International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133; Print ISSN: 2664-7125; Impact Factor: RJIF 5.28
Received: 29-01-2021; Accepted: 14-02-2021; Published: 12-03-2021
Volume 3; Issue 1; 2021; Page No. 401-404

Eco-friendly management of wilt disease in cumin under field conditions by using *Trichoderma viride* and *Trichoderma harzianum*

Ganesuni Lakshmi Prasanna, NR Patel, Jyotika Purohit, Kapil K Tiwari
Department of Plant Pathology, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

Abstract
In cumin (*Cuminum cyminum* L.), *Fusarium oxysporum* f. sp. *cumini* is a most serious disease in India. Therefore, the study conducted on eco-friendly management revealed that, the soil application of *Trichoderma viride* + seed treatment with *Trichoderma harzianum* was observed to be the most effective as it recorded the highest per cent disease control (90.52%) with the least per cent disease incidence (6.03%) and highest seed yield of 420 Kg/ha, which was followed by soil application of *Trichoderma harzianum* + seed treatment with *Trichoderma harzianum* and recorded 83.51 per cent disease control with 10.49 per cent disease incidence and seed yield of 387 Kg/ha. The highest disease incidence of 63.63 per cent was recorded in untreated control with the lowest seed yield of 196 Kg/ha.

Keywords: eco-friendly, *t. viride, t. harzianum*, disease incidence and disease control

Introduction
Cumin (*Cuminum cyminum* L.) is a small herbaceous plant in the family Apiaceae (Umbelliferae), commonly called as "zeera". In India, cumin is mainly cultivated in Western Indian states like Gujarat and Rajasthan. Gujarat produced 319.9 thousand metric tonnes from 3.5 lakh hectare area during the year 2018-19 (Anonym, 2020) [2]. Even though, cumin is one of the spice crops having a major contribution in earning of foreign exchange. The total area under cumin cultivation and production varies from year to year. Cumin is seriously affected by Fusarium wilt caused by *Fusarium oxysporum* f. sp. *cumini*, is a destructive disease and results in yield losses up to 80 per cent (Divakara Sastry and Anandaraj, 2013) [6].
Fusarium oxysporum f. sp. *cumini* is seed as well as soil borne pathogen; hence chemical control alone is not sufficient to manage the disease. Use of bio-control agents against wilt pathogen is regarded as an effective practice for successful management of wilt disease. In order to evaluate efficacy of different fungal bio-control agents against test pathogen, the present investigation was undertaken with a view to use different species of *Trichoderma viz., harzianum* and *viride* for the management of wilt disease in cumin.

Material and methods
The field experiment in eco-friendly management was conducted during *rabi* 2019-20 at Agronomy farm, S. D. A. U, C. P. College of Agriculture, Sardarkrushinagar.

Experimental details
Experimental site: Agronomy farm, S. D. Agricultural University, Sardarkrushinagar.
Crop: Cumin
Variety: GC-2
Year: *Rabi* 2019-20
Design of experiment: Randomized block design (RBD)
No. of treatments: 9 (Nine)
No. of replications: 3 (Three)
Plot size: Gross: 4.0 m × 3.6 m; net: 3.0 m × 2.4 m
Spacing: 30 cm row spacing

Method and observations recorded
The fungal bioagents were obtained from Department of Plant Pathology, College of Agriculture, Navsari Agricultural University, Navsari. Two species of *Trichoderma viz., harzianum* and *viride* were evaluated for their antagonistic activity against the test pathogen *Fusarium oxysporum* f. sp. *cumini*. The formulations contain 2×10^6 CFU of bioagent. Seeds were treated with *Trichoderma harzianum* and *Trichoderma viride* @ 10g/kg of seeds along with soil application of *Trichoderma viride* and *Trichoderma harzianum* @ 2.5 Kg in 1 t of FYM/ha and their combinations. The untreated seed as well as soil served as untreated control. The recommended agronomical practices were followed.
For the seed treatment, the cultures of fungal bio-control agents were individually grown on 2 per cent malt extract broth for 10 days. The mycelial mat along with the spores was separated by filter paper and dried over night at room temperatures. The dried cultures of each bio-control agent were macerated gently and mixed with equal amount of sterilized fine clay and water to make slurry. These mixtures were used for seed coating. The clay-based formulation of Antagonists *viz., T. harzianum* and *T. viride* was used as seed treatment. The seeds were treated at the rate of 10 g/kg of seed with test antagonist formulation before sowing. The weighed quantity of clay-based formulation of antagonists and seeds were taken in 100 ml flask and shaken thoroughly to give uniform coating of formulation on the seeds.
For the soil application, the culture of bio-control agents was prepared on sorghum grain medium. The sorghum grains were soaked overnight in 5 per cent sucrose and chloramphanical (30 mg/L) solution. The soaked seeds were then transferred to conical

