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INTEGRATED MANAGEMENT OF SHEATH BLIGHT (*Rhizoctonia solani* Kuhn) OF RICE UNDER FIELD CONDITION

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ABSTRACT

The present investigation was undertaken to assess the per cent disease index (PDI) and grain yield against sheath blight of rice through different combinations of indigenous strains of *Pseudomonas fluorescens* under field condition during *kharif* 2022-23. Results indicated that Carbendazim 0.1% was recorded highly effective and significantly suppressed the sheath blight severity (73.20%) followed by Carbendazim 0.05% (69.60%) and *P. fluorescens* 1% + Carbendazim 0.05% (64.60%) as compared to other treatments including *P. fluorescens* alone. Moreover, among rhizobacteria *P. fluorescens* + *Bacillus subtilis* 10% (62.70%) was found significantly more effective followed by *Pseudomonas fluorescens* 10% (60.60%) and *Pseudomonas fluorescens* 5% (57.70%). Similarly, significantly higher grain yield was recorded from Carbendazim 0.1 % (54.60 q ha^{-1}) treated plot followed by Carbendazim 0.05% (53.80 q ha^{-1}), *P. fluorescens* 1% + Carbendazim 0.05% (52.80 q ha^{-1}) and *P. fluorescens* +*Bacillus subtilis* 10% (48.30 q ha^{-1}) as compared to untreated control plot (38.00 q ha^{-1}). It is inferred from the data that treatments of Carbendazim 0.1% ,Carbendazim 0.05% and *P. fluorescens* 1% + Carbendazim 0.05% were found most effective in reducing per cent disease index and enhancement in yield of rice.

(Key words: *Rhizoctoniasolani*, rice, sheath blight, integrated disease management and grain yield)

INTRODUCTION

Sheath blight of rice is potentially a serious fungal disease caused by *Rhizoctonia solani* Kuhn [*Thanatephorus cucumeris* (Frank) Donk]. Sheath blight of rice is one of the most destructive rice diseases and affected by many others diseases and insect pests (Kaushik and Nirmalkar, 2020).

It is widespread throughout the world's rice-growing regions (Thakur *et al*., 2022). Yield losses of 4 to 50% have been recorded, depending on the tillering stage at the time of infection (Bhunkal *et al*., 2015). The pathogen *R. solani* is a versatile soilborne saprophyte with highly competitive saprophytic ability and wide host range. It survives in soil as sclerotia or thick-walled mycelia. They remain viable in soil for several months over a wide range of temperature and moisture. Combination of *Pseudomonas* species there are expose in which several workers reported that combination of *Pseudomonas fluorescens* with other bacterial and fungal bio-agents enhance efficacy against the rice sheath blight disease. *Pseudomonas fluorescens* and *Trichoderma viridi* perform well in combination against rice sheath blight and also promote plant growth (Nirmalkar *et al*., 2018).The present investigation, therefore aimed towards developing a sustainable integrated disease management system.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* 2022-23 to assess the efficacy of most effective *Pseudomonas fluorescens* strains alone as well as in integration with fungicide and with other bio control agent i.e. *Bacillus subtilis*. The experiment was laid out in Randomized Block Design (RBD) with the plot size of 2 m x 1 m, and each treatment was replicated thrice. Thirty days old seedlings of rice variety -Swarna was transplanted in the field at a spacing of 20 cm × 10 cm and 2 seedlings planted hill^{-1}.

Bacterial suspension of *Pseudomonas fluorescens*

Liquid formulation of indigenous strains of *Pseudomonas fluorescens* and *Bacillus subtilis* was procured from State Bio Control Laboratory (SBCL) BTC College of Agriculture and Research Station (IGKV), Chorbhatti, Bilaspur (C.G.) and was used as treatments under the experiment and applied as foliar application.

Preparation of pathogen inoculum

Fresh inoculum of sheath blight (*Rhizoctonia solani*) was prepared in the Plant Pathology laboratory on weed grass (*Saccharum* spp.) which was used as host for the growth and multiplication of pathogen. The grasses was cut into small pieces of desired size and packed in polythene bags for sterilization in autoclave at (121.6°C for

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15 min.). 10 discs of 5 mm of five days old culture of *Rhizoctonia solani* was aseptically inoculated into the grasses and incubated for the seven days in BOD incubator at 25 ±2 ° C.

