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RESEARCH ARTICLE

Mitigation of rice blast disease by using biocontrol agents and new molecular fungicides

■ S. Malathi

SUMMARY

Rice blast is one of the most devastating diseases which is caused by *Pyricularia grisea*. The disease infects the all growth stages of rice crop and causes severe yield loss. Biocontrol agents and new molecular fungicides were tested against blast disease of rice. Among the nine treatments tested, Seed treatment with *Bacillus subtilis* + Foliar spray of Tebuconazole 50% + Trifloxystrobin 25% WG @ 1g/l (T7) recorded the maximum (67.88 %) reduction of the blast disease followed by Seed treatment with *Bacillus subtilis* @10g/kg + Foliar spray of Picoxystrobin 6.78% + Tricyclazole 20.33% SC @1ml/l (T8) which recorded 58.67 % reduction of the blast disease. Combined application of biocontrol agents having ability to reduce rice blast disease and increase the yield significantly.

Key Words : Rice blast, *Pyricularia grisea,* Biological control, Fungicides

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Rice is an important staple food which is grown in almost all the tropical and subtropical regions of the world. In India, rice is cultivated in Uttar Pradesh, West Bengal, Punjab, Telegana, Odisha, Tamil Nadu and Andhra Pradesh. In Tamil Nadu, rice is cultivated in an area of 21.65 lakh hectares and the production is 74 lakh tonnes. The major constraints for low productivity of rice are diseases which are caused by fungi, bacteria and viruses. In rice cultivation the topmost obstruction is the rice blast disease (RBD) caused by *Pyricularia grisea* which reduces the yield depending upon the location, variety and severity of disease (Chittaragi *et al*., 2022). The *Pyricularia grisea* is a filamentous ascomycetes fungus infecting more than 50 hosts and is considered as a major threat to rice production because of its wide spread distribution and its destructiveness under favorable conditions (Ou, 1985). The fungus attacks the crop at any stages of crop growth and the symptoms appears on leaves, nodes, rachis and glume. The disease appears early as white to grey/brown leaf spots or lesions which enlarged to spindle shaped spots with grey centre and dark brown margin. The spots coalesce and become large further the leaves were dried and wither. In India the blast disease occurred in epidemic

AUTHOR FOR CORRESPONDENCE

S. Malathi, Department of Plant Pathology, Information and Training Centre, Tamil Nadu Agricultural University, **Chennai (T.N.) India**
Email : malathiagri83@gmail.com

at Thanjavur (Tanjore) delta of Tamil Nadu during 1919 and it becomes a devastating disease in Tamil Nadu. The rice blast fungus is very sensitive to minute changes of temperature and other environmental parameters and also the life cycle of the fungus is very much complicated in nature.

The farmers depends on fungicides for the management of various diseases in crops. Nowadays new molecular fungicides are coming which are screened for various diseases. Recently, bio - pesticides are also used for the management of the various diseases and research are underway by utilizing new strains for the management of various diseases (Harish *et al*., 2009). Vidyasekaran *et al*., 1997 reported that pretreatment of rice leaves with *P. fluorescens* as a seed and foliar spray effectively controlled the blast disease and increased grain yield. The combined inoculation of *P. fluorescens* and salicylic acid improved plant growth and resistance against *P. oryzae* .

Seed treatments with systemic fungicides and foliar sprays have remained effective from the beginning in rice blast management. Hence, chemical control is still widely practiced and is the most successful strategy for managing crop losses. The fungicides chlorothalonil, tricyclazole, hexaconazole, carbendazim, and propiconazole have been reported to be effective in the management of rice blast disease. Several fungicides belonging to different groups have been synthesized and evaluated for use in the rice ecosystem throughout the world.

Biological control is an important component of integrated disease management (IDM) that provides disease control while being relatively harmless to humans, non-polluting and bio-degradable, selective in mode of action, difficult for pathogens to develop resistance, unlikely to harm other beneficial microorganisms and generally improves soil health and sustainability of agriculture (Sheo Raj *et al.,* 2004).

Wilhelm *et al.* (1997) reported that *B.subtilis* strains isolated from the xylem sap of healthy chestnut trees exhibited antifungal effect against *Cryphonectria parasitica* causing chestnut blight. Seed bacterization of tomato with *B. subtilis* F2B 44 significantly reduced the yield loss caused by *Pythium aphanidermatum*.

Development of blast resistant rice varieties is very expensive and time consuming and also mutation occur in *P. oryzae* which affect the efficiency of the resistance (Jia *et al*. 2016). Beneficial microorganisms associated with plants can help the plants grow faster and may protect them from the harmful microbes (Todorova and Kozhuharova 2010). Harish *et al.* (2009) demonstrated that *B. subtilis* can control the plant pathogens through secondary metabolites. Biological control of plant diseases with antagonistic microorganisms is now considered as a promising along with the use of fungicides. To manage certain crop diseases no single approach has been proved to be satisfactory. Hence, it is necessary to use microbial biocontrol agents followed by fungicides for effective management of diseases. In the present investigation, the biocontrol agents and new molecular fungicides were tested against blast disease of rice.

