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Effect of Organic Fertilizer Formulation and Eco-Enzyme Application Timing on the Growth and Yield of Cherry Tomato

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Abstract

Tomat is rich in substances that are beneficial to human health, such as lycopene which functions as an antioxidant. The use of organic fertilizer formulations consisting of Tithonia, chicken manure, and Clotalaria, as well as the timing of eco-enzyme application, aims to ensure the availability of nutrients needed for the growth period of cherry tomato. The study aims to determine the effect of the interaction between the dosage of organic fertilizer formulation and the timing of eco-enzyme application in increasing cherry tomato yields, obtaining the dosage of organic fertilizer formulation in increasing cherry tomato yields, and determining the right timing of eco-enzyme application in increasing cherry tomato yields. The study was conducted in Kakaskasen Tomohon, North Sulawesi Province, Indonesia from May to October 2024. Randomized Block Design (RBD) factorial pattern with three replications. The first factor I (A) is the time of application of eco-enzyme (A) which consists of: A1=1 x eco-enzyme application/week, A2=2 x eco-enzyme applications/week, A3= 3x eco-enzyme applications/week. Factor II (B) is the dosage of organic fertilizer formulation, namely B1= 10 tons/ha of organic fertilizer formulation, B2 = 20 tons/ha of paitan grass organic fertilizer formulation, and B3= 30 tons/ha of organic fertilizer formulation. The application of eco-enzyme with a concentration of 100 ml per liter of water was proven to be effective in increasing the weight of tomato fruit per plant. The results showed that the best application frequency was twice a week, with an average fruit weight reaching 425.78 grams per plant. The application frequency of twice a week provides an ideal balance between a sufficient supply of eco-enzyme to support plant physiological activity without causing saturation or decreasing its effectiveness.

Keywords: *Cherry Tomato; Organic Fertilizer; Eco-Enzyme*

Introduction

Tomato is rich in substances that are beneficial to human health, such as lycopene which functions as an antioxidant. In addition, tomato also contain other important nutrients, such as vitamins C, A, K, and various minerals (Munthe et al., 2018). The various health benefits of tomato include lowering high blood pressure, preventing heart disease, and fighting cancer cells. This is due to the content of compounds such as solanine alkaloids, saponins, folic acid, malic acid, citric acid, bioflavonoids, proteins,

fats, sugars, adenine, trigonelline, choline, tomatin, minerals, vitamins, and histamine. People usually consume cherry tomato as a dessert fruit, an addition to salads, or as a flavoring agent. Therefore, increasing the quality and quantity of cherry tomato production is important to do. One effective way to increase cherry tomato production is to add nutrients to the soil through organic fertilizers and *eco-enzyme*.

The use of organic fertilizer formulations consisting of *Tithonia*, chicken manure, and *Clotalaria*, as well as the timing of *eco-enzyme* application, aims to ensure the availability of nutrients needed for the growth period of cherry tomato. Variations in organic materials in organic fertilizer formulations produce different fertilizer qualities according to the nutrient composition of the basic ingredients. These various basic ingredients are formulated to complement the macro, micro, and plant growth regulator content in them. One of the main components in *eco-enzyme* is acetic acid (CH_3COOH), in addition to nitrate compounds (NO3) and carbon trioxide (CO3), which act as important nutrients for the soil. *Eco-enzyme* has the main benefits of fertilizing the soil and plants, controlling pests, and improving the quality and taste of cultivated fruits and vegetables (Munthe et al., 2018).

Paitan grass (*Tithonia diversifolia*) has great potential as a source of organic fertilizer to support plant growth and production. This plant is also effective in reducing pollutants and reducing the levels of active phosphorus (P), aluminum (Al), and iron (Fe) absorption in the soil (Prasetyo & Suriadikarta, 2006). Paitan (*Tithonia diversifolia*) has the potential as a natural pesticide because of its allelopathic properties, which can suppress the growth of pests and diseases in plants. Research by Mokodompit et al., (2013) showed that paitan leaf extract is effective as an alternative insecticide. In addition, compost produced from paitan weeds can replace up to 50% of synthetic fertilizer use. Hakim et al., (2012) found that the application of paitan compost was able to substitute half of the need for synthetic fertilizer without reducing crop yields. *Tithonia diversifolia* has a high nutrient content, namely nitrogen (3.5%), phosphorus (0.38%), and potassium (4.1%), which makes it very potential to increase soil fertility and land productivity (Rahmawati et al., 2017; Simanihuruk et al., 2022). In addition, the orok-orok plant (*Crotalaria juncea* L.) from the *Leguminoceae* family can also be used as organic material because of its high nitrogen content (Rudiarto et al., 2014). Meanwhile, chicken manure plays a role in increasing the organic carbon (C-organic) content of the soil. This is due to the high levels of C-organic in chicken manure, which directly increases the organic carbon reserves in the soil (Ramadhan et al., 2018).

