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Growth and Yield of Sweet Corn Grown Organically Using Palm Oil Sludge at Different Doses and Composting Methods

Pertumbuhan dan Hasil Jagung Manis yang Dibudidayakan Secara Organik dengan Menggunakan Lumpur Sawit pada Dosis dan Metode Pengomposan yang Berbeda

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ABSTRACT

Palm Oil Sludge (POS) has been used in oil palm plantation in Bengkulu as fertilizer for the last several years without any significant treatment prior to the application on the field. Since the sludge has a high of C/N ratio, its usage for annual crops such as sweet corn need to be processed into mature or final compost. The final nutrient compositions of organic matter would depend on the method of composting process. This study was done to evaluate the effect of different composting process of POS (with EM4 or with vermi) on growth and yield of sweet corn. Field experiment was done on Ultisol , compost rates of 0, 5, 10, 15, and 20 ton ha^{-1} were applied. The nutrient analysis of POS-vermicompost showed higher content on N,P, and K (2.52%, 0.33%, and 1.10%, respectively) compared to POS-EM4 i.e. 0.98% of N, 0.32% of P, and 0.82% of K. Nevertheless, there was no different effect indicated on the growth and yield of plants. Under the treatment applied, the plant growth responses were linearly possitive. The weight of ears were 210.90 g under POS-EM4 20 tons ha^{-1} and 200.91 g under POS-vermicompost 20 ton ha^{-1}.

Key words: palm oil sludge, EM4, vermicompost, sweet corn

ABSTRAK

Lumpur minyak sawit telah lama digunakan sebagai pupuk di perkebunan kelapa sawit di daerah Bengkulu. Lumpur sawit biasanya diberikan langsung ke lahan tanpa ada perlakuan tambahan. Namun karena bahan organik ini mengandung C/N rasio yang masih tinggi di samping adanya aroma yang menyengat, penggunaannya untuk tanaman semusim akan lebih baik bila dilakukan dalam bentuk kompos yang telah masak. Kandungan unsur hara yang tersedia untuk tanaman dari suatu bahan organik antara lain ditentukan oleh metode pengomposannya. Penelitian ini bertujuan untuk mengkaji pengaruh proses pengomposan lumpur minyak sawit yang berbeda, yaitu dengan EM4 atau dengan Cacing , terhadap pertumbuhan dan hasil jagung manis yang dibudidayakan secara organik. Penelitian dilakukan di Ultisol dalam bentuk percobaan lapang. Dosis kompos lumpur sawit yang digunakan yaitu 0, 5, 10, 15, dan 20 ton ha^{-1}. Hasil analisis vermikompos lumpur minyak sawit menunjukkan kandungan unsur – unsur N, P, dan K yang lebih tinggi (berturut – turut 2,52%; 0,33%; dan 1,10%) dibandingkan kandungan kompos-EM4 lumpur minyak sawit yaitu 0,98% N, 0,32% P, dan 0,82% K. Namun demikian tidak ada perbedaan yang nyata pada pertumbuhan dan hasil jagung manis pada kedua perlakuan metode pengomposan tersebut. Seluruh variabel pertumbuhan dan hasil yang meliputi tinggi tanaman, jumlah daun, berat brangkasan segar, berat brangkasan kering, diameter tongkol, maupun bobot tongkol menunjukkan hubungan linier positif terhadap dosis yang diuji. Bobot tongkol pada dosis 20 ton ha^{-1} dari kompos-EM4 lumpur minyak sawit adalah 210,90 g sedangkan bobot tongkol dari perlakuan vermikompos lumpur sawit adalah 200,91 g pada dosis yang sama.

Kata kunci : lumpur minyak sawit, EM4, vermikompos, jagung manis.

INTRODUCTION

The issues on low input and organic farming systems are prominent during the last two decades. Green revolution has been no doubt increasing crop productivity but the environmental effects such as degradation of soil fertility and insect as well as disease resistances insist people to go back to nature. The consequences are the expanding researches on alternative rich-nutrient organic materials allowing in sustainable agriculture and especially in organic farming.

