizer on Growth of Long Beans (*Vigna sinensis* L.)

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Abstrack: Various factors influence the growth rate of long beans. One of the external factors that determines the growth rate of long beans is the availability of nutrients on agricultural land. The nutrient content of the planting medium can be increased by applying fertilizer. Research has been conducted on the effectiveness of bokashi and NPK fertilizer on the growth of long beans. The study aimed to determine the effectiveness of giving bokashi on the growth of long beans. Effectiveness of NPK fertilizer application on long bean growth. Effectiveness of the interaction of bokashi and NPK fertilizer on long bean growth. The research was designed in 2 factors, and data analysis used analysis of variance. Data analysis showed that giving bokahi effectively increased the number of leaves, plant height, and length but did not increase leaf width. The application of NPK fertilizer was effective in improving all measured parameters.

Keywords: Bokashi; NPK; Growth of Long Beans; Fertilizer.

Introduction

Long beans are a plant from the Leguminoceae family that grows on vines. Long bean stems have many branches. Long beans are green, elongated pods [1]. Long bean stems grow in twists, and the fruit is a pod with a pod length of about 40 cm. The seeds are elliptical, slightly flat, and sometimes curved. The color of the seeds varies depending on the variety, and some are yellow, brown, black, or reddish yellow [2]. Various factors influence the growth rate of long beans. One of the external factors that determines the growth rate of long beans is the availability of nutrients on agricultural land. To increase the availability of nutrients, it is necessary to fertilize using both organic and inorganic fertilizers. Since 1970, Indonesian people, especially those living on the island of Lombok, have used chemical fertilizers to increase the availability of nutrients and plant growth.

In reality, the use of chemical fertilizers has a negative impact on environmental sustainability. The accumulation of mineral content in inorganic fertilizer can kill the microorganisms responsible for soil decomposition so that the soil becomes complex and less able to hold water and nutrients [3]. The application of chemical inputs in the form of synthetic fertilizers and pesticides at high doses not only has the effect of reducing soil fertility levels but also results in a decline in biodiversity, increased pest and disease attacks, the emergence of resistant pests and the development of parasitic organisms [4]. Their use must be combined with organic fertilizers to reduce the negative impact of using inorganic fertilizers.

Bokashi is an organic fertilizer that can increase the availability of nutrients and plant growth on agricultural land. Bokashi fertilizer significantly affected plant growth and fruit weight compared to manure [5]. Using bokashi fertilizer mixed with NPK fertilizer produces 3 times more fruit weight per hectare than manure mixed with NPK fertilizer. The beneficial microorganisms and other organic compounds in bokashi fertilizer can increase the diversity and activity of microbes in the soil, thereby increasing nutrients and supporting plant growth.

Some researchers report that giving bokashi can increase plant growth. Giving bokashi to the rice fields of Montong Are Village can increase purple eggplant production [6]. The optimum level of bokashi that needs to be given to the rice fields of Montong Are Village so that purple eggplant is produced optimally is 1.2 kg for every 10 kg of soil. In elephant grass, it was reported that giving bokashi influenced the number of tillers 8 weeks after planting, plant height, and number of leaves at 28 days, 42 days, and 56 days after planting. Giving a dose of 30 tons of bokashi for 1 hectare provides the best average vegetative growth for elephant grass when compared to other doses [7].

Based on the explanation above, researchers have researched the effectiveness of bokashi and NPK fertilizer on the vegetative growth of long beans. This research aims to determine (1) the effectiveness of giving bokashi on the growth of long beans, (1) the effectiveness of NPK fertilizer on the growth of long beans, (3) analyzing the effect of the interaction of bokashi and NPK fertilizer on the vegetative growth of long beans.

Research Method

This research used various materials: bokashi, long bean seeds, NPK fertilizer, bamboo, well water, neat rope, iron nails, and rice field soil. The tools used

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were hoes, machetes, sickles, plastic buckets, artco push knives, and scissors. A two-factor, completely randomized design was applied when planting long beans. The bokashi treatment consists of 4 application doses: treatment S0 = 0 kg, S1 = 0.8 kg, S2 = 1.6 kg, and S3 = 2.4 kg for 1 m2 of agricultural land. The NPK fertilizer treatment consisted of P0 = 0 g, P1 = 0.5 g, P2 = 1 g and P3 = 1.5 g of NPK fertilizer for 1 long bean.

The research stages are: (1) procurement of tools and materials, (2) determining the research location, (3) clearing the research location of weeds, (4) cultivating the soil at the research location, (5) application of bokashi on the experimental land, (6) planting long bean seeds, (7) treating NPK fertilizer twice, (8) irrigating long beans regularly, (9) controlling plant pests and diseases, (10) measuring growth parameters of experimental plants. Growth parameters were measured when the plants were 28, 29, and 30 days after planting. The longbean growth parameters measured were plant length, number of leaves, leaf length, and leaf width. Research data was analyzed using ANOVA.

