

Article

Growth and Production of Long Bean Plants (*Vigna sinensis L.*) on Concentration Level of Liquid Organic Fertilizer Banana Webs and Chitosan

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Abstract. The aim of this study was to determine the interaction of the concentration of liquid organic fertilizer on banana weevil and chitosan on the growth and yield of long beans. This study used a completely randomized design, with 2 factors. The first factor is banana weevil liquid organic fertilizer consisting of 3 levels, namely, 0 ml/L, 45 ml/L, and 90 ml/L. The second factor was chitosan consisting of 3 levels, namely, 0 ml/L, 3 ml/L, and 6 ml/L. Based on the experimental results, it can be concluded that there is an interaction between liquid organic fertilizer of banana weevil and chitosan with the parameters of plant length and number of branches. Increasing the concentration of liquid organic fertilizer on banana weevil can increase the number of pods and the weight of fresh pods per plant, the highest fresh pod weight per plant is 1.20 kg/plant with a concentration of 90 ml/L. The administration of chitosan concentration only affected the number of pods parameter, the highest number of pods was in the provision of 6 ml/L, namely 55.55 pods/plant.

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1. Introduction

Long bean (*Vigna sinensis L.*) is a vegetable plant that is much favored by the people of Indonesia which is used as fresh vegetables [1,2,3,4,5,6]. Peanut plants contain a lot of nutrients, namely vitamin A, vitamin B, vitamin C, and minerals in the pods, while the seeds contain protein, fat, and carbohydrates. This long bean plant is one of the vegetable commodities that has the potential to be developed, because it has a fairly high economic value. Long bean seeds contain carbohydrates (70.00%), protein (17.30%), fat (1.50%) and water (12.20%), so this commodity is also a source of vegetable protein [7,8]. Based on national long bean production data, in 2015 it was 12,941 tons, in 2016 it was 12,029 tons, in 2017 it was 14,107 tons, in 2018 it was 19,050 tons, in 2019 it was 20,821 tons [9].

So far, farmers have been farming using inorganic fertilizers [10,11,12,13,14,15,16]. Efforts are being made to overcome this by using organic fertilizers from agricultural waste, one of which is banana weevil waste. This banana weevil waste has not been utilized properly, it is necessary to make efforts to utilize this banana weevil by making it POC, so that it can improve the quality of the banana weevil itself [17,18,19,20,21]. The banana weevil POC also contains microorganisms that are very useful for plants, namely *Azospirillum*, *Azobacter*, *Aeromonas*, *Aspergillus*, *Bacillus*, phosphate solubilizing microbes and cellulosic microbes [22,23,24,25,26,27]. In addition, banana weevil POC also contains macro elements consisting of N 101.41 ppm, P 233.84 ppm and K 2007.4 ppm [28,29,30,31,32,33]. Banana weevil liquid organic fertilizer has a role in the vegetative growth of plants and plants are tolerant to disease, high levels of phenolic acids help bind Al ions, Fe and Ca thus form the availability of Phosphorus (P) in the soil which is useful in the process of flowering and fruit formation [34,35,36]. Based on research that has been done on cucumber plants, giving a concentration of 90 ml/L gave the best effect on the parameters of plant height, number of fruit planted, fruit diameter, fruit length, and fruit weight [37,38,39].

In addition to plant organic matter, another potential that can be used as fertilizer is Chitosan residue from animals that can be added to increase soil fertility. Chitosan is the result of animal shell waste such as shrimp, crabs and insects so that it is easy to obtain, does not damage the environment and is easily absorbed by plants. Chitosan contains macro nutrients consisting of 0.05% N, 0.01% P₂O₅, and 0.01% K₂O, besides that it also contains many micro nutrients consisting of 6.3 ppm Fe, Mn < 0.01 ppm, B 0.01%, Cu < 0.1 ppm, Co < 0.01 ppm, Zn 0.2 ppm, and Mo < 0.1 ppm which act as constituents of plant tissue, forming enzymes, forming growth hormones, as catalysts, and helps plant growth.

Based on the description above, research has been carried out on the Growth and Yield of Long Bean Plants (*Vigna sinensis L.*) at the Concentration Level of Liquid Organic Fertilizer Banana Weevil and Chitosan. The purpose of this research is the purpose of this study was to determine the interaction of banana weevil POC concentrations with chitosan on the growth and yield of long bean plants.

