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Influence of application methods of *Pseudomonas fluorescens* for managing rice sheath blight

RAJBIR SINGH and A.P. SINHA
Centre of Advanced Studies in Plant Pathology, G. B. Pant University of Agriculture and Technology, Pantnagar 263 145

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Sheath blight caused by *Rhizoctonia solani* Kûhn is one of the most important diseases of rice, which is known to cause considerable yield loss in all the rice growing tracts of the country. Yield losses due to the disease is reported to range from 1.2-69.0% (Naidu, 1992) depending on cultivars,environmental conditions, crop stages at which the disease appears and cultivation practices. Application of high doses of nitrogen fertilizers (Roy, 1978), closer plant spacing (Kannaiyan and Prasad, 1983), cultivation of high yielding varieties and weather conditions like low light, cloudy days and high relative humidity (Dath, 1990) favour the disease development.

Management of sheath blight by resistant cultivars has not been successful because adequate level of resistance has not been found (Mew and Rosals, 1986). For disease management biological control is eco-friendly, environment conscious and an alternative method to chemical control. Reports are available indicating *Pseuodomonas. fluorescens* as a highly effective biocontrol agent against sheath blight (Gnanamanickam *et al.,* 1992; Krishnamurthy and Gnanamanickam, 1997). The bioagent inhibits pathogen by competion, antibiosis induced resistance, siderphore production or by plant growth promotion. (Weller, 1988). In the present study, experiments were conducted, under glasshouse condition to assess the efficacy of *P.fluorescens* as seed treatment, soil application, foliar spray, root dip and their combinations against rice sheath blight.

The pathogen *R. solani* was multiplied on sorghum grain medium. Rice seeds of cultivar Pant Dhan 4 were surfaced sterilized with 2.5% sodium hypochlorite for 3 minutes followed by 2-3 washings with sterile distilled water. The seeds were treated with talc based formulation of *Pfr* 1 @ 2 g/kg. seed. Thirty cm diameter plastic pots were filled with clay loam soil obtained from the rice field. Biocontrol agent @ 2 kg/ soil was applied and incorporated up to the topsurface of soil and mixed on the top 1 cm soil. The pots were covered with polyethylene sheet to maintain proper moisture.. After 7 days, 20 seeds of were sown in each pot. For soil treatment, talc based formulation formulation of the biocontrol agent was added to the soil surface, 7 days after pathogen inoculation and mixed well on the top 2 cm soil. For seedling root dip treatment, roots of 21 day old seedlings were dipped in *Pfr1* suspension (cfu 10^8/g) for 10 minutes and then the seedlings were transplanted. The pathogen was inoculated at maximum tillering stage (45 days after transplanting) by placing rice stem pieces covered with mycelium and sclerotia of *R. solani* in between tillers above water level. Foliar spray with the antagonist was given 2 days after inoculation and second spray was given at 15 days later. The pots without any spray served as control. Three replications were maintained for each treatment. The first observation on disease severity and infected tillers/hill was recorded a day before the second spray of the antagonist, following standard evaluation systems for rice (IRRI, 1996). All plants from each pot were harvested and threshed separately from which 1000 grain weight and total yield was recorded.

The result of the present study revealed that all the methods of application significantly reduced disease severity and incidence as compared to

control (Table 1). Combinations of more than two methods of application were more effective in reducing sheath blight as compared to single method. Among single method of applications, foliar spray with *Pfr* 1 was found to be highly effective in reducing disease severity (47.07%) and incidence (28.94%). Maximum reduction in disease severity (60.95%) and incidence (48.99%) was recorded when all the four method were combined. Combinations of soil treatment, seedling root dip and foliar spray, resulted in 56.97 and 40.17% reduction in disease severity and incidence, respectively. Minimum reduction in disease severity (33.82%) and incidence (14.49%) were recorded with seed treatment alone.

Reduction in sheath blight by seed treatment with bacterial bioagent has been observed by Dandurand *et al.* (1994). Vidhyasekaran and Muthamilan (1995) applied bacterial biocontrol agents only by seed mixing, PpV14i which reduced sheath blight upto 60%. When applied seed treatment in combination with root dip and 2 foliar sprays, the performance was on par with that of Validamycin. Vidyasekaran and Muthamilan (1999) demonstrated that when the talc based formulation of *P.fluorescens* was applied as seed treatment, the bacteria established well in the rice rhizosphere. Root treatment or soil application of the formulation was less effective in establishing the bacteria into the rhizosphere. Effective control of rice sheath blight was obtained when the powder formulation was applied to seed, roots, soil and foliage and these methods of application increased grain yield in 4 field trials. In the present investigation also combinations of seed + soil + rood dip and foliar spray were found highly effective against sheath blight. Shivakumar and Narayanaswamy (1998) reported that the application of *Pseudomonas* isolates as seed treatment, followed by soil application was found to be highly effective in reducing the proportion of infected tillers and disease severity under field conditions.

Reports obtained from present investigation indicate that all the methods of application with *Pfr*1 significantly increased grain yield/plant and 1000-grain weight as compared to check (Table 1). Among single method of application, foliar sprays with *Pfr* 1 was found best in increasing grain yield/ plant (23.97%) and 1000-grain weight (9.93%) as compared to other methods of application. Root dip method was next in order of effectivity giving 19.72 and 8.96% increase in grain yield/plant and 1000-grain weight, respectively. Maximum increase in grain yield/plant (33.38%) and 1000-grain weight (15.27%) was observed with the combination of the treatments viz. seed + soil + root dip + foliar

Table 1. Effect of different methods of application of *Pfr*1 on sheath blight, grain yield and 1000 grain weight on transplanted rice, under glasshouse conditions

Treatments	Disease severity (%)	Disease incidence (%)	Grain yield (g/plant)	1000-grain weight (g)
Seed treatment (ST)	43.7 (41.38)	81.1 (64.30)	28.8	26.3
Soil treatment (SLT)	40.7 (39.66)	75.4 (57.96)	29.4	26.8
Root dip (RD)	38.3 (38.24)	71.6 (57.85)	29.8	27.0
Foliar spray (FS)	34.9 (36.25)	66.0 (54.36)	30.1	27.4
ST + SLT	35.1 (36.37)	70.0 (57.93)	30.1	27.1
ST + RD	33.8 (35.58)	62.7 (51.79)	31.2	27.5
ST + FS	32.4 (34.68)	61.4 (51.63)	31.6	28.1
ST + SLT + RD + FS	25.7 (30.46)	48.3 (44.03)	33.3	28.5
ST + RD	34.2 (35.82)	63.7 (53.00)	31.0	27.4
SLT + RD + FS	28.3 (32.15)	56.7 (48.86)	32.5	28.3
RD + FS	31.2 (33.95)	59.1 (50.31)	32.4	27.8
Control	66.1 (54.40)	94.9 (77.07)	24.9	24.8
CD at 5%	2.9	3.8 1.3	1.6	

Mean of three replications.

Figures in parantheses are angular transformed values.

sprays, which is followed by the combinations of soil treatment+ root dip and foliar sprays giving 30.59 and 14.54% increase in grain yield/plant and 1000-grain weight, respectively. Minimum increase in grain yield/plant (15.67%) and 1000-grain weight (6.26%) was observed when the bioagent was applied as seed treatment. Vidhyasekaran and Muthamilan (1999) also obtained maximum grain yield with the combination of seed treatment, seedling root dip, soil application and foliar sprays.

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