Palm oil sludge is waste product in the process of oil palm fruits to Crude Palm Oil (CPO). The waste is a potential organic material to be processed as compost and be used in growing crop as organic fertilizer. Data of USDA in 2008 revealed that Indonesia is the largest producer of CPO in the world with production of 18.3 million tonnes per year followed by Malaysia with its production of 17,7 million tonnes (Sheil et al., 2009). As much as 2% of post-processing CPO is in the form of palm oil sludge (Devendra, 1977). Unless this material is managed properly, environmental pollution will become a serious problem. Utilization of oil palm sludge on annual crop plants is less informed compared to its utilization on husbandry. Since palm oil sludge contains some stringent odor and considerably high C/N ratio, its application for annual crop such as sweet corn need to be processed into mature compost. Effective microorganism technology has been used widely as decomposer or used directly on crop field. The previous studies clearly showed that EM-4 compost increased yields of rice and vegetables (Ting *et al.*, 1995; Lee and Cho, 1995). In addition, using EM4 in organic material can also eliminate the odor of raw material.

Vermicompost is one of organic fertilizers widely used on organic farming system. As indicated on some studies, vermicompost resulted in the increasing of SSC (soluble solid content) of tomato fruits (Premuzic *et al*., 1998), while Reider *et al*. (2000) stated that the water holding capacity and cation exchange capacity of vermicompost were relatively high. Vermicompost usually contains higher nutrient compared to conventional compost. Greater amount of microorganisms and plant growth regulator might accelerate.plants to grow and get higher yield (Dominguez *et al*., 1997). This study was proposed to evaluate the possibility of two palm oil sludge composting methods applied on sweet corn under organic system and to observe their effects on sweet corn growth and yield under different rates of application.

MATERIALS AND METHODS

Field study was conducted on Ultisol in Bengkulu. Sweet corn cv. Seleksi Darmaga II was used. Research was arranged in a Randomized Complete Block Design with two factors and three replications. Composting methods used in this experiment were vermin-composting and EM4-composting. The compost rates applied on field were 0, 5, 10, 15, and 20 tonnes Ha^{-1}., which were incorporated into the soil one week prior to planting. Each unit of bed was 4.0 m x 2.0 m, between individual bed was separated by 50 cm, while between block was separated by 100 cm. Seeds were planted on 80 cm between rows and 30 cm in-rows. Five plants were tagged as samples.

Composting of palm oil sludge was processed as followed: Raw material, palm oil sludge taken from CPO plant in Bengkulu, was spread on the floor for 6 days to allow the oil in the material decreased and water evaporated. The sludge for vermicompost was amended with rice brand and livestock manure as a starter and then was placed in plastic boxes of 40 cm x 20 cm x 10 cm. One ounce of Lumbricus rubellus was placed in each box. The boxes were covered with rami cloth. The humidity of the media was maintained by splashing water on top of cloth 2 times a day. Vermicompost was ready for field application after 6 weeks processing.

Oil palm sludge compost from EM-4 was prepared as folllows: Air-dried oil palm sludge was sprayed with a mix of 100 mL EM-4, 100 L water, and 500 g coconut sugar. Once every 4 days sludge media was treated with EM4 stock solution. Length of time needed for the sludge to turn to mature compost was 21 days. Compost was applied in the field a long the row one week before planting. Irrigation was practiced during the first week of plant growth because of minimum rainfall, but for the remaining growing season there was an ample precipitation so additional irrigation was required. No biological control either for insect or disease since only very few of plants suffered from worms 3 days before harvesting.

Plant height and number of leaves were measured and counted at 6 weeks after planting. Other variables i.e. fresh and dry weight, weight of ear and diameter of ear were measured at harvest, 63 days after planting. Nutrient analysis of soil, POS-vermi and POS-EM4 were determined.

