JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 8 No. 1 January 2026

DOI :https://doi.org/10.36378/juatika.v8i1.5244
eissn 2656-1727
pissn 2684-785X
pages : 112 – 118

RESEARCH ARTICLE Open Access

Growth and Yield Performance of F1-Hybrid Sweet Corn (*Zea mays* saccharata) under Soil Drenching and Foliar Spray of Eco-Enzyme

Novisrayani Kesmayanti[1,*], Ummi Kalsum[1], Edi Romza[1], Ruli Joko Purwanto[1], Widya Irmawati[1], Yani Purwanti[2]

Abstract

Sweet corn is a horticultural crop with high economic value and steadily increasing market demand. However, sweet corn productivity in Indonesia remains relatively low, ranging from 8 to 10 tons per hectare, well below its genetic potential of 12 to 15 tons per hectare. This low productivity is attributed to several factors, including soil fertility degradation caused by unsustainable cultivation practices, pest and disease infestations, and limited farmer access to quality agricultural inputs at affordable prices. Sweet corn plants respond well to inorganic fertilizers; however, long-term use of these fertilizers can degrade soil quality and fertility, reduce microbial activity, and increase production costs. Moreover, excessive reliance on inorganic fertilizers leads to soil nutrient imbalances, reduced organic matter content, and adverse environmental impacts. Therefore, efforts are needed to reduce this dependence, one of which involves utilizing eco-enzymes as an organic nutrient supplement. This study aimed to evaluate the growth and yield responses of Hybrid-F1 sweet corn plants to reduced NPK fertilizer doses, combined with eco-enzyme application via soil drenching and foliar spray. The study employed a Randomized Block Design with four replications and four treatment levels, comparing full NPK fertilizer doses, a 50% reduction in NPK fertilizer combined with eco-enzyme, and standalone eco-enzyme application. The results demonstrated significant improvements in fertilization efficiency, with the combination of a 50% reduction in NPK fertilizer and weekly applications of 1 ml/l eco-enzyme via soil drenching and foliar spray achieving optimal growth and production equivalent to full fertilization. Another important finding is that eco-enzyme can be used independently without inorganic fertilizers; plants still grew normally and produced ears, although yields were relatively lower. For best results, it is recommended to use a combination of a 50% reduction in NPK fertilizer dose and eco-enzyme application through both soil drenching and foliar spray. This approach not only reduces production costs by up to 50% but also promotes more sustainable and environmentally friendly cultivation practices.

Keywords: Biostimulant, Crop Production, Cultivation System, Fertilization Management, Organic Supplement

1. Introduction

Sweet corn (*Zea mays* L. var. saccharata Sturt) is an important food commodity widely favored by consumers due to its sweet taste and nutritional content, including carbohydrates, proteins, and fats (Bapaimu et al., 2024; Haryoko et al., 2023; Kesmayanti et al., 2016). High and sustainable sweet corn production is essential to meet year-round consumer demand, which heavily depends on adequate nutrient supply (Nindita et al., 2024). Sweet corn is a horticultural crop with high economic value and a continuously growing market demand. However, sweet corn productivity in Indonesia remains relatively low, ranging from 8 to 10 tons per hectare, significantly below its genetic potential of 12 to 15 tons per hectare. This low productivity results from several factors, including soil fertility degradation caused by unsustainable cultivation

*Correspondence: noviekesmayanti@yahoo.co.id
1) Universitas IBA - Jl. Mayor Ruslan, Kelurahan Kemang Manis, Kecamatan Ilir Barat II, Kota Palembang, Sumatera Selatan, Indonesia
2) Universitas Palembang - Jl. Dharmapala No. 1-A, Bukit Besar, Palembang, Sumatera Selatan, Indonesia

practices, pest and disease infestations, and limited farmer access to quality agricultural inputs at affordable prices. Sweet corn plants respond well to inorganic fertilizers; however, long-term use of these fertilizers can degrade soil quality and fertility, reduce microbial activity, and increase production costs. Moreover, excessive reliance on inorganic fertilizers leads to soil nutrient imbalances, reduced organic matter content, and adverse effects on environmental sustainability. Therefore, efforts are needed to reduce this dependence, one of which is the use of eco-enzymes as organic nutrient supplements. Sweet corn is highly responsive to fertilization, so using high levels of nitrogen (N), phosphorus (P), and potassium (K) fertilizers significantly promotes maximum growth and production. The standard doses of N, P, and K fertilizers for sweet corn are relatively high, specifically 300 kg urea.ha^{-1}, 200 kg SP-36.ha^{-1}, and 200 kg KCl.ha^{-1} (Nindita et al., 2024; Puspadewi, 2016). The results of the study showed that the application of NPK+Mg compound fertilizer at 462 kg.ha^{-1}, 368 kg urea.ha-1, and 185 kg SP-36.ha-1 produced plants with the highest growth and production compared to standard N, P, and K treatments and other treatments (Nindita et al., 2024). While the application of high doses of inorganic fertilizers increases growth and yield, it also causes soil and environmental damage, including decreased soil organic matter, soil compaction, increased chemical residues in the soil, environmental pollution, and, in the long term, reduced soil fertility and increased plant dependence on inorganic fertilizers. Therefore, efforts are needed to reduce this dependence, one of which is through the use of organic nutrients or supplements.

