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Eco Friendly Management of Fusarium Wilt of Chickpea with Botanicals and Bio Agents

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ABSTRACT: The field experiment to determine "Eco-friendly management of Fusarium wilt of chickpea caused by *Fusarium oxysporium* f.sp. (*Ciceri arietinum* L.) in Vindhyan Plateau of Madhya Pradesh" during ravi season in the year 2020-21 to 2021-22 was conducted at the Agricultural Research Center, Ravindranath Tagore University, Raisen, Madhya Pradesh. The present investigation tests were carried out for the management of fusarium wilt using botanicals and bio-agent, against fusarium wilt and readings were taken growth parameters, yield attributes, yield and the percentage of disease incidence in chickpea. Among the treatments, soil application with *Trichoderma harzianum* @ 5g/kg seed + 2 foliar spray with datura leaf extract 10 % were found most effective in the percentage of disease control in chickpea. Followed by *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with garlic extract 10 % as compared to control. The maximum plant height, dry shoot weight, dry root weight and yield were found in application of *Trichoderma harzianum* @ 5g/kg seed + 2 foliar spray with datura leaf extract 10 %. Thus, fusarium wilt could be managed by the integrated of various approach like, application of botanicals sources and bio-agent.

Keywords: Bio-agents, botanicals, chickpea, *Fusarium oxysporum*, yield.

INTRODUCTION

Chickpea, also called garbanzo bean or Bengal gram, is a self-pollinated, annual diploid (2n = 2x = 16) species. The Cicer genus belongs to the family Leguminoseae, sub-family Papilionaceae and tribe Cicereae. It is composed of 9 annual and about 34 perennial wild species. Chickpea has the ability to increase the soil fertility, particularly in dry lands, by fixing atmospheric nitrogen (N). It is mainly used for human consumption and is an essential constituent of the Mediterranean diet and a basic food in India (Millan *et al*., 2010). Chickpea is high in protein, low in fat and sodium, cholesterol free and is an excellent source of both soluble and insoluble fiber, as well as complex carbohydrates, vitamins, folate, and minerals, especially calcium, phosphorous, iron, and magnesium (Roy *et al.,* 2010). One major limiting factor is susceptibility of cultivars to several biotic and abiotic stresses that adversely affect yield, particularly fungal diseases (Ascochyta blight and Fusarium wilt), pests (pod borer) and drought or cold stress. Parasitic plants could also be a serious problem in particular environments such as under Mediterranean condition (Singh *et al.,* 2014). The development of cultivars resistant to major diseases is one of the most important objectives of chickpea breeding programs. In recent years, cultivars resistant to Ascochyta blight, Fusarium wilt and cold have been bred and released in many countries (Singh *et al.,* 2017). Wilting is most likely caused by a combination of pathogen activities. These include accumulation of fungal mycelium in the xylem and/or toxin production, host defence responses, including production of gels, gums and tyloses and vessel crushing by proliferation of adjacent parenchyma cells (Beckman and Mahajan 2016). Wilt is one of the major soil or seed borne disease of chickpea (*C. arietinum* L.). The pathogen is both seed and soil borne, facultative saprophyte and can survive and in soil up to six years in the absence of a susceptible host (Haware *et al*., 1986). The use of chemicals has been believed to be a rapid and potential control measure against fungal diseases (Poussio *et al.,* 2021). Compost tea as foliar spray in case of potato and as soil drenching in tomato may be the best alternative approach to control late blight of potato and tomato with higher economic return (Islam *et al.,* 2013).

The spores of fungus enters the vascular system of plant via the roots. It produces enzymes that obstruct cell wall and block the plant's transport system. Bio-agent and botanicals belonging to various groups recommended for the management of fusarium wilt. Generally, farmers are using only the chemicals for managing the disease, but it has negative impact on the environment as well as develops resistant in the pathogen. Considering the effects of this disease, the present paper discusses the efficacy of *Trichoderma* sp. and botanicals for the management of fusarium wilt.

