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Application of Biopesticide Fobio Against Moler Disease (*Fusarium oxysporum*) on Three Varieties of Shallots in Probolinggo City

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Abstract

Background: Moler illness on shallots is caused by the fungus *Fusarium sp*. This disease can cause damage to shallot plants, and if not controlled, it can cause crop failure. One way to overcome Moler disease is to use the biopesticide Fobio. This research aimed to determine the potential of Fobio Biopesticide against three shallot varieties in increasing growth and reducing the intensity of *Fusarium sp* attacks. **Method:** The method used is RAKF with factor 1 consisting of three shallot varieties (Biru Lancor, Tajuk, and Batu Ijo), factor 2 consisting of farmer treatment and Fobio Biopesticide concentration levels of 5 and 10 ml/l. **Results:** The results of the study showed that treatment with a Fobio Biopesticide concentration of 5 ml/l and the Biru Lancor variety was able to increase the best results in various variables such as plant height, wet weight, dry weight, disease intensity, and incubation period. **Conclusion:** Treatment with a Fobio Biopesticide concentration of 5 ml/l had a significant effect on the Biru Lancor variety on plant height variables up to 5 – 6 cm, wet weight up to 2.8 g/tuber, dry weight up to 1.7 g/tuber, disease intensity up to 8% at 42 HST, and the most extended incubation period is up to 23 days.

Keywords: Shallots; Fobio Biopesticide; *Fusarium sp.*

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Introduction

Shallots (*Allium ascolonicum L.*) are a seasonal crop grown intensively by farmers. This type of plant is included in the category of spice plants, which are used for food flavoring and traditional medicine. The increasing demand for shallot production in the market can potentially improve the local economy, create job opportunities, and support economic growth in an area. Several varieties of shallots developed in Indonesia, namely Biru Lancor, Batu Ijo, Tajuk, Bima Brebes, Trisula, Palu Valley, Tuk-tuk, Rubaru, Bauji, Manjung, Crok Kuning, Tungganamo, and Ilokos (Saleh et al., 2018).

The increase in demand for shallots means that shallot cultivation must increase further. Even though demand for the productivity of this crop continues to grow, domestic production is still not enough to meet market demand because shallots are a seasonal crop. This condition often causes a shortage of shallot supplies in several regions, which can cause unstable price fluctuations and contribute to inflation in the agricultural sector (Setiawan & Hadiono, 2014). The decline in the productivity of shallot plants can be influenced by various factors such as climate change, the use of low-quality seeds in cultivation, and increased attacks by plant pests (OPT), which can reduce the productivity of shallot plants (Sumarni & Hidayat, 2005).

The disease that often infects shallot plants is moler, caused by the fungus *Fusarium oxysporum*. This disease is one of the main problems that arise in shallot plants; it can cause damage to the plant and reduce bulb production. Wiyatiningsih (2007) stated that the initial symptoms of moler disease in shallot plants are that the plant stem appears wilted, the leaves are pale green, and the growth of the leaves is longer and twisted than usual.

The use of pesticides is often the leading choice for farmers when dealing with damage to shallot plants due to moler disease; however, the use of pesticides raises several problems that have the potential to disrupt the environmental balance. Excessive use of pesticides can cause damage to the environment, including polluting soil and water, reducing biodiversity, and can harm non-target organisms. One alternative to overcome this problem is to carry out disease control that is more environmentally friendly, such as using Fobio Biopesticide, which is made from natural ingredients. This biopesticide acts as a microorganism that can increase plant resistance to pathogen attacks (Nurfitriana et al., 2019). Biopesticide Fobio contains several important organisms as biological agents, decomposers, and PGPR (Plant Growth-Promoting Rhizobacteria).

