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Effect of Incubation of Goat Manure on Growth and Yield of Sweet Corn

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ABSTRACT

Goat manure is one of organic fertilizers used as the main input in organic farming practice in Indonesia. Since the slower availability of nutrient elements to the plants is the characteristic of this manure compared to the other manures, then research on the time of incubation needs to be evaluated. The study was conducted in Medan Baru Fields Experiment, district Muara Bangkahulu Bengkulu city. Randomized Complete Block Design was arranged for the experiment. Time incubation of goat manure in the field was single factor consisted of no incubation, 1 week before planting, 2 weeks before planting, 3 weeks before planting, and 4 weeks before planting. As much as 20 tons/ha of goat manure was incorporated in the field, no additional inorganic fertilizer was applied on sweet corn plants var. Bonanza F1. The sweetcorn plants responded better growth to treatment 4 weeks incubation of goat manure compared to treatment of no incubation. Yet incubation time of goat manure showed no significant effects on sweet corn yield.

INTRODUCTION

Sweet corn is grown commercially in Indonesia since the 1980's (Palungkun and Budiarti 2000). Today, this plant becomes one of popular vegetables in urban as wellas rural society. Sweet corn is popular because it tastes good and sweet, contains carbohydrates, low protein and fat (Sudarsana, 2000). In line with the development of supermarkets and the increasing purchasing power of the people, the demand for sweet corn is also increasing. The average yield of sweet corn in Indonesia per hectare is 4.45 tons (BPS, 2011), while the sweet corn yield in the Australian Lockyer valley can reach 7-10 tons per hectare. Various efforts can be made to increase the production of sweet corn. The production of sweet corn can be reached by fertilizer and plant spacing arrangement (Rahmi and Jumiati, 2003).

Agriculture policy in Indonesia is to encourage the development of organic agriculture into one way to apply the concept of LEISA (Low External Input Sustainable Agriculture) so as to obtain high agroecosystem efficiency through Integrated Farming System based on Zero Waste (Suharto, 2004). The use of inorganic fertilizers (NPK) continuously causes the fertilizer to accumulate in the soil, so the soil becomes hard and difficult to process (Novizan, 2005). To overcome the accumulation of fertilizer into the soil due to continuous use of organic fertilizer (NPK) can be done with organic fertilization. Organic matter is expected to improve the physical, chemical, and biological properties of the soil (Yang *et al.,* 2004) and efficient use of fertilizer (Widowati, 2009).

This study aims to compare the growth and yield of sweet corn on the treatment of different incubation time of goat manure.

MATERIALS AND METHOD

This research used Randomized Complete Block Design with single factor consisted of 5

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experimental levels and 3 replications. The time of manure incubation were P0 = 0 week before planting (the same time as planting), P1 = 1 week before planting, P2 = 2 weeks before planting, P3 = 3 weeks before planting, and P4 = 4 Weeks before planting. Seeds of sweetcorn var Bonanza F1 were planted, field was amanded with 20 tons/ha of goat manure. Land preparationwas done by setting the land, weed cleaning, soil hoeing, then measuring the experimental plot with 2.0 m x 3..0 m. The distance between the plots was 0.5 m and the distance between block was 0.5 m.

Goat manure was applied according to treatments. The manure dosage used at 20 ton / ha, mixed in soil ± 5-10 cm from the soil surface. The application of goat manure to the experimental plot begins at manure with the longest incubation time (P4), then 1 week later followed by P3 and so on until the last in experiment P0 which was at the planting time. Sweet corn seeds were planted ± 2 cm using tugal with a spacing of 50 cm x 40 cm. Each planting hole contained 2 seeds which were selected into 1 plant a week after. Plant maintenance included plant watering, it was done twice a day in the morning and in the evening, depended on the weather conditions. No watering was done when it rained. Weed control was done manually by weeding the weeds that grow in the field once a week. Sweet corn was harvested simultaneously for each plot 65-70 days after planting.

