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Evaluation of some fungicides and neem products against *Fusarium oxysporum* f. sp. *lycopersici* the causal of vascular wilt disease of *Solanum lycopersicum*

Ghanshyam Kumar Pandey, Shafaat Ahmad, Bhushan Kewate, Anoop Yadav, Brajendra Kumar Yadav, Sunil Zacharia, Gaurav Chaudhary, Nikunj Tyagi and Pradeep Kumar Shukla

Abstract
Fusarium wilt of tomato caused by *Fusarium oxysporum* f. sp. *lycopersici* is a serious problem limiting tomato production worldwide. Biological control has emerged as one of the most promising alternatives to the chemical fungicides. For the management of disease an investigation was carried out at research laboratory of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The efficacy of bio-agents *viz. Trichoderma viride, T. harzianum, Pseudomonas fluorescens*, plant extracts *viz.* neem oil @ 10%, and neem seed kernel extract@ 10% and Neem leaf extract @ 10%, against *F. oxysporum* under *In vitro* experiment was analysed by using CRD (Complete Randomized Design) with six treatments and three replication *viz. Trichoderma viride, T. harzianum, Pseudomonas fluorescens*, Neem leaf extract, neem oil, and neem seed kernel extract. Observations recorded at 24 hrs, 48 hrs, and 72 hrs. 96 hrs. 120 hrs. 144 hrs, 168 hrs. *T. viride* was inoculated directly in PDA poured plate in a dual culture technique which gave the best results among all the treatments (1.475) followed by *Trichoderma harzianum* (1.765). Whereas in case of neem products neem oil @10% was best effective (5.450) followed by neem leaf extract (6.375) followed by NSKE (6.625). It was seen that all the treatments were significant over control (8.285).

Keywords: *Capsicum annum, F. oxysporum, T. viride, T. harzianum, Pseudomonas fluorescens,* neem oil, neem seed kernel cake and neem leaf extract

Introduction
Tomato (*Lycopersicon esculentum Mill.*) is one of the most popular and important commercial vegetable crop grown all over the world. It is excellent source of various micronutrients and antioxidants. Hence are often recommended by dieticians and nutritionists for controlling cholesterol and weight reduction (Champawat *et al.*, 2003) [1]. The major tomato producing states are Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh and West Bengal. This vegetable crop suffers from various diseases that significantly affect its growth and yield. A number of economically important tomato diseases caused by fungi are transmitted by seed or transplants. Tomatoes are parasitized by a number of pathogens, including *Fusarium oxysporum* f. sp. *lycopersici* (Choudhary *et al*., 2012) [2]. Out of these, tomato wilt is one of the most serious diseases affecting its yield. The causal agent of *Fusarium* wilt is soil borne pathogen which can persist many years in the all type of soil without a host throughout world. *Fusarium* spp. are saprophytes and are able to grow on soil organic matter for a prolonged period. Most infections originate from the population associated with infected tomato debris. Healthy plants can become infected by *F. oxysporum* if the soil in which they are growing is infested with the pathogen (Ganie *et al*., 2013) [4].
Healthy plants can become infected by *F. oxysporum* if the soil in which they are growing is infested with the pathogen (Ganie *et al*., 2013) [4]. Symptoms also include drooping, yellowing, wilting, and dying of the lower leaves, often on one side of the plant (Figure 1). These symptoms may appear on successively younger leaves with one or more branches being affected and others remaining healthy. After a few weeks, browning of the vascular system (Figure 2) may be observed by slicing the stem open lengthwise with a knife. This brown discoloration inside the stem can be found from the roots to the top of the plant. Plant growth

is stunted and, under warm conditions, the plant may die (Hossain *et al*., 2016).

