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The Effects of Compost Sources and Dosage on the Growth and Yield of Edamame Soybean (*Glycine Max* (L.) Merr) in Ultisol

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ABSTRACT

Use of marginal land use, such as Ultisol is an alternative for the extensification of soybean production. The problem of Ultisol is the low organic matter content, so fertilization is required using organic fertilizer such as compost. This study was designed to determine the effect of the compost source and its dosage on the growth and yield of Edamame soybean. The study was carried out in Pematang Gubernur Village, Muara Bangkahulu District, Bengkulu City, from February to June 2020 in Ultisol. The experiment was arranged using Randomized Complete Block Design (RCBD), with three replications. The first factor was the source of compost consisting of Wedelia (*Wedelia trilobata* L.), Siam weed (*Chromolaena odorata* L.), and Calopo (*Calopogonium mucunoides*). The second factor was the dosage, consist of 5, 10, and 15 tons ha^{-1} of the compost. No fertilization for control. There was no significant difference between Wedelia, Siam weed, and Calopo compost on the growth and yield of Edamame soybean. However, compost dosage resulted in significant differences in stem diameter, number of leaves, number of productive branches, and root dry weight. The dose of compost affects soybean growth, including stem diameter, number of leaves, number of productive branches, and dry root weight. Each increase in the compost dosage unit can increase 0.0707 mm stem diameter, 0.0896 leaves, 0.097 productive branches, and 0.1126 g dry root weight.

Keywords*: *compost source, dosage compost, Edamame, soybean, Ultisol

1. INTRODUCTION

Edamame soybean (*Glycine max* (L). Merr) is a green vegetable or green soybean vegetable which is important in Japan, Taiwan, China, and Korea. According to Widati and Hidayat [1] edamame soybeans contain protein, calcium, iron, vitamins A, B1, and C, as well as potassium, ascorbic acid, and vitamin E with a nutrient content of 40% protein, 20% fat (without cholesterol.), 33% carbohydrates, and 6% fiber (by dry weight). Muaris [2] said besides that edamame soybeans contain antioxidants and isoflavones which are good for health. Kartahadimaja et al. [3] assume that edamame soybeans are almost the same as regular soybeans, except that the plant size is bigger and the seeds are black, green, or yellow.

Balitkabi [4] reported that the demand for the export market is still relatively large, especially from Japan, but there is only 1 company producing and exporting edamame soybeans. High market demand is certainly a good prospect for edamame soybeans, so there is a need for increased production. In addition to a climate that is suitable for the growth of edamame soybeans, there should also be efforts to increase production by adding organic matter, especially on marginal lands such as ultisol.

Ultisol is a soil with a high level of washing and low fertility. Hakim [5] said that ultisol soils are found in wet tropics, and cover about 8.1% of the land that supports the world's population. Marginal land use is due to the narrowing of fertile land for agriculture, so that marginal land use such as ultisols is an option. According to Prasetyo and Suriadikarta [6], one of the obstacles of ultisol soil is its low organic matter content, making it necessary to manage the organic matter. The organic material in question can be in the form of compost, which is useful for improving the physical, biological, and chemical properties of the soil; it can also be a source of nutrients for plants.

Compost or composting can be defined as the process of decomposing compounds contained in the remaining organic material to make it easily utilized by Djaja plants [7]. The decomposition process in compost is usually assisted by certain microorganisms, which will break down the content in organic matter. Therefore, the selection of organic material to be composted is important. The organic material used is generally high in nitrogen (N) content. Organic materials in nature that have a high N content include wedelia (*Wedelia trilobata*), siam weed (*Chromolaena odorata*), and legume cover crop (LCC) of the type *Calopogonium mucunoides*. Wedelia is a wild plant and often becomes a weed for plants on cultivated land. The use of Wedelia as raw material for organic fertilizers has been widespread, both in the form of liquid fertilizer and compost. Based on the research results of Setyowati et al. [8] the use of 23 tons/ha of compost compost yields better mustard plant yields compared to the use of urea fertilizers doses of 160 tons/ha

Siam weed is also one of the wild plants in cultivated land and has now received attention as a raw material for organic fertilizer. Siam weed has a high nutrient content such as N 2.56%, P 0.38%, K 2.41%, and C/N below the critical point, this allows siam weed compost to easily and quickly mineralize Nugroho et al. [9]. According to Subaedah [10], giving organic matter siam weed and Crotalaria juncea which is then accompanied by P fertilizer can increase P uptake, plant relative growth rate, and biomass of soybean plants. Another study said the yield was 1.5 tons/ha due to the provision of 30 tons/ha of siam weed compost according to a report by Kastono [11].

