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Disease incidence of tomato plants (*Lycopersicum esculentum* Mill) on soil from different plants

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Abstract
Tomato plant cultivation is influenced by many factors, including the level of resistance of tomato plants to diseases. Several soil-borne diseases are detrimental to tomato plants, and especially when they attack nurseries. Meanwhile, nursery planting media is a part that needs to be considered so that the plants that are sought are healthy and provide maximum results. This study aims to determine the incidence of disease in tomato nurseries on different soil sources, determine the causes of diseases that attack tomato nurseries (*Lycopersicum esculentum* Mill.), and determine varieties that are resistant to disease attacks on tomato plants. This research was conducted at the green house, Agronomy Laboratory, Faculty of Agriculture, University of Mulawarman Samarinda and the Laboratory of Pest and Plant Disease Sciences, Faculty of Agriculture, Universitas Mulawarman, Samarinda. The treatment of soil, consisted of 5 levels. They are soil of ex-tomato plantation (t1), soil of ex-chilly plantation (t2), soil of ex-banana plantation (t3), soil of ex-rice plantation (t4) and soil of ex-alang-alang weed (t5). The variety treatment consisted of 2 levels, namely the Lentana variety (v1) and the Permata variety (v2). The design used in this study was a completely randomized design. The results showed that the lowest disease incidence was found in the ex-alang-alang soil; Most of the tomato nurseries were attacked by the fungus *Fusarium* sp; Lantana variety is more resistant compare to the Permata variety of tomato.

Keywords: disease incidence, tomato, dumping-off, soil, *Fusarium* sp

Introduction
Tomato plant is one of the most potential fruit vegetables to be cultivated in Indonesia. Depending on the type or variety, this plant can be planted widely from the lowlands to the highlands. Tomato plants that are suitable to be developed in the lowlands are varieties or cultivars that are heat-resistant. Several superior varieties have been released by the government and are suitable for cultivation in the lowlands and are tolerant of bacterial wilt disease. This superior variety has a yield potential of 30-35 tons/ha and has a fruit shelf life of 8-9 days and the fruit size is quite large with a weight of 35-60 grams per tomato. Tomatoes are a source of food that contains high nutrients, some of the nutrients obtained from tomatoes are antioxidants Lycopene, Vitamin C, Potassium, Folate, and Vitamin K. Antioxidants contained in tomatoes are often associated with a reduced risk of heart disease and cancer. Tomatoes can grow with a soil height ranging from 0 to 1,500 m above sea level, depending on the type. Tomato plants grow well in areas 200 to 1,500 m above sea level. Tomatoes also thrive in loose soil with rich nutrients, namely a soil pH of 5 to 6, and areas with an air temperature of 17 to 28 degrees with humidity above 60%. [1, 2, 3]
The basis of disease occurrence in plants is explained through the concept of the plant disease triangle where plant diseases can only develop if a virulent pathogen is available, a susceptible host plant is available, and suitable environmental factors are available. Virulent pathogens mean pathogens that can cause disease, susceptible host plants mean plants that are susceptible to disease, and suitable environmental factors mean environmental factors that are suitable for the needs of disease development. If any of these three factors are not present then the disease cannot progress [4].
Good soil for tomato nursery media is taken from the top (topsoil). The soil for the tomatoes plant must have good characteristics, consisting of a mixture of clay and sand. Clay is useful as an adhesive for planting media while sand is useful for providing good porosity. To enrich the nutrient content can be added with organic fertilizer. It can be in the form of mature manure or compost. The important thing is to puree the fertilizer by sifting. The rough structure is not good for the growth of seeds/seeds that have just germinated because the roots are still too soft [1]. However, each soil will contain microbiota that can be advantageous or disadvantage to the plant. Some microbial are pathogen to the plant, start to attract to the seed until to adult plant and it will harmful to the plant [5].
The common disease found in tomato nurseries is Stem Falling Disease or Dumping Off. The organisms that cause the disease are the fungi. Including the types of diseases that attack small plants at the time of seed nursery. Usually, the fungi are soil-born fungi. Symptoms of this disease appear in wet spots at the base of the seedling stem, which then causes the seedlings to wither and fall [9]. Stem fall disease is found in almost all types of vegetable crops in the small plant (seedling) phase. Some diseases that are transmitted by soil or air are known to have a very detrimental attack rate. Several soil-borne diseases that attack nurseries include Fusarium sp. All of these diseases need to be taken seriously because the level of spread and damage can result in crop failure that is detrimental to farmers [6, 7].

