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Original Research Article

Response of Pepper Seeds Affected by Root Rot Disease (*Phytophthora capsici*) Towards Application of Secondary Metabolites of Trichoderma sp.

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Abstract

Basal stem rot disease in pepper caused by *P. capsici* is the ultimate disease which can lead to the death of the plant. Trichoderma sp. produces secondary metabolite which is effective for controlling this disease. To know the effectiveness of Trichoderma sp. secondary metabolite, the experiment with different concentrations placed in the polybag to control basal stem rot disease in pepper was conducted from March to June 2020 at UPTD Pengembangan Perlindungan Tanaman Perkebunan (P2TP), Plantation Office, East Borneo. A completely randomized design with five treatments and ten replications was applied in this experiment. The data were analyzed using analysis of variance. If there is a significant difference, the test will continue at the least significant difference of 5%. The study entitled "The Growth of Pepper Seeds Attacked by Basal Stem Rot Disease (*Phytophthora capsici*) on Application of Trichoderma sp. Secondary Metabolite" concluded three main points. First, based on the intensity of disease attack, the average of both shoot internode number and shoot internode length of Trichoderma sp. secondary metabolite was mostly effective to control the disease attack or at MS_{20} concentration namely 88.06% of the intensity of disease attack. Second, based on the average number of leaves, MS_5 concentration was able to control the disease progression by calculating the number of grown leaves, around 75.40 leaves. Last, based on the growth of the plant, the effective use of secondary metabolite was at MS_{10} concentration with the height of the plant 71.50 cm.

Keywords: Malonan 1 pepper seed variety, Phytophthora capsica, Trichoderms sp. secondary metabolite.

INTRODUCTION

Pieper nigrum L is a crumb plant where the fruit can be used as cooking spices, herbal medicines, anti-bacterial and anti-oxidants as well as cosmetics. Pepper plants originate from the Malabar area, South India, entering Indonesia 100 years BC. Pepper is a source of foreign exchange for the country, national pepper production in 2014 reached 91,941 kg [1]. Pepper plants in East Kalimantan have been developed by the people for a long time with traditional management. Pepper commodity is one of East Kalimantan's export commodities which is quite important. Based on the Statistics of [2], dry pepper production in 2017 was 6,057 kg with an area of 9,012 ha. Compared to pepper production in 2015 as much as 6,923 kg with an area of 9,606 ha. This is influenced by several factors including land conversion, natural disasters and the presence of Plant Destruction Organisms (OPT) attacks.

The disease that often attacks pepper plants in East Kalimantan and is quite dangerous is pepper stem rot disease caused by the fungus Phytophtora capsici. This fungus is a soil-borne fungus (soil-borne) so it is difficult to detect its presence. In addition, the fungus is easily spread through contaminated soil, carried by water flows or diseased plant parts. Parts of plants that can be attacked by the fungus Phytophthora capsici are all parts of the plant. The most important part is dangerous if it attacks the base of the stem and roots because it can cause plant death. Symptoms of P. capsici fungus attack on leaves can occur at the ends or middle of the leaves in the form of distinctive black spots with jagged edges forming like lace which are clearly visible when directed to the light. If the attack occurs at the base of the stem it will be black, in moist conditions it will release light blue mucus causing the plant to wilt quickly or suddenly (leaves remain green) and eventually die. While the roots cause the plant to wilt slowly, the color of the leaves turns yellow [3].

Chemical control of pepper stem base rot is a control effort that has been carried out for a long time. Several synthetic chemical compounds have been tried

and found to be effective in suppressing stem rot disease in pepper. However, the excessive use of synthetic fungicides can have a negative impact on the environment, the emergence of resistance and the formation of new strains for plant pathogens. The market demand for residue-free products makes environmentally friendly controls urgently needed to support sustainable agricultural systems and reduce the use of chemical pesticides. The continuous use of chemical pesticides can cause environmental damage so it is necessary to carry out environmentally friendly controls [4].

Therefore, new tactics and ways to control pepper stem base rot disease need to be continuously researched, one of which is the use of organic biopesticides. Because organic biopesticides are still considered safe for the environment to control pests and plant diseases. Trichoderma sp. is one of the biological agents that can inhibit the development of plant diseases [3].

Trichoderma has a very important role in suppressing the growth of plant fungal pathogens, especially soil-borne fungi, while Trichoderma harzianum in in vitro conditions is able to suppress the growth of Fusarium sp. isolated from chili stem tissue. The percentage of antagonist Trichoderma harzianum on Fusarium sp in vitro was 94.2% Trichoderma sp. has the potential to produce antibiotic secondary metabolites, namely viridine and trichomidin [5].

Secondary metabolites are the results of the metabolism of organisms or microbes that are discarded because they are of no benefit to the life of organisms or microbes. However, secondary metabolites are generally formed at the end of growth in the form of metabolic wastes in the form of antibiotics, enzymes, hormones, and toxins [6]. This research is a study in the development of secondary metabolites of Trichoderma sp. for the control of root rot disease in pepper plants caused by the fungus P. capsici. The secondary metabolites in this study are products produced by the UPTD for the Development of Plantation Plant Protection at the Plantation Office of East Kalimantan Province. Therefore, it is necessary to conduct research to determine its potential in inhibiting the growth of soil-borne pathogens, especially stem rot disease in pepper seedlings.

In connection with the description above, the problem can be formulated, namely:

1. How is the response of pepper seedlings affected by stem rot disease (P. capsici) to the application of Trichoderma sp. secondary metabolites.
2. What is the most effective concentration of secondary metabolites in controlling stem rot disease of pepper seedlings (P. capsici).

This research aims to:

1. To analyze the response of pepper seedlings infected with stem rot disease (P. capsici) to the application of secondary metabolites of Trichoderma sp.
2. Obtain the concentration of secondary metabolites Trichoderma sp. the most effective for controlling stem rot disease of pepper seedlings (P. capsici).

LITERATURE REVIEW

Pepper Plant

In the international market, Indonesian pepper has its own strength and selling power because of its distinctive taste. Indonesian pepper is known as Muntok white pepper for white pepper and lampong black pepper for black pepper [7]. The development of pepper in Indonesia is currently controlled by small-scale farmers. The largest pepper centers are still concentrated in the provinces of Lampung, Bangka, South Sumatra, Kalimantan and Sulawesi. Other areas such as Kalimantan and Sulawesi vary in the type of pepper production produced and mostly consumed domestically [8].

Some of the benefits of pepper fruit for daily life such as as a cooking spice, industry that can give a sedan smell and add to the taste of food delicacy, as a food preservative, as traditional medicine as a fragrance, this comes from pepper oil which is produced from distillation [8].

Pepper Botanical Features

Pepper stalks grow vines on climbing posts and sometimes creep over the ground. Each pepper plant only grows one stem. If the stems are cut when they are one year old, 2-5 new shoots will grow [9].

Pepper plant single leaf and round or oval. The base is curved while the tips of the leaves are blunt. The surface of the leaves looks shiny, the underside of the leaves is pale green and opaque. The pinnate veins are clearly visible and firm. The length of the stalk is 1.8 – 2.6 cm, the width is between 5 – 10 cm, the length of the pepper leaf is between 14 – 19 cm. The location of the leaves on the stem alternately in each book. Each book or segment only consists of one leaf [10].

According to [9], pepper plants have flowers that belong to the hermaphrodite category. Each plant has one male flower and one female flower. The two parts of the flower are close together in one flower panicle. Each flower stalk contains about 30-50 flowers. The structure consists of the crown, crown, stamens and pistil in one unit. The occurrence of pollination is indicated by a change in the color of the pistil to brown. Furthermore, the pistil will enlarge, forming the outer skin, inner skin, flesh or seeds and the formation of ovules.