Meanwhile, *Calopogonium mucunoides* (calopo) is a type of legume cover crop (LCC) which is commonly used in plantation areas, especially rubber. However, this plant is also often found growing wild in certain areas so that it is easy to find and obtain. According to its family, namely leguminoceae, this plant can bind N from the air with the help of Rhizobium bacteria, so that calopo has a high N content Purwanto [12]. The amount of calopo nutrient content includes N 3.47%, P 0.18%, K 1.79%, Ca 0.73% and Mg 0.22% ICRI [13]. Soybean plants that were given a calopo compost of 2.5 tons/ha to produce a percentage of pithy pods, the number of seeds planted and the weight of 100 seeds which were higher than artificial fertilizers Khodijah and Rasyad [14].

Based on the description above, the addition of organic fertilizer in the form of compost from the three ingredients can increase the nutrient content in ultisols. Besides, the addition of compost can also increase the fertility of ultisols. So it is necessary to find the right dose to get the potential edamame soybean results in ultisols.

2. MATERIAL AND METHOD

2.1. Experimental Design and Treatment

The design of this study used a factorial completely randomized block design (RAKL) with 2 treatment factors, namely the type of compost and the dose of compost. The first factor is the type of compost, which consists of J1 = wedelia, J2 = siam weed and J3 = calopo. The second factor was the dosage of compost which was D1 = 5 tons / ha, D2 = 10 tons / ha, D3 = 15 tons / ha and Control = without giving compost, as a comparison. Thus obtained 9 treatment combinations and 1 control

J1D1 = wedelia 22 g
J1D2 = wedelia 44 g J1D3 = wedelia 66 g J2D1 = siam weed 22 g J2D2 = siam weed 44 g J2D3 = siam weed 66 g J3D1 = calopo 22 g J3D2 = calopo 44 g J3D3 = calopo 66 g
Control = without compost

Each treatment was repeated 3 times. For each treatment, there were 3 polybags so that 90 polybags were obtained.

The data obtained were analysed statistically by using the Analysis of Variance (ANOVA) at 5% level. The ANOVA results showed a significant effect on the dose of fertilizer, then continued with the Orthogonal Polynomial (PO) at linear levels.

2.2. Composting Procedure

Composting begins with cultivating bacteria, by mixing 1L EM-4 and 2L of water. The mixture is allowed to stand for 1 week until the bacteria multiply. Then, 10 kg of condensed plant biomass is cut to the size of 2 - 3 cm. Then 120 ml of bacterial culture dissolved in 2L of water is added. Next, the compost material and bacteria solution is mixed until evenly distributed. The compost material is then put into a large plastic bag and stored for 1 month. Every week the compost material is stirred and the temperature is low. This also applies to Siamese weeds and brokers.

2.3. Grow Media Preparation

The land used is ultisol land from in Pematang Gubernur Village, Muara Bangkahulu District, Bengkulu City. Soil is taken from the top soil to a depth of 20-30 cm, then the soil is dried in the sun and sieved. Furthermore, the soil is put into a polybag measuring 30 x 40 cm as much as 10 kg. Then the planting medium is given compost according to the treatment.

2.4. Edamame Soy Cultivation

Edamame soybeans are planted after 1 week of compost application on the planting medium. Edamame seeds were previously given Rhizobium sp. Each polybag was planted 2 seeds and given an insecticide with the active ingredient Karbofuran. Basic fertilization is carried out 1 week after planting which includes urea and KCl, for TSP given at planting. Every morning or evening the edamame soybeans are watered. Control of plant pests is carried out mechanically and chemically. Edamame plants are harvested after 65 days. The variables observed were plant height, stem diameter, number of leaves, flowering age, number of branches per plant, number of productive branches per plant, root stover dry weight, crown stover dry weight, number of pods per plant, number of empty pods per plant, number of pods. contains per plant, pod weight per plant, percentage of pods filled, weight of root nodules, number of root nodules per plant, number of effective nodules per plant.

3. RESULT AND DISCUSSIONS

3.1. Analysis of Variance

The results of observations in the field were then analyzed using ANOVA. ANOVA results showed that the interaction between the type and dose of compost did not affect the growth and yield of edamame soybeans. The single factor type of compost also has no effect. Only the compost dosage factor showed an effect on the growth of edamame soybeans (Table 1.)

