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Study the compatibility of bioagent with fungicides

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Abstract
Significant higher shoot length was recorded in *T. viride* (20.7 mm) followed by *T. harzianum-5* (25 mm) compared to control (15.3 mm). Significant higher root length/plant was recorded in which *T. viride* (13.9 mm) was followed by *T. harzianum-5* (12.1 mm) as compared to control (8.2 mm). Significant higher fresh weight/plant was recorded in which *T. viride* (200g) was followed by *T. harzianum-5* (170 g) as compared to control (69 g). Significant higher dry weight/plant was recorded in which was *T. viride* (81g) followed by *T. harzianum-1* (69g) as compared to control (37 g). Significant increase the number of nodules per plant of lentil was found in *T. viride* (14.4) and *T. harzianum-5* (12.6) as compared to control(8.6) Significant highest yield of lentil was obtained in *T. viride* (655.20 kg/ha) followed by *T. harzianum-5* (452.52 kg/ha) and *T. harzianum-1*(450.36 kg/ha) as compared to control (258.3 kg/ha).Significant increase the number of pods per plant of lentil was found in *T. viride* (58.1) followed by *T. harzianum-5* (47.2) and *T. harzianum-2* (44.1) as compared to control (26.5). Significant the highest biomass of lentil per plot was obtained in *T. viride* (868.75 g) followed by *T. harzianum-5* (780.75 g) and *T. harzianum-1* (692 g) as compared to control(471 g). Carboxin +thiram significantly inhibited the growth of *F. oxysporum* f.sp. *lentis* (0.0mm) and *S. rolfsii* (0.0mm) *in vitro* condition and followed by propineb and hexaconazol+zineb compared to control. *Trichoderma* strains *T. harzianum-3* (1.3 mm) and *T. harzianum-2* (1.2 mm) were highly compatible with hexaconazol+zineb while strains *T. harzianum-2* (1.2 mm), *T. harzianum-4* (1.1 mm) compatiable with carboxin+thiram.

Keywords: *Sclerotium rolfsii, Fusarium oxysporum, T. viride, T. harzianum* and propineb

1. Introduction
Lentil production in India has always been important as it is one of the most important *rabi* crops in the country. Lentil (*Lens culinaris Medik.*) is an important pulse crop and the second major source of protein (25%) after soybean in human and animal diet (Rahman *et al*., 2010) [7]. Lentil is important source of energy (353 kcal), protein (25%), carbohydrate (63%), sugar (2%), fat (1%), vitamin and antioxidant compounds. It is mainly cultivated in Madhya Pradesh, Uttar Pradesh, Bihar, and West Bengal, which account for 85% of total production of India (Anonymous, 2015) [1]. Lentil is grown as a *rabi* crop or winter crop in India and sown from October to November. It can be grown on a wide range of soils from light loams to black cotton soils and can stand even less fertile moderately alkaline soils and rainfed conditions. The crop matures in 90 to 120 days. The total area under lentil in India was 12.76 lakh ha with a total production of 9.76 lakh ton and 765 Kg/ha productivity. In Madhya Pradesh lentil was cultivated in an area about 5.5 lakh ha with production of 2.33 lakh tone and 424 kg/ha productivity (Anonymous 2016-17) [2]. Collar rot disease caused by *S. rolfsii* on lentil crop is very important as the polyphagus pathogenic fungus causes substantial losses in quality and productivity of yield. *S. rolfsii Sacco* is a non specialized soil borne fungal pathogen of worldwide importance and has a host range of over 500 species (Punja and Grogan, 1988) [6]. The management of disease can be done through cultural, chemical, biological methods and use of resistant varieties. In the absence of resistance/tolerant variety, it is difficult to manage the disease caused by soil borne pathogens because of complex soil environment of physical, chemical and biological origin.

2. Material and Methods

2.1. Equipments and apparatus: The equipments and apparatus which have been used in the study are given below:- Laminar air flow, BOD incubator, Refrigerator, Autoclave, Glassware, Microscope, Hot air oven, Electronic balance, Forceps, Inoculation Needle, Cork borer, Blade etc.

