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Evaluation of Commercially Available PGPR for Control of Rice Sheath Blight Caused by *Rhizoctonia solani*

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Sheath blight disease of rice caused by *Rhizoctonia solani* is a major production constraint in all rice producing areas of the world. The annual losses due to sheath blight are estimated to be 25 % under optimum conditions of disease development. Disease management is currently focused on extensive use of fungicides which has created concerns about environmental pollution, pathogen resistance and escalating costs. Field trials were conducted during the rainy seasons of 2005 and 2006 in a randomized block design with three replications to assess the commercially available bio-pesticide products for their effect on sheath blight. Products evaluated were Achook (Azadirachtin), Biotos (Plant activator), Tricure (Azadirachtin), Ecomonas (*Pseudomonas fluorescens*) and Bavistin (Carbendazim) in 2005 and Biofer (Plant extract), Biotos, Defender (Plant extract), Ecomonas, Florezen P (*P. fluorescens*), Trichozen (*Trichoderma viride*) and Bavistin in 2006. Products were applied three times as foliar sprays after appearance of first symptoms initially and repeated at 10 days interval. The disease severity was measured by adopting Highest Relative Lesion Height (HRLH) at 90 days after transplanting. The chemical (Bavistin) reduced disease severity 52% and 50% compared to the control. Corresponding reductions in disease severity with the bio-pesticides ranged from 22% to 48% in 2005 and from 15% to 31% in 2006. Specifically with PGPR, the disease reductions ranged from 14% to 38% compared to the control in both years. Grain yields were assessed at 120 days after transplanting and significantly increased grain yields (3,901 and 1,938 kg/ha) over control (2,690 and 1,550 kg/ha) were obtained with PGPR in 2005 and 2006 respectively. Our results showed that there is a scope for effective management of sheath blight disease with the use of the currently available PGPR and other products that are available under the conditions evaluated.

Key words: Rice, Sheath blight, *Rhizoctonia solani*, PGPR.

Rice is an important staple food crop for majority of the world. Many biotic stresses hamper rice production and specifically, fungal diseases cause huge economic losses. Among different fungal diseases of rice, sheath blight (ShB) is an important one responsible for losses in grain yield. Annual yield losses up to 40% were reported with ShB under optimum conditions of disease development[1]. The disease manifests initially as water soaked lesions on sheaths of lower leaves near water line. The dense crop canopy and high

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relative humidity (>95%) in the canopy usually favors sheath blight disease development. As the disease advances, the lesions expand and are bleached with a brown border. Under ambient conditions, the disease assumes severe form and chaffiness of lower grains in the panicle is usually seen. The fungus, *Rhizoctonia solani* Kuhn, is the causal agent of the disease and it survives in the form of sclerotial bodies in the soil for several years on stubbles of the previous season's crop and on weeds[2, 3]. Many chemical control methods are available in combating the disease and often sheath blight outbreaks are not uncommon[4]. Effective management of sheath blight disease in rice is possible only when the pathogen is eliminated completely or the propagules are brought down below economic threshold limits at field level.

Biological control of plant pathogens are gaining popularity in the majority of crops. However, its utilization in rice ecosystem is still at its infancy due to varied reasons. Rice is a crop that is grown under inundated conditions. Therefore, the survival, growth and establishment of biological control agents is questionable. However, effective management strategy of sheath blight disease is feasible only when the biocontrol agents survive, establish, proliferate and control sheath blight pathogen and also have a synergistic growth promoting effect on the crop. Besides, the biocontrol agent should be able to induce systemic resistance, thereby contributing to the disease control.

Among the biocontrol agents, PGPR (plant growth promoting rhizobacteria) offer a promising means of controlling plant diseases besides contributing to the plant resistance, growth and yield in rice[5]. Of different PGPR, fluorescent *Pseudomonads* offer an effective control of sheath blight besides inducing growth promoting effects[6] and systemic resistance. Although, the use of fluorescent *Pseudomonads* is reported in rice crop against major diseases, an effective biocontrol of sheath blight disease as an alternative and supplement to chemical management is yet to be formulated.

Presently, sheath blight disease management is mainly achieved through systemic fungicides and also with certain non-systemic fungicides. The resistance gain by pathogen to these systemic fungicides is of concern, thus demanding an evolution of newer fungicides and screening of certain commonly used fungicides before evolving a comprehensive and compatible integrated disease management (IDM). Moreover, host plant resistance to sheath blight range only from very susceptible to moderately susceptible levels in rice[7], thus chemical management has become a necessary component for an effective IDM.

Bacteria belonging to *Pseudomonas* and *Bacillus* genera are widely being used in biological control of plant diseases. Non-pesticidal management of plant diseases especially with PGPR, is gaining popularity due to its advantages over chemicals. PGPR may offer a promising means of controlling ShB besides contributing to growth and yield of rice. Among PGPR, fluorescent *Pseudomonads* offer an effective control of ShB besides inducing growth promoting effects and systemic resistance[8]. In view of this, the present study was conducted to test the efficacy of selective commercial PGPR and also related plant products for their role in controlling ShB under wet land conditions infested with *R. solani*.

