Biological Forum – An International Journal **13(1): 506-510(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Bio-Efficacy of *Trichoderma viride* 1.15 % WP (Bio Cure-F) Against Wilt Disease of Chilli Caused by *Fusarium oxysporum* f. sp. *capsici* under Field Condition

H. Nazneen[1], S. Patar[1] and R. Das [2*]

[1]Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.
[2]Regional Research Sub-Station (R & L Zone), Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Sekhampur, Birbhum, West Bengal, India.

(Corresponding author: R. Das)*
(Received 19 February 2021, Accepted 08 May, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: *Fusarium oxysporum* f. sp. *capsici*, the causal organism of fusarium wilt of chilli is one of the destructive disease, which causes huge loss in chilli production. Wilt disease generally caused by soil borne pathogens, cannot be managed efficiently through chemical fungicides. There are limited resistant germplasm available against wilt pathogen of chilli throughout the world. The pathogen has wide host range. These are the major challenges in the management of fusarium wilt of chilli. The exploitation of biological agents has been recognized as a feasible option alternative to synthetic chemicals in the disease management. Evaluation of the effects of *Trichoderma viride* 1.15 % WP formulation (Bio Cure-F) on chilli wilt disease and investigation of the effect on the yield components and yield of chilli plants has been conducted in the present study. The field experiment was setup at Regional Research Sub-Station (R & L Zone), Bidhan Chandra Krishi Viswavidyalaya (BCKV), Sekhampur, Birbhum, West Bengal, India during *Rabi*, 2016-17 and *Rabi*, 2017-18. For effective and eco-friendly use of *Trichoderma viride* (Bio Cure-F) 1.15 % WP as seed treatment @ 5 g /kg of seeds and seedling dip @ 5 g/l of water and soil application @ 3 kg / ha at the time of transplanting and at the time of flowering recorded the efficient disease reduction (62.45 %) and yield increase (54.78 %). Soil application @ 3 kg / ha at the transplanting time and at the time of flowering recorded the disease reduction (48.36 %) and yield increase (38.28 %).

Keywords: Bio-efficacy, Chilli wilt, *Trichoderma viride* 1.15 % WP

INTRODUCTION

India generally renowned as "The Home of Spices". Indian spices are well-known all over the world for their gastronic value possessing high medicinal values. Chilli (*Capsicum annum* L.), one of the most important spicy vegetable; belonging to the solanaceae family, is primarily grown for its spiciness, colour and pungency. It is a rich source of vitamins A and C (Rahman *et al*., 2011) and is used in cosmetics, beverages and medicines. Currently, India leads the world in production, consumption and export of chilli, contributing almost 25% of the total chilli exports. It produces 1.49 million tonnes of chillies from 0.77 million hectare land and 1.92 MT/ha of productivity (Anonymous 2014). In West Bengal, Chilli grown in an area of 63.6 thousand hectares (8.21 per cent) with a total production of 100 thousand tonnes (6.70 per cent) and the productivity was 1.57 tonnes per hectare (Anonymous 2014). Chilli production is minimized due to several constraints like continuous monoculture, lack of new generation technologies adopted by the farmers, use of poor quality seeds, adverse climate, deprived soil conditions, pests and various pathogenic fungal, bacterial and viral diseases (Abdel-Monaim 2012). Fusarium wilt of chilli incited by *Fusarium oxysporum* f. sp. *capsici* is one of the most destructive disease, which causes great loss in chilli production. The wilt pathogen attacks the plants from initial seedling stage to harvesting stage, infecting mainly the plant root system, and thereby, limiting water and nutrient transport (Miller *et al*., 1996) and subsequently disturbing the physiological processes essential for satisfactory production and quality (Morid *et al*., 2012). Characteristic disease symptoms includes yellowing of leaves, stunted growth and gradually the whole plant turns brown in colour (Alegbejo *et al*., 2006) exhibiting deteriorated vascular flow system by pathogen obstruction (El-Kazzaz *et al*. 2008). The pathogen is systemic, soil-borne in nature and continue to exist in the absence of host by forming chlamydospores (resting spores), which persists in the soil for many years and can also resist high temperatures making the pathogen thermophilic and cumbersome to diagnose and manage (Astrom and Gerhardson 1988). Moreover, there are

