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Effect of Mycorrhizal Fungi in Controlling Bacterial Leaf Disease in Lowland Rice Caused by Xanthomonas oryzae pv oryzae Bacteria

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Abstract

Bacterial leaf blight on lowland rice caused by Xanthomonas oryzaepvoryzae (Xoo) is still an important disease. Yield loss could reached 30-40%. This research was carried out in the experiment station and the plant disease laboratory, Faculty of Agriculture, Syiah Kuala University, Banda Aceh with the aim to determine the effect of mycorrhiza in controlling bacterial leaf blight on paddy rice plants. The design used was completely randomized design (CRD). Application of mycorrhiza as treatment consists of four dosage levels: 0 gram, 10 gram, 15 gram, and 20 gram per crop. Inpari 10 cultivar paddy wasusedas indicator plants. The results showed that mycorrhiza affected the incubation period of bacterial leaf blight, length of lession, disease intensity, plant height, and number of tillers of Inpari10 cultivars. The longest incubation period was obtained in the application of mycorrhiza as much as 15 grams per plant (10.33 days) and 20 grams per plant (10.12 days) after inoculation of Xoo bacteria. The shortest length of lession was obtained in the application of mycorrhiza in 20 grams perplant (2.45 cm) and the longest was obtained in plants that were not given mycorrhiza (5.05 cm). The highest disease intensity was obtained in plants that were not given mycorrhiza, namely 25.18% and the lowest in plants that were given mycorrhiza as much as 15 grams per plant and 20 grams per plant, namely 17.29 and 16.51%. The incubation period did not inhibit height growth (r = 0.399 ** and tillers formation (r = 0.348 **) Inpari cultivar paddy rice 10. But the length of the lesio inhibited plant height growth (r = - 0.618 **) and tillers formation (r = - 0.612 **) as well as the intensity of the disease inhibiting the growth of plant height (r = - 0.618 **) and the formation of tillers (r = - 0.584 **).

Keywords*: Mycorrhizae, bacterial leaf blight, lowland rice*

Introduction

Currently, bacterial leaf blight caused by *Xanthomonas oryza e*pvoryzae (Xoo) is one of the main problem of lowland rice in Indonesia. This disease causes 30-40% yield loss. So far there has no proper control measure of this disease in lowland rice.The this research intended to utilize mycorrhiza as biological fertilizer, as an alternative choice to controlling

of the disease. Using this helps reduce environmental pollution through the use of excessive and inefficient chemical fertilizers. Mycorrhiza as biological fertilizer can also help to provide certain nutrients for plants.

Mycorrhiza is actually a symbiotic relationship between mutual fungi and plant roots (M. Brundrett et al., 1996). Yerfriwati et al (2009) found that mycorrhizae can act as potential biological control agents to increase plant resistance to soil borne pathogens. In addition, mycorrhiza also has great potential as a biological fertilizer because it can facilitate nutrient absorption in the soil so that it can increase plant growth, water availability for plants and growth-promoting hormones (Prihastuti, 2007).

According to Morandi, (1996) soybean roots infected with arbuscular mycorrhiza increased glyceolin content (compounds of phenol groups that can reduce the effect of pathogenicity) by influencing of accumulation of phytoalexin compared to those not infected with arbuscularmycorrhiza and an increase in these phenol compounds in each different plant. Several studies have shown that the administration of mycorrhizal *Glomus* sp. can increase the productivity of plants affected by pathogenic fungi.

Yerfriwati, (2009) showed that mycorrhizal inoculation in Kepok banana seedlings at a dose of 5-20 grams / plant increased the resistance of these plants to blood attacks. Research using mycorrhizae has also been carried out on oil palm, maize, soybean, peanuts, and tomatoes . This research has proven successful and shows that mycorrhizae can suppress the development of plant diseases. However, mycorrhizal studies on lowland rice, particularly those related to bacterial leaf blight control, are still very limited. This study was conducted to determine the effect of mycorrhiza in controlling bacterial leaf blight on Inpari 10 cultivar paddy.

