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Research Article

Effect of Commercial Ami *Trichoderma viride* on Early and Late Blight of Potato

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Abstract

Potato (*Solanum tuberosum* L.) is a crucial crop for human nutrition and agricultural systems, but its production is severely affected by fungal diseases, especially late blight (*Phytophthora infestans*). This study evaluated the efficacy of Ami *Trichoderma viride* (liquid formulation) in controlling late and early blight and its impact on potato yield. The experiment was conducted during the 2022-2023 Rabi season at the Ami Experimental Farm in Ahmedabad, Gujarat, India, and utilized a randomized complete block design (RCBD) with three replications. The results showed that treatment with 1 L of Ami *T. viride* per acre significantly reduced both late and early blight infections, with plant infection rates decreasing by up to 84%, and leaf infection reduced by up to 79% compared to control plots. As a result, treated plots showed a 67% increase in potato yield (23 tons/ha) compared to the control (12 tons/ha). The results indicate that Ami *T. viride* is an effective biocontrol agent for managing blight diseases and improving potato yield, offering a sustainable solution for crop protection. Further studies are required to optimize application techniques and explore its broader use across different crops and disease conditions.

Keywords: *Solanum tuberosum* L.; early blight; late blight; Ami *T. viride*; Phytophthora infestans

Abbreviation

RCBD: Randomized Complete Block Design; BCAs: Biological Control Agents; GLM: General Linear Model; ANOVA: Analysis of Variance

Introduction

Potato (*Solanum tuberosum L.*) is an important crop grown all over the world [1]. As a member of the Solanaceae family, it is essential for food security and the agricultural economy [2]. Potato is not only a key source of carbohydrates, vitamins, and essential nutrients but also contributes significantly to the livelihoods of farmers and the global food industry [3]. Despite its widespread cultivation, potato production is severely impacted by various biotic and abiotic stresses, among which fungal diseases such as early blight and late blight are particularly damaging [4]. Early blight of potato, caused by the fungus *Alternaria solani*, is a common and destructive disease that affects the leaves and stems of potato plants [5]. Early blight is a polycyclic disease, and outbreaks can accumulate rapidly if environmental conditions are favorable. Alternaria survives as spores and mycelium in infected plant and in plant residues [6]. *Phytophthora infestans*, the pathogen responsible for late blight, contributes to considerable yield reductions, with significant losses occurring in regions severely impacted by the disease [7].

In response to these challenges, biological control agents (BCAs) emerged as a potential, long-term, and eco-friendly alternative to chemical pesticides [8]. BCAs have a number of advantages, includ-

ing lower toxicity to humans and non-target organisms, pathogen specificity, and cost effectiveness [9]. Among the wide range of microbial BCAs, *Trichoderma* species obtained a lot of attention for their ability to control plant diseases [10]. These fungi are common in soil environments and have a variety of beneficial characteristics, including pathogen reduction, plant growth stimulation, and inducing systemic disease resistance in plants [11].

Several species of *Trichoderma* show considerable potential in preventing plant diseases, especially those caused by *Phytophthora* [12]. *T. viride* produces extracellular enzymes such as chitinases, β-glucanases, and pectinases, which degrade the cell walls of pathogenic fungi, thereby inhibiting their growth and increasing plant resistance to disease [13]. As a biopesticide, *T. viride* has the potential to improve crop yields, effectiveness, and overall plant health [14]. The ability of *T. viride* to mitigate the effects of both early and late blight, while simultaneously promoting plant growth, makes it a beneficial option for integrated pest management strategies in potato cultivation [15]. Other biocontrol agents, such as *Trichoderma harzianum*, *Bacillus subtilis*, and *Pseudomonas fluorescens*, have also been successfully used to control a variety of plant diseases, including early and late blight [16].

Several studies have demonstrated the potential of *T. viride* in reducing the severity of both early and late blight in potatoes [17]. Previous studies have demonstrated that *Trichoderma viride* enhances potato yield and reduces the severity of early blight under field conditions [18]. similarly, other studies have reported that biocontrol agents effectively promote plant growth and mitigate the symptoms of early blight in potatoes [19]. Another study indicated that *Trichoderma viride-ES1* significantly reduced late blight severity, with an Area under the Disease Progress Curve, compared to the untreated control [20]. The purpose of this current study was to assess the effectiveness of commercially available formulation of Ami *Trichoderma viride* in managing early and late blight in potato plants, with an emphasis on the effects of the disease on tuber yield, plant growth, and disease incidence. Ami *Trichoderma viride* (liquid formulation) is an effective biocontrol agent used to protect crops from various soil-borne diseases.