Results and Discussion

Number of leaves

Bokashi treatment can cause variations in the number of long bean leaves. Variations in the dose of NPK fertilizer also caused variations in the number of long bean leaves. The results of observations on the number of long bean leaves resulting from bokashi and NPK fertilizer treatment measured when the plants were 28 days old are presented in the following table.

Table 1. Variability in Number of Long Bean Leaves Due to Bokashi and NPK Fertilizer Treatment

Combination of Treatments	Number of Leaves	Combination of Treatments	Number of Leaves
S0P0	24	S2P0	26
S0P1	25	S2P1	27
S0P2	25	S2P2	27
S0P3	26	S2P3	29
S1P0	25	S3P0	25
S1P1	26	S3P1	26
S1P2	26	S3P2	26
S1P3	28	S3P3	27

Table 1 shows that the treatment of 0 kg bokasi combined with 0 g NPK fertilizer produced the smallest number of leaves, namely 24. The treatment of 1.6 kg bokashi combined with 1.5 g of NPK fertilizer produced the highest number of leaves = 29. The Anova on the effect of NPK fertilizer gave the calculated F = 5.38, which is more significant than the F table (2.92). The ANOVA on the effect of bokashi gave a calculated F = 4.33, which is more significant than the F table (2.92). The ANOVA on the effect of the interaction of NPK fertilizer and bokashi gave the calculated F = 0.09, smaller than the F table (2.21). Therefore, the ANOVA results show that bokashi application significantly affected the number of long bean leaves. NPK fertilizer treatment significantly affected the number of long bean leaves. The interaction of bokashi and NPK fertilizer had no significant effect on the number of long bean leaves.

Bokashi is an organic fertilizer that contains various nutrients. The nutrient content in bokashi allows accelerated plant growth. [8] reported that bokashi made from tea dregs and cow dung fermented for 7 days contained N-total = 2.19%, P_2O_5 = 0.58%, K_2O = 0.77%, C-Organic = 24.00%, pH = 7.32, C/N = 11, Water content = 12.70%. Meanwhile, with 14 days of fermentation, the bokashi content was N-total = 2.76%, K_2O = 0.97%, C-Organic = 27.00%, pH = 6.26, C/N 10, Water content 14.00 %.

In other plants, it was also found that bokashi treatment could increase the number of leaves. In green mustard, it was found that the bokashi treatment of *Chromolaena odorata* leaves significantly affected the number of green mustard leaves. The 20 ton/ha *Chromolaena odorata* leaf bokashi dose treatment gave the highest number of leaves on mustard greens, namely 9.63, significantly different from all other treatments. Besides increasing the number of leaves, bokashi treatment can also increase each plant's plant height, root weight, and fresh weight [9]. The treatment of various types of bokashi significantly affected the number of leaves, plant height, primary branches, and eggplant fruit [10]. Bokashi treatment significantly affected the number of leaves, plant height, number of tillers, and rhizome weight of each red ginger [11].

NPK fertilizer treatment can also increase the number of long bean leaves. NPK fertilizer contains nitrogen, which plants need. [12] explains that plant roots absorb nitrogen in the form of nitrate or nitrite. Plants need these compounds to grow and develop. Nitrogen plays a role in producing proteins and nucleic acids, which play a role in the vegetative growth phase of plants, namely in the formation of leaves, roots, and stems. Nitrogen also plays a role in increasing the proliferation of microorganisms in the soil.

In other plants, the application of NPK fertilizer can also increase the rate of increase in the number of leaves. Providing NPK fertilizer significantly affects the number of leaves, shoot dry weight, shoot root ratio and total dry weight, plant height, and root dry weight [13]. The treatment of media composition and NPK fertilizer affects the number of leaves and plant height [14]. NPK fertilization treatment affects the number of leaves, number of tillers, and fresh weight of celery [14-15].

Stem Length

The bean stem length shows that bokashi and NPK fertilizer treatment causes differences. The average

length of long bean stems measured when the plants were 30 days old is as follows.