limited resistant sources available against this pathogen in the germplasm of chilli throughout the world. Exploitation of biocontrol agents, particularly *Trichoderma* spp., has been proven to be highly competent in managing diseases in different crops (Reena *et al*., 2013) as they have wider flexibility, rapidly growing and broad antibiotic spectrum. It activates induced resistance in plants and stimulates their growth and development through rhizospheric competition, mycoparasitism or antibiotic and enzyme production (Harman *et al*., 2004). It penetrates the cells of the pathogen by using cell wall degrading enzymes like chitinases and β-1, 3 glucanases (Harman, 2000). It also induces defense related enzymes in plants and thus reduce incidence of wilts, root rots, damping off and other soil-borne diseases (Abd-El-Khair *et al*., 2019). Thus keeping in view the importance of *Trichoderma* spp. in effective and eco-friendly strategy for disease management, the present investigation was carried out to evaluate the effectiveness of *Trichoderma viride* 1.15 % WP formulation (Bio Cure-F) in controlling the Fusarium wilt disease of chilli.

MATERIALS AND METHODS

Bio-efficacy trial was taken up to test the effectiveness of *Trichoderma viride* 1.15 % WP formulation (Bio Cure-F) supplied by M/s T. Stanes & Company Private Limited, Coimbatore, Tamil Nadu in managing *Fusarium oxysporum* f. sp. *capsici* responsible for wilt disease in chilli crop. The field experiment was conducted in a randomized block design with seven treatments and three replications in subtropical climatic condition of West Bengal at Regional Research Sub-Station (R & L Zone), Bidhan Chandra Krishi Viswavidyalaya, Sekhampur, Birbhum, West Bengal, India during *Rabi*, 2016-17 and *Rabi*, 2017-18. The crop was maintained with judicial irrigation and all the agronomic practices and fertilizer schedule were followed as per standard procedures.

Crop/variety	**:**	**Chilli (Variety Bullet)**
Design	:	RBD
Plot size	:	5 × 4 sq m
Spacing	:	60×45 cm
Treatment		Seven
Replication	:	Three

B. Assessment of disease

The disease incidence was assessed using the following formula:

$$PDI = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Treatment No.	**Treatment**	**Dose (kg/ha)**	**Dosage and Methods of application**
T_1	*T. viride 1.15 %* WP	2 kg / ha	Soil application at the time of transplanting and second application at the time of flowering)
T_2	*T. viride 1.15 %* WP	3 kg / ha	Soil application at the time of transplanting and second application at the time of flowering
T_3	*T. viride 1.15 %* WP	5 g / kg of seeds	Seed treatment
T_4	*T. viride 1.15 %* WP	5 g/ per lit	Seedling dip
T_5	*T. viride 1.15 %* WP	5 g/ Kg seeds + 5 g / lit of water + 3 kg / ha	Seed treatment + Seedling dip +Soil application at the time of transplanting and second application at the time of flowering
T_6	Carbendazim 50 % WP	0.2%	Seedling dip @ 0.2% + Soil drenching at 15 and 30 DAT @ 0.2%
T_7	Control		-

(a) (b)

Fig. 1. (a) Wilt disease in chilli crop (b) Loss of turgidity in wilt infected plant.

RESULTS AND DISCUSSION

A. Wilt incidence

Among the treatments, *T. viride 1.15 %* WP when applied as seed treatment + seedling drip + soil application (5 g/ Kg seeds + 5 g per lit water + 3 kg / ha respectively) recorded the second lowest wilt incidence of 15.5 per cent which was significantly different from untreated control (41.3%) depicted in (Table 1). In case of chemical control, Carbendazim 50 % WP @ 0.2% as seed and soil application recorded the lowest wilt incidence 10.3 per cent. *T. viride 1.15 %* WP applied as seed treatment + seedling drip + soil application (5 g/ Kg seeds + 5 g per lit water + 3 kg / ha respectively) was found superior to other eco friendly treatments. Observation on the incidence of wilt disease revealed that, soil application of *T. viride 1.15 %* WP at 15 and 30 DAT @ 3 kg/ha (T_2) recorded the wilt incidence of 21.3 per cent followed by soil application of *T. viride 1.15 %* WP at 15 and 30 DAT @ 2 kg/ha (T_1). *T. viride 1.15 %* WP applied as seedling dip @ 5 gm / lit water (T_4) and *T. viride 1.15 %* WP applied as seed treatment @ 5 gm / kg seed (T_3) recorded lesser wilt incidence of 30.3 and 34.3 percent respectively. The observations are in agreement with the findings that seedling treatment with 1% talc based formulation of *Trichoderma viride* and *Trichoderma harzianum* was found highly significant in managing wilt disease incidence in chilli under field and glass house conditions (Ankita Sinha *et al*., 2018). There is an increased sporulation of *Trichoderma* spp. around the hyphae of *Fusarium* spp. and other phytopathogens causing a decrease in the pathogen population (Arshi Jamil *et al*., 2020).

