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Control of wilt disease of lentil through bio control agents and organic amendments in Tarai region of Uttarakhand, India

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Abstract

The present work aimed at evaluating the efficacy of bioagents and organic amendments against lentil wilt pathogen. Field trials were carried out consecutively during *Rabi* 2010-11 and 2011-12 crop seasons in Randomized Block Design (RBD) with three replications, using 'Pant L-639' a popular cultivar. The plot size was 3.0×1.5 m^2 with row spacing of 30 cm. Effect of selected bioagents and organic amendments on disease incidence, 1000 grain weight and yield kg ha^{-1} of lentil was recorded. It was observed that seed treatment with *Trichoderma harizanum* + *Pseudomonas fluorescens* significant by reduced 1.73 % (2010-11) and 1.93 % (2011-12) in *Fusarium* wilt disease incidence and increase in grain yield 507.6 kg ha^{-1} and 496.0 kg ha^{-1} respectively during both crop seasons. Among organic amendments, minimum wilt disease incidence of 1.69 % (2010-11) and 1.81 % (2011-12) and maximum grain yield 496.3 kg ha^{-1} (2010-11) and 484.0 kg ha^{-1} (2011-12) were observed in farm yard manure + spent compost treated plots. This indicates that these treatments have important roles in biologically based management strategies for controling *Fusarium* wilt disease under organic mode of lentil cultivation in Uttarakhand State.

Key words

Biocontrol agent, *Fusarium*, Lentil, Organic amendment

Introduction

Lentil (*Lens culinaris* Medic) commonly known as Masur was among the first crops domesticated and has become an important food legume crop in the farming and food systems of many countries globally (Sarker and Erskine, 2006). Lentil is an important food legume cultivated for its nutritious seeds and dry *strove* and straw is used as dry fodder for animals. The area under lentil in India is around 1.59 m ha with a production of 0.94 m t and 591 kg ha^{-1} productivity. It is grown throughout Northern and Central India. Owing to biotic and abiotic stresses, the crop yield is below the attainable levels. Among biotic factors diseases are serious threat to lentil production in many part of India. Among diseases, *Fusarium* wilt, caused by fungus *Fusarium oxysporum* f.sp. *lentis,* is the most important biological constraints to productivity of lentil worldwide (Bhalla *et al.,* 1992). Lentil wilt plays a major role in reducing lentil yield (Hamdi and Hassanein, 1996).

Pathogens with high saprophytic ability can survive in soil for a pretty long period during which they may have to go through different environmental stresses and biological competition which may lead to the existence of physiological races. Therefore, integrated management strategies are only solution to maintain plant health. These strategies should include minimum use of chemicals for checking the pathogen population, encouragement of beneficial biological agents to reduce pathogen inoculums, modification of cultural practices and use of resistant varieties (Bendre and Barhate, 1998). Although various fungicides have promising results in controlling the wilt of lentil but there is a problem of phytotoxicity and fungicidal residue leading to environmental pollution. Broad-spectrum fungicides also cause environmental pollution as well as detrimental effects on human health (ElHassan *et al*., 2013). In recent times, there has been a worldwide swing to the use of eco-friendly methods for protecting the crops from pests and diseases. As such in the present context, use of biological control agents and organic amendments offers a great promise.

There are more than sufficient data to indicate that organic materials reduce disease incidence caused by a wide

range of plant pathogens (Gamliel *et al.,* 2000) including bacteria (Krause *et al.,* 2003), fungi (Conn and Lazarovits, 1999; Conn and Lazarovits, 2000; Lazarovits *et al.,* 2001) and nematode (Akhtar and Malik, 2000; Abawi and Widmer, 2000) species.

Organic matter is known to affect soil aeration, structure, drainage, moisture holding capacity, nutrient availability, and microbial ecology (Davey, 1996). Incorporating organic amendments and managing crop residues (type and quantity) have a direct impact on plant health and crop productivity. Biological control using antagonistic microorganisms is also an alternative method to the fungicides and provides an ecologically based approach to integrated pest management in sustainable agriculture in crop production systems (Singh *et al*., 1999; Sutton and Peng, 1993). The use of biocontrol agents and organic amendments for controling fungal diseases in plants is considered as an interesting alternative to synthetic fungicides due to their ecofriendly effect on the environment as well as they are economically feasible. Thus the present study was conducted to evaluate the effect of biocontrol agents and organic amendements for the control of wilt of lentil.

