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The Effect of Organic fertilizers on Growth Quality of Sweat corn (*Zea mays saccharata* L)

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***Abstract*— The experiment was conducted to study the effect of organic waste from rice husk, corn straw and sugarcane leaves as compost for sweat corn growth. The experimental design used in the study was a factorial randomized block design with two factors (compost types and doses), nine treatments, and three replications, P1: rice straw compost; P2: sugarcane leaves compost; P3: corn straw compost then doses were D1: 7,5 t ha^{-1}; D2: 15 t ha^{-1}; D3: 23 t ha^{-1}. The result showed that the compost types and dose treatments had a significant effect on the maize growth, including the height, leaf area Index, stem diameter, and dry weight on specific observations without any interaction. Besides, the treatments also affected the yield of corn production. The highest yield was found at 23 t ha^{-1} (D3) dose in all types of compost treatments. Meanwhile the highest to the lowest yields were, respectively, P3 (9,29 t ha^{-1}), P1 (8,72 t ha^{-1}), and P2 (8,00 t ha^{-1}).*

***Keywords*— Organic fertilizer, Sweat Corn, Organic Compost.**

I. INTRODUCTION

Corn, commonly known as maize, plays a crucial role as a primary cereal crop, serving as a staple food source for a significant portion of the global population. It ranks third in worldwide production, trailing only wheat and rice. Maize kernels consist of approximately 80% starch, 10% proteins, 4.5% oil, 3.5% fiber, and 2% minerals (Wangmo et al., 2020). In most of developed nations, around 90% of maize is allocated for animal feed and various industrial by-products. In contrast, a substantial proportion, ranging from 80% to 90%, is utilized for direct human consumption worldwide, unlike in developed countries (Grote, 2021). Several key factors contributing to diminished maize yields include declining soil fertility and insufficient use of fertilizers, leading to severe nutrient deficiencies.

The production of corn, rice and sugar cane is massive in most of asian and eroupean countries then resulting waste along with the number of its productivity. At least 50% of the plant's production are waste consisting of stems, leaves and roots (Amie & Nugraha, 2014; Aziz et al., 2014). Corn waste contains at least N (0.81%), P (0.16%) and K (91.33%) (Sianipar et al., 2020), while rice; N (0.5-0.8 %), P (0.070.12 %), K (1.2-1.7 %) (Abdel-rahman et al., 2016), as well as sugar cane ; N (0.3%), P (0.15 %), (K 0.53 %), (Mentari et al., 2021). Several research state that the use of corn, rice and sugar cane stover compost may increase the yield, growth and production of sweet corn (Ernita et al., 2017; Helmi et al., 2022; Suryani et al., 2022).

This research was carried out not only to determine the effect of compost on the growth and yield of sweet corn, but also to see the potential of fertilizer along with the correct and efficient dosage.

II. MATERIAL AND METHODS

This study was conducted in a field experiment at the University of Brawijaya, Malang City, East Java, from June 2021 to March 2022. The materials used were starter liquid decomposer then organic wastes including rice straws, corn husks, and sugarcane leaves.

Research design

The experiment was conducted using two factors with a factorial randomized block design (FRBD). The first one was the compost types (P), P1: rice straw compost, P2: corn husk compost, P3: sugarcane leaf compost, and the second one was the compost dose (D), D1: 7.5 t ha-1, D2: 15 t ha-1, D3: 23 t ha-1. There were nine treatments, each repeated thrice therfore it has 27 treatment units.

Compost Preparation

Composting was completed for more than two months in a greenhouse on a box-shaped tarpaulin with a 1 x 3 m size using the anaerobic method. To ensure the compost ready to use, physical observation was conducted by observing colour, temperature , smell and texture (Angraeni et al., 2020).

Land Preparation

Sterilization procedures were applied which included tasks such as weed removal, trench digging, and waste removal. The entire experimental area covered 600 square meters, comprising 27 plots measuring 5.5 meters in length and 3 meters in width."

Planting Method

Organic fertilizers (compost) were applied 14 days before planting. The plant spacing implemented was 70x25 cm. Moreover, plant protection and treatments such as weeding, spraying pesticides, and watering were also conducted. NPK pearl fertilizer at 16:16:16 was given at 14 DAP (day count after planting) and 30 DAP. The plants were harvested at age 65 DAP, at the final stage of the generative phase marked by the ripening seeds in the cob (Motasim et al., 2022)

Soil Analysis

The sample of soil were collected before fertilizer was applied on the field. At the first was collected randomly on the surface area within 0-15 cm depth. While the last stage of harvesting, soil samples were collected randomly but nearby the canopy of corn leaves (James & Wells, 1990).