The application of high doses of inorganic fertilizers without the application of organic materials as ameliorants will reduce organic matter content and soil fertility (Mahbub et al., 2023; Rahman & Zhang, 2018; Roba, 2018), increase nitrate residues and soil toxicity, and reduce land productivity (Rahman & Zhang, 2018). The application of organic materials has multiple functions, including increasing soil organic matter, supplying macronutrients (N, P, K), micronutrients, and soil organic acids, and supporting zero-waste agriculture. In the long term, it will improve the soil's physical, chemical, and biological fertility. The addition of organic materials is a modification of fertilizer recommendations (Mahbub et al., 2023). Organic materials can include manure, compost, green manure, biochar, and processed organic plant waste products, such as eco-enzymes derived from uncooked vegetable and fruit peels.

Eco-enzyme is a multipurpose solution from the fermentation of a mixture of brown sugar/molasses, vegetable/fruit waste, and water (1:3:10) (Nusantara, 2020). Based on its history and background of manufacture, eco-enzyme, first discovered by Dr. Rosukon Poompanvong (Founder of the Thai Organic Farming Association), was intended to help local farmers achieve better yields. Eco-enzyme is often called a bio-stimulant and bio-fertilizer because it can help fertilize the soil through a combination of biological, physical, and chemical processes that occur when eco-enzyme interacts with the soil ecosystem. Eco-enzymes are fermented liquids rich in beneficial microorganisms and natural enzymes that can enhance the activity of soil microorganisms (biology). The natural enzymes in eco-enzymes can accelerate the decomposition and breakdown of organic matter into simple nutrients for soil and plants. Eco-enzymes can stimulate the growth of soil microbes, which help maintain the nutrient cycle and balance the underground ecosystem. The biological activity of eco-enzymes will loosen the soil, increase pore capacity, and improve soil aeration and drainage. It could be improving the physical condition of soil that tends to compact due to excessive application of inorganic fertilizers over a long period. Eco-enzymes are acidic with a pH range below 4. When diluted and applied to the soil, eco-enzymes will help neutralize overly alkaline soil and repair soil damaged by chemical residues. This eco-enzyme working system acts as a booster, helping release nutrients bound in the soil so they become available and easily absorbed by plants. The organic acid content of eco-enzymes can function similarly to natural plant growth hormones. The application of eco-enzymes offers many benefits, is environmentally friendly, and reduces production costs.

The application of an eco-enzyme at a concentration of 1 ppm can replace fertilizers and pesticides (Hemalatha & Visantini, 2020; Nusantara, 2020). Eco-enzyme has an acidic pH; banana peel pH 3.3 (Tuhumury et al., 2024); papaya and pineapple peel pH 3.29 and 3.15, respectively. The acidity of eco-enzyme is due to its organic acid content, which is one of the nutritional richness of eco-enzyme. Organic acids can make eco-enzymes function as insecticides and pesticides (Rochyani et al., 2020). Because it has an acidic pH, the recommended concentration of eco-enzyme is 1-10 ml.l-1 in water, applied by watering and mixing into the soil. Continuous application of 1 ml.l^{-1} every week had a positive effect on plant growth and production (Nusantara, 2020). Some studies showed that the nutrient content of eco-enzyme from orange and pineapple peel consisted of 1.98% C-organic, 1.74% N, 0.06% P, 77.15 mg.l-1 Ca, and 1522.70 mg.l^{-1} K and pH 5.3 (Sitompul et al., 2025). Eco-garbage-enzyme contains small amounts of N, K 203 mg.l$^{-1,}$ and P 21.79 mg.l^{-1}, making it good for fertilizing soil and plants (Yuliandewi et al., 2018). In the Anjasmoro variety of soybeans, 20 ml.$^{l-1}$ of eco-enzyme significantly affected plant height, number of primary branches, number of pods per plant, number of filled pods, weight of 100 seeds, and production per hectare (Soverda et al., 2023). A concentration of 1.5 ml.l^{-1} produced mustard greens with higher fresh shoot weight and wet shoot weight than concentrations of 1 ml.l^{-1}, 2 ml.l^{-}

