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Pseudomonas fluorescens, a Potential Bioagent for Effective Management of Diseases in Organic Rice Production

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Abstract

Three sources of *Pseudomonas fluorescens* were tried along with Hexaconazole (0.10%) and Tricyclazole (0.10%) fungicides against different rice diseases. Among bio-control agents, seed treatment (1.0%), seedling root dip (0.1%), soil application @ 2.5 kg/ha and three foliar sprays (0.2%) with talc formulated *P. fluorescens* of Mahatma Phule Krishi Vidyapeeth, Rahuri were found effective for management of leaf, neck and node blasts, leaf scald, sheath rot, brown spot and seed discoloration diseases and increasing grain yield of rice up to 26.58 per cent as against control. Further, three sprays of fungicides *viz.,* tricyclazole (0.10%) and hexaconazole (0.10%) were found to be more effective than bio-agents in management of rice diseases. However, though the fungicides were more effective than bioagents, in organic rice production there is no alternative to the bioagent *P. fluorescens,* which takes care of most of the rice diseases under study.

Key words: Rice, Pseudomonas fluorescens, disease control

Introduction

Rice (*Oryza sativa* L.) is the most widely cultivated food crop in the world. The productivity of rice is less (1.8 t/ha) in Maharashtra as compared to India (2.41 t/ha) [Anonymous, 2016]. The major constraints for low productivity are diseases occurring on this crop which are caused by fungi, bacteria, viruses or nematodes. Among these, the most severe diseases infecting rice in Maharashtra are blast (*Pyricularia grisea*), leaf scald (*Rhynchosporim oryzae*), sheath rot (*Sarocladium oryzae*), brown spot (*Bipolaris oryzae*) and grain discolouration (*Sarocladium oryzae, Bipolaris oryzae,* etc.), which cause about 10-80 per cent loss in paddy yield depending upon the location, variety infected and severity of disease.

Sustainable agriculture depends on minimum use of chemical fungicides, pesticides, herbicides and fertilizers. Repeated use of these chemicals not only develops chemo-resistance in pathogens, but also causes severe problems from the health and environmental point of view. In view of these, the use of biologically based control method of diseases is now viewed as an eco-friendly and good alternative for chemical methods for sustainable agriculture. In present study of organic farming of rice, an experiment was conducted to study the efficacy of bioagents against different rice diseases during *kharif* seasons at Agricultural Research Station, Lonavala. Three sources of *Pseudomonas fluorescens* like talc formulation and liquid formulations from the Indian Institute of Rice Research (ICAR-IIRR), Hyderabad and talc formulation from MPKV., Rahuri were tested along with commonly used systemic fungicides *i.e*., Hexaconazole (0.10%) and Tricyclazole (0.10%) against rice diseases *viz.,* leaf blast, neck blast, node blast, leaf scald, sheath rot, brown spot and glume discolouration.

Materials and Methods

The field experiment was conducted in randomized block design (RBD) with six treatments and four replications at disease hot spot location, Agricultural Research Station, Lonavala, Tal. - Maval, Dist - Pune, Maharashtra. The experiments were conducted during *kharif* seasons of 2012 and 2013 on EK - 70, a highly susceptible variety of paddy to blast. Three sources of *Pseudomonas fluorescens* like talc (DRRT*Pf*) as well as liquid (DRRL*Pf*) formulations from DRR Hyderabad and talc formulation from MPKV., Rahuri (MPKV*Pf*) were tried along with fungicides *viz.,* Hexaconazole [(RS)-2-(2,4-dichlorophenyl)-1-(1H-1-2,4-triazol-1-yl) hexan-2-ol] and Tricyclazole (5-methyl-1,2,4-triazol [3,4,-b][1,3] benzothiazole), both @ 0.10 per cent against rice diseases. Three sprays were taken at 15 days interval, starting first spray at appearance of dis-

ease. The application of bioagents was done as per follows: (Annonymous, 2012).

Seed treatment (1.0%): Talc and liquid formulations were mixed @ 100g or ml/kg in 1000 ml of water and then mixed with 1 kg of seeds and soaked the seeds in water for overnight the methodology should have been to soak the seeds for 24hrs first, decant the excess water and then bioprime the seeds with the bioagents. Decanted the excess water and allowed the seed to sprout for 24 hours and sown the sprouted seeds.

Seedling root dipping @ 0.1 per cent: Applied 100 g and 20 ml of the Talc and liquid formulations, respectively to the water stagnated in an area of 1.0 sq. m. having depth of 10 cm. The seedlings after pulling out from the nursery were placed in stagnated water containing the bacteria for 10 minutes.

Soil application: Applied Talc and liquid formulations @ 2.5 kg and 0.5 L/ha, respectively by mixing with 50 kg of well decomposed farmyard manure (FYM) at 30 days after transplanting.

Soil application of talc formulation: Applied the product @ 2.5 kg/ha mixed with 50 kg of well decomposed farmyard manure (FYM) at 30 days after transplanting.

Soil application with liquid formulation (500ml/ha): Applied the product @ 500 ml mixed with 50 kg of well decomposed farmyard manure (FYM) per hectare at 30 days after transplanting. (Annonymous, 2012).