The chemical characteristics of soil were analyzed considering pH (H2O) and (KCl) using a digital pH meter (1:2.5; soil: solution), organic C (Walkley and Black method), total N (Kjeldahl method), and available P (Olsen method) (Cahyani et al., 2022)

BRIX index

Brix or sweetness content of corn is measured immediately after harvest using a manual hand refractometer with a scale range of 0.0-32.0% and a minimum scale: brix 0.2%.

Data Observation

Furthermore, the growth parameters observed included the plant height, number of leaves, leaf area, stem diameter, Crolophyl index, and dry weight of plants. Plant growth was observed four times 15, 30, 45, and 60 DAP. The yield parameters observed included the corn cob length, diameter, and crop yield per treatment. Plant height was observed using a ruler (up to 100 cm). The number of leaves was observed by using the Leaf collar method (counting visible leaves of Corn)(Schepers et al., 1992). The leaf area was analyzed using Leaf Area Meter (LAM). The diameter of corn fruit and stem was observed by using a vernier caliper. Meanwhile, the dry weight of corn was obtained by drying the plants in the oven until their maximum drying limit, then weighed using digital scales. Yield of corn was observed on 65 DAP including corn cob length, diameter, and crop yield per treatment.

Data analysis

The observation results that had been collected were analyzed using the Analysis of Variance (F test) at the 5% level. If the test results obtained a significant difference, it would proceed with a comparison test using the Least Significant Difference (LSD) test at the 5% level

III. RESULTS AND DISCUSSION

Plant heights

The results of the Analysis of Variance exposed that the types of compost did not significantly affect the height of the corn plants at 15 and 30 DAP (day count after planting). Nevertheless, the observation showed that the types of compost affected plant height at 45 and 60 DAP. The sugarcane and corn compost were not significantly different at 45 DAP but significantly different from the rice compost. At 60 DAP, rice, and sugarcane composts were not significantly different. However, both were significantly different from corn compost. Despite that, the compost dose affected plant height. At 15 DAP, the dose of D3 and D2 were not significantly different until the age of 30 DAP. The treatment dose was significantly different at 45 and 60 DAP.

In summary, the types and dose of compost affected plant height at a specific dose and age. The average height of sweet-corn plants is presented in Table 3. Applying organic matter as a compost would increase the nutrients and growth of corn plants (Singer et al., 2004). Giving corn husk compost can increase N, P, and K in the soil used by plants in the growth process (Chen et al., 2014).

Table 1. Plant heights as a result of compost types and dosage

Treatment	Plant height (cm) (DAP)			
	15	30	45	60
P1	14,82	38,27 a	92,49 a	135,66 a
P2	15,15	36,02 a	101,77 b	136,11 a
P3	15,68	35,42 a	105,76 b	144,29 b
LSD 5%	ns	ns	9,19	6,83
D1	13,81 a	37,70 a	86,48 a	126,31 a
D2	15,78 b	36,08 a	101,17 b	139,82 b
D3	16,06 b	35,93 a	112,36 c	149,93 c
LSD 5%	1,52	3,73	9,19	6,83
CV (%)	9,96	10,21	9,19	5,01

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

Leaves area

The results of the Analysis of Variance revealed that the corn leaf area did not significantly impact the types of compost at the age of 15 to 30 DAP. However, there was a significant response at the age of 45 and 60 DAP. Due to the corn compost (P3) given, the leaf area was 5% higher than P2 and P1 treatments at the age of 45 DAP at an average value of 468 cm2 and 12% at the age of 60 DAP compared to P2 and P1 with an average value of 404 cm2. The treatment dose of D1 and D2 were not significantly different at the age of 15 DAP, with an average of 14.24, 21% lower than the D3 treatment. At the age of 30,45, and 60 DAP, the treatment dose significantly affected the leaf area of the corn. It disclosed that the treatment of D3 was 6% higher than D2, while D2 was 13% higher than D1.

