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Integration of organic amendments and antagonists for the management of sheath blight in aromatic rice

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ABSTRACT: The effect of integration of organic amendments with fungal or bacterial antagonists (*Trichoderma harzianum* and *Pseudomonas fluorescens*) applied as soil treatment was evaluated against sheath blight disease in Basmati rice caused by *Rhizoctonia solani* under field conditions. Neem cake + *T. harzianum* was found to be the most effective treatment in reducing the disease incidence by up to 57.27% and disease severity by 54.77% followed by farm yard manure (FYM) + *T. harzianum,* which resulted in the reduction of disease incidence to 53.77% and disease severity to 52.29%, respectively. Among all the organic amendments, reduction of sheath blight was lowest with sawdust + *P. fluorescens* with disease incidence of 40.94% and disease severity of 35.29%. Maximum increase in grain yield (39.44%) and 1000-grain weight of rice (29.19g) were recorded with neem cake + *T. harzianum* treatment followed by treatments FYM + *T. harzianum* and pressmud + *T. harzianum.* Minimum increase in grain yield (9.76%) and 1000-grain weight (11.53%) were recorded with the treatment Sawdust + *P. fluorescens*.

KEY WORDS: Antagonist, organic amendment, *Pseudomonas fluorescens*, rice, sheath blight, *Trichoderma harzianum*

INTRODUCTION

Sheath blight disease of rice caused by the fungal pathogen *Rhizoctonia solani* Kuhn has become one of the most destructive diseases in almost all rice growing countries of the world. In India, cultivation of rice under rice–wheat cropping system has resulted in heavy losses to the crop ranging from 5.2 to 70% in yield (Naidu, 1992). Rapid disease development has been attributed to application of high doses of nitrogenous fertilizers, close plant spacing and weather conditions such as low light, cloudy days and high relative humidity (Kannaiyan and Prasad, 1983).

India is the home of long grained aromatic Basmati rice, which fetches a price two to three times higher than that of regular rice in international market. Several indigenous and improved varieties of aromatic rice are under cultivation but most of them are moderately to highly susceptible to sheath blight. This is an important disease which hampers the productivity of basmati rice to a great extent. This disease is managed by excessive application of chemical fungicides, which are highly recalcitrant, toxic and non-ecofriendly (Dath, 1990). The pathogen is soil borne in nature and remains viable for a long period either in soil or in rice stubbles and on seeds. Therefore it needs attention to workout biointensive disease management strategies. Biological control, an alternative to noxious chemical fungicides, has attained importance in modern agriculture to curtail the hazards of intensive use of toxic pesticides. This approach is self–sustaining, efficient and ecofriendly with long-term action (Tiwari and Singh, 2005).

The possible use of fungal and bacterial antagonists of sheath blight has been viewed as an alternative integrated disease management strategy. Among several antagonists tested by various scientists, *Trichoderma harzianum* and *Pseudomonas fluorescens* have been found effective in inhibiting the growth of *R. solani in vitro*. Although antagonistic microbes have recently been identified as effective biocontrol agents for the control of several soil borne plant pathogens, they fail to control sheath blight in the field in most of the cases due to several reasons (Walsh *et al.*, 2000; Howell, 2002; Xue, 2003). Time of application, plant growth stages, the inoculum level and virulence of pathogen as well as antagonistic potential of biocontrolagent, formulation and delivery system of bioagent and integration of soil amendments, etc. play a vital role in biocontrol strategy (Khan and Sinha, 2006). The present investigation was, therefore, undertaken to evaluate

Table 1. Comparative efficacy of different organic amendments mixed with antagonists against sheath blight of rice under field conditions

Treatments	Disease severity$		Disease incidence$	
	Disease severity* (%)	Reduction in disease severity (%)	Disease incidence* (%)	Reduction in disease incidence (%)
Neem cake + T.H.	31.19 (33.75)	54.77	36.82 (37.28)	57.27
Vermicompost + T.H.	35.63 (36.46)	48.33	41.86 (40.23)	51.43
Pressmud + T.H.	39.03 (38.57)	43.40	44.89 (41.99)	47.92
Poultry Manure + T.H.	40.03 (39.15)	41.96	43.13 (41.01)	49.95
Sawdust + T.H.	42.72 (40.77)	38.05	47.69 (45.65)	44.66
FYM + T.H.	32.90 (34.90)	52.29	39.84 (38.97)	53.77
Neem cake + P.F.	33.99 (35.37)	50.71	41.24 (39.89)	52.15
Vermicompost + P.F.	37.23 (37.55)	46.02	44.05 (41.49)	48.88
Pressmud + P.F.	39.93 (39.16)	42.10	48.38 (44.04)	43.86
Poultry Manure+P.F.	42.84 (40.84)	37.87	46.98 (43.20)	45.49
Sawdust+P.F.	44.63 (41.87)	35.29	50.90 (45.49)	40.94
FYM + P.F.	39.13 (38.58)	43.25	42.38 (40.54)	50.82
Control	68.96 (56.28)	-	86.18 (68.24)	-
CD at 5%	6.98	-	7.75	-
S.E. (d)	3.43	-	3.80	-