^{1}, 2.5 ml.l^{-1}, 3 ml.l^{-1} and 3.5 ml.l^{-1} (Novianto & Bahri, 2023). Application of 1 ml.l^{-1} eco-enzyme to sweet corn gave the highest yield compared to the control (0 ml.l^{-1}), 0.2 l^{-1}, 0.4 l^{-1}, 0.6 l$^{-1,}$ and 0.8 l^{-1} (Ermawati et al., 2023). Eco-enzyme + 50% recommended N, P, K fertilizer produces shallots with the highest number of leaves per bulb, number of leaves per clump, number of bulbs per clump, bulb circumference, weight per bulb, and bulb weight per clump. The best results are obtained when soil drenching and foliar spray are applied simultaneously, compared with either method alone (Kesmayanti et al., 2025). Eco-enzyme increases the growth and production of shallots (Jaya et al., 2021; Lubis et al., 2022), corn (Ermawati et al., 2023), kale (Sidqi et al., 2022), radish (Mandal & Verma, 2024), and encourages germination and pest-disease resistance (Vama & Cherekar, 2020). There has been little research on the application of eco-enzyme to F1-Hybrid sweet corn; therefore, this research must be carried out.

When interacting with the soil ecosystem, eco-enzymes act as biostimulants and biofertilizers, helping to fertilize and improve the soil. This increases nutrient availability for plants, stimulates the growth of soil microorganisms, and decomposes organic matter, resulting in more fertile soil. This study aimed to measure and analyze the growth and yield responses of F1-hybrid sweet corn plants to reduced N, P, and K fertilizer doses, combined with eco-enzyme application via soil drenching and foliar spray.

2. Material and Methods

The research was conducted at the Experimental Garden and Plant Physiology Laboratory, Faculty of Agriculture, IBA University, Palembang, South Sumatra, Indonesia, from October to December 2023. The university is located at coordinates 2°57'55.06"S, 104°45'49.49"E.

2.1. Materials

The materials used were F1-hybrid sweet corn seeds, eco-enzymes, inorganic fertilizer (urea, SP-36, KCl), chicken manure, and an insecticide/nematicide containing 3% carbofuran. The equipment used included measuring cups, analytical scales, sprayers and other agricultural equipment for land cultivation and maintenance.

2.2. Experimental Design and Research Procedures

The study used a randomized block design with four replications. Four treatment levels were tested: N,P,K fertilizer at recommended dosage (4.8 g urea per plant, 1.75 g SP-36 per plant, 0.875 g KCl per plant), 50% N,P,K combined with 1 ml/l eco-enzyme via soil drenching, 1 ml/l eco-enzyme via soil drenching combined with 1 ml/l eco-enzyme via foliar spray, and 1 ml/l eco-enzyme via soil drenching alone. Urea fertilizer was applied three times (1/3 at planting, 1/3 at 21 days after planting, and 1/3 at 30 days after planting), SP-36 fertilizer was applied at planting, and KCl fertilizer was applied twice (1/2 at planting and 1/2 at 21 days after planting). Chicken manure was applied to all plots at a dose of 5 tons/ha. Eco-enzyme was applied during soil preparation in all treatment plots, except in treatment P1. The volume of ee-sd was 1 liter.tan^{-1} and ee-fs were 1 liter.tan^{-1}, applied weekly. Planting was done by digging, one seed per planting hole. Planting distance was 70 cm x 20 cm. The variables observed were plant height, growing point height, stem diameter, number of leaves, leaf area, shoot weight, shoot-root ratio, root weight, total plant weight, root length, ear length, ear diameter, ear weight (yield) per plant, root weight ratio, and root-shoot ratio.

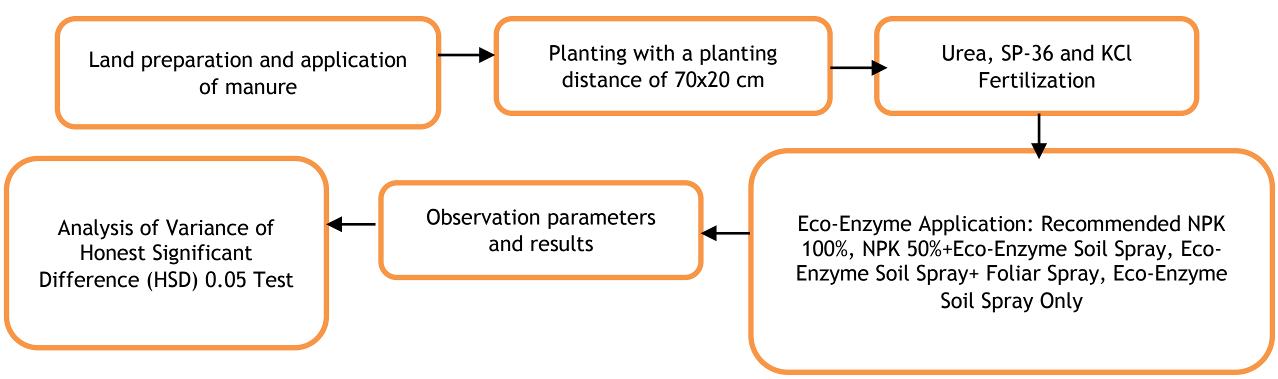

Figure 1. Research Flow Diagram.

