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Biological control of sheath blight of rice

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Abstract
The use of bio-control agent as plant growth promoting rhizobacteria (PGPR), which are capable of suppressing or preventing the phytopathogen damage. Use of plant growth promoting rhizobacteria (PGPR) as bio control agents is gaining popularity in managing rice diseases and in enhancing growth and grain yields. Strains of *Bacillus subtilis* and *Bacillus megaterium* have shown significant inhibition of *Rhizoctonia solani.* Evaluation of *Bacillus subtilis* for the management of rice sheath blight under field condition revealed that T0 (*Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 50DAT @2.5gm/lit)andT10 (*Bacillus subtilis ZB87-1/2,* 25DAT @2.5gm/lit + *Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit+Hexaconazole-5%EC 25DAT +Hexaconazole-5%EC 50DAT) was best treatment for the management of sheath blight disease which reduce 60.50 and 68.92% disease respectively over control and increase the grain yield.

Keywords: Rice, Biological control, *Bacillus subtilis, Rhizoctonia solani*

Introduction
Rice (*Oryza sativa* L.) is the second most important cereal crop and the staple food for more than half of the world's population. The production of rice to be achieved by 2020 is 128 million tonnes to feed the growing population of India. It is cultivated in all the continents except Antarctica, over an area of more than 150 million hectare, but maximum rice production takes place in Asia. Rice provides 20% of the world's dietary energy supply followed by maize and wheat. In the world at present the area of rice is 161.10 M ha with production of 483.00 million metric tons and productivity of 2.98 Mt ha-1. The fungus Rhizoctonia solani produced usually long cells of septate mycelium which are hyline within young, yellowish brown. It produced large number of globose sclerotia which initially turn white, late turn brown to purplish brown. Sclerotia serve as a major source of primary inoculums. Wide host range of the pathogen Rhizoctonia solani makes management of the disease a different tast. (Paracer *et al*. 1963; Kannaiyan, S.1987; Dasgupta, M. K. 1992: Lal *et al*. 2012) [5, 4, 1, 3].

Fungicide application is the most common approach among the farmers for the management of sheath blight throughout the world. These 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 agent as plant growth promoting rhizobacteria (PGPR), which are capable of suppressing or preventing the phytopathogen damage. Use of plant growth promoting rhizobacteria (PGPR) as bio control agents is gaining popularity in managing rice diseases and in enhancing growth and grain yields (Dasgupta, M. K., 1992; Szczech, M and Shoda, M., 2006) [1, 6]. In addition, plant growth promotion by Bacillus spp. is also elicited through increased N uptake, phosphate solubilization, siderophore and phytohormone production. Strains of Bacillus subtilis and Bacillus megaterium have shown significant inhibition of Rhizoctonia solani Kumar *et al*. (2012). Enhanced plant growth and grain yields in rice with Bacillus spp. application have also been well documented. Zohora *et al*. (2016) [7] Methods and Materials. Evaluation of "Bacillus subtilis ZB87- 1/21 MTCC" for the management of sheath blight disease of rice.

The field studies of bio-efficacy of Bacillus subtilis (Plantbiotix product "Bacillus subtilis ZB87-1/2 MTCC accession no. MTCC 5930" as active ingredients 2 billion CFU per gram) were conducted at I.G.K.V., Raipur Research field in Kharif-2017. The seedlings of susceptible variety swarna were transplanted in the field manually. In this trial, three randomized replicates per treatment were used with a minimum plot size of 3 m2. The cultivation of the crop was according to normal practical standards. Totally 22 plants with 45 days old were selected per plot and inoculated with 4-5 typha stem bits.

After inoculation the treatments were sprayed as per the treatment shedule given below. The plant height, lesion height, number of tillers, affected tillers and disease score was recorded at 11 and 21 days after inoculation. Grain yield was taken at 120 Days after transplanting.

Table 1: Evaluation of "*Bacillus subtilis ZB87- 1/21 MTCC*" for the management of sheath blight disease of rice

Tr. No.	Treatment Details	Crop Stage	Dosage
T1	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	25 DAT	1.5gm/lit
T2	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	50 DAT	1.5gm/lit
T3	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	25 DAT	2.50gm/lit
T4	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	50 DAT	2.50gm/lit
T5	Standard Check (Chemical fungicide- Hexaconale – 5% EC)	25 DAT	3gm/lit
T6	Standard Check (Chemical fungicide- Hexaconale – 5% EC)	50 DAT	3gm/lit
T7	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	25+50 DAT	1.5gm/lit+1.5gm/lit
T8	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	25+50 DAT	2.50gm/lit+2.50gm/lit
T9	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	25+50 DAT	1.5gm/lit+2.50gm/lit
T10	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray)	50+25 DAT	1.5gm/lit+2.50gm/lit
T11	*Bacillus subtilis ZB87 - 1/2* (Foliar Spray) +(Chemical fungicide- Hexaconale – 5% EC)	25+50 DAT	1.5gm/lit+2.50gm/lit
T12	Control (Untreated)	-	-

The disease development would be recorded in each variety and Percent Disease severity and Percent Disease Indexwill be calculated as:

$$\text{Disease severity} = \frac{\text{Total lesion length}}{\text{Total length of sheath}} \text{x}100$$

$$\text{Percent Disease Index (PDI\%)} = \frac{\text{Sum of all individual disease ratings}}{\text{Total no.of plants assessed x maximum rating}} \text{x}100$$

$$\text{Per cent disease control (PDC)} = \frac{\text{PDI in control} - \text{PDI in treatment}}{\text{PDI in control}} \text{x}100$$

Result and discussion

In all the field experiments, sclerotia from 7-9 days old culture and rice stem bits (*Rhizoctonia 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 or rice stem bit into the sheath just 1 ½ to 2 ½ cm above the water surface level as per the position of the sheath.