MATERIAL AND METHODS

Disease incidence :

A survey was conducted during 2020-21 on the incidence of blast disease in different rice growing areas of Tiruvallur district, Tamil Nadu. In each village, four fields were selected and four plots in each field having an average area of ten square meters were marked at random. The blast disease percent disease incidence (PDI) was recorded by using the following formula :

PDI =Sum of all rating hillsTotal No .of observed plants x Maximum disease grade (1"9) X100

Efficacy of biocontrol agents and fungicides against blast disease of rice :

An experiment was conducted with the following treatments was laid out at Rice research station, Tirur, Tiruvallur district, Tamil Nadu during 2020-2021 where the crop is grown every year. The rice variety ADT 43 was sown and transplanted in Randomized Block Design (RBD) with plot size 5 x 4 m^2. The experiment was conducted with nine treatments and each treatment replicated thrice. Totally three sprays were given, first at appearance of the disease as prophalytic spray, second at 15 days after first spray and third one at 15% emergence of the panicles. Five hills were randomly selected from each plot and were tagged. All normal agronomical practices were followed at regular intervals. The disease incidence was recorded at weekly intervals and after harvesting the yield has been recorded.

RESULTS AND DISCUSSION

A roving survey was conducted in farmer's holdings in different blocks of Tiruvallur district during 2020 – 2021 for the occurrence of rice blast disease. The intensity of the disease was observed in various places

across different varieties. In this survey, the incidence of blast ranged between 18.32 to 52.48 per cent. Maximum incidence of 52.48 per cent blast was recorded at Ponneri in BPT 5204 rice variety at Thiruvallur district of Tamil Nadu (Table 1).

Table 1: Survey on the incidence of rice blast disease in Tiruvallur district in Tamil Nadu

Sr. No.	Places	Rice varieties	PDI
1.	Poondhavakkam	ADT 43	28.56
2.	Kadampathur	NLR 34449	27.18
3.	Thannerkulam	BPT 5204	45.72
4.	Killampakkam	ADT 43	35.76
5.	Pothaturpettai	ADT 37	21.45
6.	Pandravedu	BPT 5204	48.74
7.	Thirumalrajpet	ADT 43	24.82
8.	Agoor	BPT 5204	31.43
9.	Chekkanur	NLR 34449	28.73
10.	V.K.R Puram	TKM 13	18.32
11.	R.K.Pettai	NLR 34449	33.64
12.	Gummidipoondi	BPT 5204	47.36
13.	Ponneri	BPT 5204	52.48
14.	Uttukottai	NLR 34449	42.67
15.	Periyapalayam	TKM 13	20.35

Biological control has become an efficient, alternative and eco friendly method for plant disease management (Kumar *et al.,* 2017). A number of *Bacillus* strains were capable of promoting plant growth and also producing biofilms on plant surfaces, enabling antagonistic activities against various plant pathogens (Chen *et al.,* 2013)

In the present study, biocontrol agents and fungicides were tested against blast disease of rice in field condition. In this experiment, seven treatments were tested, among the treatments T7 Seed treatment with *Bacillus subtilis* + Foliar spray of Tebuconazole 50% + Trifloxystrobin 25% WG @ 1g/l treatment was recorded maximum (67.88) per cent disease reduction with yield of 5867 kg/ acre followed by T8 which accounted 58.67 per cent reduction of the disease (Table 2). Marc *et al.* (2005) reported that *Bacillus subtilis* strain M4 decreases plant susceptibility towards fungal pathogens by increasing host resistance associated with differential gene expression.

The effects of the tested fungicides in controlling rice blast disease caused by *P. oryzae* under field conditions showed that the strobilurin fungicide, azoxystrobin, and the mixed triazole fungicides, difenoconazole + propiconazole and fuopyram + tebuconazole, exerted greater potential efect in rice blast disease reduction. Various researchers have reported that propiconazole (0.1%), azoxystrobin+difenoconazole (0.1%), and foxystrobin+tubuconazole (0.04%) were found to have significant effects on controlling rice blast disease, reducing the disease by 60.3%, 55.1%, and 53.3%, respectively (Raj and Pannu 2017).

One of the emerging strategies for managing plant diseases is the use of microbial biocontrol agents, with the aim of reducing pesticide usage, providing non-polluted produce and eventually to safeguard human health and environment. The present study strengthens that well-defined goal, giving abundant evidence to prove that field application of bioformulations and fungicides can help to manage the rice blast disease. In conclusion, the biocontrol agents and fungicide application effectively reduce the blast disease and enhanced the plant growth

Table 2: Evaluation of biocontrol agent and agrochemicals against the blast disease

Treatments	Treatment details	PDI*	Per cent reduction over control	Yield Kg/ha
T_1	Seed treatment with *Bacillus subtilis* @10g/kg	32.46	31.69	3897
T_2	Foliar spray of Tricyclozole 75 WP @ 1g/l	25.64	46.04	4425
T_3	Foliar spray of Picoxystrobin 6.78% + Tricyclazole 20.33% SC @1ml/l	23.58	50.37	4985
T_4	Foliar spray of Tebuconazole 50% + Trifloxys`trobin 25% WG @ 1g/l	22.43	52.79	5160
T_5	Seed treatment with *Bacillus subtilis* @10g/kg + Foliar spray of *Bacillus subtilis* @ 5ml/l	27.95	41.18	4123
T_6	Seed treatment with *Bacillus subtilis*@10g/kg+Foliar spray of Tricyclozole 75 WP @ 1g/l	21.34	55.09	5226
T_7	Seed treatment with *Bacillus subtilis* + Foliar spray of Tebuconazole 50% + Trifloxystrobin 25% WG @ 1g/l	15.26	67.88	5867
T_8	Seed treatment with *Bacillus subtilis* @10g/kg + Foliar spray of Picoxystrobin 6.78% + Tricyclazole 20.33% SC @1ml/l	19.64	58.67	5685
T_9	Untreated control	47.52		3642
	C.D. (P=0.05)	3.56		

*Mean of three replications

parameters and there by increased yield in rice.

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