2.2. Cleaning and sterilization of equipments: Corning make glassware were used during the period of investigation. All the glassware were cleaned with chronic acid, followed by thorough washing with detergent powder and then rinsing tap water before use. The sterilization of media was done at 15lbs, pressure for 20 min. Petriplates were sterilized in hot air sterilizer at 180°C for 2 hrs. The plastic petriplates used in bio control study, were sterilized by alcohol. The isolation chamber was sterilized by alcohol, followed by ultraviolet exposure for 20 min. The other equipments used in isolation chamber like forceps, inoculation needle, cork borer, blade, etc. were sterilized by dipping them in alcohol, followed by heating on flame.

2.3. Effect on germination: Germination per cent of lentil was recorded by counting the complete plant population of each plot after thirty days of sowing and percentage emergence was calculated on the basis of seeds sown /plot. The data were transformed angularly and analyzed.

2.4. Incidence of disease: Incidence of disease were taken at 30 and 60 DAS.

2.5. Shoot and Root length: Shoot and root length of each plant were recorded in cm. The shoot and root length of plant were recorded after 30 and 60 DAS and mean of 20 plants were calculated.

2.6. Fresh and dry weight of Plants

Fresh and dry weight of each plant were recorded in g. The fresh and dry weight of plant were recorded after 30 and 60 DAS and mean of 20 plants were calculated.

2.7. Number of nodules

Numbers of nodules of each plant were recorded. The number of nodules of plant were recorded after 30 and 60 DAS and mean of 20 plants were calculated.

2.8. Effect on yield components

The yield contributing characters like, numbers of pods, biomass per plot and yield (kg per ha) were recorded on 20 plant in treatment of experiment.

3. Results and Discussion

3.1. Effect on yield components Number of pods per plant

The data on effect of seed dressing with *Trichoderma* strains *viz., T. harzianum-1, T. harzianum-2, T. harzianum-4, T. harzianum-5, T. viride* and *Trichoderma mutant* on number of pods per plant of lentil are presented in table-4.9.The average number of pods/plant ranged between 35 to 58 all the seed treatments with *Trichoderma* strains significant increase the number of pods /plant was observed in *Trichoderma viride* (58.1) followed by *T. harzianum-5* (47.2), *T. harzianum-2*(44.2),*T. harzianum-1* (42.6) compared to control.

Table 1: Number of lentil pods, biomass, yield (kg/ha) in seed dressing of *Trichoderma* strains and fungicides.

Treatment	Number of pods/plant	Biomass (g)/plot	Yield (kg/ha)
T. harzianum-1	42.6	692.00	450.36
T. harzianum-2	44.1	700.25	481.14
T. harzianum-4	40.9	680.25	441.72
T. harzianum-5	47.2	780.75	452.52
T. viride	58.1	868.75	655.20
T. mutant	40.5	667.25	413.1
Propineb	34.5	649.25	389.88
Hexaconazol+Zineb	33.8	645.75	394.74
Carboxin +Thiram	35.4	541.75	302.7
Control	26.5	471.00	258.3
SE(m)	1.70	73.06	27.35
C.D at 5%	4.93	212.09	79.39

*Average of 4 replications

3.2. Biomass/plot (g)

The data on effect of seed dressing with *Trichoderma* strains on biomass / plot are presented in table-4.9. Significant increase in biomass/plot was found in *T. viride* (868.7g) and *T. harzianum-5* (780.7g) treated plants as compare to control.

3.3. Yield /plot (g)

Significant increase in yield kg/ha was noticed in *Trichoderma* strains, *T.harzianum-1, T. harzianum-2, T. harzianum-4, T.harzianum-5, T. viride* and *T. mutant*. The highest yield kg/ha was found in *T. viride* (655.20 kg/ha) followed by *T. harzianum-5* (452.2 kg/ha) *T. harzianum-1* (450.36) and *T. harzianum-4* (441.72 kg/ha) as compared to control.

