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Evaluation of a liquid formulation of *Pseudomonas fluorescens* for management of sheath blight in paddy

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Abstract

Sheath blight is a soil-borne disease caused by the fungus *Rhizoctonia solani* and one of the most economically significant rice diseases worldwide. Two year pooled results of field experiment revealed minimum disease intensity (11.8%) and maximum reduction (58.0%) , maximum yield of paddy (3750.7 kg/ha) and cost benefit ratio (1.75) from the treatment *Pseudomonas fluorescens* @ 2.0 l/ha as foliar spray which was at par with *P. fluorescens* @ 3ml/kg as seed treatment followed by 1.5 l/ha as foliar spray (PDI 10.3 and PDC 64.5%) with grain yield (3911 kg/ha) as compared to control. However, standard check with fungicide Hexaconazole 5% EC @ 2ml/kg as seed treatment followed by 1.0 l/ha as foliar spray gave minimum disease intensity (9.3%), maximum disease control (67.9%) and highest yield of paddy (3944 kg/ha) with highest cost benefit ratio (1.95).

Keywords: Paddy, sheath blight, *Rhizoctonia solani, Pseudomonas fluorescens* and bio-agent

Introduction

Rice (*Oryza sativa* L.) is the second most important cereal and the staple food for more than half of the world's population. It provides 20 per cent of the world's dietary energy supply followed by Maize and Wheat. Sheath blight incited by *R. solani* is one of the potentially devastating disease of rice in almost all over the rice growing countries of the world. In India, intensive and extensive cultivation of rice mostly under rice-wheat cropping system have resulted heavy losses to the crop ranging from 5.2 to 70 per cent in yield. Losses due to sheath blight disease generally vary from 30 to 40 per cent and may be even 100 per cent in endemic areas (Li *et al.,* 2009). The reduction in yield due to the disease has been estimated to vary from 5.2 to 50.0 per cent (Ou, 1985, Hori 1969). Per cent relative lesion height (RLH) was to the tune of 68.68 percent (Naik *et al.,* 2017).The disease development was favoured due to the application of high doses of nitrogenous fertilizers, close plant spacing, widespread cultivation of high yielding varieties and weather conditions such as low light, cloudy days and high relative humidity. Infected plants are usually found in a circular pattern, locally referred to as 'bird's nest' (Hollier *et al.,* 2009). The disease appears at tillering stage on leaf sheath as elliptical or oval to irregular, 1-3 cm long, greenish gray spots with brown margin at or above the water line. Presence of many such spots on the leaf sheath gives the appearance of snake skin. Under favourable conditions, the infection spreads rapidly to the upper plant parts and also to the neighbouring plants by means of normal emergence and expansion of the ears and results in poor filling of the grains. The pathogen is also known to cause panicle infection resulting in production of unfilled or partially filled discoloured seed bearing brownish black spots or black to ashy gray patches (Acharya *et al.,* 2004). The use of pesticides caused an incredible harm to the environment and hazard in natural ecosystems, which resulted into replacement of chemicals with biological

approaches, which are considered more environment friendly in the long term. One of the emerging research area for the management of different phytopathogenic factors is the application of antagonistic plant growth promoting rhizobacteria (PGPR), which are capable of suppressing the phytopathogen damage. Therefore, the present study was undertaken to assess the bio-efficacy of *Pseudomonas fluorescens* for the management of Sheath blight in paddy.

Materials and Methods

The experiment was conducted at Agricultural Research Station, Agriculture University, Kota during *Kharif* 2018 and 2019 to evaluate the bio-efficacy of liquid formulation of *P. fluorescens* in managing sheath blight in paddy. The experiment was laid out in a Randomized Block Design (RBD) with three replications and nine treatments comprised of testing of *P. fluorescens* as a positive check *i.e.* Hexaconazole 5% EC @ 1.0 l/ha and one untreated control plot for comparison. Paddy (*cv*.P-1509) was raised by using all recommended agronomical package of practices in both the seasons. Treatments were sprayed twice using a hand operated knapsack sprayer fitted with hollow cone nozzle and water volume of 500 lit/ ha was maintained. Seedling dip treatment and first spraying was given just after the appearance of the disease and second was given 14 days after the first spray. Observations on diseases were recorded 15 days after each spray. The PDI was calculated on five plants / sampling unit by counting the number of infected tillers. Each selected plant was approximately divided into three portions as bottom, middle and top. The disease severity was assessed based on the Standard Evaluation System (0-9) of IRRI during the experimentation.

The percent disease Index (PDI) was finally calculated using the following formula:

$$PDI = \frac{\text{Sum of numerical rating}}{\text{Total number of hills observed} \times \text{maximum of score}} \times 100$$

Scoring of the diseases was done as per the scales given below.

Scale for sheath blight disease

Score	Description
0	No infection
1	Vertical spread of the disease up to 20% of plant height
3	Vertical spread of the disease up to 21-30% of plant height
5	Vertical spread of the disease up to 31-45% of plant height
7	Vertical spread of the disease up to 46 – 65% of plant height
9	Vertical spread of the disease more than 66% of plant height

Yield: Plot wise yield recorded after harvest and then calculated in to Kg/ ha.

