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The improvement of biomass accumulation, cob yield and yield quality of sweet corn (*Zea mays saccharata* sturt) through the application of eco enzyme and different extracts of organic materials

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Abstract. The demand for sweet corn in Indonesia tends to increase in parallel with the increase in population. An optimum nutrient availability is indispensable to high production of sweet corn. The application of organic materials is a promising way of increasing sweet corn production. The objective of this experiment was to evaluate the effectiveness of Eco Enzyme and organic material extracts in increasing biomass accumulation, cob yield and yield quality of sweet corn (*Zea mays saccharata* Sturt). Field experiment was conducted in Kota Sepang, Bandar Lampung of Lampung Province, Indonesia in 2024. Factorial treatments were arranged in Randomized Block Design with three replications. First factor was Eco Enzyme consisting of three levels (control (E0), Eco Enzyme 1 ml (E1) and Eco Enzyme 2 ml (E2)), while second factor was organic material extracts consisting of control (P0), extracts of poultry manure (P1) and mix extracts of poultry manure, shrimp waste and vermicompost (P2). The result of the experiment indicated that the application of Eco Enzyme 2 ml (E2) and mix extracts of poultry manure, shrimp waste and vermicompost increased biomass accumulation, cob weight, K content and brix of sweet corn (*Zea mays saccharata* Sturt). It seems that the increase in biomass accumulation, cob weight and yield quality is due most likely to the stimulation of sweet corn growth and K content enhancement. **Key words:** biomass accumulation, cob weight, sweet corn, yield quality

1. Introduction

The demand for sweet corn (*Zea mays saccharata* Sturt) in Indonesia tends to increase in parallel with the increase in Indonesian population. Thus, increasing sweet corn production is indispensable to meet the national demand. In general, in Indonesia sweet corn has been cultivated in upland regions. The improvement of cultural practices could help in increasing sweet corn production in upland regions.

Good nutrient management plays an important role in maximizing sweet corn production. Macro nutrients such as N, P and K are highly required for sweet growth and development. The use of N, P and K fertilizers has been reported as an effective way to increase sweet corn yield (Fauziah *et al.*, 2022; Trinurani *et al.*, 2018; Furqoni, 2025). Growing awareness on the negative



effect of inorganic fertilizers on environment and healthy products, the use of organic fertilizers and organic farming is getting promising in producing healthier agricultural products.

Organic materials have been used in crop production in different types and manners such as agricultural waste, compost, green manure, poultry manure and shrimp waste. These materials could be used either directly or indirectly. Many studies indicated that the application of organic liquid fertilizers could increase growth and production of purple eggplant (Sembiring *et al.*, 2024), melon (Ulmilah *et al.*, 2025) and sorghum plants (Irmansyah *et al.*, 2024). Specifically, it has been reported that the application of eco enzyme is a promising way to increase crop production (Sembiring *et al.*, 2021; Kesmayanti *et al.*, 2025).

The objective of this experiment was to evaluate the effectiveness of Eco Enzyme and organic material extracts in increasing biomass accumulation, K content, cob yield and yield quality of sweet corn (*Zea mays sacharrata* Sturt). This information could help in utilizing organic waste as an eco-friendly liquid organic fertilizer.

2. Materials and Methods

2.1. Experimental site

Field experiment was conducted in Kota Sepang, Bandar Lampung, Lampung Province of Indonesia in 2024. Soil analysis of experimental location indicated that the nutrient content of N, P and K was 0.09 %, 30.59 mg P₂O₅/100 g and 20.91K₂O mg/100g, respectively, while soil pH and C-organic content were 5.7 and 0.11 % respectively.

2.2. Experimental design

Factorial treatments were arranged in Randomized Complex Block Design with three replications. The first factor was Eco Enzyme consisting of three levels (control (E0), 1 ml eco enzyme (E1) and 2 ml eco enzyme (E2), while the second factor was organic material extracts consisting of control (P0), extracts of poultry manure (P1) and mix extracts of poultry manure, shrimp waste and vermicompost (P2). Therefore, there were nine treatment combinations. The treatments of eco enzyme and organic material extracts were applied by foliar spray on 3, 4, 5, and 6 weeks after planting.

2.3. Cultural practices

Sweet corn plants (cv. Bonanza f1) were planted with row spacing of 70x20 cm. Two seeds of sweet corn plants were planted for each hole. The sweet corn seedlings were then thinned to one plant per hole and maintained until harvest. Sweet corn plants were fertilized by Urea, SP-36 and KCl. Their dosages were 200, 150 and 100 for Urea, SP-36 and KCl, respectively.