Materials and Methods

Experiments were conducted during Rabi 2010-11 and 2011-12 crop seasons, respectively in RBD with three replications. Plot size was 3.0 × 1.5 m^2 with 30 cm inter row spacing and 3-4 cm sowing depth. Seeds of resistant cultivars of lentil 'Pant L-639' were sown in November during both the crop seasons. Treatments consisted of seed treatment with different bioagents *viz*., *Trichoderma harzianum*, *Pseudomonas fluorescens* and *Trichoderma harzianum* + *Pseudomonas fluorescens* @ 6 g kg^{-1} seed. Untreated seeds were sown in check plots. In case of organic amendments, the plots were treated by 2 kg $plot^{-1}$ organic amendment. Farm yard manure, Spent compost and FYM +SC were taken as treatments. All organic amendments were applied in the field one month before sowing of seed. Untreated plot was taken as the check plot. Sixty gram seed of lentil was sown per plot. Observations were made at 15 d after sowing till harvest and disease incidence was calculated. Data of disease incidence, grain yield and 1000-grain weight were subjected to analysis of variance (ANOVA) for a complete randomization design. All statistical analysis was conducted with STPR3 software.

Results and Discussion

Effect of biocontrol agents: The data given in Table 1 revealed that all the treatments significantly decreased disease incidence, increased grain yield as well as 1000 grain weight as compared to check. During 2010-11 crop season, plots treated with a mixture of *T. harzianum* and *Ps. fluorescence* recorded lowest disease incidence (1.73) followed by *T. harzianum* (2.49) and *Ps. fluorescence* (2.92) alone. The highest grain yield (507.6 kg ha^{-1}) was recorded in *T. harzianum* + *Ps. fluorescence* treated plots followed by *T. harzianum* (465.6 kg ha^{-1}) and *Ps. fluorescence* (443.0 kg ha^{-1}) alone. Maximum 1000 grain weight (14.1 g) was recorded in *T. harzianum* + *Ps. fluorescence* treated plots followed by *T. harzianum* (13.0 g) and *Ps. fluorescence* (12.3 g), while in check 412.6 kg ha^{-1} yield was recorded. Maximum decrease in disease incidence (67.8 %) and increase in grain yield (23.0%) was recorded in *T. harzianum* + *Ps. fluorescence* treated plots.

During the crop season 2011-12, *T. harzianum* + *Ps. fluorescence* treated plots again resulted in lowest disease incidence (1.93) followed by *T. harzianum* and *Ps. fluorescence*. Highest grain yield (496 kg ha^{-1}) and 1000 grain weight (12.9g) were recorded in *T. harzianum* + *Ps. fluorescence* treated plots, while 394.6 kg ha^{-1} yield was recorded in the check plot. Maximum per cent decrease in disease incidence (67.55%) and increase in grain yield (25.69%) were recorded in *T. harzianum* + *Ps. fluorescence* treated plots.

The use of potential chemical is viewed with dissatisfaction in many ways. As such in the present context, biological control of wilt with bioagents offers a great promise**.** Biological control is the best alternative, especially against soil borne pathogens such as *Fusarium* spp. (Akrami *et al*., 2011). From several studies, it has been confirmed that *Trichoderma* spp. have antagonistic and biologically control potential against a diversity of soil borne pathogens (Grondona *et al*., 1997; Bajwa *et al*., 2004). Results revealed that all strains of *T. harzianum* were effective as it grew over and parasitized *F. oxysporum* f. sp. *lentis* and checked growth completely. The strains of *T. harzianum* were faster growing than pathogen. The suppression in growth may be due to lack of nutrition for growth of pathogen and production of certain inhibitory chemicals by antagonists in culture. The growth inhibition may be due to the hyphal parasitization and production of wall degrading enzymes by the test antagonists. However, this needs further investigation. In field study, combination of *Trichoderma harzianum* + *Ps. fluorescence* are best against the wilt disease in comparison to the use of a single bioagent. The development of mixtures of biocontrol agents is needed because they may adapt better to environmental changes that occur throughout the growing season and protect against a broader range of pathogens (Akhtar *et al.,* 2010).

Effect of organic amendments : Organic amendments *i.e.* FYM, spent compost and their combination were also tested against lentil wilt pathogen. All treatments were applied in the field one month before sowing. The results revealed that during 2010-11, minimum disease incidence (1.69%) was recorded in case of FYM + spent compost followed by FYM (2.29%) and spent compost (2.71%) (Table 4). The highest grain yield was recorded in FYM + spent compost treated plots (496.3 kg ha^{-1}) followed by FYM (483.7). Spent compost showed lowest grain yield (464.0 kg ha^{-1}) in comparison to other treatments while in check plot, 376.0 kg ha^{-1} grain yield was recorded. In FYM + SC treated plots, decline disease was recorded (69.21%) followed by FYM (58.28)

Table 1: Effect of biocontrol agents on per cent wilt incidence, grain yield, 1000-grain weight during 2010-11 and 2011-12 crop seasons