Pepper fruit consists of several layers from outside to inside, namely outer skin (epicarp), inner skin (inner epicarp), outer epidermis (outer mesocarp), inner epidermis (inner mesocarp) and fruit flesh. Each panicle (stalk) usually has 30-50 pieces. Pepper fruit has a spicy taste that is different from cayenne pepper. In plant taxonomy, pepper plants (Piper nigrum L.) are classified as follows Kingdom Plantae (plants), Division Spermatophyta (seed plants), Sub Division Angiospermae (seeds are in the fruit), Class Dicotyledoneae (seeds in two pieces), Order Piperales, Family Piperaceae, Genus Piper, Species Piper ningrum L. [10].

Malonan Varieties 1

The type of pepper plant in East Kalimantan by the local community is called a local variety pepper which has the characteristic of being able to bear fruit almost all year round. The local pepper variety has met one of the criteria for release because it has been developed in East Kalimantan for more than five years. In an effort to provide pepper seeds of local varieties in accordance with applicable laws, observations were made on the production and quality of local pepper populations in Kutai Kartanegara Regency, which is the largest pepper development area in East Kalimantan. Observations were carried out for two years, at three high yielding block (BPT) locations in Loa Janan and one at Non BPT locations in Muara Badak, as the origin of local East Kalimantan pepper which is currently growing in Loa Janan. The results of quality analysis showed that local white pepper in East Kalimantan contained 2.35% essential oil, 11.23% oleoresin, and 3.82% piperine, higher than petaling 1 (3.03%). Therefore, East Kalimantan local pepper has a high level of piperine (spicy), with the name Malonan 1 which means a combination of Muara Badak and Loa Janan [11].

Terms of Growing Pepper Plants

Live climbing poles (tajar) in pepper cultivation are very necessary because they reduce excessive light intensity and make plants live long. Cover crops will help reduce dryness due to drought and inhibit the spread of Phytophthora capsici during the rainy season. Making adequate drainage channels and terracing adapted to land conditions is needed to avoid waterlogging during the rainy season [10].

Climate

Pepper plants require tropical areas with hot and humid climates, with native elevations below 600 m above sea level. Rainfall is fairly even throughout the year, with an average of 2,000 – 3,000 mm/year and 110 – 170 rainy days. The dry season is only 2-3 months/year. Air humidity ranges between 70-90% with a maximum temperature of 340 C and a minimum of 200 C [12].

Soil

Pepper plants want soil that is fertile but not easily waterlogged. Because pepper is very sensitive to waterlogging in the soil, a slightly sloping soil is chosen, so that water does not stagnate on pepper plants. The soil that is suitable for pepper plants is sandy clay, as long as the sand is not too much. These are usually found on hillsides. These soils, from a physical point of view, have good water and air circulation, if the humus content in the soil is large enough. This does not mean that the mineral content is not so important, because abundant pepper production depends on the mineral content. Pepper really needs N and K. Soils that are not good for pepper plants are heavy clay, because the soil contains more than 60% clay grains [10].

Root rot disease

According to [13], the root rot pathogen is the fungus Phytophthora capsica. Root rot disease (BPB) is very detrimental to farmers and can cause death in pepper plants because this disease can attack the roots or stem bases and can cause plants to wilt and die quickly in pepper plants, thereby reducing pepper production. Currently, Pangkal Batang rot disease is present in all pepper plantation areas in Indonesia. The fungus Phytopthora capsici is a soil-borne fungus that can form a resting structure that can last a long time. Phytophthora capsici attacks mostly occur in the rainy season. Its spread can be carried by water, wind that occurs during rain, plant material, livestock/animals, humans and agricultural tools. In addition, Phyophthora capsici has a wide host range. The fungus Phytophthora capsici can attack all ages/stadia of plants, from nurseries to productive plants. The most dangerous attack is at the base of the stem or roots because it causes plant death quickly [9].

Symptoms of Pepper Stem Rot Disease

Fungal attacks on leaves cause leaf spot symptoms in the center or edges of the leaves. Black spots with jagged edges like lace (a typical symptom) which will be clearly visible when the leaves are directed to the light. These typical symptoms only appear in immature patches and occur in humid conditions (lots of rain). Diseased leaves will fall, and become a source of inoculum for other plant parts that are nearby, including the base of the stem. Attacks on flowers and fruit cause black rot. This symptom is usually found in flowers and fruits that are located near the soil surface [9].

Infection/attack of Phyophthora capsici at the base of the stem causes rapid/sudden wilting of the plant. Quick wilt, the color of the leaves remains green (hanging), then turns brown – black (like dry leaves) remains hanging and will fall gradually.

Symptoms of wilting will be obvious in the dry season because the roots have been damaged by Phyophthora capsici attacks, and the attack often extends to the base of the stem [9].

Symptoms of early attacks are difficult to identify, while symptoms that appear like plant wilting indicate advanced attacks. According to [14], symptoms in the form of sudden wilting of plants (leaves remain green) will appear when there is a pathogen attack at the base of the stem. The base of the affected stem becomes black, in moist conditions it will secrete light blue mucus. Attacks on the roots, causing the plant to wither and the leaves to turn yellow.

How Pathogens Spread

The fungus P. capsici undergoes a dormant stage during the dry season and becomes active again in the rainy season. During the rainy season, the air temperature becomes low and the soil moisture becomes high so that if there are sufficient nutrients, it will stimulate the resting structure of the fungus to germinate. Raindrops that fall to the ground can help transfer fungal propagules from the soil to leaves or fruit near the soil surface, thereby allowing infection to occur. The spread of pathogens can occur through the air and soil. Besides that, the spread can also occur through agricultural tools contaminated with P. capsici fungus, carried by humans, large and small animals such as snails, through water and plant materials [9].

Ways of the spread of Pathogens include:

1. Dissemination by air;
2. Spread through the soil; and
3. Cycle life.

Stem Rot Disease Control

Use of Healthy Plant Ingredients

Root infection can occur from the start, namely at the nursery stage or when the cuttings are planted directly in the field. This is due to the use of plant material/cuttings that have been contaminated or infected with P. capsici but have not yet shown symptoms. The spread of P. capsici through plant material can occur at long distances from the origin of the plant material taken. For example, pepper planting in Sulawesi brings pepper cuttings from Lampung. Therefore, it is necessary to directly observe the seed source area to ensure that the source nursery is really healthy (free of pests and diseases) [15].

Garden Sanitation

Destroying or burning diseased plants is a valuable measure to prevent the spread of disease. Disease-free plants are watered with 4-5 liters of 0.2% copper oxychloride (Copper oxychloride) or bordoux slurry, and it is recommended not to plant pepper for one year. The addition of organic matter mixed with biological agents before planting pepper is highly recommended [15].

Technically Cultural

Technical culture control is carried out by:

a. Make drainage channels and ditches around to avoid waterlogging in the garden.
b. Avoid root injury.
c. Remove worms and hanging vines.
d. Fertilize as recommended.
e. Perform live natural pruning before fertilizing during the rainy season so that the garden conditions are not too humid and get enough sunlight. These conditions can suppress the development of pathogenic fungi, thereby reducing the possibility of occurring in pepper plants.
f. Planting ground cover followed by limited weeding only around pepper plants.

Agricultural tools that have been used on diseased plants should not be used directly on healthy plants. So it must be cleaned/washed first [15].