Foliar application*:* Sprayed the Talc and liquid formulations @ 0.2 and 0.5 per cent, respectively commencing from disease appearance at 10 days interval for 3 times.

Fungicide sprays: Sprayed the fungicides at their respective dose thrice at 10 days interval starting at first appearance of the disease.

Sprayed the fungicides at their respective dose thrice at 10 days interval starting at first appearance of the disease. (Annonymous, 2012).

The gross plot size for each treatment was 5.30 x 2.30 m^2 with plant to plant and row to row distance of 15 cm. Fertilizer was applied @ 100, 50 and 0 kg of NPK. The observations on diseases were recorded by following 0 – 9 SES scale as per IRRI, Philippines (Anonymous, 2002) and then converting into per cent disease intensity by using the formula.

$$\text{Per cent disease intensity} = \frac{\text{Sum of the scores X 100}}{\text{Number of observations X highest rating i.e. 9}}$$

As Lonavala is 'Hot spot' for the blasts (leaf. neck and node) and brown spot, whereas the disease pressure is very high for sheath rot and leaf scald so there is no need of artificial inoculation. The data on the yield were recorded in net plot by marking 5.00 x 2.00 m^2 section within each plot using a wire frame as described by (Seebold *et al.*, 2004) and tillers within the frame were cut and harvested in order to determine the yield.

Results and Discussion

Leaf, neck and node blasts

The observations in Tables 1 divulge that among bio-control agents, MPKV*Pf* had lowest incidence (45.64%) and intensity (26.89%) of leaf blast and thereby recorded disease reduction of 45.66 per cent. In addition, MPKV*Pf* also showed less incidence of 42.00 and 34.86 per cent with 35.38 and 34.10 per cent reduction in neck and node blast, respectively. While, it was at par with DRRT*Pf* and DRRL*Pf* those recorded 38.92 and 31.16 per cent leaf blast, 30.77 and 18.46 per cent neck blast and 31.29 and 25.07 per cent node blast reduction over control, respectively. The untreated control had significantly highest incidence of 72.96, 65.00 and 52.89 per cent of leaf, neck and node blasts, respectively as well as severity of 49.48 per cent of leaf blast. These results are in agreement with the work of David *et al*., 2008; Shyamala and Sivakumaar, 2012; Sutruedee *et al*., 2013 and Carla *et al*., 2014 wherein they noticed good control of rice blast with *P. fluorescens*.

Sheath rot

The MPKV*Pf* showed lowest intensity (42.22%) of sheath rot and thereby showed disease control of 29.89 per cent. But, it was at par with DRRT*Pf* and DRRL*Pf*, which

Figure 1. Nearly healthy plots due sprays of talc formulation of MPKV Pf (MPKVTPf)

Table 1. Blasts and sheath rot of paddy as influenced by bio-agents and fungicides (Pooled results of 2012 and 2013)

Sl. No.	Treatments	Leaf blast (%)			Neck blast (%)		Node blast (%)		Sheath rot (%)		
		Incidence	PDI	Reduction	Incidence	Redu-tion	Incidence	Reduction	Incidence	PDI	Reduction
1	Talc formulation of DRR *Pf* (DDRT*Pf*)	53.53	30.22	38.92	45.00	30.77	36.34	31.29	91.00	44.78	25.64
		47.03	**33.33**		**42.07**		**37.06**		**73.27**	**42.00**	
2	Liquid formulation of DRR *Pf* (DDRL*Pf*)	58.94	34.06	31.16	53.00	18.46	39.63	25.07	94.00	46.78	22.32
		50.15	**35.65**		**46.73**		**38.87**		**76.93**	**43.15**	
3	Talc formulation of MPKV *Pf* (MPKV*Pf*)	45.64	26.89	45.66	42.00	35.38	34.86	34.10	85.00	42.22	29.89
		42.49	**31.13**		**40.38**		**36.13**		**67.25**	**40.51**	
4	Hexaconazole 5% SC @ 1.0 ml/l	32.78	18.14	63.35	30.00	53.85	23.35	55.85	69.00	30.78	48.89
		34.89	**25.18**		**33.15**		**28.87**		**56.51**	**33.64**	
5	Tricyclazole @ 1 ml/l	26.95	14.20	71.30	27.00	58.46	18.20	65.59	71.00	33.67	44.09
		31.18	**22.10**		**31.18**		**25.15**		**57.75**	**35.37**	
6	Control	72.96	49.48	--	65.00	--	52.89	--	100.0	60.22	--
		58.85	**44.71**		**53.86**		**46.79**		**85.95**	**51.01**	
	SE ±	1.68	1.50		2.11		2.84		2.68	1.89	
	CD (0.05)	5.06	4.54		6.36		8.56		8.09	5.69	
	CV (%)	7.61	9.40		10.24		16.00		7.71	9.22	

The figures in the bold faces are arc sin values

recorded 25.64 and 22.32 per cent sheath rot reduction over control, respectively. The untreated control had significantly highest incidence of 100.00 per cent and severity of 60.22 per cent of sheath rot. These findings are matching with the reports of Sakthivel and Gnanamanickam (1987), Manoharan (2012) and Subramaniam *et al.,* (2013) who also recorded good control of rice sheath rot with *P. fluorescens*.