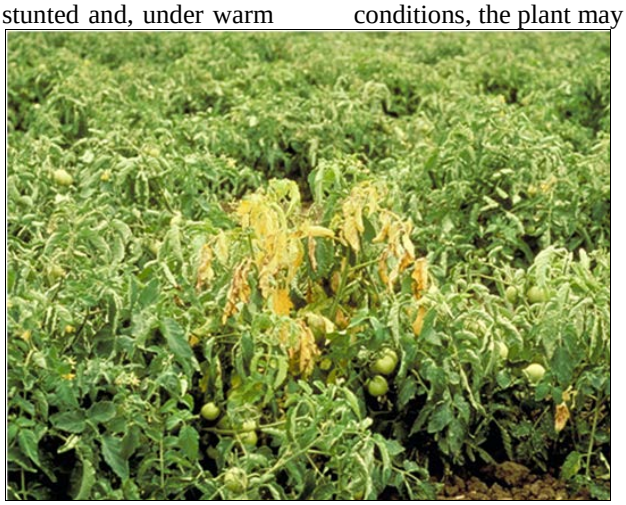

Fig 1: *Fusarium* wilt, yellowing, wilt symptoms include foliage. Symptoms and browning of often occur only on plant. (Photo: Research Field. SHUATS, Prayagraj, Uttar Pradesh, India)

Materials and methods

The experiment was conducted in the Laboratory of the Department of Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. Talcum based formulation of *Trichoderma harzianum*, *Trichoderma viride* and *Pseudomonas fluorescens* was used. It was cultured and purified with the help of serial dilution method. From purified culture plate, a bit was transferred to a PDA poured plate already inoculated with *Fusarium oxysporum* f. sp. *lycopersici*. Another treatment of leaf extract, oil and seed kernel cake were collected and then crushed along with methanol to prepare an extract, was mixed in potato dextrose agar @ 10% of the volume then was sterlised in autoclave. After sterilization as the PDA gets cooled down, inoculated with *Fusarium oxysporum* f. sp. *lycopersici* (Malesh *et al*., 2009) [6].

Results and Discussion

The study entitled, "*In Vitro* Evaluation of Some Fungicides and Neem Products against *Fusarium oxysporum* f. sp. *lycopersici* the causal of vascular wilt disease of Tomato" under lab condition were conducted at Research Laboratory of Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences. Prayagraj. The Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents after 24, 48, 72 and 96 hrs on dual cultured:

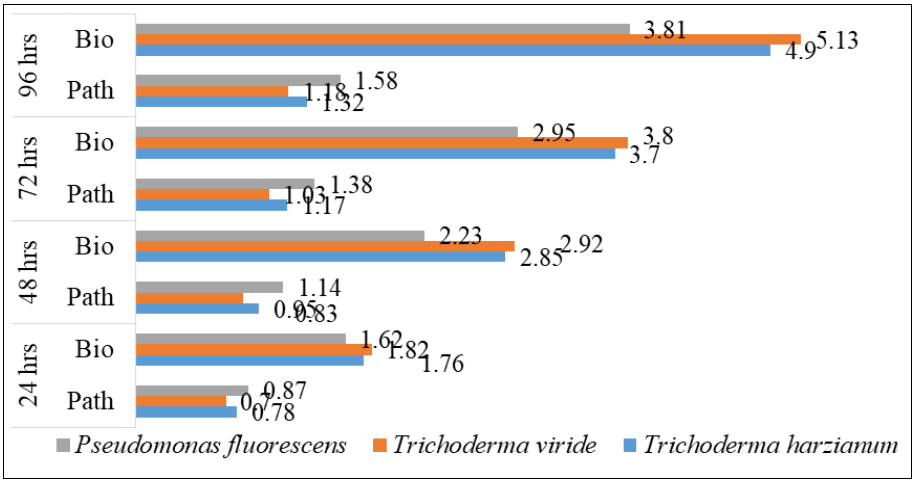

Fig 1: Antagonist effect of *Fusarium oxysporum* f. sp. *Lycopersici* against bio-agents and Botanicals on dual cultured

