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EFFECTIVENESS OF ECO-ENZYME DOSAGE ON THE GROWTH OF POTATO PLANTLET CUTTINGS (*Solanum tuberosum* L.) OF THE GRANOLA KEMBANG VARIETY

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ABSTRACT

This study aims to determine the effectiveness of various doses of eco-enzyme on the growth of Granola Kembang potato (Solanum tuberosum L.) plantlets. The study was conducted at the Screen House of the Kutagadung Horticultural Seed Center, Berastagi, Karo Regency, from December 2017 to January 2018. A completely randomized design (CRD) was used with four eco-enzyme dose treatments: 0 mg/L (control), 70 mg/L, 150 mg/L, and 250 mg/L, each repeated three times. The parameters observed included plant height, number of leaves, and leaf area. The data were analyzed using analysis of variance (ANOVA) and followed by a 5% DMRT test. The results showed that eco-enzyme application had a significant effect on the growth of potato planlets. The 150 mg/L dose produced the best growth in all parameters, with an average plant height of 12.84 cm, 10.23 leaves, and a leaf area of 36.77 cm². The 250 mg/L dose was not significantly different from the 150 mg/L dose, but it was higher than the control. It can be concluded that the 150 mg/L dose is the optimum dose for the growth of Granola Kembang potato planlets.

Keywords: eco-enzyme, planlets, potatoes, Solanum tuberosum, Granola Kembang

INTRODUCTION

Potatoes (*Solanum tuberosum* L.) are a leading horticultural commodity in Indonesia, possessing high economic value and serving as an important source of carbohydrates after rice and corn. Demand for potatoes continues to increase in line with the growth of the food industry and growing public awareness of food diversification. One widely cultivated variety is the Granola Kembang variety, known for its high productivity, uniform tuber size, and consumer-favored flavor. However, the availability of quality seeds remains a major obstacle to increasing potato production in Indonesia. In vitro propagation of potato plantlets has become a solution for producing disease-free and genetically uniform seedlings. The next stage, growing plantlet cuttings in an adaptation medium (ex vitro), is a critical phase that determines the success of seed propagation. During this phase, plantlets require an optimal growing environment and a balanced supply of nutrients and growth hormones to adapt quickly. Adding plant growth regulators (PGRs) or natural biostimulants to the growth medium can accelerate the formation of new leaves and stems, thereby increasing the success of acclimatization. One natural ingredient with potential as a biostimulant is eco-enzyme, a liquid produced by fermenting organic waste such as fruit and vegetable scraps and brown sugar with the help of microorganisms for three months. Eco-enzyme contains various active compounds such as amylase, protease, lipase, organic acids, and natural growth hormones such as auxin, cytokinin, and gibberellin (Rahmawati et al., 2021). These substances play a crucial role in accelerating plant vegetative growth, increasing nutrient absorption, and improving microbial activity around the roots (Putri et al., 2021; Setiawan et al., 2022).

Previous research has shown that administering eco-enzymes at certain doses can increase plant height, leaf number, and leaf area in several horticultural commodities such as tomatoes, chilies, and butterfly pea flowers (Wulandari et al., 2022; Sembiring et al., 2023). However, the effect of eco-enzymes on the growth of potato plantlet cuttings, particularly the Granola Kembang variety, has not been widely studied. In fact, in the early stages of plantlet growth, the addition of natural enzyme and hormone sources has great potential to increase

plant vigor, accelerate leaf and root formation, and strengthen the plantlets' adaptability to new environments.

Based on this, this study was conducted to assess the effectiveness of administering several doses of eco-enzyme on the growth of potato (*Solanum tuberosum* L.) plantlet cuttings of the Granola Kembang variety. The main objective of this study was to determine the most optimal eco-enzyme dosage in increasing plant height, leaf number, and leaf area of potato plantlets. The results of this study are expected to provide scientific information and practical recommendations for the development of environmentally friendly potato breeding technology based on natural biostimulants.

MATERIALS AND METHODS

Place and Time

This research was conducted at the Screen House of the Kutagadung Horticultural Parent Seed Technical Implementation Unit (UPTD), Berastagi, Karo Regency, North Sumatra Province. The research was conducted for two months, from June 2025 to August 2025. The research location was at an altitude of approximately 1,300 meters above sea level with temperatures ranging between 18–25°C and relative humidity of 70–80%.

Materials and Tools

The materials used in this study consisted of biological materials, treatment materials, and other supporting materials. The biological materials used were potato (*Solanum tuberosum* L.) plantlet cuttings of the Granola Kembang variety, approximately two weeks old, from tissue culture propagation, with stems 3–5 cm long and two to three leaves. The treatment material used was an eco-enzyme solution, a liquid produced by fermenting organic materials such as orange, pineapple, and papaya peels with brown sugar and water in a ratio of 3:1:10 (material : sugar : water). Fermentation was carried out for three months until a yellowish-brown liquid with a distinctive sweet and sour aroma was obtained. This was then diluted with water according to the treatment dosages of 0, 70, 150, and 250 mg/L of water.

