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Response of Growth and Seed Yield of Mung Bean (*Vigna radiata* L.) to Chicken Manure and Banana Hump Liquid Organic Fertilizer Application

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ABSTRACT

Mung bean is highly important legume crop in Indonesia. Attempts to improve the yield and quality of mung bean seeds can be done through improving the planting media by adding organic fertilizer. The objective of this study was to determine the response of growth and seeds production of mung bean due to chicken manure and banana hump organic fertilizer. The research was performed in the greenhouse at the Balai Pengujian Standar Instrumen Tanaman Aneka Kacang (BSIPTAKA), Muneng Probolinggo. This study was structured in a factorial block design with three replications executed randomly. The first factor was doses of CM consisting of 0, 8.3, 16.7, and 25 ton/ha. The second factor was concentrations of banana hump liquid organic fertilizer (LOF) consisting of 0, 10, 20, and 30 ml/L. The result showed that doses of CM had a significant effect on plant height at 10 DAP, seed weight per plant, and seed yield. The interaction between CM doses and banana hump LOF was able to increase leaf chlorophyll index at 30 DAP. Combination of 16.7 ton/ha CM and 20 ml/L banana hump LOF produced the highest average chlorophyll index of 55.07 CCI.

1. INTRODUCTION

Mung bean (*Vigna radiata* L.), locally called kacang hijau, is highly important legume crop in Indonesia, following soybeans and peanuts. Therefore, mung beans have the potential to be developed. The latest data of mung bean production in Indonesia for the period 2015-2018 show a decreasing trend from 271,463 tons in 2015 to 252,985 tons in 2016 and continued to 241,334 tons in 2017, and to 234,718 tons in 2018 (Kementrian Pertanian, 2019). The cause of the decline in mung bean production is due to the decreasing of harvested area. In addition, the low mung bean yields at the farmer level which is caused by less than suboptimal cultivation practices (Suratmin *et al*., 2017).

Increasing harvested area through extensification on fertile land is difficult to do, thus forcing the use of sub-optimal land (Candra *et al*., 2020). The environment for Mung Bean production is generally in the form of suboptimal land, especially rainfed rice fields, acid dry land, and dry climate dry land (Kuntyastuti & Lestari, 2016). Alfisol is a soil that is poor in N, P, and K content due to very low humus, although alfisol soil has the advantage of relatively good physical properties. The low level of nutrients in alfisol soils due to high weathering levels causes nutrients in the soil to be leached (Arista *et al*., 2015). Efforts to improve the production and quality of mung bean seeds can be done in various ways including improving the planting media by adding soil organic fertilizer. According to Sumiati *et al*.,

(2021) organic fertilizers involved fertilizers comes from animal manures and green plants. Organic fertilizers are highly vital to improve biological, physical, and chemical properties of the soil. According to Mayrowani (2016), using organic fertilizer in planting media can create environmentally friendly and residue-free agriculture, thus providing benefits for agricultural development. Examples of the use of organic fertilizers are chicken manure (CM) and liquid organic fertilizers which can come from plant and animal waste.

Poultry manures such as CM are solid organic fertilizer containing high water content and mucilage. But, CM is a cold fertilizer because the change from the material contained in the fertilizer to being available in the soil takes place slowly (Sitinjak & Purba, 2018). CM is superior than goat and cow manure because it has a higher nutrient content. According to Sari *et al*., (2016), CM contains 2.44% Nitrogen (N), 0.67% Phospor (P), 1.24% Potassium (K), and 16.1% C-Organic. These elements (N, P, K) found in CM are so high that potentially improve fertility in the degraded soils and increase crop production. Candra *et al*. (2020) reported that the optimum dosage of CM was able to provide sufficient nutrients for growth and seed production of mung bean.

Liquid organic fertilizer (LOF) is a solution derived from the fermentation of organic materials. LOF can also be produced from organic waste, including animal manures, plant residues, activated sludge, wood sawdust, garbage, where the quality of LOF depends on the formation process. Kesumaningwati (2015) stated that banana hump has the potential as a source of local soil microorganisms because contains nutrients as food for microbes to develop properly.

