J. Biol. Control, 22(2): 315-320, 2008

Effect of spinosad against major insect pests and natural enemies in rice ecosystem

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ABSTRACT: **Field experiments were carried out to evaluate the efficacy of spinosad 45 SC, a biological product from actinomycetes, *Saccharopolyspora spinosa* @ 45 and 54 g a..i/ha in comparison to three other insecticides, *viz*., lambdacyhalothrin (12.5 g a.i./ha), chlorpyriphos 50% + cypermethrin 5% @ 344 g a.i./ha and monocrotophos @ 500 g a.i./ha as check against major insect pests of rice at Regional Agricultural Research Station, Pattambi, Kerala Agricultural University for three seasons *viz*., *Kharif* 2005, Rabi 2005 and 2006. Pooled analysis of three crop seasons indicated that spinosad @ 54 g a.i./ha was the most effective against rice stem borer, gall midge, leaffolder and whorl maggot. It caused 63 and 49 per cent reduction in dead hearts and white ears, respectively. The lower dosage of spinosad @ 45 g a.i./ha reduced whorl maggot infestation by 34 per cent. Spinosad @ 54 g a.i./ha resulted in 94 per cent reduction in leaffolder and 50 per cent reduction in gall midge infestation. Spinosad treatment also resulted in 14 per cent increase in rice yield. Spinosad caused no significant effect on spider population and was safe to spiders that predominate the predatory fauna in rice. Monocrotophos and lambdacyhalothrin significantly reduced the spider and larval parasitoid populations in the rice ecosystem.**

KEY WORDS: Leaffolder, rice gall midge, spinosad, stem borer, whorl maggot

INTRODUCTION

Insecticides which result in quick and effective control of insect pests when their population reaches the economic threshold level form one of the important components of integrated pest management (IPM) in rice. Spinosad (Tracer 45 SC), a new fermented product from the actinomycetes, *Saccharopolyspora spinosa*, has been reported to show exceptional effectiveness against insect pests belonging to Lepidoptera, Coleoptera, Thysanoptera and Diptera in many crops with selectivity to many natural enemies and non-target insects and hence is considered to be ideal for IPM in different crops (Dutton *et al*., 2003). No information is available on the efficacy of spinosad against the major insect pests of rice. Hence, the present study was undertaken to investigate the bioefficacy of spinosad against the major pests of rice and also

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assess its safety to the natural enemy fauna in the rice ecosystem.

MATERIALS AND METHODS

Field investigations were undertaken at the Regional Agricultural Research Station, Kerala Agricultural University, at Pattambi during three seasons, *viz.*, *Kharif* 2005, *Rabi* 2005 and 2006. The experiments were laid out in randomized block design with six treatments, *viz.*, two concentrations of spinosad 45 SC @ 45 and 54 g a.i./ha, chlorpyrifos 50 %+ cypermethrin 5% @ 344 g a.i./ha, lambdacyhalothrin 5 EC @12.5 g a.i./ha, monocrotophos 36 WSC (500 g a.i./ha) as check and an untreated control, with four replications for each treatment.

Twenty-five days old rice seedlings (variety Jyothi) were transplanted at a plant to plant spacing of 20cm and row to row spacing of 15 cm in plots of 24 m^2. Fertilizers were applied at the rate of 70:35:35 kg / ha as per the package of practices of the Kerala Agricultural University. The treatments were applied as sprays at 15, 35 and 45 days after transplanting using a high volume knapsack sprayer. Observations on the incidence of rice yellow stem borer, *Scirpophaga incertulas* (Walker) (dead heart and white ear head); gall midge, *Orseolia oryzae* (Wood-Mason) (silver shoot); whorl maggot, *Hydrellia philippina* Ferino (leaf damage) and leaffolder, *Cnaphalocrocis medinalis* (Guenee) (leaf damage) were recorded a week after spraying on 10 randomly selected hills per plot.

The populations of spiders, damsel flies and larval parasitoids were sampled from different treatments by making ten net sweeps walking diagonally across the entire plot on the same day of recording the damage of pests. Grain yield of all the treatments at harvest was also recorded. The data of results thus collected during the three seasons were pooled and subjected to analysis in a randomized block design and the treatment means were compared by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Bioefficacy of spinosad against major rice pests

a) Rice yellow stem borer (*Scirpophaga incertulas*)

All the insecticide treatments were effective against *S. incertulas* (Table 1). Spinosad @ 54 g a.i./ ha was significantly superior to all the other insecticides in reducing the damage caused by yellow stem borer with the lowest incidence of dead heart (3.48%) and 62.9 per cent reduction in dead hearts over the untreated control. The lower dose of spinosad @ 45 g a.i./ha resulted in 3.83% incidence of dead hearts and 59.3 per cent reduction in dead hearts. Monocrotophos, the check insecticide, caused the highest incidence of dead hearts (9.06 per cent) and white ears (14.87 per cent). Lambdacyhalothrin and chlorpyriphos 50% + cypermethrin 5% were statistically on par in their efficacy, resulting in 11.3 and 37.8 per cent damage reduction, respectively. The insecticide treatments showed no significant effect on the incidence of white ears. The present finding on the effectiveness of spinosad thus adds this insecticide to the list of other promising insecticides, *viz.*, cartap (Gubbiah *et al.*, 1995), chlorpyriphos (Vavadia *et al.*, 1996), carbosulfan (Karthikeyan and Purushothaman, 2000), triazophos (Panda *et al.*, 2002), calypso (Dhivahar and Dhandapani, 2003), carbofuran (Muhammad *et al.*, 2003), and fipronil (Jena *et al.*, 2004) against *S. incertulas*.