Plant height was measured from the soil surface to the tip of the highest leaf using a measuring tape at 14, 28, 42, and 56 days after planting (dap). Growing point height was measured from the soil surface to the growing point using a measuring tape at the same intervals. Stem diameter was measured at 5 cm above the soil surface using a digital caliper at 14, 28, 42, and 56 days after planting. The number of leaves was counted manually by recording all fully opened leaves per plant at 14, 28, 42, and 56 days after planting. Leaf area was measured at harvest using the gravimetric method, where all leaves were traced on graph paper, cut out, weighed, and calculated based on the known weight per unit area of the graph paper.

Shoot weight was determined by oven-drying the above-ground plant parts (stem and leaves) at 70°C until constant weight was achieved. Root weight was measured by carefully excavating the root system, washing with water to remove soil, and oven-drying at 70°C until constant weight. Total plant weight was calculated by summing shoot and root weights. Root length was measured from the crown to the tip of the longest root using a measuring tape. Shoot-root ratio was calculated by dividing shoot dry weight by root dry weight. Root weight ratio was calculated by dividing root dry weight by total plant dry weight. Root-shoot ratio was calculated by dividing root dry weight by shoot dry weight.

Ear length was measured from the base to the tip of the ear using a measuring tape at harvest. Ear diameter was measured at the middle part of the ear using a digital caliper. Ear weight per plant was determined by weighing fresh ears immediately after harvest using a digital balance.

2.3. Data Analysis

Observational data were analyzed using Analysis of Variance (ANOVA) to determine the effect of the treatment. This was followed by Honest Significant Difference (HSD) at the 5% level. The research data were processed using SAS software version 9.0 and Microsoft Excel.

3. Results and Discussion

The results of the analysis of variance showed that the treatment of reducing the dose of N, P, K fertilizer and the application of eco-enzyme with the soil drenching and foliar spray methods had a significant effect on plant height, growing point height, leaf area, shoot weight, total shoot weight, root weight, root length, shoot-root ratio, root-shoot ratio, root weight ratio and ears weight (yield) per plant. However, they had no significant effect on stem diameter, number of leaves, ear length, or ear diameter.

3.1. Shoot growth response

The results showed that the average of plant height, growing point height and leaf area in the treatment of 50% reduction N,P,K + ee-sd and the treatment that only received ee-sd and ee-fs without N,P,K nutrients were relatively same and not significantly different from the 100% N,P,K but the ee-sd treatment was significantly different. The total plant weight and shoot weight of plants were significantly different (Table 1).

Table 1. Average of plant height (PH), growing point height (GPH), leaf area (LA), shoot weight (SW), total plant weight (TPW), stem diameter (SD) and number of leaves (NL) of F1-Hybrid sweet corn in the treatment of reduced doses of N, P, K fertilizer and eco-enzyme application using soil drenching (sd) and foliar spray (fs)

Treatment	PH (cm)	GPH (cm)	LA (cm^2)	SW (g)	TPW (g)	SD (cm)	NL (leaf blade)
N, P, K 100%	158.37±4.75b	119.21±4.76b	179.25±4.57b	1524.99±70.12c	1785.79±87.35c	2.45±0.12	10.25±0.25
N, P, K 50% + ee-sd	155.97±3.26b	114.65±4.13b	167.54±3.78b	1207.32±73.24b	1447.32±80.19b	2.47±0.24	10.50±0.21
Ee-sd + ee-fs	143.64±4.63ab	106.25±4.19ab	155.72±4.12ab	933.99±70.19a	1157.97±81.23a	2.27±0.19	10.50±0.19
Ee-sd	138.73±a	100.91±3.24a	152.34±4.25a	915.5976.34±a	1140.85±80.15a	2.11±0.15	10.00±0.12
HSD 0,05	13.42	12.92	13.45	212.88	247.13		

Note: Numbers in the same column followed by the same letter are not significantly different at the 0.05 HSD level.

Based on Table 1, there was a decrease in growth when N, P, and K fertilizers were reduced or omitted, even with the addition of eco-enzymes. This indicates that sweet corn plants require readily available N, P, and K macronutrients in high concentrations to stimulate growth and yield. Macronutrients N, P, and K are essential for optimal growth and production. Deficiencies in these macronutrients will disrupt growth and reduce production (Kesmayanti et al., 2023; Kumar et al., 2021). The macronutrients N, P, and K are essential for plant growth. Nitrogen is essential for the synthesis of chlorophyll, nucleic acids, and proteins, for metabolism, and for the growth of shoots and vegetative organs. Phosphorus is essential for the synthesis of energy-rich phosphates, proteins, and amino acids, as well as for flowering and fruiting. Kalium is essential for stomatal opening and closing, enzymatic reactions, and sugar transport within the plant (Johnson & Mirza, 2020). The results of this study also show that although eco-enzymes have advantages because they contain beneficial microorganisms and organic nutrients, they are not yet able to match the speed and adequacy of nutrients provided by inorganic fertilizers.

