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Response of Microorganism Suspension and Various Kinds of Organic Fertilizers to the Development of Pathogen *Fusarium sp*. on Shallots

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ABSTRACT

Shallot (*Allium ascalonicum L.*) is one of the horticultural plants that acts as a natural antioxidant. Shallot's productivity in Indonesia is relatively low. It's influenced by various factors, one of which is due to the attack of a soil-borne pathogen, namely *Fusarium oxysporum*. Symptoms of *Fusarium oxysporum* pathogen attack are yellow or pale green leaves and more elongated growth. Severe attack leads plant to death. Balanced fertilization and biopesticides application can prevent Fusarium wilt. This study aims to reduce and control Fusarium wilt disease. The research method used was the Split Plot Design method which consisted of two factors with the main plot, namely the application of suspension of microorganisms (S) which consists of two levels, namely fungicide application (S0) and Fobio application and the sub-plot, namely the application of various organic fertilizers (M) which consists of three levels, namely control (chemical fertilizer) (M0), chicken manure (M1), and Piensbio organic fertilizer (M2). Observation data for each treatment will be analyzed using analysis of variance (ANOVA). Followed by Duncan test (α = 5%) if there were differences in each treatment. The results of this study, the main plot treatment, fungicide application (S0), showed an incubation period of 29 days and an average intensity of disease attacks of 4.2%. The treatment of subplots, a type of organic fertilizer (M), is unable to suppress the intensity of the attack and slow down the incubation period of the *Fusarium sp* on shallot crops. There was no interaction between the treatment of the main plots and the subplots on all the observation parameters.

1. Introduction

Shallot (*Allium ascalonicum L.)* is a horticultural crop that has many benefits for Indonesian and has a fairly high selling price in Indonesia. Shallots act as natural antioxidants that can suppress free radical compounds from outside. Shallots are often found at an altitude of 10–250 m above sea level. Shallots can live in climates that are rather hot, dry, and sunny weather. Rainfall that is suitable for the growth of shallots is 300 – 2,500 mm/year. The need for sunlight for shallots is 11-16 hours per day (Wartapa *et al*., 2017). According to the Central Bureau of Statistics (2021), Indonesia will produce 1,815,445 tons of shallots overall in 2020.

In Indonesia, shallots are one of the horticultural products with a potential yield of 77,53% especially in Java (Setiani, 2019). However, shallot production in Probolinggo decreased by 22.4% in 2021, or 663,708 tons (BPS, 2022). The low productivity of shallots, especially in Probolinggo City, is influenced by many factors, one of which is due to shallot pests and pathogens. The main pathogen that attacks shallots is the fungus *Fusarium oxysporum*. According to Sukaryorini & Wiyatiningsih (2009), The pathogenic fungus *Fusarium oxysporum* is a soil-borne pathogen and its attack occurs through plant roots. The pathogenic fungus *Fusarium oxysporum* has the ability to survive in living and dead plant tissues and can even survive for a long time in the soil and is saprophytic. The pathogen enters the plant root tissue through wounds. Klasmidiospores can germinate if there is root stimulation from sugar and amino acid compounds and also due to the accumulation of plant residues in the soil (Saputra, 2020). If the pathogen attack is not immediately controlled, resulting in a production loss of more than 50% (Rahmiyati *et al*., 2021).

Fusarium wilt disease on shallots occurs at the age of 5-20 days after planting (DAP) (Aprilia *et al*., 2020). Symptoms of *F. oxysporum* attack are leaves turning yellow or pale green and growing more elongated, twisted, curly, so that the plants become short and sluggish due to the disruption of the process of transferring water and nutrients. (Prakoso *et al*., 2016 and Sari & Inayah, 2020). According to Wahyu *et al*. (2012), if the shallots affected by the fungus *Fusarium oxysporum* are cut lengthwise, rotting of the tuber base can be seen from top to side.