Table 2. Average Stem Length after Bokashi and NPK Fertilizer Treatment

Combination of Treatments	Number of Leaves	Combination of Treatments	Number of Leaves
S0P0	126	S2P0	134
S0P1	127	S2P1	134
S0P2	129	S2P2	135
S0P3	130	S2P3	137
S1P0	128	S3P0	134
S1P1	130	S3P1	135
S1P2	132	S3P2	135
S1P3	134	S3P3	136

The data in Table 2 shows that applying bokashi and NPK fertilizer causes variations in the average length of long bean stems. Treatment of 0 kg bokashi combined with 0 g NPK fertilizer resulted in the lowest stem length = 126 cm. The highest stem length was produced by treating 1.6 kg of bokashi combined with 1.5 g of NPK fertilizer. The ANOVA on the effect of NPK fertilizer gave the calculated F = 5,00, which is more significant than the F table (2.92). The analysis of variance on the impact of bokashi gave a calculated F = 12.18, which is more significant than the F table (2.92). The ANOVA on the effect of the interaction of NPK fertilizer and bokashi gave the calculated F = 0.35, smaller than the F table (2.21). Therefore, the analysis of variance shows that the bokashi application significantly affected the stem length of the longbean. NPK fertilizer treatment significantly affected the stem length of the longbean. The interaction of bokashi and NPK fertilizer had no significant effect on the stem length of the longbean.

The increase in long bean stem length due to the application of bokashi is because bokashi is an organic fertilizer that meets the minimum technical requirements for organic fertilizer to increase plant growth. The results of laboratory analysis show that bokashi made from husk, cow dung, and goat dung has pH (8.00), C-Organic (16.20%), N-Total (1.22%), P-total (0.53%), and K-total (1.71%) which meets the minimum technical requirements for organic fertilizer. Furthermore, the analysis results of soil treated with bokashi show that the application of bokashi can increase the potassium and magnesium content in the soil [16]. In other plants, results were also similar to the results of this study. Bokashi treatment on agricultural land in Selebung Ketangga Village can increase stem height, wet weight, dry weight, leaf wet weight, and corn fruit production. The optimum level of bokashi that needs to be given to agricultural land in Selebung Ketangga Village so that corn can grow and produce optimally is 0.8 kg bokashi/10 kg soil [17]. The addition of the bokashi dose significantly affected plant height, fresh weight production, and dry matter production. However, it did not significantly affect the number of tillers or the proportion of elephant grass leaves. The optimum bokashi dose for elephant grass is 36.73 tons Ha^{-1} [18].

NPK fertilizer can increase the length of long bean stems because it contains the elements N, P, and K that plants need. [19] Explain that nitrogen plays a role in photosynthesis and makes plants greener, accelerating growth in height and the number of saplings and plant branches. Phosphorus forms growing point tissue, increasing tissue growth and making plants healthier and more robust. Potassium can speed up photosynthesis and accelerate plant growth at the initial stage.

In Moringa, it was found that the level of NPK fertilizer treatment significantly affected plant height, number of leaf stalks, stem weight, leaf petiole weight, leaf weight, and biomass weight [20]. Providing NPK fertilizer has a significant effect on gmelina height. Providing 10 grams of NPK fertilizer had the most significant impact on plant height, with an increase in height growth of 109.72% compared to the control. Apart from that, NPK fertilizer treatment can also increase stem diameter [21]. Kailan's height increased significantly due to NPK fertilizer treatment, up to a dose of 6.0 g/plant. Each increase in one unit dose of NPK fertilizer will increase plant height by 0.39 cm [22].

Leaf Length

Long bean leaf length, measured when the plants were 29 days old, varied due to bokashi and NPK fertilizer treatment. Data on long bean leaf length is presented in Table 3.

Table 3. The average length of long bean leaves after bokashi and NPK fertilizer treatment.

Combination of Treatments	Leaves length (mm)	Combination of Treatments	Leaves length (mm)
S0P0	125	S2P0	127
S0P1	126	S2P1	128
S0P2	128	S2P2	130
S0P3	128	S2P3	132
S1P0	126	S3P0	127
S1P1	126	S3P1	127
S1P2	128	S3P2	129
S1P3	128	S3P3	131

The data in Table 3 shows that the maximum average leaf length was 132 mm, found in the treatment of 1.6 kg bokashi and 1.5 g NPK fertilizer. The average minimum leaf length = 125 mm was had by plants treated with 0 kg bokashi and 0 g NPK fertilizer. The ANOVA on the effect of NPK fertilizer gave the calculated F = 6,92, which is more significant than the F table (2.92). The analysis of variance on the impact of bokashi gave a calculated F = 3,64, more significant than the F table (2.92). The ANOVA on the effect of the interaction of NPK fertilizer and bokashi gave the calculated F = 0.16, smaller than the F table (2.21). Therefore, the results of the variance analysis show that bokashi application had a significant effect on the leaf length of long beans. NPK fertilizer treatment significantly affected the leaves' length of longbean. The interaction of bokashi and NPK fertilizer had no significant effect on the leaf length of the longbean.