Treatment	Dose (g kg^{-1})	Disease incidence (%)		Disease decline (%)		Grain yield (kg ha^{-1})		1000-grain weight (g)		% increase in grain yield	
		2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Pseudomonas fluorescens	4.0	2.92(3.21)	3.39(3.47)	45.64	43.05	443.0	431.6	12.3	12.2	7.4	9.3
Trichoderma harzianum	4.0	2.49(2.93)	3.00 (3.23)	53.64	49.60	465.6	454.3	13.0	12.6	12.8	15.1
Trichoderma harzianum + *Pseudomonas fluorescens*	4.0	1.73 (2.41)	1.93 (2.54)	67.8	67.55	507.6	496.0	14.1	12.9	23.0	25.7
Check	–	5.38 (4.64)	5.96 (4.96)	–	–	412.6	394.6	11.2	10.4	–	–
SEM±		1.18	1.07	–	–	13.5	16.96	0.23	0.24	–	–
CD(P=0.05)		4.09	3.71	–	–	46.6	58.63	0.81	0.86	–	–

* Figures in parenthesis are angular transformed values

Table 2: Effect of Organic amendments on per cent wilt incidence, grain yield, 1000-grain weight during 2010-11 and 2011-12 crop seasons

Treatment	Dose (kg plot^{-1})	Disease incidence (%)		Disease decline (%)		Grain yield (kg ha^{-1})		1000-grain weight (g)		% increase over check	
		2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
FYM	2.0	2.29 (8.72)	2.81 (9.63)	58.28	51.13	483.7	466.3	13.4	12.6	24.3	24.0
Spent compost	2.0	2.71 (9.50)	3.13 (10.14)	50.63	45.56	464.0	448.0	12.5	12.1	19.2	19.1
FYM + SC	2.0	1.69 (7.49)	1.81 (7.71)	69.21	68.17	496.3	484.0	13.9	13.0	27.6	28.7
Check	–	5.49 (13.44)	5.75 (13.94)	–	–	389.0	376.0	10.9	10.4	–	–
SEM±	–	1.31	2.28	–	–	7.60	7.12	0.077	0.20	–	–
CD(P=0.05)	–	4.56	7.87	–	–	26.3	24.61	0.27	0.72	–	–

* Figures in parenthesis are angular transformed values

while lowest decline was recorded in spent compost (50.63%) treated plot. The grain yield increased over check (27.6%) in FYM + spent compost followed by FYM (24.3%). Spent compost showed lowest grain yield (19.1%). Maximum 1000-grain weight (13.9 g) was recorded in FYM+ spent compost followed by FYM (13.4 g) while, spent compost showed lowest grain weight (12.5 g).

During 2011-12 crop season, the observations indicated that FYM + spent compost again resulted in minimum disease incidence (1.81%) followed by FYM (2.81%) while it was maximum (3.13%) in spent compost. Highest grain yield (484 kg/ha) and 1000-grain weight (13.0 g) was recorded in FYM + SC. Percentage decrease in disease incidence (68.2%) and increase in grain yield (28.7%) was recorded in FYM + SC followed by FYM and spent compost. FYM amended plots showed disease decline (51.13%), 1000-grain weight (12.6 g) and grain yield (467 kg ha^{-1}), while in the spent compost amended plots shows lowest disease decline (45.56%), 1000 grain weight (12.1 g), grain yield (448 kg ha^{-1}) and increased over check (19.1%) was recorded. Rajiv and Dubey (2003) observed the effect of soil amendments alone or in combination with fertilizers on *Fusarium oxysporum* f. sp. *lentis* at seedling and flowering to pod formation stages. The results obtained in respect of organic amendments were similar to those reported by Nikam *et al.* (2007) who reported significant reduction in the incidence of *Fusarium oxysporum* f.sp. *ciceri* after application of groundnut cake and neem cake. There are more than sufficient data to indicate that organic materials reduce disease incidence caused by a wide range of plant pathogens and plant pests including bacteria **(**Krause *et al.,* 2003**),** fungi (Conn and Lazarovits, 1999 ; Lazarovits *et al.,* 2001) and nematode (Akhtar and Malik, 2000; Abawi and Widmer, 2000) species. Results revealed that among the organic amendments, a combination of FYM and spent compost resulted in minimum disease incidence and maximum grain yield, while spent compost alone resulted in higher disease incidence and minimum grain yield in comparison to other treatments during both crop seasons.

The results of the present study clearly indicate that biocontrol agents and organic amendments have important roles in the management of wilt disease of lentil. Among biocontrol agents, combination of *Trichoderma harzianum* and *Ps. Fluorescence* were found best and among organic amendments, combination of FYM + spent compost were found best for control of wilt disease of lentil.

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