In addition to organic matter, *eco-enzyme* play an important role in supporting plant growth. The nutrient content in eco-enzymes includes nitrogen (N), phosphorus (P), potassium (K), and organic carbon (C-organic). The fermentation process of *eco-enzyme* produces organic acids that cause the pH to become acidic, a condition that supports the production of phytohormones such as auxins, cytokinins, and gibberellins. These phytohormones play a significant role in encouraging vegetative and generative growth, as well as accelerating fruit ripening (Hastanti et al., 2017).

Method

This research was conducted in Kakaskasen Tomohon, North Sulawesi Province, Indonesia from May to October 2024, using a Randomized Block Design (RBD) with a factorial pattern and three replications. The study involved two main factors. The first factor (A) is the frequency of *eco-enzyme* application, with three treatments: A1=1 time *eco-enzyme* application per week, A2=2 times *eco-enzyme* application per week, and A3=3 times *eco-enzyme* application per week. The second factor (B) is the dose of organic fertilizer formulation, consisting of: B1=10 tons/ha, B2=20 tons/ha (using organic fertilizer formulation from paitan grass), and B3=30 tons/ha. Each treatment combination was repeated three times so that there were a total of 27 experimental units. *Eco-enzyme* was used with a concentration of 100 ml per liter of water. The variables measured included plant height, number of fruits per plant, and fruit weight per plant. The research data were analyzed using the F test, followed by the Least Significant Difference (LSD) analysis at a significance level of 5%.

Results and Discussion

The results of the analysis of variance revealed that the combination of *eco-enzyme* application and organic fertilizer dosage did not provide significant interaction on the height of cherry tomato plants or the number of fruits per plant (Figures 1 and 2). However, separately, the timing of *eco-enzyme* application had a significant effect on the weight of tomato fruit per plant. This indicates that the frequency of *eco-enzyme* application plays an important role in increasing cherry tomato production, especially in fruit weight. The results of further analysis with the Least Significant Difference (LSD) test at a significance level of 5% (Table 1) showed the effect of a single treatment. The data showed that the timing of *eco-enzyme* application can be specifically optimized to increase cherry tomato productivity. This study explains the importance of paying attention to the *eco-enzyme* application schedule as one strategy to increase agricultural commodity yields.

Table 1. Effect of *Eco-enzyme* Application Time on Cherry Tomato Fruit Weight

Treatment	Fruit Weight
A1 (1x application of *eco-enzymes*)	107,44a
A2 (2x application of *eco-enzymes*)	425,78b
A3 (3x application of *eco-enzymes*)	388,11b
BNT 5% = 99,56	

Note: Numbers followed by the same letter are not significantly different based on the 5% LSD test

The results of the study showed that the combination of *eco-enzyme* application and organic fertilizer doses did not provide significant interactions on cherry tomato plant height or the number of fruits per plant. However, the timing of *eco-enzyme* separately significantly affected fruit weight per plant. This is in line with previous studies which stated that *eco-enzyme* act as a biostimulant that can increase the availability of nutrients in the soil and improve soil microbial activity (Kumar & Aloke, 2020; Vasconcelos & Chaves, 2020)