Materials and Methods

Location and experimental field

The present study was conducted at the Ami Experimental Farm in Ahmedabad, Gujarat, India, during the 2022 to 2023 Rabi season, aiming on evaluating the efficacy of Ami *Trichoderma viride* (liquid formulation) in preventing early and late blight in potatoes.

Potato variety and seed preparation

Healthy and good-quality potato tubers were selected for the study. The tubers were collected from the local market and were cut into pieces with a clean, sterilized knife, ensuring that each piece contained at least two eyes or buds to facilitate sprouting.

Experimental design and application of fungicides

This study employed a randomized complete block design (RCBD) with three replications. The experimental plots were treated with the bio-fungicide Ami *Trichoderma viride* (liquid formulation) at a dosage of 1 liter per acre. The fungicide was applied to the crops at a 7-day interval, starting when the first symptoms of early and late blight were observed in the field. A knapsack sprayer was used to apply the fungicide to provide a uniform application. Additionally, a control group was treated with only water to monitor natural growth of the disease. The spraying was done carefully to avoid cross-contamination between plots.

Disease severity assessment and data collection

Disease severity was evaluated based on visible symptoms of early and late blight on potato leaves as shown in previous study [21]. A total of 100 plants per replication were randomly selected for assessing plant infection, while 30 plants per replication were selected for evaluating leaf infection. Plant infection refers to the invasion of harmful pathogens affecting various parts of the plant, while leaf infection specifically targets the leaf tissue [22]. The number of infected plants and infected leaves were recorded from each plot, both before and 7 days after fungicide application: The following calculations were used to determine the proportion of plant and leaf infestations.

Percent plant infestation = (Number of infected plants / Total number of plants) × 100

Percent leaf infestation = (Number of infected leaves / Total number of leaves) × 100

The reduction in infection rate was calculated as follows:

Percent reduction of infection = ((Infection in control - Infection in treatment) / Infection in control) × 100

Additionally, the weight of the harvested tubers was recorded to estimate the yield.

Statistical analysis

The data collected from the experiment were statistically analyzed using the General Linear Model (GLM) in SAS software to conduct an Analysis of Variance (ANOVA).

Results and Discussion

Effectiveness of Ami *T. viride* (liquid formulation) in decreasing plant infection by late blight of potato

The field application of Ami *Trichoderma viride* (1 L/acre) considerably ($P < 0.05$) reduced late blight infection in plants. The plant infection rate in the Ami *T. viride* treated plots was 27% before spraying, whereas it decreased to 18% after spraying. In contrast, the control group showed a substantial increase in plant infection, ranging from 23% to 94% after the spray. In comparison to the control, the Ami *T. viride* treatment reduced plant infection by 76%, while the control displayed no reduction (Table 1). The results indicate that Ami *Trichoderma viride* is specifically effective in controlling late blight and preventing disease growth. Other studies have shown that seed treatment with Trichoderma viride substantially reduced the impact of late blight disease in potatoes, with a 73.21% decrease in disease severity compared to the control [23]. Soil application of *Trichoderma viride* for controlling Phytophthora leaf blight in nutmeg resulted in a 69.42% reduction in disease severity over the control [24].

Effectiveness of Ami *T. viride* on late blight potato leaf infection

The use of Ami *Trichoderma viride* considerably reduced leaf infection. The leaf infection in treated plots was 16% before spraying and subsequently decreased to 15%. The infection rate increased substantially from 18% to 64% in the control group. In contrast to the control group, which showed no decrease in leaf infection, the treatment resulted in a 79% decrease (Table 1). These results show that Ami *T. viride* effectively prevents potato leaf late blight infection. Another study found that using *Trichoderma viride* as a soil amendment effectively reduced the rate of late blight (*Phytophthora infestans*) in potatoes, with a leaf blight incidence of 57.77% [25]. Seed treatment with Trichoderma viride (2×10^7) effectively controlled late blight disease in potatoes by 34.2% compared to the control [26].