Chemically

According to [15], areas in the garden that have been attacked by P. capsici or areas endemic to stem rot disease, need special attention. If in one garden there has been an attack by P. capsici fungus, the pepper plants around the diseased plants and also the former diseased plants must be treated to prevent the spread of the disease. The decision to take site-specific control measures is an important factor. Here are some suggested chemical control measures that can be applied. At the beginning of the rainy season, it is recommended that all plants be watered with 0.3% Potassium phosphonate as much as 5-10 liters/plant. Besides, spraying was done with 0.3% potassium phosphonate. The second watering and spraying is carried out at intervals of 2 -3 months after the first application. If the rainy season is prolonged, it is necessary to do a third watering a month after the second application. At the beginning of the rainy season, it is recommended that all plants be watered with 0.125% metalaxyl-maneozeb as much as 5-10 liters/plant, and spraying with 0.125% metalaxyl-mancozeb. If using a biological control formulation, avoid using copper oxychloride. It is recommended that the biocontrol formulation be given as soon as (at least) 40 days after the chemical fungicide is given.

Biologically

Biological formulations which are mixtures of organic matter (forage manure, manure/cow) are highly recommended to be applied at the beginning of the rainy season, repeated 2-3 months after initial application with rain to reduce the population of pathogens in the soil. At the beginning of the rainy season, apply a formula containing Trichoderma spp., Pseudomonas flourescens, Mycorhiza Vesicular arbuscular (VAM) at the base of pepper plants [15].

Use of Tolerant Varieties

There are no cultivated pepper varieties that are resistant to stem rot disease. Two pepper varieties that are tolerant to P. capsici fungal infection are Natar 2 for black pepper production and Petaling 2 for white pepper production [15].

Secondary Metabolites of Trichoderma sp

Secondary Metabolites of Trichoderma sp. (Biological Control Agents) are organic compounds which are remnants of primary metabolism that are of no use in the normal growth, development, reproduction of organisms or microbes and are formed during the late or near stationary stage (separation).

According to [6], states that in general there are two kinds of metabolites, namely Primary Metabolites and Secondary Metabolites. Primary metabolites are organic compounds formed during the growth of organisms or microbes that directly affect the life of organisms or micro-organisms. The materials produced by the Primary Metabolites are alcohol, amino acids, proteins and fats. While Secondary Metabolites are organic compounds which are remnants of primary metabolites that are of no use in the normal growth, development, reproduction of organisms or microbes and are formed during the late or near stationary stage (separation).

There are several reasons why the Secondary Metabolites of Trichoderma sp. used:

1. Acting as a plant protector means the Secondary Metabolites of Trichoderma sp. can increase chemical compounds in plants that function in plant resistance to pests and diseases, so that plants can avoid pests and diseases.
2. It is important in dealing with environmental stress when the Secondary Metabolites of Trichoderma sp. given at the beginning of planting can overcome environmental stress due to its role as an inducer of plant resistance.
3. Important in overcoming pests and causes of plant diseases that are in the plant, meaning the Secondary Metabolites of Trichoderma sp. able to reach the presence of pests and diseases that are difficult to detect in plant tissues such as stem borer pests, wilt disease, molt disease and so on.
4. Ease of preparation, application, storage, and packaging means Secondary Metabolites of Trichoderma sp. in its preparation can be done by ordinary farmers who do not have complete tools such as in the laboratory. Its application is carried out in various ways regardless of the ecological differences of the region. Storage can be done for a long time with certain conditions and the packaging is also very simple and easy [6].

The results of research conducted by [16], reported that the Secondary Metabolites of Trichoderma sp were able to control Vascular Streak Die Back (VSD) disease by 47.50% to 81.8%, higher and the same as chemical fungicides by 63.6 %.

CONCEPTUAL FRAMEWORK

The conceptual framework in this study is as follows:

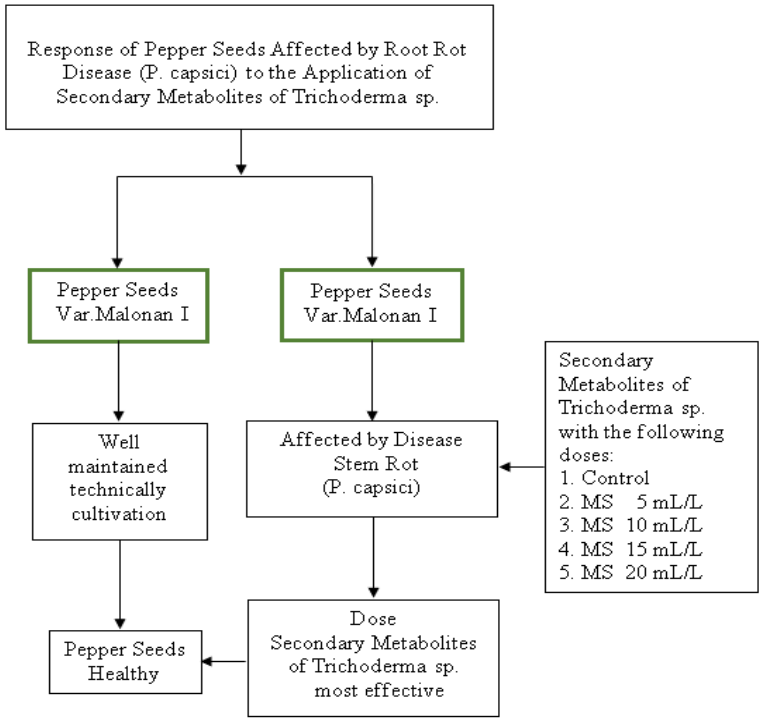

Fig-1: Conceptual Framework

Hypothesis

Response of pepper seedlings affected by stem rot disease (P. capsici) to the application of Secondary Metabolic Trichoderma sp. at a concentration of 15 mL/L.

METHODOLOGY

Time and place

This research was carried out for approximately 4 (four) months starting from March 2020 to June 2020. The research location is located at the Office of the Regional Technical Implementation Unit for the Development of Plantation Plant Protection (UPTD P2TP) Plantation Office of East Kalimantan Province Jalan Slamet Riyadi Gang VI Samarinda District Ulu Samarinda City.

Materials and tools

The materials used in this study were secondary metabolites of Trichoderma sp, isolates of the fungus Phytophthora capsici, seeds of pepper plant variety Malonan 1 and other supporting materials. The tools used are polybag, meter, scope, cork drill, stationery, camera, shade, laboratory equipment, and other supporting tools.

Experimental design

This study is an experiment arranged in a completely randomized design (CRD) consisting of 5 (five) treatments with 10 (ten) replications. The treatment is as follows:

1. No Treatment (Control) (TPO)
2. Secondary Metabolic Treatment 5 mL/L (MS5)
3. Secondary Metabolic Treatment 10 mL/L (MS10)
4. Secondary Metabolic Treatment 15 mL/L (MS15)
5. Secondary Metabolic Treatment 20 mL/L (MS20)

More details of the research can be seen below:

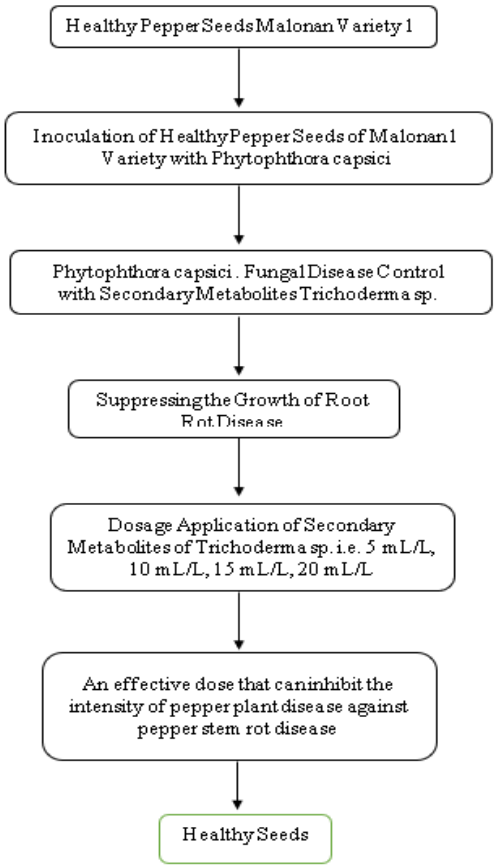

Fig-2: Research Flow of Pepper Seedlings Affected by Root Rot Disease (P. capsici) Against Application of Secondary Metabolites of Trichoderma sp.