An interesting research finding is that the growth response in the 50% N, P, K + ee-sd treatment combination was not significantly different from that of. This suggests that eco-enzymes have the potential to substitute for chemical fertilizers to address nutrient deficiencies when fertilizer doses are reduced. The results also showed that plants that were not fertilized with N, P, and K, and only received ee-sd, ee-fs, and ee-sd, continued to grow and produce, although at lower levels (Table 1). This substitution potential arises because eco-enzymes improve soil through a combination of biological, physical, and chemical processes that occur when they interact within the soil ecosystem. This process will encourage soil microbial activity, soil loosening, increased pore space, nutrient release, and increased soil fertility, thereby supporting plant growth. This study used 5 t ha-1 of chicken manure as the basic treatment. The presence of eco-enzymes in the soil will increase the activity of soil microorganisms, converting chicken manure into a nutrient source for plants, thereby supporting the normal life cycle of plants until the harvest phase.

3.2. Root growth response

The results showed that in the treatment of 50% of N,P,K + ee-sd and ee-sd + ee-fs without fertilizer, the weight of the root and the length root were relatively the same and not significantly different from the 100% N, P, K. But, in the ee-sd treatment, the root growth was relatively lower and significantly different from the others. The roots of plants that received eco-enzyme application had a higher average root weight ratio and were significantly different from those that did not (Table 2).

Table 2. Average of root weight (RW), root length (RL), root weight ratio (RWR), shoot-root ratio (SRR), and root-shoot ratio (RSR) of F1-Hybrid sweet corn plants in the treatment of reduced doses of N, P, K fertilizer and eco-enzyme application using soil drenching (sd) and foliar spray (fs)

Treatment	RW (g)	RL (cm)	RWR	SRR	RSR
N,P,K 100%	260.80±12.87b	25.19±1.87b	0.15±0.003a	5.84±0.09c	0.17±0.004a
N,P,K 50% + ee-sd	240.00±14.34ab	22.88±1.56ab	0.17±0.004b	5.03±0.012b	0.20±0.003b
Ee-sd + ee-fs (P3)	225.26±12.75ab	21.70±1.89ab	0.20±0.002c	4.15±0.009a	0.25±0.005c
Ee-sd	223.98±12.56a	19.26±1.27a	0.19±0.004c	4.07±0.007a	0.24±0.002c
HSD 0,05	36.38	5.36	0.01	0.28	0.01

Note: Numbers in the same column followed by the same letter are not significantly different in the 0.05 HSD test

There was no significant difference in the weight and length of roots of P2 and P3 compared to P1, but P4 was significantly different. The higher RWR was due to the plant that applied ee-sd + ee-fs, followed by the plant that applied ee-sd + ee-fs (Table 2). The plant treated with eco-enzyme has better RWR than the untreated one. It was because the eco-enzyme made the soil looser (more porous) and better aerated, allowing oxygen to penetrate deeper into the plant root area to support growth. The root weight ratio explains the efficiency of roots in supporting plant biomass formation. The higher the root weight ratio, the higher the root efficiency in supporting plant growth and production.

3.3. Plant yield response

The research results showed that the yield components of the F1-Hybrid sweet corn plant under 50% reduction of N, P, K + ee-sd (P2) were similar to those under 100% N, P, K (P1) and not significantly different. However, the ee-sd + ee-fs (P3) and ee-sd (P4) treatments were relatively lower and significantly different from P1 (Table 3).

Table 3. Average of ears weight per plant (EW), ears length (EL), ears diameter (ED) of F1-Hybrid sweet corn plants in the treatment of reducing the dose of N, P, K fertilizer and eco-enzyme application using soil drenching (sd) and foliar spray (fs)

Treatment	EW (g)	EL (cm)	ED (cm)
N,P,K 100%	453.58±32.03b	26.37±0.94	10.35±0.33
N,P,K 50% + ee-sd	421.38±34.06ab	26.86±0.82	9.75±0.35
Ee-sd + ee-fs	354.08±31.02a	26.01±0.95	9.50±0.26
Ee-sd	353.25±30.15a	24.62±0.90	9.07±0.31
HSD 0,05	90.64		

Note: Numbers in the same column followed by the same letter are not significantly different in the 0.05 HSD test

The weight of ears per plant in the combination of 50% reduction in N, P, K fertilizer + ee-sd (P2) was relatively the same and not significantly different from the 100% N, P, K (P1). This indicates that the fertilization strategy combining 50% NPK with eco-enzymes is an effective and efficient approach to reduce production costs and dependence on inorganic fertilizers while maintaining optimal yields.