MATERIALS AND METHODS

The Field experiment was conducted at Agricultural Research Farm, Rabindranath Tagore University, Raisen, and M.P. during Ravi season 2020-21 and 2021-22. The geographical position of experimental filed at 23.134273°N latitude and 77.564305°E latitude. The total rainfall of 131.30 mm was received during the

wheat crop growth period of first (2020-21) year, was higher (46.30 mm) than second (2021-22) year. The weekly mean minimum temperature was ranged from 6.2 to 20.90 C with an average of 12.8 ℃ in 2020-21, and 7.2 to 23.10 C with a range with an average of 13.6 ℃ in 2021-22 during wheat crop season, respectively. The soil characteristics of the region are vertisols of various depth from medium to deep and slightly alkaline in soil reaction and low availability of nutrient status in term of nitrogen and phosphorus. All the bio-agents were collected from Bio-control Laboratory, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Efficacy of all the bio-agents was tested by Double culture technique and mycelia growth of pathogen will be recorded at different day's interval. Inhibition (%) will be calculated by given formula: by Bliss (1934).

$$\text{Inhibition (\%)} = \frac{C - T}{C} \times 100$$

Whereas,

T= Radial growth of pathogen on treated plates
C=Radial growth of pathogen on untreated plates

Eight bio-agent combinations, *viz*., T_1 *Trichoderma viride* @ 5g/kg seed + 2 Foliar spray with garlic extract, $T_2$10 %, *Trichoderma viride*@ 5g/kg seed + 2 Foliar spray with neem leaf extract, $T_3$10 %, *Trichoderma viride*@ 5g/kg seed + 2 Foliar spray with Tulsi Leaf extract T_4 10 %, Trichoderma viride@ 5g/kg seed + 2 Foliar spray with Datura Leaf extract, T_5 10 %, *Trichoderma harzianum*@ 5g/kg seed + 2 Foliar spray with garlic extract, T_6 10 %, *Trichoderma harzianum*@ 5g/kg seed + Foliar spray with neem leaf extract, T_7 10 %, *Trichoderma harzianum*@ 5g/kg seed + 2 spray with Tulsi Leaf extract, $T_8$10 %, and *Trichoderma harzianum*@ 5g/kg seed + 2 Foliar spray with Datura Leaf extract 10 % by using dual culture technique (Morton and Strouvle 1955). The cultures of test fungi and antagonists were multiplied on potato dextrose agar medium. A 5 mm disc of test fungus and the antagonists cut from the edge of a seven-day-old culture plate were placed in such a manner that the test fungus was placed before 72 hours of bio-agent placement on potato dextrose agar medium in Petri plates. The test fungus and bio- agent were placed opposite each other at a distance of 5 mm from the periphery of the Petri plate. The same disc of the test fungus was placed alone on only one side of the PDA plates as a control. Each treatment was replicated three times and incubated at 25±1^{O}C. The data were recorded after seven days of bio-agent placement, when the inhibition.

RESULTS AND DISCUSSION

A. Plant height and dry shoot weight

The data related to plant height as affected by bio-agent at different day's interval was presented in Table 1. Significantly maximum plant height recorded under the application of *Trichoderma harzianum* @ 5g/kg seed + 2 foliar spray with Datura leaf extract 10 % followed by *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with garlic extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with garlic extract, 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with neem leaf extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with Tulsi leaf extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with datura leaf extract 10%, *Trichoderma harzianum* @ 5g/kg seed +2 foliar spray with garlic extract compared to control respectively, during both of the experimental year of 2019-20 and 2021 at all the stage such as 30, 60 and 90 day after application. These results were similar to the finding of Animisha *et al.* (2012) that *in vitro* condition (dual culture technique) *Trichoderma viride* was highest inhibiting the growth of *Fusarium oxysporum* f. sp. ciceris. After that carbendazim it was neem cake at concentrations 7% followed by 5 and 3% in that order which give maximum inhibition of test pathogen under field condition. Lowest percentage of incidence of wilt (19.0%) was found with *T. viride* (T2) followed by carbendazim (21.0%), neemcake (42.6%), carbendazim + neem cake (45.2%), carbendazim + *T. viride* (47.2%), neem cake +*T. viride* (48.2%). Similar results were reported by Vishwapal *et al.* (2013); Mahmood *et al.* (2015). These findings were comparable to those of Abdulle *et al.* (2022) in that *Trichoderma viride* had the highest dry shoot weight and dry root weight and outperformed all other treatments.