Research procedure

Laboratory Activities

Exploration of the Fungus Phytophthora capsici

The fungal pathogen Phytophthora capsici in this study was obtained from the exploration of soil samples contaminated with pepper stem rot disease from the field. After exploration, it was isolated from chayote. For 8 days the chayote was covered with hyphae of P. capsici and then isolated on PDA (Potatoes Dextrose Agar) media as shown in Figure 3a. The method of making PDA media is that 200 gr potatoes are cleaned, cut into cubes, add 500 ml of distilled water and boil until it becomes a broth over medium heat. Lift then drain. Reheat on the stove the potato

water broth and then add 500 ml of Aquades water, 20 g of dextrose, 20 g of gelatin while stirring so as not to clot, let it boil, stir the mixture again until smooth, remove from the stove. After adding the mixture to each of the petri dishes as much as 15 ml then sterilized using an autoclave using saturated steam at a pressure of 1 atm for 15 minutes at a temperature of 121 0C [17]. Obtaining pure culture of P. capsici fungus was transferred from PDA media to Rose Bengal Agar Base media. The trick is to take what we suspect is P. capsici fungal hyphae from PDA media and then transfer or scratch them onto Rose Bengal Agar Base media and incubate for 2-3 days at 35oC. After growing, hyphae such as white threads were identified using a microscope to determine whether P. capsici function or not can be seen in Figure 3b.

Fig-3: a. Isolation on chayote fruit; b. Fungal Zoospores P. capsici Jamur

Detecting the presence of Phytophthora spp in plant tissues is often difficult because this species can be in the form of resistant propagules in the soil or through water flow using chayote, an easy way to do direct bait because chayote contains a lot of water [18].

Phytophthora capsici Mushroom Propagation

Propagation of pure culture of Phytophthora capsici using Rose Bengal Agar Base media which contains 5 g soy protein, 10.0 g glucose, 1.0 g KH2PO4, 0.5 g MgSO4, 15.0 g agar and 35.0 mg Rose Bengal. The trick is to dissolve 18 g of Rose Bengal media into 497 ml and then sterilize the media using an autoclave at 121oC for 15 minutes. Next, 3 mL of chloramphenicol solution was added to the media with a concentration of 100 mg/L Rose Bengal Agar Base media and the media was poured into a petri dish.

Based on macroscopic observations of the P. capsici fungus, morphological results were obtained, namely having a flower-like colony shape with white color and thick texture. Shaped like an egg. Sporangia that grow and germinate indirectly can produce zoospores as shown in Figure 3b.

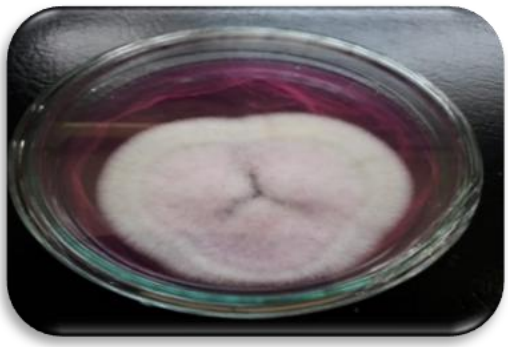

Fig-4: Pure Culture of P. capsici Fungus Colonies

Phytophthora capsici Spore Density Test

The spore density test of the fungus P. capsici was carried out approximately 7 and seven days after isolation from pure culture, carried out with a 10-2 dilution. Then 0.2 mL of the suspension solution was taken and dropped into the counting field on a Neubauer Improve Haemacytometer and observed using a microscope with two replications.

Method of Making Secondary Metabolites of Trichoderma sp

Methods of making secondary metabolites of Trichoderma sp. The ingredients are to prepare rice, corn, coconut water, palm sugar, Em4 1 L, and clean water. The utensil used is a large pot. The rice and corn are put into a pot with clean water and then cooked over medium heat for 1 hour or the rice and corn until soft and then strain the broth. Then cook the water, palm sugar, broth (rice, corn), coconut water and Em4 until it boils. Then put it in a jirigen to chill for 2 days. Put the Trichoderma sp starter into the jirigen and let it rest for 2 days. Then it was locked for 7 days without stopping. The secondary metabolites are ready to be applied as shown in Figure 5.

Secondary metabolites of Trichoderma sp. which is used in this research is the product produced by UPTD P2TP East Kalimantan Province. The secondary metabolite solution of Trichoderma sp required in this study was 500 mL/L. The content contained in the secondary metabolites of Trichoderma sp. namely proteases, Phosphate Solvents, Chitinases, Sellulases, and Hormones according to the results of tests conducted by the Laboratory of Plant Protection, Jenderal Soedirman University, Faculty of Agriculture, Surabaya.

a b

Fig-5: a. Secondary Metabolites of Trichoderma sp in open containers; b. Secondary Metabolites in 1 L packs

Test of Antagonist Fungus Phytophthora capsici With Secondary Metabolites Trichoderma sp. In Vitro

This antagonist test was carried out in the laboratory of UPTD P2TP, East Kalimantan Province. The aim is to see the effectiveness of the Secondary Metabolites of Trichoderma sp. against the fungus P. capsici.

How to do the Antagonist test, namely: Provide 3 petri dishes measuring 20 cm (three times) containing Rose Bengal Agar Base media, P. capsici fungus isolate, Trichoderma sp. Secondary Metabolite solution, sterile aquadest, cork drill and cotton but. The first step was to wipe the P. capsici fungal isolate with a cotton swab into a petri dish containing Rose Bengal Agar Base media and leave it for one hour. The second step is to make a well using a cork drill as many as five wells in each petri dish on Rose Bengal Agar Base media. The third step is to incubate in a dark room and observe every day for five days as shown in Figure 6.

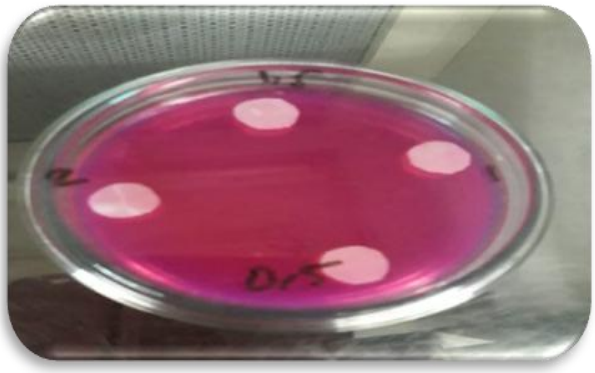

Fig-6: Antagonistic test between P. capsici and Secondary Metabolites of Trichoderma sp

Activities in the Field

Research Land Preparation

The land used in this study is land that has been cemented in palybags given a brick base so that it does not flood when it rains. tin roof with a height of 2.5 meters.

Preparation of Planting Media

Preparation of planting media for research in the form of soil consisting of top soil, bukosi fertilizer, sp. with a ratio of 1: 1 then put into poly bags measuring 30 X 30 cm as many as 50 polybags with a weight of soil content in poly bags of 6 kg each arranged with a distance between treatments of 70 X 70 cm. For two weeks the soil in the poly bag is left so that the seeds transferred to the polybag are not stressed. The age of the pepper plant used for the study was 8 months.

