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THE POTENTIAL OF TRICHODERMA BIOCONTROL AGENTS FOR INCREASING THE PRODUCTION OF SOYBEAN PLANTS RESISTANT TO SOYBEAN MOSAIC VIRUS

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Abstract

SMV infection at early growth stages can reduce crop productivity by 25.48% to 93.84%. Viral infections may reduce plant growth due to disruptions in physiological processes and photosynthetic output, hormonal imbalances, and decreased nutrient uptake, ultimately preventing the plant from growing optimally. The research was conducted at the Experimental Field and Basic Science Laboratory of the Faculty of Agricultural Technology, Satu Nusa Lampung University, as well as the Analysis Laboratory of Politeknik Negeri Lampung, from May to August 2025. The method used in this research was an experimental method. The study employed a Randomized Complete Block Design (RCBD) with the following treatments: T0 = Control, T1 = 10 ml Trichoderma solution, T2 = 20 ml Trichoderma solution, T3 = 30 ml Trichoderma solution, T4 = 40 ml Trichoderma solution,T5 = 50 ml Trichoderma solution per plant (with a spore concentration of 1 ml T. asperellum = 46.5 × 10^2 spores). Result Based on the study of the potential of Trichoderma asperellum in enhancing the resistance of soybean plants infected with SMV, it can be concluded that the 50 ml T. asperellum treatment showed the best results, with an incubation period of 18 days after inoculation (DAI), disease severity of 14%, and a plant resistance rating categorized as resistant to SMV. The highest yield increase was also recorded in the 50 ml Trichoderma treatment (T5), reaching 77.45%.

Keywords: ***Soybean, Soybean Mosaic Virus, Trichoderma asperellum.***

INTRODUCTION

Soybean Mosaic Virus (SMV) is a species within the Potyvirus genus, family Potyviridae, which includes nearly one-quarter of all known plant RNA viruses that infect agriculturally important crops. Potyvirus is the largest genus among all plant RNA virus genera, comprising 160 species (Hajimorad et al., 2018). SMV has a host range within the families Fabaceae, Amaranthaceae, Chenopodiaceae, Passifloraceae, Scrophulariaceae, and Solanaceae (Hill and Whitham, 2014). SMV can be naturally transmitted by several aphid species, and infection can occur through infected leaves or seeds (Hajimorad et al., 2018). SMV infection at early growth stages can reduce crop productivity by 25.48% to 93.84% (Andayanie, 2012). SMV infection causes symptoms such as uneven leaf surfaces, leaf shrinking with mosaic patterns, inward leaf curling, chlorosis at the leaf margins, and stunted plant growth (Koning and Krony, 2003).

Viral infection in leaves leads to a reduction in chlorophyll content. The decreased chlorophyll level can inhibit plant growth. Viral infections may reduce plant growth due to disruptions in physiological processes and photosynthetic output, hormonal imbalances, and decreased nutrient uptake, ultimately preventing the plant from growing optimally. During the replication process, viruses within plant cells utilize cellular metabolites such as enzymes, amino acids, and ribosomes for protein synthesis. This results in a deficiency of essential metabolites in the plant and directly reduces the plant's protein synthesis (Sartika et al., 2017; Semangun, 2000). Efforts to reduce the intensity of Soybean Mosaic Virus (SMV) infection and thereby increase soybean yield can be achieved by enhancing plant resistance through systemic resistance induction using Trichoderma asperellum. Trichoderma is a fungus with biocontrol capabilities that can suppress pathogen growth while also promoting plant growth and yield. Trichoderma species are easy to find and cultivate, commonly grown on Potato Dextrose Agar (PDA) or rice-based media. This accessibility makes Trichoderma a promising candidate not only as a biological control agent but also as a plant growth promoter. Trichoderma plays a role in increasing beneficial soil microbes, accelerating composting processes, and maintaining soil fertility. In addition to its function as a decomposer, Trichoderma also acts as a growth stimulator for plants (Oktapia, 2021). The mechanism of plant resistance induction by Trichoderma occurs through the contact of fungal spores with the root surface. Once attached, these structures produce chemical substances such as peptides and proteins that can enhance the plant's defense system. The compounds released by Trichoderma are recognized by the plant as if they were pathogen-related molecules. This recognition is possible because plants possess specific receptor proteins capable of identifying elicitor molecules—compounds typically released by pathogens. These elicitors may include pathogen gene products, viral coat proteins, or other pathogen cell wall components, thus activating the plant's defense mechanisms (Sartika et al., 2017). It is expected that improved plant resistance will result in increased soybean production. Based on the above explanation, it is necessary to conduct research on the potential of Trichoderma as a biocontrol agent to enhance the yield of soybean plants resistant to Soybean Mosaic Virus.