B. Effect of treatments on disease incidence (%)

Observation on the incidence of wilt disease was highest in the control plot at 30 days after sowing, which was 20.14%, while it was lowest in *Trichoderma harzianum* @5g/kg seed + 2 foliar sprays with datura leaf extract 10 %, which was 4.40%. Following rest treatments, it was at par but not significantly different from *Trichoderma viride* @ 5 g/kg seed + 2 foliar sprays with garlic extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar sprays with garlic extract 10 % and *Trichoderma viride* @ 5g/kg seed + 2 foliar sprays with neem leaf extract 10 % during 2020- 21. Data was collected on 60 DAS, and the minimum disease incidence was observed from *Trichoderma harzianum* @ 5g/kg seed + 2 foliar spray with datura leaf extract (10%) treated plotted at 7.60 percent, and it was at par with other treatments. *Trichoderma viride* @ 5g/kg seed + 2 foliar sprays with garlic extract 10 % was in second place with a 9.47 percent disease incidence, but it was not significantly differ from *Trichoderma harzianum* @ 5g/kg seed + 2 foliar sprays with datura leaf extract 10 % and *Trichoderma viride* @ 5g/kg seed + 2 foliar sprays with garlic extract10 %. Data was recorded at 90 DAS, based on the treatment performance in ascending order as *Trichoderma harzianum* @ 5g/kg seed + 2 foliar spray with datura leaf extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with garlic extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with garlic extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with neem leaf extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with datura leaf extract 10%, *Trichoderma harzianum*@5g/kg seed+2 foliar spray with garlic extract 10 %, *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with Tulsi leaf extract 10 %, *Trichoderma harzianum* @ 5g/kg seed + 2 foliar spray with neem leaf extract 10%, and *Trichoderma harzianum*@ 5g/kg seed + 2 foliar spray with Tulsi

Leaf extract 10%, respectively and same tend was found in both of the years. Among the treatments, soil application with *Trichoderma viride* were found most effective in the percentage of disease control in chickpea.

Table 1: Effect of bio-agents on Plant height (cm).

Treatments	Plant height(cm)					
	2019-20			2020-21		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	7.40	16.27	39.23	7.17	15.60	36.17
T_2	7.33	15.37	38.63	7.00	15.50	35.93
T_3	7.17	14.30	37.83	6.73	15.27	35.77
T_4	6.97	14.07	36.83	6.57	15.13	35.60
T_5	6.90	13.93	36.43	6.27	14.90	35.57
T_6	6.67	13.80	35.60	6.07	14.87	35.10
T_7	6.47	13.67	34.90	18.34	5.77	14.73
T_8	6.40	13.37	32.83	17.53	5.60	14.53
T_9	6.27	12.80	25.10	14.72	5.13	12.60
CD at 5%	0.085	0.165	0.195	0.307	0.116	0.155
SE(m)	0.028	0.054	0.064	0.102	0.038	0.051

Note : T_1- *Trichoderma viride* @5g/kg seed + 2 foliar spray with garlic extract 10 %, T_2- *Trichoderma viride* @5g/kg seed + 2 foliar spray with neem leaf extract10 %, T_3- *Trichoderma viride* @ 5g/kg seed + 2 foliar spray with Tulsi leaf extract10 %, T_4- *Trichoderma viride* @ 5g/kg seed+ 2 foliar spray with datura leaf extract 10%, T_5- *Trichoderma harzianum* @5g/kg seed+ 2 foliar spray with garlic extract 10 %, T_6- *Trichoderma harzianum* @5g/kg seed+ 2 foliar spray with neem leaf extract10%, T_7- *Trichoderma harzianum*@5g/kg seed + 2 foliar spray with Tulsi Leaf extract 10 %, T_8- *Trichoderma harzianum* @5g/kg seed+ 2 foliar spray with Datura leaf extract 10 % and T_9 control.

Table 2: Effect of treatments on dry shoot weight.

Treatments	Dry shoot weight(g)					
	2019-20			2020-21		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	2.47	4.52	8.87	2.66	4.43	8.50
T_2	2.40	4.23	8.63	2.44	4.27	8.60
T_3	2.32	4.35	8.43	2.32	4.23	8.43
T_4	2.27	4.17	8.37	2.28	4.20	8.14
T_5	2.11	3.73	8.13	2.25	3.87	8.07
T_6	1.96	3.87	7.67	2.15	3.62	7.87
T_7	1.87	3.50	7.60	1.93	3.47	7.54
T_8	1.73	3.40	7.43	1.87	3.17	7.07
T_9	0.97	2.30	5.37	1.03	2.13	5.04
CD at 5%	0.073	0.161	0.108	0.115	0.122	0.098
SE(m)	0.024	0.053	0.036	0.038	0.04	0.032

Table 3 : Effect of treatment on percent disease incidence (%).

