Comparative Performances of Organic and Inorganic Sweet Corn Grown on Coastal Land

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Abstract

Coastal land serves as an alternative growing area for organic sweet corn production. Establishing an organic growing environment requires at least two years for short growing crop like sweet corn. This experiment aimed to evaluate the first year growth and yield performances of organic and conventional sweet corn production systems on coastal land. Experiment was conducted on entisol of coastal land from August to November 2019 at the City of Bengkulu and was arranged in a randomized complete block design with three replicates. Treatments were (1) organic production systems and (2) inorganic production systems. Sweet corn performances were observed in terms of plant weight, leaf number, leaf length, leaf greenness, shoot fresh weight, root fresh weight, root dry weight, level of sweetness, fresh weight of husked ear and fresh weight of unhusked ear. Results indicated that during the first year of organic production system for sweet corn, sweet corn grown in organic production system had similar plant weight, leaf number, leaf length, leaf greenness, shoot fresh weight, root fresh weight and root dry weight of sweet corn grown in inorganic production systems, except shoot dry weight. In addition, yield of organic sweet corn, as indicated by fresh weight of husked ear and fresh weight of unhusked ear, were 29 % and 23 %, respectively, lower than sweet corn grown in inorganic production system.

Keywords: *Organic Farming; Sweet Corn; Coastal Land.*

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INTRODUCTION

Organic vegetable productions, including sweet corn, in coastal areas of Indonesia, are becoming great interests of many parties due to declining arable land in highland production areas (Sugino, 2008) as well as increasing demands for organic vegetables (Golijan and Dimitrijevic, 2018). Increasing worldwide demands for organic vegetables were attributed to increasing awareness and concern of consumers on harmful effects of synthetic fertilizers, pesticides and machinery on the safety of food and human as well as the sustainability of soil and environment (Singh et al., 2017).

Extending organic sweet corn from high altitude to coastal areas require comprehensive understandings of how crop adapts to coastal environment. Stuart (2010) concluded that coastal ecosystem is strongly determined by specific location and land uses. According to Awal (2014) dynamic changes in coastal ecosystem is terms of salinity, tidal processes, water stresses, and water logging bring about agricultural practices in coastal areas are becoming unstable. Such variations might result locally variations in land fertility among coastal areas. Sandy and coarse textures, easily cultivated, low water holding capacity and high water permeability are among characteristic of Indonesia coastal lands (Ma'ruf, 2018).

Crop adaptation to new environment requires favourable growing environment, including temporal stability of soil nutrient of coastal lands. For example, the application of nitrogen fertilizer in the first year was only able to be detected in the second year, but not detected in the third year after application (Diaz et al., 2012).

Switching inorganic soil to organic soil is not an overnight process, since it involves many complex interactions between biological, chemical and physical aspects of soil ecosystems. Land conversion from conventional to organic land requires both temporal and spatial requirement and involves many aspects of rhizosphere elements. This process is not merely replacing synthetic inputs with organic inputs in the soil environments. According to Neeson (2010), establishing organic soil for growing environment goes through three critical stages, *i.e.* adjustment phases, comfort phases and maintenance phases. According to the Indonesian National Standard (2016), conversion of non-organic into organic soil for short growing season crops requires at least two consecutive years. However, conversion time might be different among regions and ecosystems.

Br*ü*ckler et al., (2018) concluded that crop yields on organic production systems vary among crop species and regions. First year performance of crop growth and yields are very important to provide information for improving cultural practices and management in the following years. Nevertheless, information of crop establishment for organic production systems in the coastal lands is considerably limited. This experiment aimed to determine the growth and yields performances sweet corn grown in organic and inorganic production systems during the first year of establishing organic growing environment on coastal areas.

MATERIAL and METHOD

The field experiment was conducted on entisol of coastal land from August to November 2019 at the City of Bengkulu (elevation of 5 m above sea level, 3°, 45', 26.40" South Latitude and 102°, 15', 41.78'' East Longitude). The experiment was arranged in a randomized complete block design with three replicates. Treatments were (1) organic production systems and (2) inorganic production systems. For each production system, a soil-bed of 1.5 m x 4.0 m was established, separated by 1.5 m within the block and each block was separated by 1.5 m away.

