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BIOCONTROL POTENTIAL OF *TRICHODERMA VIRIDE* AGAINST MAJOR FOLIAR DISEASE OF SOYBEAN (*GLYCINE MAX L.*) UNDER IN MID HILL CONDITIONS OF HIMACHAL PRADESH INDIA

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ABSTRACT

Soybean (*Glycine max* L.) is a major leguminous oil seed crop with high in vegetable protein and oil. It is the third most important oil seed of India after mustard and groundnut. The current study entitled “Biocontrol potential of *Trichoderma viride* on Soybean (*Glycine max* L.) in mid hill conditions of Himachal Pradesh” was carried out at Agriculture research farm in 2023 and 2024 at Abhilashi University. The results indicated that in year 2023, minimum *Septoria* brown spot disease incidence (12 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). The results indicated that in year 2023, minimum *Cercospora* leaf blight disease incidence (9.2 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Similarly, results indicated that in year 2024, minimum *Cercospora* leaf blight disease incidence (12 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Similarly, results analysis for the year 2024 indicated that minimum pod blight disease incidence (10.4 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease incidence (24 %) was recorded in T₇ Control.

Keywords: Soybean, *Trichoderma viride*, growth parameters, disease and biological control.

Introduction

Soybean (*Glycine max* L.) is a major leguminous oil seed crop with high in vegetable protein and oil (Herridge *et al.*, 2008; Prevost *et al.*, 2010). It is an important oil-yielding commercial crop that is useful not only for oil extraction but also for many important products useful for animal feed and human diet. The Soybean belong to the family Leguminaceae and subfamily Fabaceae has tremendous agricultural and the ability to fix nitrogen in the soil. Soybeans account for more than half of global vegetable oil production. Farmers are becoming more interested in soybean cultivation in response to the growing demand for high-quality protein in human food products and plants

used for animal feed. (Szostak *et al.*, 2020). Nutritionally, seeds of Soybean contain approximately 40% protein, 18% oil, 20-26% carbohydrate contents, and a high concentration of calcium, phosphorus, and vitamins (Rahman *et al.*, 2011; Mahbuba 2020). It is one of the most important fodder plants, accounting for approximately 58% of total oilseed production globally and 69% of protein in livestock diets (Borawska *et al.*, 2014).

Septoria brown spot (*Septoria glycines*) common symptoms include circular or angular lesions on leaves, often with a dark center and yellowing around the edges. Severely infected leaves may turn yellow, wither and drop off. *Septoria* brown spot (also called

brown spot) is common leaf disease of soybean across the Midwestern U.S. Its incidence can be high but it rarely develops to cause significant yield loss. Yield losses of five to eight percent may occur under severe conditions when much defoliation occurs.

Cercospora leaf blight (*Cercospora kikuchii*) common Symptoms of the disease are easily identifiable on infected plants. The leaves present irregular reddish-brown, purple or purple spots, often with poorly defined edges. These spots may coalesce, leading to widespread necrosis and early defoliation of the plants. The impact of *Cercospora* blight on soybean yield can vary depending on the severity of the disease and the stage of plant development. Yield losses of up to 30% have been reported in fields with high disease pressure. The disease can also reduce seed quality, leading to lower germination rates, and increased levels of seed-borne pathogens (Giesler and Miller, 2017).

Pod and stem blight is caused by the fungus *Diaporthe sojae*. Pod and stem blight is characterized by black, raised specks that appear in linear rows on mature soybean stems. These specks are fungal reproductive structures known as pycnidia. Pycnidia can also cover pods, but they may not follow the linear pattern seen on stems. These signs are most prevalent from R6 through R8. These fungi cause more losses in the United States than any other soybean disease or disease complex, with the possible exception of the soybean crown and root rot complex. Members of this fungal complex and the diseases they cause result in serious crop losses wherever soybeans are grown around the world.