The severity of pathogen attack or the level of disease incidence is also influenced by plant resistance, including the variety of plants that will affect the level of disease incidence that occurs in tomato plants. Plant resistance is defined as plant traits that can be inherited and can affect the level of damage by plant-disturbing organisms [4]. Based on the description above, it is necessary to conduct research on the diversity of soil sources on the dumping –off diseases in tomato nurseries (Lycopersicum esculentum Mill); to identify the causes of diseases on tomato nurseries; and to see the better variety for tomato.

Research Methods

1. Place

This research was conducted at the Agronomy Laboratory, Faculty of Agriculture, Universitas Mulawarman Samarinda and and the Laboratory of Pest and Plant Disease Sciences, Faculty of Agriculture, Universitas Mulawarman, Samarinda.

2. Experimental Design

The study used a Completely Randomized Design (CRD) with 5x2 factorial analysis which was repeated 4 times. The first factor was the treatment of soil (T) which consisted of 5 levels, namely: soil of ex-tomato plantation (t1); soil of ex-chilly plantstion (t2); soil type of ex-banana plantation (t3); soil of ex-rice plantation (t4); and soil of ex-alang-alang (Imperata cylindrica) weed (t5). The secng factor was variety (V) consisted of 2 levels, namely: Lentana variety (v1) and the Permata variety (v2).

3. Research Procedure

3.1 Field Activities

The soil taken from the field ex-tomato plantation, soil of ex-chilly plantstion, doil og ex-bsnsns plantation, soil of ex-rice plantation, and soil of ex-alang-alang weed. Tomato plant nurseries are carried out in plant nurseries using 2 varieties, namely Permata variety and also lentana variety at AgronomyNursery, Faculty of Agriculture, Universitas Mulawarman. Watering is carried out every morning and evening according to weather conditions and soil conditions.

3.2 Laboratory Activities

Activities in the laboratory include identifying the causes of diseases found in tomato nurseries from various types of soil media used. Each of symptoms of deases seedlings are cultured in Agar Media, then each colony of pathogen isolated, then identify the colony of pathogen on Agar Media, and then identify the pathogen under microscope. The identification of pathogen used guidance book of Alexopoulus, 1979.

3.3 Data Collection and Data Analysis

The data taken is the disease Incidence. Observations began 3 days after the nursery was carried out. Subsequent observations are made everyday. The formula is used: X = n/N (Description: X = Disease Incidence; n = Number of diseased plants; and N = Number of all plants).

The data obtained were analyzed using the method of variance. If there is a significant difference, it will be continued with the Least Significant Difference Test (BNT) at the 5% level.

Results and Discussion

1. Disease Incidence

1.1 Deases Incidence in Tomato Plants 6 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) and tomato varieties (V) had no significant effect on the average incidence of disease attacks in tomato nurseries aged 6 days after planting. The results of observations of the average incidence of disease attacks in tomato nurseries aged 6 days after planting can be seen in Table 1.

Table 1: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 6 Days After Planting (%)

Varieties (V)	Soil Type (T)					Mean
	t1	t2	t3	t4	t5	
	……%.....					
v1	6,85	6,00	6,49	5,90	5,44	6,14
v2	5,63	6,01	7,69	5,63	5,63	6,12
Mean	6,24	6,00	7,09	5,76	5,54	

1.2 Disease Incidence in Tomato Plants 7 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) had no significant effect on the average disease incidence in tomato nurseries aged 7 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 7 days after planting can be seen in Table 2.

