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Evaluation of Fungicides, Bio Control Agents and Plant Extracts against Rice Blast Caused by *Pyricularia grisea* (Sacc.) Under Field Conditions

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A B S T R A C T

A field experiment was conducted to know the efficacy of bio control agents, plant extracts and fungicides against rice blast caused by *Pyricularia grisea* (Sacc.). Among the bio control agents and plant extracts *Pseudomonas fluorescens* (29.5%) and *O. sanctum* (33.1%) recorded less leaf blast incidence and higher grain yields of 2173 kg ha^{-1} and 2082 kg ha^{-1} compared with untreated plot 1552 kg ha^{-1}. Out of seven fungicides were tested, spraying with tricyclazole resulted lowest leaf blast severity with 18.0% PDS followed by isoprothiolane (20.3% PDS) but the grain yields were higher in isoprothiolane treated plots 4061 kg ha^{-1} followed by tricyclazole treated plots 3837 kg ha^{-1} compared with untreated plots.

Introduction

Rice (*Oryza sativa* L.) is an important food crop in supplying approximately 23% per capita energy for Six billion people worldwide. Rice blast caused by *Pyricularia grisea* Sacc. is an important biotic constraint for rice production across the world where paddy is being cultivated (Ratna Madhavi, 2011). The fungus has ability to overcome the resistance within a short time after release and spread of a resistant cultivar (Mc Donald *et al.,* 1989). In recent times, rice blast has become one of the prevalent and major diseases on rice in Prakasam and Sri Potti Sreeramulu Nellore districts of Andhra Pradesh, causing heavy losses to the rice growing farmers. The objective of the present investigation was to study various fungicides, biocontrol agents and plant extracts *in vivo* for the management of rice blast caused by *P. grisea* in Prakasam and Sri Potti Sreeramulu Nellore districts of Andhra Pradesh.

Therefore an attempt was made on evaluation of fungicides, bio control agents and plant extracts against Rice Blast Caused by *Pyricularia grisea* (Sacc.) Under Field Conditions

Materials and Methods

Five plant extracts i.e., *Datura stramonium*, *Calotropis gigantia*, *Pongamia pinnata*,

Ocimum sanctum, two bio control agents *viz*., *Trichoderma viride*, and *Pseudomonas fluorescens* and seven fungicides tricyclazole, isoprothiolane, kasugamycin, metominostrobin, trifloxystrobin+ propiconazole, trifloxystrobin + tebuconazole and tricyclazole + mancozeb were tested under field conditions.

To know the efficacy of plant extracts and bio control agents a field experiment was laid out in Randomized Block Design (RBD) with seven treatments and three replications during *Kharif* and *Rabi*, 2010-11 using susceptible rice variety BPT 5204 at Krishi Vigyan Kendra, Darsi, Prakasam District. Twenty five day old seedlings of blast susceptible variety BPT 5204 were planted at 15×15 cm spacing in a randomized block design with three replications.

The plot size was 5×2 m. The fertilizer dose of 150 kg N, 60 kg P_2O_5 and 50 kg K_2O was applied in all the plots. Half of the nitrogen and full dose of phosphorus and potash were applied just before transplanting as basal dose. Remaining nitrogen was top dressed in two equal splits at tillering and panicle initiation stages.

In each plot three sampling units of 1×1 m size were fixed at random for recording of observations on blast severity at appearance of disease, 10 days after first spray (DAFS), 10 days after second spray (DASS), and 10 days after third spray (DATS). Disease severity was recorded as per cent leaf area affected (Per cent Disease Severity–PDS). Grain yields were recorded from individual plots and compared with control plot.

To know the efficacy of fungicides tricyclazoe (Beam 75 WP), isoprothiolane (Fuji one 40 EC), kasugamycin (Kasu B 2L), metominostrobin, tricyclazole 33% + propiconazole 24% (Filia 52.5 SE), trifloxystrobin 25%+ tebuconazole 50% (Nativo) and tricyclazole 33% + mancozeb (Merger) were tested against rice blast. Unsprayed plots were used as control.

Results and Discussion

In the present investigation, seed treatment with carbendazim, foliar sprays with tricyclazole, *P. fluorescens* and *Ocimum sanctum* leaf extract were evaluated in possible combinations to assess the integrated affect of these combinations on leaf blast severity on susceptible variety BPT 5204. For comparison, resistant cv NLR 34449 was also included without any plant protection measures directed against leaf blast. Observations on leaf blast severity and grain yield were recorded and compared with unsprayed plots of BPT 5204. Field experiment was conducted during *Kharif* and *Rabi* 2011-12.