Trichoderma was first proposed as a genus by Persoon in 1794 on the basis of material collected in Germany. *Trichoderma* is a free-living fungus common in soil and root ecosystem. Highly interactive in root, soil and foliar environment. *Trichoderma* is use against phytopathogenic fungi. It supress pathogen by different mechanisms of biocontrol. *Trichoderma* is a very effective biological means for plant disease management especially the soil borne. *Trichoderma* has symbiotic relation with roots of plant. It also acts as plant growth promoter.

Materials and Methods

Experimental site

In the present study, the field experiments were conducted during 2023 and 2024 at Research Farm of the School of Agriculture situated in the campus of Abhilashi University, Chail Chowk, Mandi, Himachal Pradesh.

Experimental details

The details of the experiment regarding the design, crop, variety, spacing, plot size, etc., are described below.

Design	Randomized Block Design (RBD)
Number of treatments	7
Replications	3
Experiment year	2023 and 2024
Variety	Braag
Time of sowing	June
Seed rate	75 kg/ha
Spacing	30 × 10 cm
Total number of plots	21
Plot size	4 m ²

A field experiment was conducted to evaluate the effect of seed treatment with different combinations viz. T₁- Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare, T₂- Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare, T₃- Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare, T₄- Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare, T₅- Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed, T₆- Seed treatment with *Trichoderma viride* @ 10 g / kg of seed and T₇-Control on disease incidence and severity of *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease of soybean.

Disease severity

Five plants were randomly selected and tagged. These plants were used for the leaf disease severity scale system of 0- 9, where 0 = no leaf spot and 9 = plants completely defoliated and killed by leaf spots (Table 1). *Per cent* disease severity was recorded by using scale system of 0- 9. It was calculated by formula according to (Pramesh *et al.*, 2017).

Percent disease severity (PDS) =
$$\frac{\text{Sum of all diseased ratings}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

Table 1 : Soybean Leaf Disease Severity Scale Rating (Paul and Donald, 2011)

Disease Scale Rating	Disease Severity	Description
0	--	No lesions/spots
1	1%	Leaf area covered with lesions/spots
3	1.1 - 10%	Leaf area covered with lesions/spots; no spots on stem
5	10.1 – 25%	Leaf area covered with lesions/spots, no defoliation; little damage
7	25.1 – 50%	Leaf area covered with lesions/spots; some leaves drop; death of few plants; damage conspicuous
9	50% of Above	More than 50% of the area is covered, lesions/spots are very common on all parts, defoliation is common, death of plants common; damage more than 50%.

Disease incidence

The observations were recorded for the evaluation of disease incidence. The disease incidence and calculated with the formula (Morris *et al.* 2017).

$$\text{Percent disease incidence(PDI)} = \frac{\text{Total number of infected plants}}{\text{Total number of plants assessed}} \times 100$$

Results and Discussion

Effect of seed treatment with different formulations on *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease incidence of soybean plant

The results presented in Table 2 and Figure 1 indicated that in year 2023, minimum *Septoria* brown spot disease incidence (12 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease incidence (26.4 %) was recorded in case of T₇ Control followed by 20 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 18.4 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g/kg of seed), 17.2 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g/kg of seed + Vermicompost @ 2-5 kg/hectare), 16 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare), and 13.2 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare).

Similarly, results presented in Table 2 and Figure 1 indicated that in year 2024, minimum *Septoria* brown spot disease incidence (14.4 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease incidence (24 %) was recorded in the case of T₇ Control followed by 22.4 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 21.2 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g/kg of seed), 18.4 % in T₂ (Seed treatment with

Trichoderma viride @ 10 g/kg of seed + Vermicompost @ 2-5 kg/hectare), 17.2 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 16 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare). A similar type of observation was reported by Hassan *et al.* (2017), *Septoria* brown spot disease incidence of rice was recorded in *Trichoderma viride* i.e., 12.00 %. Hegde *et al.* (2022) revealed the lowest *septoria* leaf spot diseases incidences of tomato were recorded in T₃ Seed treatment with *Pseudomonas fluorescens* @ 5 g kg⁻¹ Fb seedling dip, spray with *P. fluorescens* 10 g l⁻¹ four times at 15 days interval (26.40%), T₅ (Seed treatment with *T. harzianum* @ 5 g kg⁻¹ Fb spray with *B. subtilis* @ 10 g l⁻¹ four times (24.78%), and T₆ Seed treatment with *T. harzianum* @ 5 g kg⁻¹ Fb spray with *P. fluorescens* @ 10 g l⁻¹ four times (24.12%), T₈ compared to control (41.42%) during the Kharif season of 2018– 2019.

