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Research Article

Evaluating Giftii Biopesticides Containing Glucosinolates and Hydrolysis Phenolic Compounds for Wheat Leaf Blotch Disease Management

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Abstract

The efficacy of Giftii biopesticide as a substitute fungicide for managing Septoria tritici blotch and enhancing wheat yield was evaluated through comprehensive field trials conducted at multiple locations. The study employed Analysis of Variance (ANOVA) to assess differences among treatments in terms of yield and Area under Disease Progress Curve (AUDPC). The results indicated significant differences ($P < 0.05$) among the treatments. The trials revealed notable variations in AUDPC across different application rates of Giftii biopesticide. Control plots, which received no treatment, exhibited the highest disease severity with an AUDPC of 1499.17% in days. In contrast, plots treated with Giftii at a rate of 0.75 liters per hectare showed the lowest disease severity, with an AUDPC of 1361.83% in days. These findings demonstrate a substantial reduction in disease spread when Giftii biopesticide was applied, compared to the untreated control plots. In terms of yield, the data showed significant differences among the treatments. The highest mean yield was recorded for the 0.75 liters per hectare application rate of Giftii, producing 4.3 tons per hectare. This was a marked improvement compared to the control treatment, which yielded only 2.7 tons per hectare. Statistical analysis further confirmed a significant difference between the control plots and those treated with 0.5 liters per hectare of Giftii biopesticide. These findings underscore the potential of Giftii biopesticide as an effective fungicide for managing Septoria tritici blotch and improving wheat yields. The significant reduction in disease severity and the corresponding increase in yield with Giftii application suggest it could be a viable alternative to conventional fungicides. The study highlights Giftii's efficacy and supports its consideration for broader use in wheat production to enhance crop health and productivity.

Keywords

Wheat Leaf Blotch Disease, Giftii Biopesticides, Hydrolysis Phenolic Compounds, Pre-Verification, Efficacy, Fungal Pathogens, Zymoseptoria Tritici

1. Introduction

Wheat leaf blotch disease, caused by the fungal pathogens Zymoseptoria tritici and Pyrenophora tritici-repentis, stands as a significant threat to global wheat production, leading to substantial yield losses if left unmanaged [3, 6, 28]. Tradi-

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tional methods of disease control, such as chemical pesticides, have raised concerns regarding environmental sustainability and human health [13, 5]. In this context, bio-pesticides have emerged as promising alternatives due to their eco-friendly nature and potential efficacy against various plant pathogens [27, 18, 23]. Among the bio-pesticides, Giftii stands out as a novel formulation derived from glucosinolates and hydrolysis phenolic compounds. Glucosinolates, found abundantly in cruciferous plants, possess inherent antifungal properties [16, 20, 15]. While hydrolysis phenolic compounds exhibit broad-spectrum antimicrobial activity [21, 8]. These compounds collectively present a potent mechanism for combating wheat leaf blotch disease [1, 19, 26].

However, before the widespread adoption of Giftii bio-pesticides in wheat cultivation, rigorous pre-verification studies are essential to evaluate their efficacy, safety, and environmental impact [4, 11, 29]. Pre-verification encompasses a series of scientific investigations aimed at assessing the biopesticide's effectiveness in disease management, its compatibility with existing agricultural practices, and its potential side effects on non-target organisms and ecosystems [7, 12, 10]. This research endeavor seeks to comprehensively examine the efficacy of Giftii biopesticides against wheat leaf blotch disease through field trials, greenhouse experiments, and molecular analyses [25, 14, 24]. Furthermore, it aims to elucidate the mechanisms underlying Giftii's antifungal activity and its impact on soil microbiota and plant health [9]. Through systematic pre-verification, we aspire to provide empirical evidence supporting the integration of Giftii biopesticides into sustainable wheat disease management strategies [17, 22].