Both production systems were applied with vermicomposts at planting, 10 ton ha^{-1} for organic production systems and 5 ton ha^{-1} of vermicompost for inorganic production system. Additional 5 ton ha^{-1} of vermicompost was uniformly applied to the experimental plot of organic production system at three weeks after planting. This vermicompost contained 2.15 g kg^{-1} of total N, 0.24 g kg^{-1} of P, 0.55 g kg^{-1} of K, and 25.6 g kg^{-1} of organic C (Muktamar et al., 2017).

For inorganic production system, land was fertilized with 300 kg ha^{-1} of urea (applied at 2 and 4 weeks after planting with 150 kg ha^{-1} and 150 kg ha^{-1}, respectively), 100 kg ha^{-1} of SP36 and 100 kg ha^{-1} of KCl (applied at 2 weeks after planting).

For organic sweet corn production, crops were fertilized with tithonia-based liquid organic fertilizer (LOF) with a volume of 50, 100, 200, 300 and 350 ml for each plant, at 14, 21, 28, 35 and 42 days after planting, respectively.

LOF was produced by following the method suggested by Fahrurrozi et al. (2017). Lab analysis indicated that this LOF contained 0.37 % N, 0.18 % P, 0.87 % K, 0.72% organic-C, and 7.3 in pH. Seed of sweet corn (CAPS 5x6) was planted at 5 cm in depth, at the spacing of 0.25 m x 0.75 m to make 30 plants per plot. Sweet corns were watered every day since very few precipitations occurred during the experiment. Weed removals were conducted at 25 and 45 days after planting. Pest controls for organic sweet corn were conducted by using bio-pesticide Pestona® and bio-fungicide Glio®. Meanwhile, for inorganic sweet corn, pests were controlled by using Curacron® accordingly. Sweet corn performances were measured in terms of plant weight, leaf number, leaf length, leaf greenness, shoot fresh weight, root fresh weight, root dry weight, level of sweetness, fresh weight of husked ear and fresh weight of unhusked ear. Comparisons of observed variables between organic and inorganic production systems were determined by using t-Test Paired Two Sample for Means at $P < 0.05$.

RESULTS and DISCUSSION

Environmental Conditions

Soil of the experimental site was characterized with neutral pH (6.8), medium N-total (0.24%), low organic C (1.32%, very low available P (3.31 ppm), medium exchangeable K (0.37 me/100g), and low cation exchange capacity (14.28 me/100g). In addition, data from Meteorology, Climatology, and Geophysical Agency Bengkulu (ID WMO: 96255) indicated that the averages recorded monthly rainfall were 7.8 mm, 58 mm, 42.2 mm and 61.3 mm, for August, September, October and November 2020, respectively. Meanwhile, the averages monthly air temperatures were 26.1 ^{o}C, 26.19 ^{o}C, 26.12 ^{o}C and 26.92 ^{o}C, respectively. The averages monthly air relative humidity were 82.19 %, 83.33 %, 86.13 %, and 83.87 %, respectively. Although sweet corns were daily watered during the absence of precipitation, the quantity of water availability to support sweet corn growth was likely not effective since this coastal type was very permeable to water. Davis (2019) sweet corn will have successful pollination and kernels' growth if a continuous supply of moisture was guaranteed.

Growth of sweet corn

Results indicated that sweet corn grown in organic production system had similar plant weight, leaf number, leaf length, leaf greenness, shoot fresh weight, root fresh weight and root dry weight of sweet corn grown under inorganic production systems (Table 1). However, sweet corn grown in organic production had lower shoot dry weight compared to those of grown under conventional production systems.

Table 1. Effect of production system on growth of sweet corn

No	Observed variables	Production systems	
		Organic	Inorganic
1	Plant height (cm)	125.93 a	123.33 a
2	Leaf number (pieces)	11.20 a	10.67 a
3	Leaf length (cm)	68.40 a	72.60 a
4	Leaf greenness (SPAD values)	47.97 a	51.01 a
5	Root fresh weight (g)	14.60 a	15.07 a
6	Shoot fresh weight (g)	113.13 a	128.53 a
7	Root dry weight (g)	6.86 a	8.94 a
8	Shoot dry weight (g)	39.18 a	50.95 b

Note: Means in the same row followed with the same letter are not significantly different according to t-Test: Paired Two Sample for Means at $P < 0.05$

Relatively similar performances of sweet corn growth in organic production system to inorganic production systems, except for leaf width and shoot dry weight, implied that under new organic growing condition, growth of sweet corn was comparable to their counterparts grown with conventional systems. Similar growth performances might have attributed to the availability of similar nutrient sources in the soil since both production systems were fertilized with sufficient nutrients.