Treatments	Infection of Plant (%)		Reduction of plant infection over control (%)	Leaf infection		Reduction of leaf infection over control (%)	Yield performance of *T. viride*	Increase of yield over control
	Before Spray	After Spray	-	Before Spray	After Spray	-	-	-
T. viride	27	18	76	16	15	79	23	67
Control	23	94	0	18	64	0	12	24

Table 1: Effect of Ami *Trichoderma viride* treatment on potato plants infected with late blight.

Effectiveness of Ami *T. viride* on potato yield

The yield of potato was notably increased in the treated plots, as Ami *T. viride* effectively controlled late blight. The yield in the treated plots was 23 tons per hectare, compared to 12 tons per hectare in the control plots. The increase in yield for the treated plots was 67% over the control, which had a 24% increase. This demonstrates that Ami *T. viride* not only reduced the disease, but also increased yield as compared to the control (Table 1). Additional study indicates that the application of *Trichoderma viride* (TV-0.7%) effectively controlled late blight in potatoes, with an average yield of 22.63 t/ha [27]. In another study, the application of *Trichoderma viride* at 2.0% effectively reduced the severity of late blight disease (*Phytophthora infestans*) in potatoes. This treatment resulted in a considerable increase in tuber yield, obtaining 28.10 t/ha, compared to the control group, which yielded 24.40 t/ha [28].

Effectiveness of Ami *T. viride* on plant infection caused by early blight of potato

Similarly to its effect on late blight, Ami *T. viride* substantially reduced early blight infections. Plant infection in the treated plots

decreased from 16% before spraying to 6% after the application. In the control plots, infection increased from 17% to 91% illustrated in Figure 1. Compared to the control, the Ami *T. viride* treatment reduced plant infection by 84%, demonstrating its efficiency in controlling early blight shown in Figure 2. Similar study showed that, the use of *Trichoderma viride* considerably decreased the severity of leaf blight disease and enhanced the growth of potato plants [29]. The biocontrol agent *Trichoderma viride* showed an 80.67% growth inhibition against *Alternaria solani*, the pathogen responsible for early blight in tomatoes [30].

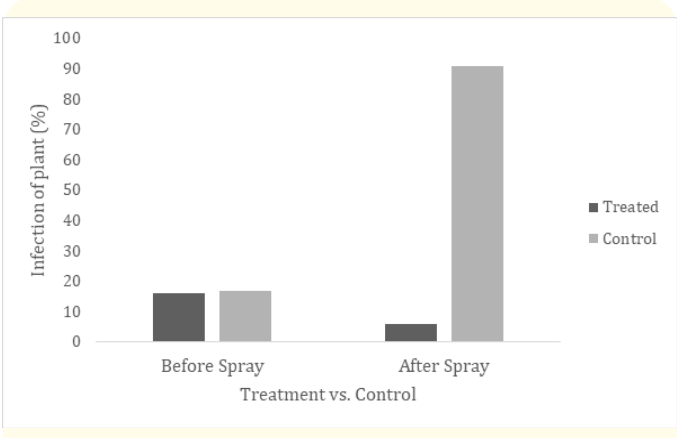

Figure 1: Impact of Ami *T. viride* on early blight infection in potato plants.

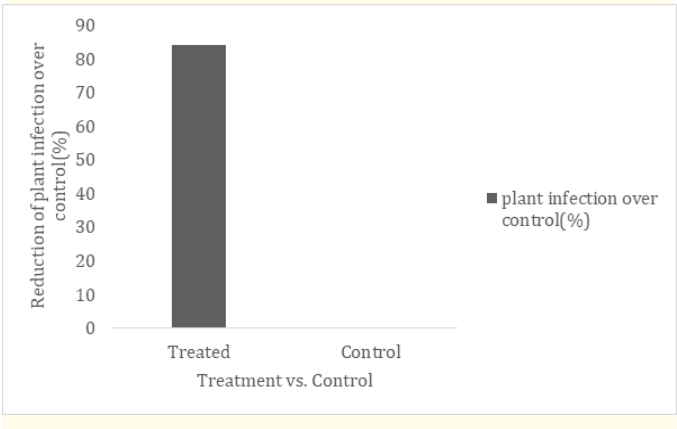

Figure 2: Reduction of plant infection over control.