Materials And Methods

This research was conducted at the Experiment Station, and Plant Disease Laboratory Faculty of Agriculture, Syiah Kuala University, Banda Aceh. The study was conducted from September 2016 to December 2016. This research was conducted using a Completely Randomized Design (CRD). As a treatment wasapplicationofmycorrhiza consisting of 4 dose levels, namely 0 grams, 10 grams, 15 gram, and 20 grams of mycorrhizapercrop. Lowland rice cultivars used in this study were Inpari 10.

Two weeks age rice seedlings were planted in the condition of the land shredding as much as three stems per planting hole. One day after planting, mycorrhiza were spread

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around the stems of rice plants. Inoculation of Xoo was carried out on plants that are 3 weeks after planting by applying to the leaves that had been cut at the tip.

Observation variable

(1) Incubation Period. The incubation period was observed every day after inoculation with Xoountil the plants showed the first symptoms that were marked by small patches on the surface of the leaves. (2) Length of Lession. Lesiolength wereobservedat the 3rd week after inoculation (MSI) of Xoo, by measuring the length of symptoms on the cut parts of the leaves (3) Disease intensity. Observation of disease intensity was carried out 3 weeks after inoculation (MSI) using the Standard Evaluation System for Rice (IRRI, 1996) with the following formula:

$$\text{Disease intensity} = \frac{(\text{Infected leaf length})}{(\text{Overall leaf length})} \text{x } 100\%$$

Representation of growth is observed through the following variables: 1). Plant Height, observed at age 46 after planting (HST). Plant height was measured starting from the base of the stem to the highest leaf tip, 2). Number of tillers. Observation of the number of tillers was done at 60 days after planting (HST) by counting the number of tillers per planta.

Results And Discussion

Incubation Period

The results showed that mycorrhiza affected the incubation period. The lowest incubation period of bacterial leaf blight was obtained in plants without mycorrhizal application (7.34 days) after inoculation of the pathogen Xoo (Figure 1). The incubation period of this disease in Inpari10 cultivar was longer with increasing dose of mycorrhiza. The longest incubation period was found in the application of 15 and 20 grams of mycorrhiza, ie 10.33 days and 10.12 days after inoculation of Xoo pathogen, respectively.

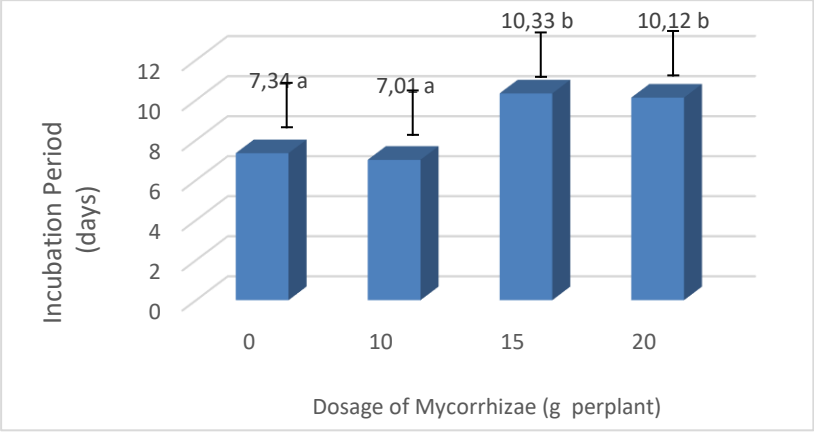

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Figure 1. The incubation period of bacterial leaf blight in Inpari 10 cultivars based on mycorrhizal fungal dose

Note: Numbers followed by the same letter are not significantly different based on the Least Significant Difference Test (LSD) at $\alpha_{0.05}$ level.

Length of lession

Application of mycorrhiza can significantly reduce the length of lession. The higher the dose level of mycorrhiza, the shorter the length of lession in Inpari 10 cuiltivar lowland rice (Figure 2). The shortest length of lesion was obtained by giving 20 grams of mycorrhiza (2.45 cm), while the longest lesion was obtained in plants without mycorrhiza (5.05 cm).