Research conducted by Hayati et al. (2012) in coastal area of Lampuuk Lokhnga, Aceh Besar, Indonesia, concluded that there was no different between organically fertilized and inorganically fertilized sweet corn in terms of plant height and leaf length of three commercial sweet corn varieties at 42 and 63 days after planting. In addition, Sari et al. (2017) also found that both plant height and leaf number of sweet corn fertilized with organic fertilizer grown in coastal area was similar to those of fertilized with synthetic fertilizer. Such comparable performances in terms of plant weight, leaf number, leaf length, leaf greenness, shoot fresh weight, root fresh weight and root dry weight must be properly maintained to ensure robust generative growth.

As sweet corn growing older, growth response changed as reflected by the higher shoot dry weight of sweet corn grown in inorganic production compared to organically grown sweet corn (Table 1). Shoot dry weight is one the acceptable measures to measure plant biomass as well as to estimate crop yield. Dry weight might have further responsible to higher yield of inorganic sweet corn compared to those of grown in organic system.

Sweet corn yields

Results indicated that fresh weight of husked ear and fresh weight of unhusked ear of sweet corn were lower than sweet corn grown under inorganic production system (Table 2). Fresh weight of husked ear and fresh weight of unhusked ear of sweet corn of organically grown sweet corn were, respectively, 29 % and 23 % lower than those of conventional production system.

Table 2. Effect of production system on yields of sweet corn

No	Observed variables	Production systems	
		Organic	Inorganic
1	Fresh weight of husked ear (g)	188.87 a	266.27 b
2	Fresh weight of unhusked ear (g)	141.07 a	182.73 b
3	Sweetness (^{o}Brix)	14.67 a	13.00 a

Note: Means in the same row followed with the same letter are not significantly different according to t-Test: Paired Two Sample for Means at P < 0.05

Lower yield of organically grown sweet corns compared to those grown with inorganic production systems, especially during the first year of growing season, generally reported. This period could be classified as the adjustment phases in the soil ecosystems in which sweet corn might not be able to optimally use the nutrients and other growing resources in the rhizosphere to support its growth. Murmu et al. (2013) found that sweet corn yields in the first year and the second year grown in organic production was 29 % and 30 %, respectively, lower than their counterparts grown in conventional production systems. Sofyan and Sara (2018) also concluded that yields of sweet corn grown in organic plots were significantly lower than those in inorganic plots. They suggested this was due to lower nutrient uptake of sweet corn grown under organic condition compared to sweet corn grown using inorganic fertilizer.

Lower biological yield of organic farming does not necessarily imply that organic production systems had lower economic returns. Research conducted by Sgroi et al. (2015);

Ankamah-Yeboah et al., (2016), for examples, concluded that consumers are will to pay by 20% more for organic products than non-organic products. This suggested that lower biological yield was compensated by higher selling prices which eventually benefit the farmers and at the same time the agricultural lands remain sustainable. Recently, Krause and Machek (2018) concluded that organic agricultural companies had higher profitability than conventional companies. This study was conducted based on a sample of Czech 291 organic and 4045 conventional farmers over the period 2009–2013.

Result from this experiment also revealed that the level of sweetness of sweet corn from both production systems was similar (Table 2), although organic sweet corn was 11.4 % sweeter than those of inorganic production system (14.67 ^{o}Brix vs. 13.00 ^{o}Brix). Nevertheless, this level was higher compared to sweetness level of commercial sweet corn available in the market, e.g. Bonanza F1 (12 ^{o}Brix) and Secada F1 (>12 ^{o}Brix).

CONCLUSION

During the first year of organic production system, organically grown sweet corn had similar plant weight, leaf number, leaf length, leaf greenness, shoot fresh weight, root fresh weight and root dry weight with conventional sweet corn production. However, sweet corn grown in organic production had lower shoot dry weight compared to those of grown under conventional production system. In addition, yield of organic sweet corn, as indicated by fresh weight of husked ear and fresh weight of unhusked ear, were 29 % and 23 %, respectively, lower than sweet corn grown in inorganic production system.

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