Treatment details

Treatments	Concentration% Cfu ml^{-1}	Doses (ml l^{-1} water)
T_{1}-*Pseudomonas fluorescens*	1% (1×10^{7})	10
T_{2}-*Pseudomonas fluorescens*	5 % (1×10^{9})	50
T_{3}- *Pseudomonas fluorescens*	10% (1×10^{10})	100
T_{4}-*P. fluorescens* + *Bacillus subtilis*	10% (1×10^{10})	50 +50
T_{5}-*P. fluorescens* + *Bacillus subtilis*	5%(1×10^{10})	25 +25
T_{6}-*P. fluorescens* + *Bacillus subtilis*	1%(1×10^{9})	5 + 5
T_{7}-Carbendazim	0.1 %	1g
T_{8}-Carbendazim	0.05%	0.5g
T_{9}-*P. fluorescens* + Carbendazim	1%(1×10^{7})+0.05 %	10 + 0.5 g
T_{10}- Untreated control		

Inoculation into rice plants

30 days old rice seedlings was collected from nursery field and transplanted into experimental field. Maximum tillering stage was artificially inoculated. The inoculum of pathogen (*Sclerotia*/mycelia) was multiplied on grass bits and used for the inoculation of the rice plants at maximum tillering stage, the details of various treatments was demonstrated in the form of tags which were placed on each primary tiller. Relative Humidity was maintained at 85-90% by spraying sufficient clean water. Water was applied to seedlings when required for the entire experimental period for development of sheath blight disease.

Treatment application

After the appearance of first symptoms of sheath blight, different bacterial suspension treatments i.e. *P. fluorescens* 1%, 5% and 10% was sprayed, as well as combination of *P. fluorescens*+ *Bacillus subtilis* of indigenous isolates, *Pseudomonas fluorescens* along with fungicide was applied as a foliar spray with the help of micro sprayer, three sprays were applied at an interval of seven days. Pre treatment observations was recorded after 7 days of inoculation whereas; post treatment observations recorded just after the completion of first second and third spray. The final observation was recorded after 7 days of third spray (Tiwari *et al*., 2016).

Observations were recorded as followed

Plants were observed critically for visual scoring of disease incidence and severity using the standard evaluation scale (0–9) suggested by International Rice Research Institute (Anonymous, 1996).

Table 1. Visual scoring of sheath blight incidence rating scale given by International Rice Research Institute (Anonymous,1996)

Scale	Symptoms
0	No infection
1	Vertical spread of the lesions up to 20% of plant height
3	Vertical spread of the lesions up to 21-30% of plant height
5	Vertical spread of the lesions up to 31-45% of plant height
7	Vertical spread of the lesions up to 46-65% of plant height
9	Vertical spread of the lesions up to 66-100% of plant height

The Per cent Disease Index (PDI) was calculated by formula given by Wheeler (1969).

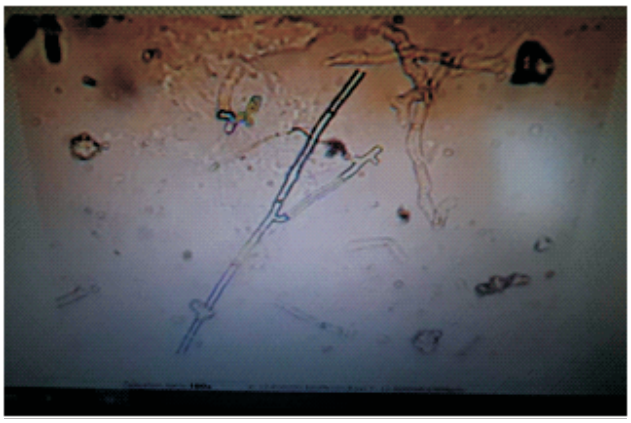
$$\text{PDI } (\%) = \frac{\text{Sum of all individual rating}}{\text{Total number of plants observed}} \times \frac{100}{\text{Maximum disease scale}}$$

Table 2. Efficacy of isolates of *Pseudomonas fluorescens* against sheath blight of rice under field experiment