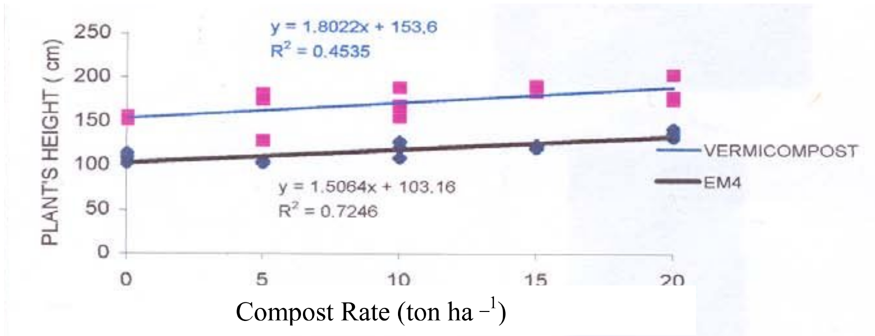
Growth and yield data were analysed using analyses of variance. Treatments were considered significantly different if the P-value was < 0.05. Comparison between POS-vermi and POS-EM4 was tested using T-test 5%. Regression procedures were performed to relate the compost rate and variables studied. Means separation among rates of compost on weight of ear was shown with Duncan Multiple Range-Test 0.05.

RESULTS AND DISCUSSION

Comparing the effect of two forms of POS composting methods, it was indicated that there was no differences on growth and yield of sweetcorn observed. Data of compost analysis pointed out that POS-vermicompost contained higher nutrient level compared to POS-EM4 except for potassium and magnesium, while the mineral soil had much lower nutrient levels (Table 1). The T-test revealed that growth and yield of plants treated with POS-vermicompost was similar to those treated with POS-EM4. It indicated that higher content of Nitrogen in POS-vermicompos or higher potassium in POS-EM4 led to the same response on sweetcorn. Hodges (2001) stated that in organic farming system, organic materials are the main supplier of plants nutrients. Under compost rate of 20 tonnes Ha^{-1}, the N, P, and K of compost would be equal to 504 kg Ha^{-1}, 66 kg Ha^{-1}, and 146 kg Ha^{-1}, respectively for POS-vermicompost. POS-EM4 nutrient contens were 196 kg N Ha^{-1}, 64 kg P Ha-1, and 230 kg K Ha^{-1}. High amount of nitrogen in POS-vermi did not affect negative plant growth such as leggy plants or weak shoots as usually found in plants with excessive tratment of nitrogen (Davidson *et al*., 1988).

Table 1. Nutrient analysis of POS-EM4, POS-Vermi, and Mineral Soil.

Variables	POS-EM4	POS-vermi	Mineral Soil
Nitrogen	0.98%	2.52%	0.22 %
Phosphor	0.32%	0.33%	32 ppm
Potassium	1.15%	0.73%	0.44 me/100 g
Calsium	0.82%	1.10%	3.85 me/100 g
Magnesium	0.81%	0.45%	0.98 me/100 g



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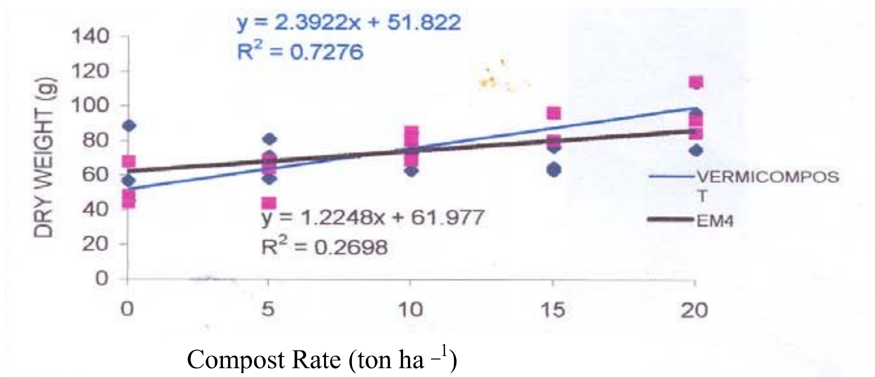