Table 1. Summary of analysis of variance

Variable	F Count			
	Type	Dose	Interaction	KK (%)
Plant height	0.08 ns	0.53 ns	0.32 ns	10.86
Stem diameter	2.17 ns	6.19 **	1.30 ns	12.59
Number of leaves	0.13 ns	4.02 *	0.87 ns	14.27
Flowering age	1.27 ns	0.27 ns	1.41 ns	8.89
Number branches of plan	1.44 ns	3.06 ns	0.89 ns	19.41
Number of productive branches	1.13 ns	3.58 *	0.58 ns	20.41
Dry root weight	0.14 ns	4.42 *	2.70 ns	26.38
Dry canopy weight^{T}	0.01 ns	2.37 ns	0.71 ns	17.78
Number pod of plant	1.21 ns	2.80 ns	0.35 ns	22.28
Number empty pod of plant	0.38 ns	0.76 ns	2.44 ns	18.25
Number pithy pod of plant	0.23 ns	0.71 ns	2.00 ns	5.62
Pod weight of plant	0.02 ns	1.16 ns	0.46 ns	23.33
Percentage pithy pod	0.23 ns	0.71 ns	2.00 ns	5.62
Root nodules weight^{T}	1.19 ns	1.72 ns	0.12 ns	15.00
Number root nodules of plant^{T}	0.31 ns	1.54 ns	0.16 ns	38.82
Number effective root nodules^{TT}	1.17 ns	1.68 ns	0.11 ns	9.21

* = Significantly different, ** = Very significant difference, ns = not significantly different T = transformation data $\sqrt{(x + 1)}$ TT = transformation data $\sqrt{(x + 2)}$

3.2. Effects of Compost Type on Growth and Yield of Edamame

The three types of compost used did not show any differences or different effects on the growth and yield of edamame soybeans. This is because the nutrient content of the three types of compost is not much different. The content of the wedelia was N 2.52%, P 0.63%, K 1.03%, C-organic 13.469%, and KA 31.83%. The content of siam weed was N 3.08%, P 0.81%, K 1.09%, C-organic 14.243%, and KA 25.93%. While the content of calopo is N 2.80%, P 0.55%, K 0.90%, C- organic 13.469% and KA 18.75%. So this makes the effect or effect of the type of compost not visible on the growth and yield of edamame soybeans. However, the nutrient content in the compost used is classified as moderate to high, such as the minimum content of N 0.40%, P 0.10%, K 0.20%, C 9.80% - 32%, maximum KA 50% (Standardization Body National (BSN), 2004). The observations on the growth of edamame soybeans due to the application of siam weed compost gave the highest yields for almost all growth variables except crown dry stover weight (Table 2). While the effect of the type of compost on edamame soybean yields gave the best results for pod variables was siam weed compost, but for root nodule variables the highest was calopo (Table 3).

Table 2. Effect of compost types on the growth of edamame soybeans

Type of fertilizer (ton/ha)	Variable							
	PH	SD	NL	FA	NB	NPB	DRW	DCW
Wedelia	28.21	6.00	8.41	4.78	4.67	4.59	4.65	11.78
Siam weed	28.31	5.56	8.70	4.96	5.37	5.22	4.93	11.12
Calopo	27.76	5.33	8.52	5.11	4.78	4.67	4.94	7.22
control	26.78	5.13	7.44	5.22	4.11	4.00	4.04	5.67

PH = Plant height , SD = Stem diameter, NL = Number of leaves, FA = Flowering age, NB = Number branches of plan, NPB = Number productive branches of plant, DRW = Dry root weight, DCW =Dry canopy weight

Table 3. Effect of compost types on edamame soybean yield

Type of fertilizer (ton/ha)	Variable							
	NP	NEP	NPP	PW	PPP	RNW	NRN	NERN
Wedelia	25.11	1.52	23.59	60.52	93.35	0.35	4.59	3.81
Siam weed	63.33	1.78	25.04	59.74	92.08	0.56	5.22	4.30
Calopo	22.89	1.41	21.48	59.11	93.67	0.70	6.89	6.07
control	18.33	0.78	17.56	41.78	94.89	0.23	3.33	2.69

NP = Number pod of plant, NEP = Number empty pod of plant, NPP = Number pithy pod of plant, PW = Percentage pithy
pod, PPP = Percentage pithy pod, RNW = Root nodules weight, NRN = Number root nodules of plant, NERN = Number effective root nodules

3.3. Effect of Compost Dosage on Edamame Growth and Yield

Compost application to edamame showed significantly different results. The different results were shown by the observation variables of stem diameter, number of leaves, number of productive branches per plant, and dry weight of root stover. The table of observations on the dosing factors can be seen in Tables 4 and 5.