Treatments	Per cent disease index (PDI)				Percent reduction over control	Yield (q ha^{-1})
	BS	**7th DAS after 1st spray**	**7th DAS after 2nd spray**	**7th DAS after 3rd spray**		
T_{1}- *Pseudomonas fluorescens* @ 1%	11.20 (19.50)	30.10 (33.10)	27.70 (30.90)	23.30 (28.60)	44.80 (41.90)	42.30
T_{2}- *P. fluorescens* @ 5 %	11.50 (19.80)	28.30 (32.10)	25.50 (29.40)	17.70 (24.80)	57.70 (49.420)	44.70
T_{3}- *P. fluorescens* @ 10%	11.50 (19.80)	27.30 (31.40)	20.90 (27.40)	16.50 (23.90)	60.60 (51.00)	46.70
T_{4}- *P.fluorescens+Bacillus subtilis* @ 10%	11.40 (19.70)	25.70 (30.40)	18.90 (25.50)	15.60 (23.30)	62.70 (52.30)	48.30
T_{5}- *P.fluorescens+B. subtilis* @ 5%	11.30 (19.60)	28.30 (32.00)	23.40 (28.20)	18.20 (25.20)	56.50 (48.70)	45.00
T_{6}- *P .fluorescens+B. subtilis* @ 1%	11.50 (19.70)	30.50 (33.40)	29.20 (30.90)	22.60 (28.20)	46.50 (42.90)	42.80
T_{7}- Carbendazim @ 0.1%	11.60 (19.80)	19.40 (26.10)	16.60 (21.90)	11.20 (19.40)	73.20 (58.90)	54.60
T_{8}- Carbendazim @ 0.05%	11.50 (19.80)	24.50 (29.60)	17.00 (23.80)	12.70 (20.80)	69.60 (56.50)	53.80
T_{9}- *P.fluorescens*+carbendazim @ 1%+0.05%	11.60 (19.80)	25.30 (30.10)	18.60 (24.50)	14.80 (22.60)	64.60 (53.50)	52.80
T_{10}- Untreated control	11.50 (19.80)	37.50 (37.70)	39.90 (39.10)	42.00 (40.30)	0	38.00
SE(m)±	**0.09**	**1.29**	**1.13**	**1.40**	**2.59**	**3.06**
CD at 5 %	**-**	**3.87**	**3.38**	**4.20**	**7.78**	**9.16**
CV	**0.85**	**7.08**	**6.95**	**9.43**	**9.88**	**11.31**

*** Figure in the parentheses indicated arcsine transformed BS = Before spray DAS = Day after spray**

Sheath blight symptoms



Microscopic identification

T7 Carbendazim (0.1%)

T8 Carbendazim (0.05%)

T9 *P. fluorescens*(0.1%)+Carbendazim (0.05%)

T4 *P. fluorescens+Bacillussubtilis*(10%)

T3 *P. fluorescens* (10%)

Control

Plate 1. Evaluation of isolates of *Pseudomonas fluorescens* against *R. solani* (sheath blight of rice) under field condition

RESULTS AND DISCUSSION

Data presented in Table 2 indicates that some treatments were found significantly effective in controlling rice sheath blight severity and increasing the yield over control. Considering the data of 1st, 2nd and 3rd spray lowest per cent disease index (PDI) and maximum reduction per cent were observed by the application of Carbendazim 0.1% (PDI-11.20% and 73.20%) which was found to be most effective treatments. This treatment was found at par with treatments Carbendazim 0.05% (PDI-12.70% and 69.60%) and *Pseudomonas fluorescens* 1% + Carbendazim 0.05% (PDI-14.80% and 64.60%) when compared with control and rest of the treatments under study. Treatments i.e.*P. fluorescens*+ *Bacillus subtilis* 10% (PDI -15.60% and 62.70%), *Pseudomonas fluorescens* 10% (PDI -16.50% and 60.60%) and *Pseudomonas fluorescens* 5% (PDI -17.70% and 57.70%) were also found significantly and highly effective in controlling sheath blight disease over untreated control (PDI-42.0%). Application of half doses of *Pseudomonas fluorescens* 1% + Carbendazim 0.05% (PDI-14.80% and 64.60%) was also found significantly effective when compared to *Pseudomonas fluorescens* applied alone and control.

Some treatments produced significantly more grain yield over control. However, Carbendazim 0.1% treated plots recorded significantly highest grain yield of (54.60 q ha^{-1}) and found at par with treatments Carbendazim 0.05% (53.80 q ha^{-1}), *P. fluorescens* 1% + Carbendazim 0.05% (52.80 q ha^{-1}) and *P. fluorescens* +*Bacillus subtilis* 10% (48.3 q ha^{-1}) over untreated control (38.00 q ha^{-1}).

The findings therefore suggest that the fungicide used alone or in combination with *Pseudomonas fluorescens* out performed all treatments in respect to providing significantly higher grain yield. The combination of half dose of Carbendazim and *Pseudomonas fluorescens* was found to be at par with full dose of Carbendazim used alone which suggests the possibility of using bio agents with reduced dose of compatible fungicides for control of sheath blight of rice.

Similar to present findings Pal *et al*. (2015) reported that the application of bio control agents *Trichoderma viride* as a seed treatment + 3 sprayings gave lowest PDI (10.93 %) and was found very effective in reducing the disease incidence, disease severity against *Rhizoctonia solani* followed by seed treatment + 3 sprayings with *Pseudomonas fluorescens* (PDI -18.71%). Similarly, Sultana *et al*. (2023) studied the effect of bio agent against *Rhizoctonia solani* and many other pathogens and reported 73.75% reduction of *R. solani* mycelia growth while 17 isolates showed plant growth potential of rhizobacteria.

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