Effectiveness of Ami *T. viride* on leaf infection by early blight in potato

Ami *Trichoderma viride* substantially decreased early blight infection in leaves. Leaf infection in the treated plots reduced from 18% before spraying to only 5% after treatment. In comparison, the control group had an increase in leaf infection from 17% to 83% demonstrated in Figure 3. The treated plots had an 84% reduction in leaf infection compared to the control, while the control had none depicted in Figure 4. Further study indicated that, the application of *Trichoderma viride* to control early blight in cherry tomatoes showed a disease incidence of 26.28% before spraying. After three sprays, the incidence increased to 40.53% [31].

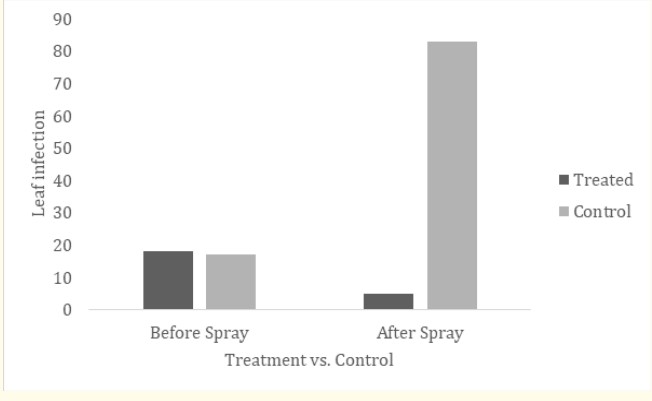

Figure 3: Effect of Ami *T. viride* on early blight leaf infection in potato.

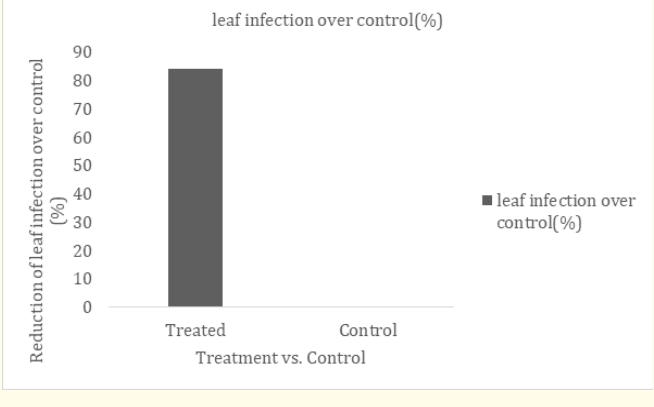

Figure 4: Reduction of leaf infection.

Efficacy of Ami *T. viride* on potato yield

Ami *Trichoderma viride* treatment resulted in considerably higher potato yield compared to control plots. The treated plots yielded 26 tons per hectare, whereas the control crops yielded 11 tons showed in Figure 5. The treated plots showed a 61% increase in yield above the control, demonstrating Ami *T. viride*'s notable impact on potato production (Figure 6). This illustrates that Ami *T. viride* is highly effective in preventing disease and increasing potato production. In another study, *Trichoderma viride* reduced disease severity by 72.29% and increased tomato yield by 68.71% compared to the control [32]. Another study found that applying *Trichoderma viride* to potato plants infected with Alternaria solani in the field substantially increased tuber production, obtaining 230.45 q/ha [33].

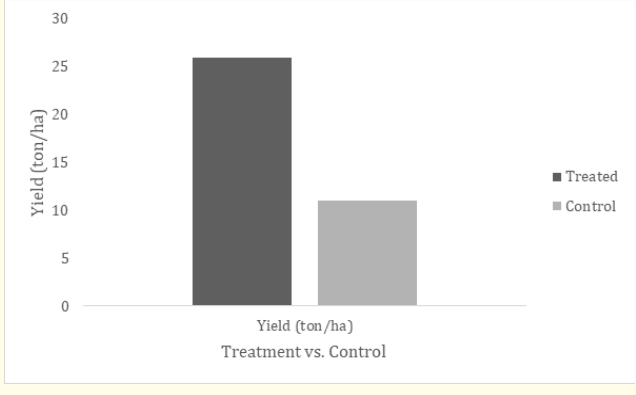

Figure 5: Yield performance of Ami *T. viride*.