Fobio biopesticide has the advantage of reducing residues that usually accumulate in soil and plants by utilizing various microorganisms. This biopesticide not only provides a solution for controlling plant diseases but also helps maintain soil quality and reduces the negative impact of pesticide residues on the environment. According to the research results of Wiyatiningsih & Sukaryorini (2009), spraying biopesticide at a dose of 2.5 ml/l on a greenhouse scale has been proven to increase the resistance of shallot plants to moler disease caused by *Fusarium oxysporum*. This shows that biopesticides can help improve plant resistance to onion diseases. This research aimed to evaluate the potential of Fobio Biopesticide against three different varieties of shallot plants. The main focus of the study is to find out how effective Biopesticide Fobio is in increasing plant growth and reducing the level of *Fusarium sp* disease attacks. By conducting this research, it is hoped that we will be able to find important information about how effective Fobio Biopesticide is.

Method

Time and Place

This research was carried out from March to May 2023 in Jrebeng Kulon Village, Kedopok District, Probolinggo City. This research used three varieties of shallots obtained from different locations in East Java, consisting of the Biru Lancor variety, which came from Probolinggo; the Batu Ijo variety, which came from Batu Malang; and the Tajuk variety, which came from Nganjuk.

Tools and materials

The tools and materials used in this research included a hoe, sickle, sprayer, measuring cup, ruler, and camera. Meanwhile, the materials used in this research were three types of shallot varieties: Biru Lancor, Tajuk, Batu Ijo, manure, ZA, SP36, KCL, Fabio biopesticide, and mancozeb fertilizer.

Research methods

This research used a factorial randomized block design consisting of two factors; namely, factor 1 consisted of three shallot cultivars such as M1= Biru Lancor shallot variety, M2= Batu Ijo shallot variety, M3= Tajuk shallot variety, and factor 2 was B0. = farmer treatment, B1= Fobio Biopesticide concentration 5 ml/l, and B2= Fobio Biopesticide concentration 10 ml/l. Then, 2,700 shallot plants were used in this research, and each experimental plot consisted of 100 plants. Three repetitions were carried out on each experimental plot.

Planting and Observation Parameters of Shallots

This research used three varieties of shallots obtained from different locations in East Java: the Biru Lancor variety from Probolinggo, the Tajuk variety from Nganjuk, and the Batu Ijo variety from Batu Malang. Shallot planting is carried out on a land area of 20 x 20 m with a planting distance of 15 x 15 cm. In this study, various variables were observed to evaluate the response of shallot plants to the use of Fobio Biopesticide. The variables that are the main focus include the incubation period of the disease, which is carried out when the plant has shown disease symptoms, the intensity of the disease, agronomic observations in the form of plant height, which is carried out by measuring the height of the plant using a ruler from the base of the plant to the highest leaf, the number of leaves which is carried out using a ruler. How to count the number of leaves formed on each shallot plant: wet weight is done post-harvest by cleaning the plants from the soil attached to them due to the liquidation process and then carrying out the weighing process; dry weight is done when the plants have been dried and weighed using digital scales, and disease intensity can be determined through direct observation in each treatment plot and after that, the disease intensity is calculated. According to Nurhayati (2011), systemic diseases can be calculated using the formula:

$$I = \frac{a}{b} x\ 100\%$$

Information:
I = Disease Intensity
a = Number of plants affected by the disease
b = Total number of plants

Data analysis

Data analysis was carried out to determine the effect of Fobio Biopesticide concentration on three shallot varieties. The data collected will be analyzed using analysis of diversity (ANOVA). If the data results show a real difference, proceed with the Mean Difference Test (DMRT), carried out at a significance level of 5%.

Result and Discussion

Incubation Period

The incubation period is the initial time for the appearance of moler disease symptoms in shallot plants. Incubation period data can be found by observing the time of the appearance of moler disease symptoms calculated from the beginning of the growth of shallot plants, and this observation is carried out every day. The results of the diversity analysis in shallot plants show that there are differences between treatments of the moler disease incubation period. Table 1. shows that the treatment with a concentration of Fobio Biopesticide 5 ml/l and the Biru Lancor variety has an incubation period of 23 days. It is suspected that the longer the incubation period, the longer the plant will experience damage so that it can produce new bulbs. Fobio Biopesticide is considered to be able to increase the resistance of shallot plants to Fusarium wilt. Then, the lowest incubation was found in the farmer's treatment with the Biru Lancor variety and the farmer's treatment with the Batu Ijo variety, with an incubation period of 15.7 and 16 days.