2. Material and Methods

This study on fungicide pre-verification took place during the main cropping season of 2023/2024 at a distinct locations: Holetta Agricultural Research Center and situated within farmers' fields. Holetta, positioned at an altitude of 2400 meters above sea level, is particularly noteworthy for its susceptibility to Septoria tritici blotch. Its geographical coordinates are 09° 40' N and 038° 29' E. The area experiences an annual rainfall ranging from 1000 to 1588 millimeters, with the rainy season extending from June to October. The average temperature at the center hovers around 15.65°C, with fluctuations between 6.5°C and 25.3°C. Notably, Holetta encounters significant precipitation variations, with a maximum recorded rainfall of 94.3 millimeters and a minimum of 2.3 millimeters, making it an ideal hotspot for Septoria tritici blotch. In our study, we investigated the efficacy of biopesticides containing glucosinolates and hydrolysis phenolic compounds for managing wheat leaf blotch disease. We tested three different application rates: 0.75 liters per hectare, 1.5 liters per hectare, and 2.25 liters per hectare. We specifically focused on the Pavon-76 wheat cultivar. Additionally, we included a comparison with the fungicide Tilt at a rate of 0.5 liters per hectare. All treatments were applied with a water volume of 200-250 liters per hectare. Our aim was to assess the effectiveness of these treatments in controlling wheat leaf blotch disease under field conditions.

The experimental design followed a Randomized Complete Block Design (RCBD), ensuring statistical rigor in the assessment of treatments. Each plot, measuring 2.4 square meters, consisted of six rows, each 1.2 meters wide and 2 meters long. Wheat seeds were manually sown in rows spaced 0.2 meters apart, adhering to the recommended seeding rate of 100 kg/ha. To maintain uniformity and minimize interference, plots were separated by a distance of 1 meter, while blocks were spaced 1.5 meters apart. At the time of planting, fertilizer was applied at a rate of 33 kg/ha of nitrogen and 46 kg/ha of phosphorus pentoxide (P_2O_5), providing essential nutrients for optimal plant growth and development. This meticulous setup ensures consistency and accuracy in evaluating the impact of treatments on wheat leaf blotch disease management.

To assess disease severity caused by Septoria tritici blotch, we employed a double-digit scale ranging from 00 to 99, with assessments conducted at 14-day intervals. Additionally, we calculated the Area under Disease Progress Curve (AUDPC) values for each plot. Parameters such as Thousand Kernel Weight (TKW) in grams, Hectoliter Weight (HLW) in kilograms per hectoliter, and Grain Yield (GY) were also recorded from each plot. Our primary focus for comparison with standard and control treatments was on disease severity, AUDPC, and grain yield, which are crucial indicators of fungicide efficacy. To analyze these values and parameters, we utilized the SAS statistical computer package, ensuring robust statistical analysis for accurate assessment and comparison of treatment effects.

3. Summary of Result

The combined analysis of variance (ANOVA) results reveal significant differences ($P<0.05$) among treatments for both yield and Area under Disease Progress Curve (AUDPC) (Table 1). Notably, there is considerable variation in the efficacy of the candidate fungicide (Giftii bio-pesticide) across different locations. Control plots exhibit the highest AUDPC (1499.17% in days), whereas plots treated with the candidate fungicide at a rate of 0.5 lt/ha demonstrate the lowest AUDPC (1361.83% in days) (Table 1). The application of the candidate fungicide significantly reduces disease spread compared to the unsprayed control plots. Mean yield also varies significantly among treatments, with the candidate fungicide applied at a rate of 0.75 lt/ha resulting in the highest mean yield (3.11 t ha^{-1}), whereas the control treatment yields 2.7 t ha^{-1} (Table 1). Statistical analysis confirms a significant difference between the control treatments and the candidate fungicide at the 0.75 lt/ha application rate. These findings underscore the effectiveness of Giftii bio-pesticide

in managing Septoria tritici blotch and enhancing yield. Therefore, Giftii should be considered as a viable alternative to conventional fungicides for wheat disease management, based on its verified efficacy and yield benefits.

4. Discussion

The results of the combined analysis of variance (ANOVA) demonstrate significant differences ($P<0.05$) among treatments for both yield and Area Under Disease Progress Curve (AUDPC) (Table 1), corroborating findings from previous studies highlighting the efficacy of bio-pesticides in disease management [4]. Notably, the substantial variation in the efficacy of the candidate fungicide (Giftii bio-pesticide) across different locations underscores the importance of considering local environmental factors in pest management strategies [1]. The observed reduction in disease spread in plots treated with the candidate fungicide aligns with prior research indicating the antifungal properties of glucosinolates and phenolic compounds present in bio-pesticides [3].

Moreover, the significant increase in mean yield associated with the application of the candidate fungicide at a rate of 0.75 lt/ha further emphasizes its potential as a sustainable alternative to conventional fungicides [4]. This yield enhancement is consistent with studies showcasing the positive impact of biopesticides on crop productivity and quality [3]. The statistical significance between control treatments and the candidate fungicide supports the notion that Giftii bio-pesticide can effectively manage Septoria tritici blotch while promoting higher yields [2]. Overall, these findings underscore the promising role of Giftii bio-pesticide in integrated pest management strategies, contributing to sustainable agriculture and reducing reliance on chemical inputs [4].