Evaluation of "*Bacillus subtilis* ZB87- 1/21 MTCC" for the management of rice sheath blight of rice.

The Bio-efficacy studies of *Bacillus subtilis* for the management of sheath blight of rice. The data revealed (Table no.2 and fig.1) that all the treatments were significantly superior to untreated (control) T12 in reducing per cent disease incidence (PDI). The disease% incidence ranged from 12.12 per cent in T5Standard check (Hexaconazole-5%EC), 25 DAT to 25.25 per cent in T1 *Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit whereas it was 40.06 per cent in T12 (control). Minimum disease incidence *i.e.*12.12 per cent was recorded in T5 Standard check (Hexaconazole-5%EC), 25 DAT which was 69.74 per cent less over control treatment. T11*Bacillus subtillis*ZB87- 1/2, 25DAT@1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit + Standard check (Hexaconazole-5% EC), 25DAT + Standard check (Hexaconazole-5% EC), 50 DAT shows minimum incidence of the disease only 12.45 per cent followed byT10*Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 25DAT @2.5gm/lit 15.82% reducing disease severity and recorded 60.50 decrease of the disease over control when we compared it with T5 Standard check (Hexaconazole-5%EC), 25 DAT which was 12.12 cent disease incidence while with T6 Standard check (Hexaconazole-5%EC), 50 DAT),T11 *Bacillus subtillis* ZB87- 1/2, 25DAT@1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit + Standard check (Hexaconazole-5% EC), 25DAT + Standard check (Hexaconazole-5% EC), 50DAT and T10*Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 25DAT @2.5gm/lit show minimum per cent disease incident. However, T11*Bacillus subtillis* ZB87- 1/2, 25DAT@1.5gm/lit + *Bacillussubtilis ZB87-1/2,* 50DAT @1.5gm/lit + Standard check (Hexaconazole-5% EC), 25DAT+ Standard check (Hexaconazole-5% EC), 50DAT record PDI 12.45was significantly different from other treatments. However, T9 *Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 50DAT @2.5gm/litrecorded minimum (37.81) per cent disease reduction over control followed by T1 (*Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit) and T2 *(Bacillus subtilis* ZB87-1/2, 50DAT @1.5gm/lit) in which the per cent disease reduction over control was 39.42 and 39.44% only.

The above results are accordance with the findings of Kumar *et al.* (2012) they evaluated the efficacy of the commercial liquid formulation of *Bacillus subtilis* strain MBI 600, against rice sheath blight and for plant growth promotion. He concluded that The Integral treatments of seed treatment + seedling deep + foliar spray at 2.2×109 cfu/ml significantly suppressed sheath blight over other treatments.

Table 2: Evaluation of *Bacillus subtilis* for the management of rice sheath blight

Treatments	Treatment Details	Mean PDI (%)	% disease reduction over control
T1	*Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit	25.25 (30.12)	39.42
T2	*Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit	24.57 (29.69)	39.44
T3	*Bacillus subtilis ZB87-1/2,* 25DAT @2.5gm/lit	22.89 (28.56)	39.48
T4	*Bacillus subtilis ZB87-1/2,* 50DAT @2.5gm/lit	22.22 (28.05)	39.50
T5	Standard check (Hexaconazole-5%EC), 25DAT	12.12 (20.35)	69.74
T6	Standard check (Hexaconazole-5%EC), 50DAT	19.52 (26.21)	51.27
T7	*Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit + *Bacillus subtilis ZB87- 1/2,* 50DAT @1.5gm/lit	24.24 (29.47)	39.49
T8	*Bacillus subtilis ZB87-1/2,* 25DAT + *Bacillus subtilis ZB87-1/2,* 50DAT	22.55 (28.31)	43.70
T9	*Bacillus subtilis ZB87-1/2,* 25DAT @1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 50DAT @2.5gm/lit	24.91 (29.92)	37.81
T10	*Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit + *Bacillus subtilis ZB87-1/2,* 25DAT @2.5gm/lit	15.82 (23.41)	60.50
T11	Bacillus subtillis ZB87- 1/2, 25DAT@1.5gm/lit +*Bacillus subtilis ZB87-1/2,* 50DAT @1.5gm/lit +Standard check (Hexaconazole-5% EC), 25DAT + Standard check (Hexaconazole-5% EC), 50DAT	12.5 (20.63)	68.92
T12	Control	40.06 (39.25)	
	SE(m)±	0.777	
	CD at (5%)	2.292	

*figures in the parenthesis are arcsin transformed values.

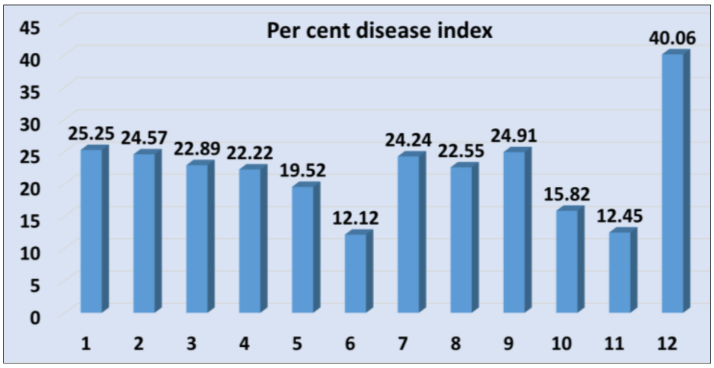

Fig 1: Evaluation of *Bacillus subtilis* for the management of rice sheath blight

General view of experiment/plots **Tagging of inoculated plant**

Fig 2: Evaluation of "*Bacillus subtilis* ZB87- 1/21 MTCC" for the management of rice sheath blight of rice

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