The growing medium used was sterile cocopeat, which has a high water retention capacity and good aeration, making it suitable for the initial growth of plantlet cuttings. Additionally, a 0.2% Dithane M-45 fungicide solution was used to prevent fungal infections in the plantlets before planting, 70% alcohol for sterilizing the equipment, and clean water as a solvent and watering agent. Additional materials included treatment labels, transparent plastic to cover the plants during the adaptation period, and rubber bands to tie the covers to the planting pots.

The equipment used in this study included an analytical balance for weighing materials, a measuring ruler and calipers for measuring plant height, and a leaf area meter for measuring leaf area. A manual sprayer was also used for watering and administering treatments, a measuring cylinder and pipette for measuring solutions, a razor blade and tray for cutting cuttings, a plastic planting box and 10 cm diameter pots for the growing medium, a drying oven for sterilizing the cocopeat, and stationery and an observation notebook for documenting the research data. All materials and equipment were sterilized before use to avoid contamination that could affect the results of the experiment.

Research Method

This study was designed using a Completely Randomized Design (CRD) with one treatment factor, namely the eco-enzyme dose given to the Granola Kembang variety potato plantlet cuttings. The treatment factor consisted of four dose levels, namely 0 mg/L as a control without eco-enzyme administration (P0), 70 mg/L as a low dose (P1), 150 mg/L as a medium dose (P2), and 250 mg/L as a high dose (P3). Each treatment was repeated three times, resulting in twelve experimental units in total. Each experimental unit consisted of five sample plants treated equally according to the predetermined dose.

The general linear model of the Completely Randomized Design used in this study is:

$$Yi=\mu+\tau i+\varepsilon iY\_$$

Explanation :

Yi = observation value in treatment -i
μ = general mean value
τi = the effect of eco-enzyme dose treatment -i
εi = experimental error

Data were analyzed using analysis of variance (ANOVA) at a 95% confidence level (α = 0.05). If the results showed significant differences between treatments, a further Duncan's Multiple Range Test (DMRT) was conducted at a 5% level to determine the differences between treatment means.

Work procedures

Eco-Enzyme Manufacturing

The eco-enzyme manufacturing process in this study was carried out in accordance with the recommendations of the 2021 Nusantara Eco-enzyme module. The first step in the eco-enzyme manufacturing process was preparing the tools and materials. The tools used included: a closed container, a knife, a sieve, a bucket, a bottle, and a cutting board. The materials used included: water, vegetable and fruit waste, and molasses. The fruit peels used to make eco-enzymes in this study were pineapple, orange, banana, and papaya peels. The next step was to clean the fruit peel waste first, then cut it into small pieces using a knife on a cutting board. Next, 10 liters of water, 3 kg of fruit waste (750 g pineapple, 750 g papaya, 750 g orange, 750 g banana), and 1 kg of molasses (10 parts water, 3 parts fruit waste, and 1 part molasses) were prepared. Then, all the ingredients were placed in a closed container and closed tightly, and left for 3 months. On the 14th day after the eco-enzyme manufacturing process is carried out, the container lid is opened for 5 to 10 seconds.

Preparation of Planting Media

The cocopeat growing medium is sterilized by steaming it for 30 minutes to kill any pathogens and fungi that may have been introduced from the raw material. After cooling, the cocopeat is placed in 10 cm diameter plastic pots labeled with the appropriate treatment.

Potato Plantlet Cutting Preparation

Approximately 2-week-old Granola Kembang potato plantlets were taken from in vitro cultures. The plantlets were cut into 3–5 cm long cuttings with at least 2 leaves. The cut ends of the cuttings were soaked in a 0.2% Dithane M-45 fungicide solution for 2 minutes, then air-dried before planting.

Planting and Adaptation

The plantlet cuttings were carefully planted in sterile cocopeat media. After planting, the pots were covered with transparent plastic to maintain high humidity and prevent excessive evaporation. The adaptation phase lasted for 7 days without treatment, with watering every other day with clean water.

Eco-Enzyme Treatment

After the adaptation period ended, the eco-enzyme treatment was administered according to the dosage. The treatment was carried out by spraying the eco-enzyme solution using a fine sprayer until the growing medium was moist (approximately 50 mL per pot). The treatment was administered every 7 days for 6 weeks. The control (P0) was given only water without eco-enzyme.

