Testing Soybean Resistance to *Fusarium* in the Rainy Season by Giving *Trichoderma harzianum*

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Abstract. Planting soybeans in the rainy season to increase production will be hampered by fusarium seedling blight caused by the fungus *Fusarium oxysporum f. sp. glycine*. The infection will increase in humid environments. This research aims to test the resistance of soybean varieties to fusarium seedling blight attacks in the rainy season by administering the biological agent *Trichoderma harzianum.* The method used was a factorial randomized block design with varieties and doses of biological agents as treatment and repeated four times. The results showed that the Gepak Kuning variety has good disease resistance and adaptability to the rainy season. The dose of *T. harzianum* did not have a different effect on *Fusarium* infection.

Keywords: Fusarium *oxysporum f. sp.*, Glycine, Soybean, Rainy Season, *Trichoderma harzianum.*

1.0 Introduction

Soybeans are a food crop that has a high vegetable protein content. The protein content in soybeans is around 37-42% [1]. The need for soybeans continues to increase, but on the other hand, soybean production is decreasing. In 2019, Indonesia is still required to import soybeans to meet soybean needs, with the number of imports still high, namely 2.6 million tons [2]. Soybean production in Indonesia still needs to reach the potential genetic yield of recommended varieties. This is due to cultivation techniques and methods of controlling plant pest organisms that are rarely paid attention to by farmers. This is because soybean plants are very sensitive to changes in their growing environment. Wijaya et al. [3] reported that the adaptability of soybean lines tested in different environments gave different performances depending on the ability of the lines to optimize the negative impacts of environmental changes. Efforts that can be made to increase national soybean production require improvements in cultivation and engineering techniques to reduce the impact of changes in the growing environment.

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Planting soybeans in Season Rain is Wrong. One effort was undertaken _ To utilize land cistern Rain to optimize for planting soybeans. Soybeans can grow optimally in the last 2 months of the rainy and dry seasons if irrigation water is sufficient for cultivation needs [4]. There are several factors in tropical areas that are less supportive of soybean growth, one of which is that if soybean plants are planted at the start of the rainy season with high rainfall, this will affect the maturity of the harvest and the number of pods formed [5]. The rainy season results in high relative air humidity, which encourages disease development and causes low soybean production [6]. So, it is necessary to select varieties resistant to the rainy season's environmental conditions and diseases that often infect during the rainy season.

One of the diseases that is often found in the rainy season is fusarium seedling blight. A fungus causes Fusarium seedling blight, *Fusarium oxysporum f. sp. Glycine*. Fungus *Fusarium oxysporum* grows optimally on pH 6.3 And temperature 27.1°C [7]. Disease attacks on adult plants can cause the plants to wilt and rot on the side roots, root cap, and base of the plant stem [8]. Biological control is an effective control technique and friendly environment in suppressing fusarium seedling blight attacks. Results research Rodovikov et al. [9] report that microbial strain family Bacillaceae and family Actinomycetaceae is an effective microbial strain control disease Fusarium. Control of fusarium seedling blight can only be done by improving soil drainage and aeration [10]. Chang et al. [11] report that planting soya beans in a way that intercropping soybeans/corn can reduce infection of rotten roots and aggressiveness fungus *Fusarium*.

Biological agents that can be used to suppress fusarium seedling blight attacks are biological agents that contain *Trichoderma. Trichoderma* is well known for controlling soil-borne diseases such as *Fusarium* seedling blight caused by Fusarium [12]. The antagonistic fungus that has the most potential in suppressing fusarium seedling blight is *Trichoderma harzianum.* The research results of Alfizar et al. [13] show that the higher the dose of *Trichoderma harzianum* given, the more it will suppress the disease caused by the *Fusarium oxysporum pathogen*. As a result, the ability of pathogens to develop becomes narrower so that the percentage of wilting plants becomes lower.

