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Assessment on compatibility of *Trichoderma asperelloides* with different systemic fungicides

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ABSTRACT

An in vitro investigation was undertaken to assess the compatibility of *Trichoderma asperelloides* with six systemic fungicides and to identify suitable chemical partners for its integration into integrated disease-management programmes. The study was conducted during 2025–2026 at the Department of Plant Pathology, Dr. Sharadchandra Pawar College of Agriculture, Baramati. Compatibility was evaluated at half of the recommended fungicide concentration using the poisoned-food technique under laboratory conditions. The experiment was laid out in a Completely Randomized Design with three replications. Among the fungicides evaluated, Fosetyl-Al 80% WP exhibited the greatest compatibility with *T. asperelloides*, causing only 1.85% inhibition of mycelial growth. Fluxapyroxad 33.3 g/l FS was also highly compatible, with 3.33% inhibition of mycelial growth. Kresoxim-methyl 44.3% SC showed moderate compatibility, causing 33.33% inhibition. Azoxystrobin 23% SC was classified as slightly compatible, with 61.85% inhibition of mycelial growth. Conversely, Propiconazole 25% EC and Carbendazim 50% WP exhibited the highest inhibition of mycelial growth, each causing 94.44% inhibition, and were classified as incompatible with *T. asperelloides*. Under the conditions of the present laboratory assay, Fosetyl-Al 80% WP was identified as the most compatible systemic fungicide for use with *T. asperelloides*. Nevertheless, greenhouse and field studies are necessary to confirm its compatibility and biocontrol performance before making practical recommendations.

Keywords: *Trichoderma asperelloides*, Systemic fungicides, Compatibility, Biological control agent, Poisoned-food technique, Integrated disease management, Mycelial growth inhibition

1. Introduction

Sustainable crop production requires disease-management strategies that are effective, economically viable, and environmentally responsible. In this context, biological control agents have gained considerable importance as alternatives or supplements to conventional chemical pesticides. Species of the genus *Trichoderma* are among the most widely studied fungal biocontrol agents because of their ability to suppress diverse plant pathogens through multiple mechanisms, including mycoparasitism, competition for nutrients and colonization sites, antibiosis, secretion of hydrolytic enzymes, and stimulation of plant defence responses (Harman *et al.*, 2004; Vinale *et al.*, 2008) [1]. Among these beneficial fungi, *Trichoderma asperelloides* has shown potential for suppressing soil- and seed-borne pathogens and may serve as an important component of integrated disease-management programmes.

Despite the advantages of biological control, synthetic fungicides remain an essential component of modern crop protection. Their rapid action, broad-spectrum activity, and effectiveness against several economically important pathogens make them valuable for managing disease outbreaks. However, the repeated and indiscriminate use of fungicides may contribute to the development of resistant pathogen populations, environmental contamination, and adverse effects on non-target organisms. Therefore, integrated disease-management strategies that combine biological and chemical methods are increasingly being considered to achieve reliable disease suppression while reducing dependence on chemical pesticides.

Systemic fungicides are extensively used in crop protection because they are absorbed and translocated within plant tissues, providing effective management of pathogens at different sites of infection. Their systemic activity allows them to protect newly developing plant parts and, depending on the active ingredient, may provide preventive, curative, or eradication disease control. However, systemic fungicides may also affect beneficial microorganisms such as *Trichoderma*. Depending on their chemical properties, mode of action, concentration, and active ingredient, systemic fungicides may inhibit the mycelial growth, sporulation, germination, or survival of *Trichoderma*. Therefore, their compatibility with *Trichoderma* should be evaluated before their integration into disease-management programmes involving biological control agents.

The successful integration of *Trichoderma* with fungicides depends largely on the selection of chemical products that do not significantly impair the growth and biocontrol potential of the fungus. Compatibility testing provides a preliminary basis for identifying fungicides that can be applied alongside *Trichoderma*

without substantially reducing its effectiveness. Previous investigations have shown that the response of *Trichoderma* to fungicides varies according to the species or isolate, active ingredient, formulation, and concentration used. Thus, individual combination fungicides should be screened under controlled laboratory conditions before their evaluation in greenhouse or field experiments.