The results indicated that in year 2023, minimum *Cercospora* leaf blight disease incidence (9.2 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease incidence (20 %) was recorded in T₇ Control followed by 18.4 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 17.2 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 14.4 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 13.2 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 12 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare) (Table 5 and Figure 1).

Similarly, results presented in Table 2 and Figure 1 indicated that in year 2024, minimum *Cercospora* leaf blight disease incidence (12 %) was recorded in T₄

(Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease incidence (22.4%) was recorded in T₇ Control followed by 21.2 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 18.4 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 16% in T₂ (Seed treatment with *Trichoderma viride* @ 10 g/kg of seed + Vermicompost @ 2-5 kg/hectare), 14.4 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 13 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare), respectively. An experiment performed by Triana *et al.* (2017) reported the effects of *Trichoderma* species on soybean. They observed *Cercospora kikuchii* incidence (13 %) in treatment *Trichoderma asperellum* + suelo + tallo. An experiment performed by Hashmi (2024) indicted that reduced (18.25%) disease incidence of black gram was recorded in T₇ (*Trichoderma* spp. @ 10%) After 1st spray. In case of T₉ (control plot), 33.33 percent disease incidence was recorded after 1st spray of the bioagents. Minimum 24.25 percent disease incidence was recorded in T₇ (*Trichoderma* spp. @ 10%), whereas, in case of T₉ (control plot), 40.33 percent disease incidence was recorded after 2nd spray of the bioagents. Similarly, Sri Veda (2022) investigated the effects of *Trichoderma* species on chilli. They observed minimum *Cercospora* leaf spot disease incidence (49.20 %) was recorded in *Trichoderma harzianum*. and maximum *Cercospora* leaf spot disease incidence (68.23 %) in untreated plot.

The results presented in Table 2 and Figure 1 indicated that in year 2023, minimum Pod blight disease incidence (9.2 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas maximum disease incidence (26.4 %) was recorded in T₇ Control followed by 25.2 % in T₅ (Seed treatment with

Trichoderma viride @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 21.2 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 18.4 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 16 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 13.2 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare).

Similarly, results analysis for the year 2024 indicated that minimum pod blight disease incidence (10.4 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease incidence (24 %) was recorded in T₇ Control followed by 22.4 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 20 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 17.2 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 14.4 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare) and 13.2 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare), respectively. Similar result performed by Amrate (2018) also revealed the effect of *Trichoderma* species on soybean. They observed Pod blight disease incidence (13.37 %) was recorded in treatment-T₃ *Trichoderma viride* @ 5 g/kg seed and maximum Pod blight disease incidence (15.17 %) was recorded in T₉ untreated plot (Table 4.10 and Figure 4.10). Similar results obtained by Lalhruaitluangi *et al.* (2018) also reported the effects of *Trichoderma* species on soybean. They observed pod blight disease incidence (12.46 %) was recorded in *Trichoderma atroviride* (KU933472) and maximum disease incidence (20.11 %) was observed in untreated plot.

Table 2: Effect of different formulations on the disease incidence of *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease

Treatment No.	Treatment details	Percent Disease Incidence (PDI %)					
		<i>Septoria</i> brown spot		<i>Cercospora</i> leaf blight		Pod blight	
		2023	2024	2023	2024	2023	2024
T ₁	Seed treatment with <i>Trichoderma viride</i> @ 10 g/ kg of seed+ FYM @ 2-5 kg/hectare	13.2	16.0	12.0	13.2	13.2	14.4
T ₂	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare	17.2	18.4	14.4	16.0	18.4	17.2
T ₃	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare	16.0	17.2	13.2	14.4	16.0	13.2
T ₄	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare	12.0	14.4	9.2	12.0	9.2	10.4