flasks, were sterilized in autoclave, twice at 1.5 kg/cm^2 pressure at 121 ^{0}C for 20 minutes. Then the flasks were inoculated with each antagonist separately and then incubated in B. O. D incubator at 28 ± 1 ^{0}C for 10 days. The flasks were shaken periodically for uniform growth of bio-control agents. After the establishment of inoculum of bio-control agents, the sorghum grains were grounded and finally the powdered grains were mixed with soil for soil treatment of bio-control agents, at the time of seed sowing. The observations on disease incidence were recorded regularly at 10 days interval after sowing. The final data was recorded for healthy and wilted plants, and disease incidence (%) was calculated by using the formula:

$$Disease\ incidence = \frac{Number\ of\ plants\ wilted}{Total\ number\ of\ plants\ examined} \times 100$$

Disease reduction over control or per cent disease control (PDC) with the treatments, over untreated control was calculated by applying following formula:

$$PDC\ (Per\ cent\ disease\ control) = \frac{C - T}{C} \times 100$$

Where,
C = Wilt disease incidence in untreated control plot
T = Wilt disease incidence in treatment plot

Seed yield

The crop was harvested after 120 days when the seeds were matured and dried enough to be separated by threshing. The seeds were cleaned and plot-wise yield was recorded. The yield per hectare was calculated and these data were subjected to statistical analysis.

Statistical analysis

Analysis and interpretation of the experimental data was done by employing randomized block design (RBD). Before analyzing the data, per cent values were converted into arcsine values. The data on disease incidence and per cent disease control were analyzed. Standard error (SE) and critical difference (CD) at 5% level of significance were worked out. The treatment means were compared at 5% level of significance.

Results

Nine different treatments with the antagonists *viz.*, *Trichoderma viride* and *Trichoderma harzianum* were evaluated under field conditions as soil application and seed treatment at the rate of 2.5 Kg in 1 t of FYM/ha and 10 g/kg seeds, respectively. The treatments were selected on the basis of effectiveness of different isolates of *Trichoderma viride* and *Trichoderma harzianum* under *in vitro* condition study and the results are presented in table 4.8. The results of field experiments indicated that the per cent disease incidence of wilt was significantly lower in all the treatments as compared to untreated control (Plate I).

Among the treatments, soil application of *T. viride* + seed treatment with *T. harzianum* was observed to be the most effective as it recorded the highest per cent disease control (90.52%) with the least per cent disease incidence (6.03%) and the highest seed yield of 420 Kg/ha, which was followed by soil application *T. harzianum* + seed treatment with *T. harzianum*, which recorded 83.51 per cent disease control with 10.49 per cent disease incidence and seed yield of 387 Kg/ha. The soil application of *T. viride* + seed treatment with *T. viride* was recorded 12.77 per cent disease incidence, 79.93 per cent disease control and seed yield of 365 Kg/ha and was statistically at par with the soil application of *T. harzianum* + seed treatment with *T. viride* with 13.18 per cent disease incidence and 79.28 per cent disease control with seed yield of 358 Kg/ha, respectively. The remaining treatments also showed significantly lower wilt incidence and higher seed yield *viz.*, seed treatment with *T. harzianum* (15.54%, 316 Kg/ha), seed treatment with *T. viride* (17.85%, 264 Kg/ha), soil application of *T. viride* (16.92%, 295 Kg/ha) and soil application of *T. harzianum* (21.75%, 228 Kg/ha), respectively. The highest disease incidence of 63.63 per cent was recorded in untreated control with the lowest seed yield of 196 Kg/ha (Table 2, Plate I & II and Fig. 1).

Discussion

The two different fungal biocontrol agents used in this study showed a significant reduction in per cent disease incidence and also increasing the seed yield. The seed treatment with *Trichoderma viride* 6-8 g/kg was found effective in controlling wilt disease in cumin (Bhatnagar *et al*., 2013) [4].