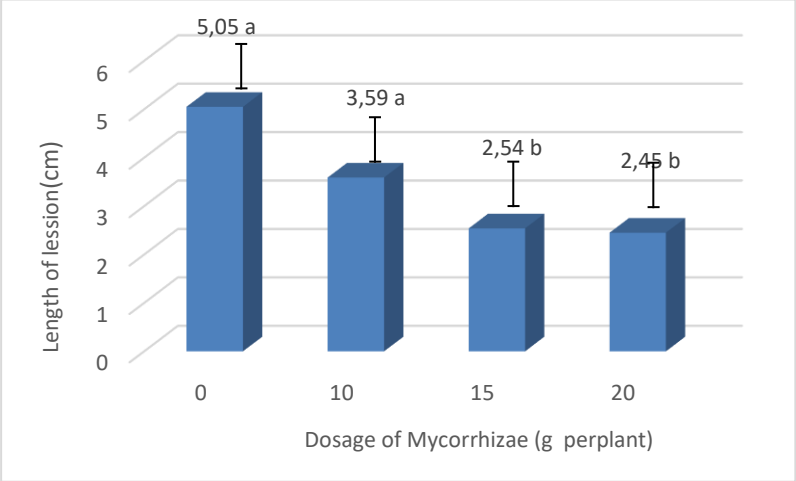

Figure 2. Lenght of lesion Inpari 10 cultivar according to fungal dose mycorrhizae.

Note: Numbers followed by the same letter are not significantly different based on the Least Significant Difference Test (LSD) at $\alpha_{0.05}$ level.

Disease intensity

The applicatiom of mycorrhiza reduced the bacterial leaf blight disease intensity in Inpari 10 cultivar. The intensity of the disease decreased with increasing dose of mycorrhiza. The lowest disease intensity was obtained on application of 15 and 20 grams of micorrhiza per plants, whichwere 17.29% and 16.51%respectively. The highest percentage of disease intensity was obtained in plants that did not receive mycorrhiza, which was 25.18%, followed by plants that received 15 grams of mycorrhiza, ie 22.70% (Figure 3).

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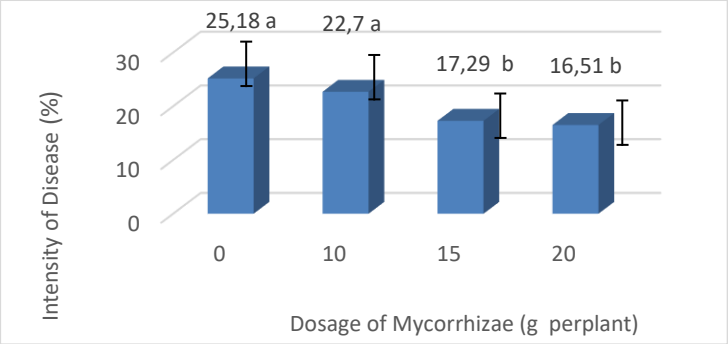

Figure 3.Intensity of desease bacterial leaf blight in Inpari 10 cultivar according to mycorrhizal fungal dose

Note: Numbers followed by the same letter are not significantly different based on the Least Significant Difference Test (LSD) at α0.05 level.

The results of this study indicated that mycorrhiza were able to suppress the development of bacterial leaf blight in Inpari 10 ricecultivar caused by Xoo bacteria. The application of mycorrhizae in the root rhizosphere region suppressed the development of disease that develops in the leave.The mechanism couldbe systemic resistance. García-Garcia-Garrido, (2002) stated that mycorrhiza isolates have the potential asan inducers of plant resistance to pathogens by activating local and systemic resistance. Systemic induction of mycorrhiza that can protect plants from leaf blight can be characterized by suppression of disease parameters, including an extending incubation period, decreasing disease intensity, and decreasing lession length, as shown Figures 1, 2, and 3.

According to Hoffland et al., (1996), salicylic acid plays an important role in systemic resistance, stimulated bymycorrhiza on plants. It can further be interpreted that the ability of mycorrhiza to suppress the development of leaf blight in Inpari 10 cultivar paddy, was possible because mycorrhiza was able to accumulate salicylic acid in plants which then acts as an induction signal that will express defense genes in the form of pathogenesis related (PR) protein which functions as an anti-microbial because it can inhibit the penetration of several pathogens systemically.