Table 2: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 7 Days After Planting (%)

Varieties (V)	Soil Type (T)					Mean
	t1	t2	t3	t4	t5	
	……%.....					
v1	6,85	6,00	6,49	5,90	5,44	6,14
v2	5,63	6,01	7,69	5,92	5,63	6,18
Mean	6,24	6,00	7,09	5,91	5,54	

1.3 Disease Incidence in Tomato Plants 8 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) had a significant effect on the average disease incidence in tomato nurseries aged 8 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 8 days after planting can be seen in Table 3.

Table 3: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 8 Days After Planting (%)

Varieties (V)	Soil Type (T)					Mean
	t1	t2	t3	t4	t5	
	……%.....					
v1	8,00	5,90	6,68	7,31	5,16	6,61
v2	6,29	6,01	7,88	5,90	5,82	6,38
Mean	7,15	5,95	7,28	6,60	5,49	

1.4 Disease Incidence in Tomato Plants 9 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) had a very significant effect on the average disease incidence in tomato nurseries aged 9 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 9 days after planting can be seen in Table 4.

Table 4: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 9 Days after Planting (%)

Varieties (V)	Soil Type (T)					Mean
	t1	t2	t3	t4	t5	
	……%.....					
v1	8,58	7,42	8,61	8,62	5,06	7,66
v2	8,55	8,52	8,70	7,41	6,29	7,90
Mean	$8,57^{c}$	$7,97^{b}$	$8,66^{c}$	$8,01^{b}$	$5,68^{a}$	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test (BNT,T = 0.42)

Based on the results of the 5% BNT test as shown in table 5 above, shows that the highest attack incidence was found in the t3 treatment, which was 8.66%, while the lowest attack average was in the t5 treatment, which was 5.68%.

1.5 Disease Incidence in Tomato Plants 10 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) had a very significant effect, while the treatment of tomato varieties (V) had a significant effect on the average disease incidence in tomato nurseries aged 10 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 10 days after planting can be seen in Table 5.

Table 5: Effect of Soil Types and Varieties on the Average Disease Incidence In Tomato Nurseries Aged 10 Days After Planting (%)

Varieties (V)	Soil Type (T)					Mean
	t1	t2	t3	t4	t5	
	……%.....					
v1	9,04	8,03	9,28	10,14	5,06	$8,31^{a}$
v2	10,96	9,34	8,97	10,48	7,21	$9,39^{b}$
Mean	$10,00^{d}$	$8,69^{b}$	$9,13^{c}$	$10,31^{d}$	$6,13^{a}$	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test (BNT,T = 0.42; V=0,26)

Based on the results of the 5% BNT test as shown in Table 6, it shows that the highest disease incidence was found in the t1 and t4 treatment, while the lowest attack average was found in the t5 treatment. The higher disease incidence was found in treatment v2, while the lower disease incidence was found in treatment v1.

1.6 Disease Incidence in tomato plants 11 days after planting

The results of variance showed that the treatment of several nursery soil origins (T) and tomato varieties (V) had a very significant effect on the average disease incidence in tomato nurseries aged 11 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 11 days after planting can be seen in Table 6.

Table 6: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 11 Days after Planting (%)

Varieties (V)	Soil Type (T)					Rata-rata
	t1	t2	t3	t4	t5	
	……%.....					
v1	9,78	8,70	9,28	10,35	5,06	8,63[a]
v2	10,96	10,98	9,65	11,54	7,57	10,14[b]
Rata-rata	10,37[c]	9,84[b]	9,46[b]	10,95[d]	6,32[a]	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test (BNT,T = 0.41; V=0.26)

Based on the results of the 5% BNT test as shown in Table 7 above, it shows that the highest disease incidence was in the t4 treatment, while the lowest attack average was in the t5 treatment. The higher disease incidence was found in treatment v2, while the lower disease incidence was found in treatment v1.

1.7 Disease Incidence in Tomato Plants 12 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) and tomato varieties (V) had a very significant effect on the average disease incidence in tomato nurseries aged 12 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 12 days after planting can be seen in Table 7.

