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The Effectiveness of Trichoderma Biofertilizer on the Vegetative Growth of Rice Plants

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Abstract. This study aims to examine the effect of the combination of Trichoderma biofertilizer and liquid micro-nutrient fertilizer sprayed on the canopy at different time intervals and their interaction on the vegetative growth of rice plants. The treatments in this experiment were arranged factorially in a Randomized Block Design (RBD). The first factor was the combination of liquid micro-nutrient fertilizer and Trichoderma, consisting of without and with liquid fertilizer combination, while the second factor was the spraying interval, consisting of every week, every two weeks, and every three weeks. The experiment was repeated four times, resulting in 24 experimental units. The plant growth variables observed were plant height, number of tillers, and number of panicles. The interaction between the combination of liquid micro-nutrient fertilizer and Trichoderma and the spraying interval on the canopy significantly increased plant height but did not significantly affect the number of tillers and the maximum number of panicles. Spraying liquid biofertilizer and liquid microfertilizer every three weeks showed the highest results at a height of 55.27 cm. The combination of biofertilizer and microfertilizer has the potential to be applied to increase rice production.

Keywords: Liquid Micro-Nutrient Fertilizer, Trichoderma, Interval

1 Introduction

Rice is one of the staple foods for Asians. According to data from the Food and Agriculture Organization (FAO), in the last 10 years, the global rice production trend has tended to increase. Production even reached 520.8 million tons in the 2021-2022 period, setting a record high for the past decade[1] .On the other hand, soil nutrient problems are triggered by inappropriate agricultural practices[2] . Therefore, sustainability issues must be at the core of decision-making when determining the most appropriate agricultural practices and land use. Generally, conventional agriculture still relies on the use of chemical fertilizers, both macro and micro elements, causing a decline in rice field fertility. Unfertile rice fields have an impact on suboptimal rice production[3] .

Therefore, other more environmentally friendly alternatives are needed. One option is to utilize the biological agent Trichoderma. Trichoderma is a fungus that can be used as a biological control agent and also has the ability to act as a biofertilizer for plants[4] . The use of Trichoderma can help farmers in the field of agriculture as a natural fertilizer free of chemicals[5] . Trichoderma has beneficial properties for plants by improving the structure of the soil around them[6] . Meanwhile, the use of Trichoderma can protect plant health as this fungus has an inhibitory effect on pathogens that cause plant diseases[7] . So far, more attention has been paid to the use of synthetic chemical macro fertilizers, while the use of micro fertilizers has also attracted a lot of public attention, but they always use synthetic chemical compounds. Microelements are needed in small amounts by plants, but they also play an important role in the growth and production processes[8] . Microfertilizers are usually applied by spraying at intervals of about 10 days, but not much has been revealed about the levels below and above that period.

Similarly, there has been little research on the application of spraying on rice with regard to the spraying interval, except for tests on paddy rice plants combined with entomopathogens with a spraying frequency of every two weeks[9] . The application of micronutrients through the leaves can instantly reduce the time gap between application and absorption of nutrients by the plant root system, which can be considered an important factor during the active phase of rapid growth[10] .

Given the abundance and ease of obtaining chicken manure, the biological agent Trichoderma can be formulated in chicken manure. Its combination with the biological agent Trichoderma is expected to reduce the need for chicken manure without decreasing the effectiveness of the fertilizer applied to meet the optimal needs of the plants. The application of chicken manure can affect plant growth[11] . To date, it is not yet widely known

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how effective liquid micro-fertilizer formulations are in promoting plant growth when formulated with Trichoderma as a biofertilizer to enhance plant growth support. Similarly, the effect of liquid Trichoderma formulations on rice canopy combined with liquid micro-fertilizer applications on the vegetative growth of rice plants is also not yet widely known.

2 Methods

This study was conducted on rice fields in Penambangan village, Balongbendo subdistrict, Sidoarjo. The laboratory was located at the agrotechnology department of Muhammadiyah University Sidoarjo. The study was conducted from October 2023 to February 2024. The materials and tools used in this study were IR 64 rice seeds, Trichoderma biological agent, and Java Green liquid microfertilizer containing Zn, S, Mo, Cu, and MgO. Other tools included plastic tools, hoes, sickles, buckets, scales, measuring tapes, plow tractors, spray bottles, writing instruments, and mobile phones.