B. Plant growth and yield attributing characters

Growth and yield attributing parameters *viz*., plant height, stem diameter, number of leaves/plant, number of branches/plant, number of fruits/plant, weight of fruit (g/plant) were recorded in the two season field trials. The growth and yield attributing characters of chilli were increased in the application of *T. viride 1.15 %* WP powder formulation as compared to untreated control under field condition.

In the field trial, *T. viride 1.15 %* WP applied as seed treatment + seedling drip + soil application (5 g/ Kg seeds + 5 g per lit water + 3 kg / ha respectively) recorded the highest plant height (96.67 cm), stem diameter (2.05 cm), number of branches (9.11/plant) in chilli compared to other treatments (Table 2). Control plants recorded only 86.00 cm of plant height, 1.42 cm of stem diameter, 8.44 number of branches/plant. It was observed that powder formulation of *T. viride 1.15 %* WP (Bio Cure –F) significantly increased the number of fruit per plant and fruit yield of chilli under field conditions. Among the treatments, *T. viride 1.15 %* WP applied as seed treatment + seedling drip + soil application (5 g/ Kg seeds + 5 g per lit water + 3 kg / ha respectively) recorded the highest fruit yield of 15.84 t/ha which was followed by soil application of Bio-cure –F at 15 and 30 DAT @ 3 kg/ha (T_2) with 14.15 t/ha (Table 3). Chemical treatment i.e. Carbendazim 50 % WP recorded the yield of 16.58 t/ha. The lowest fruit yield of 10.25 t/ha was recorded in the untreated control plants. It was in the line of findings that *Trichoderma* spp. augmented plant growth in crops such as tomato, cucumber, cacao and beans ((Macias- Rodriguez *et al*. (2018). This may be related to the fact that *Trichoderma* spp. colonize the plant roots and secretes chemical stimulants acting as endophytic symbionts beneficial for the plants. The plant growth-promoting effects along with biocontrol and bio-stimulant properties have crucial role in increased plant yield (Harman *et al*. 2012) and are known to mitigate abiotic stress in plants and boost their nutrient uptake (Saba *et al*. 2012) by solubilization of the soil phosphorus and through production of siderophores (Li *et al*. 2018).

Table 1: Effect of *Trichoderma viride* 1.15% WP (Bio Cure –F) against wilt disease of chilli.

S. No.	Treatments	Wilt Incidence		
		Percent disease incidence*		Percent disease control
1.	*T. viride 1.15 %* WP as soil application @ 2 kg / ha	26.5	(31.0)	35.66
2.	*T. viride 1.15 %* WP as soil application @ 3 kg / ha	21.3	(27.5)	48.36
3.	*T. viride 1.15 %* WP as seed treatment @ 5 gm/ kg seeds	34.3	(35.8)	16.97
4.	*T. viride 1.15 %* WP as seedling dip @ 5 gm / lit water	30.3	(33.4)	26.57
5.	*T. viride 1.15 %* WP as seed treatment + seedling dip + soil application (5 gm / kg seeds + 5 gm per lit water + 3 kg / ha)	15.5	(23.2)	62.45
6.	Carbendazim 50% WP@ 0.2%	10.3	(18.7)	75.08
7.	Control	41.3	(40.0)	
	CD (P=0.05)	**1.08**		
	CV(%)	**2.1**		

*Two years pooled data. Values in parentheses are arcsine-transformed values.

Table 2: Effect of *Trichoderma viride* 1.15 % WP (Bio cure –F) on plant growth promotion.