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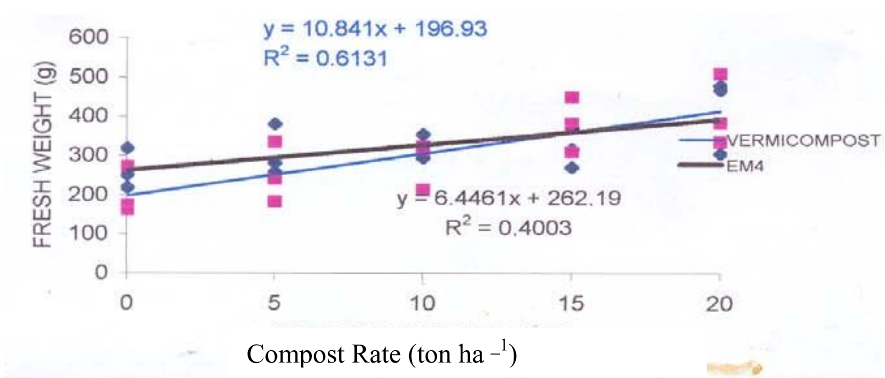

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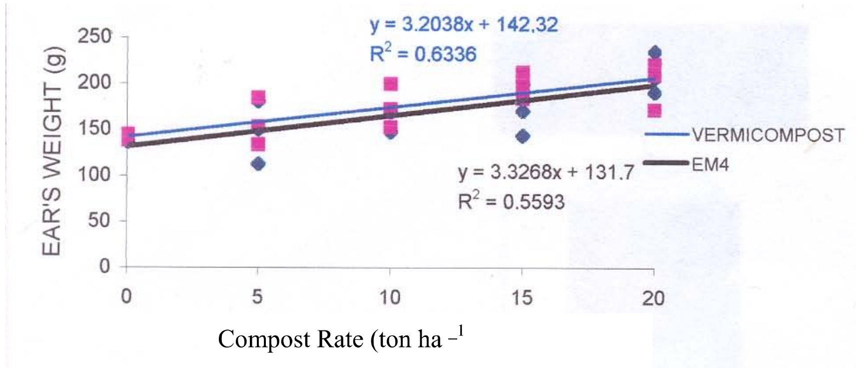
Figure 1. Plant's height (a), fresh weight (b), and dry weight (c) of sweetcorn at different rate of POS-Vermi and POS-EM4 application.



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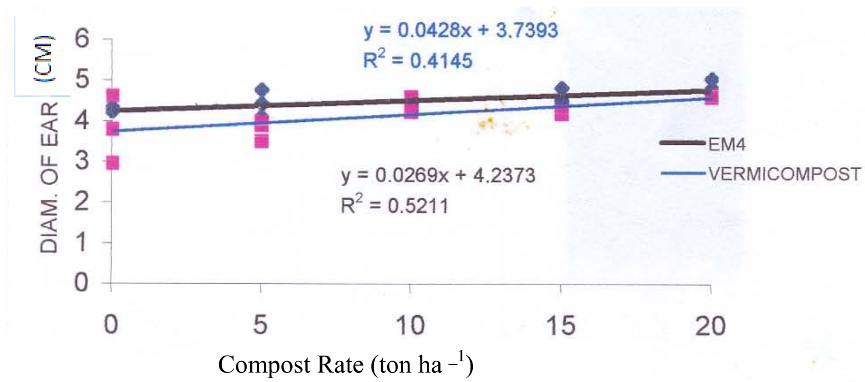

