



## The Effectiveness of the Combination of Types and Methods of Organic Fertilizer Application on Growth and Yield of Sweet Corn in Inceptisols

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### ABSTRACT

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This study aimed to obtain a combination of organic fertilizers and the method of giving solid organic fertilizer to the growth and yield of sweet corn. The research was conducted from March to May 2019 in Karang Dapo Village, Bingin Kuning District, Lebong Regency, Bengkulu Province. This study used a Randomized Complete Block Design with one factor and three replications, consisting of 11 combinations, namely control, solid organic fertilizer (SOF) dose of 2.5 tons/ha by localized placement, 5 tons/ha by localized placement, Petroganic 500 kg/ha by localized placement, Petroganic 1000 kg/ha by localized placement, Petroganic 2000 kg/ha by localized placement, SOF 2.5 tons/ha by side dressing, SOF 5 tons/ha by side dressing, Petroganic 500 kg/ha by side dressing, Petroganic by 1000 kg/ha by side dressing, Petroganic 2000 kg/ha by side dressing. The results showed that the distribution of SOF 5 tons/ha by localized placement affected stem diameter, which gave 3.25 cm, the number of leaves 13.1 strands, and the percentage of marketable cob 100%. Giving SOF 5 tons/ha by localized placement yields reached 34.4 tons/ha. Giving organic fertilizer gave better results than without applying organic fertilizer to all observed variables.

### INTRODUCTION

Sweet corn (*Zea mays saccharata* Sturt) is a popular and healthy food among Indonesians. This commodity is good for the health of the human body. Sweet corn has a short harvest period, about 70-80 days. Sweet corn products can be processed in processed foods such as stewed corn, cake, corn pudding, corn

omelette, and other corn processed products.

Sweet corn production in 2014 in Bengkulu was 72.76 tons with a harvest area of 15,643 ha and productivity of 4.65 tons/ha. This number decreased compared to 2013, which reached 93,988 tons with a harvest area of 18,257 ha and productivity of 5.15 tons/ha. The decline in sweet corn production in Bengkulu Province was presumably due to infertile land, reduced

harvest area, inappropriate way of farming, and varieties used are not adaptive (Badan Pusat Statistik, 2014).

Sweet corn production in Bengkulu can be improved by improving land productivity and expanding cropping areas. The expansion of the sweet corn crop area in Bengkulu Province can be done in Inceptisols that has a spread of 991,000 ha (Sukisno *et al.*, 2010). Although the spread is quite wide and potential, it does not mean Inceptisols in its utilization do not face problems in the field. Dryland such as Inceptisols generally has low soil fertility rates, physical, chemical, and soil biology. This is worsened by the continuous use of inorganic fertilizers to disturb ecosystems soil (Damanik *et al.*, 2011). Therefore, it is necessary to improve crop cultivation in the form of inorganic fertilizer substitutes that can improve soil productivity. The application of organic fertilizer is expected to be an alternative to inorganic fertilizers.

Organic fertilizers can increase the number of microbes in the soil, improve soil structure, increase the availability of nutrients N, P, and K, stimulate plant growth, neutralize toxic chemicals in the soil, improve the quality and quantity of crop production, and make plants more resistant to pest attacks (Asmaning *et al.*, 2017). Giving organic fertilizer up to 20 tons/ha can increase the growth and production of sweet corn (Kriswantoro *et al.*, 2016). One form of organic fertilizer used is granule made in the factory or better known as Petroganic.

Petroganic is an organic fertilizer made from manure and organic waste derived from city waste. At first, Petroganic was powder-like in shape as compost. However, after various trials, finally, this fertilizer is in the form of granules with a composition of C-organic 12.5%, C/N ratio 10-25, and water content of 4-12% (Petrokimia-Gresik, 2012). The advantages of Petroganic compared to other organic fertilizers are high levels of C-organic, grain-shaped, safe, environmentally-friendly (free of organic microbes), and free from grains/weeds. Petroganic water content is relatively low, making it efficient in transportation and storage (Widyana, 2015). The application of Petroganic fertilizer as much as 2000 kg/ha on

sweet corn plants affects the height of plants, the number of leaves, the diameter of the stems, the area of the leaves, the weight of the cob per plant, and the weight of cobs without ear (Abidin *et al.*, 2017).

Another organic fertilizer that can be used as a source of organic fertilizer is solid palm waste (SPW), one of the most potent sources of soil organic matter in Bengkulu Province. PT. Bio Nusantara Technology transforms SPW into solid organic fertilizer (SOF) in the form of compost with a content of 1.38% N, 2.78% P<sub>2</sub>O<sub>5</sub>, 0.25% K<sub>2</sub>O, 17.72 C/N, 19.14% water content, and 24.45% C-organic. Nutrient content contained in SOF can be used to add nutrients for plants. Puspitasari research (2017) on melon plants showed that the application of SOF with a dose of 2.5 tons/ha and 5 tons/ha affects on plant length, plant height, and the level of sweetness of melon fruit.