The experiments in this study were arranged factorially in a Randomized Block Design (RBD). The first factor was the combination of Trichoderma and liquid microfertilizer application, consisting of no application (T0) and the combination of Trichoderma biofertilizer and liquid microfertilizer (T1). The second factor was the interval of liquid fertilizer spraying, consisting of: every week (W1), every two weeks (W2), and every three weeks (W3). Each of the six treatment combinations was repeated four times, resulting in 24 experimental units. Each experimental unit consisted of a 2x5 m2 plot containing 16 plants.

Table 1. Treatment Combinations

	T	
W	**T0**	**T1**
W1	T0W1	T1W1
W2	T0W2	T1W2
W3	T0W3	T1W3

From these two combinations of factors, six treatment combinations were obtained, and the experiment was repeated four times, resulting in 24 experimental units.

This study began with the preparation of PDA (Potato Dextrose Agar) media and the propagation of Trichoderma sp. isolates. Potato pieces were boiled in water until the potato juice was extracted, then filtered and mixed with dextrose and agar powder. This solution was added to distilled water to reach a volume of 1000 ml, then boiled until homogeneous and clear in color. After that, the medium was divided into small Erlenmeyer flasks (250 ml) and sterilized at a temperature of 121°C for 25 minutes.

Trichoderma propagation is carried out by inoculating the isolate into PDA medium using an ose needle, then incubating it for 4–7 days until the colonies fill the medium. This culture is then used as biological fertilizer by applying it to chicken manure.

Land preparation begins with plowing until the soil is fine and flooded with water to a depth of 35 cm, then base fertilizer from chicken manure is applied. Plots are made with a planting distance of 20 x 20 cm, and three-week-old rice seedlings are transferred to the field.

Plant care includes manual weeding at 10, 20, and 30 days after planting. Microfertilizer application is carried out every 1–3 weeks starting from the second week after planting, with an initial dose of 100 ml/10 m² and increasing to 200 ml/10 m². Liquid biofertilizer is prepared by mixing Trichoderma solid fertilizer with water to a total of 100 liters, incubating for 6 hours, filtering, and spraying onto the plants periodically.

3 Results and Discussion

3.1 Research Results

An analysis of variance was performed to determine the effect of the combination of liquid Trichoderma biofertilizer and liquid micro-nutrient fertilizer with time intervals on the variables of plant height, number of tillers, and number of panicles per plant ( ). A 5% BNJ (Beda Nyata Jujur) test was performed if the analysis of variance showed significant differences.

The following are the results of the variance analysis for growth parameters and crop yield in Table 2.

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Table 2. Plant Height

Biofertilizer Formula and Interval	HST 21	HST 28	HST 35
Without liquid fertilizer interval 1 (T0W1)	30	50.5 a	61.30
Without liquid fertilizer interval 2 (T0W2)	31.23	51.27 a	61.60
Without liquid fertilizer interval 3 (T0W3)	31.30	51.00 a	61.63
Combination of interval 1 (T1W1)	32.53	51.40 a	61.27
Combination interval 2 (T1W2)	32.27	52.60 b	61.60
Combination interval 3 (T1W3)	32.33	55.27 b	63.97
BNJ 5%	tn	2.19	tn

Note: Numbers followed by different letters in the same column indicate significant differences based on the BNJ 5% test.

Based on Table 2, it is known that the effect of the combination application of Trichoderma and liquid micro fertilizer every 3 weeks on the plant canopy shows a significant difference in plant height at 28 days after planting. However, there is no significant difference at 21 days after planting and 35 days after planting.

Table 3. Number of offspring

Biofertilizer formula and interval	HST 21	HST 28	HST 35
Without liquid fertilizer, interval 1 (T0W1)	7.67	15.00	18.67
Without liquid fertilizer interval 2 (T0W2)	7.33	14.33	18.67
Without liquid fertilizer at interval 3 (T0W3)	8.00	15.67	21.33
Combination of interval 1 (T1W1)	8.0	14.33	19.67
Combination interval 2 (T1W2)	8.00	15.00	19.67
Combination interval 3 (T1W3)	8.0	16.00	22.00
BNJ 5%	tn	tn	tn

Based on Table 3, it is known that the effect of the combination of Trichoderma and micro liquid fertilizer with time intervals showed insignificant results on the number of tillers, so it was not necessary to continue with the 5% BNJ test. The analysis of the effect of the combination of Trichoderma biofertilizer and micro liquid fertilizer on the number of tillers is presented in Table 3.

