Evaluation of the *Pseudomonas fluorescens* Isolate for Sheath Blight Disease Management of Rice in Field Condition

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A B S T R A C T

An experiment was laid out in the field conditions during 2017-2018 at experimental field of IGKV, Raipur to control sheath blight disease of rice by application of different doses of *P. fluorescens* strain P11 suspension. The field evaluation study of *P. fluorescens* isolate P11 for management of sheath blight revealed that the three foliar spray of *P. fluorescens* isolate P11 @ 8ml^{-1} reduced the percent disease index (13.70%) and decreased the disease over control (35.07%) and increase the grain yield (7400 Kg ha^{-1}) as over percent disease index (21.10%) and grain yield (6030 Kg ha^{-1}) respectively in untreated (control).

Introduction

Rice (*Oryza sativa* L.) is second most important cereal and the staple food for more than half of the world's population. It provides 20% of the world's dietary energy supply followed by Maize and Wheat. In Chhattisgarh state rice occupies an area of 3.68 Mha[-1] with the production of 5.22 Mt and productivity of 1.14 Mt ha^{-1} (Anonymous, 2016).

Sheath blight is one major biotic constraints of rice. The disease is caused by *Rhizoctonia solani* Kuhn (teleomorph: *Thanetophorus cucumeris* (Frank) Donk). The disease has been named as "Sheath blight" because of primary infection on leaf sheath. The symptoms of the disease appear on leaf and leaf sheath as 2-3 cm long greenish gray lesions, turning to straw colour and surrounded by bluish gray narrow bands. The lesions increase in size and girdle the stem. Once the infection is established, it spread through contact between diseased and healthy plants. Spherical grayish black sclerotia are formed under natural conditions on the lesions which fall in the field slightly damage. In severe infection, sclerotia form even on the grain. Sclerotia serve as a major source of primary inoculums (Ou, 1985). The diseased ear, grains remain unfilled. Wide host range of the pathogen *Rhizoctonia solani* makes management of the disease a different task. The yield loss due to this disease is reported to range from 5.2 to 50 % depending on the

environmental conditions, crop stages at which the disease occurs, cultivation practices and cultivars used. A modest estimation of losses due to sheath blight disease in India approximately 54.3% (Rajan 1987 and Roy, 1993).

Fungicide application is the most common approach among the farmers for the management of sheath blight throughout the world. These fungicides to control diseases cause several adverse effects i.e. development of resistance in the pathogen, residual toxicity, pollution to the environment etc. *R. solani* is a typical soil borne fungus and its management through chemicals is expensive and not feasible, because of the physiological heterogeneity of the soil, other edaphic factors *etc.* might prevent effective concentrations of the chemical reaching to the pathogen. These chemicals agents are hazardous and may persist and accumulate in natural ecosystems an answer to this problem is replacing chemicals with biological approaches, which are considered more environment friendly in the long term. One of the emerging research area for the control of different phytopathogenic agents is the use of bio-control, plant growth promoting rhizobacteria (PGPR), which are capable of suppressing or preventing the phytopathogen damage (Nihorembere *et al.,* 2011).

P. fluorescens bacteria, a major constituent of rhizobacteria, encourage the plant growth and bio-control avaibility through their diverse mechanisms like phosphate solubilization, siderophore production, biological nitrogen fixation, production of 1-Aminocyclopropane-1-carboxylate deaminase (ACC), phytohormone production, exhibiting antifungal activity, production of volatile organic compounds (VOCs), induction of systemic resistance, promoting beneficial plant-microbe symbioses, interference with pathogen toxin production etc (Gupta *et al.,*

2001; Nandakumar *et al.,* 2001; Noori and Saud, 2012). They can improve the extent or quality of plant growth by direct and indirect methods. The potentiality of PGPR in agriculture is steadily increased as it offers an attractive way to replace the use of chemical fertilizers, pesticides and other supplements. As its name implies, it secretes a water soluble greenish fluorescent pigment called fluorescein. Several strains of *P. fluorescens* have been successfully used for the plant growth promotion and biological control of rice sheath blight (Mew and Rosales, 1986; Rabindran and Vidhyasekaran, 1996; Vidhyasekaran and Muthamilan, 1999).