2. Materials and Methods

This experiment was carried out on an ultisol soil type in the Kalumbuk village, Kuranji district, Padang City. With an altitude of 10 meters above sea level. This research was started from December 2020 to February 2021. The materials used were long bean seeds of the Canton tavi variety, POC hump banana chitosan, urea fertilizer, SP-36, KCL. The tools used are machetes, hoes, rakes, shovels, hantsprayer, tape measure, labels, markers, lanjaran, raffia rope, scales, stationery, gembor, and others if needed

This experiment used a completely randomized design (CRD) with 2 factors, namely, the first factor was the concentration of banana weevil POC with 3 levels, namely control 0 ml/L (P1), 45 ml/L (P2), 90 ml/L (P3). The second factor was the concentration of chitosan with 3 levels, namely control 0 ml/L (K1), 3 ml/L (K2), 6 ml/L (K3). The combination of these two factors is 3×3 = 9 with

3 replications, so 27 experimental units are obtained. The data from the observation of variance and F was tested at the level of 5% and 1% if the calculated F was greater than the F table 5%, followed by the Duncan's News Multiple Range Test (DNMRT) test.

The land was cleared of weeds, roots and twigs, after that the land was processed by making plots of 150 cm × 180 cm in 27 plots with a distance between plots of 30 cm. Seeds soaked for 10 minutes used are seeds that are immersed in water. Planting is done by making planting holes in a dilugal way and a depth of 3 cm, the distance in rows is 30 cm and the distance between rows is 60 cm. Each planting hole is filled with 2 seeds. After that, the labeling was carried out 1 week after land preparation, the stakes were installed near the 30 cm high stake sample plants and the lanjars were carried out after the plants were 2 weeks HST. For lanjars, you can use wooden sticks or bamboo halves with a length of 150-200 cm and a width of 2-3 cm. The stakes are inserted between the planting holes with a depth of 25-30 cm.

POC administration of banana weevil was carried out once a week starting 1 MST until the beginning of flowering, this POC was given the day before the chitosan treatment. It is given by spraying it on the leaves until the leaves are wet, the concentration according to the treatment is the level of 0 ml/L (P1), 45 ml/L (P2), and 90 ml/L (P3).

Chitosan treatment was given once a week starting at the age of 1 MST until the beginning of flowering with Chitosan treatment levels (K), namely concentrations: 0 ml/L (K1), 3 ml/L (K2), 6 ml/L (K3). This is done by spraying the leaves until the leaves are wet. Chitosan treatment should be given in the morning and given the day after the banana weevil POC treatment

Maintenance is done by replanting and hoarding, thinning, watering, weeding, pruning, controlling pests and diseases, harvesting. Meanwhile, observations were made on plant length, number of main branches, flowering period, age of first harvest, pod length, average number of fresh pods planted, fresh pod weight per plant, fresh pod production per plot and per hectare.

3. Results and Discussion

3.1 Plant Length

The length of the long bean plant with the provision of POC banana beetles and chitosan can be seen in the Table 1.

Table 1. Length of Long Bean Plants with POC Administration of Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)		
	0 (cm)	3 (cm)	6 (cm)
0	217.22 Bb	233.51 Ba	242.23 Ba
45	252.33 Aa	262.07 Aa	222.39 Bb
90	255.31 Ab	241.71 Bb	291.64 Aa
KK = 9.73%			

The inline numbers followed by the same lowercase letters and the column numbers followed by the same capital letters were not significantly different according to the 5% DNMRT test.

Table 1 shows that the concentration of POC banana weevil with chitosan was able to increase plant length in long beans. The administration of banana weevil POC with a concentration of 0 ml/L with 0 ml/L chitosan, plant length 217.22 cm was lower than the concentration of 0 ml/L banana weevil POC with 3 ml/L and 6 ml/L chitosan with each plant length, namely 233.51 cm and 242.23

cm. In the administration of 45 ml/L banana weevil POC with 0 ml/L chitosan, the plant length was 252.33 cm, with 3 ml/L chitosan the plant length was 262.07 cm and with 6 ml/L chitosan. 222.39 cm. Furthermore, the administration of POC banana weevil 90 ml/L with chitosan 0 ml/L plant height is 255.31 cm with 3 ml/L chitosan plant length is 241.71 cm and by giving POC banana weevil 90 ml/L with 6 ml/L plant length is 291.64.