Kharif 2011-2012

The results of *Kharif* 2011-12 revealed that the lowest PDS (11.8%) was recorded with resistant variety NLR 34449 (T2) followed by seed treatment with carbendazim @ 2g/kg + spraying tricyclazole @ 0.06% twice at seven days interval, *i.e*., T9 (21.9%) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *P. fluorescens* @ 0.4%, *i. e.*, T6 (26.2%).

The treatments involving seed treatment with carbendazim @ 2g/kg + one spray of tricyclazole @ 0.06% spray (T3) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% after 7 days of first spray and spraying of *P. fluorescens* @ 0.4 g/l after 7 days of first spray (T8) resulted in 27.7% and 28.3% PDS respectively. Seed treatment with carbendazim @ 2g/kg + foliar spray with *P. fluorescens* @ 0.4% (T4), seed treatment with carbendazim

alone @ 2g/kg (T1) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *O. sanctum* leaf extract @ 15% (T7) resulted in 32.5%, 33.1% and 34.1% PDS. Seed treatment with carbendazim @ 2g/kg + foliar spray with *O. sanctum* @ 15% (T5) recorded highest PDS of 35.8% among different treatments tested though it differed significantly when compared with untreated control (45.4%) (T10) (Table 1 and 2).

Lowest grain yields were recorded in unsprayed treatment (T10) (2031 kg ha^{-1}) followed by seed treatment with carbendazim @ 2g/kg + foliar spray with *O. sanctum* @15% (T5) (2058 kg ha^{-1}), seed treatment with carbendazim alone @ 2g/kg (T1) (2337 kg ha^{-1}) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15%+ spraying of *P. fluorescens* @ 0.4% (2501 kg ha^{-1}) (T8) with insignificant differences between them. Significantly superior grain yield was recorded in seed treatment with carbendazim @ 2g/kg + two sprays of tricyclazole @ 0.06% at seven day interval (T9) (3809 kg ha^{-1}) followed by seed treatment with carbendazim @ 2g/kg + one spray of tricyclazole @ 0.06% (T3) (3298 kg $ha^{-1)}$. Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% (2556 kg ha^{-1}) (T7), seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *P. fluorescens* @ 0.4% (2664 kg ha^{-1}) (T6) and seed treatment with carbendazim @ 2g/kg + foliar spray with *P. fluorescens* @ 0.4% (2731 kg ha^{-1}) T4 had insignificant differences among themselves.

Rabi 2011-12

The results of *Rabi* 2011-12 revealed that the highest PDS (55.3%) was observed in untreated control plot (T10) followed by seed treatment with carbendazim @ 2g/kg + foliar spray with *O. sanctum* @ 15% (T5) (53.3), seed treatment with carbendazim @ 2g/kg (T1) (38.1%) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% (T7) (44.1%). The treatments involving seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *P. fluorescens* @ 0.4% (T6) (31.9%), seed treatment with carbendazim @ 2g/kg + one spray of tricyclazole @ 0.06% (T3) (34.0%), seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% after 7 days of first spray + spraying of *P. fluorescens* @ 0.4 g/l after 7 days of first spray (T8) (31.0%) and seed treatment with carbendazim @ 2g/kg + foliar spray with *P. fluorescens* @ 0.4% (T4) (34.8%) were found to differ insignificantly among themselves. The lowest PDS was observed with resistant variety NLR 34449 (T2) 11.2 % followed by seed treatment with carbendazim @ 2g/kg + twice spraying of tricyclazole @ 0.06% at seven days interval (T9) (22.2%) differed significantly with all other treatments but insignificant differences between them.

In unsprayed control plot (T10) grain yield was 2037 kg ha^{-1}. Treatments involving seed treatment with carbendazim @ 2g/kg + foliar spray with *O. sanctum* @ 15% (T5) (2386 kg ha^{-1}) followed by seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% after 7 days of first spray + foliar spray with *P. fluorescens* @ 0.4% (T8) (2620 kg ha^{-1}), seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum*@ 15% (T7) (2735 kg ha^{-1}) gave lesser grain yields with insignificant differences among themselves but significant difference with untreated control plot.

