Pseudomonas flourescens and *Heterorhabditis indica* Poinar for the management of major insect pests of rice

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ABSTRACT

An investigation was carried out to assess the efficiency of *Pseudomonas flourescens* (PGPR) and *Heterorhabditis indica* Poinar (Entomopathogenic Nematode) against major rice pests. Rice seedling dip plus spraying in the main field @ 15g/litre with *P. flourescens* was found to be significantly effective in reducing the incidence of stem borer (*Scirpophaga incertulas).* Spraying of *H.indica* @ 3000 IJs /ml was effective in reducing the white ear incidence. The incidence of gall midge (*Orselia orzae*) was significantly reduced with the treatment of *P. flourescens* seedling dip plus spray @ 10g/litre. EPN spray @ 2500 IJs /ml was also equally effective in reducing the gall midge incidence at 25 DAT. Case worm (*Paraponyx stagnalis)* damage was observed to be lowest in plots treated with *P. flourescens* seedling dip plus spray @ 15g/litre. Treatment with *H. indica* indicated a lowest incidence of leaffolder (*Cnaphalocrocis medinalis).* *H. indica* applied @ 3000 IJs /ml was the superior treatment at 25 days after transplanting while at the later stage (55 days after transplanting), a lower dose @ 2500 IJs /ml was found to be sufficient to bring about significant control of leaffolder. The incidence of *P. stagnalis* was significantly lowest with *P. flourescens* seedling dip plus spray @ 15g/litre. But the treatments showed no significant difference against the incidence of blue beetle (*Leptispa pygmaea)* and whorl maggot (*Hydrellia phillippina*).

Key words: *Pseudomonas flourescens*, *Heterorhabditis indica*, stemborer, leaffolder, caseworm, whorlmaggot, blue beetle, crop pest

INTRODUCTION

Insect pest cause at least 20 per cent field losses in rice in India (Pathak *et al.,* 1982). The use of chemical pesticides in Asian countries has been sharply increased in recent years particularly in India. The use of biopesticides, as a vital component in sustainable agriculture, has assumed greater significance as an important tactic in IPM due to the economic viability and eco-friendly nature (David, 2008). In recent years, the antagonistic bacteria, *Pseudomonas flourescens* and the entomopathogenic nematodes (EPN) - steinernematids and heterorhabditids- are widely used in biological control (Gaugler and Kaya, 1990; Grewal and Georgis, 1998). Poinar *et al*. (1992) detected *Heterorhabditis indica* in sugarcane fields at Coimbatore. The present study was undertaken to assess the efficacy of the PGPR, *P. flourescens* and the EPN, *Heterorhabditis indica* Poinar against the major pests of rice *viz.,* stem borer, *(Scirpophaga incertulas* Walker), gall midge, (*Orseolia oryzae* Wood-Mason) whorl maggot (*Hydrellia phillippina* Ferino), case worm, (*Paraponyx stagnalis* Zeller), leaffolder, (*Cnaphalocrocis medinalis* Guenee) and blue beetle, (*Leptispa pygmaea* Baly)..

MATERIALS AND METHODS

Two seasons rice field experiments in randomized block design were conducted at the Regional Agricultural Research Station, Pattambi, Kerala Agricultural University during *Kharif* and *Rabi* 2008. The efficacy of eight treatments consisting of four with *P. flourescens* seedling dip and spraying @ 5g, 10g and 15g /litre and the rest four with EPN, *H. indica* spraying @ 1500, 2000, 2500 and 3000 IJs /ml along with an untreated control were studied. Three replications were maintained for each treatment. The cultures of *P. flourescens* obtained from the Department of Plant Pathology of RARS, Pattambi and *H. indica* from the Cardamom Research Institute Station, Pampadumpara were used for the experiments. Twenty five days old rice seedlings, variety Jyothi, were transplanted at a spacing of 20x15 cm in plots of size 18 sqm and the treatment sprays were applied at 20, 30, 40 and 50 and 70 days after transplanting with a high volume knapsack sprayer. Glycerin 10% was also mixed with sprays of EPN in order to increase the survival and activity of nematodes on the foliage of plants (Nash and Fox, 1969). Observations on the incidence of damage caused by *S. incertulas*, *O. oryzae H. phillippina, P. stagnalis, C. medinalis* and *L.*

Table 1. Efficacy of *Pseudomonas flourescens* and *Heterorhabditis indica* against rice stem borer and gall midge (pooled analysis of two seasons)