Table 4. Effect of compost dosage on the growth of edamame soybeans

Fertilizer dosage (ton/ha)	Variable							
	PH	SD	NL	FA	NB	NPB	DRW	DCW
0	26.78	5.13**	7.44*	5.22	4.11	4.00*	4.04*	5.67
5	27.32	4.96**	7.81*	4.89	4.33	4.15*	4.03*	9.12
10	28.80	5.95**	9.41*	4.93	5.07	5.00*	4.71*	11.08
15	28.16	5.98**	6.26*	5.04	5.41	5.33*	5.78*	13.63

PH = Plant height , SD = Stem diameter, NL = Number of leaves, FA = Flowering age, NB = Number branches of plan, NPB = Number productive branches of plant, DRW = Dry root weight, DCW =Dry canopy weight

Table 5. Effect of dosage of kopos fertilizer on edamame soybean yield

Fertilizer dosage (ton/ha)	Variable							
	NP	NEP	NPP	PW	PPP	RNW	NRN	NERN
0	18.33	0.78	17.56	41.78	94.89	0.23	3.33	2.69
5	22.00	1.30	20.70	54.19	94.29	0.33	3.56	3.11
10	28.04	1.22	26.15	62.85	91.39	0.53	5.52	4.41
15	24.81	1.52	23.26	62.33	93.42	0.47	4.85	4.33

NP = Number pod of plant, NEP = Number empty pod of plant, NPP = Number pithy pod of plant, PW = Percentage pithy pod, PPP = Percentage pithy pod, RNW = Root nodules weight, NRN = Number root nodules of plant, NERN = Number effective root nodule

The dose of compost affects stem diameter, number of leaves, number of productive branches, and dry weight of edamame soybean root stover and forms an Orthogonal Polynomial graph as follows.