Data collection. The data of plant variables were measured for : Plant height, was measured weekly until tassel appeared. Number of leaves were taken for leaves that were fully opened. Stem diameter was measured using caliper, 10 cm above the lowest node. Weight of the cob with husk or without husk were measured at harvest. Length of cob was measured from the base of the fruit to the end of fruit. The diameter of the cob was measured in three parts, namely base, center, and end of cob then was averaged. Measurements are made using calipers. Total soluble solid content (SSC) (^{0}Brix) was measured using Handrefractometer.

Data analysis. The data obtained were analyzed statistically using analysis of variance with F test at 5% level and if there is significant difference , the data will be further tested using Duncan's Multiple Range Test (DMRT) at 5% level.

Table 1. Analysis of Variance of Sweetcorn Growth and Yield

Plant Variables	F-Value
Plant Height	
1 WAP	2.95*
6 WAP	0.38^{ns}
Number of Leaf	
1 WAP	8.01**
5 WAP	4.12*
6 WAP	2.68^{ns}
Diameter of Stem	
1 WAP	8.27**
6 WAP	0.86^{ns}
10 WAP	0.02^{ns}
Weight of Cob + Husk	0.99^{ns}
Weight of Cob	1.53^{ns}
Diameter of Cob + Husk	0.88^{ns}
Diameter of Cob	0.53^{ns}
Length of Cob	1.35^{ns}
Soluble Solid Content	2.36*

Note: * = significant effect on the F test with the level of 5%
ns = no significant effect on the F test with the level of 5%

RESULT AND DISCUSSION

The analysis of variance showed a significant effect of incubation treatment to the growth of plant height at 1 week after planting (wap), number of leaves at 1 WAP, 4 WAP, 5 wap, stem diameter at 1 WAP, and soluble solid content (SSC). While growth of plant height at 2 WAP to 6 WAP, growth of leaf number at 2 WAP, 3 WAP, 6 WAP, growth of stem diameter at 2 WAP up to 6 WAP and 10 WAP, cob weight +husk, cob weight without husk, cob diameter with husk, cob diameter without husk, length of cob did not show significant effect (Table 1).

Different incubation time treatment showed different growth rates for each week because of the relatively slow nutrient availability of certain observational variables indicating a different growth response in each treatment. The incubation treatment of goat manure was not significantly different for the variable of plant height at age 2 WAP, 3 WAP, 4 WAP, 5WAP and 6 WAP but showed a significant difference at 1 WAP (Table 2)

The difference in incubation time of goat manure showed a significant effect on the growth of plant height at the 1 WAP. The goat manure incubated 4 weeks before planting (P4) showed a better plant growth response compared with goat manure treatment without incubation (P0) and P2 (Table 2). Incubation of goat manure did not affect plant height at 2 WAP to 6 WAP. The incubation treatment of goat manure showed a significant difference to the variation in the number of leaves each week (Table 3)

Treatment of P4 and P3 showed a significant growth response to increase in number of leaves compared with treatment without incubation (P0) and P1. Where P4 and P3 show more number of leaves than P0 and P1. However, P4 and P3 treatments did not show significant differences in P2 experiments. At age 2 WAP treatment with incubation time of 4 weeks before planting (P4) showed a significant difference on the number of leaves added to the treatment without incubation (P0). Where P4 shows more number of leaves than P0. However, P4 treatment did not show a significant difference to the treatment of P3, P2 and P1. At age 3 WAP treatment with incubation time of 4 weeks before planting (P4) also showed significant differences on the number of leaves added to the treatment without incubation (P0). Where P4 shows a much higher number of leaves than P0. However, P4 treatment did not show a significant difference compared to the treatments of P3, P2 and P1.

Table 2. Plant Height of Sweetcorn

Time of Incubation (weeks before planting)	Plant Height (cm) at Weeks After Planting					
	1	2	3	4	5	6
0	10.86 b	29.74 a	58.52 a	95.60 a	143.49 a	187.49 a
1	11.25 ab	29.74 a	59.57 a	98.24 a	146.11 a	189.88 a
2	11.11 b	28.52 a	58.77 a	94.05 a	142.16 a	180.83 a
3	11.94 ab	29.77 a	58.27 a	94.83 a	143.66 a	188.94 a
4	12.77 a	33.91 a	65.97 a	101.16 a	150.44 a	193.44 a

Note: Numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test with α= 5%.