In view of these considerations, the present study was undertaken to evaluate the *in vitro* compatibility of *Trichoderma asperelloides* with selected systemic fungicides applied at half of their recommended concentrations. The investigation aimed to identify fungicides that cause minimal inhibition of *T. asperelloides* growth and therefore have potential for integration with this bioagent in sustainable integrated disease-management programmes.

2. Materials and Methods

2.1 Source of *Trichoderma asperelloides* culture

Rhizospheric soil samples were collected from the experimental farm of Dr. Sharadchandra Pawar College of Agriculture, Baramati, for the isolation of *Trichoderma asperelloides*. The samples were subjected to serial dilution, and suitable dilutions were inoculated onto *Trichoderma* Selective Medium (TSM) and Potato Dextrose Agar (PDA) under aseptic conditions. The plates were incubated under ap-

propriate laboratory conditions, and the developing fungal colonies were examined for their cultural and morphological characteristics.

The isolate was identified based on colony appearance, pigmentation, growth pattern, and microscopic features, including the structure and branching pattern of the conidiophores, shape and arrangement of the phialides, and morphology of the conidia. The identified isolate produced characteristic green colonies with concentric growth zones. Microscopically, it exhibited highly branched conidiophores, nine pin-shaped phialides, and globose to subglobose conidia, confirming its identity as *T. asperelloides*.

For maintenance, the culture was periodically subcultured on PDA slants and preserved under suitable laboratory conditions. The actively growing and viable culture was used for subsequent *in vitro* compatibility experiments.

2.2 Systemic fungicides

The present investigation comprised six systemic fungicides, viz., Azoxystrobin 23% SC, Kresoxim-methyl 44.3% SC, Fluxapyroxad 33.3 g/L FS, Propiconazole 25% EC, Carbendazim 50% WP, and Fosetyl-Al 80% WP, which were obtained from the Plant Pathology Department of Dr. Sharadchandra Pawar College of Agriculture, Baramati, and used in the present study.

List 1. Details of systemic fungicides used for *in vitro* compatibility studies

Tr. No.	Systemic fungicide	Concentration(ppm) (half of recommended)	Trade name
T ₁	Azoxystrobin 23% SC	500	SyngentaAmistar
T ₂	Kresoxim-methyl 44.3% SC	250	TATA Ergon
T ₃	Fluxapyroxad 33.3g/l FS	500	BASF Systiva
T ₄	Propiconazole 25% EC	250	Syngenta Tilt
T ₅	Carbendazim 50% WP	500	Bavistin
T ₆	Fosetyl AL 80% WP	1000	BAYER Aliette
T ₇	Control	-	-

2.3 *In vitro* compatibility of *Trichoderma asperelloides* with systemic fungicides

The compatibility of *Trichoderma asperelloides* with the selected systemic fungicides was assessed using the standard poisoned-food technique described by Nene and Thapliyal (1993). The quantity of each fungicide formulation required to obtain the desired concentration was calculated according to its active ingredient content. Each fungicide was separately incorporated into sterilized, cooled potato dextrose agar (PDA) under aseptic conditions. Approximately 20 ml of the amended medium was dispensed into sterile 90-mm Petri plates and allowed to solidify.

A 5-mm-diameter mycelial disc was excised from a seven-day-old, actively growing culture of *T. asperelloides* and placed centrally on each fungicide-amended plate. PDA plates without fungicide, inoculated with an equivalent mycelial disc, served as untreated controls. Three replicates were maintained for each treatment.

The inoculated plates were incubated under suitable laboratory conditions. Radial mycelial growth was measured when the fungus had completely covered the medium in the control plates. The mean colony diameter recorded for each treatment was expressed in millimeters and used to determine the effect of the respective systemic fungicide on the growth of *T. asperelloides*.