Eco enzyme was made from vegetable and fruit waste. This waste was mixed with 10 liters of water and fermented for 3 months. After that, the mix was filtered and the liquid was poured into bottles and sealed to protect them from the air. The organic material extracts were made from poultry manure, shrimp waste and vermicompost. These materials were mixed with water and then fermented. In general the method used to produce eco enzyme, and extract of poultry manure, shrimp waste and vermicompost referred to the method explained before (Sembiring *et al.*, 2021). The form of eco enzyme and extracts of poultry manure, shrimp waste and vermicompost was a liquid material.

Treatment of this experiment was as follows:

Eco enzyme (first factor)

1.E0 = control (only water)

2.E1 = eco enzyme 1 ml/liter of water

3.E2 = eco enzyme 2 ml/liter of water

Organic material extracts (second factor)

1.P0 = Control (only water)for for nutrient content

2.P1 = Poultry manure extract (150 ml/liter of water)

3.P2 = Mix extract of poultry manure, shrimp waste and vermicompost (1:1:1 in volume).

Since the treatments were arranged in factorial, there were nine combinations, those combinations were as follows:

E0P0 = without eco enzyme and without organic material extracts

E0P1 = without eco enzyme + poultry manure extracts

E0P2 = without eco enzyme + mix extracts of organic materials

E1P0 = eco enzyme 1 ml/l and without organic material extracts

E1P1 = eco enzyme 1 ml/l + poultry manure extracts

E1P2 = eco enzyme 1 ml/l + mix extracts of organic materials

E2P0 = eco enzyme 2 ml/l and without organic material extracts

E2P1 = eco enzyme 2 ml/l + poultry manure extracts

E2P2 = eco enzyme 2 ml/l + mix extracts of organic materials

The treatments were applied by foliar spray at 3, 4, 5 and 6 weeks after planting. Before being applied, the liquids of eco enzyme, poultry manure, shrimp waste and vermicompost were analyzed for nutrient content at the laboratory of Testing and Calibration, Center for standardization and industrial services, Bandar Lampung, Indonesia.

2.4. Collection and analysis of observation data

The variables observed in this experiment included fresh and dry biomass, K content, cob weight, brix and ratio of cob weight/biomass. Then, the data were analyzed for variances (ANOVA). The differences among mean values were determined by the LSD test at the significant level of 5 % ($P=0.05$).

3. Results and Discussions

Nutrient analysis of liquid materials used in this experiment indicated that eco enzyme, poultry manure, shrimp waste and vermicompost contained N, P and K differently. The highest content of N was found in shrimp waste extract and followed by Eco enzyme, while the highest content of P was found in poultry manure extract followed by vermicompost extract. The highest content of K was found in poultry manure extract and followed by vermicompost extract (Table 1).

Table 1. Nutrient content of eco enzyme and extracts of poultry manure, shrimp waste and vermicompost

Liquid materials	Nutrient content (%)		
	N	P	K
Eco enzyme	0.54	0.10	0.04
Poultry manure extract	0.27	0.83	0.33
Shrimp waste extract	0.81	0.25	0.03
Vermicompost extract	0.27	0.59	0.22

The result of the experiment indicated that the application of eco enzyme and organic material extracts significantly increased fresh weight of sweet corn biomass (Table 2). The application of eco enzyme 2 ml/l could increased 28.2 % fresh weight of biomass compared to control, while the application of extract mix of poultry manure, shrimp waste and vermicompost enhanced 25.2 % fresh weight of biomass compared to control. This means that the application of eco enzyme and organic materials extracts could stimulate sweet corn growth. As explained before (Table 1), both eco enzyme and organic materials extract contained N, P and K, required for plant growth and development. Shah *et al.* (2024) reported that N and K plays an important role in carbon and nitrogen metabolism such photosynthesis and protein synthesis, resulting in more materials used for plant growth. Thus better supply of N and K would produce better plant growth. Fresh weight also indicated the freshness of the products, which is very important for horticultural products.