The seed treatment @ 10 g/kg and soil application @ 2.5 kg/ha with *Trichoderma viride* were the most effective in controlling wilt in cumin (Sharma *et al*., 2015) [11]. Jat *et al*., (2017) [7] reported that the seed treatment with *T. harzianum* was found to be the most effective in controlling wilt in coriander. So the present findings are in conformity with the work done by the earlier workers.

Table 1: List of treatments for eco-friendly management of wilt disease in cumin

Sr. No.	Treatment
T_1	Seed treatment with *Trichoderma harzianum* [ST (TH)]
T_2	Seed treatment with *Trichoderma viride* [ST (TV)]
T_3	Soil application of *Trichoderma harzianum* [SA (TH)]
T_4	Soil application of *Trichoderma viride* [SA (TV)]
T_5	Soil application of *Trichoderma harzianum* + Seed treatment with *Trichoderma harzianum* [SA (TH) + ST (TH)]
T_6	Soil application of *Trichoderma viride* + Seed treatment with *Trichoderma harzianum* [SA (TV) + ST (TH)]
T_7	Soil application of *Trichoderma viride* + Seed treatment with *Trichoderma viride* [SA (TV) + ST (TV)]
T_8	Soil application of *Trichoderma harzianum* + Seed treatment with *Trichoderma viride* [SA (TH) + ST (TV)]
T_9	Untreated control

Table 2: Effect of different treatments on wilt disease Incidence, disease reduction over control and yield of cumin under field conditions

Sr. No.	Treatment	**Wilt incidence (%)	Disease reduction over control (%)	Yield (Kg/ha)
1.	[ST (TH)]	23.13^{cd} (15.54)	75.57	316^{e}
2.	[ST (TV)]	24.85^{c} (17.85)	71.94	264^{g}
3.	[SA (TH)]	27.75^{b} (21.75)	65.81	228^{h}
4.	[SA (TV)]	24.26^{c} (16.92)	73.40	295^{f}
5.	[SA (TH) + ST (TH)]	18.84^{e} (10.49)	83.51	387^{b}
6.	[SA (TV) + ST (TH)]	14.05^{f} (06.03)	90.52	420^{a}
7.	[SA (TV) + ST (TV)]	20.87^{de} (12.77)	79.93	365^{c}
8.	[SA (TH) + ST (TV)]	21.19^{de} (13.18)	79.28	358^{d}
9.	Untreated control	53.06^{a} (63.63)		196^{i}
	S. Em. ±	0.93	1.86	
	C.D at 5%	Significant	Significant	
	C.V.%	6.41	6.67	

**Average of three replications

Figures in the parenthesis are re-transformed values of Arc-sign transformation Treatment means with the letter(s) in common are not significant by Duncan's New Multiple range test at 5 per cent level of significance

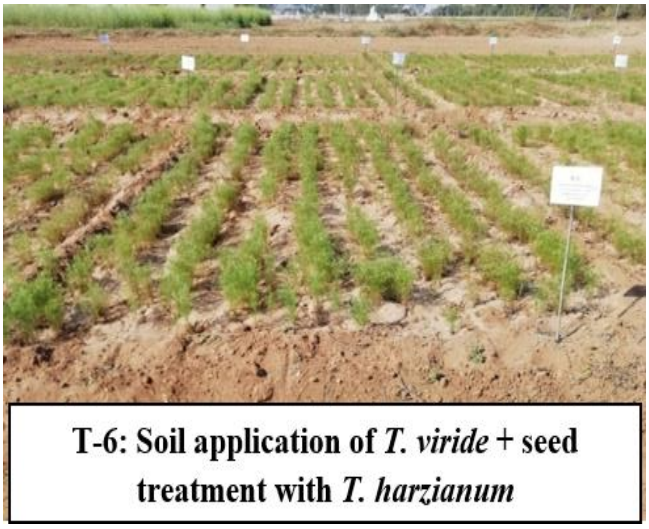
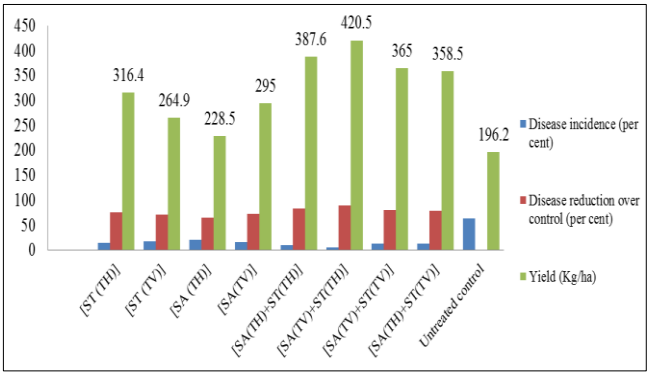


