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Field efficacy of formulation of fungal bioagents against bacterial leaf blight of rice caused by *Xanthomonas oryzae* pv. *oryzae* (Uyeda and Ishiyama) Dowson

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Abstract: In the present study, *Trichoderma harzianum, T. hamatum, T. virens* and three isolates of *Trichoderma* spp. were evaluated for their comparative efficacy against bacterial leaf blight of rice, under field conditions. All the bioagent formulations were significantly effective in reducing disease severity over check during *Kharif* season 2006 and 2007. *T. harzianum* was found to be most effective and resulted 48.26 and 59.22 % reduction in disease severity during *Kharif* season 2006 and 2007, respectively. Maximum increase in grain yield (16.21%) was recorded with *T. harzianum* followed by isolate 40 (14.58%), during *Kharif* season 2006. Whereas during *Kharif* season 2007, maximum increase in grain yield (18.95%) was recorded with *T. harzianum* which is followed by *T. virens* (14.65%) and isolate 40 (12.57 %). Present study revealed that *T. harzianum* (isolated from rice phylloplane) was found to be most effective in reducing disease severity and increasing grain yield as compared to other isolates obtained from different sources.

Keywords: Bacterial leaf blight of rice, Field efficacy, *Trichoderma hamatum*, *Trichoderma harzianum*, *Trichoderma virens*, *Xanthomonas oryzae* pv. *oryzae*,

INTRODUCTION

Bacterial leaf blight of rice caused by *Xanthomonas oryzae* pv. *oryzae* is the disease of great economic importance in all rice growing areas of the world and is particularly destructive in South East Asia during the heavy rains of monsoon season (Mew *et al.*, 1993). Non-availability of effective chemical control measures and inconsistent performance of resistant rice varieties have forced the plant pathologists to look for new approaches of disease management (Buddenhagen, 1983; Kaul & Sharma, 1987; Mew, 1987). Interest in biological management has increased considerably in the recent past due to their added advantage over the other methods of plant disease management (Whipps and Mequilken, 1993; Dube, 1995; Pankhurst and Lynch, 1995). The microbial antagonists occurs in nature are host specific, virulent, self perpetuating and genetically stable. Hence, biological control has emerged an alternative and most promising means of the management of plant pathogens. Many workers reported the effectivity of *Trichoderma* spp., *T. harzianum, T. hamaum and T. virens* (Manmeet and Thind, 2002; Nzojiyobiri *et al.*, 2003; Gangwar and Sinha, 2010a,b; Gangwar and Sinha, 2012a,b) and phylloplane microflora (Sindhan *et al.*, 1997) against *X. oryzae* pv. *oryzae* causing bacterial leaf blight disease in rice.

Trichoderma harzianum, T. hamatum, T. virens and 49 isolates of *Trichoderma* spp. (isolated from different sources and locations) were screened for comparative antagonistic potential against *X. oryzae* pv *oryzae* (*Xoo*) *in vitro* (Gangwar and Sinha, 2010a; Gangwar and Sinha, 2012a) and ten potential fungal bioagents (seven isolates of *Trichoderma* spp. and *T. harzianum, T. hamatum* and *T. virens*) were selected for their evaluation against bacterial leaf blight of rice, under glass house conditions (Gangwar and Sinha, 2012b). Among these, six potential fungal bioagents were selected for testing field efficacy against bacterial leaf blight of rice. In the present study, these six potential bioagents were evaluated for their comparative efficacy against bacterial leaf blight of rice, under field conditions.

MATERIALS AND METHODS

In the present study, comparative efficacy of six potential fungal bioagants *viz. Trichoderma harzianum, T. hamatum* and *T. virens* and three isolates of *Trichoderma* spp. (isolate 25, 31 and 40) which were isolated from different sources (Table 1) were tested against bacterial leaf blight of rice, under field conditions.

Mass multiplication of fungal bioagents and preparation of formulation: The fungal bioagents were mass multiplied on barnyard millet (*Echinocloa frumentacae*). Grains colonized by *Trichoderma* spp. were air dried in open shade and ground with the help of Willy Mill to get fine powder. This powder was passed through 50 and 80

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mesh sieves simultaneously to obtain spore powder and diluted with talcum powder (mesh = 350 with 95% whiteness) and 1% carboxyl methyl cellulose (CMC) to get desired concentration (10^6 cfu/g).