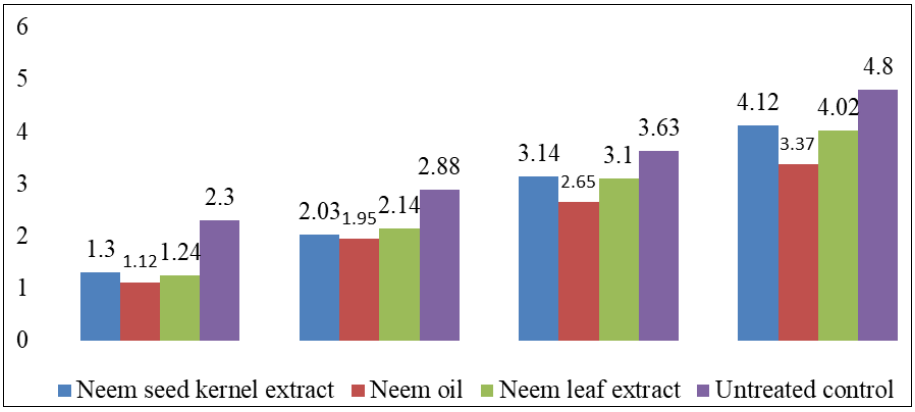

Fig 2: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against Botanicals after 24, 48, 72 and 96 hrs on dual cultured

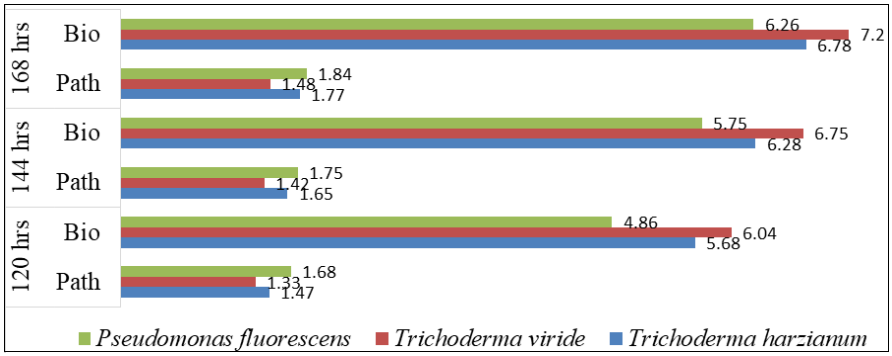

Fig 3: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 120, 144 and 168 hrs on dual cultured

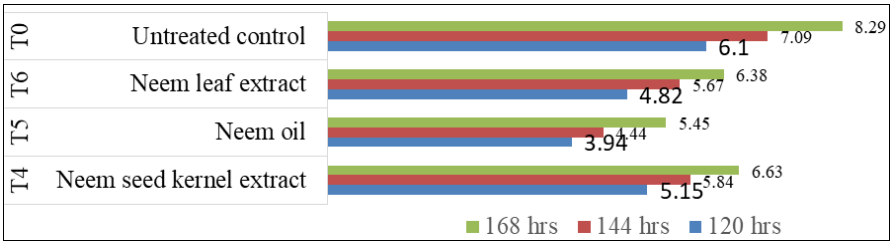

Fig 4: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against Botanicals after 120, 144 and 168 hrs on dual cultured