To control Fusarium wilt disease, farmers in Probolinggo often rely on chemical products such as fungicides made from the active mancozeb. The use of chemical products has a positive impact as well as a negative impact because the use of these chemicals leaves residues that can pollute the environment, have extensive killing power to reduce natural enemies and biological control agents. In order to suppress the population of the fungus *Fusarium oxysporum*, various methods have been carried out culturally, mechanically, and even biologically. One of the technical crop controls is the application of biopesticide and balanced fertilization. Research results from Nuryani *et al*. (2013) show that the application of Gliocompost may act as a biological fungicide and organic fertilizer. combined with synthetic chemical fertilizers can control Fusarium wilt and provide a good effect on plants. One of the biopesticides that can be used is Fobio and organic fertilizers that can be used are chicken manure and Piensbio fertilizer.

Fobio is a bio-pesticide with the Ordinary Patent Registration Number P00201200183, which is made from a suspension of microorganisms obtained from various types of plant roots such as coconut plant roots, mangrove plant roots, sugarcane plant roots, sapling plant roots, and siwalan plant roots. Also, obtained from coconut water, green coconut water, siwalan water, and cow's milk. Fobio Medium is made from liquid meat extract, black glutinous rice extract, potato extract, and glucose extract. This phobio contains beneficial microorganisms including yeast, phosphate solubilizing bacteria, Lactobacillus sp., Rhizobium sp., amylolytic bacteria, proteolytic bacteria, photosynthetic bacteria, ammonification bacteria, and nitrifying bacteria (Sukaryorini and Wiyatiningsih, 2009).

Chicken manure is an organic fertilizer made from fermented chicken manure. Chicken manure is useful in the process of improving soil physical properties, especially soil aggregates, moisture content, and soil porosity (Fadillah *et al*., 2020), as well as increasing the activity of microorganisms in the soil to carry out the soil decomposition process. This role is proven because chicken manure contents high level of macro nutrients (nitrogen, phosphorus, potassium, calcium, and sulfur) as well as micronutrient factors (iron, zinc, boron, cobalt and molybdenum) in small amounts (Nurrudin *et al*., 2020). Based on Silalahi *et al.* (2018)

Chicken manure contains 1,3% N, 1,3% P_2O_5 and 0,8% K_2O. The amount of chicken manure can help plants grow from the vegetative to the generative phase. It's also able to decrease the percentage of pathogenic attack intensity Fusarium sp by 48% (Sutarini *et al.*, 2015)

Piensbio is included as solid bokashi fertilizer because the method of making Piensbio has a way of making and the ingredient needed are almost the same as making solid bokashi fertilizer but in this Piensbio does not use EM4 as an activator but uses Phobio. The basic ingredients for making Piensbio are chicken manure, temulawak, rice husks, rice bran, rice washing water, and Fobio which are fermented for three weeks. Based on the results of laboratory tests, Piensbio containing nutrients N 1,13%, P 0,84%, and K 0,97%. The aim of this research is to reduce and control the invasion of Fusarium lethargy in shallot.

2. Methodology

This research was conducted from August to October 2022, in a farmer's experimental field located in Jrebeng Lor Village, Kedopok District, Probolinggo City, East Java. The materials used in this research were shallot seeds of the Biru Lanchor variety, NPK, ZA, KCl, chicken manure, Piensbio solid organic fertilizer, chemical pesticides, and Fobio. This study used a split plot design, with the main plot are the application of suspension of microorganisms (S) consisting of 2 levels, namely S0 = Control (without suspension of microorganisms) and S1 = suspension of microorganisms (Fobio). Meanwhile, the sub-plot is the type of organic fertilizer (M) which consists of 3 factors, namely M0 = Control (Inorganic Fertilizer), M1 = Chicken manure, and M2 = Piensbio. All treatments were repeated 5 times and there were 30 experimental combinations. One treatment consisted of 100 plants.