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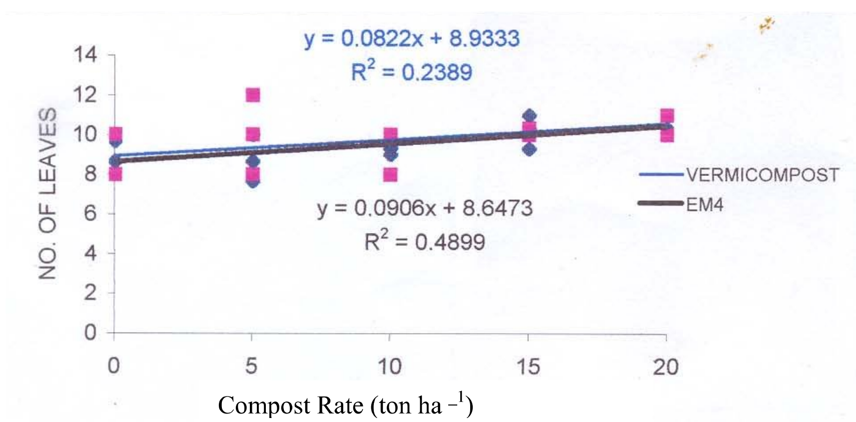

(c)

Figure 2. Weight of ear (a), diameter of ear (b), and number of leaves (c) of sweetcorn at different rate of POS-Vermi and POS-EM4 application.

Figure 1 and Figure 2. presented the linear response of growth and yield components of sweet corn to application rates of POS-compost up to 20 ton ha^{-1}. The regressions were not significantly different for number of leaves under the application of POS-vermi and plants dry weight under POS-EM4. The increasing responses of growth and yield a long with the increasing rate of POS- compost was due to the higher nutrients received from organic fertilizer. With other factors favourable, growth and yield of plants reflect the amount of nutrient uptake during the growing season. This implied that plant yield might be increased if more sludge compost applied to the field. In our other experiment, application of POS-vermi at the rate of 40 tonnes Ha^{-1} yielded 232.87 g on weight of ear (complete data not shown). Comparing the weight of ear under two different POS-compost processings, it was found that at the application compost doses below 20 tonnes ha^{-1}, POS-vermi tended to gain better weight of ears (Table 2). POS-EM4 treatment resulted in higher weight of ear, 210.91 g, at 20 tonnes ha^{-1}; while under POS-vermi treatment the weight of ear was 200.90 g. There was no different weight of ear observed at that compost rate . Rosazlin *et al*. (2005) applied sewage sludge on their study with sweetcorn and found the yield were only 84 g at the sewage sludge rate contained nitrogen equal to 560 kg ha^{-1}.

Table 2. Effects of application rates of POS-EM4 and POS-Vermi on weight of ear (g).

Rate of POS-compost (ton ha-1)	POS-EM4	POS-vermi
0	139.40 b	141.23 b
5	147.47 b	157.09 b
10	155.24 b	174.60 b
15	171.35 b	197.94 a
20	210.91 a	200.90 a

Note: Comparison of means was calculated according to t-test 0.05

Even though all variables observed responded linearly, to gain higher yield by adding more organic matter in the same field is not always a necessity. The changing pattern on crop yield which increases gradually a long with time and soil management is commonly found. Farming sites used to be managed under conventional farming system resulted a dropped yield of cowpea for the first harvest under organic system (Nusantara *et al*., 2001). But in the third growing season, with lower input of vermicompost than the input in the first growing season, the yield of cowpea was similar to that grown under high input of inorganic fertlizer.

CONCLUSION

Organic system using input of palm oil sludge composted with EM4 or vermi provided a satisfying result to the growth and yield of sweetcorn. The highest weight of ears was achieved at application rate 20 tonnes ha-1 of POS-vermi as well as POS-EM4. The weight of ears under this rate were 200.91 g and 210.90 g respectively. The response of plants up to the rate 20 tonnes ha-1 of POS was linier both for growth and for yield components.

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