Table 1. Observation of the Incubation Period for 6 Weeks

Treatment	Incubation Period
B0M1	15,7 a
B0M2	16,0 a
BOM3	16,7 a
B1M1	23,0 b
B1M2	18,7 a
B1M3	17,7 a
B2M1	17,0 a
B2M2	17,7 a
B2M3	17,7 a

Description: Numbers followed by the same letter indicate no significant difference.

Fusarium sp. can attack shallots 9-10 days after planting (Ramadhina, 2013). *Fusarium sp*. can also cause crop failure of up to 100% if not controlled; this is because *Fusarium sp*. spores can be carried through water so that the infection spreads widely (Nurcahyanti et al., 2023). Based on the study's results, treatment with Fobio Biopesticide inhibited the appearance of symptoms of moler disease damage in shallots for up to 23 days. Farisa et al. (2023) stated that applying Fobio Biopesticide with Trichoderma sp. increased the resistance of shallot plants to inhibit symptoms of damage caused by moler disease for up to 20 HST. It can be concluded that the administration of Fobio was able to inhibit the growth of *Fusarium sp*., but this inhibition was not only caused by the use of Fobio biopesticide; the use of different varieties and the process of caring for shallots can also affect the growth of *Fusarium sp*. Hasyidan et al. (2021) stated that Fobio Biopesticide could suppress the rate of fusarium wilt development due to the lactic acid content of Lactobacillus sp., which functions as a pathogen antagonist.

Disease Intensity

The intensity of moler disease caused by *Fusarium sp*. fungus can be determined by direct observation in the treatment plot. This observation was carried out once a week for two months. The results of the diversity analysis showed that there were differences between treatments. Based on the results, the lowest damage intensity was in the treatment with a concentration of Fobio Biopesticide 5 ml/l and the Biru Lancor variety with a damage scale of 8% at 42 HST, while the highest damage intensity was in the farmer treatment and the Batu Ijo variety with a damage scale of 12% at 42 HST (Table 2). So, it can be said that Fobio Biopesticide can inhibit the intensity of *Fusarium sp*. damage.

The damage intensity data obtained on average showed an increase but not too significant in the control treatment (BO), showed that the highest increase was followed by treatment (B2) 10 ml/l, and the last was in treatment (B1) 5 ml/l. The administration of Fobio has been proven to inhibit the growth of *Fusarium sp*. This is because it contains microorganisms originating from the rhizosphere of coconut, sugar cane, siwalan, tunjang, mangrove plants, phosphate-solubilizing bacteria, Rhizobium sp., amylolytic bacteria, proteolytic bacteria, photosynthetic bacteria, ammonifying bacteria, nitrifying bacteria where these microorganisms can increase plant resistance to pathogens (Sukaryorini & Wiyatiningsih, 2009). In addition, the use of varieties can also affect the growth of *Fusarium sp*. This is because each variety has different plant resistance Subrahmanyan et al. (2020).

Table 2. Observation of Moler Disease Intensity for 6 Weeks

Treatment	14 HST	21 HST	28 HST	35 HST	42 HST
B0M1	3 c	5 b	8 c	10 c	11 b
B0M2	3 c	6 b	9 d	11 c	12 c
BOM3	2 b	5 b	8 c	10 c	11 b
B1M1	1 a	3 a	5 a	2 a	8 a
B1M2	2 b	4 a	6 a	8 b	9 a
B1M3	2 b	4 a	7 b	8 b	9 a
B2M1	1 a	3 a	5 a	7 a	8 a
B2M2	2 b	4 a	7 b	9 b	10 b
B2M3	2 b	5 b	7 b	9 b	10 b