Table.2 Integrated disease management of rice blast

S. No.	Treatments	Per cent Disease Severity (PDS)*			Yield (kg ha^{-1})		
		2011-12 *Kharif*	2011-12 *Rabi*	Pooled Mean	2011-12 *Kharif*	2011-12 *Rabi*	Pooled Mean
1	T1 - Seed treatment with carbendazim @2g/kg	33.1 (35.1)	38.1 (38.1)	35.6 (36.6)	2337	2846	2592
2	T2 - Resistant variety (NLR 34449)	11.8 (20.1)	11.2 (19.6)	11.5 (19.9)	3046	3070	3058
3	T3 - Seed treatment with carbendazim @ 2g/kg + Foliar application of tricyclazole @ 0.06 %	27.7 (31.8)	34.0 (35.4)	30.8 (33.7)	3298	3192	3245
4	T4 - Seed treatment with carbendazim @ 2g/kg + foliar spray with *Pseudomonas fluorescens* @ 0.4 %	32.5 (34.8)	34.8 (36.2)	33.6 (35.4)	2731	2844	2788
5	T5 - Seed treatment with carbendazim @ 2g/kg + foliar spray with *Ocimum sanctum* @ 15%	35.8 (36.8)	53.3 (46.9)	44.5 (41.8)	2058	2386	2222
6	T6 - Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + Spraying of *Pseudomonas fluorescens* @ 0.4% after 7 days of first spray	26.2 (30.8)	31.9 (34.4)	29.0 (32.6)	2664	3231	2947
7	T7 - Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *Ocimum sanctum* @ 15% after 7 days of first spray	34.1 (35.7)	44.1 (41.6)	39.1 (38.7)	2556	2735	2646
8	T8 - Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *Ocimum sanctum* @ 15%, 7 days of first spray + spraying of P*seudomonas fluorescens* @ 0.4 g/l after 7 days of first spray	28.3 (32.1)	34.0 (35.7)	31.0 (33.8)	2501	2620	2396
9	T9 - Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% twice at weekly interval	21.9 (27.9)	22.2 (28.1)	22.1 (28.0)	3809	4217	4013
10	T10 - Control (Without seed treatment, spraying any fungicide, plant extract and bio control agents)	45.4 (42.4)	55.3 (48.0)	50.3 (45.2)	2031	2037	2034
	S. Em	1.09	1.2	0.9	119.6	183.6	176.2
	CD (P=0.05)	3.3	3.5	2.9	487	457	310
	CV (%)	6.4	5.7	5.2	7.7	6.7	4.7

*Mean of fifty plants ** Figures in parentheses are arc sine transformed values

Table.1 Treatment details for integrated disease management of rice blast

Treatments	Treatment Details
T1	Seed treatment with carbendazim @2g/kg
T2	Resistant Variety (NLR 34449)
T3	Seed treatment with carbendazim @ 2g/kg + Foliar application of tricyclazole @ 0.06 %
T4	Seed treatment with carbendazim @ 2g/kg + foliar spray with *Pseudomonas fluorescens* @ 0.4 g/l
T5	Seed treatment with carbendazim @ 2g/kg + foliar spray with *Ocimum sanctum* @ 15%
T6	Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + Spraying of *Pseudomonas fluorescens* @ 0.4 g/l after 7 days of first spray
T7	Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *Ocimum sanctum* @ 15% after 7 days of first spray
T8	Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *Ocimum sanctum* @ 15%, 7 days of first spray + spraying of *Pseudomonas fluorescens* @ 0.4 g/l after 7 days of first spray
T9	Seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + second spray of tricyclazole @ 0.06% after 7 days of first spray
T10	Control (Without seed treatment, spraying any fungicide, plant extract or bio control agents)

Significantly superior grain yield of 4217 kg ha^{-1} was recorded with seed treatment with carbendazim @ 2g/kg + twice spraying tricyclazole @ 0.06% at seven days interval (T9). Seed treatment with carbendazim @ 2g/kg + foliar spray with *P. fluorescens* @ 0.4% (T4) (2844 kg ha^{-1}), seed treatment with carbendazim @ 2g/kg (T1) (2846 kg ha^{-1}), seed treatment with carbendazim @ 2g/kg + tricyclazole @ 0.06%) (T3) (3192 kg ha^{-1}) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *P. fluorescens* @ 0.4% (T6) (3231 kg ha^{-1}) were next to T9 with significantly higher grain yields compared to untreated control but lesser than T9.