3.4. *In vitro* evaluation of fungicides against *Fusarium oxysporum* f. sp. *lentis and Sclerotium rolfsii* and *Trichoderma* strains

On Fusarium oxysporum f. sp. lentis and *Sclerotium rolfsii Invitro* evaluation of fungicides and their combination was carried out by poison food technique. three fungicides was assayed against On *Fusarium oxysporum* f.sp. *lentis* and *Sclerotium rolfsii*. observation on radial growth of *Fusarium oxysporum* f.sp. *lentis* and *Sclerotium rolfsii* were recorded after seven days of observation.

Table 2: Radial growth of *Fusarium oxysporum* f. sp. *lentis* and *Sclerotium rolfsii.*

Fungicides	Dose (g/kg seeds)	Colony diameter of *Fusarium oxysporum* f. sp. *lentis* (mm)**	Colony diameter of *Sclerotium rolfsii* (mm)**
Propineb	3 g	2.0	0.0
Hexaconazol+Zineb	3 g	2.86	2.0
Carboxin +Thiram	2.5 g	0.0	0.0
Control	--	3.36	2.66
SE(m)		0.213	0.167
CD (0.05)		.70	0.55

*Average of 4 replications

Data presented in Table- 2. clearly indicated that all the fungicides inhibited the growth of *Fusarium oxysporum* f. sp. *lentis* and *Sclerotium rolfsii in vitro* condition. After 168 hrs of incubation, Carboxin +Thiram inhibited maximum growth of *Fusarium oxysporum* f. sp. *lentis* and *Sclerotium rolfsii* (0.0 mm) followed by Propineb (2 & 0 mm) were second next in order of toxicity per cent inhibition of radial growth. Least inhibition was recorded in hexaconazol+zineb (2.86 & 2 mm) respectively. Evaluation of *Trichoderma* isolates for their antagonistic potential against two major soil borne plant pathogens *viz*., *Sclerotium rolfsii* and *F. oxysporum* f. sp. *lentis* causing collar rot in lentil, respectively. It was found under laboratory conditions that *T. viride* (64.3% & 75.3%), followed by *Th-5* (66.2% & 70.1%) showed maximum biocontrol potential against wilt and collar rot on lentil. Patel *et al*., (2014) [4] screened seven different strains of *Trichoderma*, isolated from wilt infected leguminous crops of Madhya Pradesh and tested for their antagonistic activity against *Fusarium* (soil borne pathogen). Among the seven strains identified as *T. viride, T. harzianum, T. asperellum, T. koningii, T. atroviride, T. longibrachiatums* and *T. virens* the best strain of *Trichoderma species was T. viride*. *Invitro* evaluation of fungicides and their combination was carried out by poison food technique. Three fungicides were assayed against on *Fusarium oxysporum f. sp. lentis* and *Sclerotium rolfsii.* All the fungicides inhibited the growth of *Fusarium oxysporum f.sp. lentis* and *Sclerotium rolfsii in vitro* condition. After 168 hrs of incubation, Carboxin +thiram inhibited maximum growth of *Fusarium oxysporum f.sp. lentis* and *Sclerotium rolfsii* (0 & 0mm). Propineb was second next in order of toxicity per cent inhibition of radial growth of both the pathogens. Least inhibition was recorded in Hexaconazol+zineb. Archana *et al.*, (2018) [3] evaluated nine fungicides *in vitro* against *Sclerotium rolfsii* the result revealed that the fungicides carbendazim (0.1%)+Mancozeb (0.2%), Thiram (0.2%) and Mancozeb (0.2%) recorded 100% growth inhibition and were significantly superior over rest of the fungicidal treatments, it was followed by Captan (55.55), Hexaconazole (38.88%), Bordeaux mixture (33.33%), Benomyl (25.55%), Copper Oxychloride (11.11%) and (3.33%). Patil *et al*. (2015) [5] evaluated four fungicides, all the fungicides found to be significantly superior over control in checking the radial growth and sporulation of *Foc*. Among all the fungicides Carbendazim (22.41%) was significantly superior and was at par with Benomyl (21.4%), Thiram (31.42%) and Captan (31.82%). Very scarce sporulation was observed in Carbendazim, Benomyl, Thiram and Captan. *Invitro* evaluation of fungicides and their combination was carried out by poison food technique. four fungicides were assayed against on *Trichoderma* strains. observations on radial growth of *Trichoderma strains* were recorded after seven days of inoculation. The *Trichoderma* strains *T. harzianum-5* and *T.harzianum-4* was highly compatible with Hexaconazol+zineb (2.5 & 2.2mm) and followed by *T. harzianum-2*, compatible with Carboxin +thiram (1.4 & 1.2mm). Tomer *et al.*, (2018) [8] evaluated four fungicides *viz*. Mancozeb, Thiram, Carboxin and Propiconazole at 25, 50, 75 and 100 ppm for their compatibility with *T. harzianum* by poisoned food technique. All the four concentrations of Mancozeb were highly compatible with almost negligible toxic effect against *T. harzianum invitro*. as there was no or very little (0.00, 0.00, 5.19 and 7.03) inhibition of radial growth of *Trichoderma harzianum* due to Mancozeb at 25, 50, 75 and 100 ppm concentrations, respectively. Thiram was less compatible than Mancozeb. Carboxin and Propiconazole were toxic and incompatible with *Trichoderma harzianum*. Two non-systemic fungicides i.e., Mancozeb and Thiram were found to be compatible, as compared to systemic fungicides *viz*. Carboxin and Propiconazole which exhibited acute toxicity for growth of *T. harzianum in vitro*.