Plants in P3 and P4 grew more slowly than those in P1 and P2, but still grew normally and produced well. This suggests that eco-enzymes can act as an alternative nutrient source, promoting soil microbial activity by releasing nutrients and making them available to soil and plants. However, the release is slower than that of inorganic fertilizers and at lower concentrations. Nutrient availability will boost crop yields. This also suggests that the use of eco-enzymes has functional value for plant growth and yield, even if it does not achieve optimal yield targets.

Several studies have shown that eco-enzyme application increases the whole ears weight and ear diameter. Application of 1 ml L-1 increases growth and yield of sweet corn (Ermawati et al., 2023). Eco-enzyme application significantly affects leaf number and flowering age. The combination of eco-enzyme and banana stem compost significantly affects the diameter and length of sweet corn ears (Rahma & Andri, 2025).

3.4. Analysis of plant response to eco-enzyme application method

This study also measured and analyzed the growth and yield responses of F1-Hybrid sweet corn plants to eco-enzyme application method by soil drenching and foliar spray. The results of the study, presented in Tables 1, 2, and 3, show that the growth and yield responses to the ee-sd + ee-fs and ee-sd methods were relatively similar and not significantly different. The measured average figures were relatively lower than the expected figures, but were statistically similar and not significantly different. Visually in the field, plants that received ee-sd and ee-fs looked brighter green, also their stems and leaves were more upright.

Continuous weekly application of eco-enzymes improved plant growth and production (Nusantara, 2020). Watering 1 $ml.l^{-1}$ of eco-enzyme on sweet corn plants produced the highest yields (Ermawati et al., 2023). Application using the ee-sd and ee-fs methods together on shallots produced the best results (Kesmayanti et al., 2025).

3.5. Analysis of the reduction in plant growth and yield due to N, P, K reduction and eco-enzyme application

The results of the study showed that the response of plant growth and yield in the treatment of 50% reduction of N, P, K + ee-sd, ee-sd + ee-fs without fertilizer, and ee-sd was relatively lower than 100% N, P, K although statistically several variables in were relatively same and not significantly different from N,P,K 100%. The percentage reduction is shown in Tables 4 and 5.

Table 4. Percentage of reduction in shoot growth of F1-Hybrid sweet corn plants in the treatment of reducing the dose of N, P, K fertilizer and eco-enzyme application using soil drenching (sd) and foliar spray (fs)

Treatment	PH	GPH	SD	LN	LA	SW	TPW
N,P,K 50% + ee-sd	1.52	3.82	-0.44	-2.44	6.54	20.83	18.95
Ee-sd + ee-fs	9.30	10.87	7.34	-2.44	13.13	38.75	35.16
Ee-sd	12.40	15.35	13.88	2.44	15.01	39.96	36.12

Table 5. Percentage of reduction in roots and yield of F1-Hybrid sweet corn plants in the treatment of reducing the dose of N, P, K fertilizer and eco-enzyme application using soil drenching (sd) and foliar spray (fs)

Treatment	RW	RL	EW	ED	EL
N,P,K 50% + ee-sd	7.98	9.16	7.10	5.81	-1.87
Ee-sd + ee-fs	13.63	13.88	21.94	8.21	1.34
Ee-sd	14.12	23.54	22.12	12.44	6.62

Based on Tables 4 and 5, it can be seen that in the treatment N,P,K 50% + ee-sd, the percentage decrease was relatively lower than in Ee-sd + ee-fs and Ee-sd. This is because in N,P,K 50% + ee-sd, plants still received 50% N, P, K + ee-sd 1 $ml.l^{-1}$ every week. The combination of nutrients from inorganic fertilizer and ee-sd made plant growth and yield better. The nutrient from ee-sd, although not as large as the effect of inorganic fertilizers, but the use of eco-enzymes has been proven to support the plant life cycle until harvest. It is suspected that the role of eco-enzymes is as catalysts and nutritional supplements through biological, physical, and chemical activities in the soil ecosystem.

Decreased plant growth and yield due to reduced or absent N, P, and K fertilizers. It indicates that to achieve optimal growth and yield, F1-Hybrid sweet corn plants still require macronutrients N, P, and K as their primary nutrients. This finding is consistent with the statements of Amir et al. (2022), Nindita et al. (2024), Puspadewi (2016), and Rohmaniya et al. (2023), who report that sweet corn is highly responsive to high N, P, and K fertilization for optimal growth and yield.

4. Conclusion

Based on the research findings, it was concluded that for optimal growth and yield, a combination of a 50% reduction in macronutrients (N, P, K) and eco-enzyme at 1 ml/l can be applied weekly through both soil drenching and foliar spray. When eco-enzyme was applied independently (without inorganic fertilizers N, P, K), the plants still grew normally and produced ears, although the yield was lower than in treatments with 100% N, P, K and 50% N, P, K combined with eco-enzyme. The effectiveness of soil drenching and foliar spray methods in supporting plant growth and yield was similar; however, using both together is preferable.