METHOD

The research was conducted at the Experimental Field and Basic Science Laboratory of the Faculty of Agricultural Technology, Satu Nusa Lampung University, as well as the Analysis Laboratory of Politeknik Negeri Lampung, from May to August 2025. This study consisted of several stages, including the preparation of tools and materials. The tools and materials used in this research included: Biosoy 1 soybean seeds, polybags (35 × 35 cm), Trichoderma asperellum fungal isolates derived from rice plant endophytes, Potato Dextrose Agar (PDA) medium, SMV-infected soybean leaf inoculum obtained naturally via aphid vectors placed on intentionally planted soybean plants as the inoculum source, planting media composed of compost and soil in a 1:1 ratio, Petri dishes, Erlenmeyer flasks, a stove, a pot, hoes, seedling polybags, a trowel, a spectrophotometer, treatment label paper, writing tools, a spray bottle, a ruler, a scale, and documentation equipment. The method used in this research was an experimental method. The study employed a Randomized Complete Block Design (RCBD) with the following treatments: T0 = Control, T1 = 10 ml Trichoderma solution, T2 = 20 ml Trichoderma solution, T3 = 30 ml Trichoderma solution, T4 = 40 ml Trichoderma solution,T5 = 50 ml Trichoderma solution per plant (with a spore concentration of 1 ml T. asperellum = 46.5 × 10^2 spores). The experiment consisted of 6 treatments, each with 4 samples, and was repeated 4 times, resulting in a total of 96 experimental units. The data obtained were analyzed using Analysis of Variance (ANOVA) at a 5% significance level. If a significant effect was found, it was followed by a Least Significant Difference (LSD) test at 5%.

RESULTS AND DISCUSSION

Incubation Period

Table 1 shows that the treatment without Trichoderma asperellum was significantly different from the treatments with T. asperellum at 10, 20, 30, 40, and 50 ml. The best treatment was Trichoderma asperellum at 50 ml, which resulted in the longest incubation period of 18 days after inoculation (DAI).

Table 1. Effect of Trichoderma asperellum on the incubation period of Soybean Mosaic Virus (SMV) in soybean plants

Treatment	Incubation Period (hsi)
Control (T0)	10,40 a
10 ml Trichoderma solution (T1)	15,60 d
20 ml Trichoderma solution (T2)	15,70 d
30 ml Trichoderma solution (T3)	16,10 d
40 ml Trichoderma solution (T4)	16,40 d
50 ml Trichoderma solution (T5)	18,00 e
KK (%)	7,29
LSD 5%	2,48

Disease Severity Intensity (%)

Table 2 shows that the treatment without Trichoderma asperellum was significantly different from the treatments with T. asperellum at 10, 20, 30, 40, and 50 ml. The best treatments were Trichoderma asperellum at 40 ml and 50 ml, with disease severity intensities of 17.60% and 14.00%, respectively.

Table 2. Effect of Trichoderma asperellum on SMV disease severity intensity in soybean plants

Treatment	Disease Severity Intensity (%)
Control (T0)	59,10 g
10 ml Trichoderma solution (T1)	26,10 c
20 ml Trichoderma solution (T2)	27,30 c
30 ml Trichoderma solution (T3)	27,40 c
40 ml Trichoderma solution (T4)	17,60 a
50 ml Trichoderma solution (T5)	14,00 a
KK (%)	11,59
LSD 5%	7,59

Plant Resistance Assessment

Table 3 shows that Trichoderma asperellum significantly influenced the increase in plant resistance ratings. The treatment with 50 ml Trichoderma asperellum produced the best result, as resistant to SMV.