Table 4. Number of Panicles

Biofertilizer Formula and Interval	Per clump
Without liquid fertilizer, interval 1 (T0W1)	18.67
Without liquid fertilizer, interval 2 (T0W2)	18.67
Without liquid fertilizer interval 3 (T0W3)	21.33
Combination of interval 1 (T1W1)	19.67
Interval combination 2 (T1W2)	19.67
Interval Combination 3 (T1W3)	22.00
BNJ 5%	tn

Based on Table 4, it is known that the effect of the application of the combination of Trichoderma and liquid micro fertilizer with time intervals shows no significant results on the number of panicles, so it is not necessary to continue with the 5% BNJ test.
The analysis of the effect of the combination of Trichoderma biofertilizer and micro liquid fertilizer on the number of tillers is presented in Table 4.

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3.2 Discussion

Based on the above research results, it is evident that the application of liquid Trichoderma biofertilizer and liquid microfertilizer at different time intervals has a significant effect on plant height. This is thought to be due to the essential microelement manganese (Mn) contained in liquid microfertilizer. Manganese is known to play an important role in various plant physiological processes, especially as an enzyme cofactor in nitrogen metabolism and chlorophyll synthesis (Broadley et al., 2012). Adequate Mn content can increase photosynthetic activity, which directly supports plant vegetative growth, including increased plant height. These results are in line with the research by Alejandro[12] , which shows that Mn application can significantly increase plant growth.

However, the combined application of liquid Trichoderma biofertilizer and liquid micronutrient fertilizer did not show a significant effect on the number of tillers and panicles. This indicates that other factors influencing tiller and panicle formation, such as the availability of macronutrients (especially N, P, and K), environmental conditions, and the physiological phase of the plant[13] ,[14] , are likely more dominant in regulating these reproductive parameters. In addition, Trichoderma is better known for its role in increasing plant resistance to stress and nutrient absorption efficiency through phosphate solubilization and phytohormone production such as auxin[15] , but its direct effect on reproductive aspects such as tiller and panicle formation still needs further research.

It is important to note that the results of this study cannot be interpreted to mean that the application of a combination of liquid Trichoderma biofertilizer and liquid microfertilizer at certain intervals is generally ineffective. Its effectiveness can be greatly influenced by specific agroecosystem conditions such as soil type, water availability, soil pH, and the type and variety of plants used. For example, soils with low Mn content or excessively high pH conditions can inhibit Mn availability to plants, resulting in different responses to microfertilizer application.

Therefore, further research is needed, taking into account other variables such as soil type (e.g., ultisol, inceptisol, or andisol), microclimate conditions, and more varied and adaptive fertilizer application intervals according to the plant growth phase. Further research could also examine the synergistic or antagonistic effects between Trichoderma microorganisms and certain micronutrients in influencing plant growth parameters and yields, in order to formulate more efficient and location-specific sustainable fertilization strategies.

4 Conclusion

The combination of liquid micronutrient fertilizer and Trichoderma, as well as the fertilization interval applied through the canopy, had a significant effect on plant height at 28 days after planting (DAP) with an application interval of every three weeks. However, there was no significant difference at 21 DAP and 35 DAP.

The application of the combination of Trichoderma and liquid microfertilizer at different intervals did not significantly affect the number of tillers and panicles. Spraying liquid biofertilizer and liquid microfertilizer every three weeks showed the highest results at a height of 55.27 cm. The combination of biofertilizer and microfertilizer has the potential to be applied to increase rice production.

The use of Trichoderma can still be an alternative choice for farmers as a chemical-free natural fertilizer. Trichoderma is capable of improving the structure of the soil around it. The combination of Trichoderma biofertilizer and micro nutrient liquid fertilizer has the potential to be applied to increase rice production. Therefore, further research is needed to determine the effect on rice growth on a larger scale and under different environmental conditions.

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