2.4 Treatment details

- Design : Completely Randomized Design (CRD)
- Replication : Three
- Treatment : Seven
- Technique : Poison Food technique (Nene and Thapliyal, 1993)

Observations on the mycelial growth of *Trichoderma asperelloides* were recorded when the untreated control plates attained complete growth. The colony diameter in each plate was measured in two perpendicular directions, and the mean radial growth was calculated for each treatment. The average values obtained from the three replications were expressed in millimetres.

The inhibitory effect of each systemic fungicide on the growth of *T. asperelloides* was determined by calculating the percentage inhibition of mycelial growth over the untreated control. The percentage inhibition was calculated using the formula proposed by Vincent (1947).

$$I = \frac{C - T}{C} \times 100$$

where:

- *I* = Percent growth inhibition
- *C* = Radial growth of *T. asperelloides* in the control plate
- *T* = Radial growth of *T. asperelloides* in the fungicide-treated plate.

The compatibility of the systemic fungicides with *T. asperelloides* was categorized according to the percentage inhibition values, following the classification described by Saha *et al.* (2023) [2].

Compatibility classification

The systemic fungicides were classified according to the percentage inhibition of mycelial growth as follows:

List 2. The range for compatibility based on inhibition percentage (Saha *et al.*, 2023) [2]

Percentage inhibition	Compatibility
0–30%	Highly compatible
31–60%	Moderately compatible
61–90%	Slightly compatible
91–100%	Non-compatible

2.5 Statistical analysis

The experimental data were subjected to statistical analysis using appropriate procedures for a Completely Randomized Design (CRD). The standard error (SE) and critical difference (CD) were calculated at the 5% level of significance ($P = 0.05$) to determine the statistical significance of differences among treatment means. The analysis was performed according to the methods described by Panse and Sukhatme (1954).

3. Results and Discussion

The results of the *in vitro* compatibility studies revealed considerable variation in the response of *T. asperelloides* to different systemic fungicides. The radial growth of the bioagent in the untreated control was 90.00 mm, whereas the growth in fungicide-amended media varied from 5.00 to 88.33 mm. The corresponding inhibition of mycelial growth ranged from 1.85 to 94.44 per cent, indicating differences in the compatibility of the tested systemic fungicides with *T. asperelloides*.

As shown in Table 1, among the six systemic fungicides tested, Fosetyl-Al 80% WP exhibited the highest compatibility with *T. asperelloides*. It recorded a radial mycelial growth of 88.33 mm, compared with 90.00 mm in the untreated control, resulting in only 1.85 per cent inhibition of mycelial growth. Based on the adopted compatibility classification, this treatment was categorized as highly compatible.

The high compatibility of Fosetyl-Al 80% WP indicates that the fungicide caused only a negligible reduction in the growth of *T. asperelloides* under the tested *in vitro* conditions. The low level of inhibition suggests that this systemic fungicide may have potential for integration with *T. asperelloides* in integrated disease management programmes, subject to further validation under field conditions.

Similarly, Fluxapyroxad 33.3 g/L FS exhibited high compatibility with *T. asperelloides*. The treatment recorded a radial mycelial growth of 87.00 mm and 3.33 per cent inhibition of mycelial growth compared with the untreated control. According to the adopted compatibility classification, it was categorized as highly compatible. The very low inhibition indicates that Fluxapyroxad had only a limited suppressive effect on the mycelial growth of *T. asperelloides* under the experimental conditions.

Kresoxim-methyl 44.3% SC recorded 60.00 mm radial mycelial growth and 33.33 per cent inhibition of mycelial growth. Based on the adopted compatibility scale, it was classified as moderately compatible. Although considerable fungal growth was observed in the presence of the fungicide, the reduction in colony growth compared with the untreated control indicated a moderate inhibitory effect on *T. asperelloides*.