S. No.	Treatment details	*Pl. height (cm)	*Stem diameter (cm)	*No. of leaves/ plant	*No. of branches/ plant
1.	*T. viride 1.15 %* WP as soil application @ 2 kg / ha	92.67	1.82	482.33	8.95
2.	*T. viride 1.15 %* WP as soil application @ 3 kg / ha	93.67	1.90	491.00	9.00
3.	*T. viride 1.15 %* WP as seed treatment @ 5 gm/ kg seeds	88.33	1.58	451.67	8.65
4.	*T. viride 1.15 %* WP as seedling dip @ 5 gm / lit water	90.33	1.69	472.00	8.83
5.	*T. viride 1.15 %* WP as seed treatment + seedling dip + soil application (5 gm / kg seeds + 5 gm per lit water + 3kg / ha)	96.67	2.05	504.33	9.11
6.	Carbendazim @ 0.2%	90.00	1.70	465.00	8.79
7	Control	86.00	1.42	443.33	8.44
	CD (P=0.05)	**8.96**	**0.16**	**26.63**	**0.57**
	CV(%)	**5.79**	**5.39**	**3.32**	**3.78**

* Two years pooled data.

Table 3: Effect of *Trichoderma viride* 1.15% WP (Bio cure –F) on yield attributing characters of chilli.

S. No.	Treatment details	No. of Fruits / Plant*	Weight of fruits / plant (g)*	Yield (t / ha)*	Yield increase (%)
1.	*T. viride 1.15 %* WP as soil application @ 2 kg / ha	154.33	380.33	13.82	34.83
2.	*T. viride 1.15 %* WP as soil application @ 3 kg / ha	159.67	385.33	14.15	38.28
3.	*T. viride 1.15 %* WP as seed treatment @ 5 g/ kg seeds	147.67	362.00	11.65	13.66
4.	*T. viride 1.15 %* WP as seedling dip @ 5 g / lit water	151.33	371.67	12.54	22.34
5.	*T. viride 1.15 %* WP as seed treatment + seedling dip + soil application (5 g / kg seeds + 5 g per lit water + 3kg / ha)	162.00	389.67	15.84	54.78
6.	Carbendazim 50 % WP @ 0.2%	165.67	401.67	16.58	61.76
7.	Control	142.00	351.67	10.25	0.00
	CD (P=0.05)	**7.15**	**10.33**	**1.38**	
	CV(%)	**2.72**	**1.61**	**4.3**	

*Two years pooled data.

CONCLUSION

Application of powder formulation of *Trichoderma viride* 1.15 % WP (Bio Cure- F) as seed treatment @ 5 g /kg of seeds and seedling dip @ 5 g/l of water and soil application @ 3 kg / ha at the time of transplanting and at the time of flowering recorded the effectual disease reduction and yield increase. Findings of the present experiment demonstrated a potential approach of biological control of wilt disease of chilli. Results of this work could be used as valuable, promising and eco-friendly strategy for the management of *Fusarium* wilt of chilli.

FUTURE SCOPE

Biological control through the application of *Trichoderma* antagonists has been found to be promising in destruction of *Fusarium oxysporum* f. sp. *capsici* inoculum causing wilt of chilli. In the absence of resistant cultivars, use of such potential bio-agents would go a long way in the near future in managing fusarium wilt thus favoring sustained chilli production in infested fields. The biocontrol technology is eco-friendly and free from environmental hazards since it avoids soil application of chemical to manage such soil borne disease.

REFERENCES

Abd-El-Khair, H., Elshahawy, I.E., Haggag, HEK. (2019). Field application of *Trichoderma* spp. combined with thiophanate-methyl for controlling *Fusarium solani* and *Fusarium oxysporum* in dry bean. *Bull. Nat. Res. Cent.*, **43**: 19.

Abdel-Monaim, M.F. (2012). Induced systemic resistance in tomato plants against *Fusarium* wilt diseases. *Int. Res. J. Microbiol.*, **3**: 14–23.