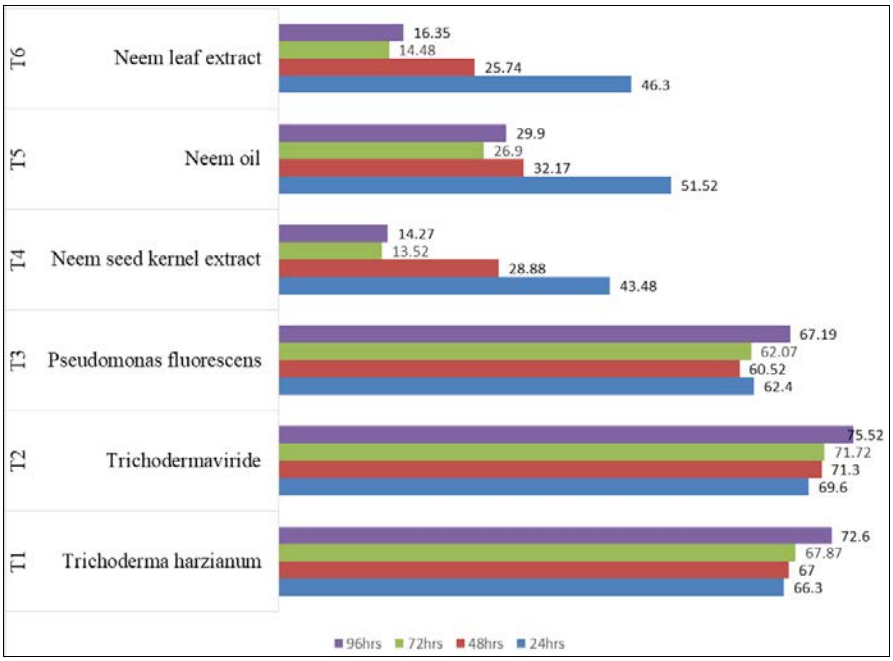

Fig 5: Inhibition percentage of *Fusarium oxysporum* f. sp. *lycopersici* mycelium after 24, 48, 72 and 96 hrs

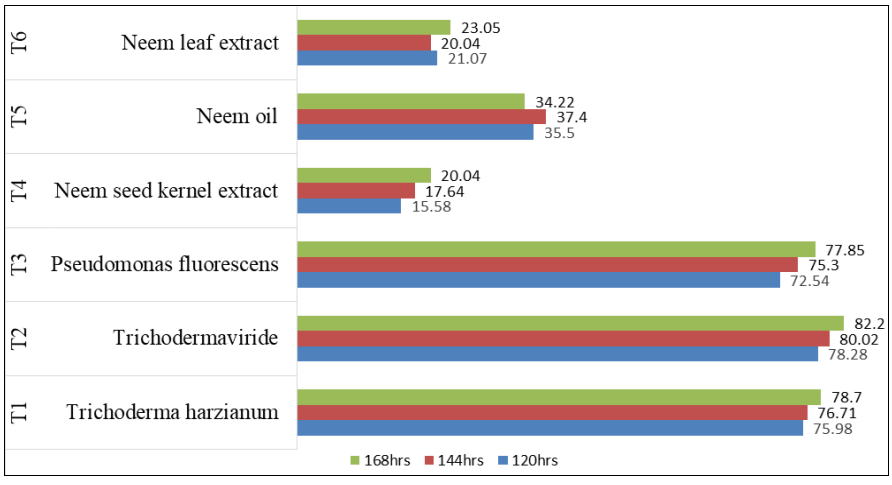

Fig 6: Inhibition percentage of *Fusarium oxysporum* f. sp. *lycopersici* mycelium after 120, 144 and 168 hrs

The data in Fig. no.1 and Fig. no.2 shows maximum radial growth recorded in isolate T_0 (2.300) followed by the T_4 (1.300), T_6 (1.235), T_5 (1.115), T_3 (0.865), T_1 (0.775) and T_2 (0.700) isolate. However, T_0 isolate was found to have the maximum growth rate, whereas T_2 isolate was having the minimum growth rate and medium growth found in T_5 isolate. Isolates T_4, T_6 and T_5 were non-significant to each other whereas significant to treatments T_3, T_1, T_2 and T_0. Also treatments T_3, T_1, T_2 were non-significant to each other whereas significant to T_4, T_6, T_5 and T_0 after 48 effect of *Fusarium oxysporum* f. sp. *lycopersici* on dual culture the isolate T_0 (2.875) followed by the T_4 (2.015), T_6 (2.135), T_5 (1.950), T_3 (1.135), T_1 (0.950) and T_2 (0.825) isolate. However, T_0 isolate was found to have the maximum growth rate, whereas T_2 isolate was having the minimum growth rate and medium growth found in T_5 isolate. Isolates T_4, T_6 and T_5 were non-significant to each other whereas significant to treatments T_3, T_1, T_2 and T_0. Also treatments T_3, T_1, T_2 were non-significant to each other whereas significant to T_4, T_6, T_5 and T_0 and after 72 hrs effect of *Fusarium oxysporum* f. sp. *lycopersici* on dual culture isolate T_0 (3.625) followed by the T_4 (3.135), T_6 (3.100), T_5 (2.650), T_3 (1.375), T_1 (1.165) and T_2 (1.025) isolate. However, T_0 isolate was found to have the maximum growth rate, whereas T_2 isolate was having the minimum growth rate and medium growth found in T_5 isolate. Isolates T_4, T_6 were non-significant to each other whereas significant to treatments T_5,T_3, T_1, T_2 and T_0. Also also treatments T_3, T_1were non-significant to each other whereas significant to T_2, T_4, T_6, T_5 and T_0. Even T_1, T_2 were non-significant to each other whereas significant to treatments T_5, T_3, T_4, T_6 and T_0 and after 96 hrs effect of *Fusarium oxysporum* f. sp. *lycopersici* on dual culture isolate T_0 (4.800) followed by the T_4 (4.115), T_6 (4.015), T_5 (3.365), T_3 (1.575), T_1 (1.315) and T_2 (1.175) isolate. However, T_0 isolate was found to have the maximum growth rate, whereas T_2 isolate was having the minimum growth rate and medium growth found in T_5 isolate. Treatments T_1, T_2 were non-significant to each other whereas significant to T_3, T_4, T_6, T_5 and T_0. Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents after 120, hrs on dual cultured the data in table no.1 and table no.2 shows maximum radial

