

A REVIEW ON EFFECTIVENESS OF TRICHODERMA SPP TO CONTROL BASAL STEM ROT DISEASE IN OIL PALM

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Abstract: *Oil palm (Elaeis guineensis) is the primary agriculture industry in Malaysia. Currently, Malaysia ranks second in palm oil production after Indonesia. The one factor of oil palm production decreasing is because disease infection. The major oil palm disease in Malaysia is Basal Stem Rot (BSR) that causes by Ganoderma boninense. BSR disease can causes yield of oil palm production decrease in Malaysia. Various control approaches, such as cultural control, biological control, and chemical control, can be used to combat this disease in oil palm. Nowadays, many companies or smallholders use chemical control to overcome BSR such as uses hexaconazole in application injection fungicides. However, chemical control can give disadvantage to human health, especially to agricultural farmworkers that use chemicals. This review focus on uses of Trichoderma spp. as a biological control in controlling BSR disease in oil palm because the implementation of biological control is more safe compared to the use of chemical. This study review the effectiveness of biological control, which uses Trichoderma spp. and to review the factor efficiency that influencing Trichoderma spp. as biological agent to control BSR disease. The finding shows the use of Trichoderma spp. as biological control showed effective in terms of controlling the severity of BSR that affected to oil palm crop.*

Keywords: *Biological control, Trichoderma, basal stem rot, effectiveness, factor, oil palm, Elaeis guineensis*

Introduction

Oil palm (*Elaeis guineensis*) is the primary agriculture industry in Malaysia. Oil palm is originated in Africa and has been consumed for over 5000 years (Shafawati et al., 2013). *Elaeis guineensis*, the oil palm, is the most important species in the *Elaeis* genus, the *Palmae* family. Oil palm is known as "Malaysia's golden crop" since it creates excellent profits and can reduce the level of poverty in Malaysia (Bivi et al., 2010). Malaysia and Indonesia are the largest palm oil producers, accounting for almost 90% of world production. Currently, Malaysia ranks

second in palm oil production after Indonesia. In Malaysia, the area of oil palm cultivation is 6.5 million hectares consisting of 62% in Peninsular Malaysia and 28% in Sabah and Sarawak, as well as 10% of the total area, respectively (Star, 2021). However, the danger of disease can result in a drop in the quality of the oil palm fruit itself (Maluin et al., 2020).

The decrease in oil palm production is caused by several factors, including seasonal factors, water supply, nutrition, and plant pest attacks (Woittiez et al., 2017). In addition, the main factor for the reduction in oil palm production in Malaysia is disease attacks. Oil palm disease can attack all parts of the plant, starting from the roots, stems, and shoots of plants. The major oil palm disease in Malaysia is Basal Stem Rot (BSR) disease that causes by *Ganoderma boninense*. Based on a study Ishaq (2014), BSR is the most serious and dangerous disease that attack oil palm crop in Malaysia, where RM 1 billion in income is lost every year because BSR infects 3.5% of plantation lands. The outward symptoms of BSR at the oil palm plant appear on the leave condition and the growth of fruit body from the tree trunk. Internal growth of the fungus may occur before symptoms are visible in young oil palm. The fungal infection kills the roots and the basal stem of oil palm (Ishaq, 2014).