3.5. On *Trichoderma* strains

Invitro evaluation of fungicides and their combination was carried outby poison food technique. Four fungicides (Propineb, Hexaconazol+Zineb Carbendazim+ Mancozeb, Carboxin +Thiram) were assayed against on *Trichoderma* strains. Observations on radial growth of *Trichoderma strains* were recorded after seven days of inoculation.

Table 3: Radial growth of *Trichoderma* strains.

Treatment	Radial growth of *Trichoderma* strains (mm)**						
	T. harzianum -1	*T. harzianum-2*	*T. harzianum -4*	*T. harzianum-5*	*T. viride*	*T. mutant*	Mean of fungicide
Propineb	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hexaconazol+Zineb	0.0	1.2	1.3	0.0	0.0	0.0	0.41
Carboxin +Thiram	0.0	1.2	1.1	1.0	0.0	0.0	0.60
Carbendazim + Mancozeb	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean of *Trichoderma*	0.0	0.60	0.61	0.3	0.0	0.0	0.0

Factors	SE(m)	CD at 5%
Factor A	0.207	0.155
Factor B	0.253	0.190
Treatment(A*B)	0.380	0.380

The *Trichoderma* strains *T. harzianum-3* and *T.harzianum-2* was highly compatible with Hexaconazol+Zineb (1.3 & 1.2 mm) and followed by *T. harzianum-2*, compatible with Carboxin +Thiram (1.2 mm).