Fig 7: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 24 hrs. (Radial growth)

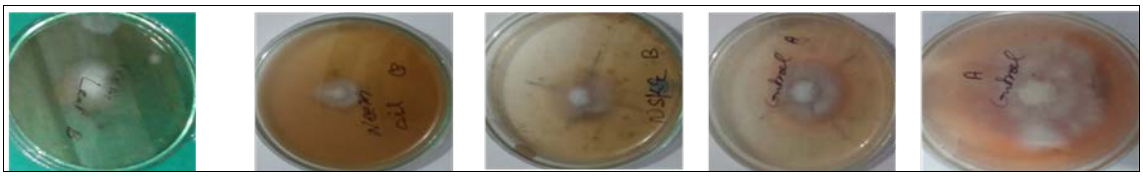

Fig 8: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 48 hrs (Radial growth)

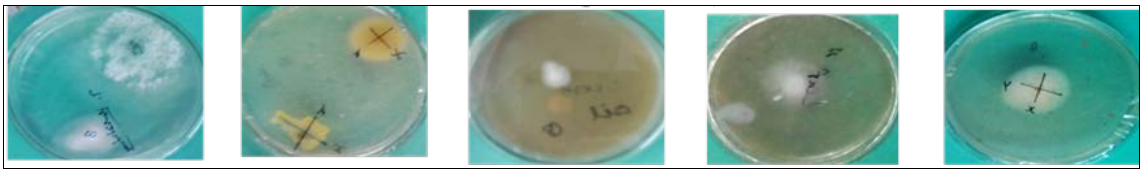

Fig 9: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 72 hrs (Radial growth)

Fig 10: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 96 hrs (Radial growth)

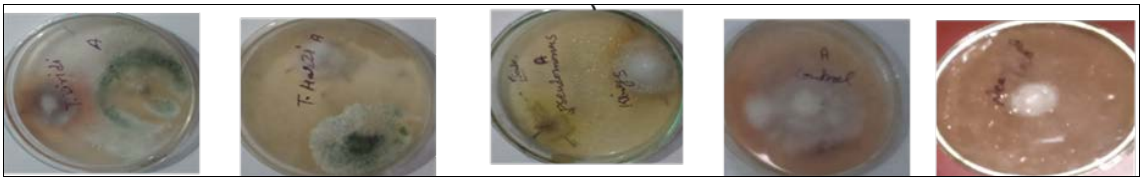

Fig 11: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 120 hrs (Radial growth)