The results of the above statement indicate that the administration of POC banana weevil and chitosan was significantly different to the length of the plant. The longest plant length was in the treatment of POC banana weevil 90 ml/L and chitosan 6 ml/L. This was because the concentration of POC banana weeds was able to stimulate the increase in plant length because it contained macronutrients consisting of N 101.41 ppm. P 233.84 ppm and K 2007.4 ppm are needed by plants to stimulate growth. In addition, the administration of chitosan plays a role in regulating the plant immune system, activating cells and increasing the ability to fight diseases and insects [40]. Chitosan contains macro nutrients consisting of 0.05% N, 0.01% P₂O₅, and 0.01% K₂O, besides that it also contains many micro nutrients consisting of 6.3 ppm Fe, Mn < 0.01 ppm, B 0.01%, Cu < 0, 1 ppm, Co < 0.01 ppm, Zn 0.2 ppm, and Mo < 0.1 ppm which act as constituents of plant tissue, forming enzymes, forming growth hormones, as catalysts, and helping plant growth. The fulfillment of nutrients, both macro and micro nutrients, will help the metabolic process run smoothly so that it can stimulate plant growth, both plant height and plant roots.

3.2 Number of Main Branches

Number of main branches of long beans with POC banana weevil and chitosan can be seen in the Table 2.

Table 2. Number of Main Branches of Long Beans with POC Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)		
	0 (branch)	3 (branch)	6 (branch)
0	9.43 Ba	8.73 Cb	9.87 Ba
45	9.43 Bb	9.53 Bb	9.87 Ba
90	10.07 Ab	10.97 Ab	12.52 Aa
KK = 6.13%			

The inline numbers followed by the same lowercase letters and the column numbers followed by the same capital letters were not significantly different according to the 5% DNMR test.

Table 2 shows that the administration of banana weevil POC with chitosan was able to increase the number of branches. The administration of POC banana hump with a concentration of 0 ml/L with 0 ml/L chitosan resulted in 9.43 branches, with 3 ml/L chitosan 8.73 branches and with 6 ml/L chitosan 9.87 branches. . In the administration of POC banana hump 45 ml/L and chitosan 0 ml/L the main branch was 9.43 branches and with 3 ml/L chitosan the number of branches was 9.53 branches and with 6 ml/L the number of main branches was 9.87. The administration of 90 ml/L banana hump POC with 0 ml/L chitosan resulted in 10.07 branches, with 3 ml/L 10.97 branches and 6 ml/L chitosan 12.52 branches. The results of the above statement indicate that the administration of POC banana weevil and chitosan was significantly different to the number of main branches.

The highest number of main branches was in the POC treatment of banana weevil 90 ml/L and chitosan 6 ml/L. This was due to the sufficient N nutrient available to plants by local microorganisms contained in the banana weevil. While chitosan significant effect on the number of branches. This is because Chitosan can improve biological properties in the soil such as biological activity and reform compounds formed to form a better soil structure, chitosan can also be used to increase N fixation in plants, where nitrogen nutrients play a role in increasing plant growth. One of which is the number of branches produced by plants [41].

3.3 Flowering Age

Flowering age of long beans can be seen in the Table 3.

Table 3. Flowering Age of Long Beans by Giving POC Weevil Banana and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (HST)	3 (HST)	6 (HST)	
0	34.83	35.20	34.77	34.93
45	34.87	34.63	34.73	34.74
90	34.64	34.97	33.77	34.46
Average	34.78	34.93	34.42	
KK = 1.90%				

Table 3 shows that the administration of banana weevil POC can accelerate the flowering age of long bean plants when compared to the description of the plant. POC administration of banana weevil with a concentration of 0 ml/L was 34.93 DAP, a concentration of 45 ml/L was 34.74 DAP and a concentration of 90 ml/L was 34.46 DAP but it was not significantly different to flowering age. This is because banana weevil POC contains high levels of phenolic acid which helps bind Al, Fe, and Ca ions so that it helps the availability of P in the soil which can support the flowering process in plants [42].

Table 3 also shows that the application of chitosan can increase the flowering life of long beans. The administration of chitosan with a concentration of 0 ml/L for flowering age was 34.78 DAP, with a concentration of 3 ml/L the flowering age was 34.93 DAP and a concentration of 6 ml/L for the flowering age was 34.42 DAP, but the administration of POC banana weevil was not significantly different from the flowering age. This is because the concentration of chitosan given to each plant is able to accelerate the process of flower formation in plants because chitosan contains the hormones auxin and gibberellins which play a positive role for plant growth [43].

3.4 First Harvest Age

First harvest age of long beans can be seen in the Table 4.