b) Gall midge (*Orseolia oryzae*)

Spinosad @ 54 g a.i./ha was the most significantly effective treatment in reducing silver shoots caused by gall midge (Table 1). It reduced the incidence of silver shoots by 50.1 per cent over untreated check while the check insecticide monocrotophos brought about only 38.0 per cent reduction in silver shoots. Monocrotophos @ 500g a.i./ha caused the highest silver shoots (4.48 per cent) while spinosad @ 54 g a. i/ ha resulted in lowest damage (3.61 per cent). The other insecticide treatments were found to be on par.

Table 1. Efficacy of spinosad against major rice pests (Pooled analysis of three crop seasons)

Treatments	Dose @ g a.i./ha	Stem borer		Gall midge	Whorl maggot	Leaf folder	Grain YieldKg/ha
		% DH	% WE	%SS	% DL	% DL	
Spinosad 45% SC	45	3.83 (0.16^{ab})	9.20 (0.29^{a})	4.08 (0.19^{ab})	3.60 (0.17^{a})	1.57 (0.10^{a})	2630^{ab}
Spinosad 45 % SC	54	3.48 (0.09^{a})	8.25 (0.27^{a})	3.61 (0.13^{a})	3.77 (0.20^{ab})	0.86 (0.08^{a})	2702^{a}
Chlorpyriphos 50% + Cypermethrin 5%	344	5.85 (0.22^{abc})	7.81 (0.26^{a})	4.38 (0.20^{ab})	4.29 (0.21^{ab})	3.61 (0.10^{a})	2422^{ab}
Lambdacyhalothrin 5%EC	12.5	8.34 (0.27^{abc})	13.76 (0.33^{a})	3.77 (0.16^{ab})	4.46 (0.23^{ab})	6.45 (0.26^{b})	2476^{ab}
Monocrotophos 36%WSC	500	9.06 (0.30^{bc})	14.87 (0.34^{a})	4.48 (0.21^{ab})	4.05 (0.21^{ab})	10.05 (0.31^{b})	2489^{ab}
Untreated control		9.40 (0.37^{c})	16.18 (0.37^{a})	7.23 (0.29^{b})	5.45 (0.25^{b})	15.03 (0.39^{b})	2370^{b}

* Figures in parentheses are arcsine transformed values; *Figures followed by different letters are significantly different at p=0.05; * DH: Dead hearts, WE: White ear, SS: Silver shoots, DL: Damaged leaves

c.) Whorl maggot (*Hydrellia philippina*)

The lower dose of spinosad @ 45 g a.i. /ha was the most effective treatment (3.6 per cent damage) against whorl maggot (Table 1). It brought about 33.6 per cent reduction in damage over the unreated control whereas monocrotophos produced only 25.7 per cent reduction. All the insecticide treatments other than spinosad @ 45 g a.i. /ha were on par in their efficacy against the whorl maggot. However, the highest damage was observed in lambdacyhalothrin indicating its ineffectiveness against whorl maggot.

d.) Leaffolder (*Cnaphalocrocis medinalis*)

The leaffolder damage was significantly reduced by spinosad @54 g a.i./ha by 94.3 per cent over untreated control. Leaf damage was found to be the highest in monocrotophos (33.3 per cent reduction over control). Chlorpyrifos 50% + cypermethrin 5% was on par with spinosad with 76 per cent reduction in damage over control. Spinosad thus proved its efficacy against *C. medinalis* and hence it could be added to the list of other promising insecticides like quinalphos and phosalone (Saroja, 1989), chlorpyrifos, fenitrothion and monocrotophos (Borah and Saharia, 1989), ethofenprox (Mishra *et al.*, 1998), methyl parathion, phosphamidon and endosulfan (Kushwaha, 1995), triazophos and profenofos (Panda *et al.*, 1999), fipronil (Guozhang *et al.*, 2002), flufenoxuron and lambdacyhalothrin (Rao *et al.*, 2002) against rice leaffolder. In the present study, spinosad @ 54 and 45 g a.i./ha were equally effective showing 94.3 and 89.5 per cent reduction in leaffolder damage respectively, whereas monocrotophos brought about lowest reduction in damage of 33.1 per cent. The highest leaffolder damage observed in monocrotophos treatment was on par with that in lambdacyhalothrin treatment. Spinosad at both dosages and chlorpyriphos 50 % + cypermethrin 5 % were found to be on par and more effective than monocrotophos and lambdacyhalothrin against rice leaffolder.