In contrast, Azoxystrobin 23% SC recorded a radial mycelial growth of only 34.33 mm, resulting in 61.85 per cent inhibition of mycelial growth. It was therefore categorized as slightly compatible according to the adopted compatibility classification. The comparatively high inhibition indicates that Azoxystrobin substantially suppressed the mycelial growth of *T. asperelloides* under the tested *in vitro* conditions.

Propiconazole 25% EC exhibited a pronounced inhibitory effect on *T. asperelloides*. The treatment recorded only 5.00 mm radial mycelial growth, corresponding to 94.44 per cent inhibition of mycelial growth. It was therefore classified as incompatible. The marked reduction in colony growth indicates strong suppression of *T. asperelloides* by Propiconazole under the experimental conditions.

Likewise, Carbendazim 50% WP recorded only 5.00 mm radial mycelial growth and 94.44 per cent inhibition of mycelial growth. The treatment was classified as incompatible with *T. asperelloides*. The very high inhibition observed with Carbendazim indicates a strong adverse effect on the mycelial development of the bioagent.

Overall, the systemic fungicides showed considerable variation in their compatibility with *T. asperelloides*. Based on the percentage inhibition of mycelial growth, the compatibility followed the order Fosetyl-Al 80% WP > Fluxapyroxad 33.3 g/L FS > Kresoxim-methyl 44.3% SC > Azoxystrobin 23% SC > Propiconazole 25% EC = Carbendazim 50% WP. The results demonstrate that systemic fungicides differed markedly in their effects on the growth of *T. asperelloides*, ranging from highly compatible to incompatible.

The variation in compatibility may be attributed to differences in the active ingredients, chemical nature, mode of action, and concentration of the systemic fungicides. Fungicides with different modes of action can exert varying degrees of toxicity towards non-target beneficial fungi such as *Trichoderma*. The present findings emphasize the importance of evaluating individual systemic fungicides for compatibility before their integration with *T. asperelloides* in integrated disease management programmes.

The present observations are consistent with the general findings reported in compatibility studies, where different fungicides exhibited varying degrees of inhibition against *Trichoderma* isolates. Dinkwar *et al.* (2023) [3] reported considerable variation in compatibility among fungicides tested against potent *Trichoderma* isolates. Saha *et al.* (2023) [2] also reported variation in the compatibility of fungicides with *T. asperelloides*. Such findings support the view that compatibility is fungicide-specific and should be evaluated before simultaneous use of fungicides and biological control agents.

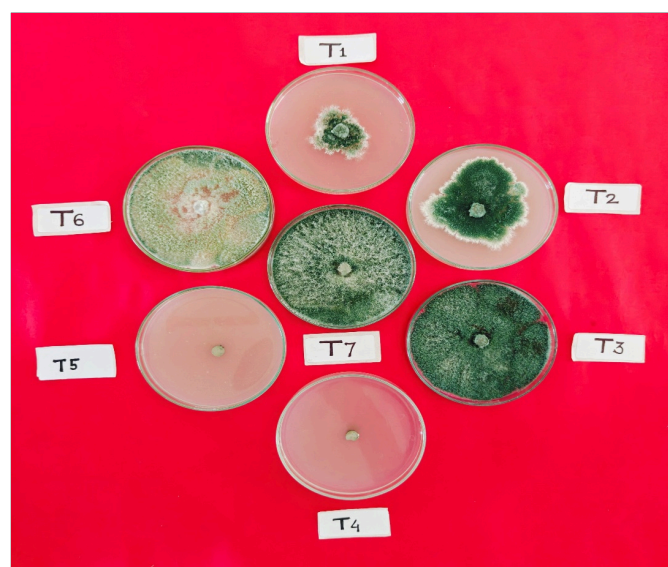


Plate 1. *In vitro* assessment on compatibility of *Trichoderma asperelloides* with systemic fungicides.