Plate I: Best treatment for eco-friendly management of cumin wilt

Plate II: Field view of eco-friendly management of Fusarium wilt in cumin



*X –axis: Treatment
*Y –axis: Series 1 –Per cent disease incidence
Series 2 –Per cent disease reduction over control
Series 3 -Yield (Kg/ha)

Fig 1: Effect of different treatments on wilt disease incidence, disease reduction over control and yield of cumin under field conditions

Conclusion

Results obtained in the present investigation concluded that, compared to untreated control plot reduction in per cent disease incidence and increased yield was observed in treated plots with *Trichoderma viride* and *Trichoderma harizianum*. Among the nine treatments studied, the treatment that is soil application of *Trichoderma viride* + seed treatment with *Trichoderma harzianum* was observed to be the most effective as it recorded the highest per cent disease control (90.52%) with the least per cent disease incidence (6.03%) and highest seed yield of 420 Kg/ha. Hence these fungal biocontrol agents are the useful tools to reduce wilt disease incidence and increasing yield in a sustainable and eco-friendly way

References

1. Aghnoom R, Falahati Rastegar M, Jafarpour B. Comparison of chemical and biological control of cumin wilt (*Fusarium oxysporum* f. sp. *cumini*) in laboratory and greenhouse conditions. Iranian Journal of Agricultural Science. 1999; 30:619-630.
2. Anonymous. Production of cumin seed India 2018-2019 by state. Spice board of India. *Statista Research Department*, 2020, 1-3.
3. Bardia PK, Rai PK. *In vitro* and field evaluation of biocontrol agents and fungicides against wilt of cumin caused by

Fusarium oxysporium f. sp. cumini. Journal of Spices and Aromatic Crops. 2007; 16(2):88-92.
4. Bhatnagar K, Tak SK, Sharma RS, Majundar VL, Meena R L. Management of cumin wilt caused by *Fusarium oxysporum* f. sp. *cumini* through chemical and biological agents. Indian Phytopathology. 2013; 66(1):101-102.
5. Deepak P, Saran L, Lal G. Control of wilt and Blight Diseases of cumin through Antagonistic fungi under *in vitro* and field conditions. *Natulae Botanicae Horti Agrobotanici Cluj-Napoca.* 2008; 36(2):91-96.
6. Divakar sastry EV, Anandaraj M. Soils, plant growth and crop production-Cumin, Fennel and Fenugreek. Encyclopedia of Life Support System, 2013.
7. Jat MK, Ahir RR, Choudhary S, Kakraliya GL. Management of coriander wilt using biocontrol agents. International Journal of Chemical Studies. 2017; 5(2):523-525.
8. Madhavi M, Chandra Kumar CP, Raja Ram Reddy D, Singh TVK. Integrated management of wilt of chilli incited by Fusarium solani. Indian Journal of Plant Protection. 2006; 34(2):225-228.
9. Nikam PS, Jagtap JP, Sontakke PL. Management of chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri*. African Journal of Agricultural Research. 2007; 2(12):692-697.
10. Senthil P, Balabaskar P. Effect of antagonists in combination with organic amendments on growth and wilt incidence of tomato. Journal of Mycology and Plant Pathology. 2007; 37(1):187.
11. Sharma YK, Lodha SK, Sriram S, Ramanujam B. Comparative efficacy of biological control agents for the management of cumin wilt caused by Fusarium oxysporum f. sp. cumini. Journal of Spices and Aromatic crops. 2015; 24(1):18-22.
12. Singh PK, Kumar V. Biological control of Fusarium wilt of chrysanthemum with Trichoderma and Botanicals. Journal of Agricultural Technology. 2011; 7(6):1603-1613.
13. Wafaa M, Haggag, Abo-Sedera SA. Characteristics of three Trichoderma species in Pea nut Haulms compost, involved in biocontrol of cumin wilt disease. International Journal of Agriculture and Biology. 2005; 7(2):222-229.