Materials and Methods

To test the efficacy of *P. fluorescens* isolate P11 is selected for sheath blight disease management in field condition. The 30days old seedlings of cv "Kranti' were transplanted in a net plot size of 5×2 m^2 with a spacing of 1m between replication to replication. Row to row and plant to plant spacing was 20×15 cm. The experiment was laid in Randomized Block Design (RBD) with three replications. Fertilizer was applied @ N$_{120}$: P$_{50}$: K$_0$ ha^{-1} Fifty percent of N and total P were given as basal dose and remaining N applied in two split doses as top dressing at tillering and panicle initiation stage.

The RBD experiment comprises eight treatments and three replications each. To test the efficacy of *P. fluorescens* against sheath blight disease of rice the 48 hours old *P. fluorescens* of concentration 10^{-8} was prepared for foliar spray (Biswas and Datta, 2013). The treatment details are one foliar spray of *Pseudomonas fluorescens*, @4ml/lit of water, Two foliar spray of *Pseudomonas fluorescens*, @4ml/lit of water, Three foliar spray of *Pseudomonas fluorescens*, @4ml/lit of water, One foliar spray of *Pseudomonas fluorescens*, @8ml/lit of water, Two foliar spray of

Pseudomonas fluorescens, @8ml/lit of water, Two foliar spray of *Pseudomonas fluorescens*, @8ml/lit of water, Three foliar spray of *Pseudomonas fluorescens*, @8ml/lit of water, Three foliar spray of Hexaconazole 5 SC (Contaf) @1ml/lit of water and Untreated (control). Bio-efficacy was evaluated after spraying all the different doses and spray of *P. fluorescens* isolate P11 at 10 days intervals starting from initiation of the disease.

Artificial inoculation

In the field experiments, sclerotia from 7-9 days old culture and rice stem bits (*R. solani* mycelium profusely grown) were used for inoculation of the rice plants at the maximum tillering stage. The primary tillers of each hill were tagged and inoculated gently by punching and pushing single sclerotium into the sheath just 1 ½ to 2 ½ cm above the water surface level as per the position of the sheath.

Disease assessment and statistical analysis

The sheath blight disease was measured after ten days of application of different doses of *P. fluorescens*. The sheath blight disease was measured in 0-9 scale developed by International Rice Research Institute (IRRI, Teng *et al.,* 1990). Further, the score data was converted into percent disease index (PDI) by using formula as given below. The data on the yield were recorded. The data on disease severity and yield parameters were subjected to appropriate for statistical analysis.

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of all individual disease ratings}}{\text{Total no. of plant asseded X maximum rating}} \times 100$$

Results and Discussion

An experiment was laid out during 2017-2018 at experimental field of IGKV, Raipur to control sheath blight disease of rice by application of different doses of *P. fluorescens* strain P11 in the concentration level of 10^{-8} i.e. one foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water, two foliar spray of *P. fluorescens* strain P11@4ml^{-1} of water, three foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water, one foliar spray of *P. fluorescens* strain P11@8ml^{-1} of water, two foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water, three foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water and check fungicide Hexaconazole 5 SC (Contaf) three foliar spray @1ml^{-1} of water, were used under the study.

Data on (Table 1 and Fig. 1) revaluated that after 30 days of inoculation of *R. solani* all treatments significantly reduced sheath blight severity over control treatment. The tested check fungicide *i.e.* Hexaconazole 5 SC (Contaf) treatment found superior in reducing the disease severity of sheath blight 11.11% and 47.34% decrease of the disease was followed by three foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water reducing the disease severity of sheath blight 13.70% and 35.07% decrease of the disease over control, three foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water reducing the disease severity of sheath blight 14.07% and 33.31% decrease of the disease over control, two foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water reducing the disease severity of sheath blight 14.81% and 34.81% decrease of the disease over control, two foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water reducing the disease severity of sheath blight 15.18% and 28.05% decrease of the disease over control and one foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water reducing the disease severity of sheath blight 15.92% and 24.54% decrease of the disease over control. The minimum decrease in disease severity 16.29% with 22.79% disease severity was recorded in one spray of *P. fluorescens* strain P11 @4ml^{-1} of water.