4. Conclusion

The present investigation revealed considerable variation in the compatibility of *Trichoderma asperelloides* with the systemic fungicides evaluated under *in vitro* conditions at half of the recommended concentration. Fosetyl-Al 80% WP and Fluxapyroxad 33.3 g/L FS were found to be highly compatible, causing only 1.85 and 3.33% inhibition of mycelial growth, respectively. Kresoxim-methyl 44.3% SC showed moderate compatibility with 33.33% inhibition, whereas Azoxystrobin 23% SC was classified as slightly compatible, causing 61.85% inhibition of mycelial growth.

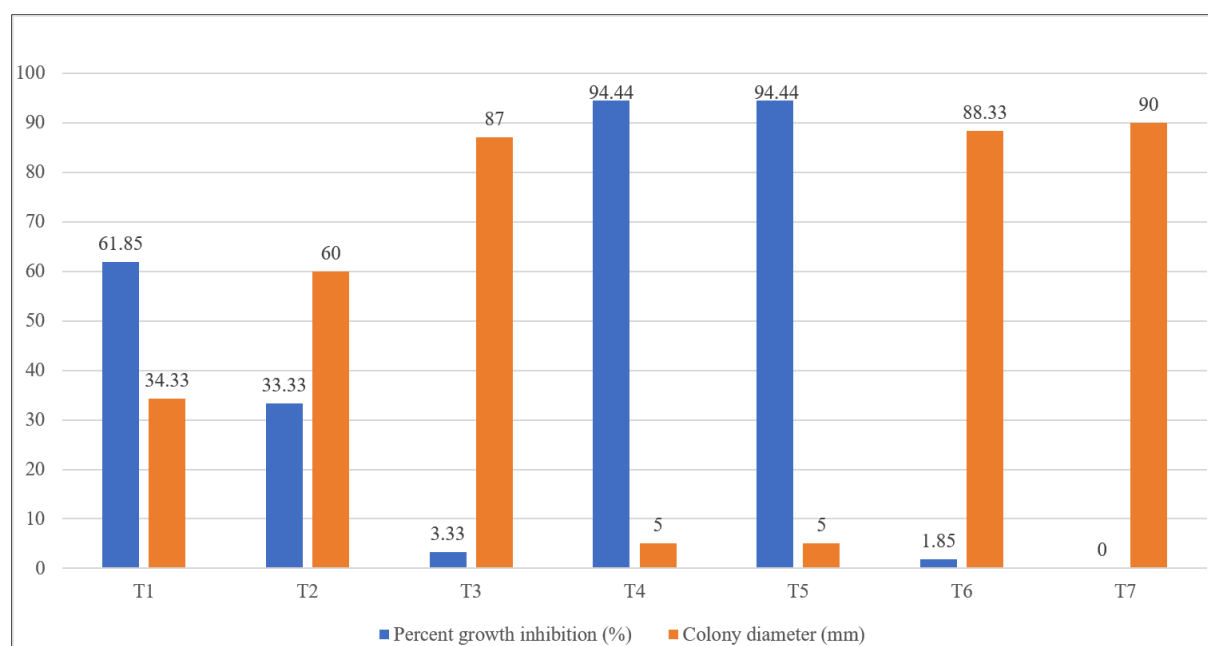
Table 1. *In vitro* effect of systemic fungicides on *Trichoderma asperelloides*

Tr. No.	Treatment	Radial mycelial growth (mm)*	% growth inhibition	Compatibility
T ₁	Azoxystrobin 23% SC	34.33	61.85	Slightly compatible
T ₂	Kresoxim-methyl 44.3% SC	60	33.33	Moderately compatible
T ₃	Fluxapyroxad 33.3g/l FS	87	3.33	Highly compatible
T ₄	Propiconazole 25% EC	5	94.44	Non-compatible
T ₅	Carbendazim 50% WP	5	94.44	Non-compatible
T ₆	Fosetyl AL 80% WP	88.33	1.85	Highly compatible
T ₇	Control	90.00	00	-
	S.E.(m)±	0.77	-	-
	C.D. (5%)	2.35	-	-

*Mean of three replications.