Table 7: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 12 Days after Planting (%)

Varieties (V)	Soil Type (T)					Rata-rata
	t1	t2	t3	t4	t5	
	……%.....					
v1	10,61	10,83	9,51	10,90	6,85	9,74[a]
v2	10,96	12,10	11,66	13,02	9,04	11,35[b]
Rata-rata	10,79[b]	11,46[c]	10,58[b]	11,96[d]	7,94[a]	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test (BNT,T=0.39; V=0.25)

Based on the results of the 5% BNT test as shown in Table 8 above, it shows that the highest disease incidence was found in the t4 treatment, while the lowest attack average was in the t5 treatment. The higher disease incidence was found in treatment v2, while the lower attack was found in treatment v1.

1.8 Disease Incidence in Tomato plants 13 Days after Planting

The results of variance showed that the treatment of several nursery soil origins (T) and tomato varieties (V) had a very significant effect on the average disease incidence in tomato nurseries aged 13 days after planting. The results of observations of the average disease incidence in tomato nurseries aged 13 days after planting can be seen in Table 8.

Table 8: Effect of Soil Types and Varieties on the Average Disease Incidence in Tomato Nurseries Aged 13 Days after Planting (%)

Varieties (V)	Soil Type (T)					Mean
	t1	t2	t3	t4	t5	
	……%.....					
v1	10,86	11,32	9,51	11,58	6,85	10,02[a]
v2	12,53	12,52	11,66	13,67	9,87	12,05[b]
Mean	11,69[c]	11,92[c]	10,58[b]	12,63[d]	8,36[a]	

Notes: Numbers followed by the same letter show no significant difference in the 5% BNT test (BNT T=0.39; V=0.24)

Based on the results of the 5% BNT test as shown in Table 8 above, it shows that the highest disease incidence was found in the t4 treatment, while the lowest attack average was in the t5 treatment. The higher disease incidence was found in treatment v2, while the lower attack was found in treatment v1.

Based on the results of observations made on tomato seedlings aged 6-8 days after planting, it showed that it had no significant effect on the two varieties and soil types used. Meanwhile, the incidence of the disease that had a significant effect was only seen at the age of 9-13 days after planting. The highest disease incidence was found on soil type of ex-rice plantation, then follow by t1 (soil type of ex-tomato plants) and t2 (soil type of ex-chilly plants), then t3 (soil type of ex-banana plantation) and the lowest of disease incidence happen in soil type of Alang-alang (Impretara cylindrica) weed (t5) This can be explained that the former rice planting soil is soil that contains a lot of microbes, especially microbes that cause damping-off in plants. The most common cause of damping off is the fungal pathogen Fusarium sp. This fungi is soil-born pathogens that can survive in the soil for years. As long as there is a host, then these two types of fungi can develop properly which will then survive in the soil until this pathogen meets a suitable host, then attacks the host so that it becomes sick, and then the pathogen will multiply. The land used for planting rice, tomatoes and chilies is an annual crop which means the land will be processed again for the cultivation of the next crop. So that these soils will have a fairly good structure so that it is possible for the microbes that are in the soil to last a long time in these soils. However, the type of soil used for banana cultivation, because banana is an annual plant, the soil is usually not treated properly, so that the microbes that inhabit the soil on this banana will not develop properly, especially the population. Meanwhile, the results of the study showed that the soil type used by Imperata cylindrica caused the lowest disease incidence. Imperata is a type of weed that is capable of removing root exudate which is a secondary compound, where if we find reeds in one place, usually these weeds will dominate the place. In addition to the very massive way of growing, but also because this plant produces secondary compounds, so that other plants are usually unable to grow or survive in the soil. Related to this, there is a great chance that the microbes found in the soil type of weeds former growth will also be few or the population will be low, so that research using reed soil produces the lowest disease incidence. The mechanism of pathogen attack is through weak seedling stems by infecting tomato seedling stems, then the fungus will enter the tomato stems or enter through tomato's roots.