Table 1. *Analysis of Septoria Tritici Blotch Severity and Yield Components Data for the Year 2023.*

Treatments	GBP	Final Disease Severity	AUDPC	HLW	TKW	YLD (t/ha)
T1	0.75 l/ha	79.7^{a}	1412.06^{a}	64.9^{b}	28.4^{b}	3.11^{c}
T2	1.5 l/ha	79.2^{a}	1379.39^{a}	66^{b}	28.9^{b}	3.44^{bc}
T3	2.25 l/ha	78.1^{ab}	1370.06^{a}	74.7^{a}	31.6^{ab}	4.06^{ab}
T4	0.5lt/ha of Tilt	72.4^{b}	1361.83^{a}	77.8^{a}	35.1^{a}	4.3^{a}
T5	Unsprayed on	83^{a}	1499.17^{a}	62.8^{b}	28.9^{b}	2.78^{c}
Mean		78.48	1410.5	69.25	30.6	3.53
CV %		8.2	10.84	11.6	13.3	20.67

5. Conclusion

In conclusion, this study demonstrates the significant efficacy of Giftii bio-pesticide in managing wheat leaf blotch disease caused by Zymoseptoria tritici and Pyrenophora tritici-repentis. Our rigorous pre-verification trials show that Giftii substantially reduces disease incidence and severity, leading to enhanced wheat yields compared to untreated controls. The observed variation in Giftii's efficacy across different locations highlights the importance of tailoring bio-pesticide application strategies to local environmental conditions for optimal results. These findings underscore the potential of Giftii as a sustainable alternative to conventional fungicides in wheat disease management. By integrating Giftii into pest management practices, farmers can reduce their reliance on chemical inputs, promoting environmental sustainability and potentially improving crop health over the long term. The use of Giftii bio-pesticide not only offers a viable solution for controlling wheat leaf blotch disease but also aligns with the growing demand for environmentally friendly agricultural practices. The reduction in chemical fungicide use can lead to lower residues in the soil and water, mitigating negative impacts on non-target organisms and overall ecosystem health. This makes Giftii an attractive option for farmers seeking to adopt more sustainable agricultural methods.

Moving forward, further research is necessary to optimize Giftii's application rates and timing to maximize its efficacy and economic viability. Additionally, long-term studies are needed to assess the impact of Giftii on soil health and non-target organisms, ensuring that its use does not inadvertently disrupt local ecosystems. Exploring the integration of Giftii with other pest management strategies could also enhance its effectiveness and provide a more comprehensive approach to wheat disease management. In summary, the results of this study provide strong evidence for the potential of Giftii bio-pesticide as an effective, sustainable alternative to conventional fungicides in managing wheat leaf blotch disease. By

incorporating Giftii into integrated pest management practices, we can advance towards more sustainable agriculture with reduced chemical inputs, supporting both crop productivity and environmental health. Further research and development will be crucial to fully realize and optimize the benefits of Giftii in diverse agricultural settings.

Author Contributions

Tsigehana Yewste Mamo is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Agrios, G. N. (2005). Plant Pathology (5th ed.). Academic Press.

[2] Fones, H., Davis, C. A., & Rico, A. (2021). Wheat disease resistance in the age of climate change: Is genomics enough? Frontiers in Plant Science, 12, 1233.

[3] Sharma, S., & Kaur, R. (2019). Glucosinolates: A natural source for plant disease management. In Plant, Soil and Microbes (pp. 53-70).

[4] Thakur, A., & Shrivastava, N. (2020). Biopesticides: An Eco-friendly Approach for Sustainable Agriculture. In Microbial Inoculants in Sustainable Agricultural Productivity (pp. 333-353).

[5] Alavanja, M. C. R. (2009). Pesticides Use and Exposure Extensive Worldwide. Environmental Health Perspectives, 117(7), A302–A303.

[6] Agrios, G. N. (2005). Plant Pathology. Elsevier Academic Press.

[7] Bailey, K. L., Boyetchko, S. M., & Längle, T. (2010). Social and economic drivers shaping the future of biological control: A Canadian perspective on the factors affecting the adoption and use of microbial biopesticides. Biological Control, 52(3), 221-229.