Table 2. Effect of eco enzyme and organic material extracts on fresh weight of biomass of sweet corn plants at maximum vegetative growth

Treatments	Fresh weight of biomass (g/plant)
<u>Eco enzyme application:</u>	256.36 c
Cointrol (without eco enzyme)	302.40 b
Eco enzyme 1 ml/liter	329.22 a
Eco enzyme 2 ml/liter	
<u>Organic material extracts:</u>	
Control (without treatments)	258.84 b
Extract of poultry manure 1	
Extract mix of poultry manure, shrimp waste and vermicompost	305.07 ab 324.07 a

Note: the mean value followed by the same letters indicated no significant differences by the LSD test at P=0.05

The application of eco enzyme and organic material extracts also increase the dry weight of biomass of sweet cornplants (Table 3). Compared to control the increase was 30,94 and 24,3 % for eco enzyme and mix extracts of organic materials, respectively. This was substantiated by the data presented in Table 2 in which the application of eco enzyme and organic material extracts enhanced the fresh weight of sweet corn biomass. The study reported by Kesmayanti *et al.* (2025) also indicated that the application of eco enzyme stimulated the growth of sha

The application of eco enzyme and organic material extracts also increased the dry weight of sweet corn biomass (Table 3). Compared to the control, the increase in the dry weight of biomass was 30.94 and 24.3 % for eco enzyme and mix extract, respectively. This was substantiated by the data presented in Table 2 in which the application of eco enzyme and organic material extracts enhanced the fresh weight of sweet corn biomass. The stimulation of plant growth by the application of eco enzyme was also reported by Kesmayanti *et al.* (2025). Sembada *et al.* in Syarifah RNK *et al.* (2024) reported that higher dry weight production indicated more productive photosynthesis processes and better plant growth. Thus the application of eco enzyme might promote the photosynthetic activity, resulting in higher capacity to produce photosynthate required for sweet corn growth.

Table 3. Effect of eco enzyme and organic material extracts on dry weight of biomass of sweet corn plants at harvest time

Treatments	Dry weight of biomass (g/plant)
<u>Eco enzyme application:</u>	
Cointrol (without eco enzyme)	46.70 b
Eco enzyme 1 ml/liter	55.85 ab
Eco enzyme 2 ml/liter	61.15 a
<u>Organic material extracts:</u>	
Control (without treatments)	43.83 b
Extract of poultry manure 1	
Extract mix of poultry manure, shrimp waste and vermicompost	55.37 ab 60.04 a

Note: the mean value followed by the same letters indicated no significant differences by the LSD test at P=0.05

Beside promoting sweet corn growth, the application of eco enzyme also tended to increase K content (Table 4). This means that the application of eco enzyme could enhance K absorption, leading to greater capacity to supply K for sweet corn growth. As mentioned earlier (Table 3), the application of eco enzyme increased sweet corn biomass accumulation. Potassium(K) plays a significant role in accumulation and translocation of sugars (Shah *et al.*, 2024). The study reported by Song *et al* (2025) indicated that the application of potassium increased absorption capacity of water, essential nutrients and K utilization. Moreover, Cao et al (2025) reported that potassium (K) plays a significant role on stomatal movement, facilitating CO₂ diffusion from atmosfer to chloroplast.

Table 4. Effect of eco enzyme and organic material extracts on K content in sweet corn

Treatments	K content (%)
<u>Eco enzyme application:</u>	
Control (without eco enzyme)	1.33
Eco enzyme 1 ml/liter	1.30
Eco enzyme 2 ml/liter	1.28
<u>Organic material extracts:</u>	
Control (without treatments)	1.20
Extract of poultry manure 1	
Extract mix of poultry manure, shrimp waste and vermicompost	1.23 1.63

The application of eco enzyme and organic material extracts also increased cob weight of sweet corn plants (Table 5). Compared to control, the application of eco enzyme 2 ml increased 13,8 % of cob weight, while the increase in cob weight of sweet corn by the application of organic material extracts was 24,4 %. This was substantiated by the data presented in Table 2 and 3 in which the application of eco enzyme and organic material extracts promoted sweet corn growth since they contained essential nutrients such as N, P and K. Better growth resulted in greater capacity to supply assimilates required for cob growth and development. The study reported by Zulfikar *et al.* (2023) indicated that the application of organic fertilizers could enhance sweet corn growth and yield although the magnitude of enhancement depended on dosages and types of compost.

Table 5. Effect of eco enzyme and organic material extracts on cob weight with husks of sweet corn plants

Treatments	Cob weight (g/cob)
<u>Eco enzyme application:</u>	
Control (without eco enzyme)	273.60 b
Eco enzyme 1 ml/liter	298.11 ab
Eco enzyme 2 ml/liter	311.36 a
<u>Organic material extracts:</u>	
Control (without treatments)	261.42 b
Extract of poultry manure	
Extract mix of poultry manure, shrimp waste and vermicompost	296.49 ab
	325.16 a

Note: the mean value followed by the same letters indicated no significant differences by the LSD test at $P=0.05$

The application of eco enzyme and organic material extracts also affected the ratio of cob weight/biomass weight (Table 6). The application of eco enzyme 2 ml and mix extracts of poultry manure, shrimp waste and vermicompost increased the ratio of cob weight/biomass weight, indicating that the treatments promoted the translocation and accumulation of assimilates to sweet corn cobs, which in turn, result in greater cob weight (Table 5).