Kharif and *Rabi* 2011-12 (Pooled)

The results of pooled data (*Kharif* and *Rabi*, 2011-12) revealed that the highest PDS (50.3%) was observed in untreated control with significant differences with PDS in treated plots. Among the treated plots, seed treatment with carbendazim @ 2g/kg + foliar spray with *O. sanctum* @ 15% (T5) resulted in significantly higher PDS of 44.5% followed by seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% (T7) (39.1%), seed treatment with carbendazim @ 2g/kg (T1) (35.6%) and seed treatment with carbendazim @ 2g/kg + foliar spray with *P. fluorescens* @ 0.4g/l (T4) (33.6%). The lowest PDS was observed with resistant variety NLR 34449 (T2) (11.5 %) followed by seed treatment with carbendazim @ 2g/kg + twice spraying tricyclazole @ 0.06% at seven days interval (T9) (22.1 %). The treatments involving seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O.sanctum* @ 15% after 7 days of first spray + spraying of *P. fluorescens* @

0.4% (T8) (31.0 %), seed treatment with carbendazim @ 2g/kg + one spray of tricyclazole @ 0.06% (T3) (30.8%) and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *P. fluorescens* @ 0.4% (T6) (29.0%) had significantly lower PDS compared to untreated control plots.

Pooled results of grain yield (Table 2) for *Kharif* 2011-12 and *Rabi* 2011-2012 revealed that maximum grain yield of 4013 kg ha^{-1} was observed in seed treatment with carbendazim @ 2g/kg + twice spraying of tricyclazole @ 0.06% at 7 days interval (T9) followed by seed treatment with carbendazim @ 2g/kg + one spray of foliar application of tricyclazole @ 0.06% (T3) (3245 kg ha^{-1}), and seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of *P. fluorescens* @ 0.4% after 7 days of first spray (T6) (2947 kg ha^{-1}). Seed treatment with carbendazim @ 2g/kg + foliar spray with *P. fluorescens* @ 0.4%) (T4) (2788 kg ha^{-1}), seed treatment with carbendazim @ 2g/kg + spraying of tricyclazole @ 0.06% + spraying of plant extract of *O. sanctum* @ 15% after 7 days of first spray (T7) (2646 Kg ha^{-1}), seed treatment with carbendazim alone @ 2g/kg (T1) (2592 kg ha^{-1}) and spraying of tricyclazole @ 0.06% + spraying of + spraying of plant extract of *O. sanctum* @ 15% 7 days of first spray+ foiliar spray with *P. fluorescens* @ 0.4% after 7 days of first spray + (T8) (2396 kg ha^{-1}) were significantly superior to untreated plots but yielded lesser than the best treatments, *i. e.*, T9 and T3. Among the treated plots lowest grain yield was obtained with seed treatment with carbendazim @ 2g/kg + foliar spray with *O. sanctum* @ 15% (T5) (2220 kg ha^{-1}) which was on par with untreated control (T10) (2034 kg ha^{-1}).

Result of experiment on integrated disease management revealed that combination of seed treatment with carbendazim @ 2g/kg + twice spraying of tricyclazole @ 0.06% at 7 days interval showed significant decrease in the disease severity and grain yield. IDM schedule involving integration of fungicide (seed treatment and spray), biocontrol agent (spray) and plant extract (spray) resulted in significant decrease in disease severity and increase in yield compared to untreated control. However, fungicide application alone resulted in significantly lower disease severity associated with superior yield.

Yashoda *et al.,* (2000) reported that integration of fungicidal seed treatment and spraying has been a common practice and seed treatment with carbendazim (2 g kg^{-1}) in combination with 3 sprays of tricyclazole at 0.06% or 3 sprays of pyroquilon at 0.1% resulted in lowest leaf blast incidence whereas chlorothalonil has the lowest efficacy in controlling leaf blast. Hossain and Kulakarni (2001) reported that seed treatment with carbendazim 2 g kg^{-1} followed by 2 sprays of tricyclazole (0.06%) was found best in managing the disease. The next best treatment was seed treatment with carbendazim (2 g kg^{-1}) followed by two sprays of propiconazole (0.1%) which was superior to hexaconazole. Ramanathan *et al.,* (2002) stated that, Integrated Disease management is the best way to control the abovementioned diseases. The concern is to maintain the health of the crops. Chemical control generally dominates the IDM. Crop health surveillance is a good strategy within the IDM system.

It involves a thorough monitoring system to check prevalence and severity of disease. It may be a onetime activity or a regular periodical activity. Surveillance activity also helps in identifying potential disease in early stages so that corrective action may be taken. Hai *et al.,* (2007) reported that management of rice blast needs integration of all available techniques including resistant varieties and

proper cultural practices followed by timely application of fungicides.

Le *et al.,* (2007) stated that management of rice blast needs integration of all available techniques including resistant varieties and proper cultural practices followed by timely application of fungicide. Muralidharan and Dinaker (2007) reported that, there was a great reduction in neck blast incidence by using tricyclazole or carbendazim in plots with resistant variety as border crop compared to plots with susceptible variety border and the application of tricyclazole increased yield by 41 and 87% in 2000 and 2001 respectively.

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