Fig.1 Efficacy of different doses of *P. fluorescens* for the control of sheath blight of rice
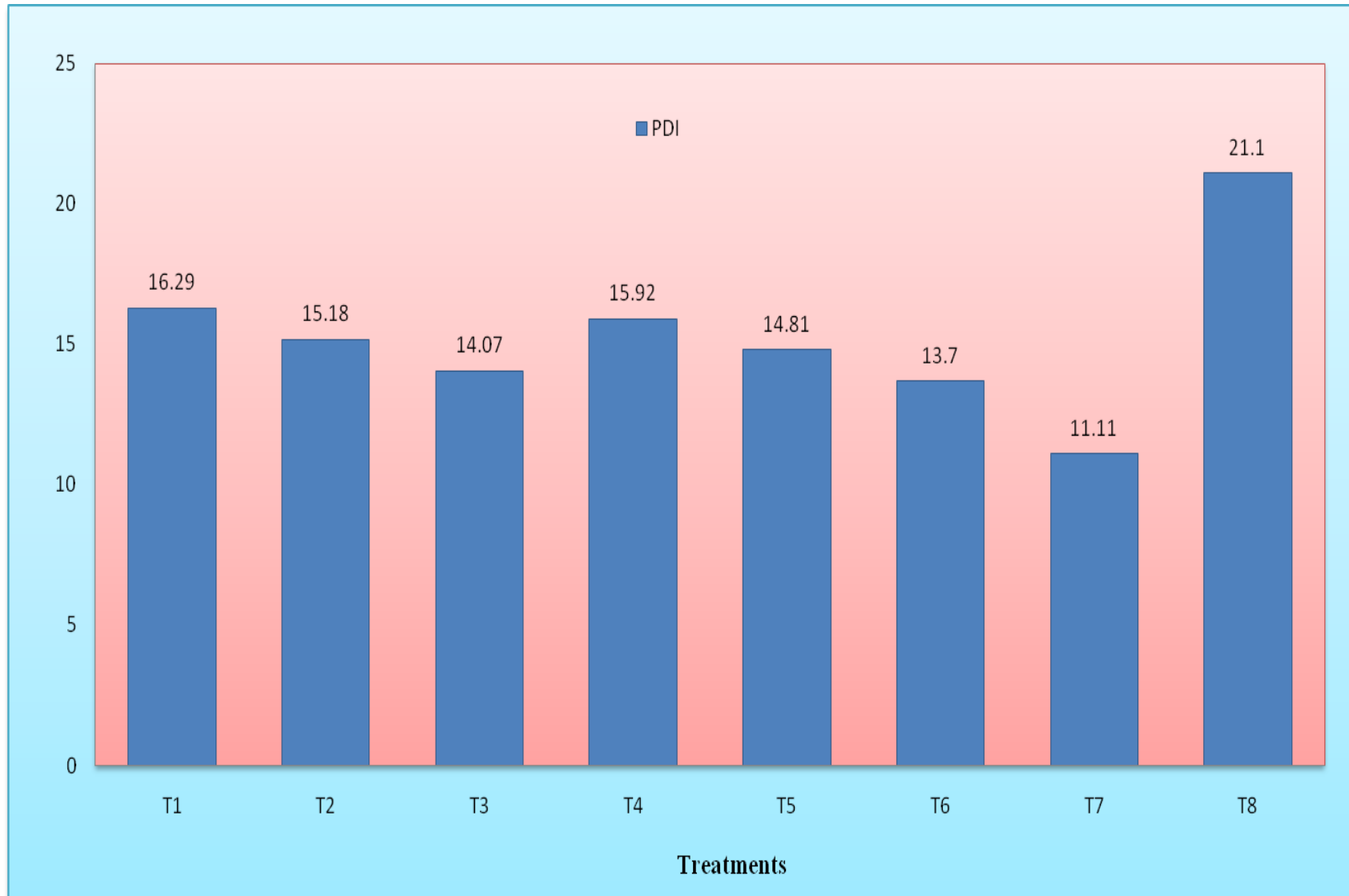
Table.1 Evaluation of different doses and number of sprays of *P. fluorescens* for the management of sheath blight of rice