T₅	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + <i>Pseudomonas fluorescens</i> @ 10 g / kg of seed	20.0	22.4	18.4	21.2	25.2	22.4
T₆	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed	18.4	21.2	17.2	18.4	21.2	20.0
T₇	Control (no manure or no fertilizer)	26.4	24.0	20.0	22.4	26.4	24.0
	C.D. (At 5 % level)	N/A	N/A	1.718	1.806	1.976	2.083
	SE(m)	0.808	0.580	0.552	0.580	0.634	0.669

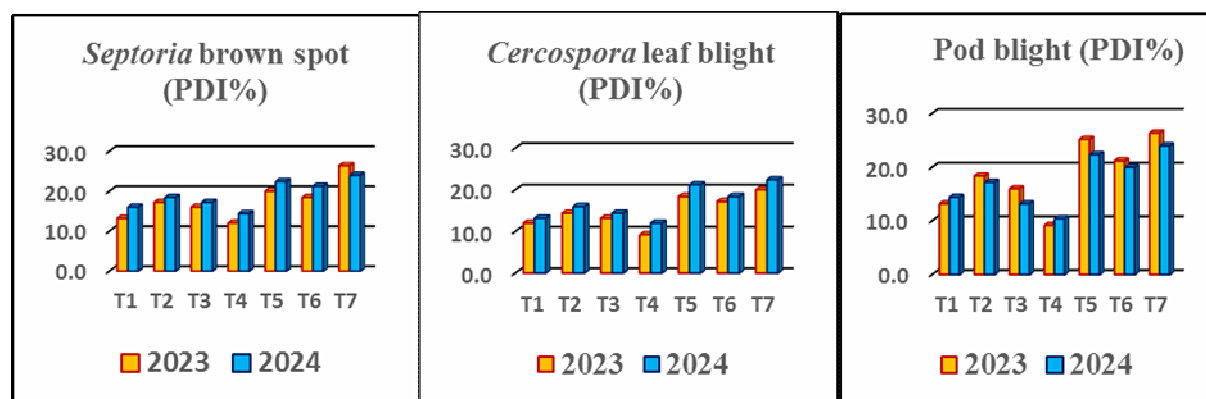


Fig. 1 : Effect of different formulations on the disease incidence of *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease

Effect of seed treatment with different formulations on *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease severity of soybean plant

The results presented in Table 3 and Figure 2 indicated that in year 2023, minimum *Septoria* brown spot disease severity (23.4 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease severity (43.2 %) was recorded in T₇ Control followed by 41.9 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 39.5 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 38.2 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 37 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 30.8 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed + FYM @ 2-5 kg/hectare).

Similarly, results for the year 2024, indicated that the minimum *Septoria* brown spot disease severity (25.9 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease severity (45.6 %) was recorded in T₇ Control followed by 43.2 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 39.5 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 37 % in T₂

(Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 34.5 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 32 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare) (Table 4.11 and Figure 4.11). Similar results were reported by Hassan *et al.* (2017) while working on *Trichoderma* species of rice. They observed minimum *Septoria* brown spot disease severity of (23 %) was recorded in *T. viride*. Singh *et al.* (2017) also revealed the effects of *Trichoderma* species on Rice. They observed *Septoria* brown spot disease intensity (10 %) was recorded in Seed treatment *Trichoderma viride* and maximum disease intensity (20 %) was recorded in control.

The results presented in Table 3 and Figure 2 revealed that in year 2023, minimum *Cercospora* leaf blight disease severity (20.9 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease severity (55.5 %) was recorded in T₇ Control followed by 53 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 50.6 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 35.8 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 33.3 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed

+ Neem cake @ 1-2 kg/hectare) and 32 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare)