Mycorrhiza will activate resistance genes to protect plants from pathogens (Bent, 1996; Blee & Anderson, 1996,; Ruiz-Lozano et al., 1999) The activation process involves plant defense mechanisms associated with physiological and biochemical responses of plants that involve the induction of hydrolytic enzymes such as: peroxidase (Pozo et al., 1999; Gianinazzi et al., 1992). According to Van Loon et al., (1994), the peroxidase enzyme is a group of PR-proteins (pathogenesis related proteins) from the PR-9 group that accumulates

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when plants are infected by pathogens or are colonized by biological agents such as mycorrhizae. This enzyme is a compound that catalyzes the oxidation of hydrogen peroxide with lignin monomers such as: r-kumaryl alcohol, coniferil alcohol and alcohol synapses into polymers in the form of lignin. In the presence of lignin, plant cell walls become thicker so that it is difficult for pathogens to penetrate (Webster et al., 2005)

Plant height

The results showed that mycorrhiza significantly affected the height of Inpari 10 cultivar. The application of mycorrhiza as much as 20 grams perplant yielded the highest plant height (69.12 cm) but did not differ from plant height with application of 15 grams per plant of mycorrhiza (68.57 cm) (Figure 4).

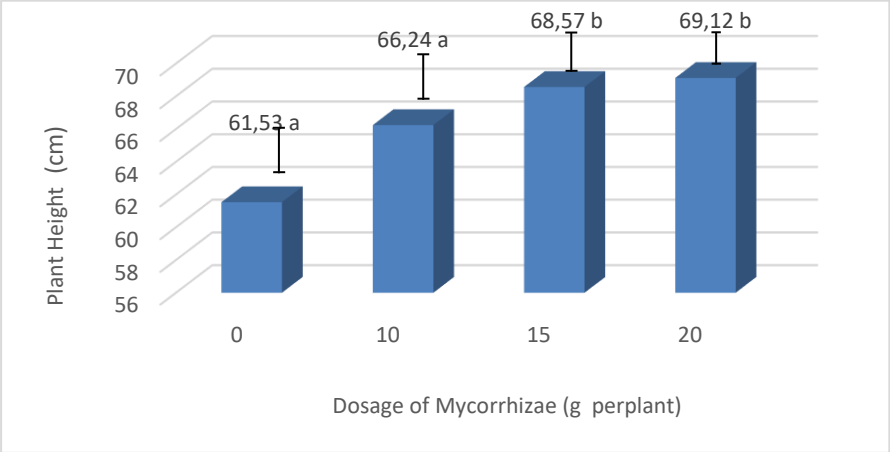

Figure 4. Inpari 10 cultivar rice height at various doses of mycorrhiza

Note: Numbers followed by the same letter are not significantly differentbased on the Least Significant Difference Test (LSD) at α0.05 level.

Number of tillers

Mycorrhiza affect the number of tillers of Inpari 10 cultivar. The application of mycorrhiza as much as 15 to 20 grams perplant yields the highest number of tillers, 10.33 and 10.12 respectively. Plants without the provision of biological fertilizer and with the provision of biological fertilizer as much as 10 grams of produced the lowest number of tillers, 7.34 and 7.01respectivelyand both were significantly lower than the number of tillers in the application of mycorrhiza of 15 grams and 20 grams per plant (Figure 5).