Treatments	Percent Disease Incidence (%)					
	2019-20			2020-21		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	4.40	7.60	12.17	4.23	7.70	13.50
T_2	4.80	11.40	14.17	5.30	9.27	15.60
T_3	5.67	9.47	14.93	6.17	8.97	17.93
T_4	5.47	6.53	16.63	7.87	14.57	17.50
T_5	5.83	10.87	19.10	8.17	13.60	20.33
T_6	7.50	14.27	28.40	10.33	18.07	29.03
T_7	9.10	17.50	34.90	12.47	19.90	35.27
T_8	10.60	19.50	36.53	15.13	23.60	38.40
T_9	13.25	25.57	42.37	16.87	26.93	45.17
CD at 5%	15.37	28.30	4.095	2.835	4.073	6.126
SE(m)	2.827	4.095	1.354	0.937	1.347	2.026

The data related to yield attributes and yield as affected by bio-agent at different day's interval was presented in Table 4. The significantly maximum yield attributes such as no. of pod/plant, number of grain /pod, test weight and yield (2985 kg/ha) recorded under the application of *Trichoderma harzianum* @ 5g/kg seed + 2 foliar sprays with datura leaf extract) flowed by *Trichoderma viride* @ 5g/kg seed + 2 foliar sprays with garlic extract 10%, respectively. Significantly lower yield attributes and yield noticed in control. Present funding support in fungicides effect on plant yield attributes and according to Khaliq *et al.* (2020) examined the influence of yield attributes and bio-agent treatments.

Table 4: Effect bio-agent treatments on yield attributes and yield of chickpea plant 2019-20 and 2020-21.

Treatments	No. of pod /plant		No. of grain/pod		Grain yield kg/ha		Straw yield kg/ha		Biological yield		Test weight (g)		Harvest index (%)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
T1	311.33	306.67	1.83	1.87	2985	3027	11.80	12.4	30.20	30.60	2985.10	3027.11	93.59	93.39
T_2	292.67	291.67	1.77	1.80	2842	2905	10.73	11.4	26.60	27.70	2842.09	2905.10	92.76	92.73
T_3	282.00	272.00	1.73	1.70	2712	2842	9.03	9.8	24.30	25.03	2712.08	2842.09	92.14	91.27
T_4	257.33	246.00	1.60	1.63	2650	2652	10.13	11.1	23.60	24.00	2650.06	2652.08	90.98	90.15
T_5	238.67	228.33	1.53	1.57	2534	2550	9.63	10.5	22.27	22.50	2534.05	2550.07	90.02	89.18
T_6	223.33	217.33	1.47	1.53	2451	2412	8.00	8.6	20.17	20.83	2451.04	2412.05	89.20	89.02
T_7	190.33	171.00	1.43	1.37	2358	2239	7.50	8.2	19.17	19.07	2358.03	2239.04	87.46	84.51
T_8	150.33	125.00	1.33	1.30	2257	2185	6.17	6.8	17.17	17.93	2257.03	2185.03	84.80	81.01
T_9	95.00	86.67	1.07	1.17	1405	1400	5.17	5.6	15.73	15.83	1405.02	1400.02	75.52	74.09
CD at 5%	0.941	1.275	0.074	0.060	3.320	3.542	0.444	0.466	0.330	5.62	-	-	-	-
SE(m)	0.311	0.422	0.024	0.020	1.098	1.171	0.147	0.154	0.109	5.36	-	-	-	-

CONCLUSIONS

The present study, it were found that bio- agent *Trichoderma viride* soil application were most effective against fusarium wilt, which causes wilt disease in chickpea. By using bio-agent and organic amendment, we can avoid use of harmful fungicides and prevent development of resistance in pathogen. Results of the present study was found to be significantly effective under Raisen agro-climatic conditions. It may vary with region and climatic conditions, therefore for validation of the results more such trials should be carried out in future.

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