Similarly, results presented in Table 3 and Figure 2 indicated that in year 2024, minimum *Cercospora* leaf blight disease severity (33.3 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). The maximum disease severity (49.3 %) was recorded in T₇ Control followed by 45.6 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 40.7 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 39.5 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 38.2 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 35.8 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare). Promwee and Intana (2022) in their experiment concluded that the effects of *Trichoderma* species on green oak. They observed that minimum disease severity (67.51 %) was recorded in *Trichoderma asperellum* and maximum disease severity of *Cercospora* leaf blight disease (85.56 %) was recorded in *Cercospora lactucae-sativae*. Similarly, Sarangia and Tiwari (2023) also revealed the effects of *Trichoderma* species on okra. They observed minimum disease intensity of *Cercospora* leaf blight disease at 60 DAS was recorded in T₄-Mancozeb (1%) + *Trichoderma* (2%) + *Pseudomonas* (2%) (14.36) and maximum disease intensity-(29.18) in T₀-untreated control.

The results presented in Table 3 and Figure 2 indicated that in year 2023, minimum Pod blight disease severity (29.6 %) in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas, maximum disease severity (50.6 %) was recorded in T₇ Control followed

by 44.4 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 41.9 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 39.5 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 38.2 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 35.8 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare).

Similarly, results presented in Table 3 and Figure 2 indicated that in year 2024, minimum Pod blight disease severity (28.3 %) was recorded in T₄ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare). Whereas maximum disease severity (54.3 %) was recorded in T₇ Control followed by 43.2 % in T₅ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + *Pseudomonas fluorescens* @ 10 g / kg of seed), 41.9 % in T₆ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed), 38.2 % in T₂ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare), 37 % in T₃ (Seed treatment with *Trichoderma viride* @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare) and 30.8 % in T₁ (Seed treatment with *Trichoderma viride* @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare). Similarly, Singh *et al.* (2019) in their experiment found that the effects of *Trichoderma* species on soybean. They observed that disease severity of Pod blight (20.89 %) was recorded in T₁ *Trichoderma* seed treatment and maximum disease severity of Pod blight disease (39.69 %) was recorded in T₈ untreated control. Guldekar and Potdukhe (2010) also revealed the effects of *Trichoderma* species on soybean. They observed that disease intensity of Pod blight disease (16.15 %) was recorded in *Trichoderma viride* and maximum disease intensity (53.17 %) was observed in untreated control.

Table 3 : Effect of different formulations on the disease severity of *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease

Treatment No.	Treatment details	Percent Disease Severity (PDS %)					
		<i>Septoria</i> brown spot		<i>Cercospora</i> leaf blight		Pod blight	
		2023	2024	2023	2024	2023	2024
T ₁	Seed treatment with <i>Trichoderma viride</i> @ 10 g per kg of seed+ FYM @ 2-5 kg/hectare	30.8	32.0	32.0	35.8	35.8	30.8
T ₂	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + Vermicompost @ 2-5 kg/hectare	38.2	37.0	35.8	39.5	39.5	38.2
T ₃	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + Neem cake @ 1-2 kg/hectare	37.0	34.5	33.3	38.2	38.2	37.0
T ₄	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + Mustard cake @ 1-2 kg/hectare	23.4	25.9	20.9	33.3	29.6	28.3

T ₅	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed + <i>Pseudomonas fluorescens</i> @ 10 g / kg of seed	41.9	43.2	53.0	45.6	44.4	43.2
T ₆	Seed treatment with <i>Trichoderma viride</i> @ 10 g / kg of seed	39.5	39.5	50.6	40.7	41.9	41.9
T ₇	Control (no manure or no fertilizer)	43.2	45.6	55.5	49.3	50.6	54.3
	C.D. (At 5 % level)	N/A	3.217	3.049	N/A	N/A	2.420
	SE(m)	1.130	1.033	0.979	1.180	1.103	0.777