According to Suhastyo *et al*. (2013) Banana hump is an organic material that contains both macro and micro nutrients, as well as chemical content in the form of carbohydrates which stimulate the growth of microorganisms in the ground. Chaniago *et al*. (2017) research on mung bean showed that banana LOF had a greatly significant influence on plant height, plot yield, and 100 seed weight, as well number of pods and production per plant. The objective of this study were to determine the response of growth and seeds production of mung bean due to CM and banana hump LOF.

2. METHODS

2.1. Site Research

The research was taked on 15 October – 31 December 2021. The research was carried out in the greenhouse owned by Balai Pengujian Standar Instrumen Tanaman Aneka Kacang (BSIPTAKA), Muneng Kidul Village, Sub-District of Sumberasih, District of Probolinggo, East Java in 42 m asl at the coordinate of 7’47’20’S and 113’09’51’E..

2.2. Material

The tools used in this research included stationery, polybags, paper envelopes, hoes, gembor, camera, knapsack, label, ruler, scale, SPAD, bucket, tarpaulin, hammer, and sickle. Materials used in this research included, seed of Mung Bean Variety Vima-5, soil, banana hump, sugar palm, Furadan (insecticide/nematicide), water, wastewater from rice washing, EM4 solution, Urea, SP36, KCl and pesticides.

2.3. Experimental Design

This study used factorial randomized block design with three replication. Chicken manure (CM) doses (D) consisting of 0, 8.3, 16.7, and 25 ton/ha as the first factor. The banana hump LOF (K) consisting 0, 10, 20, and 30 ml/L as the second factor.

2.4. Procedure

Analysis of nutrient content was carried out before the research began by taking soil samples. Soil samples were taken from 5 different points then homogenized and weighed as much as 500 grams to be used as an analysis sample. In the process of soil analysis, the elements observed were macro nutrients including elements N, P, and K. The results of soil analysis showed that alfisol soil contained Nitrogen (0.21%), P2O5 (88ppm) and K2O (0.669 cmol/kg). Planting was carried out using polybags measuring 45cm x 45cm, with a capacity of 9 kg. Each polybag contains 8 kg of soil and planted with two seeds. Plant maintenance includes fertilizing, irrigation, weeding and pest and disease control.

CM was applied by mixing it with planting media that has been prepared and according to the dosage fertilizer for each treatment. The CM was applied a week before planting.

Making banana hump liquid organic fertilizer refers to Wahyudi *et al*., (2019) research using raw materials from the hump of the kepok banana which has been separated from the stem. The banana hump used was 10 kg and 250 ml of organic decomposer. Then chop the banana hump into small pieces of approximately 0.5 to 1 cm in size. The chopping was done using a knife or sickle. As much as 500 g of brown sugar was dissolved into 20 L of rice washing waste water in the container vat, added cuts of banana hump and 250 ml of EM4 activator. The mixture was homogenized and fermented for about 2 weeks. The application of banana hump LOF was carried out starting at the age of 7 day after planting (DAP) up to the generative phase according to the designed concentration treatments. Fertilization was done at intervals once a week during the vegetative phase with a total 3 times application. The dose for each application was 10 ml/L.

2.5. Parameter and Data Analysis

Response parameters in this study included plant height, number of leaves, chlorophyll index, number of pods per plant, seed weight per plant, seed yield per hectare, weight of 1000 seeds, and seed germination. The results of the observations were analyzed and processed statistically using ANOVA. Further test was carried out with the Duncan Multiple Range Test (DMRT) at $\alpha = 5\%$.

3. RESULTS AND DISCUSSION

Table 1 shows that doses of CM (D) has a highly significant (**) different effect on parameter of plant height at 10 DAP. Addition of CM showed significantly different effect (*) on seed weight per plant and seed production. However, CM showed no significant difference (ns) on plant height at 20 and 30 DAP, leaf number, and chlorophyll index at 20 and 30 DAP, weight of 1000 seeds, number of pods/plant, as well as on seed germination.