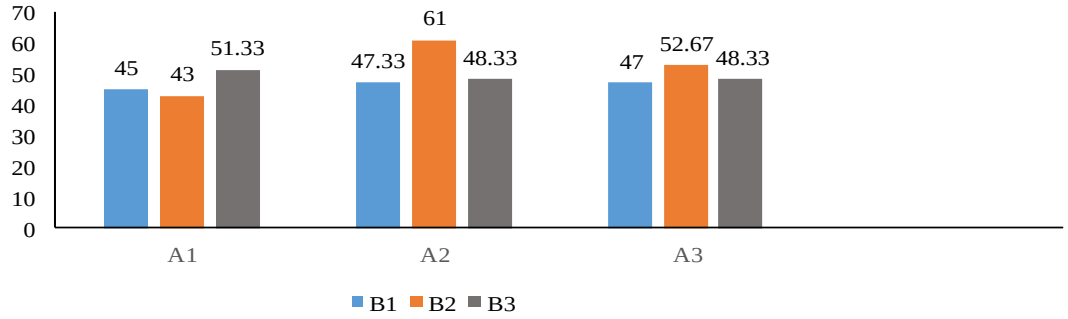

Figure 1. Height of Cherry Tomato Plants

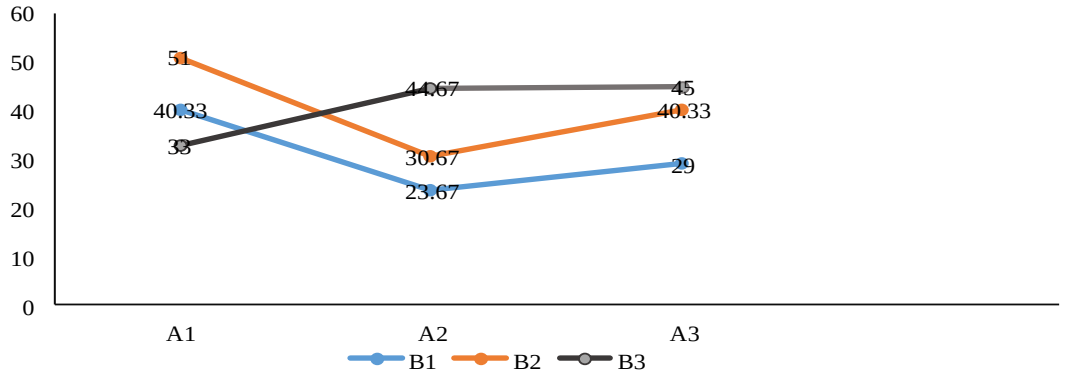

Figure 2. Total Fruit of Cherry Tomato

The frequency of *eco-enzyme* application of 2 times per week proved to be the best treatment to produce cherry tomato fruit weight, with an average weight of 425.78 grams per plant (Table 1). According to Lakitan, (2011), the size or weight of the fruit is more influenced by genetic factors (internal factors) compared to environmental factors. However, other factors such as the number of fruits produced per harvest also play an important role in determining fruit weight. The more fruits produced by a plant, the smaller the size or weight of the individual fruit tends to be. Conversely, the fewer the number of fruits produced, the larger the size or weight of the fruit. This is due to the distribution of photosynthate, which is the result of the photosynthesis process, which is translocated to parts of the plant that require energy for generative growth, such as flowering and fruiting. When the number of fruits increases, the available photosynthate must be divided more, so that each fruit receives fewer resources, resulting in a smaller size (Figure 2). Conversely, if the number of fruits is less, photosynthate can be focused on the development of individual fruits, resulting in a larger size. The results of this study emphasize the importance of managing genetic and environmental factors simultaneously to optimize cherry tomato yields.

Discussion

Application of *eco-enzyme* with certain concentrations can help increase the efficiency of nutrient use and improve the activity of soil microorganisms that support plant growth. In addition, *eco-enzyme* as biostimulants play a role in stimulating plant physiological processes, such as photosynthesis and photosynthate transport, which support plant generative growth (Antal-Tremurici et al., 2022; Kumar & Aloke, 2020; Sanjay et al., 2024). Previous studies have shown that *eco-enzyme* can improve soil structure, increase nutrient availability, and support beneficial soil microbial activity (Sembiring et al., 2021; Irmansyah et al., 2024).

The significant effect of *eco-enzyme* application time on fruit weight per plant indicates that the application management aspect is very important in optimizing plant growth. According to Qiang et al., (2024), the efficiency of organic biostimulant utilization such as *eco-enzyme* is influenced by the frequency and time of application, where application in the early vegetative phase can increase root growth, while application in the generative phase can optimize fruit formation. In addition, the role of *eco-enzyme* in increasing cherry tomato production can also be associated with its ability to increase the activity of soil enzymes such as dehydrogenase and phosphatase, which play a role in nutrient mineralization and phosphorus availability for plants (Gomiero et al., 2011). Thus, the timely application of *eco-enzyme* can increase the efficiency of nutrient utilization by cherry tomato plants, thus providing more optimal results.

Further test results with the Least Significant Difference (LSD) showed that the timing of *eco-enzyme* application had a significant impact on fruit weight per plant. This confirms that in sustainable agricultural practices, biostimulant application strategies need to be specifically designed according to the plant growth phase to maximize productivity. Furthermore, the application of *eco-enzyme* as part of an organic farming system can be a sustainable alternative to reduce dependence on chemical fertilizers and improve soil health (Chojnacka et al., 2014; Salvage et al., 2024).

Conclusion

The application of *eco-enzyme* with a concentration of 100 ml per liter of water has been proven to be effective in increasing the weight of tomato fruit per plant. The results showed that the best application frequency was twice a week, with an average fruit weight reaching 425.78 grams per plant. The effectiveness of this *eco-enzyme* can be explained by its role as a natural biostimulant that helps increase the efficiency of nutrient absorption by plants and optimizes the activity of microorganisms

around the root zone. The application frequency of twice a week provides an ideal balance between a sufficient supply of *eco-enzyme* to support plant physiological activity without causing saturation or decreasing its effectiveness. The results of this study indicate that the management of the dose and frequency of *eco-enzyme* application plays an important role in increasing the yield of cherry tomato.

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