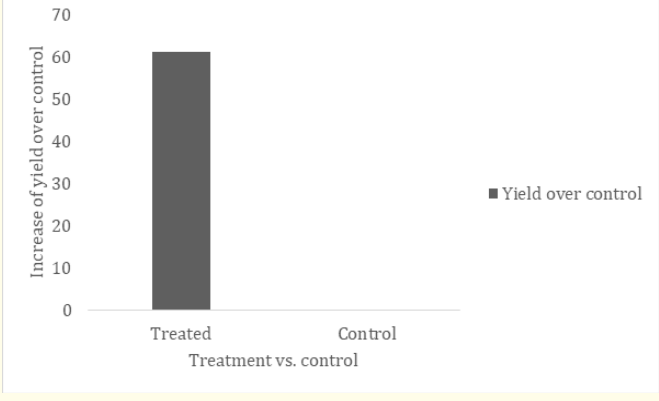

Figure 6: Effect of Ami *T. viride* Treatment on Potato Yield.

Conclusion

This study indicates the efficacy of Ami *Trichoderma viride* (liquid formulation) as a biocontrol agent for late and early blight diseases in potatoes. The use of Ami *T. viride* resulted in considerable decreases in disease severity caused by *Phytophthora infestans*, improving overall plant health. The results of this study suggest that *T. viride* can be used as a sustainable and environmentally friendly alternative to traditional chemical fungicides, providing a more responsible approach to disease management in potato farming. Furthermore, the use of *T. viride* not only enhances potato yields but also decreases the environmental and economic costs caused by chemical pesticides. *T. viride* is a promising approach for sustainable agriculture because of its ability to sustain biodiversity, cultivate more beneficial soil ecosystems, and increases long-term crop yields. Ami *T. viride* is more effective against early blight and late blight, as it helps control soil-borne pathogens that cause this disease. Future research should focus on studying its efficacy against other blight strains and optimizing application methods for broader disease management.

Bibliography

1. Reddy B J., *et al*. "A review on potato (*Solanum tuberosum L.*) And its genetic diversity". *International Journal of Genetics* (2018): 0975-2862.
2. Dos S Costa Dora., *et al*. "Extension of Solanaceae food crops shelf life by the use of elicitors and sustainable practices during postharvest phase". *Food and Bioprocess Technology* 15.2 (2022): 249-274.
3. Ahmadu Tijjani., *et al*. "The role of crop protection in sustainable potato (*Solanum tuberosum L.*) Production to alleviate global starvation problem: An overview". *Solanum tuberosum-A Promising Crop for Starvation Problem* (2021): 19-51.
4. Chakrabarti SK., *et al*. "Potato pests and diseases: a global perspective". *Sustainable Management of Potato Pests and Diseases*. Singapore: Springer Singapore, (2022): 1-23.
5. Dhaval Pansuriya., *et al*. "Early blight (*Alternaria solani*) etiology, morphology, epidemiology and management of tomato". *Pharma Innovation* 10 (2021): 1423-1428.

6. Meno Laura., *et al*. "Looking for a sustainable potato crop. Field assessment of early blight management". *Agricultural and Forest Meteorology* 308 (2021): 108617.

7. Tsedaley Binyam. "Late blight of potato (*Phytophthora infestans*) biology, economic importance and its management approaches". *Journal of Biology, Agriculture and Healthcare* 4.25 (2014): 215-225.

8. Sheoran Asha Rani., *et al*. "Enhancing Plant Disease Resistance: Insights from Biocontrol Agent Strategies". *Journal of Plant Growth Regulation* (2024): 1-24.

9. Patel Riddhi M and Yogesh T Jasrai. "Bio-control agents (BCAs) as a potential tool to uphold sustainability of environment: types, methods and commercialization". *Phytotechnology* 2012 (2012): 170.

10. Palmieri Davide., *et al*. "Advances and perspectives in the use of biocontrol agents against fungal plant diseases". *Horticulturae* 8.7 (2022): 577.

11. Woo Sheridan L., *et al*. "Trichoderma: a multipurpose, plant-beneficial microorganism for eco-sustainable agriculture". *Nature Reviews Microbiology* 21.5 (2023): 312-326.

12. Asad Saeed Ahmad. "Mechanisms of action and biocontrol potential of Trichoderma against fungal plant diseases-A review". *Ecological Complexity* 49 (2022): 100978.

