Integrated management of blast diseases in rice

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ABSTRACT

This paper deals about the application of SIR (Systemic Induced Resistance) chemicals and organic sources like *Panchakavya* to the host along with Bio control agent would enhance disease suppressing mechanisms against rice blast disease. Among the various treatments, seed treatment of *Pseudomonas fluorescens* (PFS) a native isolation @ 10 g/kg of seeds along Annamalai nagar with foliar application of chemical Nicotinic acid NA1 (15 DAT- days after transplanting @ 100 ppm) and organic product "*Panchakavya*" (Modified) PK2 (30 DAT @ 5 %) increased plant height, Number of tillers, Number of productive tillers per clump, panicle length, thousand grain weight and minimum disease incidence recorded in IR 50 under pot culture conditions. Percentage of filled grain, grain yield and straw yield are improved when compared to other treatments. Also, Seed and foliar application of bio protectant increased the rhizosphere population.

Keywords: Rice blast, Biocontrol agent, Organic product, Resistance inducing chemical, Integrated Pest management

MS History: 01.10.2018 (Received)-30.10.2018 (Revised)-10.11.2018 (Accepted).

Citation: Jaiganesh, V. 2018. Integrated management of blast diseases in rice. *Journal of Biopesticides,* **11**(2): 82-88.

INTRODUCTION

Rice (*Oryza sativa* L.) is the second most cultivated crop worldwide and it has been estimated that half the world's population survives wholly or partially on this crop (Van Nguyen and Ferrero, 2006), Rice provides more calories per hectare than any other cereal food grains. Rice crop is widely affected by a number of diseases caused by fungi, bacteria, viruses and mycoplasma which results in considerable yield losses (Ou, 1985). Among the various fungal diseases, Blast disease of rice caused by *Pyricularia oryzae* Cav. is found to occur in almost all the rice growing countries and is the most destructive disease causing loss up to 90 per cent (Mehrotra, 1998). The possible control measures of blast disease are the use of fungicides, growing resistant varieties, application of organic amendments, balanced nutrition, biological agents and resistance inducing chemicals. Modern agriculture largely depends on the use of chemical fertilizers due to introduction of high yielding fertilizers responsive rice cultivars. The application of chemical fertilizers has undoubtedly increased the production at the same time led to the accumulation of hazardous pollutants and undesirable effect on soil sustainability in the long term; however, it increases the incidence the disease. In this context there is an imperative need to improve the production of food grains without affecting the environment and the quality of food grains with improved agricultural technology. Based on these concepts the use of *Panchakavya* is gaining momentum among the farmers (Natarajan, 1999; Natarajan, 2001; Natarajan, 2002).

In addition to organic nutrition, induced resistance by chemicals may provide an efficient approach to plant protection especially for problems not satisfactorily controlled by various fungicides (Schoenbeck *et al.*, 1980; Schoenbeck, 1996). Resistant inducing chemicals are known as inducers of phytoalexins and/or elicitors of resistance in different plant species (Biswas *et al.*, 2008;

Shabana *et al.*, 2008; Hadi and Balali, 2010). Several chemicals viz., Salicylic acid (Sarwar *et al*., 2011), Acibenzolar – S – Methyl (Bengtsson *et al*., 2008), Acetyl Salicylic acid (White, 1979), Nicotinic acid (Jaiganesh, 2005), Jasmonic acid (Cohen *et al*., 1993) and Oxalic acid (Toal and Jones, 1999) have shown induced resistance in various crops.

The indiscriminate use of chemical fungicides resulted in environmental pollution and ill health to biotic community in this context the biological methods of plant disease management seems to be the only alternative to chemical fungicides in managing the blast disease. To combat these, *Pseudomonas* strains appear to be ideal agents for the control of blast disease as they are known to survive in the rhizosphere of plants grown under inundated conditions (Seiya Tsushima *et al*., 1991 and Twng wah Mew *et al*., 2004) as well as in the phyllosphere (Beattie and Lindav, 1999, Wilson *et al*., 1999 and Hiranol and Upper, 2000) and of many plants. However a biological method of plant disease management has so far not proved as efficient in bringing down the disease incidence below the economic threshold level.