Table 2. leaves area as a result of compost types and dosage

Treatment	Leaf area (cm2) (DAP)	
	30	60
P1	182	388,03 a
P2	192,29	420,25 b
P3	209,49	456,44 c
LSD 5%	ns	27,97
D1	176,29 a	381,70 a
D2	188,59 ab	417,96 b
D3	218,9 b	465,07 c
LSD 5%	28,11	27,97
CV %	15,99	6,63

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

In conclusion, the compost treatment types only significantly affected the leaf area at 45 and 60 DAP. On the other side, the treatment dose significantly affected all ages during the observation. The highest value in the types of compost treatment was found in the corn compost, while the compost dose was found at 22 t ha^{-1}. It was obtained that the K elements in rice, corn, and sugarcane compost were as follows: 3349, 5562, and 3857 ppm. Due to that case, it emerged an assumption that the K element capitalized on the growth of leaf area with that the reason that the element contributed to helping the photosynthesis process of plants was by increasing the leaf area index; thus, the process of CO2 assimilation and translocation of photosynthetic products increased (Clover & Mallarino, 2013).

Stem Diameters

The results of the Analysis of variance revealed no significant effect on the types and dose of compost treatment at the age of 15-30 DAP (see Table 7). The actual effect was only seen at 60 DAP on the types of compost treatment. The type of compost P3 was significantly different from P2 and P1. P2 treatment was 3% higher than P1. Meanwhile, the dose of D3 compost had a significant effect on stem diameter compared to D2 and D1. Likewise, at the age of 60 DAP, the D1 and D2 treatments were not significantly different.

The stem diameter was related to the growth of sweet-corn plants. One of the factors that affected the diameter of the stem was the nitrogen content of the plant. The application of compost with good N could affect the diameter of corn because the element of N played an important role in compiling amide acids, nucleotides, and nucleoproteins and was essential for cell division and enlargement.

Table 3. Stem diameter as a result of compost types and dosage

Treatments	Dry weight (DAP)			
	15	30	45	60
P1	3,03	19,51 a	37,61 a	85,80 a
P2	3,09	21,07 ab	45,45 b	91,74 ab
P3	3,17	23,77 b	51,91 b	93,01 b
LSD 5%	ns	3,36	7,48	7,08
D1	2,73 a	18,53 a	34,90 a	83,22 a
D2	3,18 b	21,3 a	43,40 b	89,53 b
D3	3,37 b	24,53 b	56,67 c	97,8 b
LSD 5%	0,37	3,36	7,48	7,08
CV %	11,87	15,64	16,62	6,25

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

Dry weight of plants

The results of the Analysis of Variance disclosed that the types of compost did not affect the plant's dry weight at the age of 15 DAP. The type of P3 compost was significantly different, 25% higher than the P1 compost at the age of 30-60 DAP with an average of 59 and 47 g. Meanwhile, 16% compared to D2 with an average of 59 and 51 g. The dry-weight corn significantly responded to the compost dose treatment at all ages in the observation. It was known that D2 treatment was not significantly different from D3 at the age of 15 and 60 DAP but significantly different from D1, which was 19% at the age of 15 DAP and 12% at the age of 60 DAP with an average value of 93.66 g.

Table 4. Plant dry weight due to compost types and dosage

Treatments	Dry weight (DAP)			
	15	30	45	60
P1	3,03	19,51 a	37,61 a	85,80 a
P2	3,09	21,07 ab	45,45 b	91,74 ab
P3	3,17	23,77 b	51,91 b	93,01 b
LSD 5%	ns	3,36	7,48	7,08
D1	2,73 a	18,53 a	34,90 a	83,22 a
D2	3,18 b	21,3 a	43,40 b	89,53 b

D3	3,37 b	24,53 b	56,67 c	97,8 b
LSD 5%	0,37	3,36	7,48	7,08
CV %	11,87	15,64	16,62	6,25

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

At the age of 30 and 45 DAP, the D3 treatment was 3% higher than D2 and D1 treatments, with an average value of 40.6 g. This summarized that the types and dose of compost treatments significantly affected the dry weight of the plants. The type of P3 compost was not much different from the P2 compost, but it was significantly different from the P1 compost. The treatment dose had a significant effect on the dry weight of the corn. The highest values were found in the D3 and D2 treatments at 15 and 60 DAP. In detail, D2 treatment was significantly different from D1 in all ages in the observation, except at 45 DAP. On the other hand, the D3 treatment was significantly different from D1 at all ages in the observation and was significantly different from D2 at 45 DAP.

For further information, the dry weight measured the plant growth and development as the dry weight reflected the accumulation of organic compounds synthesized by plants. Plant dry weight reflects the plants' nutritional status and acts as an indicator that determines whether the plants' growth and development were better .

BRIX index

The results shows that there is no significant interaction between the type and dose of fertilizer on Brix index. In addition, there is also no significant effect of both the dose and type of fertilizer.