Alegbejo, M., Lawal, A., Chindo, P., Banwo, O. (2006). Outbreak of basal stem rot and wilt disease of pepper in Northern Nigeria. *J Plant Protect Res.*, **46**: 7–13

Ankita, S., Harshita, R.S. and Ankur, V. (2018). Bioefficacy of *Trichoderma harzianum* and *Trichoderma viride* against *Fusarium oxysporum* f. sp. *capsici* causing wilt disease in chilli. *Journal of Pharmacognosy and Phytochemistry*, **7(5)**: 965-966.

Anonymous (2014). Directorate of Economics and Statistics and National Horticulture Board, Ministry of Agriculture, Government of India, New Delhi.

Anonymous (2014). Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi.

Astrom, B., Gerhardson, B. (1988). Differential reactions of wheat and pea genotypes to root inoculation with growth-afecting rhizosphere bacteria. *Plant Soil*, **109**: 263–269.

El-Kazzaz, M.K., El-Fadly, G.B., Hassan, M.A.A., El-Kot, G.A.N. (2008). Identifcation of some *Fusarium* spp.

using molecular biology techniques. *Egypt J Phytopathol.*, **36**: 57–69.

Harman, G.E. (2000). Myths and dogmas of biocontrol: changes in perceptions derived from research on *Trichoderma harzianum* T-22. *Plant Dis.*, **84**: 377–393.

Harman, G.E., Herrera-Estrella, A.H., Horwitz, B.A., Lorito, M. (2012). Special issue: *Trichoderma*-from basic biology to biotechnology. *Microbiology*, **158**: 1–2.

Harman, G.E., Howell, C.R., Viterbo, A., Chet, I., Lorito, M. (2004). *Trichoderma* species-opportunistic, avirulent plant symbionts. *Nat. Rev. Microbiol.*, **2**: 43–56.

Jamil, A., Musheer, N., & Ashraf, S. (2021). Antagonistic potential of *Trichoderma harzianum* and *Azadirachta indica* against *Fusarium oxysporum* f. sp. *capsici* for the management of chilli wilt. *Journal of Plant Diseases and Protection*, **128**(1), 161-172.

Li, Y.T., Hwang, S.G., Huang, Y.M., Huang, C.H. (2018). Effects of *Trichoderma asperellum* on nutrient uptake and *Fusarium* wilt of tomato. *Crop Protect*, **110**: 275–282.

Macias-Rodriguez, L., Guzman-Gomez, A., García-Juárez, P., Contreras Cornejo, H.A. (2018). *Trichoderma atroviride* promotes tomato development and alters the root exudation of carbohydrates, which stimulates fungal growth and the biocontrol of the phytopathogen *Phytophthora cinnamomi* in a tripartite interaction system. *FEMS Microbiol. Ecol.*, **94**: 1–11.

Miller, A.S., Rowe, R.C., Riedel, R.M. (1996). Fusarium and verticillium wilts of tomato, potato, pepper, and eggplant. The Ohio State University, Columbus, pp 1–3

Morid, B., Hajmansoor, S., Kakvan, N. (2012). Screening of resistance genes to *Fusarium* root rot and *Fusarium* wilt diseases in tomato (*Lycopersicon esculentum*) cultivars using RAPD and CAPs markers. *Euro J Exp Biol.*, **2**: 931–939

Rahman, M.M., Rahman, S.M.M., Akter, A. (2011). Comparative performance of some insecticides and botanicals against chilli fruit borer (*Helicoverpa armigera*). *J. Exp. Sci.*, **2**: 27–31

Reena, A., Anitha, M., Aysha, O.S., Valli, S., Nirmala, P., Vinoth kumar, P. (2013). Antagonistic activity of *Trichoderma viride* isolate on soil borne plant pathogenic fungi. *Int J Bioassays*, **2**: 294–297

Saba, H., Vibhash, D., Manisha, M., Prashant, K.S., Farhan, H., Tauseef, A. (2012). *Trichoderma*: a promising plant growth stimulator and biocontrol agent. *Mycosphere*, **3**: 524–531.

How to cite this article: Nazneen, H., Patar, S. and Das, R. (2021). Bio-Efficacy of *Trichoderma viride* 1.15 % WP (Bio Cure-F) Against Wilt Disease of Chilli Caused by *Fusarium Oxysporum* F. sp. *Capsici* under Field Condition. *Biological Forum – An International Journal*, **13**(1): 507-511.