Condition environment season Rain and existing infectious disease Fusarium will impact the growth plant soybeans. Condition environment season Rain And attack disease Fusarium make plants soya bean not optimal. A need exists for information about varieties of Adaptive soybeans _ on condition that. Results study Wijaya and Makin [14] report that varieties tested soybeans _ on season Rain show A low yield _ compared to an optimal environment. This shows that the environment's growth influences the results of soya beans. Results study Wijaya et al. [15] Susanto et al. [16] report that results seed planted soybeans _ in several conditions environments show different results _ in a significant way. Based on the matter, it is necessary to identify adaptive varieties _ during the environmental season rain and to attack the *Fusarium* disease.

Based on this description, this research aims to identify the resistance of several soybean varieties and the best dose of the biological agent *Trichoderma harzianum* in controlling Fusarium wilt disease in soybean plants planted in the rainy season. The results of this research will likely provide information regarding soybean cultivation techniques in the rainy season, especially in preventing Fusarium wilt disease.

2.0 Materials and Method

The experiment was conducted in Cicurug Village, Majalengka District, Majalengka Regency, West Java Province. According to O element, the experimental site is located at an altitude of ± 124 meters above sea level with climate type C 2. The land used in this experiment was rice fields in Cicurug Village. The experiment was carried out in December 2020 – March 2021. The materials used were six soybean genotypes (Grobogan, Anjasmoro, Deja 2, Gepak Kuning, Dega 1, Dering 1), the biological agent *Trichoderma harzianum*, NPK fertilizer, and pesticides. The tools used during the research included a hose, sprayer, small shovel, measuring tape, jug, writing tools, and camera.

The research method used was experimental in the field with a factorial Randomized Group Design (RAK), which was repeated four times. The plot size used is 200x200 cm with a planting distance of 20x40 cm. The treatments used include the first treatment varieties K1= Grobogan, K2= Anjasmoro, K3= Deja 2, K4= Gepak Kuning, K5= Dega 1, K6= Dering, and the second treatment, namely treatment with doses of biological agents including P0 = concentration of 0g/kg of seed, P1 = concentration 5g/kg seeds, P2 = concentration 10g/kg seeds, P3 = concentration 15g/kg seeds.

Observation of the attack level of Fusarium Seedling Blight using the formula:

$$I = \frac{n}{N} \times 100\% \tag{1}$$

Information:
I = Attack intensity (%)
n = number of soybean plants affected
N = number of soybean plants observed

The variables observed in this study were the number of plants attacked at the ages of 1, 2, 3, and 4 WAP, the intensity of disease attacks, and the weight per Plot (g). The environmental factors observed are temperature, humidity, rainfall, and rainy days.

3.0 Result and Discussion

The interaction effect of variety uses and dosage of biological agents showed no significant effect on fusarium seedling blight attacks and soybean yields in rainy season planting at 1 WAP, 2 WAP, 3 WAP, and 4 WAP. This is due to differences in resistance genes between each variety to the environment and disease. This follows the statement by Fitria and Masnilah [22] that each variety has different resistance genes.

This study's attack time for fusarium seedling blight was more common at the age of 2 WAP (Table 1). These results align with the research results of Inayati and Yusnawan [10], which stated that the chance of attack by fusarium seedling blight on soybean plants was higher at the age of 10-30 days after planting.

Table 1. Number of plants affected by Fusarium seedling blight at the age of 1 WAP, 2 WAP, 3 WAP, 4 WAP.