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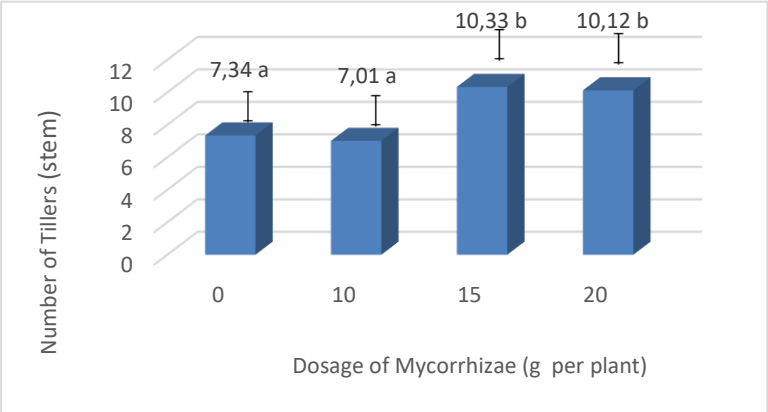

Figure 5. Number of tillers Inpari 10 cultivars in various doses of mycorrhiza

Note: Numbers followed by the same letter are not significantly different based on the Least Significant Difference Test (LSD) at α0.05 level.

The effect of mycorrhizae in increasing plant growth appears to be related to its role in increasing the ability of roots to absorp nutrients and water. Tirta, (2006) stated that mycorrhizae have a significant effect on plant height and leaf length, because mycorrhizae can improve the function and role of roots in utilizing water and nutrients. This was also supported by Sastrahidayat & Ika Rochdjatun (2011) who stated that the application of *Glomusmanihotis* mycorrhiza, and *Gigaspora margarita* in rice plants could have a significant effect on plant height and leaf length.

According to Brundrett et al., (1996) the presence of mycorrhizae in plant roots is not always related to the supply of nutrients needed by plants, but sometimes more on their role as symbiotic microorganisms that can make plants healthy. This will encourage the process of metabolism in plants totake place maximally, so that plant growth is better, for example, there are a greater number of tillers in rice plants.

Mycorrhizae can help in water absorption so that the stem length can grow optimally and increase with the addition of mycorrhizal fungal doses. Mycorrhiza helps water absorption with the help of external hyphae so that it can expand the area of water absorption by roots of soybean (Nedorost & Pokluda, 2012). This happens because mycorrhizal spores have germinated and began to form functional structures that can help plants absorb water and nutrients. In addition, mycorrhizae are also able to stimulate plant growth hormones such as cytokinins and auxins. Both of these hormones play a role in cell division and elongation, including stem cells thereby increasing the length of stems in a plant (Talanca, 2010). Plants that are infected with mycorrhiza have a higher auxin content than plants that are not infected

with mycorrhiza. Auxin plays a role in cell elongation in vegetative growth of plants such as in stems and buds. In addition, mycorrhizae can also stimulate the formation of growth hormones in a plant because mycorrhiza can increase the absorption of the element P which acts as one of the elements forming ATP or energy. Therefore, plants with micoriza can optimize the absorption of P so that the ATP produced can support metabolic processes that will produce growth hormones that are important for plant development (Sastrahidayat & Ika Rochdjatun, 2011).

Relationship between disease variables and growth

Disease in plants generally affects the growth which can then cause a decrease in yield. Thus variables such as incubation period, lesion length, and disease intensity need to be found to correlate with growth in order to know which variable is most disturbing growth. The results of the correlation analysis between these variables with growth which in this case is plant height and number of tillers indicate that there is a close relationship between incubation period with plant height (r = 0.339 **) and number of tillers (r = 0.348 **). This relationship shows that sooner or later the incubation period does not affect the growth of plant height and the formation of tillers in Inpari cultivar paddy 10. The closeness of the relationship between the length of the lesion with the growth of Inpari 10 cultivar paddy plant height is indicated by the value (r = - 0.618 **) and number of tillers (r = - 0.612 **). It can further be interpreted that the longer the lesion the more it inhibits the growth of plant height and inhibits the formation of tillers. Likewise, the intensity of the disease, the higher the intensity of the disease in plant height growth (r = - 0.618 **) and the formation of the number of tillers (r = - 0.584 **) the more inhibited.

Conclusions

It can be concluded that mycorrhiza application could control bacterial leaf blight caused by Xanthomonasoryzaepvoryzae (Xoo) in Inpari 10 cultivar rice. The length of the lesion and the intensity of the disease inhibit the growth of height and number of tillers of Inpari 10 cultivar paddy, but the incubation period does not inhibit growth.

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