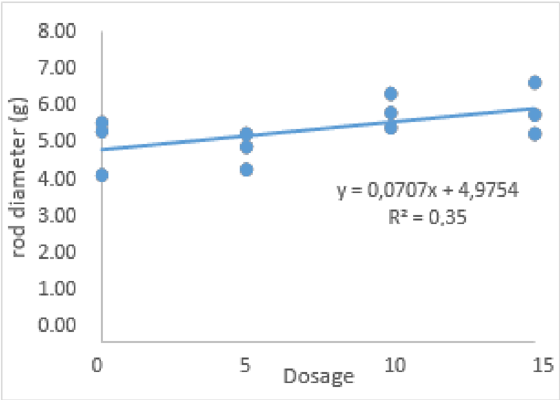

Figure 1. Effect of dose on stem diameter

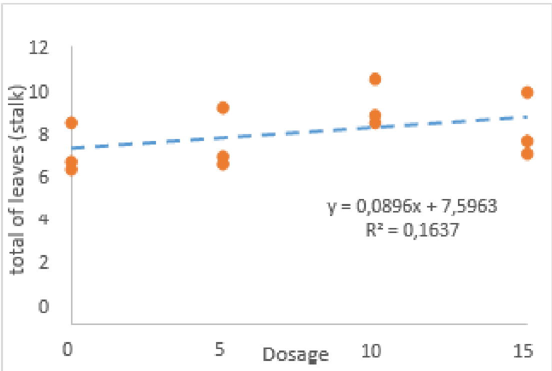

Figure 2. Effect of Fertilizer dosage on number of leaves

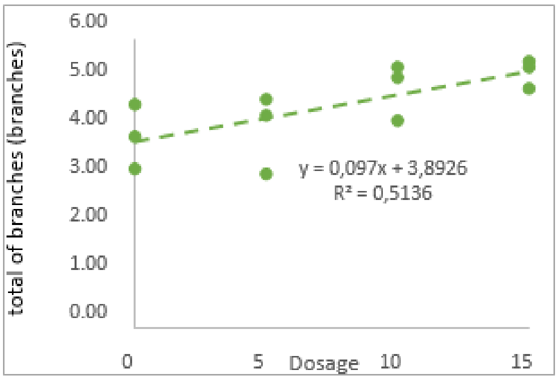

Figure 3. Effect of Fertilizer dosage on the number of productive branches

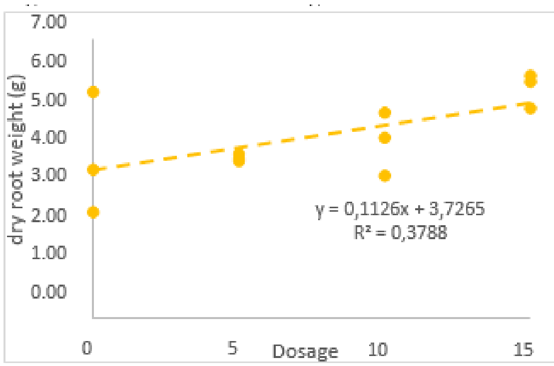

Figure 4. Effect of dose on dry root weigh

1. Stem Diameter

The PO test results (Figure 2) show that the stem diameter response to compost dosage follows a linear pattern with Y = 0.0707x + 4.9754 with a coefficient of determination R2 = 0.35. This equation means that each additional compost dose unit can increase the stem diameter by 0.0707 mm. Based on field observations, the largest stem diameter was given a fertilizer dose of 15 tons/ha with a stem diameter of 5.98 mm. Whereas in giving a fertilizer dose of 10 tons/ha the stem diameter was 5.95 mm (Table 4.). The nutrient content in the fertilizer greatly affects the dosage requirements of the fertilizer to be used. The higher the nutrient content in the fertilizer, the less fertilizer is needed, and vice versa. In addition, the number of fertilizer doses is not always good, from the observation that the fertilizer dose of 10 tons/ha is more effective than the fertilizer dose of 15 tons/ha. In accordance with the report of Nursyabani et al. [15] administration of a dose of 7.5% (w / w) increases the rate of hydrocarbon degradation by 0.18% / week while the 5% (w / w) dose increases 0.15% / week, but the analysis results show that the dose of 5% (w / w)

% is the best dose.

2. Number of Leaves

The PO test results on the number of leaves due to compost dosing, formed a linear pattern with Y = 0.0896x + 7.5963 with a dermination coefficient R2 = 0.637 (Figure 3.). this means that each additional unit dose of compost tends to increase the number of leaves as much as 0.0896. The most leaf yields in field observations were given a fertilizer dose of 10 tonnes / ha which could produce an average of 9 leaves. A fertilizer dose of 15 tonnes / ha produced fewer leaves on average, namely 6 pieces (Table 4.). Giving high doses of fertilizer can actually reduce the average number of leaves. This is the same as the report of Safuf et al. [16] giving a dosage of 75g / plant compost yields an average leaf rate of 4.8 leaves, but at a dose of 100g / plant the average leaves decreased to 4.0 leaves.

3. Number of Productive Branches

PO analysis in Figure 4. Shows a linear pattern that forms the equation Y = 0.097x + 3.8926 with the coefficient of determination R2 = 0.5136. This equation means that each increase in the unit dose from a dose of 5 tons/ha - 15 tons/ha is able to increase the number of productive branches by an average of 0.097 branches. Giving compost dosage of 15 tons/ha was able to produce an average productive branch of 5.33 branches. These results are not much different from the administration of a dose of 10 tons/ha which is able to produce an average of 5 productive branches. So it can be said that the dose of 10 tons/ha is more effective in increasing the number of productive branches.

4. Dry Root Weight

Furthermore, from the graph in Figure 5, it is found that Y = 0.1126x + 3.7265 and the coefficient of determination R2 = 0.37. This equation means that each increase in the unit dose of manure will increase the dry weight of root stover by 0.1126 g. Giving a dose of 15 tons/ha can increase the highest root dry stover weight, namely an average of 5.78 g (Table 4.). However, at a dose of 10 tons/ha it was able to increase the root stover weight by 4.71 g on average (Table 4.). So that at a dose of 10 tons/ha it is sufficient. This opinion is in line with the cultivation guidelines of Soewanto et al. [17] who add 10-20 m3 / ha or the equivalent of 10-20 tons/ha of manure.

4. CONCLUSIONS

Based on the results of research and analysis, the following conclusions were obtained:

1. There were no interactions between dosage and compost types on the growth and yield of edamame soybeans.

2. The types of compost have no significant effect on the growth and yield of edamame soybeans.

3. The dose of compost has an effect on soybean growth, including stem diameter, number of leaves, number of productive branches, and dry root weight. Each increase in the compost dosage unit can increase 0.0707 mm stem diameter, 0.0896 leaves, 0.097 productive branches, and 0.1126 g dry root weight.

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