Hence it was thought that the application of SIR (Systemic Induced Resistance) chemicals and organic sources like *Panchakavya* to the host along with Bio control agent would enhance disease suppressing mechanisms against *P.oryzae*.

METRIALS AND METHODS

Organic sources -*Panchakavya*

The following ingredients were used to prepare approximately 20 liters of *Panchakavya* stock solution. Cow dung (5 kg), cow's urine (3 Ll), cow's milk (2 Ll), cow's curd (2 Ll) and cow clarified butter/ghee (1 Ll). In addition sugarcane juice (3 litres), tender coconut water (3 Ll) and ripe banana (1 kg) were added to accelerate the fermentation process (Natarajan, 1999). All the materials were added to a wide mouthed clay pot and kept open under shade. The contents were stirred twice a day for about 20 minutes, both in the morning and evening to facilitate aerobic microbial activity. Fifteen days after the preparation, from the stock solution 5% concentration was prepared at the vali of and sprayed (500 L ha-1) using hand-operated sprayer with cone type nozzle four times for each crop as per the treatment schedule.

Pot culture experiment

The effective treatments observed on screened tests under pot culture experiments were pooled together (Bio control agent + Organic Product + Resistance inducing chemical – Annamalai Nagar Native isolate of *Pseudomonas fluorescens* + *Panchakavya* + Nicotinic acid (At their respective MIC's)) and a new schedule of treatments for the effective management of blast was evaluated. The treatment details are given below;

Treatment combinations

T1 – PFS PFF1 PFF2, T2 – PFS NA1 NA2, T3 – PFS PK1 PK2, T4 – PFS PFF1 NA2, T5 – PFS NA1 PFF2, T6 – PFS NA1 PK2, T7 – PFS PK1 NA2,T8 – PFS PK1 PFF2,T9 – PFS PFF1 PK2, T10 – Tricyclazole 0.2 % (Comparison fungicide), T11 – Control (Where, PFS -Seed treatment with Annamalai Nagar native isolate of *Pseudomonas fluorescens* @ 10 g/kg of seeds ; PFF1 – foliar application of Annamalai Nagar native isolate of *Pseudomonas fluorescens* @ 1 % on 15 DAT ; PFF2 - foliar application of Annamalai Nagar native isolate of *Pseudomonas fluorescens* @ 1 % on 30 DAT ; NA1 – foliar application of Nicotinic acid @ 100 ppm on 15 DAT; NA2 – foliar application of Nicotinic acid @ 100 ppm on 30 DAT; PK1 - foliar application of *Panchakavya* @ 5% on 15 DAT; PK2 – foliar application of *Panchakavya* @ 5% on 30 DAT). The Blast susceptible variety IR 50 grown in rectangular pots of size, 30x45 cm was used for the study. The plants were given artificial inoculation by spraying the spore suspensions with adequate spore load (50,000 spores / mL) at 15 DAT in the evening hours. The crop was maintained in a poly house with frequent spraying of water to provide adequate moisture and relative humidity to enable successful infection by the pathogen. The experiments were conducted in a randomized block design with three replications for each treatment and a suitable

control. The fungicide Tricyclazole 75 WP @ 0.2 per cent was used for comparison and the standard agronomic practices as recommended by the State Agricultural Department were followed. In all the studies observations on disease incidence, grain and straw yield were recorded at the time of harvest. The disease incidence was observed from a randomly selected set of three hills per pot.

Blast incidence was assessed by adopting 0-9 scale according to "Phytopathometry", by Mayee and Datar (1986) and then the per cent disease incidence was calculated based on the procedure formulated by Vidhyasekaran *et al*., (1989).

Disease evaluation

$$\text{Percent Disease Index} = \frac{\text{Total ratings}}{\text{Total number of leaves graded} \times \text{Maximum grade in the score chart}}$$

Grain yield: After the harvest, the grains were separated, winnowed, dried in the sun and dry weight was recorded and expressed as g/pot.

Straw yield: After thrashing and separation of grains, the straw was dried pot wise in sun for two days. Later the straw weight was recorded and expressed as g/pot.