RESULT AND DISSCUSSION

1. Plant Height (cm)

Observations on plant height showed that the administration of eco-enzyme at various doses significantly affected the growth of potato cuttings of the Granola Kembang variety. The average plant height in various treatments is presented in Table 1. The treatment without eco-enzyme (P0) produced the lowest plant height of 8.37 cm. Increasing the dose to 70 mg/L (P1) resulted in an increase in plant height to 10.68 cm, while a dose of 150 mg/L (P2) produced the highest plant height of 12.84 cm. At a dose of 250 mg/L (P3), plant height decreased slightly to 12.47 cm, but was not statistically significantly different from the dose of 150 mg/L. The increase in plant height up to a dose of 150 mg/L indicates that eco-enzyme can accelerate plant vegetative growth. Eco-enzyme contains natural hormones such as auxin and gibberellin which play a role in stimulating plant cell division and elongation (Putri et al., 2021). However, at higher doses, growth decreased slightly due to the possible excess organic acid content resulting from fermentation which caused changes in the pH of the media and disrupted nutrient absorption (Susanti et al., 2020).

Table 1. Average Height of Potato Plantlet Cuttings (cm) at Various Eco-Enzyme Doses

Treatment	Plant Height (cm)
P0 (0 mg/L)	8.37 a
P1 (70 mg/L)	10.68 b
P2 (150 mg/L)	12.84 c
P3 (250 mg/L)	12.47 bc

Description: Numbers followed by different letters in the same column indicate a significantdifference at the 5% level based on the DMRT test..

2. Number of leaves

The administration of eco-enzyme also significantly affected the number of leaves formed during the observation period. Based on the results of the analysis of variance, increasing the dose of eco-enzyme generally increased the number of leaves on potato plantlet cuttings (Table 2).

Table 2. Average Number of Potato Plantlet Cutting Leaves (Shells) at Various Eco-Enzyme Doses

Treatment	Number of leaves
P0 (0 mg/L)	6.21 a
P1 (70 mg/L)	8.72 b
P2 (150 mg/L)	10.23 c
P3 (250 mg/L)	9.84 bc

Description: Numbers followed by different letters in the same column indicate a significant difference at the 5% level based on the DMRT test.

The treatment without eco-enzyme (P0) only produced an average of 6.21 leaves, while the administration of 70 mg/L (P1) increased the number of leaves to 8.72. The treatment with a dose of 150 mg/L (P2) produced the highest number of leaves, namely 10.23 leaves, significantly different from the other treatments. At the highest dose (250 mg/L, P3), the number of leaves decreased slightly to 9.84 leaves and was not significantly different from P2. The increase in the number of leaves at the medium dose (150 mg/L) is closely related to the role of eco-enzyme, which contains macro and micro nutrients that help the formation

of new leaf tissue. Furthermore, the cytokinin content in eco-enzymes functions to stimulate cell division in the apical meristem tissue, thereby increasing the number of shoots and leaves (Rahmawati et al., 2021). However, at higher concentrations, excess active ingredients can cause saturation or physiological stress in plants, resulting in decreased leaf growth.

3. Leaf Area (cm²)

Observations showed that eco-enzyme administration significantly increased the leaf area of potato plantlets. The average leaf area values at various doses are presented in Table 3. The treatment without eco-enzyme (P0) resulted in an average leaf area of 24.15 cm², while the 70 mg/L dose (P1) increased the leaf area to 30.45 cm². The 150 mg/L dose (P2) produced the highest yield of 36.77 cm², significantly different from the other treatments. Meanwhile, at the highest dose (250 mg/L, P3), the leaf area decreased to 34.52 cm², not significantly different from the 150 mg/L dose.

The increase in leaf area at the medium dose indicates that eco-enzyme can improve nutrient availability and enhance plant photosynthesis. A larger leaf area indicates increased chlorophyll content and light absorption efficiency, enabling optimal plant photosynthesis. The active microorganisms and enzymes contained in eco-enzyme are thought to improve the biological activity of the medium, which results in faster leaf tissue growth (Setiawan et al., 2022).

Table 3. Average Leaf Area of Potato Plantlet Cuttings (cm2) at Various Eco-Enzyme Doses

Perlakuan	**L**uas Daun (Cm^2)
P0 (0 mg/L)	24.15 a
P1 (70 mg/L)	30.45 b
P2 (150 mg/L)	36.77 c
P3 (250 mg/L)	34.52 bc

Description: Numbers followed by different letters in the same column indicate a significant difference at the 5% level based on the DMRT test..