After the germination tube enters, the mycelium moves towards the xylem vessels. In he xylem vessels, the mycelium will release toxins that will change the permeability of the plasma membrane of host plant cells so that they lose water more quickly. The fungus will infect the roots through wounds, then will settle and develop in the bundle vessels[8]. The alleged result of this condition was due to the nature of the disease and the way it spread very quickly so that all the growing media used were infected with the fungus Fusarium oxysporum. The fungus Fusarium oxysporum in its life cycle undergoes pathogenesis and saprogenesis phases. In the pathogenesis phase, the fungus lives as a parasite on the host plant which begins when the pathogen begins to enter and parasitize the host[4]. If there is no host plant, the pathogen can survive as a saprophyte on plant residues, and survive in the soil for an indefinite period of time [9].

Based on the results of the variance, the significant difference in the Varieties (V) treatment occurred in plants aged 10 days after planting and very significant differences at the age of 11-13 days after planting, where the two varieties, namely Lentana (v1) and Permata (v2) in each treatment, were affected by the disease. The highest attack occurred in the v2 treatment of the Permata variety with the highest average attack incidence at the age of 10 -13 days after planting and Lentana got the lowest average disease incidence at the age of 10-13 days after planting. The Lentana variety was more resistant to infection of the dumping-off disease in various types of soil media. It can be concluded that the seeds of the Lentana variety can be recommended for use in tomato cultivation so as to minimize the mortality rate of seeds in tomato nurseries. Another advantage of the Lentana is that it is resistant to storage (still good if in long transportation), resistant to bacterial wilt, ToMV, and Fusarium race [10]. In addition to Sopialena's opinion, 2015 Patoghen of dumping-off can survive in the soil for years because it is a soil borne disease. This fungus is relatively difficult to separate from the soil. One of the control techniques used is to use disease-resistant varieties [11].

Diseases Identification

Based on observations, the symptoms that attack tomato nurseries aged 6-15 days after planting are brown spots that attack the stems, base of stems and leaves in tomato nurseries. In addition to the presence of brown spots that attack tomato nurseries is *Fusarium* sp. These symptoms can be seen in the image below:

Fig 1: Symptoms of Brown Spots on Wilted Stems and Plants

Fig 2: Symptoms of Necrotic on Leaves and Stem Base

The causes of disease in tomato nurseries can be seen in the disease identification pictures found in tomato nurseries from various types of soil media used.

Fig 3: *Fusarium* sp. on the Soil of the Former Permata Variety Tomato Plant (v2t1)

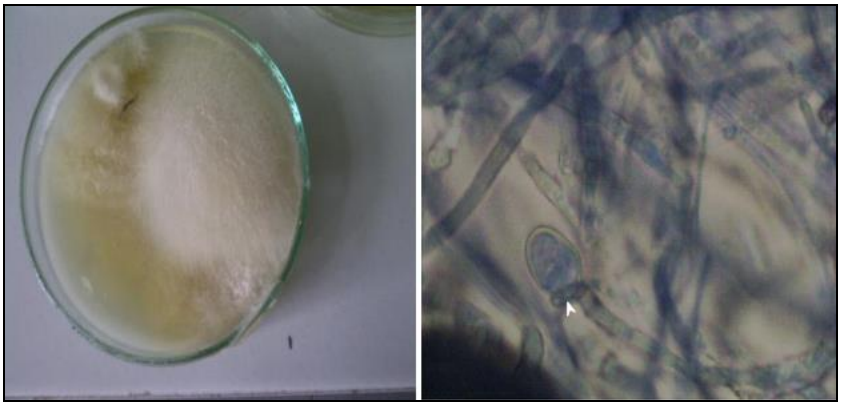

Fig 4: *Fusarium* sp Fungus on the Soil of former Chili Varieties Permata (v2t2)