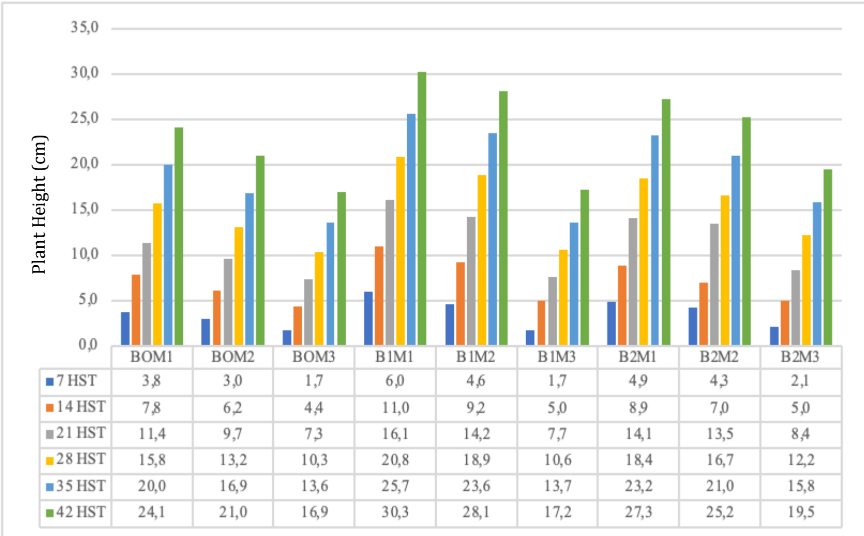
Description: Numbers followed by the same letter indicate no difference between treatments.

The disease intensity table above shows that administering Fobio Biopesticide to shallots can suppress the growth and attack of *Fusarium sp*. fungi. Hasyidan et al. (2021) stated that Fobio Biopesticide could inhibit the growth rate of *Fusarium sp*. This occurs because of the lactic acid content produced by Lactobacillus sp. This lactic acid has been proven effective in suppressing the development rate of *Fusarium sp*. and can potentially control and reduce the impact caused by pathogens on shallots. Fobio Biopesticide has a diverse microorganism content to protect plants from pathogens. Subrahmanyam et al. (2020) stated that the relationship between microbes and plants is mutualistic, where microbes can bind elements from outside and induce plant resistance while the host plant provides a place for these microbes to grow. Liu et al. (2021) also argue that soil with a high microbial diversity can inhibit the growth of soil-borne diseases.

Plant Height

The height of the shallot plant was obtained by measuring using a ruler from the base of the plant to the highest leaf. The data obtained were then processed and displayed in Figure

1, which shows that the treatment with a concentration of 5 ml/l Fobio Biopesticide and the Biru Lancor variety had a significant increase within seven days where the shallot plant was able to grow 5-6 cm taller, while the treatment that showed the lowest results was in the farmer's treatment and the Tajuk variety where within seven days it only increased by 3-4 cm.