Planting

Pepper plant seeds for this study were obtained from breeding nurseries in Batuan village, Loa Janan district, Kutai Kartanegara district, aged 6 (six) months. as many as 75 seeds, including for embroidery seeds, keeping the possibility that someone dies. Pepper seedlings taken from the field experienced stress because the distance between the garden location and the research site was quite far, so that on the way the pepper plant seeds were shaken so that the pepper seedlings experienced stress. Pepper seedlings are left for a week from the field to stabilize the condition of pepper seedlings. Then transferred to a polybag. After the plant seeds look healthy, they are then given wood to help the plants stand until the plants are really healthy. Pepper plant seeds used as research material were 8 months old.

Maintenance

Maintenance includes watering every two days according to weather conditions because pepper plants do not want the soil to be too wet nor too dry. Weeding is done when weeds are visible on the ground.

Phytophthora capsici Fungus Inoculation

Pepper Seedlings of Malonan 1 Varieties that have been planted in polybags and look healthy at the age of two months in polybags are inoculated with Phytophthora capsici mushroom each as much as 40 mL/polybag by sprinkling them into the base of the pepper plant stems.

Treatment of Secondary Metabolites of Trichoderma sp

Treatment of Secondary Metabolites of Trichoderma sp. on pepper seedlings in polybags after visible symptoms of attack are marked by leaves looking dull or leaves looking towards the stem or pointing to the side. Symptoms of this attack are seen at the age of the plant ± 1 (one) month after being inoculated with the fungus Phytophthora capsici. Then it is done by giving the secondary metabolite Trichoderma sp. on symptomatic pepper seedlings. Given according to the treatment. Secondary metabolites were sprinkled around the base of the pepper seedling stem with treatment concentrations (MS5) 5 mL/L, (MS10) 10 mL/L, (MS15) 15 mL/L, (MS20) 20 mL/L with a suspension of 400 m/polybag.

Observation Parameter

Phytophthora capsici Spore Density

The P. capsici fungus before being inoculated into pepper plants was calculated for its density at the Disease Laboratory of UPTD P2TP Plantation Office of East Kalimantan Province. The trick is P. capsici fungus on solid media with 1 mL of sterile distilled water added and put into a test tube containing 9 mL of sterile distilled water and homogenized. 0.2 mL of spore suspension was taken and flowed into the hemocytometer canal until it was completely filled and closed using a cover slip and the spore count was carried out with two replications. Furthermore, the spore density is calculated using a formula based on the Indonesian National Standard (SNI) on Biological Control Agents (APH), which is as follows:

$$S = \frac{X}{L\ (mm2)\ x\ t(mm)xd} x\ 10^3$$

Information:
S = Density of Conidium/ml
X = Amount of Conidium in Box a, b, c, d, e.
L = Area of the calculated box 0.04 mm2
T = Depth of calculated field 0.1 mm
D = Dilution Factor
103 = Calculated suspension volume (1 ml = 103 mm3)

Disease Attack Intensity

Observation of disease symptoms in pepper plants was carried out at 4, 8, 12 weeks after inoculation. Calculation of intensity, using the disease severity formula [3]:

$$I = \frac{\Sigma\ ni\ x\ vi}{Z\ X\ N}\ X\ 100\ \%$$

Information
I = Disease Intensity
n = Number of leaves that are attacked with a certain scale value that is sick
vi = Scale Value.
N = observed leaves
Z = The highest scale value

A scale value from 0 to 4 was used to calculate Disease Intensity. For more details, the scale and category values can be seen in table-1 below:

Table-1: Scale value and attack category to calculate the intensity of root rot disease in pepper plants

Scale Value	Percentage of necrotic spot area to leaf area per inoculation point (x)
0	$x = 0$
1	$1\ \% < x \leq 10\ \%$
2	$10\ \% < x \leq 25\ \%$
3	$25\ \% < x \leq 50\ \%$
4	$> 50\ \%$

Source: Data processed, 2020

Average Number of Leaves

Collecting data on the average number of leaves of pepper plants by counting all the leaves of plants in polybags. Calculations were made for each treatment. Observations were made after inoculation every 4 (four) weeks until the 12th (twelfth) week using strands.

Average number of buds

Collecting data on the average number of shoots by counting the shoots of pepper plants in polybags for each treatment. Observations were made after inoculation every 4 (four) weeks until the 12th (twelfth) week). The units used are grains.

Average Length of Shooting Space

Data collection on the average shoot length of pepper plants using a ruler at each treatment was measured from the base of the shoot to the tip of the shoot. Observations were made after inoculation every 4 (four) weeks until the 12th (twelfth) week with units of cm.

Average Plant Height

Data collection on the average height of pepper plants by measuring from the soil surface to the tip of the plant using a roller meter. Calculations were made for each treatment. Observations were made after inoculation every 4 (four) weeks until the 12th (twelfth) week with units of cm.

Data analysis

The data obtained from all parameters of this study were analyzed using variance (Anova). If there is a real effect, it will be continued with the Least Significant Difference Test (BNT) at the 5% level.

RESULTS AND DISCUSSION

Phytophthora capsici Fungus Spore Density and Antagonist Test

The results of research conducted in the laboratory to obtain the density of P. capsici spores by using the following formula (SNI):

$$S = \frac{165,5}{0,04 \times 5 \times 0,1 \times 10^{-2}} \times 10^3 = \frac{165,5}{0,2 \times 10^{-2}} \times 10^3 = 8.275 \times 10^4 \text{ spora}$$

From these calculations, the density of P. capsici spores was obtained at 8,275 x 104. this can be a virulence reference that will be applied to pepper plants used as the object of this study.

Based on the results of the secondary metabolite antagonist test of Trichoderma sp. against P. capsici, it has the highest inhibitory capacity with the diameter of the zone of inhibition at MS20 concentration of 3.05 mm, followed by MS15 concentration of 2.52 mm, MS10 of 2.05 mm and finally MS5 0.99 mm. According to [19] stated that the inhibition zone 20 mm indicates very strong inhibition, <20-10 mm indicates strong inhibition <10-5 mm indicates moderate power <5 mm indicates weak inhibition can seen in Figure 7 and Table 2 below:

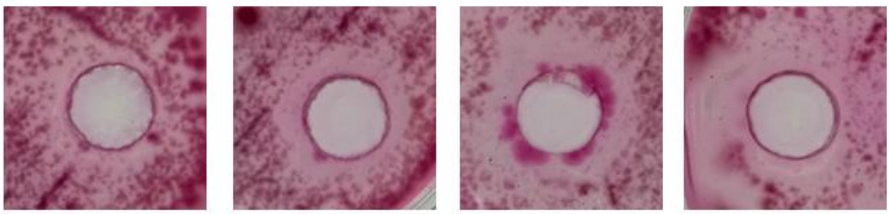

Fig-7: Test results of fungal antagonist P. capsici with Secondary Metabolites of Trichoderma sp.

Table-2: Antagonist Test Results Between Phytophthora capsici and Secondary Metabolites of Trichoderma sp.

Concentration of Secondary Metabolites of Trichoderma sp.	Inhibition zone diameter (mm) replay			Average
	I	II	III	
MS_5	0,15	1,80	1,01	0,99
MS_{10}	2,45	2,35	1,35	2,05
MS_{15}	2,60	2,75	2,2	2,52
MS_{20}	3,50	3,15	2,5	3,05

Source: Data processed, 2020

Disease Attack Intensity

The results of the data analysis were transformed into Arc Sin-1√x by using a variety of disease intensity after application with P. capsici fungus on the 30th day of the day, on the 60th day after application with the Secondary Metabolites of Trichoderma sp. and 90 days after application of P. capsici and its secondary metabolites Trichoderma sp. showed very different results. The average percentage inhibition of each concentration can be seen in table-3 below:

Table-3: Average Intensity of Attack of Pepper Stem Rot Disease at 30 Hst, 60 Hst, 90 Hst

Treatment	Day After Planting		
	30	60	90
TP_O	$18,7^d$	$21,21^d$	$22,98^c$
MS_5	$14,90^c$	$16,39^c$	$17,93^b$
MS_{10}	$14,49^c$	$16,32^c$	$18,53^b$
MS_{15}	$11,88^b$	$14,76^b$	$17,62^b$
MS_{20}	$9,24^a$	$10,60^a$	$11,94^a$

Note: Data is transformed to Arc Sin-1√x The number followed by the same lowercase letter in the same column means that it is not significantly different in the 5% BNT test (BNT = 1.59 (30 Hst), 1.18 (60 Hst) , and 1.01 (90 Hst)

Source: Data processed, 2020

Based on the results of the further test of 5% BNT, the percentage of disease intensity at the age of 30 hst showed that the MS10 concentration of 14.49% was not significantly different from the MS5 concentration of 14.90% but significantly different to the TPO concentration of 18.71%, MS15 of 11. 88%, MS20 of 9.24%.