* Mean of four replications; ** values in parentheses are angular transformed; T.H.- *Trichoderma harzianum,* P.F.- *Pseudomonas fluorescens;* $ pooled analysis, average of two years, i.e., Kharif 2004 and 2005

Table 2. Comparative efficacy of different organic amendments on antagonists on grain yield and 1000– grain weight of rice

Treatments	Grain yield$		1000 Grain weight$	
	Grain yield* (Q ha^{-1})	Increase in grain yield (%)	1000–grain weight*(g)	Increase in 1000-grain weight (%)
Neem cake + T.H.	32.66	39.44	29.19	26.37
Vermicompost + T.H.	31.58	34.83	28.27	22.40
Pressmud + T.H.	30.31	29.43	27.38	18.53
Poultry Manure + T.H.	27.82	18.77	26.81	16.04
Sawdust + T.H.	26.13	11.57	25.12	8.72
FYM + T.H.	31.17	33.11	28.66	24.05
Neem cake + P.F.	29.03	23.96	27.55	19.25
Vermicompost + P.F.	29.13	24.37	26.47	14.59
Pressmud + P.F.	27.01	15.31	25.74	11.42
Poultry Manure + P.F.	26.94	15.02	24.71	6.98
Sawdust + P.F.	25.71	9.76	25.76	11.53
FYM + P.F.	29.25	24.90	26.52	14.81
Control	23.42	-	23.12	-
CD at 5%	0.85	-	1.08	-
S.E. (d)	0.41	-	0.52	-

*Mean of four replications; T.H.- *Trichoderma harzianum,* P.F.- *Pseudomonas fluorescens*; $ Pooled analysis, average of two years, i.e., Kharif 2004 and 2005 the effect of integration of organic amendments with fungal or bacterial antagonist (*T. harzianum* and *P. fluorescens)* applied as soil treatment against sheath blight in aromatic rice caused by *R. solani* under field conditions.

MATERIALS AND METHODS

The antagonists *T. harzianum* (10^6CFUs g^{-1}) and *P. fluorescens* (10^7CFUs g^{-1}) were obtained from the Biocontrol Laboratory of Sardar Vallabh Bhai Patel University of Agriculture & Technology, Meerut, for the present investigation. The field experiments were conducted in natural clay loam soil at the Crop Research Centre of the university during *Kharif* season of 2004 and 2005 in a sick plot. The experiments were conducted in randomized block design with a plot size of 4x5 m^2 and 4 replications. The distance of 1.5 m was kept between two replications and 0.8 m between two treatments. Six organic amendments *viz*., neem cake, vermicompost, press mud, poultry manure, sawdust and FYM @ 250kg ha^{-1} with *T. harzianum* and *P. fluorescens* @ 5kg ha^{-1} talc based powder formulation were applied in combination, to the rice field. The untreated plots served as control. For better decomposition, the organic amendments with antagonist were incorporated in the filed by puddling 15 days prior to the transplanting of the seedling. After puddling, twenty one-day-old rice seedlings (2 seedlings / hill) of var. Pusa Basmati-1 were planted at a distance of 20 x 15 cm. Fertilizers ($N_{60}P_{60}K_{40}$) were applied as basal dose at the time of puddling and two top dressing with nitrogen in the form of urea were given @ 30kg nitrogen/ha after 20 and 40 days of transplanting. Approximately, 5 cm standing water was maintained in the field through out the growing season of the crop. In addition to these, all the standard recommended practices for growing basmati rice varieties were followed in raising the crop. The observations on disease severity (lesion lenght) and infected tillers/hill (disease incidence) were recorded 10 days prior to harvest using standard evaluation system (SES) scale (IRRI, 1996). The plants from each plot were harvested separately and thrashed manually leaving border rows from all sides to record grains yield/plot and other observations after drying grain yield/ha and 1000–grain weight were recorded. Percent increase in grain yield/ha, 1000–grain weight and reduction in disease severity and incidence were calculated.