Table 3. Effect of Trichoderma asperellum on resistance assessment of soybean plants infected with SMV

Treatment	Average Resistance Score	Plant Resistance Assessment
Control (T0)	0,94	Highly Susceptible
10 ml Trichoderma solution (T1)	3,65	Moderately Resistant
20 ml Trichoderma solution (T2)	3,65	Moderately Resistant
30 ml Trichoderma solution (T3)	3,65	Moderately Resistant
40 ml Trichoderma solution (T4)	3,94	Moderately Resistant
50 ml Trichoderma solution (T5)	4,82	Resistant

Increase in Production

Table 4 shows that Trichoderma asperellum has a significant effect on increasing soybean plant production. The treatment with 50 ml Trichoderma asperellum produced the best result.

Table 4. Effect of Trichoderma asperellum on the Increase of Soybean Production Resistant to SMV

Perlakuan	Production	Increase in Production
Control (T0)	43,9	0
10 ml Trichoderma solution (T1)	70,5	60,72
20 ml Trichoderma solution (T2)	73,8	68,23
30 ml Trichoderma solution (T3)	73,3	67,17
40 ml Trichoderma solution (T4)	74,3	69,50
50 ml Trichoderma solution (T5)	77,8	77,45

Discussion

The best treatment in terms of incubation period and disease severity was Trichoderma asperellum at 50 ml, with an incubation period of 18.00 days after inoculation (DAI) and a disease severity of 14%. The delayed onset of initial SMV symptoms indicates that the plants were more resistant. A longer incubation period in plants infected by pathogens signifies a higher level of resistance (Latifahani et al., 2014). The longer it takes for initial SMV symptoms to appear, the lower the resulting disease severity. Lower disease severity reflects greater plant resistance. A plant is considered resistant if it shows less damage compared to other plants (Untung, 2001). The data on incubation period and disease severity were used to calculate the plant resistance index using the method of Castillo et al. (1978, in Heroetadji 1983). Trichoderma asperellum was found to influence the plant resistance assessment against SMV infection. The best treatment was 50 ml of T. asperellum, which was categorized as resistant to SMV. The compounds released by Trichoderma trigger the plant's defense mechanisms by mimicking pathogen signals. Plants possess specific receptor proteins that can detect molecules released by pathogens, known as elicitors. These elicitors may include gene products from pathogens, viral coat proteins, or components of pathogen cell walls, which activate the plant's defense responses (Agrios, 2005). As a result, the plant perceives Trichoderma asperellum as a pathogen, thereby initiating its defense mechanisms. Application of Trichoderma at various doses showed a significant effect on increasing plant yield compared to the untreated control (T0). The data revealed that all Trichoderma treatments (T1–T5) enhanced yield, with percentage increases ranging from 60.72% to 77.45% compared to T0.

The highest yield increase was observed in the 50 ml Trichoderma treatment (T5), reaching 77.45%. This indicates that the higher the dose of Trichoderma applied, the greater its effect on yield improvement, although slight fluctuations were noted at certain dosages. For example, the 30 ml treatment (T3) resulted in a slightly lower increase (67.17%) compared to the 20 ml treatment (T2), which showed a 68.23% increase. Nevertheless, there was an overall trend of increasing yield with higher doses of Trichoderma. The mechanism behind this production increase is strongly suspected to be related to the role of Trichoderma spp. as a biological agent that enhances nutrient availability, suppresses soil-borne pathogens, and stimulates plant growth through the production of growth hormones such as auxins and cytokinins (Harman et al., 2004). In addition, Trichoderma also plays a role in improving nutrient uptake efficiency and enhancing soil structure (Widowati et al., 2014). These findings are consistent with previous studies that have shown Trichoderma application can significantly increase the yields of horticultural and food crops (Suryadi et al., 2019). Applying the appropriate dosage is crucial for achieving maximum effectiveness, as excessive application may reduce microbial efficiency or disrupt the balance of soil microbiota. Therefore, Trichoderma treatment—especially at the 50 ml dosage—can be recommended as an environmentally friendly alternative technology to sustainably increase crop productivity.

CONCLUSION

Based on the study of the potential of Trichoderma asperellum in enhancing the resistance of soybean plants infected with SMV, it can be concluded that the 50 ml T. asperellum treatment showed the best results, with an incubation period of 18 days after inoculation (DAI), disease severity of 14%, and a plant resistance rating categorized as resistant to SMV. The highest yield increase was also recorded in the 50 ml Trichoderma treatment (T5), reaching 77.45%.

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