For farmers and practitioners aiming to optimize sweet corn production while reducing costs and environmental impact, it is recommended to apply 50% of the standard NPK fertilizer dose combined with weekly applications of eco-enzyme (1 ml/l) via both soil drenching and foliar spray. This method can reduce fertilizer expenses by 50% while maintaining yields comparable to full NPK fertilization. The application should involve both soil drenching (1 liter per plant) and foliar spraying (1 liter per plant) weekly for maximum effectiveness, as the combination yields superior results compared to either method alone. In organic farming systems or areas with limited access to chemical fertilizers, eco-enzyme can be used as the sole nutrient source; although yields may be

20–25% lower than conventional methods, plants still grow normally and produce marketable ears. This integrated eco-enzyme approach not only lowers production costs but also promotes soil health, enhances microbial activity, and supports long-term agricultural sustainability, making it an ideal solution for transitioning to more environmentally friendly farming practices.

Acknowledgments

The research teams would like to thank IBA University for funding this research through the IBA University Competitive Research Grant, administered by the IBA University Research and Community Service Institute in 2023.

References

Amir, N., Marlina, N., Palmasari, B., Aluyah, C., & Aminah, I. S. (2022). Respon pertumbuhan dan hasil jagung manis (*Zea mays saccharata* Sturt L.) terhadap pupuk organik cair asal limbah buahan dan NPK di lahan kering. *Agro Bali: Agricultural Journal, 5*(3), 498–503. https://doi.org/10.37637/ab.v5i3.1027

Bapaimu, L. F., Djaja, I., & Sembiring, J. (2024). Respon pertumbuhan dan produksi tanaman jagung manis (*Zea mays saccharata* Sturt) terhadap pemberian pupuk kandang sapi di Kabupaten Merauke. *INSOLOGI: Jurnal Sains dan Teknologi, 3*(3), 234–242. https://doi.org/10.55123/insologi.v3i3.3415

Ermawati, E., Thesiwati, A. S., Diyanti, A. R., & Mahnia, S. P. (2023). Studi pengaruh pemberian eco-enzim terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* var. *saccharata* Sturt). *Agrivet, 29*(1), 39–46. https://doi.org/10.31315/agrivet.v29i1.9728

Haryoko, W., Mutia, Y. D., Karet, R. K., & Utama, M. Z. H. (2023). Kombinasi pupuk K dan kompos terhadap pertumbuhan dan hasil jagung manis (*Zea mays* var. *saccharata* Sturt). *Pangan, 32*(2), 121–128.

Hemalatha, M., & Visantini, P. (2020). Potential use of eco-enzyme for the treatment of metal-based effluent. *IOP Conference Series: Materials Science and Engineering, 716*, 1–6. https://doi.org/10.1088/1757-899X/716/1/012016

Jaya, E. R., Situmeang, Y. P., & Andriani, A. A. S. P. R. (2021). Effect of biochar from urban waste and eco-enzymes on growth and yield of shallots (*Allium ascalonicum* L.). *SEAS (Sustainable Environment Agricultural Science), 5*(2), 105–113. https://doi.org/10.22225/seas.5.2.3871.105-113

Johnson, V. J., & Mirza, A. (2020). Role of macro and micronutrients in the growth and development of plants. *International Journal of Current Microbiology and Applied Sciences, 9*(11), 576–587. https://doi.org/10.20546/ijcmas.2020.911.071

Kesmayanti, N., Asmawati, & Mareza, E. (2016). Efektivitas pupuk organik cair dan padat pada sistem budidaya jagung manis semi-organik di tanah Ultisol. Dalam *Prosiding Seminar Nasional Dies Natalis ke-53 Fakultas Pertanian Universitas Sriwijaya* (hlm. 978–979).

Kesmayanti, N., Purwanto, R. J., & Mareza, E. (2023). The adaptation of Ciherang rice variety roots to various levels of low nutrient stress in tidal swamp soils. *Agrologia, 12*(2), 239–245. https://doi.org/10.30598/ajibt.v12i2

Kesmayanti, N., Purwanto, R. J., Romza, E., Kalsum, U., Irmawati, W., & Putri, K. (2025). Effectiveness of eco-enzyme for increasing growth and production of shallot from vegetative seeds. *Journal of Agriculture (JoA), 4*(2), 106–114. https://doi.org/10.47709/joa.v4i02.6442

Kumar, S., Kumar, S., & Mohapatra, T. (2021). Interaction between macro- and micronutrients in plants (Review). *Frontiers in Plant Science, 12*, 1–9. https://doi.org/10.3389/fpls.2021.665583

Lubis, N., Wasito, M., Marlina, L., Girsang, R., & Wahyudi, H. (2022). Respon pemberian ekoenzim dan pupuk organik cair terhadap pertumbuhan dan produksi bawang merah (*Allium ascalonicum* L.). *Agrium, 25*(2), 107–115.