Field experiment: The experiment was carried out in *Kharif* season during the year 2006 and 2007 at Crop Research Center, G. B. Pant University of Agriculture and Technology, Pantnagar using randomized block design (RBD). Topographically, Pantnagar is located at 29°N latitude, 79.3°E longitude and at an altitude of 243.84 meter above the mean sea level in the humid and subtropical regions of North West Plain Zone at the foothills of Shivalik range of Himalayas. The average relative humidity was highest (70-90%) in July-August and December-January and lowest (35-40%) in April-May. Susceptible rice cultivar Jaya was used for the experiment. General agronomic practices were followed for cultivation of experimental plots. Pathogen was inoculated at maximum tillering stage by clipping off the leaf tip @ 10^6 cell/ml inoculum (Kauffman *et al*., 1973).

Application of treatments: Formulations of fungal bioagents were applied @ 10 g/l as foliar spray next day of inoculation of pathogen in the evening hours to avoid exposure to hot sunshine. Two foliar sprays of bioagents formulations and chemical treatments were given at one week interval. Check plots were sprayed with sterilized water. Each treatment was replicated thrice.

Data collection: Data was recorded as percent disease severity on artificially inoculated leaves (average 50 leaves/plot) at 14, 21 and 28 days after treatment application. After harvesting yield components (number of filled and unfilled grains per plants, grain yield and 1000 grain weight) were recorded.

Statistical analysis: Statistical analysis of the data obtained from field experiment was done using appropriate programme as per the requirement of the experiment. The critical difference (CD) was calculated at 5% level of significance for comparison of difference between the means of different treatments.

RESULTS

Effect of fungal bioagent formulations on disease severity: All the isolates of *Trichoderma* spp. significantly reduced disease severity of bacterial leaf blight over check during *Kharif* season 2006 and 2007 (Table 2). During *Kharif* season 2006 *T. harzianum* was found most effective and exhibited 48.26 per cent reduction in disease severity. Foliar spray with isolate 31, isolate 40 and *T. virens* was next in order to effectivity and exhibited 47.91 % reduction in disease severity. During *Kharif* season 2007 *T. harzianum* resulted in maximum reduction (59.22%) in disease severity followed by isolate 25 (57.97%).

Effect of fungal bioagent formulations on number of filled grains per plant: All the isolates of *Trichoderma* spp. were significantly effective in increasing number of filled grains per plant over check during *Kharif* season 2006 and 2007 (Table 3). The highest increase (36.84%) in number of filled grains was obtained with *T. harzianum* followed by isolate 40 (24.90%) and *T. virens* (23.87%) during *Kharif* season 2006. During *Kharif* season 2007, maximum increase (29.71%) in number of filled grains was obtained with *T. harzianum* followed by *T. virens* and isolate 31 which resulted in increase in number of filled grains per plant by 26.22 and 19.49 per cent, respectively.

Effect of formulation of fungal bioagents on grain yield and 1000 grain weight: The data obtained on the effect of *Trichoderma* spp. in increasing grain yield and 1000 grain weight was significantly higher over check during *Kharif* season 2006 and 2007 (Table 3). Maximum increase in grain yield (16.21%) was recorded with *T. harzianum* followed by isolate 40 (14.58%) during *Kharif* season 2006. Maximum increase (33.00%) in 1000 grain weight was observed with *T. harzianum* which is followed by *T. hamatum* (32.15%). During *Kharif* season 2007, Maximum increase in grain yield (18.95%) was recorded with *T. harzianum* application followed by *T. virens* (14.65%) and isolate 40 (12.57%). Maximum increase in 1000 grain weight was recorded with *T. hamatum* (54.44%) which is followed by *T. virens* (50.67%) and *T. harzianum* (50.55%).