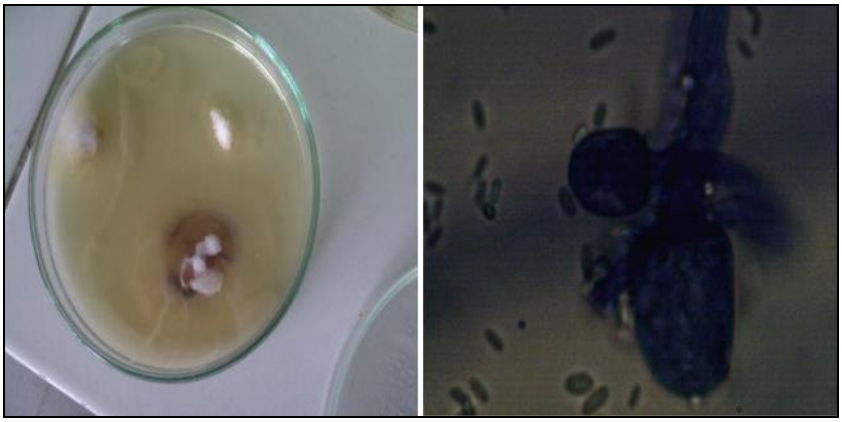

Fig 5: *Fusarium* sp Fungus on the Soil of the Former Banana Plant of the Lentana Variety (v1t3)

Fig 6: *Fusarium* sp. Fungus on the Soil of Former Banana Varieties of Permata (v2t3)

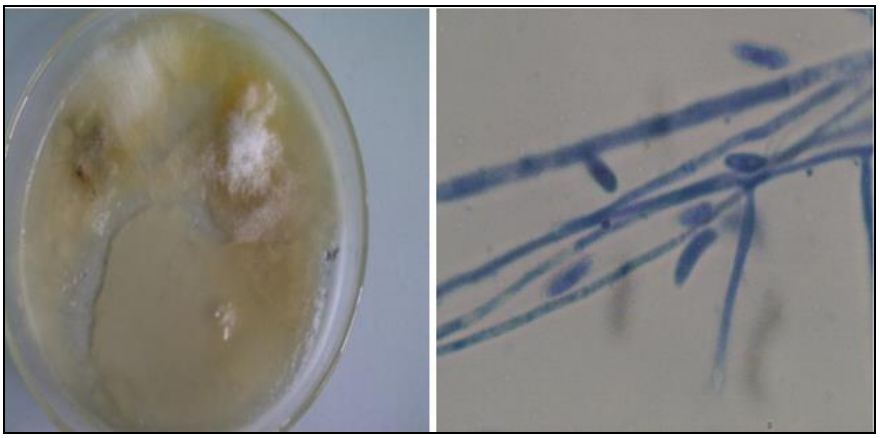

Fig 7: *Fusarium* sp. on the Soil of Former Rice Plants of the Lentana Variety (v1t4)

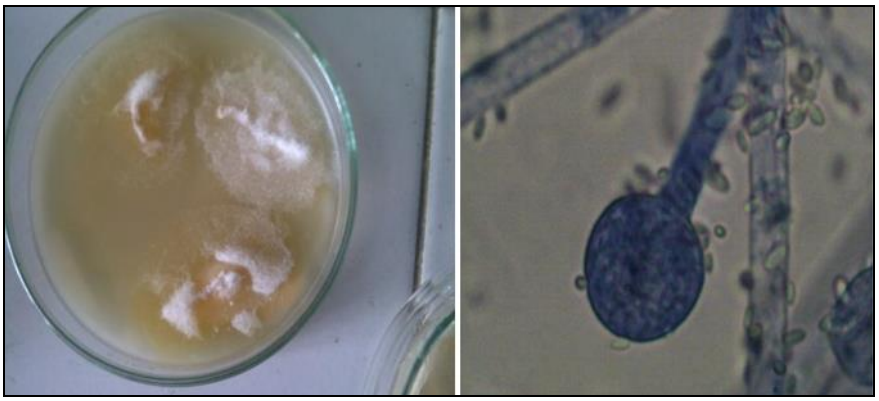

Fig 8: *Fusarium* sp. on the Soil of Former Rice Plants of Permata Variety (v2t4)

Fig 9: *Fusarium* sp. on the Soil of the Former Reed Plant of the Lentana Variety (v1t5)