Concentration of banana hump LOF shows results highly significant (**) different effect on parameter of plant height at 20 DAP, significantly different (*) on Chlorophyll index at 30 DAP and number of pods planted. However on plant height parameters of 10 and 30 DAP, number of leaves planted, index leaf chlorophyll at 10 and 20 DAP, weight of seeds per plant, seed production per hectare, weight of 1000 seeds, and seed germination yield different results unreal (ns). Interaction between basic CM dosage and concentration banana hump LOF significantly affected parameters of plant height observed at 20 DAP, and leaf chlorophyll index at 30 DAP. Moreover, the interaction of basic CM and LOF of banana hump gave no significant different effect (ns) on parameters of plant height at 10 and 30 DAP, number of leaves per plant, index leaf chlorophyll at 10 and 20 DAP, number of pods per plant, seed weight planting, seed production per hectare, weight of 1000 seeds, and seed germination.

Table 1. Fisher test of CM dose and concentration of banana hump LOF on the growth and seed production of mung bean

No	Parameters	Treatments		
		CM (D)	Banana hump LOF (K)	D x K
	Plant height at 10 DAP	6.19**	2.61 ns	1.59 ns
1	Plant height at 20 DAP	1.27 ns	4.64**	2.28*
	Plant height at 30 DAP	0.34 ns	0.20 ns	1.38 ns
	Number of leaves at 10 DAP	2.80 ns	1.16 ns	1.08 ns
2	Number of leaves at 20 DAP	2.13 ns	1.63 ns	1.33 ns
	Number of leaves at 30 DAP	1.95 ns	0.24 ns	0.97 ns
	Chlorophyll index at 10 DAP	1.12 ns	1.33 ns	1.66 ns
3	Chlorophyll index at 20 DAP	2.11 ns	2.22 ns	2.44 ns
	Chlorophyll index at 30 DAP	6.09 **	3.10*	2.94*
	Number of pods per plant	1.29 ns	4.24*	1.53 ns
5	Seed weight per plant	4.48*	1.03 ns	0.82 ns
6	Seed production per hectare	4.48*	1.03 ns	0.82 ns

Note : ** = different significantly at level of $\alpha = 1\%$, * = different significantly at level of $\alpha = 5\%$, ns = different not significantly

Table 2. Effect of CM dose (D) on plant height of mung bean

Treatments	Plant height (cm)		
	10 DAP	20 DAP	30 DAP
D0 (0 ton/ha)	11.2 ± 0.55 ab	16.9 ± 0.87 a	33.3 ± 1.86 a
D1 (8.3 ton/ha)	11.5 ± 0.34 a	17.3 ± 0.30 a	33.8 ± 1.84 a
D2 (16.7 ton/ha)	11.1 ± 0.36 ab	16.8 ± 0.27 a	33.4 ± 0.75 a
D3 (25 ton/ha)	10.6 ± 0.32 b	16.9 ± 0.95 a	32.8 ± 0.30 a
Average	11.1	17.0	33.3

Note : same letter following average number in the same column implies not significantly different in the DMRT at α = 5%.

3.1. Plant Height (cm)

Plant height is an important parameter observed in this study because plant height is an indication of whether plants can properly absorb the nutrients given. In addition, this observation is one of the parameters contained in the description of the variety, so that with this observation it can be seen whether the absorption is optimal or not and also whether the nutrients provided are optimal or not to support plant growth and development. According to Yahya *et al*. (2022), plant height affects the emergence of branches. The taller the plant, the more branches it produces

Table 2 shows that dose treatment of CM have highly significant different effect on plant height at 10 DAP. Until 10 DAP Even though all doses of CM resulted in no significant effect on plant height, but dose of 25 tons/ha produced significantly lower than that of dose 8.3 ton/ha. This indicated that the CM used has been completely decomposed. According to Wulandari *et al*. (2020), C/N ratio of good organic matter must be the same or close to the C/N ratio of soil (10-12), so that nutrient uptake can be maximized. Meanwhile according to Hartatik *et al*., (2015), C/N ratio of ready-to-use CM is 10.9 and based on SNI 19-7030-2004 the C/N ratio of CM is between 10-20.