Table 6. Brix index value of sweet corn due to type and dosage

Treatments	Brix Index
Fertilizer	Value
P1	13,33
P2	13,51
P3	13,80
LSD 5%	ns
Doses	
D1	13,44
D2	13,21
D3	13,99
LSD 5%	ns
CV (%)	4,77

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

Growth rates

Based on the Analysis of Variance results, the growth rate at 15-30 DAP did not have a significant response to the types or dose of compost treatment. The growth rate had a significant response at 30-45 and 45-60 DAP, where P3 significantly differed from P2 and P1. In the treatment of compost dose, it was indicated that the dose of D1 and D2 were not significantly different. A significant response was found in the D3 treatment, where it was 21% higher than D2 and D1.

Table 7. Growth rates of sweet corn plants as a result of compost type and dosage

Treatments	Crop Growth Rate (CGR)		
	15-30	30-45	45-60
P1	18,26	15,44 a	37,82 a
P2	19,23	17,79 ab	38,15 a
P3	22,49	19,77 b	48,51 b
LSD 5%	Ns	3,15	5,09
D1	19,29	16,96 a	36,29 a
D2	18,57	15,84 a	38,36 a
D3	22,11	20,20 b	49,83 b
LSD 5%	ns	3,14	5,09
CV (%)	18,80	17,81	12,26

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

Plant Yields

Based on the results from analysis of variance, there is a significant interaction between dosage and fertilizer type. At dosage D1, fertilizer types P2 and P3 showed no significant difference, but both were significantly different from fertilizer P1. Then, at dosage D2, fertilizer type P1 and D2 did not differ significantly. Fertilizer type P3 performed better than both of them at dosage D2. Meanwhile, at dosage D3, all three fertilizer types differed from each other.

Table 8. Plant production due to types and dosage

Plant Production (gr)

Treatments	Corn Productivity (t ha^{-1})		
	D1	D2	D3
P1	100,44 a	142,01 b	183,86 ed
P2	127,19 b	142,11 b	168,42 cd
P3	129,39 b	159,65 c	195,52 e
LSD 5%	9,22		
CV %	6,16		

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

Soil Contents

The sample of soil at the end of the research was collected when the corn reached 60 DAP at the end of research. Each fertilizers had a significant effect on the CEC, organic C, C/N ratio and N, P, K values of the soil. The highest average values were in treatments P3, P2 and P1 respectively. Meanwhile, D1, D2, and D3 also had significant differences in the CEC, organic C, C/N ratio and soil N, P, K values. Therefore, the dosage stages of fertilization also increase the nutrient value and CEC of the soil.

Table 9. Chemical soil content due to fertilizer aplication

Treatments	Soil contents after fertilizer aplication					
	CEC	C.Organic (%)	C/N	N (%)	P (ppm)	K (ppm)
Compost Types						
P1	27,19 a	3,36 a	5,79 a	0,27 a	19,12 a	33,99 a
P2	28,51 ab	3,64 b	6,28 b	0,31 b	21,20 b	36,56 b
P3	29,95 b	4,04 c	6,97 c	0,34 c	22,51 c	37,12 b
LSD 5%	1,82	0,12	0,20	0,02	0,66	1,00
Dosage						
D1	26,09 a	3,41 a	5,88 a	0,28 a	20,75 a	33,60 a
D2	28,8 b	3,73 b	6,43 b	0,30 b	20,91 b	35,79 b
D3	30,77 c	3,90 c	6,73 c	0,32 c	21,17 c	38,27 c
LSD 5%	1,82	0,12	0,20	0,02	0,66	1,00
CV (%)	6,73	3,13	3,13	5,12	3,16	2,78

Note: Values followed by the same letter in the same column are not significantly different based on the 5% of LSD test, ns = not significant, DAP = day after planting. P1: rice straws, P2: sugarcane leaves, P3: corn husks, D1: 7,5 t ha^{-1} D2: 15 t ha^{-1} D3: 22,5 t ha^{-1}

IV. CONCLUSION

Base on the result of experiment, it conclude that fertilizer made from corn straw was better than rice and sugracane compost at most of growth parameters in similar dosage. However there is no significant changes at Brix and stem diameter of corn. The dosage 22,5 t ha^{-1} was highly recommended in all types of compost for better productivity. In addition, the use of different compost and dosage resulting significant nutrient values and made improvement of soil content at certain types and dosages of compost.

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