It was also reported that bokashi influenced plant leaf length in other plants. The application of bokashi significantly affects leaf length, leaf width, stem height, and stem diameter, but it has no significant effect on the number of spinach leaves. The optimum dose of bokashi that needs to be given to agricultural land in Bajur Village to increase spinach growth is 1.6 kg for 10 kg of soil [23]. Bokashi treatment had a significant effect on the length of mustard leaves. Providing 5 tons of chicken manure bokashi ha-1 to 20 tons, ha^{-1} has significantly affected leaf length. This data shows that giving 5 tons ha^{-1} of bokashi chicken manure can increase leaf growth [24]. (Zul. The interaction between giving bokashi and N fertilizer significantly affected leaf area index, plant height observed 21 and 35 days after planting, plant wet weight, plant dry weight, and number of seeds in each row [25].

NPK fertilizer treatment can increase the length of long bean leaves. Nitrogen, Phosphorus, and Potassium are primary macronutrients that plants need in large quantities. Nitrogen is a building material for proteins, nucleic acids, enzymes, nucleoproteins, and alkaloids, as well as the formation of chlorophyll for photosynthesis. Nitrogen absorbed by plants will produce nucleic acids in the cell nucleus and play a role in cell division, resulting in plant development, leaf layers forming, and leaf size elongation [26].

The research results on the effect of NPK fertilizer application on leaf size in other plants show that the combination of NPK fertilizer and shoot sources significantly affects increasing leaf length, number of leaves, leaf width, and leaf area in pineapple [27]. NPK fertilizer treatment significantly affected the leaf length of Ficus carica L. 60 days after planting [28]. NPK fertilizer treatment significantly affected the leaf length of Capsicum frutescens L. Providing 10 grams of NPK fertilizer could increase 23.97% compared to without NPK fertilizer treatment [29].

Leaf Width

The width of long bean leaves was measured when the plants were 30 days old. Data from measurements of long bean leaf width are presented in Table 4.

Table 4. The average width of Long Bean Leaves after Bokashi and NPK Fertilizer Treatment.

Combination of Treatments	Leaves width (mm)	Combination of Treatments	Leaves width (mm)
S0P0	68	S2P0	69
S0P1	70	S2P1	70
S0P2	71	S2P2	72
S0P3	73	S2P3	74
S1P0	68	S3P0	69
S1P1	69	S3P1	71
S1P2	72	S3P2	73
S1P3	73	S3P3	73

In Table 4, it can be observed that the minimum leaf width was 68 mm found in the S0P0 treatment. The maximum leaf width of 74 mm was observed in plants treated with 1.6 kg bokashi and 1.5 g NPK fertilizer. The ANOVA on the effect of NPK fertilizer gave the calculated F = 8,49, which is more significant than the F table (2.92). The analysis of variance on the impact of bokashi gave a calculated F = 0,51, smaller than the F table (2.92). The ANOVA of the effects of the interaction of NPK fertilizer and bokashi gave the calculated F = 0.14, smaller than the F table (2.21). Therefore, the analysis of variance shows that the bokashi application had no significant effect on the leaf width of the longbean. NPK fertilizer treatment significantly affected the leaf length of the longbean. The interaction of bokashi and NPK fertilizer had no significant effect on the leaf width of the longbean.

The actual influence of NPK fertilizer on leaf width was also observed in other plants. NPK fertilizer treatment can increase leaf width, plant height, number of leaves, leaf length, stem diameter, root length, number of secondary roots, wet weight of seedlings, and dry weight of seedlings [30]. In Ipomoea aquatica, it was found that the dose of NPK fertilizer had a real influence on the width of the Ipomoea aquatica leaves at the age of four weeks after planting, had a real influence on the number of leaves at the age of four weeks after planting, had a tangible impact on the height of the kale at the age of four weeks after planting, had a significant effect on the wet weight of Ipomoea aquatica. The best dose of NPK fertilizer for the yield and growth of water spinach is 25 g $plot^{-1}$ or 250 kg ha^{-1} [31].

Conclusion

Analysis of variance in the effect of NPK fertilizer on the number of leaves, stem length, leaf

length, and leaf width, it was obtained that the calculated F = 5.38, 5.00, 6.92, and 8.49, respectively, were more significant than the F table = 2.92. Based on the results of this analysis, it was concluded that NPK fertilizer treatment significantly increased all measured growth parameters. In the analysis of variance of the effect of bokashi on the number of leaves, stem length, leaf length, and leaf width, the calculated F = 4.33, 12.18, 3.64, and 0.51, respectively. Based on the results of this analysis, it was concluded that the bokashi treatment significantly increased the number of leaves, stem length, and leaf length but had no significant effect on increasing leaf width. Analysis of variance of the effect of the interaction of bokashi and NPK fertilizer on the number of leaves, stem length, leaf length, and leaf width gave calculated F results = 0.09, 0.35, 0.16, and 0.4, respectively, which were smaller than F table = 2.21. Based on the results of this analysis, it was concluded that the interaction of NPK fertilizer and bokashi had no significant effect on all measured growth parameters

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