Review Methodology

Systematic Literature Review

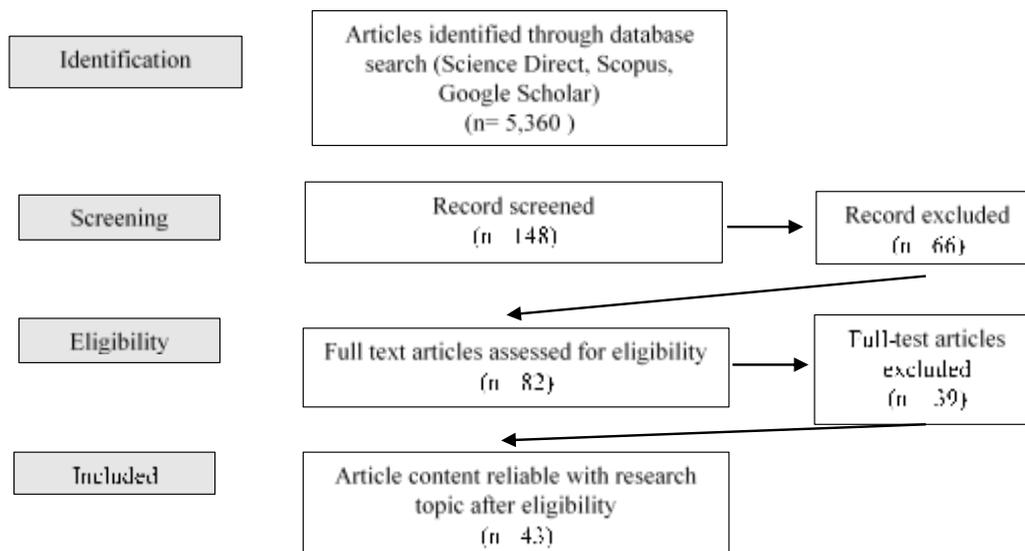


Figure 1: Shows the PRISMA flow chart diagram that uses for results and material in conducting a literature review (Shamseer et al., 2015)

This review uses a systematic literature review (SLR) methodology to achieve the objective which is to review the effectiveness of biological control which is *Trichoderma* spp. and to review the main factor efficiency that influences *Trichoderma* spp. to control BSR disease. The SLR method uses a keyword to identify the finding. Firstly, found the article using a Google scholar, Scopus, Science Direct of databases. Secondly, screening is the process of determining through scan the title. The criteria that was rejected during screening are do not match the topic with the topic. The third stage is eligibility, the titles and abstracts are checked to ensure criteria suitable for use in the current study to use in the review paper. Finally, the papers will be appraised, reviewed, and analysed following the eligibility procedure. This paper will go over the findings in depth. The data also be presented in an organized and concise manner and be

able to explain the decisions made. Finally, journals written by various authors will be compared in order to get the desired findings.

Discussion

Effective of *Trichoderma* spp. to control Basal Stem Rot disease.

According to previous research Susanto et al. (2005), has indicated that in glasshouse research, they used *Trichoderma* spp. of *T. harzianum* seemed efficient to minimize BSR after a year of inoculation. The addition of *T. harzianum* treatment seems to boost plant vigour substantially. Next, based on other observation of Alizadeh et al. (2011), they support the use of *T. harzianum* as a plant growth promoter and *G. boninense* pathogenic fungal biocontrol agent in oil palm. In addition, the most important impact of *T. harzianum* is an increase in root surface area for nutrient absorption from the soil solution to the root. In addition, finding of Tan et al. (2015), they support that *Trichoderma* spp. can against the BSR because *Trichoderma* spp. has been suggested as a way to decrease the severity of BSR infection. In this study they used *Trichoderma* spp. of *T. harzianum* in oil palm seedlings. From the study state that their contributions to enhancing the oil palm defence system through activating defence-related genes in the host remain unknown. The increased in the roots inoculated with *T. harzianum* shows successful of *Trichoderma* spp. in control BSR disease because in the root not have fungus disruption so that can growth well. Moreover, the effectiveness of *Trichoderma* spp. to against BSR disease is finding by Muniroh et al. (2019). Their study concludes that *T. asperellum* has the potential to be utilized as inoculants in the treatment of BSR infections. *T. asperellum* is one of types *Trichoderma* spp. For siderophore production test, only *T. asperellum* exhibited positive siderophore production. *Trichoderma* spp. have been identified as the most often seen biocontrol agents in the oil palm rhizosphere such as control BSR disease (Muniroh et al., 2019). In addition, according to others observation Grace et al. (2021), *Trichoderma* spp. of *T. harzianum* is effective to control BSR disease. Based on the research shows *T. harzianum* able to reduce bole severity index of BSR disease. They used combination *T. harzianum* with others biological control agents to against BSR disease. Besides, the effectiveness of *Trichoderma* spp. to against BSR disease is supports by Gene et al. (2018) showed finding that *T. harzianum* has been shown to delay and prevent the onset of BSR symptoms in oil palm seedlings can be reduced by modifying genes involved in biosynthesis. It showed that it can reduce the symptom appear on the oil palm seeding towards BSR disease. *Trichoderma* spp. is a micoparasite and produces antibiotics as well as antifungal toxins in planning the growth of a pathogen. *Trichoderma* spp. is perform biological control by partially activating the plant defence system and improving the nutritional state of the plant host. Furthermore, according to Naher et al. (2011), chemical fungicide control to BSR disease are ineffective and *Trichoderma* spp. have been identified as biocontrol bacteria capable of parasitizing other fungus and generating antibiotics and antifungal enzymes.