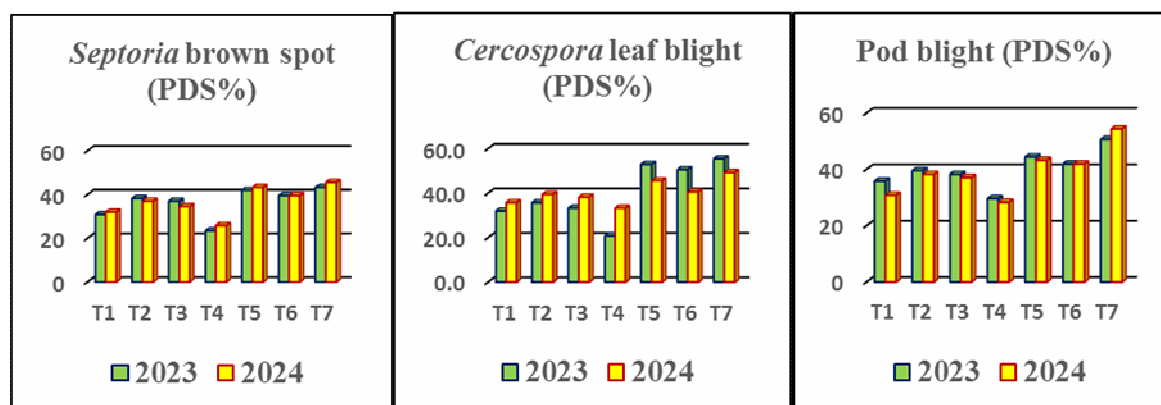


Fig. 2 : Effect of different formulations on the disease severity of *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease

Conclusion

In the present study, it was concluded that treatment T₄ (Seed treatment with *Trichoderma viride* @ 10 g/Kg of seed + Mustard cake @ 1-2 Kg/hectare) was the most effective in reducing the disease incidence and severity. This suggests that the combination of *Trichoderma viride* with organic amendments like mustard cake provides strong biological control over fungal pathogens are helpful in the management of *Septoria* brown spot, *Cercospora* leaf blight and Pod blight disease of Soybean.

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References

- Borawska, J., Darewicz, I.A. and Minkie, W.P (2014). Biologically active peptides from food proteins as factors preventing diet-related diseases. *Bromatologia i Chemia Toksykologiczna*, **47**(2), 230-236.
- Giesler, L.J. and Miller, J.J. (2017). Managing foliar diseases in soybean. Neb Guide. Nebraska Extension. University of Nebraska-Lincoln.
- Herridge, D.F., Peoples, M.B. and Boddey, R.M. (2008). Global inputs of biological nitrogen fixation in agricultural systems. *Plant Soil*, **311**; 1, 1–18.
- Mahbuba, K.H., Abul, K.M. and Farid, A (2020). Use of *Trichoderma* in Biological Control of Collar Rot of Soybean and Chickpea. *International Journal of Biochemistry Research & Review*, **29**(9), 25-31.
- Morris, M.M., Muthomi, J.W. and Wagacha, J.M (2017). Effect of soil fertility and intercropping on the incidence and severity of root rot diseases of common bean (*Phaseolus vulgaris* L.). *World Journal of Agricultural Research*, **5**, 189-199.
- Paul, V. and Donald, E.H. (2011). Assessing Foliar Diseases of Corn, Soybeans, and Wheat, Principles and Practices PPFS-MISC-06
- Persoon, C.H. (1794). Neuer Veersuch einer systematischen Eintheilung der Schwamme. *Neues Magazin für die Botanik*, **1**, 63-128.
- Pramesh, D., Alase, S., Muniraj, K.M. and Kumara, M.K. (2017). Management of stem rot disease of paddy using fungicides. *International Journal of Current Microbiology and Applied Sciences*, **6**(10), 3046- 3051
- Prevost, D., Bertrand, A., Juge, C. and Chalifour, F.P. (2010). Elevated CO₂ induces differences in nodulation of soybean depending on bradyrhizobial strain and method of inoculation. *Plant Soil*, **331**(1), 115–127.
- Rahman, M.M., Hossain, M.M., Anwar, M.P. and Juraimi, A.S. (2011). Plant density influence on yield and nutritional quality of soybean seed. *Asian Journal of Plant Sciences*, **10**(2), 125-132.
- Szostak, B., Głowacka, A., Kasiczak, A., Kiełtyka, D.A. and Bąkowski, M. (2020). Nutritional value of soybeans and the yield of protein and fat depending on a cultivar and the level of nitrogen application. *The Journal of Elementology*, **25**(1), 45-57.