Results and Conclusion

The results of field experiment revealed that there were significant differences among the treatments in reducing sheath blight severity (Table 1). Results revealed that Hexaconazole 5% EC @ 1lit/ha significantly reduced disease severity (68.00%) and disease intensity (9.3%) compared to control (29.0%). Significant differences of *P. fluorescens* treatment effects were also recorded on percent disease incidence as well as on tillers and yield. Among the different doses of *P. fluorescens,* the disease intensity was found significantly lowest (10.3%) and maximum reduction (64.5%) in the treatment (T7) *P. fluorescens* @ 3ml/ kg as seed treatment followed by 1.5 lit/ha as foliar spray which was at par with (T6) *P. fluorescens* @ 2.0 lit/ha as foliar spray (PDI 11.8 and PDC 59.3%). The highest yield of paddy (3944.2 kg/ha) was recorded in Hexaconazole 5% EC @ 2ml/kg as seed treatment followed by 1.0 lit/ha as foliar spray (T8) which was at par with *P. fluorescens* @ 3ml/kg as seed treatment followed by 1.5 lit/ha as foliar spray (3911.7 kg/ha) and *P. fluorescens* @ 2.0 lit/ha as foliar spray (3750.7

kg/ha) as compared to control (2766.3 kg/ha). The highest cost benefit ratio of 1.95 was obtained with Hexaconazole 5% EC @ 2ml/kg as seed treatment followed by 1.0 lit/ha as foliar spray. Whereas, among the biological treatments, maximum cost benefit ratio (1.75) was recorded by *P. fluorescens* @ 2.0 lit/ha as foliar spray against sheath blight of paddy.

Table 1: Bio-efficacy of *P. fluorescens* on sheath blight in rice (pooled)

Treatments	Infected tillers (%)	Yield /ha (kg)	% Disease control	B:C Ratio
T1: *P. fluorescens* @ 2ml/kg as seed treatment	27.2 (5.2)	2836.3	6.6	1:1.12
T2: *P. fluorescens* @ 3ml/kg as seed treatment	22.5 (4.7)	2933.3	22.4	1:1.17
T3: *P. fluorescens* @ 4ml/kg as seed treatment	20.7 (4.5)	3200.8	28.6	1:1.35
T4: *P. fluorescens* @ 1.0 lit/ha as foliar spray	18.0 (4.2)	3264.2	37.9	1:1.44
T5: *P. fluorescens* @ 1.5 lit/ha as foliar spray	14.3 (3.8)	3427.5	50.7	1:1.54
T6: *P. fluorescens* @ 2.0 lit/ha as foliar spray	11.8 (3.6)	3750.7	59.3	1:1.75
T7: *P. fluorescens* @ 3ml/kg as seed treatment followed by 1.5 lit/ha as foliar spray	10.3 (3.2)	3911.7	64.5	1:1.73
T8: Hexaconazole 5% EC @ 2ml/kg as seed treatment followed by 1.0 lit/ha as foliar spray	9.3 (3.1)	3944.2	67.9	1:1.95
T9: Untreated check	29.0 (5.4)	2766.3	-	1:1.11
LSD @ 5%	2.61	212.52	-	-

Values in parentheses are square root transformed values of three replications

Results are inconformity with Johnson *et al.,* (2013) who found hexaconazole as an effective fungicide against sheath blight of rice. Naik *et al.,* (2017) found that the field efficacy of hexaconazole 5EC (0.1%) and propiconazole 25EC (0.1%) could be used effectively for the management of sheath blight disease of rice and thus helped for getting higher grain yield and B: C ratio. *P. fluorescens* is ideal antagonist as they have ability to produce various inhibitory antimicrobial compounds (Schroth and Hancock, 1982). Maximum increase of all the growth parameters was recorded with combination of *P. fluorescens* and *T. harzianum.* Singh and Sinha (2009) observed growth promotion due to seed treatment with *T. harzianum* and *P. fluorescens* which enhanced nitrogen uptake and alleviated drought stress in rice crop. Tiwary and Trimurty (2009) also reported lowest disease severity under field conditions through seed treatment along with two foliar sprays of *P. fluorescens* over foliar application of carbendazim 50% WP as untreated control. Neha *et al.,* (2016) also recorded that seed treatment with *P. fluorescens* @ 10 ml kg-1 along with seedling dipping of roots @ 3.0 l ha-1 significantly enhanced the germination (75.82%), plant height (25.52), number of tillers (16.99) and grain yield (48.23 g pot-1). *P. fluorescens* has emerged as a potential bio control agent due to different modes of action such as competition for nutrients and space, antibiosis, mycoparasitism, induced systemic resistance, production of siderophore, phytohormones, production of lytic enzymes and various secondary metabolites such as DAPG, Phenazine, pyoluteorin, pyrollnitrin, which are helpful in reducing pathogen population within soil (Gupta *et al.,* 2002). Thus, the finding of present investigations is quite in conformity with the reports of earlier workers. However, hexaconazole (triazole fungicide) is a potent ergosterol biosynthesis inhibitor and sterol in most fungi and hence resulted

comparatively higher effectiveness than bio-agents, because it persists for a longer period inside the plant system and protects crop against sheath blight constantly for a longer period.

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