Tabel 3. Means of Number of Sweetcorn Leaf

Time of Incubation (weeks before planting)	Number of Leaf at Weeks After Planting					
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP
0	2.10 c	3.27 b	4.77 b	5.61 d	5.99 b	8.32 b
1	2.16 bc	3.60 ab	5.11 ab	5.66 cd	5.94 b	8.49 b
2	2.27 ab	3.44 ab	5.16 ab	6.16 b	6.33 b	8.88 ab
3	2.33 a	3.60 ab	5.05 ab	6.10 bc	6.55 ab	9.10 ab
4	2.38 a	4.00 a	5.66 a	6.66 a	7.44 a	9.99 a

Note : Numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test with α= 5%.

Treatment with incubation time of 4 weeks before planting (P4) showed a significant difference on the number of leaves, treatment P4 had higher number of leaves compared to treatment P0, P1, P2 and P3. Treatment P3 showed the same growth response of P2 and P1 (Table 4). At the age of 5 WAP treatment with incubation time 4 weeks before planting (P4) showed a significant difference on the number of leaf growth to the treatment of P2, P1 and P0. Where P4 shows more leaf number increase than P2, P1 and P0. However, P4 treatment did not show any significant difference to P3 treatment. Treatment P3 shows the same growth response with P2, P1, and P0.

At the age of 1 WAP, treatment with incubation time of 4 weeks before planting (P4) showed a significant difference in plant stem diameter to treatments of P0, P1 and P2. However, P4 treatment did not show difference to P3 treatment. At the age of 2 WAP, treatment with incubation time 4 weeks before planting (P4) showed a significant difference with plant stem diameter at treatment P0 and P2. However, P4 treatment did not show significant difference to P3 and P1 treatment. Stem diameter measured at 4 WAP indicated that treatment with incubation time of 4 weeks before planting (P4) showed to affect plant stem diameter which was higher than stem diameter at P0 treatment. However, P4 treatment did not show a significant difference to the treatment of P3, P2 and P1.

The tendency for growth differences seen in the first week after planting from the anava test results (Table 1), which is presumably because incubated goat manure has not been chemically mature. This can be seen from the analysis of the ratio of C / N goat manure is quite high. This is thought to be due to goat manure has not decomposed completely. The high C/N ratio gave an indication that organic raw materials as constituents are hard to break, so decomposition takes much longer. High C/N values also indicate that the availability of carbon is excessive while the amount of nitrogen is very limited. In addition, a high C/N ratio indicates that the compost base material has not completely decomposed. It is shown by the content of organic material is very high that is 83.25%, meaning that the organic material inside the compost is still a solid fractions that are difficult to decompose so it can not be absorbed by the plant. This situation is supported by the statement of Sutanto (2002) that organic fertilizer rich in lignin and difficult to destroy has a percentage of organic compounds higher than 70% and at the end of composting should the content of organic materials between 30% - 60%. The addition of manure in large quantities but with high C/N can disrupt the levels of N in the soil. This happens because to overhaul the organic material that has not been decomposed, so many soil microorganisms require N, where N is certainly taken from the soil N, resulting in competition between plants that grow on top with micro-bodies that require N, so the event is called immobilization nitrogen (Hasibuan, 2010).

The factors that are suspected to affect the yield are not significantly different in all treatments with

Table 4. Means of sweetcorn stem diameter

Time of Incubation (weeks before planting)	Diameter of Stem (cm) at Weeks After Planting						
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	10 WAP
0	0.29 c	0.41 b	0.87 a	1.56 b	2.00 a	2.04 a	1.95 a
1	0.32 bc	0.44 ab	0.94 a	1.61 ab	2.01 a	2.07 a	1.93 a
2	0.30 c	0.43 b	0.92 a	1.71 ab	2.08 a	2.03 a	1.93 a
3	0.34 ab	0.45 ab	0.88 a	1.62 ab	2.05 a	2.04 a	1.95 a
4	0.37 a	0.51 a	1.10 a	1.90 a	2.24 a	2.21 a	1.98 a

Note : Numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test with α= 5%.

the variables weight of cob + husk, weight of cob without husks, diameter of cob, diameter of cob without husk, length of cob because the nature of manure which needs decomposition process. Sweet corn is harvested 65 – 70 days after planting. Research of Roesmarkam *et al.* (2002) showed that the effecr of application of immature organic fertilizer to plants will be detected after several years, so that in this study it is assumed that positive effect from goat manure can not be seen optimally because organic fertilizer can not have an instant effect to support growth and crop production.