Treatment	Disease Infection			
	1 mst	2 mst	3 mst	4 mst
Variety (K)				
K1 (Grobogan)	0.125 a	0.062 a	0.062 a	0.062 a
K2 (Anjasmoro)	0,000 a	0.437 ab	0.062 a	0,000 a
K3 (Deja 2)	0,000 a	0.187 a	0.187 ab	0,000 a
K4 (Yellow Gepak)	0,000 a	0.125 a	0,000 a	0.062 a
K5 (Dega 1)	0.125 a	0.812 b	0.125 a	0,000 a
K6 (Ring 1)	0,000 a	0.062 a	0.437 b	0.062 a
Biological Agent Dosage (P)				
p0 (0gr/kg)	0.041 a	0.541 a	0.083 a	0,000 a
p1 (5gr/kg)	0,000 a	0.208 a	0.291 a	0,000 a
p2 (10gr/kg)	0.083 a	0.166 a	0.125 a	0.083 a
p3 (15gr/kg)	0.042 a	0.208 a	0.083 a	0.041 a

Note: The average value followed by the same letter in the same column indicates that it is not significantly different based on the Duncan Test with a significance level of 95%; wap = week after planting.

Statistical analysis and field observations show that the Grobogan and Gepak Kuning varieties have higher resistance to fusarium seedling blight than the Anjasmoro, Deja 2, Dega 1, and Dering one varieties. This is due to differences in the resistance of each variety and environmental factors. Wiyono [23] stated that three factors can cause disease: a vulnerable host, a pathogen with high infectious Power and sufficient numbers, and a supportive environment. This is confirmed by Syahri and Somantri [24], who said that climate or environment changes can affect a variety's resilience.

Planting in the rainy season can affect the growth and yield of soybean plants. This follows the research results of Mustikawati et al. [25], which stated that environmental factors strongly influence soybean plants' growth and production results. The rainy season makes soybean plants more susceptible to stress because not all soybean varieties can adapt well to the rainy season. The Grobogan and Gepak kuning varieties adapt well to the rainy season [26]. The Gepak Kuning and Grobogan varieties can adapt to the rainy season because they Gepak Kuning and Grobogan varieties can make morphological changes, namely giving rise to adventitious roots, which are useful for maintaining the continued availability of water and minerals and replacing the function of the main roots [27].

The results of statistical analysis of seed weight results per plot and field observations showed that the varieties that showed the highest yields were Gepak Kuning (256.0 g) and Grobogan (198.4 g) and the lowest yield was the Dega 1 variety treatment (145.1 g) (Table 2).

Table 2. Result analysis seed weight per plot (g) and intensity attack disease (%).

Treatment	Yield per plot (g)	Intensity infection of disease (%)
Variety (K)		
K1 (Grobogan)	198.4 ab	0.006 a
K2 (Anjasmoro)	161.8 a	0.008 a
K3 (Deja 2)	188.5 a	0.007 a
K4 (Yellow Gepak)	256.0 b	0.003 a
K5 (Dega 1)	145,1 a	0.021 b
K6 (Ring 1)	160.7 a	0.01 ab
Biological Agent Dosage (P)		
p0 (0gr/kg)	212.3 a	0.012 a
p1 (5gr/kg)	184.9 a	0.01 a
p2 (5gr/kg)	157.8 a	0.009 a
p4 (5gr/kg)	185.2 a	0.006 a

Note: Average values followed by the same letter in the same column indicate that they are not significantly different based on the Duncan test with a significance level of 95%.

This is because the Gepak Kuning and Grobogan varieties have genes for resistance to fusarium seedling blight and changes in the growing environment. The same research results reported by Wijaya et al. [14] that the Grobogan variety shows good seed yields when planted in water-saturated land conditions. This is in line with the analysis results of the lowest intensity of fusarium seedling blight, namely 0.03% (Table 2). Syahri and Somantri [24] stated that the intensity of disease attacks is influenced by the interaction between resistance genes in varieties and virulent genes in pathogens.

The results of statistical analysis (Tables 1 and 2) show that the treatment dose of biological agents had no significant effect on the number and intensity of *Fusarium* seedling blight attacks. This is because the biological agent *Trichoderma harzianum* cannot function optimally. This is reinforced by the research results by Dwiastuti et al. [28], which state that the viability *of Trichoderma harzianum* can be influenced by several things, such as high rainfall, high humidity, and other environmental factors.