Table 2. Biological safety of spinosad to natural enemies in rice ecosystem (Pooled analysis of three crop seasons)

Treatments@ g a. i./ha	Spiders		Damselflies		Larval parasitoids		Total natural enemy population	
	Population	Decrease (D) / increase (I) over control %	Population	Decrease (D) / increase (I) over control %	Population	Decrease (D) / increase (I) over control%	Population	Decrease (D) / increase (I) over control%
Spinosad 45% SC@ 45	3.38 (1.77 [a])	58.7 (I)	5.63 (1.95 [b])	11.8 (D)	4.75 (1.73 [abc])	17.4 (D)	13.76	3.5 (D)
Spinosad 45 % SC@ 54	2.00	6.1 (D)	(2.12 [ab])	4.1 (D)	(1.96 [ab])	2.1 (D)	13.76	3.5 (D)
Chlorpyriphos 50% + Cypermethrin 5%@ 344	(1.75 [a]) 1.88 (0.84 [b])	11.7 (D)	6.13 4.25 (1.38 [c])	33.4 (D)	5.63 3.33 (1.44 [bc])	42.1 (D)	9.46	33.7 (D)
Lambdacyhalothrin 5%EC @ 12.5	1.25 (0.97 [b])	41.3 (D)	4.38 (1.3 8 [c])	31.4 (D)	4.13 (1.17 [c])	28.2 (D)	9.76	31.6 (D)
Monocrotophos 36%WSC @ 500	1.25 (0.94 [b])	41.3 (D)	5.38 (1.84 [bc])	15.7 (D)	3.63 (1.10 [c])	36.9 (D)	10.26	28.1 (D)
Untreated control	2.13 (1. 75 [a])		6.38 (2.51 [a])		5.75 (2.14 [a])		14.26	

* Figures in parentheses are logarithmic transformed values; *Figures followed by different letters are significantly different at p=0.05

(e) Grain yield

The highest grain yield was recorded in spinosad @ 50 g a.i./ha (Table 1) and it was significantly superior to all the other treatments and 14.0 per cent higher than the yield in the control. No significant difference in yield was observed among other insecticides. The treatment with monocrotophos, the check insecticide, brought about only 5.02 per cent increase in yield over the control.

Bioefficacy of Spinosad against natural enemies of rice eco-system

Safety to natural enemies

Application of spinosad @ 45 and 54g a .i. / ha caused no significant effect on the population of spiders in the rice field (Table 2). It was on par with the untreated control indicating its safety to spiders that constitute the predominant group of predators in the rice ecosystem. The treatment with spinosad @45 g a.i. /ha showed 58.7 per cent increase in the spider population whereas all other insecticide treatments resulted in a decrease in the population of spiders. Monocrotophos, lambdacyhalothrin and chlorpyriphos 50% + cypermethrin 5% significantly reduced the population of spiders in rice by 41.3 and 11.7 per cent, respectively.

All the insecticide treatments caused a significant decrease in damselfly population. However, spinosad @ 54 g a.i./ha caused the least decrease of 4.1 per cent as compared to other insecticides. Lambdacyhalothrin and chlorpyriphos 50% + cypermethrin 5% showed the lowest damselfly population and were on par. Monocrotophos caused 15.7 per cent decrease of damselfly population over the untreated control.

The population of larval parasitoids was significantly reduced in all the insecticide treatments. However, spinosad caused only 2.1 per cent decrease as compared to 36.9 per cent decrease in parasitoid population by monocrotophos. Chlorpyriphos 50% + cypermethrin 5% caused 42.1 per cent decrease in parasitoid population. Lambdacyhalothrin and monocrotophos were on par in reducing the larval parasitoids in rice ecosystem.

It was observed that spinosad caused the lowest reduction in the total natural enemy population (spiders, damselflies and larval parasitoids) followed by monocrotophos, lambdacyhalothrin and chlorpyriphos 50% + cypermethrin 5%. Monocrotophos and lambdacyhalthrin caused 28.1 and 31.6 per cent reduction in the natural enemy population over control, respectively. Chlorpyriphos 50% + cypermethrin 5% caused the highest reduction of damselflies and larval parasitoids whereas spider population was considerably reduced by the application of monocrotophos and lambdacyhalothrin.

The safety of the tested insecticides to natural enemies based on the decrease of total natural enemy population over control was rated in the descending order as spinosad > monocrotophos > lambdacyhalothrin > chlorpyriphos 50% + cypermethrin 5%. Spinosad was thus observed to be highly effective against major pests and safe to the natural enemies, *viz.*, spiders, damselflies and larval parasitoids in rice. The safety of spinosad to natural enemies in rice ecosystem corroborates the earlier report of Murray and Lloyd (1997) in cotton ecosystem where spinosad was found to be safe to predators like the coccinellid, *Harmonia maculata*; true bug, *Nabies kinbergii* and spiders.

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(Received: 31.08.2007; Revised: 26.04.2008; Accepted: 16.05.2008)