Another factor that affects the growth and productivity of maize crops is fertilizer application. Proper fertilizer application will maximize the plants absorbing the available nutrients. Fertilizer can be done by side-dressing, circular application, localized placement, and mixed evenly on the soil media (Herianto, 2014). Organic fertilizer by localized placement with a depth of 7 cm below the soil's surface produces the largest value on the number of cobs, as well as the dry weight of corn grains, stems, and corn roots (Hartono *et al.*, 2014). Other research shows that the side-dressing application of chicken manure 15 tons/ha gave the highest weight of cob without the ear of 14.67 tons/ha (Rizqullah *et al.*, 2017).

The information about the effect of organic fertilizers and types of fertilizers on the cultivation of sweet corn has not been done much. It is necessary to research the effectiveness of the form and method of giving Petroganic fertilizers and solid organic fertilizers from palm waste. This study aims to obtain a combination of organic fertilizer and give the right way to the growth and yield of sweet corn.

## MATERIALS AND METHODS

This research was conducted from March to May 2019 in Karang Dapo Village, Bingin

Kuning District, Lebong Regency, Bengkulu Province. This study used a Randomized Complete Block Design with one factor and three replications. The treatments were consisting of 11 combinations, i.e. control, solid organic fertilizer (SOF) 2,5 tons/ha by localized placement, SOF 5 tons/ha by localized placement, Petroganic 500 kg/ha by localized placement, Petroganic 1000 kg/ha by localized placement, Petroganic 2000 kg/ha by localized placement, SOF 2,5 tons/ha by side-dressing, SOF 5 tons/ha by side-dressing, Petroganic 500 kg/ha by side-dressing, Petroganic by 1000 kg/ha by side-dressing, Petroganic 2000 kg/ha by side-dressing.

Basic fertilizer 350 kg of Urea/ha, 175 kg of TSP/ha, and 100 kg of KCl/ha (Kasno and Rostaman, 2013) was given to all experimental units. TSP and KCl were given entirely when the plant was one week after planting. While Urea was given twice, that is 175 kg of urea/ha at one week after planting and the rest (175 kg/ha) at the final vegetative phase. Basic fertilizer was given by localized placement beside the planting hole. The variable growth and yield of sweet corn crops observed were the height of the plant, the number of leaves, the total area of leaves (cm<sup>2</sup>), the diameter of the stem, the length of the cob, the length of the cob without the ear, the diameter of the cob without the ear, the weight of the cob without the ear, and the percentage of marketable cob. Data were statistically analyzed by analysis of variance at 5% level. If there were significant effects, further analysis was conducted using the Duncan Multiple Range Test at 5% level.

## RESULTS AND DISCUSSION

The results of a preliminary analysis of soil

(Inceptisols) at a research site conducted in the Laboratory of The Soil Sciences University of Bengkulu showed that soil pH 4.44 (very acidic), C-organic content of 3.30% (high), N-total 0.32% (medium), P available 7.94 ppm (medium), K-available 0.58 me 100 g/soil (medium), CEC 21.2 me 100 g/soil (medium), exchangeable Al 0.42 me 100 g/soil (low) (Balai Penelitian Tanah, 2012). From these results, it can be concluded that this soil has a low to moderate soil fertility rate. The research site is at an altitude of 410 m above sea level with average rainfall ranging from 0 mm to 82 mm/month with uneven spread. To plants avoid scarce water, watering was carried out once a day.

The results of analysis of variance showed that the form and method of organic fertilizer only had a significant effect on the number of leaves, the diameter of the stem, and the percentage of marketable cob, but had no significant effect on plant height, total leaf area, length of the cob with ear, and the weight of the cob without an ear. A summary of the analysis of variance's results is presented in Table 1.

The effects of treatments on plant height, number of leaves, the diameter of stem and total leaf area are presented in Table 2. Application of SOF at 5 tons/ha by localized placement gave the most significant number of leaves (13.1) that are not significantly different with SOF 5 tons/ha by side dressing, Petroganic 1000 kg/ha by side-dressing, and POP 5 tons/ha by side dressing that equally has an average value (13.1), but significantly different from the Petroganic treatment of 2000 kg/ha by side dressing that had the lowest number of leaves (12.1). This is suspected