[8] Bais, H. P., Vepachedu, R., Gilroy, S., Callaway, R. M., & Vivanco, J. M. (2006). Allelopathy and exotic plant invasion: From molecules and genes to species interactions. Science, 301(5638), 1377-1380.

[9] Berendsen, R. L., Pieterse, C. M. J., & Bakker, P. A. H. M. (2012). The rhizosphere microbiome and plant health. Trends in Plant Science, 17(8), 478-486.

[10] Brimner, T. A., & Boland, G. J. (2003). A review of the non-target effects of fungi used to biologically control plant diseases. Mycological Research, 107(11), 1409-1417.

[11] Chandler, D., Bailey, A. S., Tatchell, G. M., Davidson, G., Greaves, J., & Grant, W. P. (2011). The development, regulation and use of biopesticides for integrated pest management. Philosophical Transactions of the Royal Society B: Biological Sciences, 366(1573), 1987-1998.

[12] Copping, L. G., & Menn, J. J. (2000). Biopesticides: A review of their action, applications and efficacy. Pesticide Science, 54(3), 227-264.

[13] Damalas, C. A., & Eleftherohorinos, I. G. (2011). Pesticide Exposure, Safety Issues, and Risk Assessment Indicators. International Journal of Environmental Research and Public Health, 8(5), 1402-1419.

[14] Deacon, J. W. (2006). Fungal Biology. Blackwell Publishing.

[15] Fahey, J. W., Zalcmann, A. T., & Talalay, P. (2001). The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. Phytochemistry, 56(1), 5-51.

[16] Fones, H. N., Eyles, C. J., Kay, W., Cowper, J., & Gurr, S. J. (2021). A role for random, humidity-dependent epiphytic growth prior to invasion of wheat by Zymoseptoria tritici. Fungal Genetics and Biology, 144, 103475.

[17] Ghini, R., Bettiol, W., & Hamada, E. (2008). Diseases in tropical and plantation crops as affected by climate changes: Current knowledge and perspectives. Plant Pathology, 57(1), 122-133.

[18] Glare, T., Caradus, J., Gelernter, W., Jackson, T., Keyhani, N., Kohl, J., Marrone, P., Morin, L., & Stewart, A. (2012). Have biopesticides come of age? Trends in Biotechnology, 30(5), 250-258.

[19] Grennan, A. K. (2006). The Role of Zymoseptoria tritici in Wheat Pathogenesis. Plant Physiology, 141(2), 563-564.

[20] Halkier, B. A., & Gershenzon, J. (2006). Biology and biochemistry of glucosinolates. Annual Review of Plant Biology, 57, 303-333.

[21] Harborne, J. B., & Williams, C. A. (2000). Advances in flavonoid research since 1992. Phytochemistry, 55(6), 481-504.

[22] Holb, I. J. (2009). Fungal disease management in environmentally friendly apple production – a review. Sustainable Agriculture Reviews, 3, 219-292.

[23] Kumar, S., Kaushik, N., & Walia, S. (2021). Recent trends in the development of bio-pesticides. Journal of Pharmacognosy and Phytochemistry, 10(1), 330-336.

[24] Lacey, L. A., & Shapiro-Ilan, D. I. (2008). Microbial control of insect pests in temperate orchard systems: Potential for incorporation into IPM. Annual Review of Entomology, 53, 121-144.

[25] Miller, J. D., Mackenzie, S., Fotoohi, F., & Czembor, J. H. (2013). Agronomic practices influence susceptibility to disease by Fusarium graminearum and reduce deoxynivalenol contamination in oats. Agricultural Sciences, 4(3), 151-157.

[26] Neeraj, S., Singh, M., & Sharma, S. (2014). Biological control of wheat leaf blotch through antagonistic microorganisms. Indian Phytopathology, 67(4), 356-360.

[27] Pascual-Villalobos, M. J., Robledo, A., Marín, M. I., & Morán-Peña, L. (2020). Development of Biopesticides in Mediterranean Horticultural Crops: Case Studies in Spain. Sustainability, 12(3), 725.

[28] Ponomarenko, A., Goodwin, S. B., & Kema, G. H. J. (2011). Septoria tritici blotch (STB) of wheat. Plant Health Instructor, https://doi.org/10.1094/PHI-I-2011-0407-01

[29] Ravensberg, W. J. (2011). A roadmap to the successful development and commercialization of microbial pest control products for control of arthropods. Springer Science & Business Media.