Field Efficacy of Commercial Formulations of Pseudomonas fluorescens and Plant Extracts Against Rice Sheath Blight Disease

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Abstract

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 rainy seasons of 2005 and 2006 in 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*), Trich-ozen (*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 trans-planting. The chemical (Bavistin) reduce 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 the 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.

Introduction

Rhizoctonia solani, the causal agent responsible for rice sheath blight (ShB) affects rice cultivation worldwide. Annual yield losses up to 40% were reported with ShB under optimum conditions of disease develo-pment (Tan Wan Zhong *et al*., 2007). *Rhizoctonia solani* has a very wide host range and there are no strongly resistant varieties of rice. The sclerotia of the fungus survive in soil and play an important role in ShB disease and are generally disseminated by flooded water. The sclerotia survive in soil for a longtime especially in the absence of host plants. The disease initially occurs at the seedling, tillering and booting stages of rice seedlings.

Variation of disease occurrence in different soils has been attributed to soil beneficial microorganisms. Seed treatment, soil application or foliar application with fungicides have provided effective control of the disease. The high cost of fungicides and possible environmental pollution with these chemicals has prompted us to explore suitable cost effective, environmentally friendly alternative strategies. In recent years, fluore-scent pseudomonads have drawn attention worldwide because production of secondary metabolites such as siderophore, antibiotics and volatile compounds. Bacteria belonging to *Pseudomonas* and *Bacillus* genus have been also used. Non-pesticidal management of plant diseases especially with PGPR are gaining popularity due to its advantages over chemicals. PGPR may offer a promising means of controlling ShB besides contribu-ting to growth and yield of rice (Mew and Rosales, 1992). Among PGPR, fluorescent *Pseudomonads* offer an effective control of ShB besides inducing growth promoting effects (Mathivanan *et al*, 2005) and systemic resistance (Nandakumar *et al*, 2001). 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*.

Materials and Methods

Studies were conducted in 2005 and 2006 at Andhra Pradesh Rice Research Institute, Maruteru, Andhra Pradesh, India during rainy seasons (Kharif). The test site contained abundant *R. solani*, due to continuous cropping of rice. The experiments were laid out in a rando-mized 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 transpl-anting, 80-40-30, NPK kg/ha was broadcast applied 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).

The ShB pathogen, *R. solani* AG1-1A was multiplied in rice grains and broadcasted into the flood to ensure uniform disease incidence at 25 days after transplanting. In general, crop management practices were similar to guidelines of AP Rice Research Institute. The products were applied three times at 10 days 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 was analyzed using ANOVA and means were separated by a least significant difference (LSD) at $P = 0.05$.

Table 1. Evaluation of PGPR and plant extracts against rice sheath blight during rainy season, 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	2.44	--	204

Figures in parentheses are transformed values

Results and Discussion

All the products evaluated in both years significantly reduced ShB disease severity over 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 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 control was37.7%. 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 control (49.7%). The reductions in disease severity with the products evaluated ranged from 8.9% to 31.1% compared to control. Specifically, with comm-ercial 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).

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.

Our results were similar with earlier results for plant extracts such as Biotos, Achook and Tricure in reduction of rice sheath blight disease severity and increased grain yields (Biswas, 2006). Similarly, our results with tested PGPR were similar with findings of others with similar type of PGPR products (Rajbir Singh and Sinha, 2005). 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.

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