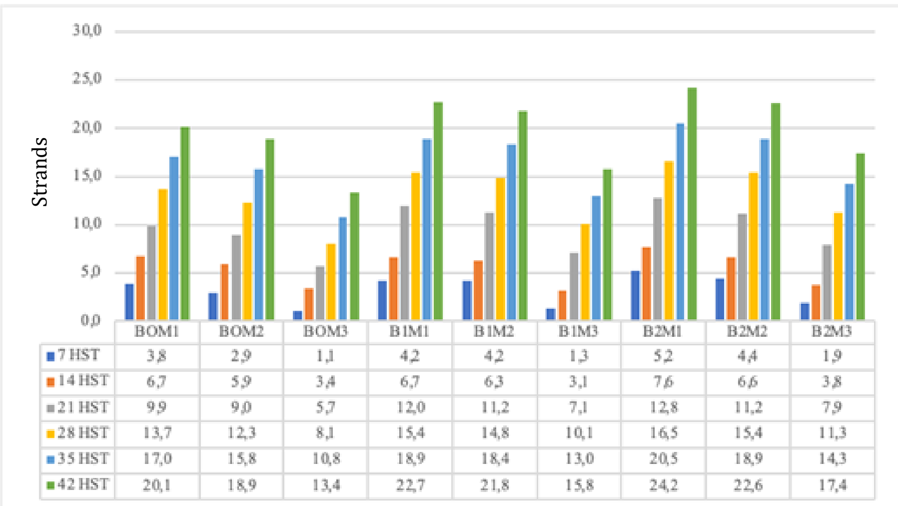
	BOM1	BOM2	BOM3	B1M1	B1M2	B1M3	B2M1	B2M2	B2M3
7 HST	3,8	3,0	1,7	6,0	4,6	1,7	4,9	4,3	2,1
14 HST	7,8	6,2	4,4	11,0	9,2	5,0	8,9	7,0	5,0
21 HST	11,4	9,7	7,3	16,1	14,2	7,7	14,1	13,5	8,4
28 HST	15,8	13,2	10,3	20,8	18,9	10,6	18,4	16,7	12,2
35 HST	20,0	16,9	13,6	25,7	23,6	13,7	23,2	21,0	15,8
42 HST	24,1	21,0	16,9	30,3	28,1	17,2	27,3	25,2	19,5

Figure 1. Diagram of the rate of growth of red onion height over six weeks.

Treatments using Fobio Biopesticide with concentrations of 5 ml/l and 10 ml/l had good height growth compared to farmer treatments. This is thought to be due to the soaking of shallot seeds for 60 minutes, which aims to allow the microbes contained in Fobio Biopesticide to grow in the shallot seeds by the SOP of Fobio Biopesticide. Nurfitriana et al. (2019) stated that the microbes contained in Fobio Biopesticide could act as PGPR (Plant Growth Promoting Rhizobium) to help the vegetative growth of shallots.

Number of Leaves

The number of shallot leaves was obtained by counting the leaf forms healthily on each shallot plant. The data obtained were processed and displayed in Figure 2, where it is known that overall, the growth of shallot leaves is only around 4-5 strands per week. Patading et al. (2021) stated that shallot leaves can increase by 6-7 strands if the conditions are optimal and the maintenance is according to the needs of the variety.



	BOM1	BOM2	BOM3	B1M1	B1M2	B1M3	B2M1	B2M2	B2M3
7 HST	3,8	2,9	1,1	4,2	4,2	1,3	5,2	4,4	1,9
14 HST	6,7	5,9	3,4	6,7	6,3	3,1	7,6	6,6	3,8
21 HST	9,9	9,0	5,7	12,0	11,2	7,1	12,8	11,2	7,9
28 HST	13,7	12,3	8,1	15,4	14,8	10,1	16,5	15,4	11,3
35 HST	17,0	15,8	10,8	18,9	18,4	13,0	20,5	18,9	14,3
42 HST	20,1	18,9	13,4	22,7	21,8	15,8	24,2	22,6	17,4

Figure 2. Diagram of the rate of development of red onion leaves over six weeks.

The farmer's treatment had less shallot leaf growth than the Fobio Biopesticide treatment with a concentration of 5 ml/l and ten ml/l, and this was because the farmer's treatment used mancozeb where this mancozeb was sprayed as much as two g/l and was carried out three times a week. Benu et al. (2019) stated that mancozeb is a chemical fungicide that can control various types of fungi in the soil, both pathogenic and non-pathogenic; their research showed that there was a decrease in the endophytic fungal diversity index from 20.52% to 16.20%, causing shallot growth to be inhibited and susceptible to other diseases. The administration of Fobio Biopesticide can increase the vegetative growth of shallot plants at specific concentrations, such as Fobio Biopesticide concentrations of 5 ml/l and ten ml/l. Research by Nurfitriana et al. (2018) stated that Fobio Biopesticide can induce plant resistance and increase plant growth because of biopesticide properties such as PGPR.