Table 4. Age of First Harvest of Long Beans with POC Administration of Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (HST)	3 (HST)	6 (HST)	
0	45.00	45.00	45.00	45.00
45	45.00	45.00	45.00	45.00
90	45.00	44.67	45.00	44.89
Average	45.00	44.89	45.00	
KK = 0.43%				

Table 4 shows that banana weevil POC can accelerate the harvesting age of long beans, administration of banana weevil POC with a concentration of 0 ml/L has a harvest age of 45.00 DAP, with a concentration of 45 ml/L the harvest age is 45.00 DAP and with a concentration of 90 ml/L. L harvest age 44.89. This is because the age of the fast harvest is also influenced by the age of the flower. By giving sufficient concentrations to increase the availability of macro elements that are useful for forming raw materials for the formation of proteins and carbohydrates, as well as assisting in accelerating flowering and accelerating fruit ripening [44].

Table 4 shows that the application of chitosan can increase the age of harvest when compared to the description of the plant. Giving chitosan with a concentration of 0 ml/L at 45.00 DAP, with a concentration of 3 ml/L at 44.89 DAP and a concentration of 6 ml/L at 45.00 DAP. This is because chitosan contains the hormone auxin which supports fruit ripening. Auxin hormone plays a role in accelerating the process of flower formation in plants while gibberellins play a role in the growth process in fruit.

3.5 Pod Length

Long bean pods with banana beetle POC and chitosan can be seen in the Table 5.

Table 5. Length of Long Bean Pods with POC Administration of Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (cm)	3 (cm)	6 (cm)	
0	77.13	78.75	79.61	78.49
45	77.92	75.55	76.22	76.56
90	78.94	77.89	76.17	77.66
Average	77.99	77.39	77.33	
KK = 4.55%				

Table 5 shows that the administration of banana weevil POC can increase the length of the long bean pods when viewed from the description, but the administration of banana weevil POC has no significant difference in pod length. POC administration of banana weevil with a concentration of 0 ml/L pod length was 78.49 cm, with a concentration of 45 ml/L the length of the pod was 76.56 cm and with a concentration of 90 ml/L the length of the pod was 77.66 cm. This is due to the availability

of sufficient N elements in the banana weevil POC. The length of the pod is strongly influenced by the availability of N in optimal quantities, because the N element is utilized in the plant metabolic processes so that it affects the increase in pod length [45].

Table 5 shows that chitosan can increase the pod length of long bean plants. This is because the nutrients contained in chitosan are able to stimulate the length of the long bean pods, besides that environmental factors also affect the length of the pods. This is in accordance with the opinion of [40] that Chitosan acts as a carbon source for microbes in the soil, accelerates the process of transforming organic compounds into inorganic and helps the root system of plants to absorb more nutrients from the soil.

3.6 Average Number of Fresh Pods Per Plant

Quantity of fresh pods from long bean plantation by provision of banana beetle POC and chitosan can be seen in the Table 6.

Table 6. Number of Fresh Pods from Long Bean Plantations with POC Administration of Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (pods/plants)	3 (pods/plants)	6 (pods/plants)	
0	43.33	56.33	52.33	50.66 A
45	45.33	41.00	46.33	44.22 B
90	53.00	57.00	68.00	59.33 A
Average	47.22b	51.44a	55.55a	
KK = 11.28%				

Table 6 shows that the administration of banana weevil POC was able to increase the number of long bean pods. Giving POC banana weevil 0 ml/L resulted in the number of pods 50.66 pods, with administration of 45 ml/L banana hump resulted in the lowest number of pods, namely 44.22 pods, significantly different with a concentration of 90 ml/L producing the highest number of pods, namely 59.33 pods. . Increasing the concentration of banana weevil is able to provide optimal nutrients needed by long bean plants for growth including the formation of the number of pods, banana weevil POC can increase the number of long bean pods, because sufficient N nutrients are available to plants by local microorganisms.

Table 6 also shows that the application of chitosan can increase the number of long bean pods. Giving chitosan 0 ml/L resulted in the number of pods 47.22 pods significantly different from the treatment with chitosan 3 ml/L and 6 ml/L, each of which resulted in the number of pods, namely 51.44 pods and 55.55 pods. This is because the auxin hormone contained in chitosan given to plants can optimize the photosynthesis process that occurs in plants because of the high light absorption process in the leaf area so that the photosynthate produced can increase the number of fully filled pods [45].

3.7 Fresh Pods Weight Per Plant

Fresh fruit weight in long bean plantation can be seen in the Table 7.