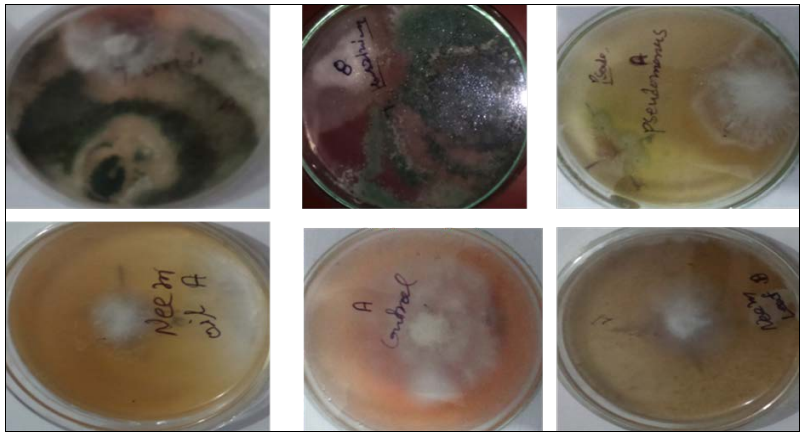

Fig 12: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 144 hrs (Radial growth)

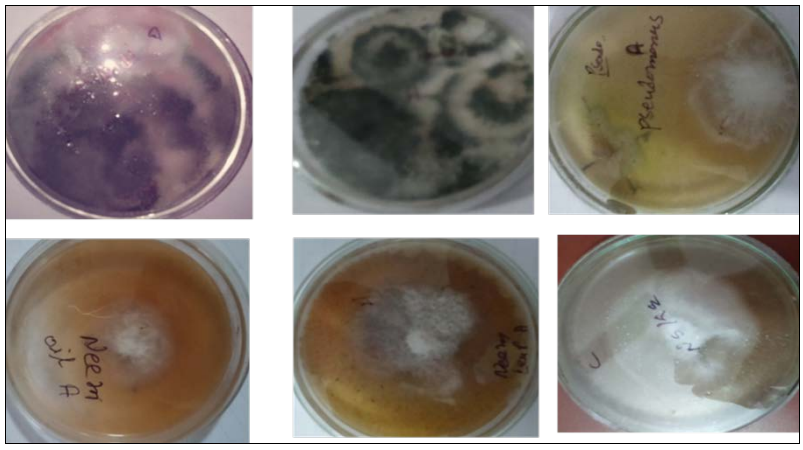

Fig 13: Antagonist effect of *Fusarium oxysporum* f. sp. *lycopersici* against bio-agents and Botanicals after 168 hrs (Radial growth)

Recorded in isolate T_0 (6.100) followed by the T_4 (5.150), T_6(4.815), T_5(3.935), T_3 (1.675), T_1 (1.465) and T_2 (1.325) isolate. However, T_0 isolate was found to have the maximum growth rate, whereas T_2 isolate was having the minimum growth rate and medium growth found in T_5 isolate. Treatments T_1, T_2 were non-significant to each other whereas significant to T_3, T_4, T_6, T_5 and T_0. and after 144 & 166 hrs effect of *Fusarium oxysporum* f. sp. *lycopersici* on dual culture isolate T_0 (7.085) followed by the T_4 (5.835), T_6 (5.665), T_5(4.435), T_3 (1.750), T_1 (16.50) and T_2 (1.415) isolate. However, T_0 isolate was found to have the maximum growth rate, whereas T_2 isolate was having the minimum growth rate and medium growth found in T_5 isolate. Treatments T_1, T_2 were non-significant to each other whereas significant to T_3, T_4, T_6, T_5 and T_0.

Conclusion

Observations recorded at 24 hrs, 48 hrs, 72 hrs., 96 hrs., 120 hrs., 144 hrs., 168 hrs. *T. viride* was inoculated directly in PDA poured plate in a dual culture technique which gave the best results among all the treatments (1.475) followed by *Trichoderma harzianum* (1.765). Whereas in case of neem products neem oil @10% was best effective (5.450) followed by neem leaf extract (6.375) followed by NSKE (7.325). It was seen that all the treatments were significant over control (8.285). *Trichoderma viride* was found to be the best treatment among all treatments followed by *T. harzianum*. As, the results of present experiments are limited to a single experiment as such more trials should be carried out in future to validate the findings. Hence, treatment of wilt of chilli can be easily done by using bio agents which are much beneficial on account costing and also do not affect the environment and other organisms.

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