RESULTS AND DISCUSSION

Effect of soil organic amendments and antagonist on disease severity and incidence

The experiments were carried out to evaluate the effect of integration of organic amendments and antagonists (*T. harzianum* and *P. fluorescens*) on sheath blight. The beneficial effects of soil amendment in plant disease management lie in their ability to produce toxic substances during their decomposition and also suppress pathogen populations through the stimulation of soil saprophytes. All the organic amendments had synergistic effect on effectivity of *T. harzianum* and *P. fluorescens* and significantly reduced the disease severity and incidence of sheath blight under field conditions. The treatment, neem cake + *T. harzianum* was most effective in reducing the disease incidence (57.27%) and disease severity (54.77%) and it was followed by FYM + *T. harzianum* which resulted in the reduction of disease incidence by 53.77% and disease severity by 52.29%, respectively (Table 1). Among all the organic amendments, reduction of sheath blight was lowest in the combination of sawdust + *P. fluorescens* with disease incidence of 40.94% and disease severity of 35.29%. Meena and Muthusamy (1999) reported a reduction in disease incidence from 78.87% to 27.07% and disease severity from 18.84 to 2.54% in the treatment with neem cake applied in soil followed by FYM and decomposed coir pith, where the disease incidence was 31.50 and 36.50%, respectively. Khan and Sinha (2005) observed that neem cake + *T. harzianum* was the most effective in reducing the disease incidence (77.35%) and disease severity (61.73%), followed by FYM + *T. harzianum* and Dhaincha + *T. harzianum.* They concluded that the soil borne pathogens might be controlled successfully by the use of organic amendments in soil. The efficacy of fungal antagonist was greatly enhanced when they were used in combination with organic amendment. Baby and Manibhushanrao (1993) found higher population densities of fungi, bacteria and actinomycetes in soil amended with organic manures and consequent reduction of the sheath blight pathogen *R. solani.* The suppression of soil borne plant pathogens by organic amendments has been ascribed to the volatile and non-volatile substances produced during their decomposition and / or by the stimulation of resident antagonists. Antagonists are capable of rapid colonization of organic material leading to decrease in inoculum potential of soil borne plant pathogens. Therefore, significant reduction in sheath blight by *T. harzianum* with neem cake might be due to compounds produced by the decomposition of amendment or by the influence of the antagonist and other saprophytes that compete for the nutrients and space with *R. solani*. The present study also proved the efficacy of antagonistic bacteria in reducing sheath blight disease of rice.

Effect of soil organic amendments and antagonist on grain yield and 1000-grain weight

Significant increase in grain yield and 1000 grain yield was recorded when the bio–agents were applied as soil treatment mixed with organic manures (Table 2). Maximum increase in grain yield (39.44%) and 1000–grain weight

(26.37%) of rice was observed with the treatment neem cake + *T. harzianum*. FYM + *T. harzianum* and pressmud + *T. harzianum* were the next in order of effectiveness in increasing grain yield and 1000–grain weight. Minimum increase in grain yield (9.76%) and 1000–grain weight (11.53%) were recorded with the treatment Sawdust + *P. fluorescens*. The inoculation of antagonist reduced disease severity, incidence and thereby increased the grain yield and grain weight significantly as compared to control when the soil was treated with *T. harzianum* (Tiwari and Singh, 2005). Das *et al.* (1996) also observed significant increase in grain yield when antagonists were applied as seed treatment. Better influence of *T. harzianum* and *P. fluorescens* on management of sheath blight of rice using a combination of organic manure might be attributed to better establishment of the antagonist in the targeted niche and they have also been higher antagonistic potential against the *R. solani*. The results of the present investigation indicate that the antagonistic bacterium *P. fluorescens* when mixed with organic manure reduced sheath blight disease and also increased grain yield and grain weight of rice. Vidhyasekaran and Muthamilan (1999) have also reported that maximum control of sheath blight could be achieved when the biocontrol agent *P. fluorescens* was applied as soil treatment, seedling root dip and foliar spray. However, still better responses may be achieved if different antagonists having a different mode of action (comprising of parasitization, competition and antibiosis) are applied as soil treatment mixed with organic manures.

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