Ineffective of *Trichoderma* spp. Against The Basal Stem Rot (BSR)

However, based on study Bastian et al. (2021) showed that *Trichoderma* spp. is less efficient to BSR disease in oil palm. New finding shows have organic treatment can reduce the disease severity index of BSR infected. Lastly, according to Alexander et al. (2021), showed that *Trichoderma* spp. not effective to control BSR disease nursery stage. Based on observation biological control agent that they used such as *Trichoderma* spp. and *Bacillus* spp. were unable to reduce Disease Severity Index (DSR) of BSR disease. This study shows *Trichoderma* spp. is not effective to control BSR disease compare to other biological agent (*Lactobacillus*, *Nattobacillus* and *Saccharomyces cerevisiae*).

Table 1: Summaries of effectiveness *Trichoderma* spp. to control to bsr disease that supported by reference.

Effectiveness	<i>Trichoderma</i> spp.	Reference
Effective	<i>T. harzianum</i>	(Susanto et al., 2005)
Effective	<i>T. harzianum</i>	(Alizadeh et al., 2011)
Effective	<i>T. harzianum</i>	(Tan et al., 2015)
Effective	<i>T. asperellum</i>	(Muniroh et al., 2019)
Effective	<i>T. harzianum</i>	(Grace et al., 2021)
Effective	<i>T. harzianum</i>	(Gene et al., 2018)
Effective	<i>T. harzianum</i>	(Zin et al. 2020)
Ineffective	<i>Trichoderma</i> Bio Fungicides	(Bastian et al., 2021)
Ineffective	<i>Trichoderma</i> spp.	(Alexander et al., 2021)

^a Sample of a Table footnote. (*Table footnote*)

Factor Efficiency that Influence of *Trichoderma* spp. to Control BSR Disease

Table 2: The Table Show Summaries of Factor Efficiency That Influence of *Trichoderma* SPP. To Control BSR Disease That Supported By Reference

Factors	Application	Reference
Combination treatment of <i>Trichoderma</i> spp. to BSR disease	<i>Trichoderma</i> spp. + mulch (PPF)	(Sundram, 2013)
Enzyme strains of <i>Trichoderma</i> spp	<i>T. virens</i> (7b)	(Pei et al., 2019)
Enzyme strains of <i>Trichoderma</i> spp.	<i>T. harzianum</i> (FA1132)	(Sundram et al. 2008)
Mechanism enzyme activities of application <i>Trichoderma</i> spp.	<i>T. harzianum</i> (mycoparasitism and chitinase)	(Aeny, 2010)
Formulation of <i>Trichoderma</i> spp. application (powder)	<i>Trichoderma</i> spp. (powder form)	(Cumagun, 2017)

Combination Treatment of *Trichoderma* spp. to BSR disease.