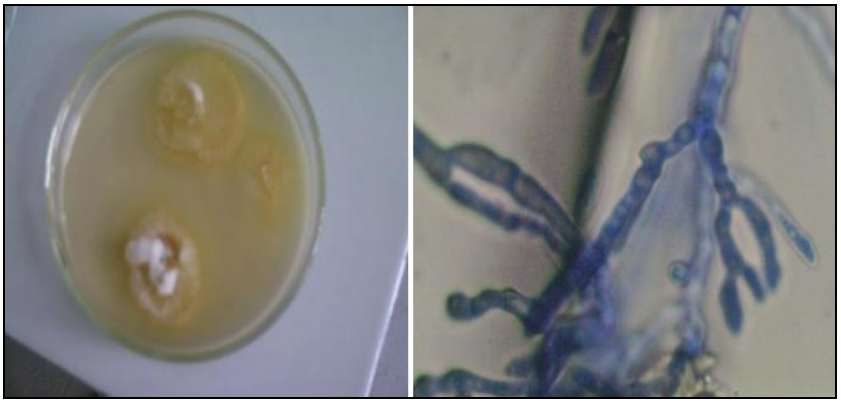

Fig 10: *Fusarium* sp Fungus on the Soil of the Former Reed Plant of the Permata Variety (v2t5)

Based on the identification that has been developed on culture media (PDA), the type of disease that attacks all types of soil has the same characteristics as the results of the previous identification, they are dumping-off disease. Soil moisture that helps plants, it also helps the development of pathogens. Like most pathogens, this pathogen can live in a wide variety of soil.

The development of Fusarium sp. is very suitable in soils with a pH range of 4.5-6.0 while in pure culture it will grow well in a pH range of 3.6-8.4. The optimum pH for sporing is around 5.0, sporing that occurs in soils with a pH below 7.0 is 5-20 times greater than that in soils with a pH above 7.0 [12]. The spread of the fungus is influenced by the low pH conditions that allow the fungus to grow. The optimal temperature for the development of dumping-off fungus is 24-27ºC. Temperature in addition to affecting plant growth, also affects the development of the disease [9]. The fungus can be spread by splashing rainwater, irrigation water carrying infected soil and infected seeds. The spread of the dumping-off disease also occurs very quickly in moist soil, soil moisture not only helps plants, and it also helps disease development [13]. This situation allows the soil of former banana plants (t3), treatment of former rice plants (t4) and treatment of former chili plants (t2) to be easily infected with the fungus. Damping off symptoms include seedlings that fail to emerge from the soil, seedling stems and first leaves appear water soaked, soft, or mushy, and oftentimes discolored gray or brown. Stems sometimes become very thin, or thread-like where infected. Young leaves begin to wilt, roots are absent, or stunted with sunken gray or brown spots.

Based on the identification that has been developed in culture media (PDA), the type of disease that attacks two types of tomato plant varieties is Fusarium sp. The results of observations on tomato seedlings showed that the characteristics of the attack on the plants were brown spots due to dryness of the stems and fall down to the land and the seedlings wilting and then dying. Damping off is of deadly seedling disease that are fatal for tomato seedlings. Damping off affects the stems of seedlings both above and below the soil line. Some affected seedlings will grow and quickly wither, while others will appear to be pinched or broken near the soil line, collapsing with their young healthy-looking leaves still attached. Sometimes, damping off causes a gradual discoloration and wilting, however, most cases of damping off cause a very sudden death of a large group of seedlings. Caused by several different fungi, damping off attacks tomato seeds, stems, and roots. Most affected by cold, wet, humid conditions, young seedlings are susceptible to infection, and damping off disease can be devastating to a new tomato crop. Then [9] state that the initial symptoms of tomato dumping-off disease are brown spot to the stem followed by drooping of the stalks, and finally the plant wilts as a whole. Withering can occur unilaterally. In young plants it can cause the plant to die suddenly because the base of the stem is damaged.

Conclusion

The research can be concluded that the lowest disease incidence was found in the ex-alang-alang soil; Most of the tomato nurseries were attacked by the fungus *Fusarium* sp.; and Lantana variety is more resistant compare to the Permata variety of tomato.

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