The dose of organic fertilizer in the M1 and M2 treatments was 6 kg/plot by spreading it evenly with the soil moist. Furthermore, soil sterilization was carried out 3 times using Fobio with a concentration of 10 ml/liter of water which was sprayed evenly on the soil that had been mixed with solid organic fertilizer and then chopped to mix it evenly. Planting the seeds is done with a soil distance of 20 cm x 20 cm. The maintenance of shallot plants includes irrigation with the deep flow irrigation, replanting and weeding, fertilizing using inorganic fertilizers in the M0 treatment (inorganic fertilizer) 3 times at a dose of 5 kg/plot, and controlling plant pests in the S0 treatment (without suspension or control) using a synthetic fungicide with the active ingredient mancozeb at a dose of 2 g/l, and in the S1 treatment (microorganism suspension (Fobio) it was carried out once a week at a dose of 10 ml/l water.

The observation parameters consist of calculating the wet weight and dry weight per plot, the incubation period of the pathogen which is calculated from the beginning of the appearance of disease symptoms until the end of the appearance of symptoms, and calculating the percentage of disease intensity using the Rahmayani & Pramudi formula (2021):

$$P = \frac{n}{N} x 100\%$$

Abbreviations:
P = percentage of disease attacks (%)
n = number of diseased plants
N = all observed plants

Each treatment's observational data will be examined using analysis of variance (ANOVA). If there were variations between the treatments, the Duncan test (= 5%) was performed.

3. Results and Discussion

3.1 Incubation Period

Incubation period is the time or period for the appearance of symptoms from the beginning to the end due to a pathogen attack on a crop (Kaeni *et al*., 2014). The incubation period for Fusarium sp. on shallot plants showed that the interaction between the application of suspension of microorganisms (S) and various kinds of organic fertilizers (M) showed no significant difference. However, based on the main plot, the application to the soil or the suspension of microorganisms (P) showed very significantly different results. The average value of the incubation period of the pathogen can be seen in Table 1.

Table 1. Average Incubation Period of Pathogens in Shallot Plants Due to Suspension of Microorganisms and Various Kinds of Organic Fertilizers

Treatment	Incubation Period (DAP)
Main Plot:	
Control (S0)	29b
Fobio (S1)	26a
DMRT 5%	0,000254
Sub-plot:	
Control (M0)	27a
Chicken Manure (M1)	27a
Piensbio (M2)	28a
DMRT 5%	0,000279

Note: Numbers followed by the same letters, in the same treatment and column, were not significantly different in the DMRT test at α = 5%

(a) (b)

Figure 1. (a) & (b) the condition of the plant is attacked by Fusarium wilt disease

The average performance of incubation periods in the shallot plants in Table 1 was highest in the application treatment with no suspension or control (S0). The treatment on the subplot, namely control, manure and Piensbio organic fertilizer (M2) showed the same incubation period. These results are in accordance with research by Supriyadi *et al*. (2013) that the incidence of Fusarium wilt attack on shallots occurred at the age of 20 HST.

The mean value of this incubation period indicates that the higher the average incubation period, the higher the plant's resistance level. The speed of the incubation period of the pathogen in shallot plants is influenced by the environmental factors that support the development of the fungus *Fusarium* sp. During the planting season of shallots, the environmental conditions in Probolinggo were in extreme weather conditions, namely relatively high air temperatures, low air and soil humidity, little rainfall, so that these environmental conditions were not optimal for the growth and development of the fungus *Fusarium* sp. in high numbers. According to Supriyadi *et al*. (2013) the incubation period of the fungus *Fusarium* sp. influenced by the higher soil temperature will result in plant roots becoming more easily injured thereby accelerating and making it easier for pathogens to penetrate the host root tissue, and also dry soil conditions resulting from rising temperatures and low soil moisture can accelerate the attack of *Fusarium* sp.