In contrast, Propiconazole 25% EC and Carbendazim 50% WP exhibited pronounced inhibitory effects, each causing 94.44% inhibition of mycelial growth, and were therefore classified as incompatible with *T. asperelloides*. Based on the present findings, Fosetyl-Al 80% WP showed the highest compatibility among the systemic fungicides tested, followed by Fluxapyroxad 33.3 g/L FS.

These results indicate that Fosetyl-Al and Fluxapyroxad may have potential for integration with *T. asperelloides* in integrated disease-management programmes. However, since the study was conducted under laboratory conditions, further greenhouse and field evaluations are required to confirm the compatibility, persistence, and disease-suppressive performance of this bioagent–fungicide combination before recommending it for large-scale agricultural use.

**Figure 1.** *In vitro* assessment on compatibility of *Trichoderma asperelloides* with systemic fungicides.

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References

- Vinale F, Sivasithamparam K, Ghisalberti EL, Marra R, Woo SL, Lorito M. *Trichoderma*-plant-pathogen interactions. *Soil Biology and Biochemistry*. 2008;40(1):1–10.
- Saha S, Pharate S, Thosar RU, Chavan V. Compatibility of *Trichoderma asperelloides* with fungicides controlling downy mildew and powdery mildew in grapes. *Grape Insight*. 2023;1(1):32–36.
- Dinkwar GT, Yadav VK, Kumar A, Nema S, Mishra S. Compatibility of fungicides with potent *Trichoderma* isolates. *International Journal of Plant and Soil Science*. 2023;35(18):1934–1948.
- Al-Hazmi AS, Tariq Javeed M. Compatibility of *Trichoderma* spp. with seven chemical fungicides used in the management of soil-borne plant pathogens. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2016;7(1):251–256.
- Bindu MG, Bhattiprolu SL, Balireddy V. Compatibility of biocontrol agent *Trichoderma viride* with various pesticides. *Journal of Horticultural Sciences*. 2011;6(1):71–73.
- Joseph LA, Sousa KO, Chagas Júnior AF, Luc F. Compatibility of fungicides with *Trichoderma asperelloides* and *Azospirillum brasilense*. *Scientia Agraria*. 2022;23:30–35.
- Khore TT, Shende CV, Chaudhari NA, Dhawan SS, Kumbhar AS, Shitole PA. Assessment of compatibility of *Trichoderma asperellum* with different fungicides. *Asian Research Journal of Agriculture*. 2025;18(2):238–245.

8. Maheshwary NP, Gangadhara Naik B, Amoghavarsha Chittaragi M, Naik MK, Satish KM, Nandish MS. Compatibility of *Trichoderma asperellum* with fungicides. The Pharma Innovation Journal. 2020;9(8):136–140.
9. Manandhar S, Timila RD, Karkee A, Gupt SK, Baidya S. Compatibility study of *Trichoderma* isolates with chemical fungicides. Journal of Agriculture and Environment. 2020;21:9–18.
10. Silva MAF, *et al.* Compatibility of *Trichoderma* isolates with pesticides used in tropical crops. Summa Phytopathologica. 2018;44(4):357–363.
11. Srinivasan K, Santhosh RS, Kumar V. Compatibility of *Trichoderma* spp. with commonly used agrochemicals and its implication in IDM. Journal of Biological Control. 2019;33(2):132–139.
12. Sunkad G, *et al.* Compatibility of indigenous *Trichoderma asperellum* with chemical fungicides for the management of chick-pea wilt. Journal of Biological Control. 2023;37(1):6–12.
13. Widmer TL. Compatibility of *Trichoderma asperellum* isolates to selected soil fungicides. Plant Disease. 2007;91(4):454–459.

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