Based on the results of the BNT test 5% the percentage of disease intensity at the age of 60 hst

showed that the MS20 treatment was 10.60% significantly different from all treatments MS15 by 14.76%, MS10 by 16.32%, MS5 by 16.39%, and The TPO was 21.21%, but the MS5 and MS10 treatments were not significantly different, namely 16.39% and 16.32%.

Based on the results of the BNT test 5% the percentage of disease intensity at the age of 90 hst showed that the MS20 treatment was 11.94% significantly different from all MS15 treatments by 17.62%, MS10 at 118.53%, MS5 at 17.93%, and The TPO was 22.98%, but the MS15, MS5, and MS10 treatments were not significantly different, namely 17.62%, 17.53% and 18.53%.

Average Number of Leaves

On days 0, 30, 60 and 90 days after planting, the average number of leaves showed no significant difference. From the observations on days 0, 30, 60 and 90 days after planting, the lowest average number of leaves was in the MS20 treatment, which was 19.10 strands, 25.80 strands, 59.20 strands and 63.00 strands, followed by MS15 treatment which was 23.20 strands, 26.00 strands, 57.50 strands and 66.20 strands, then in TPO treatment 22.40 strands, 31.70 strands, 57.00 strands and 67.70 strands strands, MS10 was 21.70 strands, 30.10 strands, 61.80 strands and 74.20 strands, and the highest was MS5 treatment of 21.60 strands, 29.40 strands, 62.20 strands and 75.40 strands sheet.

From the results of the research that the average number of leaves that experienced the most leaf growth in the MS5 treatment 90 days after planting was 75.40 leaves and it was also known that the average number of leaves in all treatments increased every 30 days.

The results of observations on the average number of leaves can be seen in table-4 below:

Table-4: Average Number of Leaves at 0 Hst, 30 Hst, 60 Hst, 90 Hst

Treatment	Day After Planting			
	0	**30**	**60**	**90**
TP_O	22,40	31,70	57,00	67,70
MS_5	21,60	29,40	62,20	75,40
MS_{10}	21,70	30,10	61,80	74,20
MS_{15}	23,20	26,00	57,50	66,20
MS_{20}	19,10	25,80	59,20	63,00

Source: Data processed, 2020

Average number of buds

From the results of observations on days 0, 30, 60 and 90 after planting, the lowest average number of shoots was in the TPO treatment, namely 8.20 segments, 9.00 segments, 11.40 segments and 11.90 segments. , followed by MS10 treatment which is 9.00 segment, 9.70 segment, 13.20 segment and 17.80 segment, then in MS5 treatment 9.90 segment, 12.40 segment, 13.30 segment and 18.30 segment segments, MS15 is 9.70 segments, 11.10 segments, 16.40 segments and 24.40 segments, and the largest is the MS20 treatment of 7.20 segments, 11.90 segments, 22.50 segments and 29.90 segment. From the results obtained, it is known that the highest average increase in the number of internodes in MS20 treatment is 29.90 segments and it is also known that the average increase in the number of buds in all treatments increases every 30 days.

On day 0 after planting the average number of buds showed no significant difference, but the results of the 5% BNT Test on day 30 after planting the average number of buds showed a significant difference, and on day 60 and 90 after planting the 5% BNT test also showed that the average shoot internode was significantly different.

The results of observations on the average number of buds can be seen in table-5:

Table-5: Average number of buds in 0 Hst, 30 Hst, 60 Hst, 90 Hst

Treatment	Day After Planting			
	0	**30**	**60**	**90**
TP_O	8,20	9,00^a	11,40^a	11,90^a
MS_5	9,90	12,40^a	13,30^b	18,30^b
MS_{10}	9,00	9,70^a	13,20^b	17,80^b
MS_{15}	9,70	11,10^a	16,40^c	24,40^c
MS_{20}	7,20	11,90^a	22,50^d	29,90^d

Note: Numbers followed by the same lowercase letter in the same column, mean that they are not significantly different in the BNT 5% test (BNT = 2.47 (30 Hst), 2.37 (60 Hst), and 2.65 (90 Hst)

Source: Data processed, 2020

Average shoot length

From the results of observations on days 0, 30, 60 and 90 after planting, the lowest average shoot length was in the TPO treatment, namely 11.28 cm, 11.62 cm, 15.39 cm and 16.54 cm. , followed by MS5 treatment of 13.25 cm, 16.37 cm, 17.94 cm and 22.27 cm, then in MS10 treatment of 12.96 cm, 14.28 cm, 19.85 cm and 23.39 cm, MS15 of 13.81 cm, 15.85 cm, 21.97 cm and 28.11 cm, and the highest treatment was MS20 of 10.51 cm, 16.15 cm, 23.83 cm and 33.39 cm.

From the results of the study, it can be seen that the average length of the longest shoots in the MS20 treatment is 33.39 cm and it can also be seen that the increase in the average length of the shoots in all treatments increases every 30 days.

The results of observations on the average length of buds can be seen in table-6 below:

Table-6: Average shoot length in 0 Hst, 30 Hst, 60 Hst, 90 Hst

Treatment	Day After Planting			
	0	30	60	90
TP_O	11,28	11,62[a]	15,39[a]	16,54[a]
MS_5	13,25	16,37[c]	17,94[b]	22,27[b]
MS_{10}	12,96	14,28[b]	19,85[c]	23,39[b]
MS_{15}	13,81	15,85[c]	21,97[d]	28,11[c]
MS_{20}	10,51	16,15[c]	23,83[e]	33,39[d]

Note: Numbers followed by the same lowercase letter in the same column, mean that they are not significantly different in the 5% BNT test (BNT = 3.6 (30 Hst), 2.88 (60 Hst), and 3.27 (90 Hst)

Source: Data processed, 2020

On day 0 after planting the average yield of internode length did not show a significant difference, but based on the results of the 5% BNT test variance on day 30 after planting showed a significant difference, and at 60 and 90 days after planting the variance yields 5% BNT test showed a very significant difference.

Average Plant Height

From the results of observations on days 0, 30, 60 and 90 days after planting the lowest plant height was in the TPO treatment, namely 35.70 cm, 38.70 cm, 46.00 cm and 51.80 cm, followed by MS20 treatments were 33.10 cm, 38.30 cm, 47.80 cm and 56.90 cm, MS15 were 35.60 cm, 40.50 cm, 47.90 cm and 58.00 cm, then the MS5 treatment of 37.80 cm, 41.60 cm, 48.90 cm and 58.50 cm, and the highest was the MS10 treatment of 36.60 cm, 44.00 cm, 55.90 cm and 71.50 cm.

From the results of the study, it was found that the average plant height in the MS10 treatment experienced a significant increase in plant height of 74.50 cm and it was also known that the average plant height in all treatments increased every 30 days.