Meanwhile the dose of manure on plant height at the age of 20 and 30 DAP had no significant effect. This is because at the age of 20 and 30 dap, the CM applied has integrated and improved soil conditions so as to create a good growing environment for mung bean plant growth, one of which is plant height. Hastuti *et al*., (2018) states that plant height can be influenced by the dose of organic fertilizer and good soil condition. According to Sutrisna *et al*. (2018) CM can increase absorbable macro nutrients (N, P, K) which are used by plants for vegetative growth in height of plant. Also Candra *et al*., (2020) stated that CM played a role in increasing plant height of mung bean. Referring to the variety description released by Kementrian Pertanian (2019), that the height of the Vima 5 is 73.5 cm, although the description does not explain how measurement was carried out, the results of this study show that the average height of the mung bean at 30 DAP is 33.3 cm. Authors suggest that measurement of plant height can also be carried out at an older age so as to validate the results of measuring plant height with a description of the variety.

In this study, application of banana hump organic fertilizer have not a significant effect on mung bean plant height. This result is thought to be due to the low value of the C/N ratio in banana hump organic fertilizer. According to Ole, (2013), banana hump LOF fermented for two weeks has a C/N ratio between 4.22 and 6.54. The low C/N in banana hump LOF can cause ammonia to form, so that nitrogen will be lost into the air.

3.2. Number of Leaves

Table 3 show that number of leaves increase from 4 to 5 strands at 10 DAP 13 – 14 at 20 DAP and to 22 – 25 at 30 DAP. This study, however, showed that no significant effect of CM and banana hump LOF on number of leaves of mung bean. This is indicate both of the dose of manure and banana hump LOF is not sufficient to increase number of leaves per plant, even though the organic CM used has been perfectly decomposed. According to Hartatik *et al*., (2015), the C/N ratio in ready-to-use CM is 10.6% and the C/N ratio of the CM used complies with SNI 19-7030-2004 which must have C/N ratio between 10-20%. The application of banana hump LOF also has not significant effect on the parameter of the number of leaves per plant. This result is thought to be due to the low value of the C/N ratio in banana hump organic fertilizer. Another indicates are that concentration of LOF is too small to be absorbed by plants so that the impact is less visible on the number of leaves parameter. Triadiawarman & Rudi (2019) state, concentration of LOF which has a low level of concentration cannot increase on number of leaves per plant.

Table 3. The effect of interaction CM dose (D) and banana hump LOF (K) on number of leaves at 10, 20, and 30 DAP

Treatments	Number of Leaves		
	10 DAP	20 DAP	30 DAP
D0K0	4.7 ± 0.29 a	13.5 ± 0.50 a	22.5 ± 3.68 a
D0K1	4.0 ± 1.32 a	13.7 ± 0.29 a	22.4 ± 1.11 a
D0K2	5.0 ± 0.00 a	13.7 ± 0.29 a	22.4 ± 1.87 a
D0K3	4.3 ± 0.29 a	13.2 ± 0.29 a	21.1 ± 1.70 a
D1K0	4.8 ± 0.29 a	13.7 ± 0.58 a	21.8 ± 1.08 a
D1K1	4.7 ± 0.29 a	14.0 ± 0.00 a	24.0 ± 3.09 a
D1K2	4.8 ± 0.29 a	14.0 ± 0.00 a	24.2 ± 2.41 a
D1K3	5.0 ± 0.00 a	13.5 ± 0.50 a	21.7 ± 2.67 a
D2K0	4.7 ± 0.29 a	13.7 ± 0.58 a	22.3 ± 1.02 a
D2K1	4.7 ± 0.29 a	14.0 ± 0.00 a	22.3 ± 1.25 a
D2K2	4.5 ± 0.00 a	13.7 ± 0.29 a	20.8 ± 0.60 a
D2K3	4.3 ± 0.58 a	13.7 ± 0.58 a	22.3 ± 2.36 a
D3K0	5.0 ± 0.00 a	13.7 ± 0.29 a	25.3 ± 2.75 a
D3K1	4.8 ± 0.29 a	13.5 ± 0.50 a	23.3 ± 0.95 a
D3K2	4.8 ± 0.29 a	14.0 ± 0.00 a	22.0 ± 2.65 a
D3K3	4.8 ± 0.29 a	14.0 ± 0.00 a	24.9 ± 2.27 a