Leaf scald

The leaf scald observations reported in Table 2 reveal that the MPKV*Pf* was found to be most effective bio-control agent that had 51.64 and 22.75 per cent incidence and intensity, respectively and thus controled leaf scald upto 40.33 per cent over control. But, it was at par with DRRT*Pf* and DRRL*Pf* those recorded 34.42 and 30.81 per cent leaf scald reduction over control, respectively.

Figure 2. Control plots of rice showing heavy incidence of neck blast, scald, sheath rot and brown spot

Figure 3. Control plots of rice showing heavy incidence of seed discolouration

Brown spot and seed / glume discolouration

The observations (Table 2) illustrated that the bio-agent MPKV *Pf* was effective in reducing brown spot and seed discolouration by 28.18 and 33.33 per cent, respectively. However, it was at par with DRRT*Pf* and DRRL*Pf* those recorded 22.34 and 18.22 per cent as well as 28.16 and 21.84 per cent reduction of brown and seed discolouration, respectively over control. Earlier scientists (Sakthivel and Gnanamanickam,1987; Srivastava, 2008; Manoharan, 2012 and Sutruedee *et al*., 2013) also reported the effectiveness of *P. fluorescens* in controlling the brown spot and seed discolouration in rice.

Grain yield

The yield data presented in Table 2 are statistically significant. Among the bio-agents, the MPKV *Pf* produced maximum yield of 25.57 q/ha with 26.58 per cent yield increase followed by DRRT*Pf* (24.47 q/ha) and DRRL*Pf* (23.29 q/ha) with 21.14 and 15.30 per cent increase in yield, respectively. These results are in consonance with several scientists (Sakthivel and Gnanamanickam, 1987; Vasudevan *et al*., 2002; Vijay Krishna, 2009; Jeyalakshmi *et al*, 2010; Karthiba *et al*., 2010; Manoharan, 2012 and Subramaniam *et al*, 2013) who also noticed increased grain yield due to use of *P. fluorescens* for management of different diseases in paddy.

Table 2. Efficacy of bio-agents and fungicides against leaf scald, brown spot and glume discoloration and grain yield as influence by management of paddy diseases (Pooled results of 2012 and 2013)

Sr. No.	Treatments	Leaf scald (%)			Brown spot (%)			Glume discoloration (%)		Grain yield	
		Incidence	PDI	Reduction	Incidence	PDI	Reduction	Incidence	Reduction	q/ha	Increase over control
1	Talc formulation of DRR *Pf* (DDRT*Pf*)	54.17	25.00	34.42	70.00	31.39	22.34	31.25	28.16	24.47	21.14
		47.40	**29.95**		**56.98**	**34.00**		**33.94**			
2	Liquid formulation of DRR *Pf* (DDRL*Pf*)	57.26	26.37	30.81	73.75	33.06	18.22	34.00	21.84	23.29	15.30
		49.21	**30.79**		**59.78**	**35.07**		**36.25**			
3	Talc formulation of MPKV *Pf* (MPKV*Pf*)	51.64	22.75	40.33	67.50	29.03	28.18	29.00	33.33	25.57	26.58
		45.94	**28.39**		**55.32**	**32.52**		**31.91**			
4	Hexaconazole 5% SC @ 1.0 ml/l	42.41	17.50	54.10	46.25	14.86	63.23	21.25	51.15	29.77	47.38
		40.62	**24.69**		**42.84**	**22.48**		**27.37**			
5	Tricyclazole @ 1 ml/l	35.16	14.96	60.75	55.00	21.81	46.05	18.25	58.05	31.61	56.49
		36.33	**22.71**		**47.91**	**27.68**		**25.25**			
6	Control	66.44	38.12	--	86.25	40.42	--	43.50	--	20.20	--
		54.67	**38.10**		**70.24**	**39.28**		**41.25**			
	SE ±	1.53	1.43		3.72	2.43		1.40		1.57	
	CD (0.05)	4.60	4.31		11.21	7.33		4.22		4.74	
	CV (%)	6.67	9.84		13.40	15.27		8.58		12.19	

The figures in the bold faces are arc sin values

In addition to bioagents, the fungicides *viz.,* tricyclazole (0.10%) and hexaconazole (0.10%) were also used for comparison in management of rice diseases. It indicated that significantly lowest incidence / intensity of leaf, neck and node blasts, sheath rot, leaf scald, brown spot and seed discolouration were noticed in the treatment with tricyclazole (0.10%) followed by hexaconazole (0.10%). The fungicides were found to be more effective than bioagents for management of rice diseases.

Conclusion

The bioagent, MPKV*Pf* was found to be more effective for management of diseases *viz.,* leaf, neck and node blasts, leaf scald, sheath rot, brown spot and glume discolouration of paddy and thereby increasing the grain yield. Though the fungicides were more effective than bioagents, in organic rice production, *P. fluorescens,* is a better alternative which takes care of most of the rice diseases.

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