Treatments	Dead Heart (%)		White Ear (%)	Silver shoots (%)	
	Days after transplanting				
	25	45	75	25	35
P. flourescens seedling dip plus spray @ 5g/litre	4.23(1.41)	7.25(2.23)	7.95(2.69)	4.95(1.89)	4.75(1.80)
P. flourescens seedling dip plus spray @ 10g/litre	4.83(1.76)	4.75(1.74)	7.92(2.70)	1.85(0.96)	4.80(1.82)
P. flourescens seedling dip plus spray @ 15g/litre	2.38(0.92)	4.00(1.15)	8.30(2.84)	5.25(2.00)	4.85(1.84)
Spray with *H.indica* @ 1500 IJs /ml	7.66(2.28)	4.75(1.74)	8.23(2.80)	5.15(1.96)	7.85(2.48)
Spray with *H.indica* @ 2000 IJs /ml	4.85(1.76)	7.83(2.62)	7.95(2.74)	4.85(1.84)	4.90 (1.87)
Spray with *H.indica* @ 2500 IJs /ml	5.05(1.81)	5.10(1.81)	5.50(2.22)	3.95(1.40)	5.00 (1.91)
Spray with *H.indica* @ 3000 IJs /ml	8.25(2.81)	4.12(1.61)	5.20(2.16)	4.80(1.82)	3.25(1.17)
Untreated control	16.57(8.26)	11.24(6.50)	10.95(5.17)	11.05(5.23)	11.15(6.30)
CD (0.05%)	0.94	1.12	1.08	0.52	1.09

Figures in parentheses are arcsine transformed values

pygmaea were recorded. The results of both the seasons were pooled and the data are presented in the tables.

RESULTS AND DISCUSSSION

Effect on *S. incertulas*

Lowest incidence of dead heart caused by *S. incertulas* (Table 1) was observed with the treatment *P. flourescens* seedling dip plus spray @ 15g/litre (2.38) and was followed by *P. flourescens* seedling dip plus spray @ 5g/litre (4.23%) at 25 days after transplanting (DAT). All the tested treatments were superior over the untreated control at 25 DAT. At 45 DAT also, *P. flourescens* seedling dip plus spray (15g/litre) was most effective against *S. incertulas* with the lowest incidence of 4.00 per cent dead heart and was followed by EPN spray @ 3000 IJs /ml with a mean damage of 4.12 per cent. All other treatments were better than the control at this period too. The efficacy of *P. flourescens* against stem borer was earlier reported in sugarcane by Herrera *et al*. (1994) who indicated that sugarcane treated with *P. flourescens* 14: omegan-Km-cry was resistant to sugarcane borer (*Eldana saccharina*).

At reproductive stage, the EPN, *H.indica* spray @ 3000 IJs /ml produced lowest incidence of white ear (5.2%) followed by EPN spray @ 2500 IJs /ml while *P. flourescens* treatments were less effective. Spraying of *H.indica* @ 3000 IJs /ml was significantly effective with 52.51 per cent

Table 2. Efficacy of *Pseudomonas flourescens* and *Heterorhabditis indica* against rice case worm and leaffolder (pooled analysis of two seasons)

Treatments	Case worm Damaged leaves (%)		Leaffolder Damaged leaves (%)	
	Days after transplanting			
	25	45	35	55
P. flourescens seedling dip plus spray @ 5g/litre	4.80(1.75)	7.85(2.64)	5.95(2.16)	5.08(2.04)
P. flourescens seedling dip plus spray @ 10g/litre	4.85(1.84)	5.85(2.14)	5.75(2.10)	4.95(1.93)
P. flourescens seedling dip plus spray @ 15g/litre	4.70(1.66)	4.95(1.96)	6.95(2.25)	4.75(1.65)
Spray with *H.indica* @ 1500 IJs /ml	5.15(2.11)	5.06(2.03)	4.90(1.92)	4.20(1.33)
Spray with *H.indica* @ 2000 IJs /ml	4.85(1.84)	5.75(2.10)	4.23(1.41)	4.15(1.30)
Spray with *H.indica* @ 2500 IJs /ml	5.05(2.02)	5.80(2.12)	3.95(1.08)	3.92(1.07)
Spray with *H.indica* @ 3000 IJs /ml	4.95(1.96)	5.95(2.18)	1.50(0.55)	4.00(1.17)
Untreated control	10.50(4.56)	10.75(5.13)	11.15(4.95)	10.45(5.10)
CD (0.05%)	0.37	0.29	1.00	1.20