Table 1. Summary of analysis of variances on all observed variables

No	Variables	Calculated F Value	Description*
1	Plant height	1.88 <sup>ns</sup>	Non-significant
2	Number of leaves	3.18 <sup>*</sup>	Significant
3	Diameter of stem	2.57 <sup>*</sup>	Significant
4	Total of leaves area	1.91 <sup>ns</sup>	Non-significant
5	Length of cob with ear	0.78 <sup>ns</sup>	Non-significant
6	Diameter of cob with ear	1.07 <sup>ns</sup>	Non-significant
7	Weight of cob without ear	0.86 <sup>ns</sup>	Non-significant
8	Percentage of marketable cob	2.85 <sup>*</sup>	Significant

\*Based on 5% F-value

Table 2. The effect of the combination of forms and method of giving organic fertilizer to the growth variables of sweet corn

Treatments	Variables			
	Plant height (cm)	Number of leaves	Diameter of stem (cm)	Total of area leaves (cm <sup>2</sup> )
Control	174.33	12.2 b	2.75 b	4887.92
SOF 2,5 tons/ha by localized placement	184.78	12.3 b	3.08 a	5025.57
SOF 5 tons/ha by localized placement	195.11	13.1 a	3.25 a	5118.52
Petroganic 500 kg/ha by localized placement	192.00	12.6 ab	3.14 a	5108.96
Petroganic 1000 kg/ha by localized placement	198.78	12.8 ab	3.21 a	4951.91
Petroganic 2000 kg/ha by localized placement	181.00	12.2 b	3.14 a	4924.37
SOF 2,5 tons/ha by side dressing	200.03	13.1 a	3.24 a	5112.97
SOF 5 tons/ha by side dressing	199.28	13.1 a	3.01 ab	5607.44
Petroganic 500 kg/ha by side dressing	206.00	12.7 ab	3.10 a	5114.52
Petroganic by 1000 kg/ha by side dressing	185.61	13.1 a	3.08 a	5067.54
Petroganic 2000 kg/ha by side dressing	179.00	12.1 b	3.01 ab	4954.79

Note: The numbers followed by different letters in the same column are significant different at Duncan Multiple Range Test

because SOF has a high nutrient content of N by 1.38 %, P<sub>2</sub>O<sub>5</sub> by 2.78 %, and K<sub>2</sub>O by 0.25 %. Vegetative growth of plants requires high amounts of N nutrients. If the N elements available are high, the chlorophyll formed will increase. Chlorophyll has an essential function in photosynthesis, which absorbs solar energy which further translocated to all parts of the plant, especially on the leaves (Handayunik, 2008). In addition, nutrients given by localized placement can be absorbed well by plants. Lingga (2009) concluded that the application of fertilizer by localized placement is more effective and efficient for sweet corn crops.

The placement of organic fertilizer by localized placement is more effective in improving the physical properties of the soil than by broadcast method that is easily lost. Getting better the physical, chemical, and biological properties of the soil, the greater the soil CEC. So that the availability of more nutrients in the soil and more easily absorbed by the roots of plants. Differences in soil physical properties result in differences in the availability of water and nutrients that plants can absorb, thus affecting the growth of sweet corn crops. The application of SOF 5 ton/ha by localized placement gave the largest stem diameter (3.25 cm) is significantly different from the control (2.75 cm) but different from

other treatments. This is thought SOF has a high nutrient content of N by 1.38%, P<sub>2</sub>O<sub>5</sub> by 2.78%, and K<sub>2</sub>O by 0.25%. The control treatment gave the smallest average to the diameter of the stem. This is caused the control is not given any organic fertilizer, so the control treatment lacks nutrients. Amir and Rosmiah (2018) concluded that if a plant is deficient in elements, then the plant's growth rate will slow down and not be optimal in the production of a plant. In addition, the placement of fertilizer by localized placement causes the nutrients in SOF to accumulate near the rooting zones, so that plants can well and not be easily lost by evaporation and leaching. Hartono *et al.* (2014) stated that the placement of organic matter close to the rooting system would increase the nutrient content in the soil and be easily absorbed by plants.

The statistical analysis of the effect of organic fertilizer on the yield components of sweet corn showed that all treatments had an insignificant effect on all yield components measured except the percentage of marketable cob (Table 3). However, the 5 ton/ha SOF treatment given by localized placement tends to produce the best average at the length of the cob with the ear (30.96 cm), the diameter of the cob with the ear (6.30 cm), and the weight of the cob without ear (320,39 g). This is

Table 3. The effect of the combination of forms and method of giving organic fertilizer to the yield component variables of sweet corn