13. Tyśkiewicz Renata., *et al*. "Trichoderma: The current status of its application in agriculture for the biocontrol of fungal phytopathogens and stimulation of plant growth". *International Journal of Molecular Sciences* 23.4 (2022): 2329.

14. Tyagi Anshika., *et al*. "A Review on Biocontrol Agents as Sustainable Approach for Crop Disease Management: Applications, Production, and Future Perspectives". *Horticulturae* 10.8 (2024): 805.

15. Tiwari Rahul Kumar., *et al*. "Recent advancements in integrated management of potato diseases". Recent advances in root and tuber crops. Brillion Publishing, New Delhi (2021): 185-203.

16. Karthika S., *et al*. "Exploring the efficacy of antagonistic rhizobacteria as native biocontrol agents against tomato plant diseases". *3 Biotech* 10.7 (2020): 320.

17. Tähtjärv Terje. "Cultivar resistance and population studies of late blight pathogen in potato breeding in Estonia". Diss. Estonian University of Life Sciences, (2016).

18. Yadav Vikash Kumar., *et al*. "Evaluation of fungicides, biocontrol agents and plant extracts against early blight of potato caused by *Alternaria solani*". *International Journal of Chemical Studies* 6.1 (2018): 1227-1230.

19. Stridh Linnea J., *et al*. "Reduced efficacy of biocontrol agents and plant resistance inducers against potato early blight from greenhouse to field". *Journal of Plant Diseases and Protection* 129.4 (2022): 923-938.

20. Zegeye Ephrem Debebe., *et al*. "Biocontrol activity of *Trichoderma viride* and *Pseudomonas fluorescens* against *Phytophthora infestans* under greenhouse conditions". *Journal of Agricultural Technology* 7.6 (2011): 1589-1602.

21. Khatun H., *et al*. "Evaluation of *Trichoderma harzianum* in controlling late blight of potato". *Sustainable Food and Agriculture* 2.2 (2021): 92-98.

22. Bora Rina., *et al*. "Plant leaf disease detection using deep learning: a review". 2022 IEEE 7th International conference for Convergence in Technology (I2CT). IEEE, (2022).

23. Basu A. "Potentiality of bioagents on growth, yield and late blight disease of potato".

24. Sumbula V and Sally K Mathew. "Management of *Phytophthora* leaf fall disease of nutmeg (*Myristica fragrans* Houtt.)". *Journal of Tropical Agriculture* 53.2 (2015): 180-186.

25. Peerzada SH., *et al*. "Studies on management of late blight (*Phytophthora infestans* (Mont) de Bary) of potato using organic soil amendments". *International Journal of Current Microbiology and Applied Sciences* 9 (2020): 2093-2099.

26. Basu Amitava. "Employing eco-friendly potato disease management allows organic tropical Indian production systems to prosper". *Asian Journal of Food and Agro-Industry* 2 (2009): S80-S87.

27. Lal Mehi., *et al*. "Integrated management of late blight of potato". *Journal of Applied and Natural Science* 9.3 (2017): 1821-1824.

28. Lal Mehi., *et al*. "Evaluation of bio-agents and neem based products against late blight disease (*Phytophthora infestans*) of potato". *Indian Phytopathology* 74 (2021): 181-187.

29. Susiana Purwantisari., *et al*. "The resistance of potatoes by application of *Trichoderma viride* antagonists fungus". E3S web of conferences 73 (2018).

30. Naik S C., *et al*. "In-vitro efficacy of biocontrol agents against *Alternaria solani* (Early Blight of Tomato)". *Journal of Pharmacognosy and Phytochemistry* 9.5S (2020): 550-552.

31. Naik SC., *et al*. "Effects of selected biological control agents and plant extracts on early blight disease management and yield of cherry tomato". *Journal of Pharmacognosy and Phytochemistry* 9.5S (2020): 587-592.

32. El-Tanany M M., *et al*. "Efficiency of biotic and abiotic inducers for controlling tomato early blight". *Middle East Journal* 7.2 (2018): 650-670.

33. Kumar Sumit and Ram Chandra. "Integrated field application of T. viride, botanicals, and fungicides for managing early blight (*Alternaria solani*) and enhancement of plant growth, tuber nutritional quality, and potato yield". *Journal of Natural Pesticide Research* 8 (2024): 100070.