The planting media used in this study may also be affected by the growth of the pathogen *Fusarium* sp. on shallots. The organic fertilizer content applied to shallots, including in the treatment of chicken manure, contains elements N 1,3%, P2O5 1,3%, and K2O 0,8% (Silalahi *et al*., 2018), and in the treatment of organic fertilizer Piensbio based on the results of laboratory tests containing nutrients N 1,13%, P 0,84%, and K 0,97%. Depending on the concentration of potassium nutrients are able to increase the resistance of plants to pathogenic attacks, particularly on shallots. Indeed, potassium can increase the formation of phenolic compounds and reduce inorganic nitrogen elements in plant tissues (Subandi, 2013).

3.2 Attack Intensity

The interaction between the application of micro-organism (S) suspension and various types of organic fertilizers (M) gave unreal and different results in the interaction of both. However, based on the main plot, application to soil or application of suspension of microorganisms (S) showed highly significant different results on the intensity of attack by the fungus Fusarium sp. on shallot plants. The average value of the intensity of pathogen attack can be seen in Table 2.

Table 2. Average Intensity of Shallot Plant Pathogen Attack Due to Microorganism Suspension and Various Kinds of Organic Fertilizers

Treatment	Average attack intensity		
	28 DAP	35 DAP	42 DAP
Main Plot:			
Control (S0)	2,33b	4,13b	6,13b
Fobio (S1)	4,07a	5,93a	8,93a
DMRT 5%	0,156	0,176	0,294
Sub-plot :			
Control (M0)	3,50a	5,20a	7,40a
Chicken Manure (M1)	3,20a	5,30a	7,80a
Piensbio (M2)	2,90a	4,60a	7,40a
DMRT 5%	0,185	0.369	0,441

Note: Numbers followed by the same letters, in the same treatment and column, were not significantly different in the DMRT test at α = 5%

(28 DAP) (35 DAP) (42 DAP)

Figure 2. Intensity of Shallot Plant Pathogen Attack from the age of 28 – 42 DAP

The results of the average attack intensity of Fusarium sp. in the shallot plants presented in Table 3 the highest average values were at 42 DAP, namely the treatment of the application of suspension of microorganisms or Fobio (S1) and the application of chicken manure (M1), namely 8.93% and 7.8%. These results indicate that the fungicide treatment reduced the intensity of Fusarium sp. When compared with the use of Fobio. This is because the fungicide has high toxicity, so when applied to shallots it can directly control Fusarium wilt. Meanwhile, Fobio has a relatively slow way of working, because according to Sukaryorini and Wiyatiningsih (2009) Fobio contains various kinds of microorganisms such as yeast, namely Saccharomyces sp. and Lactobacillus sp. able to control Fusarium sp. so it takes a long time to control Fusarium sp.

According to Agustining (2012), that *Saccharomyces cerevisiae* was able to control the fungus Fusarium sp. because Saccharomyces cerevisiae is antifungal because it is able to produce volatile compounds, antibiotics, ethanol, chitinase, and peroxidase which can inhibit the growth of the fungus Fusarium sp. Use of Lactobacillus sp. able to control pathogens such *as Fusarium sp. and Pseudomonas sp.* because *Lactobacillus sp.* has antimicrobial properties capable of producing metabolites including hydrogen peroxide, carbon dioxide, lactic acid, acetic acid, and bacteriocins (Hasyidan *et al*., 2021). According to Wiyatiningsih *et al*. (2020), *Lactobacillus sp* bacteria. capable of converting lactose into lactic acid, where lactic acid can cause infertility in microorganisms, so as to suppress the growth of bacteria such as the fungus Fusarium sp. and accelerate the process of decomposition of organic matter. The potassium content of chicken manure and Piensbio can increase plant resistance to pathogens. This will reduce the percent intensity of *Fusarium* sp pathogen attacks on shallots.

3.3 Wet and Dry Weight

Wet weight and dry weight of shallot stover, the interaction between the application of suspension of microorganisms (P) and various kinds of organic fertilizers (M) proved that the results were not significantly different. The average water weight and dry weight per plot can be seen in Figure 3.