Table 6. Effect of eco enzyme and organic material extracts on ratio cob weight with husks/fresh weight of biomass of sweet corn plants

Treatments	Ratio of cob weight/biomass
<u>Eco enzyme application:</u>	
Control (without eco enzyme)	1.14 b
Eco enzyme 1 ml/liter	1.15 ab
Eco enzyme 2 ml/liter	1.36 a
<u>Organic material extracts:</u>	
Control (without treatments)	1.12 b
Extract of poultry manure l	
Extract mix of poultry manure, shrimp waste and vermicompost	1.18 ab
	1.24 a

Note: the mean value followed by the same letters indicated no significant differences by the LSD test at $P=0.05$

The quality of sweet corn yield indicated by the brix value of sweet corn seeds was also affected by the application of eco enzyme and organic material extracts (Table 7). The application of eco enzyme 2 ml/l and mix extracts of organic materials increased the brix value of sweet corn seeds. This was related to the nutrient content in eco enzyme and mix extracts of organic materials such as N and K, in which these nutrients played an important role in accumulation and translocation of assimilates, especially sugar (Shah *et al.*, 2024). Brix value was positively correlated with sucrose content. At one and two days after harvest, the brix value for the treatments of eco enzyme and mix extracts of organic materials was still higher than that of control. This proved that the application of eco enzyme 2 ml/l and mix extracts of organic materials could improve yield quality of sweet corn.

Table 7. Effect of eco enzyme and organic material extracts on brix value of sweet corn seeds at harvest (H)

Treatments	Brix value (° Bx)		
	H	H + 1	H + 2
<u>Eco enzyme application:</u>			
Control (without eco enzyme)	13.93 b	10.82 b	9.78 b
Eco enzyme 1 ml/liter	14.96 b	12.29 ab	10.33 ab
Eco enzyme 2 ml/liter	16.02 a	12.27 a	11.04 a
<u>Organic material extracts:</u>			
Control (without treatments)	13.69 b	11.16 b	9.64 b
Extract of poultry manure	15.36 ab	12.13 ab	10.51 ab
Extract mix of poultry manure, shrimp waste and vermicompost	15.87 a	12.09	11.00 a

Note: the mean value followed by the same letters indicated no significant differences by the LSD test at $P=0.05$.

Fresh weight of sweet corn cobs after one and two days was also significantly affected by the application of eco enzyme and mix extracts of organic materials (Table 8). Compared to control, the treatments of eco enzyme 2 ml/l and mix extracts of organic materials resulted in higher fresh weight of cobs compared. This means that the application of eco enzyme 2 ml/l and mix extracts of organic materials could maintain the freshness of sweet corn cobs. As horticultural products, freshness is important. It seems that the freshness of sweet corn cobs was related to the brix value (Table 7) in which after one and two days after harvesting the brix value of sweet corn seeds was higher on the treatments of eco enzyme 2 ml/l and mix extracts of organic materials.

Table 8. Effect of eco enzyme and organic material extracts on fresh weight of sweet corn cobs one day after harvest (H+1) and two days after harvest (H+2)

Treatments	Fresh weight of cobs (g/cob)	
	H + 1	H + 2
<u>Eco enzyme application:</u>		
Control (without eco enzyme)	160.69 b	157.40 b
Eco enzyme 1 ml/liter	203.91 ab	199.96 ab
Eco enzyme 2 ml/liter	206.09 a	201.96 a
<u>Organic material extracts:</u>		
Control (without treatments)	169.24 b	165.13 b
Extract of poultry manure	192.29 ab	188.71 ab
Extract mix of poultry manure, shrimp waste and vermicompost	209.16 a	205.47 a

Note: the mean value followed by the same letters indicated no significant differences by the LSD test at $P=0.05$

4. Conclusion

The application of eco enzyme 2 ml/l and mix extracts of poultry manure, shrimp waste and vermicompost increased growth, cob weight and yield quality of sweet corn plants. The enhancement of cob weight and yield quality of sweet corn was most due likely to the stimulation of growth and K content in relation to eco enzyme application. In quantity, the use of eco enzyme was more efficient in increasing cob weight and yield quality of sweet corn than that of organic material extracts (poultry manure, shrimp waste and vermicompost).

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