Treatments	Name of treatment	Doses l^{-1} of water	No. of spray	Percent disease index	Percent decrease over control	Grain yield (kgha^{-1})
T1	P11	4ml	1	16.29 (4.243)*	22.79	6433
T2	P11	4ml	2	15.18 (4.110)*	28.05	6966
T3	P11	4ml	3	14.07 (3.880)*	33.31	7200
T4	P11	8ml	1	15.92 (4.197)*	24.54	6850
T5	P11	8ml	2	14.81 (3.969)*	29.81	7000
T6	P11	8ml	3	13.70 (3.830)*	35.07	7400
T7	Hexaconazole	1ml	3	11.11 (3.480)*	47.34	7560
T8	Control	-	-	21.10 (4.698)*	-	6030
C.D. (5%)				0.219		
SE(m)+				0.071		

*figures in the parenthesis are square root transformed values

Whereas the maximum disease severity 21.10% was recorded under control treatment.

The doses of *P. fluorescens* strain P11 also enhances the yield ha^{-1} of rice over control treatment. There was significant difference in yield increase was observed by application of different doses of *Pseudomonas fluorescens* strain P11on over control treatment. The check fungicide Hexaconazole 5SC (Contaf) was recorded higher grain yield (7560 kg ha^{-1}) and followed by three foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water grain yield (7400 kg ha^{-1}), three foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water grain yield (7200 kg ha^{-1}), two foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water grain yield (7000 kg ha^{-1}), two foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water grain

yield (7400 kg ha^{-1}), one foliar spray of *P. fluorescens* strain P11 @8ml^{-1} of water grain yield (6850 kg ha^{-1}) and one foliar spray of *P. fluorescens* strain P11 @4ml^{-1} of water grain yield (6433 kg ha^{-1}) respectively. Whereas the lowest grain yield was recorded under untreated control (6030 kg ha^{-1}).

Present finding are in agreement with the findings of Singh and Sinha, 2005 studied under field conditions to compare relative efficacy of potential isolates of *P. fluorescens* against sheath blight of rice. Foliar sprays with different isolates of fluorescent pseudomonads in transplanted rice significantly reduced severity and incidence of sheath blight disease of rice. Among the all *P. fluorescens* isolates Pfr 1 (a rice rhizosphere isolate) was more effective in

reducing the disease and increasing grain yield and 1000 per grain weight. Tiwari and Thrimurty, 2009 reported that the *P. fluorescens* isolate PFR1 effectively reduced the blast and sheath blight diseases when applied as seed treatment along with one or two foliar sprays, seed treatment along with two foliar sprays were significantly effective in reducing the alternaria blight of wheat. The yield advantages were also recorded in these treatments. Afsharmanesh *et al.,* (2010) and Surendran *et al.,* (2013) were also found that Fluorescent pseudomonads are able to produce secondary antifungal metabolites can inhibit soil-borne plant pathogens and the antagonistic activity of *R. solani* AG-4 was assessed under *in vivo* and *in vitro* conditions. The findings revealed that with the production of some secondary metabolites and non-volatile metabolites *P. fluorescens* UTPF5 could inhibit the growth of *R. solani* both *in-vitro* and *in-vivo*, and suppress the disease by 33.34% and 14.29% by soil drenching and seed treatment, respectively.

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