4.0 Conclusion

Based on the results of the research conducted, it can be concluded that there is no interaction between soybean plant varieties and fusarium seedling blight in the rainy season due to differences in gene resistance between varieties. There are differences in the resistance genes of each variety to fusarium seedling blight in the rainy season when given *Trichoderma harzianum.* The biological agent dose treatment did not show any differences at any level. This is thought to be because the *Trichoderma harzianum biological agent* cannot work optimally because the environment is less supportive of *Trichoderma harzianum* viability.

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References

1. O'Keefe, L. B., & Sharman, J.: Soybean nutrition. SM Journal of Nutrition and Metabolism **1**(2),1006 (2015)
2. BPS.: Impor Kedelai Menurut Negara Asal Utama 2010-2019. https://www.bps.go.id/statictable/2019/02/14/2015/impor-kedelai-menurut-negara-asal-utama-2010-2019.html. last accessed on 07/11/2020
3. Wijaya, A. A., Rahayu, H. D., Oksifa, A. R., Rachmadi, M., & Karuniawan, A.: Penampilan karakter agronomi 16 genotip kedelai (*Glycine max* L. Merrill) pada pertanaman tumpangsari dengan jagung (*Zea mays L.*) pola 3:1. Jurnal Agro **2**(2), 30-40 (2015)
4. Adisarwanto, T., Subandi, & Sudaryono.: Teknologi produksi kedelai. Pusat Peneletian dan Pengembangan Tanaman Pangan (2013)
5. Tambunan, S., Afkar, A., & Sebayang, N. S.: Growth and yields response of some varieties of soybean (*Glycine max* (L) Merill) on ultisol soil. Indonesian Journal of Agricultural Research **2**(3), 196– 204 (2019)
6. Saleh, N., & Hardaningsih, S.: Pengendalian penyakit terpadu pada tanaman kedelai. Malang: Badan Penelitian dan Pengembangan Pertanian (2013)
7. Cruz. D. R., Leandro, L. F. S., & Munkvold. G. P.: Effects of temperature and pH on *Fusarium oxysporum* and soybean seedling disease. Plant Disease **103**(12), 3234-3243 (2019)
8. Malvick, D.: Fusarium root rot on soybean. https://extension.umn.edu/pest-management/fusarium- root-rot-soybean last accessed on 17/01/2021
9. Rodovikov, S. A., Churakov, A. A., Popova, N. M., Abduraimov, P. O., & Khizhnyak, S. V.: Bacterial strains for biological control of *Fusarium* root rot of soybean in Siberia. IOP Conf. Series: Earth and Environmental Science **548**, 042054 (2020)
10. Inayati, Alfi, & Yusnawan, E.: Identifikasi penyakit utama kedelai dan cara pengendaliannya. Jakarta: Badan Penelitian dan Pengembangan Pertanian (2017)
11. Chang, X., Yan, L., Naeem, M., Khaskheli, M. I., Zhang, H., Gong, G., Zhang, M., Song, C., Yang, W., Liu, T., & Chen, W.: Maize/soybean relay strip intercropping reduces the

occurrence of *Fusarium* root rot and changes the diversity of the pathogenic *Fusarium* species. Pathogens **9**(3), 211 (2020)