According to Sundram (2013), with mixture *Trichoderma* spp. with bio-waste application such as palm press fibre (PPF) to oil palm seedling is one on factor of successful of effectiveness of *Trichoderma* spp. to reduce severity BSR disease that causes by *G. boninense*. Based on their research treatment seedlings *Ganoderma* infection with the exception on seedlings in the positive control where no inoculation of *Trichoderma* spp. was carried out.

Enzyme Strains of *Trichoderma* spp.

Trichoderma spp. function as an elicitor to begin Induced Systemic Resistance (ISR) in plants, which is one of the disease's biocontrol mechanisms. According to Pei et al. (2019) they noticed that treatment with *T. virens* increased the activity of these enzymes in oil palm leaves. Increased enzyme activity in the leaves indicates a systemic response to the rhizosphere application of *T. virens* isolates 7b and 159c. Single application of *T. virens* isolates 7b which recorded the highest enzyme activity. This shows enzyme activity can influence the effectiveness of *Trichoderma* spp. (Pei et al., 2019, Pei et al., 2016). Besides, according to others observation which is Sundram et al. (2008) about factor of successful *Trichoderma* spp.

is depends on the enzymes activities of application *Trichoderma* spp. to against BSR disease. In this research they used two *T. harzianum* strains which are FA1132 and FA1166 was tested to know the effectiveness which one better to control BSR disease. Based on the result they observe that a single strain which is *T. harzianum* of FA1132 that shows lowest in Disease Severity Index (DSI). These results show the factor of successful of *Trichoderma* spp. to control BSR disease depends on application strains in the *Trichoderma* spp.

Mechanisms of *Trichoderma* spp.

Trichoderma spp. exploited numerous strategies to suppress BSR disease, including mycoparasitism, antibiosis, competition for nutrition and life space, improved plant growth hormone, and triggered plant defence response. According to Benitez et al. (2004), *T. harzianum* produces secondary metabolites in the form of lytic enzymes, such as mycoparasitism, chitinase, glucanase, and protease, which degrade fungal cell walls. Mycoparasitism is one of the antagonist mechanisms of *T. harzianum* against BSR disease.

Formulation of *Trichoderma* spp.

The factor that influence the successful of *Trichoderma* spp. is the form of formulation. The effectiveness of a *Trichoderma* spp. as biocontrol agent is highly determined by the form of the formulation consisting of active ingredients. The formulation of *Trichoderma* spp. greatly determines the how it can survive in the environment and the period the *Trichoderma* spp. can survive in method of application. Seed treatment using seed dressing formulation has been proven more effective (Cumagun, 2017). Seed treatment are using powder formulation.

Conclusion

The use of *Trichoderma* spp. as biological control showed effective in terms of controlling the severity of BSR that affected to the oil palm that supported by reference. Based on the review and analyses journal is found that *Trichoderma* spp. is effective to control BSR disease that supported by reference that agree *Trichoderma* spp. is one of biological agent against BSR disease. Based on the review only have two journals that state *Trichoderma* spp. is not ineffective to control BSR disease because they found new technology and new formulation to overcome the BSR disease problems. As the result, *Trichoderma* spp. is effective to control BSR disease in oil palm. The factor of *Trichoderma* spp. influence the success of *Trichoderma* spp. to against the disease is combination treatment of *Trichoderma* spp. to BSR disease which is application *Trichoderma* spp. + mulch (palm press fibre) to control BSR disease. Secondly, the factor of *Trichoderma* spp. influence the successful is enzyme strains of *Trichoderma* spp. is such as use 7b strains *T. virens* can reduce the severity of infection BSR disease. Thirdly, the factor is mechanism enzyme activities of application *Trichoderma* spp. which is mycoparasitism that the major mechanism that responsible to against BSR disease. Lastly, the factor efficiency that influence of *Trichoderma* spp. to control BSR disease is formulation of *Trichoderma* spp. application to the oil palm crop which is powder form is more efficient to control BSR compare to others formulation.

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