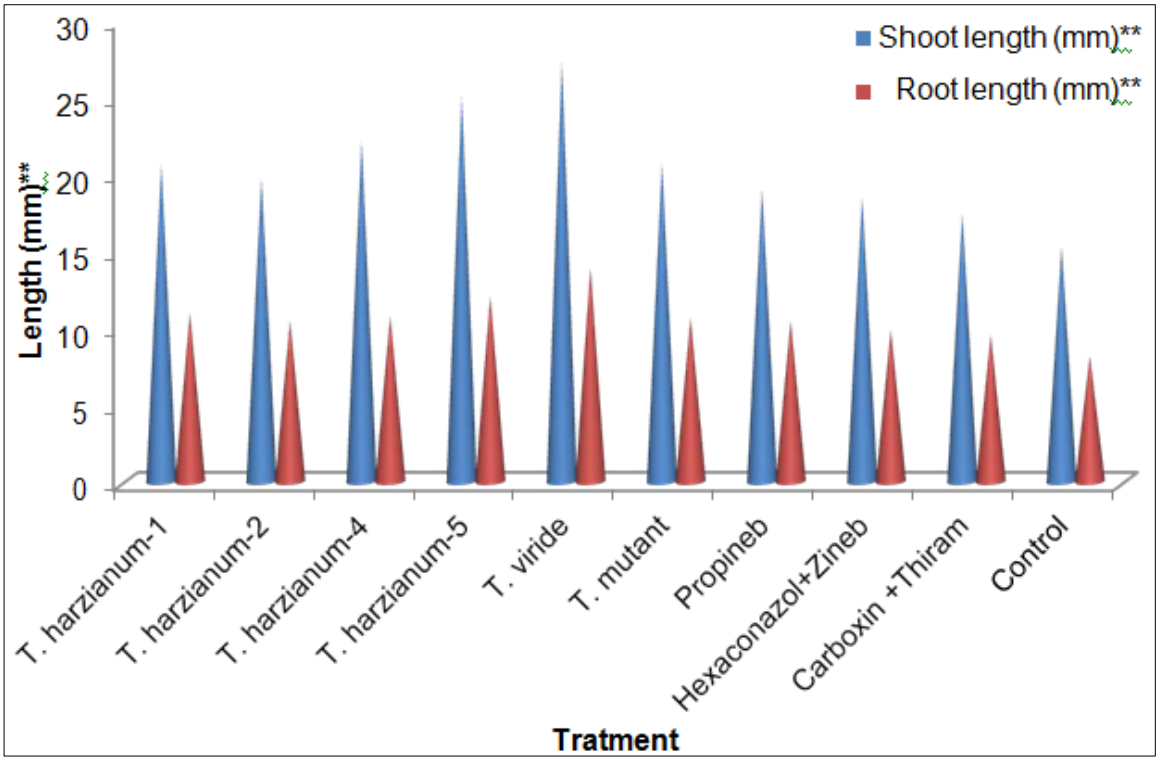

Fig 1: Radial growth of *Trichoderma* strains.

4. Conclusion

From evaluation of *Trichoderma* strains for bio-efficacy, compatibility with fungicides and growth promoting ability (GPA) of lentil, it could be concluded that *Trichoderma* strains *viz. T. virie and T. harzianum-5*. Among the *Trichoderma* strains *T harzianum-5* and *T. harzianum-4* were highly compatible with hexaconazol+zineb, while strains *T. harzianum-2, T. harzianum-4* were compatible with carboxin + thiram. *Trichoderma* strains *T. viride* increased growth of lentil plant followed by other *Trichoderma* strains *viz. T.harzianum-5, T.harzianum-4, T. harzianum- 2* and *T. mutant.*

5. References

1. Anonymous. Project Coordinator MULLARF. ICAR, Kanpur 2015.
2. Anonymous. Project Coordinator MULLARF. ICAR, Kanpur, 2016-17.
3. Archana TS, Pankaj B, Jagtap SD, Patil BS. *In vitro* Evaluation of fungicides and bioagents against root rot of Chilli caused by *Sclerotium rolfsii* Sacc ISSN:2320 – 7051 Int. J Pure App. Biosci. 2017;6(1):982-986.
4. Patel R, Patel D. Screening of *Trichoderma* and antagonistic analysis of a potential strain of *Trichoderma* for production of a bioformulation. International Journal of Scientific and Research Publications, 2014, 4(10).
5. Patil VB, Gawade DB, Surywanshi AP, Zagade SN. biological and fungicidal management of chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri*. Bioscan. 2015;10(2):685-690.
6. Punja ZK, Grogan. The biology, ecology and control of *Sclerotium rolfsii*. Annual Review of Phytopathology. 1988;23:97-127.
7. Rahman T, Ahmed A, Islam M, Hosen M. Physiological study and both In vitroand *In vivo* antifungal activities against *Stemphylium botryosum* causing Stemphylium blight disease in lentil (*Lens culinaris*). Plant Pathol. J. 2010;9:179-187.
8. Tomer A, Singh R, Prasad D. Compatibility *Trichoderma harzianum* with Systemic and two non-systemic fungicides of *in vitro*. Asian Journal of Crop Science. 2018;10(4):174-179.