Treatments	Variables			
	Length of the cob with ear (cm)	Diameter of the cob with ear (cm)	Weight of the cob without ear (g)	Percentage of the marketable cob (%)
Control	28.66	6.00	278.11	89 b
SOF 2,5 tons/ha by localized placement	28.78	5.92	297.78	100 a
SOF 5 tons/ha by localized placement	30.69	6.30	320.39	100 a
Petroganic 500 kg/ha by localized placement	29.86	6.19	301.56	100 a
Petroganic 1000 kg/ha by localized placement	29.48	6.16	312.83	100 a
Petroganic 2000 kg/ha by localized placement	28.74	6.04	299.28	94 ab
SOF 2,5 tons/ha by side dressing	29.01	5.87	284.61	89 b
SOF 5 tons/ha by side dressing	29.93	6.21	296.28	100 a
Petroganic 500 kg/ha by side dressing	29.86	6.10	291.89	100 a
Petroganic by 1000 kg/ha by side dressing	30.15	6.15	295.50	100 a
Petroganic 2000 kg/ha by side dressing	30.22	5.98	270.17	100 a

Note: The numbers followed by different letters in the same column are significant different at Duncan's Multiple Range Test

suspected because the nature of organic fertilizer can bind water well and nutrient content in organic fertilizers such as N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O are quite high. Pramurdika *et al.* (2014) stated that the properties of organic fertilizers could improve soil structure, add microorganisms in the soil, increase absorption of water, and provide macro and micronutrients for plants.

Another factor is the high content of C-organic in the soil used in this research. The initial analysis of soil from the Soil Science Laboratory showed a C-organic content of 3.30%, which is classified as high. This causes all treatments to have no significant effect because C-organic in the soil is relatively high. Pasta and Barus (2015) showed that the applying organic fertilizer on soil with a high C-organic content does not affect the growth and yield of sweet corn crops. In addition, it is suspected that organic fertilizer is a slow-release fertilizer so that organic acids bind some nutrients. Budiyanto *et al.* (2017) stated that compost is a fertilizer that releases nutrients slowly and continuously and is not directly available to plants.

The percentage of marketable cob is one indicator of the yield of sweet corn crops.

Variance analysis test results show that the treatment of the form and method of organic fertilizer application has a natural effect on the percentage of marketable cob. Duncan's Multiple Range Test results at 5% level show that giving SOF 5 tons/ha by localized placement gave the highest percentage of marketable cob (100%). These results differ significantly from the controls and the 2.5 ton SOF/ha by side-dressing that gave the lowest percentage of marketable cob (89%) but is insignificant compared to other treatments. This is thought that the nutrient needs of sweet corn crops have been fulfilled. This can be seen from the analysis of organic fertilizers that are pretty high, namely N by 1.38%, P<sub>2</sub>O<sub>5</sub> by 2.78%, and K<sub>2</sub>O by 0.25%. Pasta and Barus (2015) stated that the weight of the cob is influenced by the length of the cob, the diameter of the cob, and the number of seeds in the cob. The greater the value of the length of the cob, the width of the diameter of the cob, and the number of seeds in the cob, the heavier the weight of the cob produced. The results of this research showed that the average value of the weight of the marketable cob had met even passed the weight of the marketable cob sweet corn, which is 250 g to 300 g. The results of

Sesanti *et al.* research (2014) showed that the weight of sweet corn cob without ear about 274.5 g and 236.75 g has met the criteria of a marketable cob.

The percentage of marketable cob does not reach 100% on control treatment, Petroganic 2000 kg/ha by localized placement, and SOF 2.5 tons/ha by side-dressing, while other treatments reach 100%. This is thought to be because one plant is allowed to grow 2 cobs, affecting the yield of sweet corn crops. The photosintat was divided into 2 cobs instead of focused on one cob, while observed in this study only one cob on one plant.

The yield per hectare description of the variety of Bonanza-F1 is 33.0 tons/ha. In this study, the application of SOF 5 tons of/ha by localized placement gave the highest yield among other treatments, namely 34.4 tons/ha, while Petroganic giving 1000 kg/ha by localized placement gave a yield 33.6 tons/ha. However, given that the application of SOF 5 tons/ha by localized placement is nonsignificant with the provision of Petroganic 1000 kg/ha by localized placement, then the Petroganic application of 1000 kg/ha by localized placement in this study is considered more efficient. For marketable cob per hectare, giving SOF 5 tons/ha by localized placement gave the highest yield of 19.1 tons/ha while control gave the lowest yield of 15.9 tons/ha for marketable cob per hectare. This is suspected because the placement of fertilizer by localized placement causes the nutrients contained in SOF to accumulate near rooting zones to be absorbed by plants well. Hartono *et al.* (2014) stated that the placement of fertilizers close to the root system, the nutrient content in the fertilizer could be absorbed well by plants.

## CONCLUSION

Localized placement of 5 tons/ha SOF result in the highest value of stem diameter, number of leaves, and percentage of marketable cob. The application of organic fertilizer provides better results than without organic fertilizer to all observed variables.

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