DISCUSSION

In the present investigation, six fungal bioagent formulations were evaluated against bacterial leaf blight disease of rice during *Kharif* season during the year 2006 and 2007. *T. harzianum* (rice leaf isolate) was found most effective in reducing disease severity and increasing grain yield. *Trichoderma* spp. (isolate 40) and *T. virens* were found next in order of effectivity in reducing disease severity and increasing the grain yield. This indicates that fungal bioagents could proliferate and establish on rice host surface which resulted in reduction in bacterial blight disease severity. Similar results were observed in glasshouse studies carried by Gangwar and Sinha, (2012b). Higher effectivity of *Trichoderma* isolates obtained from rice phylloplane against bacterial leaf blight

Table 1. List of fungal bioagents isolated from different sources.

Isolates of *Trichoderma* spp.	Sources
Isolate 31	Soil of rice field
Isolate 25	Soil of rice field
Isolate 40	Soil of rice field
T. harzianum	Rice phylloplane
T. virens	Rice phylloplane
T. hamatum	Rice phylloplane

Table 2. Efficacy of *Trichoderma* spp. on disease severity of bacterial leaf blight applied as foliar spray, under field condition during *Kharif* season 2006 and 2007.

Treatments	Disease severity (%)					
	Kharif season 2006			*Kharif* season 2007		
	14 days After first spray	21 days After first spray	28 days After first spray	14 days After first spray	21 days After first spray	28 days After first spray
Isolate 31	15.33 (23.03)	47.33 (43.46)	50.00 (44.99)	17.33 (24.57)	27.00 (31.30)	40.00 (39.22)
Isolate 25	17.00 (24.33)	52.33 (46.33)	53.33 (46.91)	17.66 (24.83)	27.66 (31.72)	38.66 (38.44)
Isolate 40	15.33 (23.04)	48.00 (43.84)	50.00 (44.99)	17.66 (24.78)	28.00 (31.92)	42.66 (40.78)
T. harzianum	13.83 (21.79)	41.66 (40.19)	49.66 (44.81)	15.00 (22.73)	25.33 (30.21)	37.51 (37.76)
T. virens	16.66 (23.96)	45.00 (42.12)	50.00 (44.99)	16.00 (23.55)	25.66 (30.43)	39.66 (39.03)
T. hamatum	15.66 (23.28)	49.00 (44.41)	58.33 (49.83)	16.66 (24.08)	27.00 (31.29)	41.00 (39.78)
Check	21.00 (27.25)	66.66 (54.83)	96.00 (78.67)	21.00 (27.23)	41.66 (40.20)	92.00 (73.82)
CD at 5 %	ns	10.43	8.77	3.20	2.78	6.17

*Mean of three replications; Values in parenthesis are angular transformed

Table 3. Efficacy of *Trichoderma* spp. on number of filled and unfilled grains per plant, grain yield and 1000 grain weight applied as foliar spray, under field condition during *Kharif* season 2006 and 2007.

Treatments	No. of filled grains/ plant		Grain yield (q/h)		1000 grain weight (g)	
	2006	2007	2006	2007	2006	2007
Isolate 31	2246	2213	26.09	26.32	25.63	24.90
Isolate 25	2242	2181	26.20	24.74	25.53	24.48
Isolate 40	2297	2051	26.81	26.68	25.64	24.30
T. harzianum	2517	2403	27.19	28.19	26.11	25.29
T. virens	2278	2338	25.60	27.17	25.31	25.31
T. hamatum	2160	2056	25.67	24.99	25.94	25.94
Check	1839	1852	23.40	23.70	19.63	16.85
CD at 5 %	218	225	2.41	2.13	2.94	2.68

*Mean of three replications

pathogen was reported by Gangwar and Sinha, (2012a). *T. harzianum* also found highly effective against bacterial blight pathogen *X. oryzae* pv. *oryzae* under *in vitro* screening (Gangwar and Sinha, 2010a; Gangwar and Sinha, 2012a). Evaluation of different antagonists for control of bacterial leaf blight pathogen in the field was carried out by Manmeet and Thind (2002) which revealed that significant reduction in the disease intensity was observed by *T. harzianum* application.

Conclusion

Present study revealed that efficacy of different *Trichoderma* spp. and isolates against bacterial leaf blight rice was varied. *T. harzianum* (isolated from rice phylloplane) was found to be most effective in reducing disease severity and increasing grain yield as compared to other isolates obtained from different sources. The observed results should be verified on large scale rice planting.

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