Integrated treatments on soil microbial populations

The samples for estimating microbial population were drawn periodically 15 days after transplanting at 25 days intervals up to 100 days. The population of bacteria, actinomycetes and fungi were determined by serial dilution plate technique (Aneja, 2001) using Soil extract agar for bacteria, Kenknight's Agar for Actinomycetes and Czapek's (Dox) Agar for fungi. Population of each microbial group was expressed as population per g of soil in 10-6, 10-3 and 10-6 dilutions for Actinomycetes, fungi and bacteria respectively.

RESULTS AND DISCUSSION

Effect of PF, NA, PK and P.oryzae inoculation on biometrics, per cent disease incidence and yield parameters of rice var. IR 50Results of the experiment (Table 1 and 2) showed that seed treatment of Annamalai nagar Native isolate *P. fluorescens* along with foliar application of NA1 (15 DAT) and PK2 (30 DAT) increased plant height (88 cm), Number of tillers (15), Number of productive tillers per clump (13), panicle length (19 cm), thousand grain weight (19 g). Percentage of filled grain (85 %), grain yield (47 g/pot) and straw yield (64 g/pot) when compared to other treatments. Minimum disease incidence of 10 per cent was recorded with the treatment of PFS 10 g/kg of seed plus foliar application of NA1 @ 0.1 per cent (15 DAT) plus PK2 @ 5 per cent (30 DAT) while control recorded the maximum disease incidence with 68 per cent. Hence, it is concluded that the combinations of Annamalai nagar Native isolate *P. fluorescens* @ 10 g/kg with NA @ 0.10 per cent (15 DAT) and *Panchakavya* @ 5 per cent (30 DAT) was found to be the most

Table 1. Efficacy of PF, NA, PK and *P.oryzae* inoculation on the biometrics of rice Var. IR 50 (Pot culture experiment, Navarai 2017- Three replications).

Sl.No.	Treatments	Plant height (cm)	No. of tillers/clump	No. of productive tillers/clump	Panicle length (cm)
1	T_1	77	10	8	16
2	T_2	78	12	10	17
3	T_3	77	11	9	16
4	T_4	78	12	11	17
5	T_5	79	13	11	18
6	T_6	88	15	13	19
7	T_7	80	14	12	17
8	T_8	78	12	10	16
9	T_9	78	12	10	17
10	T_{10}	83	13	12	18
11	Control	70	9	8	15
S.E. CD (P=0.5)		0.037 0.05	0.021 0.04	0.026 0.04	0.017 0.03

Table 2. Efficacy of PF, NA, PK and *P.oryzae* inoculation on disease incidence and yield parameters of rice var. IR 50 (Pot culture experiment, Navarai, 2017 – Three replications)

Treatments	Disease incidence (%)	Thousand grain wt. (g)	Filled grain (%)	Grain yield (g/pot)	Straw yield (g/pot)
T_1	28	17	78	37	53
T_2	12	18	80	41	59
T_3	28	17	79	38	55
T_4	20	18	80	39	57
T_5	16	18	81	41	58
T_6	10	19	85	47	64
T_7	18	19	83	40	60
T_8	30	17	79	38	55
T_9	32	17	79	39	56
T_{10}	16	18	80	43	59
Control	68	17	72	15	17
S.E. C.D. (p=0.05)	1.36 2.10	0.029 0.05	0.04 0.05	0.27 0.42	0.027 0.05

effective in improving the various biometrics and yield parameters as well as decreasing the incidence of disease.

In the present investigation, an increase in the plant growth parameters and grain yield was observed in all the treatments except control. Seed treatment of Annamalai nagar Native isolate of *P. fluorescens* suppresses the foliar pathogen by induced systemic resistance. Based on these facts, bacterial application to the rice plant has an inductive effect on defence reactions but no direct effect on fungi. This effect is through to be related to the production of elicitor like oligosaccharides from the fungal cell walls by hydrolytic action of chitinolytic enzymes of *P. fluorescens*. On the other hand, various factors produced by bacterial bio control agent (Press *et al*., 1997) have been reported as elicitors inducing systemic resistance to plant diseases. The beneficial influence of resistance inducing chemicals on the growth and yield was established by earlier workers (Shulaev *et al*., 1996; Jean-Pierre M'etradux, 2001; Venkata Ratnam *et al*., 2001). It is evident that NA is important endogenous signal molecule involved in the transduction pathway and is required for the establishment of SAR. In the present study, systemic protection in paddy against blast pathogen was induced by foliar application of NA. Protection was not solely restricted to the site of induction but was also observed with the time of application. When plants were treated with NA on 15 DAT increased resistance to blast pathogen was observed in the present study.