Note: same letter following average number in the same column implies not significantly different in the DMRT at $\alpha = 5\%$.

Table 4. The effect of interaction CM dose (D) and banana hump LOF (K) on the chlorophyll index at 30 DAP

Treatments	Chlorophyll index		
	Average	SD	Significance
D0K0	52.263	1.36	abcd
D0K1	51.293	2.34	abcd
D0K2	46.500	3.30	e
D0K3	53.987	4.51	ab
D1K0	50.209	1.98	abcde
D1K1	47.971	3.21	de
D1K2	49.422	2.98	abcde
D1K3	54.112	0.89	ab
D2K0	52.765	2.31	abc
D2K1	53.635	2.97	ab
D2K2	55.072	2.32	a
D2K3	52.204	3.87	abcd
D3K0	48.746	1.32	bcde
D3K1	48.196	9.29	cde
D3K2	50.767	3.41	abcd
D3K3	50.904	2.22	abcd

Note : same letter following average number implies not significantly different in the DMRT at $\alpha = 5\%$.

3.3. Chlorophyll Index

Interaction between CM and banana hump LOF showed an effect on the average chlorophyll index (Table 4). The highest chlorophyll index was obtained at the dose of 16.7 tons/ha of CM and 10 ml/L of banana hump LOF, but not significantly different from the control (without CM and LOF). These results indicate that the two factors mutually support each other in influencing the leaf chlorophyll index. The high content of Nitrogen in organic CM coupled with Nitrogen from banana hump organic fertilizer plays a maximum role in the chlorophyll index. According to (Wenno & Sinay, 2019), leaves that are supplied with nitrogen will form wider leaves that cause more chlorophyll content, so that plants are able to produce large amounts of carbohydrates which will later be used for vegetative growth. Chlorophyll content in the leaves roles in determining the rate photosynthesis. The more optimal photosynthesis takes place, the photosynthate produced will be maximized to support plant metabolic processes including growth and seed production. The effect of treatment interactions only occurred at the age of 30 DAP. This is due to age changes in the leaves. According to DJS *et al*., (2020), changes in leaf chlorophyll can occur due to changes in leaf structure and morphology.

3.4. Number of pods per plant

The results revealed that concentration of banana hump LOF produced a statistically different effect on the number of pods (Table 5). The results showed that the number of pods of mung bean plants was statistically different. The research results also showed that the highest concentration of banana hump LOF of 20 ml/L produced the highest number of pods per plant (17.1 pods). This study is also in line with Chaniago *et al.*, (2017) who reported that giving 20 ml/L of banana hump liquid fertilizer was able to increase number of pods per plant.

Table 5. Effect of concentration of banana hump LOF to number of pods per plant

Treatments	Number of pods per plant
K0 (0 ml/L)	14.9 ± 1.91 b
K1 (10 ml/L)	16.2 ± 0.32 ab
K2 (20 ml/L)	17.1 ± 0.90 a
K3 (30 ml/L)	15.9 ± 0.51 ab

Note : same letter following average number implies not significantly different in the DMRT at $\alpha = 5\%$.