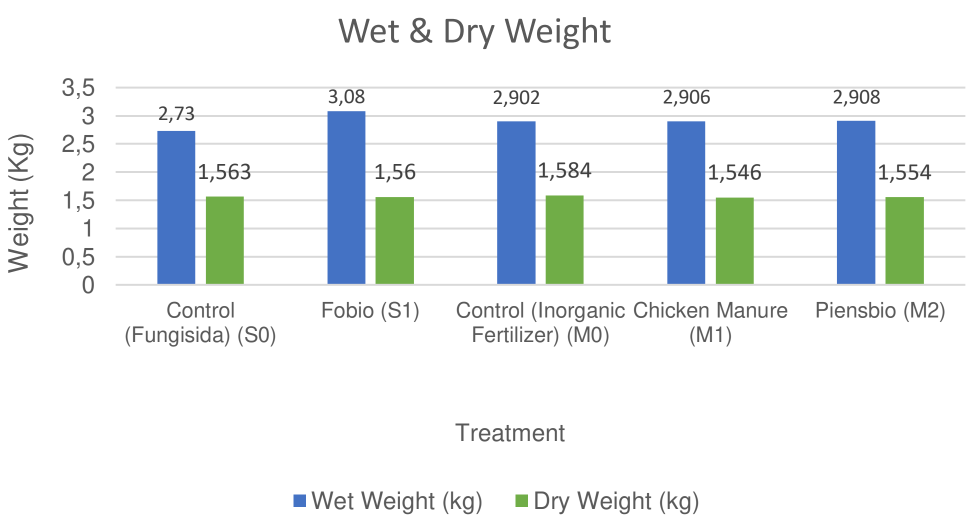

Figure 3. Average Wet Weight and Dry Weight of Shallot Plants Due to Microorganism Suspension and Various Organic Fertilizers

The mean wet weight values in Table 3 show that the main plot was treated between the control (S0) and Fobio (S1) give the same results as the existing treatments in the subplots. This shows that Fobio and Piensbio fertilizers contain nutrients that can increase shallot production, because in the process of making Piensbio fertilizer fermentation is carried out from chicken manure and Fobio. Piensbio fertilizer contains 0,84% P and 0,97 K nutrients, where the function of P nutrients is to help the formation of onion bulbs, and K nutrients function to increase growth and yield development by increasing carbohydrate and protein metabolism (Mustikawati *et al.*, 2020 and Saputra *et al.*, 2021).

In addition to the availability of nutrients, the age of the seedlings also affects tuber yield. The age of good tuber seeds is with a shelf life of 3-4 months. Based on Giamerti & Mulyaqin (2013) The shallots bulbs used by the aunt must have a minimum shelf life of 2 months and a maximum of 6-8 months. This affects the viability and size of the seeds. Based on Deden & Wachdijono (2018) stated that increased water absorption and deposition of photosynthetic products on the leaves can increase the wet weight of the tubers because the high absorption of water and the results of photosynthesis affect the tuber formation process.

The dry weight of tubers was obtained from drying for 7 days. From the results of the average dry weight of plants, yields decreased. Based on the average value of the dry weight of shallot plants, it is proven that the level of treatment in the main plot gives the same or different results is not real, as well as the level of treatment in the subplot.

It is influenced by the water in the shallot bulbs and the number of leaves where the number of leaves continues to be large so that the dry weight of the shallot plant's furnace becomes small. Based on Deden & Wachdijono (2018) Plant dry weight is influenced by environmental factors, namely humidity, temperature, and water content of leaf cells which are important factors in plant metabolic processes.

4. Conclusion

Treatment without suspension or control (S0) showed an incubation period of 29 days and an average intensity of disease attacks of the fungus *Fusarium* sp. on shallot plants in 4,2%. Treatment of various organic fertilizers (M) was not able to suppress the intensity of the attack and slowed the incubation period of the fungus Fusarium sp. on shallot plants. There is no interaction between the application of microorganism suspension and the type of organic fertilizer in all parameters.

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