Figures in parentheses are arcsine transformed values

Table 3. Efficacy of *Pseudomonas flourescens* and *Heterorhabditis indica* against rice blue beetle and whorl maggot (pooled analysis of two seasons)

Treatments	Blue beetle Damaged leaves (%)		Whorl maggot Damaged leaves (%)	
	Days after transplanting			
		25	45	25 45
P. flourescens seedling dip plus spray @ 5g/litre	6.85(2.33)	10.51(4.52)	10.51(4.52)	5.13(3.84)
P. flourescens seedling dip plus spray @ 10g/litre	7.03(2.43)	10.62(4.73)	10.62(4.73)	5.05(3.61)
P. flourescens seedling dip plus spray @ 15g/litre	7.05(2.44)	10.24(4.42)	10.24(4.42)	5.13(3.84)
Spray with *H.indica* @ 1500 IJs/ml	7.96(2.68)	10.75(4.85)	10.75(4.85)	5.95(3.95)
Spray with *H.indica* @ 2000 IJs/ml	8.05(2.96)	10.57(4.58)	10.57(4.58)	5.11(3.81)
Spray with *H.indica* @ 2500 IJs/ml	7.90(2.67)	10.60(4.69)	10.60(4.69)	5.20(3.88)
Spray with *H.indica* @ 3000 IJs/ml	7.96(2.83)	10.58(4.60)	10.58(4.60)	5.90(3.91)
Untreated control	10.55(4.65)	14.14(7.38)	14.14(7.38)	7.21(6.16)
CD (0.05%)	1.06	1.25	1.25	0.26

Figures in parentheses are arcsine transformed values

reduction of the white ear incidence caused by stem borer. An entomopathogenic nematode, *Oscheius* sp. isolated from vertisols has been reported to infect egg masses of rice stem borer (Katti *et al.*, 2003) .

Effect on *O. oryzae*

Significantly reduced incidence of silver shoot was observed in all treatments of *P. flourescens* and EPN as compared to the untreated control (Table 1). The incidence of silver shoots was significantly lowest in the treatment of *P. flourescens* seedling dip plus spray @ 10g/litre (1.85 %) and EPN spray @ 2500 IJs /ml was also equally effective (3.95 %) in reducing the gall midge incidence at 25 DAT . But at 35 DAT, a higher dose of EPN spray @ 3000 IJs /ml showed lesser incidence of silver shoots (3.25 %). *P. flourescens* was earlier reported to be lethal to other dipterans like the larvae and pupae of vector mosquitoes (Padmanabhan *et al.*, 2005).

Effect on *P. stagnalis*

With regard to caseworm incidence, *P. flourescens* seedling dip plus spray @ 15g/litre produced significantly lowest incidence at 25 (4.70 %) and 45 DAT (4.95 %) with 54.28 and 53.95 per cent reduction over untreated control (Table 2).

Effect on *C. medinalis*

All the biopesticide treatments were effective than untreated control. Significant reduction of the incidence of leaffolder was observed in EPN treated plots at 35 and 55 DAT with doses @ 2500 and 3000 IJs /ml respectively as compared to *P. flourescens* treated plots (Table 2). The finding corroborates with the earlier study of Padmakumari *et al.* (2008) who reported that *H. indica* @ 4000 IJs /ml brought about leaffolder larval mortality up to 16% and 35% after 24 and 48h after treatment under net house condition.

Effect on *L. pygmaea* and *H. phillippina*

Both the biocontrol agents *P. flourescens* and *H. indica* at all the tested doses were equally effective in reducing the leaf damage caused by blue beetle and whorl maggot. However, there was no significant difference between the treatments, but superior to untreated control (Table 3). Under laboratory conditions *H. indica* at concentrations of 5IJs to 9IJs caused a cumulative mortality from 66.67 to 91.67 per cent to grubs of *L. pygmaea* (Karthikeyan and Jacob, 2009).

It could be thus concluded from the present studies that rice seedling dip and 2-3 sprays of *P. flourescens* @ 15g /litre of water and the EPN *H. indica* can be applied in rotation sprays in order to manage pests like stem borer, gall midge, leaffolder and whorl maggot in rice.

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