The results of observations of the average plant height can be seen in table-7 below:

Table-7: Average Plant Height in 0 Hst, 30 Hst, 60 Hst, 90 Hst

Treatment	Day After Planting			
	0	30	60	90
TP_O	35,70	38,70	46,00	51,80
MS_5	37,80	41,60	48,90	58,50
MS_{10}	36,60	44,00	55,90	71,50
MS_{15}	35,60	40,50	47,90	58,00
MS_{20}	33,10	38,30	47,80	56,90

Source: Data processed, 2020

Based on the analysis of variance analysis of BNT 5% on days 0, 30, 60 and 90 days after planting, the average yield of plant height showed no significant difference.

DISCUSSION

Spore Density

The spore density of the fungus Phytophthora capsici indicates the level of virulence that attacks plants that cause stem rot disease. In the fungus Phythophthora capsici, the spore density was 8,275 x 104 spores. The mechanism of fungal attack is influenced by the nature of the fungus in producing abundant spores in environmental conditions that are in accordance with the conditions of life, namely with a temperature of 25o-30oC and humidity above 90%.

The higher the dilution, the lower the spore density, the lower the dilution, the higher the spore density. This has been proven by [20] which states that dilution affects the density of the spores produced. The high density of spores indicates the level of virulence of

pathogenic fungi in infecting their hosts. The higher the spore density, the higher the attack rate or virulence level. This is supported by [21] high spore density can be a reference in seeing the severity of disease attacks.

The Effectiveness of Secondary Metabolites of Trichoderma sp. Against Pepper Stem Root Rot Disease Control (Phytophthora capsici)

Referring to table 3, the observations prove that the secondary metabolites of Trichoderma sp. with different concentrations were able to inhibit the growth of P. capsici fungus where the best concentration was in the MS20 treatment with an average percentage of inhibition of 3.05%, while in MS5 it was only able to inhibit 0.99%. This could be due to the higher concentration of secondary metabolites of Trichoderma sp. the higher the percentage of obstacles that occur.

Secondary Metabolites of Trichoderma sp. derived from endophytic fungi or from the plant itself has a different percentage of inhibition depending on the concentration of secondary metabolites produced by an organism. This is in accordance with the research conducted by [22] which states that the effectiveness of secondary metabolites in a creature can be seen through the concentration of secondary metabolites produced, the higher the concentration produced, the organism will be resistant to a disease attack.

Disease Attack Intensity

Based on the results of the 5% BNT further test variance in Table 3, the percentage of disease intensity at the age of 30 days after planting was known that the most effective MS20 concentration in controlling pepper stem base rot was 9.24%. Observations at the age of 60 days after planting showed a MS20 concentration of 10.60%, and at 90 days after planting it showed an inhibition of stem rot disease at a concentration of 11.94% MS20. Overall, the secondary metabolites of Trichoderma sp. The most effective control of pepper stem base rot disease (P. capsici) was at a concentration of MS20.

It is suspected that the content of secondary metabolites of Trichoderma sp. such as antibiotics, enzymes, hormones and toxins are able to inhibit the development of pathogens in plants.

According to [16] stated that the secondary metabolites of Trichoderma sp. can inhibit the growth of the fungus P. capsici because of the presence of compounds such as viridin and trichomidine which are antibiosis in which these two compounds can produce the enzymes -1,3 glucanase and chitinase. These compounds are useful for degrading pathogenic cells and are able to penetrate into the hyphae of other fungi. This is also supported by [23] that secondary metabolites can inhibit disease attacks maximally if the concentration content of an organism is higher. The intensity of disease attacks can be seen in Figure 8 below.

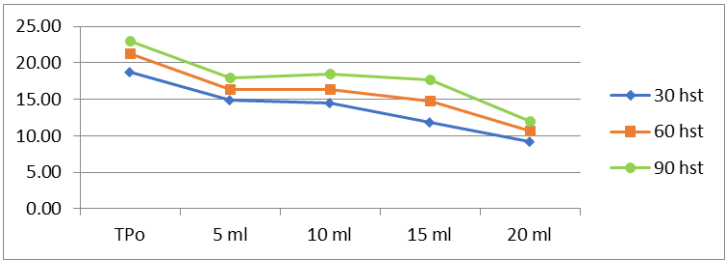

Fig-8. Intensity of Disease Attack on Various Treatments of Secondary Metabolite Concentration

Average Number of Leaves

Based on the results of the 5% BNT further test variance in table 4, it is known that the average number of leaves at the age of 0 hst is known that before the application of treatment, the highest average number of leaves was 23.20 in MS15 treatment. Pepper plants experienced a normal increase from each observation. The results of the 5% BNT further test variance in table 4 showed that the average number of leaves at the age of 0 DAP, 30 DAP, 60 DAP, 90 DAP had no significant effect. The results of observations in the field showed that the growth development of pepper plant leaves experienced a normal increase from each observation. The treatment was given an average of the highest number of leaves in the MS15 treatment amounting to 23.20 strands. Based on the observations and the results of the 5% BNT test variance that the age of the plant at 30 DAP in the TP0 treatment, the average number of leaves was 31.70 leaves and in the MS5 treatment, the average number of leaves at 60 DAP was 62.20 and accompanied by the age of the plant was 90 days after the maximum was 75.40 strands.

The growth development of pepper plant leaves experienced a normal increase from each observation in the field. It is suspected that the content contained in the secondary metabolites of Trichoderma sp. has a gibberellin hormone that stimulates cell division or cell extension and leaf growth. This is in accordance with the statement of [24] that growth regulators can affect plant growth and development, at low concentrations are stimulating. On the other hand, at high concentrations, it inhibits or kills plants. It is also supported by [25] that secondary metabolites are

able to mimic the growth of the number of leaves with a certain concentration. If the added concentration exceeds the optimum concentration limit, the growth will slow down. This is proven to be able to accelerate the growth process at a certain concentration so that the number of leaves will increase in plants. The goal is that the leaves will produce more food for plants and production will increase. So it can be said that the secondary metabolite which is more effective to control pepper base rot disease in terms of the number of leaves is the treatment or MS5 concentration of 75.40 leaves.

The development of various secondary metabolite concentration treatments on the average number of leaves can be seen in figure-9:

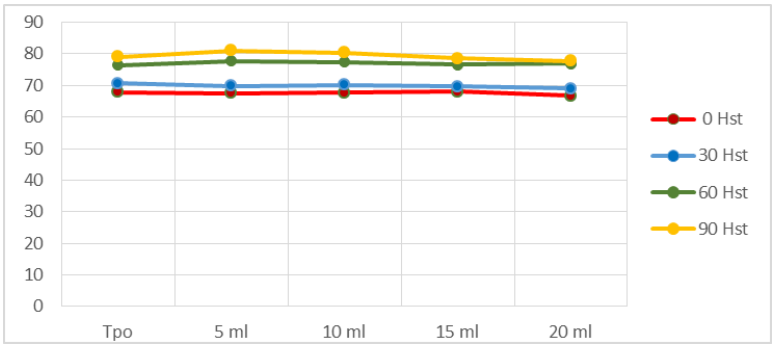

Fig-9: Average Number of Leaves on Various Treatments of Secondary Metabolite Concentration

Average number of buds

Based on the results of the 5% BNT follow-up test variance in Table 5 that the average number of buds at the age of 0 hst before the application of treatment was given the highest number of shoots on the MS5 treatment amounted to 9.90 segments. Based on the observations and the results of the 5% BNT test variance, it was found that at the age of 30 days after the MS5 treatment, the average number of buds was 12.40 internodes. At the age of 60 days after MS20 treatment, the average number of shoots was 22.50, followed by 90 days after MS20 treatment, the average number of shoots was 29.90.