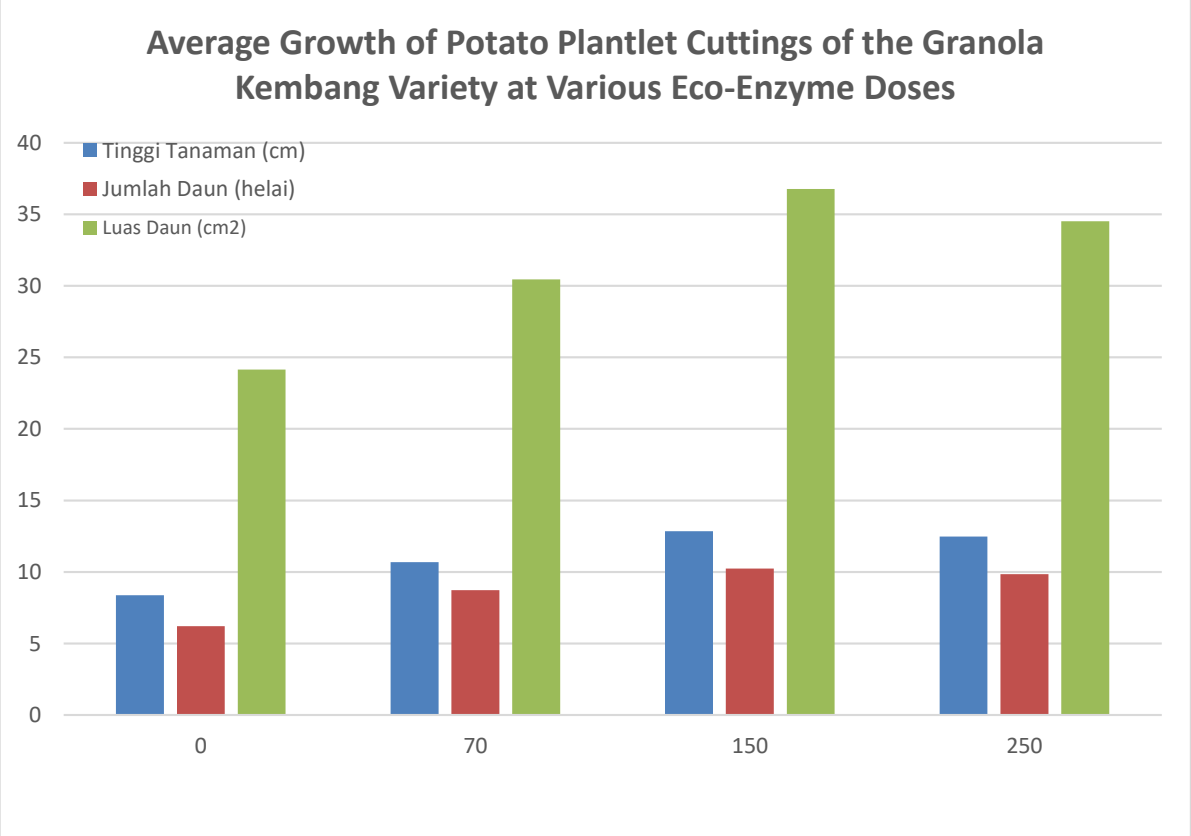

Figure 1. Graph of Average Growth of Potato Plantlet Cuttings of the Granola Kembang Variety at Various Doses of Eco-Enzyme

It was seen that the 150 mg/L treatment produced the highest growth in all parameters (plant height, number of leaves, and leaf area), while the 250 mg/L dose was not significantly different from 150 mg/L according to the 5% DMRT test.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The results of this study indicate that the application of eco-enzyme significantly affected the growth of potato (Solanum tuberosum L.) plantlet cuttings of the Granola Kembang variety in all observed parameters, namely plant height, number of leaves, and leaf area. Increasing the eco-enzyme dosage from 0 to 150 mg/L tended to increase vegetative plant growth, but increasing the dosage to 250 mg/L did not produce a significant difference compared to the 150 mg/L dosage. The 150 mg/L dosage produced the best results, with an average plant height of 12.84 cm, a leaf number of 10.23, and a leaf area of 36.77 cm². Therefore, it can be concluded that the 150 mg/L eco-enzyme dosage is the optimum dosage for enhancing the growth of potato plantlet cuttings of the Granola Kembang variety in the early growth phase.

Recommendations

Based on the results of this study, it is recommended that eco-enzyme be used at a dose of 150 mg/L as a natural biostimulant in the propagation of Granola Kembang potato cuttings, as it has been shown to promote optimal growth without adverse effects on the plants. Further research should include field acclimatization and growth testing to determine the effect of eco-enzyme on tuber formation and yield. Further research should also include more detailed dose variations around the optimum dose (e.g., 100, 150, and 200 mg/L) and testing different application frequencies to determine the maximum effectiveness of eco-enzyme in sustainable potato cultivation.

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