In the present study, the cumulative effect of seed treatment (PFS), chemical spray NA1 and PK2 spray not only checked the disease incidence. But also influenced positively on Bio-metrics and Yield parameters. This might be due to the positive interaction of PFS, Nicotinic acid and *Panchakavya* spray treatments in controlling the disease incidence and increased growth parameters.

Effect of application of PF, NA and PK on the survival of PF in the rhizosphere soil

Results (Fig. 1, 2 and 3) of the study revealed that initial population of *P. fluorescens* was found increased from 0 to 100 DAT when

Fig 1. Effect of PF, NA and PK application of fungal population blast infected rice var. IR50

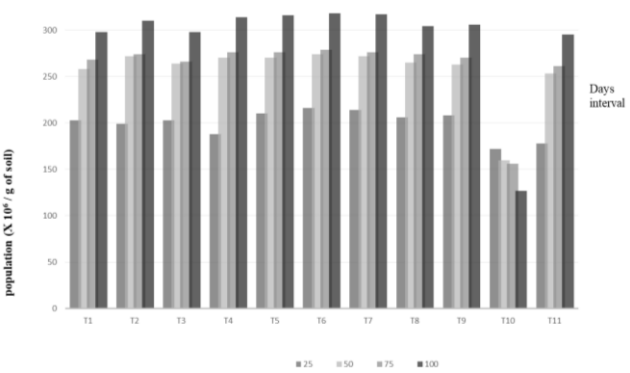


Fig 2. Effect of PF, NA and PK application of bacterial population blast infected rice var. IR50

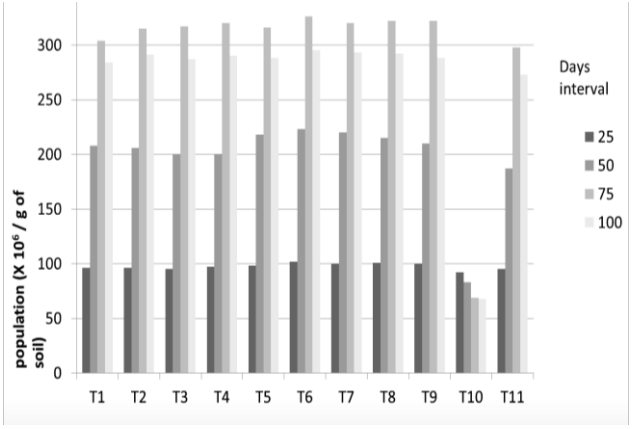
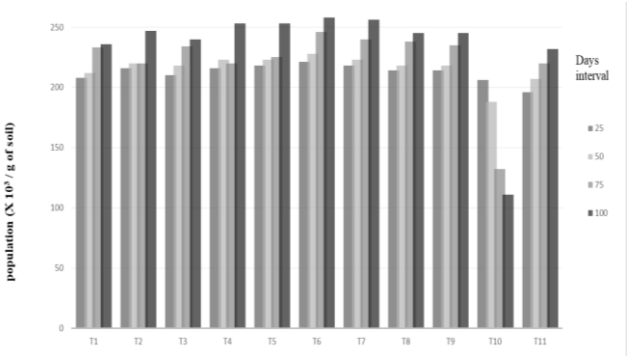


Fig 3. Effect of PF, NA and PK application of actinomycetes population blast infected rice var. IR50



compared to control. Maximum population of *P. flourescens* was recorded at 25, 50, 75 and 100 DAT in the treatment (T6) followed by T5 and T7 in 2017. The test fungicide Tricyclazole decreases the soil rhizosphere population of fungi, bacteria and actinomycetes in the soil.

These observations are in agreement with the findings of Ayyappan (2003) and Chandrasekhar (2003). From the available evidences, it can be concluded that the efficient colonization of the bio protectant in the rhizosphere might be made possible through the possession and exhibition of good competitive saprophytic ability, enzymatic antagonistic potential and other features (Sivan *et al*., 1984).

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