MATERIAL AND METHODS

Studies were conducted in 2005 and 2006 at Andhra Pradesh Rice Research Institute, Maruteru, Andhra Pradesh, India during the rainy seasons (Kharif). The test site contained abundant *R. solani* due to continuous cropping of rice. The experiments were laid out in a randomized block design with four replications per treatment. Each replicated plot consisted of five rows, 5 m long and spaced 15 cm apart. The ShB susceptible cultivar, Swarna (MTU-7029), was used to raise the seedlings at a rate of 150 kg/ha. The experimental area, before transplanting, was broadcast applied with 80-40-30 NPK kg/ha and incorporated. The study contained 6 treatments in 2005 and 8 treatments in 2006. Treatments consisting of Achook (Azadirachtin 0.15% @ 5 ml/l), Biotos (Plant activator-monoterpenes @ 2.5 ml/l), Tricure (Azadirachtin 0.03% @ 5 ml/l), Ecomonas (*P. fluorescens* @ 10 g/l), Bavistin (carbendazim 50% WP @ 1g/l), Biofer (organic plant lipid extract @ 1.5 ml/l), Defender (*Cinnamomum* leaf extract @ 2.5 ml/l), Florezen

P (*P. fluorescens* @ 2.5 g/l), and Trichozen T (*Trichoderma viride* @ 1.25 g/l)..

A pure culture of *R. solani* was multiplied on rice culm bits (5-7cm) of rice: hull (1:3) medium. The inoculum was then placed between tillers just above the water line. Fresh leaf blight infected material with active lesions was also used as inoculum. In general, crop management practices were similar to guidelines of AP Rice Research Institute. The products were applied three times at 10 day interval as foliar sprays after the disease initiation in each plot. Plots were rated for ShB incidence at 90 days after transplanting (DAT) and grain yields were taken at 120 DAT. Sheath blight disease severity was calculated by highest relative lesion height method (HRLH) by using the following formula:

$$\text{HRLH} = \frac{\text{Highest lesion height}}{\text{Highest plant height}} \times 100$$

The data were analyzed using ANOVA (SAS Institute, NC, USA) and means were separated by a least significant difference (LSD) at $P = 0.05$.

RESULTS AND DISCUSSION

All the products evaluated in both years significantly reduced ShB disease severity over the control (Tables 1 & 2). Similarly, grain yields were significantly increased compared to control (Tables 1 & 2). During 2005, among different products evaluated, maximum reduction of ShB

Table 1. Evaluation of PGPR and plant extracts against rice sheath blight during 2005

Treatment	Disease severity (%)	% Reduction of disease over control	Grain yield (Kg/ha)
Achook (Azadirachtin)	40.71[d] (42.56)	48.03	3854[b]
Biotos (Plant activator)	52.96[b] (63.69)	22.23	3785[b]
Tricure (Azadirachtin)	52.67[b] (63.12)	22.93	3851[b]
Ecomonas (*P. fluorescens*)	45.60[c] (51.02)	37.70	3901[b]
Bavistin (Carbendazim)	38.62[d] (39.01)	52.37	4289[a]
Control	65.40[a] (81.90)	-	2690[c]
LSD (5%)	2.44	-	204

Figures in parentheses are transformed values

Table 2. Evaluation of PPGR and plant extracts against rice sheath blight during rainy season, 2006

Treatment	Disease severity (%)	% Reduction of disease over control	Grain yield (Kg/ha)
Biofer (Plant extract)	58.88[e] (49.40)	31.06	2132[b]
Biotos (plant activator)	77.73[b] (62.20)	8.99	1550[d]
Defender (plant extract)	72.22[c] (58.40)	15.44	1550[d]
Economas (*P. fluorescens*)	73.17[c] (66.00)	14.53	1938[c]
Florezen P (*P. fluorescens*)	68.56[d] (56.00)	19.73	1938[c]
Trichozen T (*T. viride*)	75.92[b] (61.00)	11.11	1454[e]
Bavistin (Carbendazim)	42.98[f] (40.90)	49.68	2326[a]
Control	85.41[a] (68.20)	-	1550[d]
LSD (5%)	2.02	-	29.34

Figures in parentheses are transformed values.

severity was obtained with Bavistin (52.4%) compared to control. Corresponding reductions in disease severity with commercial products ranged from 22.2% (Biotos) to 48% (Achook). With commercial PGPR (Ecomonas), the disease reduction over the control was 37.7%. The standard chemical fungicide, Bavistin, yielded a maximum grain yield of 4289 kg/ha compared to the control (2690 kg/ha). In general, the grain yields ranged from 3785 kg/ha to 3901 kg/ha. During 2006, the standard chemical check, Bavistin, also recorded the highest disease reduction over the control (49.7%). The reductions in disease severity with the products evaluated ranged from 8.9% to 31.1% compared to control. Specifically, with commercial PGPR, the disease reduction was 14.5% and 19.7% for Ecomonas and Florezen P, respectively. Grain yields were found to be significantly superior in PGPR-treated plots (1938kg/ha each) and also in plots with Biofer treatment (2132 kg/ha) over control (1550 kg/ha). However, Bavistin recorded the highest grain yield of 2326 kg/ha (Table 2).

Our results were similar to earlier results for plant extracts such as Biotos, Achook and Tricure in reduction of rice sheath blight disease severity and increased grain yields[9]. Similarly, our results with tested PGPR were similar to findings of others with similar types of PGPR products[10]. Our results showed that there is a scope for effective management of sheath blight disease with the use of currently available commercial PGPR and other products for use under wetland conditions.

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