Table 7. Weight of Fresh Pods in Long Bean Plantations with POC Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (kg/plants)	3 (kg/plants)	6 (kg/plants)	
0	0.80	1.08	1.10	0.99 B
45	0.90	0.85	1.06	0.93 B
90	1.21	1.13	1.27	1.20 A
Average	0.97	1.02	1.14	
KK = 13.61%				

Column numbers followed by the same capital letters were not significantly different according to the 5% DNMR test.

Table 7 shows that the administration of banana weevil POC was able to increase the weight of fresh pods per long bean plant. The administration of POC banana weevil with a concentration of 0 ml/L resulted in a fresh pod weight of 0.99 kg, an increase in the concentration of up to 45 ml/L a fresh pod weight of 0.93 kg and a concentration of 90 ml/L could increase the weight of a fresh plant pod, namely 1.20 kg. This is because the POC banana hump contains growth regulators, gibberellins and cytokinins. In addition, the banana weevil liquid organic fertilizer also contains microorganisms that are very useful for plants, namely *Azospirillum*, *Azobacter*, *Aeromonas*, *Aspergillus*, *Bacillus*, phosphate solubilizing microbes and cellulosic microbes that can provide optimal nutrients for plants.

Table 7 also shows that the application of chitosan can increase the weight of fresh pods per long bean plant when compared to the description, but it is not significantly different according to the variance. Giving chitosan 0 ml/L resulted in a fresh weight of 0.97 kg per long bean plant, with 3 ml/L chitosan giving a fresh weight of 1.02 kg and with 6 ml/L chitosan giving a fresh pod weight of 1,14 kg.

3.8 Production of Fresh Pods Per Plot and Per Hectare

Production of fresh pods per plot and per hectare with banana weevil and chitosan POC can be seen in the Table 8.

Table 8. Fresh Pod Production Per Plot and Per Hectare with POC Banana Weevil and Chitosan

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (kg)	3 (kg)	6 (kg)	
0	5.48	5.40	5.24	05.37
45	4.75	4.99	4.56	4.76
90	5.23	5.48	6.01	5.57
Average	5.15	5.15	5.27	
KK = 14.03%				

POC Banana Weevil (ml/L)	Chitosan (ml/L)			Average
	0 (tons)	3 (tons)	6 (tons)	
0	20.29	20.00	19.40	19.89
45	17.59	18.48	16.88	17.65
90	19.37	20.29	22.25	20.63
Average	19.08	19.59	19.51	
KK = 14.03%				

Table 8 shows the production of long bean per plot can increase production per plot and per hectare with the application of banana weevil POC with a concentration of 0 ml/L with 90 ml/L and there is a decrease in production in the production of fresh pods per plot and per hectare with a concentration of 45 ml/L. L when compared to the description of the plant. The concentration of banana hump POC 0 ml/L is 5.37 kg or equivalent to 19.89 tons per hectare, the concentration of 45 ml/L is 4.76 kg or equivalent to 17.65 tons per hectare and the concentration of 90 ml/L is 5.57 kg or equivalent to 20.63 tons per hectare. When associated with pod length (Table 5), number of fresh pods per plant (Table 6), weight of fresh pods per plant (Table 7) giving banana weevil POC with a concentration of 45 ml/L showed the lowest concentration compared to 0 ml/L and 90 ml/L. This is because nutrients are stimulated by vegetative growth but are not sufficient for generative growth (filling seeds) so that if the concentration is increased, there will be a balance between vegetative and generative. Giving a balanced concentration can encourage growth and increase crop yields both in terms of quality and quantity [46].

Table 8 shows that chitosan has no significant effect on production per plot at the concentration of 0 ml/L of chitosan which is 5.15 kg or equivalent to 19.08 tons per hectare, with a concentration of 3 ml/L which is 5.29 or equivalent to 19.59 tons per hectare. hectares, and with a concentration of 6 ml/L production per plot is 5.27 kg or equivalent to 19.51 tons per hectare. According to [47] that in general, plant demand for fertilizer is determined by the part of the plant that is expected to be produced.

4. Conclusion

Based on the research, it can be concluded that there is an interaction between liquid organic fertilizer of banana weevil and chitosan on the parameters of plant length and number of main branches of long beans. Increasing the concentration of POC banana weevil can increase the number of pods and the weight of fresh pods planted. The highest weight of fresh pods was 1.20 kg/plant with a concentration of 90 ml/L. The concentration of chitosan only affected the number of pods. The highest number of pods was given at 6 ml/L, which was 55.55 pods/plant. Based on the conclusion, it is recommended that the cultivation of long bean plants with the best concentration is 90 ml/L liquid organic fertilizer of banana weevil.

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