The number of pods produced through the application of banana hump LOF is more than the description of the Vima 5 variety which produces 12 pods per plant. This happens because of the influence of macro-nutrient content in banana hump organic fertilizer. According to Suhastyo, *et al*., (2013), banana hump fertilizer contains sufficient macro nutrients such as N, P, K, Mg and Ca. This is presumably because micro nutrients, especially Ca, have an influence on the formation of mung bean pods. According to Fahri *et al*. (2022) the nutrient element Ca roles in pod formation and branches on plants. But Table 5 also shows that the 30 ml/L LOF treatment actually decreased the number of pods per plant. This is presumably, the application of banana hump LOF which can be absorbed optimally is only up to a concentration of 20 ml/L. However, it is not certain whether the application of 30 ml/L LOF cause saturation and toxicity to plants, so further research is needed regarding increasing the appropriate concentration.

3.5. Seed production

The results showed that there was a significantly different effect between the doses of CM and seed weight per plant and seed production per hectare (Table 6). Increasing the dose of CM to 16.7 tons.ha^{-1} was able to produce the highest seed weight per plant to 15.139 grams per plant and was also able to increase seed production per hectare to 2,019 tons/ha. This shows that the dose of CM of 16.7 tons.ha^{-1} is the ideal and optimal dose for mung bean seed production. This study also indicate that the dose of CM of 16.7 tons.ha^{-1} is the best dose that can be used to increase mung bean seed production in alfisol soil where the nutrients contained in it have been leached. So these doses it can improve the physical, chemical and biological properties of the soil. Rompas *et al*. (2020) stated that CM is an organic material that physically makes the soil more loose, aerase and drainage run smoothly. This condition can improve soil biological properties by increasing the number and activity of soil microorganisms in conducting the process of decomposing organic matter, as a result the chemical properties of the soil become better with the availability of macro and micro nutrients resulting from the decomposition of the CM which are dissolved and available in sufficient and balanced amounts to support growth and mung bean production. The results of the study showed that the highest seed production per hectare was obtained in the dosages 16.7 tons.ha^{-1} CM treatment was 2.019 tons.ha^{-1}, it was still optimal result when compared to the average yield of Vima 5 Variety (Kementrian Pertanian, 2019) which was capable of producing a maximum of 1.84 ton.ha^{-1}. This is also showed that CM application is able to maximize the genetic character of plants as indicated by the increasing seed production per hectare. According to Masnang, *et al*., (2022) providing CM can improve the physical properties of the soil by improving the soil structure so that soil water levels are maintained. Soil water content is an environmental factor that roles in increasing mung bean seed production.

Table 6. Effect of CM application on seed weight per plant and seed production per hectare

Treatments	Seed weight per plant (g/plant)	Seed production per hectare (ton.ha^{-1})
D0 (0 ton/ha)	13.10 ± 0.94 b	1.75 ± 0.13 b
D1 (8.3 ton/ha)	13.96 ± 0.87 ab	1.86 ± 0.12 ab
D2 (16.7 ton/ha)	15.14 ± 0.77 a	2.02 ± 0.10 a
D3 (25 ton/ha)	14.44 ± 0.23 a	1.93 ± 0.03 ab

Note : Numbers followed by the same letter in the same column are not significantly different in the 5% DMRT test

4. CONCLUSIONS

Application of CM doses had a significant effect on plant height at 10 DAP, seed weight per plant and seed weight per hectare. The interaction between doses of CM and banana hump LOF was able to increase the leaf chlorophyll index at 30 DAP. Interactions between CM at a dose 16.7 $ton.ha^{-1}$and banana hump LOF at a concentration of 20 ml/L produced the highest average chlorophyll index 55,072 CCI. The results of this study indicate that the organic fertilizer applied can increase the character of mung bean seed production. This is evidenced by the increase in several parameters compared to the description of the Vima 5 such as the increase in the number of pods per plant and seed production per hectare.

From this study the authors suggest several things for further research. From the research results, the resulting plant height is still not close to the description of the variety. Therefore, a longer measurement of plant age is needed, not only limited to 30 DAP. In addition, in the concentration treatment of banana hump LOF, it is necessary to add a higher level because the effect is still not visible. The effect is only seen number of pods per plant and chlorophyll index due to the interaction with manure.

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