Wet Weight and Dry Weight

The results of the analysis of the diversity of Fobio Biopesticide administration showed that there was no difference between the wet weight and dry weight variables in shallots. Figure 3 shows that the treatment with a concentration of 5 ml/l Fobio Biopesticide and the Biru Lancor variety had the best results with a wet weight of 2.8 gr/bulb and a dry weight of 1.7 gr/bulb so that it had a tangled value of 1 gr.

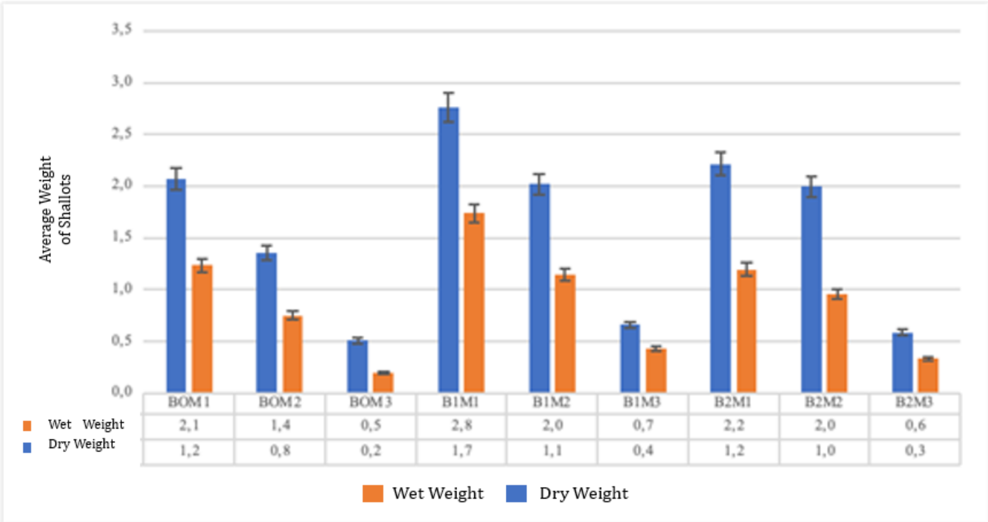


Figure 3. Diagram of wet weight and dry weight of shallots for six weeks.

Fobio Biopesticide can increase the wet and dry weight of shallots in the treatment with a concentration of 5 ml/l Fobio Biopesticide and the Biru Lancor variety. Fobio Biopesticide contains substances that function as plant growth-promoting Rhizobacteria (PGPR). These substances increase plant growth by influencing the root system, helping nutrient absorption, and protecting plants from pathogen attacks. The presence of PGPR in Fobio Biopesticide makes it more than just a solution for controlling plant diseases; it also helps improve plant health and productivity. Wiyatiningsih et al. (2009) stated that the microorganisms contained in Fobio include bacteria that can dissolve phosphate, photosynthesize, decompose starch, break down protein, convert ammonium, and nitrify. These microorganisms carry out the function of PGPR and increase resistance in shallot plants. Yadav et al. (2021) stated that microbes have an essential role in agriculture if we want to realize sustainable agriculture; apart from acting as PGPR and plant protection, microbes can also improve soil texture through soil management.

Conclusions

Based on the research that has been carried out, it can be concluded that Fobio Biopesticide can increase the resistance of shallot plants to moler disease attacks. Treatment with a Fobio Biopesticide concentration of 5 ml/l had a significant effect on the Biru Lancor variety on plant height variables up to 5 – 6 cm, wet weight up to 2.8 g/tuber, dry weight up to 1.7 g/tuber, disease intensity up to 8% at 42 HST, and the most extended incubation period is up to 23 days.

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Declaration statement

The authors reported no potential conflict of interest.

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