Mahbub, I. A., Tampubolon, G., Mukhsin, & Farni, Y. (2023). Peningkatan kesuburan tanah dan hasil padi sawah melalui aplikasi pupuk organik. *Jurnal Tanah dan Sumberdaya Lahan, 10*(2), 335–340. https://doi.org/10.21776/ub.jtsl.2023.010.2.17

Mandal, S., & Verma, D. (2024). Effect of eco-enzyme on growth, yield, and quality characters of different cultivars of radish (*Raphanus sativus* L.). *Asian Journal of Microbial Biotechnology and Environmental Sciences, 26*(1), 1–7. https://doi.org/10.53550/AJMBES.2024.v26i01.001

Nindita, A., Ikhsan, L. H., & Suwarto. (2024). Pertumbuhan dan produksi tanaman jagung manis (*Zea mays* var. *saccharata* Sturt) pada berbagai dosis pupuk majemuk NPK+Mg (8-9-39+3). *Buletin Agrohorti, 12*(2), 236–245. https://doi.org/10.29244/agrob.v12i2.56677

Novianto, & Bahri, S. (2023). Response of mustard (*Brassica juncea* L.) growth and production to application of eco-enzyme liquid organic fertilizer. *Jurnal Agrotek Tropika, 11*(1), 1–5. https://doi.org/10.23960/jat.v11i1.5773

Nusantara, E. (2020). *Pembuatan eco-enzyme*. Eco Enzyme Nusantara.

Puspadewi, S., Swandi, W. S., & Kurniawan, K. (2016). Pengaruh konsentrasi pupuk organik cair dan dosis pupuk N, P, K terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* L. var. *rugosa* Bonaf) kultivar Talenta. *Jurnal Kultivasi, 15*(3), 208–216.

Rahma, M. Y., & Andri. (2025). Pemanfaatan kompos batang pisang dan pupuk organik eco-enzim F2 mengkudu terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays saccharata* Sturt). *Jurnal Pertanian Agronitas, 7*(1), 543–552.

Rahman, K. M. A., & Zhang, D. (2018). Effects of fertilizer broadcasting on the excessive use of inorganic fertilizers and environmental sustainability. *Sustainability, 10*(3), 759. https://doi.org/10.3390/su10030759

Roba, T. B. (2018). Review on the effect of mixing organic and inorganic fertilizer on productivity and soil fertility. *Open Access Library Journal, 5*, 1–11. https://doi.org/10.4236/oalib.1104618

Rochyani, N., Utpalasari, R. L., & Dahliana, I. (2020). Analisis hasil konversi eco-enzyme menggunakan nenas (*Ananas comosus*) dan pepaya (*Carica papaya* L.). *Jurnal Redoks, 5*(2), 135–140.

Rohmaniya, F., Jumadi, R., & Redjeki, E. S. (2023). Respon pertumbuhan dan hasil tanaman jagung manis (*Zea mays saccharata* Sturt) pada pemberian pupuk kandang kambing dan pupuk NPK. *Jurnal Tropicrops, 6*(1), 37–51.

Sidqi, I. F., Krestiani, V., & Yuliani, F. (2022). Pengaruh pupuk kandang ayam dan eco-enzyme terhadap pertumbuhan dan hasil tanaman kailan (*Brassica oleracea* var. *alboglabra*). *Muria Jurnal Agroteknologi, 1*(2), 13–21.

Sitompul, H. S., Maulina, I., & Situmorang, I. (2025). Analisis kandungan unsur hara pada eco-enzyme menggunakan jeruk (*Citrus sinensis*) dan nenas (*Ananas comosus*). *Elektriese: Jurnal Sains dan Teknologi Elektro, 15*(1), 40–44.

Soverda, N., Jasminarni, Swari, E. I., & Sihombing, P. (2023). Pertumbuhan dan hasil tanaman kedelai pada pemberian beberapa konsentrasi eko-enzim. *Jagro: Jurnal Media Pertanian, 8*(2), 169–176. https://doi.org/10.33087/jagro.v8i2.217

Tuhumury, N. C., Sahetapy, J. M. F., Matakupan, J., & Rijoly, S. M. A. (2024). Aktivitas antibakteri eco-enzyme terhadap bakteri yang diisolasi dari rumput laut terinfeksi ice-ice. *TRITON: Jurnal Manajemen Sumberdaya Perairan, 20*(1), 54–61.

Vama, L., & Cherekar, M. N. (2020). Production, extraction, and uses of eco-enzyme using citrus fruit waste: Wealth from waste. *Asian Journal of Microbial Biotechnology and Environmental Sciences, 22*(2), 346–351.

Yuliandewi, N. W., Sukerta, I. M., & Wiswasta, I. A. (2018). Utilization of organic garbage as eco garbage enzyme for lettuce plant growth (*Lactuca sativa* L.). *International Journal of Science and Research*.