12. Redda, E. T., Ma, J., Mei, J., Li, M., Wu, B., & Jiang, X.: Antagonistic potential of different isolates of trichoderma against *Fusarium oxysporum*, *Rhizoctonia solani*, and *Botrytis cinerea*. European Journal of Experimental Biology **8**(2), 12.
13. Alfizar, Marlina, dan Nurul Hasanah. 2011. Efforts to control *Fusarium oxysporum* wilt disease using the biological agents of Fma and *Trichoderma harzianum* fungi. Jurnal Floratek **6**(8), 17 (2011)
14. Wijaya, A. A., & I. A. Maksudin, I. A.: Genetic gains and yield of three soybean cultivars with the use of biological fertilizer in water saturated conditions. Prosiding Konser Karya Ilmiah Tingkat Nasional Tahun 2018. Fakultas Pertanian Universitas Kristen Stya Wacana, Salatiga (2018)
15. Wijaya, A. A., Maulana, H., Susanto, G. W. A., Sumardi, D., Amien, S., Ruswandi, D., & Karuniawan, A.: Grain yield stability of black soybean line across three agroecosystems in West Java, Indonesia. Open Agriculture **7**, 749-763 (2022)
16. Susanto, G. W. A., Maulana, H., Putri, P. H., Purwanimgrahayu, R. D., Wijaya, A. A., Sekti, B. A., & Karuniawan, A.: Stability analysis to select the stable and high yielding of black soybean (*Glycine max* L.) in Indonesia. International Journal of Agronomy **2023**(1), 7255444 (2023)
17. Sumarno, & Manshuri, A. G.: Persyaratan tumbuh dan wilayah produksi kedelai di Indonesia. Malang: Badan Penelitian dan Pengembangan Pertanian (2023)
18. Herlina, N., Fajriani, S., & Rahman, F. A.: Evaluation of climate change and its effect on planting patterns, planting times and productivity of soybeans (Glycine max L. Merrill) in Malang Regency, East Java. Jurnal Lahan Suboptimal: Journal of Suboptimal Lands **7**(2), 106-120 (2018)
19. Tangkebatu, & Yohanis B.: Penyakit layu pada tanaman cabai. http://cybex.pertanian.go.id/mobile/artikel/72615/Penyakit-Layu-PadaTanaman-Cabai/ last accessed on 22/06/21
20. Taufiq, A., & Sundari, T.: Respons tanaman kedelai terhadap lingkungan tumbuh. Buletin Palawija **23**, 13-26 (2012)
21. Mirani, E. D., Burhanuddin, & Suryanti, R.: Growth test of *Fusarium* sp forming agarwood sapwood (*Aquilaria malaccensis*) on variations in growing media and temperature. Jurnal Hutan Lestari **4**(4), 446-452 (2016)
22. Fitria, & Masnilah, R.: Resistance response and phenolic compound content of six soybean varieties Glycine max (L.) merrill against stem rot disease (*Sclerotium Rolfsii Sacc.*). Berkala Ilmiah Pertanian **3**(1), 27-32 (2015)
23. Wiyono, S.: Perubahan iklim dan ledakan hama dan penyakit tanaman. Keanekaragaman Hayati Ditengah Perubahan Iklim: Tantangan Masa Depan Indonesia, 28 Juni 2007. Jakarta, Indonesia (2007)
24. Syahri, & Somantri, R. U.: The use of superior varieties that are resistant to pests and diseases supports increasing national rice production. Jurnal Litbang Pertanian **35**(1), 25-36 (2016)
25. Mustikawati, D. R., Mulyanti, N., & Arief, R. W.: Productivity of soybean on different agroecosystems. International Journal of Environment, Agriculture and Biotechnology (IJEAB) **3**(4), 1154-1159 (2018)
26. BALITKABI.: Produksi benih inti varietas gepak kuning. https:// balitkabi.litbang.pertanian.go.id/berita/produksi-benih-inti-varietas-gepak kuning/ last accessed on 10/06/2021

27. Sembiring, M. J., Damanik, R. I. M., & Siregar, L. A. M.: Growth response of several soybean varieties (*Glycine max* L. Merrill) in flooded conditions to GA3 application. Jurnal Agroekoteknologi Universitas Sumatera Utara **4**(4), 2331-2340 (2016)
28. Dwiastuti, M. E., Fajri, M. N., & Yunimar, Y.: Potential *Trichoderma* spp. as a control agent for *Fusarium* spp. causes of wilt disease in strawberry plants. Jurnal Hortikultura **25**(4), 331-339 (2015)