From the results of observations on the average number of buds, it can be seen that in the control treatment that was not given secondary metabolites, the shoots continued to increase every observation but did not increase significantly. In contrast to the treatment that added secondary metabolites, the average increase in the number of buds became very significant. From the observations MS20 is the best concentration in accelerating the growth of buds. This can happen because secondary metabolites are able to trigger shoot growth and can increase plant resistance so that plant growth will be faster. In a study conducted by [26] secondary metabolites have been shown to be able to accelerate the growth process by stimulating shoot growth. The addition of secondary metabolites contains cytokinin hormones which play a major role as a regulator of growth and cell differentiation, so that the growth of buds increases. Secondary metabolites can increase plant resistance from disease and accelerate growth by stimulating plant vigor. In a study conducted by [9] mentions that secondary metabolites trigger an increase in plant vigor so that shoot growth becomes faster, thus it can be said that a more effective treatment to control pepper stem base rot disease in terms of the average number of buds is the treatment or MS20 concentration of 29, 90 segments. The average number of buds can be seen in Figure 10:

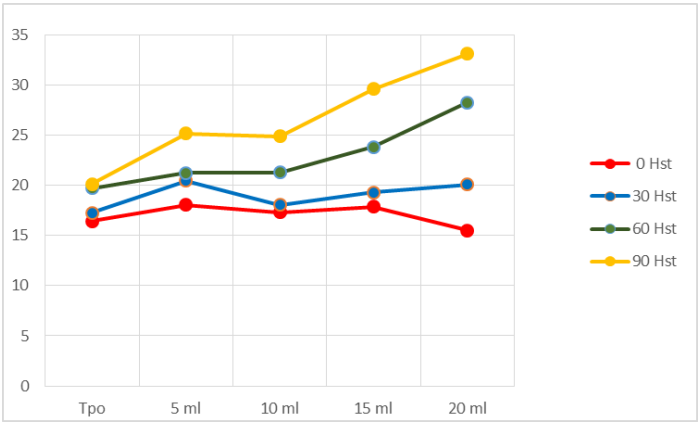

Fig-10 : Average Number of Shoots in Various Treatments of Secondary Metabolite Concentration

Average shoot length

Based on the results of the 5% BNT further test variance in Table 6, it is known that the average bud internode length at the age of 0 hst is known that before the application of treatment the average length of the longest shoot internode in the MS15 treatment was 13.81 cm high. Based on the observations and results of the 5% BNT test variance that the age of the plant at 30 DAP in the MS5 treatment the average length of the longest shoot internode was 16.37 cm and at the age of the plant 60 DAP in the MS20 treatment, the average length of the longest shoot internode was 23.83 cm. with a plant age of 90 days after MS20 treatment, the average length of the longest shoot segment was 33.39 cm.

From the results of observations on shoot length, it can be seen that in the control treatment that was not given secondary metabolites, the average shoot length continued to increase every observation but did not increase significantly. In contrast to the treatment with secondary metabolites added, the average increase in shoot internode length became very significant. From the observations, MS20 treatment was the best concentration in accelerating the growth of shoot length. This can happen because secondary metabolites are not only capable of triggering the addition of buds, they are also able to trigger the growth of shoot length and can increase plant resistance so that plant growth will be faster. In research conducted by [27], secondary metabolites have been shown to be able to accelerate the growth process by stimulating shoot growth so that shoots become longer and will result in better production. That it can be said that secondary metabolites are the most effective in controlling pepper stem base rot disease, seen from the average length of shoot internodes at plant age of 60 days after planting, 23.83 cm and 90 days after planting, 33.39 cm.

The average shoot length can be seen in Figure 11 below:

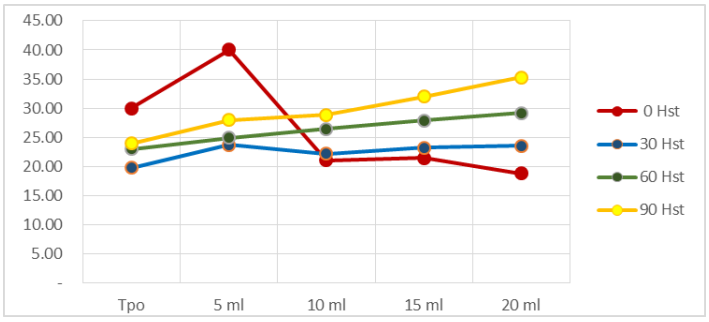

Fig-11 : Average Length of Shoots in Various Treatments of Secondary Metabolite Concentration

Average Plant Height

Based on the results of the 5% BNT further test variance in Table 7, it is known that the average plant height at the age of 0 hst is known that before the application of treatment the highest average plant height was given to the highest MS5 treatment of 37.80 cm. Based on the observations and results of the 5% BNT test variance, the plant age at 30 DAP in the MS10 treatment had the highest average plant height of 44.00 cm and at the age of 60 DAP in the MS10 treatment, the highest average plant height was 55.90 cm, accompanied by the age of 90 days after treatment with MS10 the average plant height was 71.50 cm.

From the observations in the field, it can be seen that the average plant height in the control treatment that was not given secondary metabolites, the plant height continued to increase for each observation but did not increase significantly. In contrast to the treatment with secondary metabolites added, the average increase in plant height was very significant. From the observations, MS10 concentration was the best concentration in accelerating plant height growth, but not very good in increasing shoots and bud growth. This can happen because secondary metabolites are not only capable of triggering plant growth at a certain concentration, if the added concentration exceeds the optimum concentration limit, growth will slow down. In research conducted by [28] secondary metabolites have been shown to be able to accelerate the growth process at certain concentrations by stimulating the hormone auxin which can trigger cell elongation in roots and stems in plants so that growth will be very fast and provide better results.

Based on the description above, the plant height can be used as an indicator to determine the effectiveness of the secondary metabolites of Trichoderma sp. control pepper root rot disease. In the MS10 treatment or concentration, the age of the plant was 30 days after planting as high as 44.00 cm, the age of the plant was 60 days after planting as high as 55.90 cm, the age of the plant was 90 days after planting as high as 71.50 cm.

The average plant height can be seen in Figure 12 which can be seen below:

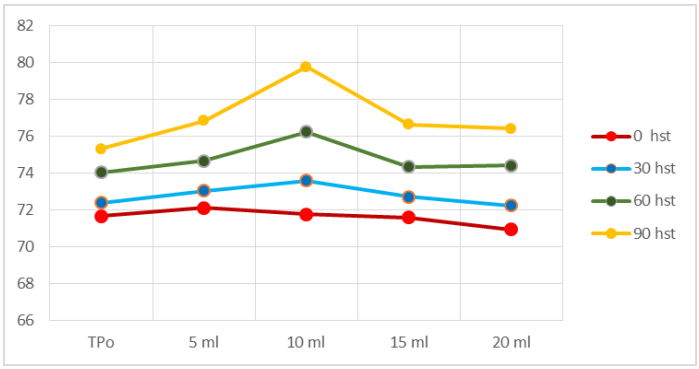

Fig-12 : Average Plant Height in Various Treatments of Secondary Metabolite Concentration

CONCLUSIONS AND SUGGESTIONS

Based on the results of the analysis that has been stated, it can draw a conclusion as follows:

1. Application of secondary metabolites of Trichoderma sp. The most effective concentration of MS20 in controlling stem rot disease of pepper (P. capsici) was 88.06%.
2. The application of secondary metabolites of various concentrations can affect the growth of pepper seedlings on:

a. The average number of leaves with MS5 concentration was 75.40 leaves
b. The average number of internodes with MS20 concentration was 29.90, and the average length of shoots with MS20 concentration was 33.39 cm.
c. The average number of plant height with MS10 concentration was 71.50 cm

Based on the results of the analysis that has been concluded, then some suggestions that can be given based on the results of this study are as follows:

1. It is hoped that further research needs to be re-examined to obtain even better results.
2. The results of this study can be informed to pepper farmers so that in controlling pepper stem base rot disease (P. capsici) to use bio-organic pesticides.

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