Soluble solid content (SSC) is the sweetness level contained by the sweet corn endosperm. From the result of Duncan's advanced test analysis with 5% significance level indicated that P4 treatment showed significant difference to treatment P0. However, P4 treatment showed no significant difference to P3, P2 and P1 treatment. Sweet corn is usually consumed when it is fresh and young, because it will affect the sugar content of the seeds, when sweet corn is harvested at the wrong time will affect the sugar content of the seeds. Surtinah (2008) reported that the harvest age of 70 days after planting showed the highest level of sweetcorn sugar content of 15.78% for Sweet Boy variety.

Sweet taste in sweet corn is thought to be influenced by the presence of nutrients K. Potassium is absorbed in the form of K^+ ions. Salisbury and Ross (1992) stated that K^+ plays a role in the process of starch formation as an activator of starch synthetase enzyme. This is one of the reasons why K^+ is important for plants and possibly why sugar and non starch are accumulated in plants lacking potassium. This is consistent with the statement of Foth (1991) who found that K deficiency can increase the sugar content in sugar and sugar cane bits. K available on P4 is thought to have a high value. The high K available on P4 will inhibit the activation of the synthetase starch enzyme so that starch formation is also inhibited. This means that the conversion of sugar to starch is inhibited so that the sugar content at P4 is high. Potassium plays a role of more than 50 enzymes either directly or indirectly. If the activity of the enzyme is hampered there will be accumulation of certain compounds because the process is stopped. For example, the enzyme catalase that converts glucose to starch, lack of potassium causes the enzyme catalase is inhibited so that the process of starch formation stops and causes glucose accumulation.

Reduction sugar level on P4 treatment did give significantly different result than P0. However, P0 was not significantly different from the treatment of P1, P2 and P3. This condition is thought to be related to the incubated goat manure condition whose decomposition is not yet perfect as described previously. This is possible because the application of manure requires longer decomposition time because the material is decomposed more, this results in K availability is also getting slower. At P4, the time required for the decomposition of potassium to be available is longer than P3, P2, P1 even compared with P0.

The result of the correlation test between the increase in the number of leaves at age 6 WAP on the process of formation of cob weights without kelobot showed that there is a linear relationship between the increase in the number of leaves with the weight of cobs without husk. The graph showed that the increasing number of sweet corn will be heavier as well as the weight of cobs without the weights to be had.

The correlation test between stem diameter increase at age 4 WAP to the formation process of cob weights without husk. Stem is part of the bud system in plants. It is on the ground. This organ is categorized as a producer of lateral organs, such as leaves, buds, and flowers. In the stem there is a node, the place of leaf attachment, and segment (internode), which is the stem part that is located in between the nodes. The stem therefore is very important organ in supporting the growth and yield of plant.

CONCLUSION

The treatment of incubation time of goat manure with P4 experiment showed a significant difference to experiment P0 (control) and P4 showed no significant difference to experiment P3, P2 and P1. This is due to the manure that is directly applied without incubation (submersion) in advance the possibility of C / N ratio is still high causing nutrient immobilization which ultimately affect the growth

and production of sweet corn. Experiment P4 gives a real effect on high varieties of plant age 1 WAP, leaf age variables 1 WAP to 6 WAP, and to variable stem diameter at week 1 WAP, 2 WAP, 4 WAP. Incubation is one method of using goat manure by burrowing goat manure into a layer of soil with a certain depth in order to occur degradation process and decomposition of goat manure and prevent leaching and nutrient evaporation.

From the results of the correlation test between stem diameter increase at the age of 4 MST on the process of formation of cob weights without husk showed that there is a linear relationship between the increase of stem diameter with the weight of cob without husk. The graph shows that the greater the diameter of the sweet corn stalks, the more likely it will be to produce the weight of cobs without the husk to be had.

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