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EFFICIENCY OF SPINOSAD AND RUNNER AGAINST PINK BOLLWORM AND PREDATORS POPULATION ON COTTON FIELDS

Yousif-Khalil, S.I.[1], S.A.A. Raslan[2], Ola I. Hegab[1], and Omnia S. Abd-Elsttar[2]

1. Plant Protection Dept., Faculty of Agriculture, Zagazig Univ., Zagazig, Egypt.
2. Plant Protection Research Institute, Dokki, Giza, Egypt.

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ABSTRACT: Relative effectiveness of spinosad and Runner compared with Dursban against pink bollworm, *Pectinophora gossypiella* infesting cotton green bolls as well as some important predators in cotton fields were evaluated under field conditions at Sharkia Governorate, during 2004 and 2005 cotton seasons.The seasonal average reductions in *P.gossypiella* infestation attained 86.9, 81.93 and 63.62 in 2004; 84.79, 82.19 and 5.76% in 2005 due to Spinosad, Dursban, and Runner treatments, respectively. Conventional insecticide Dursban resulted in the highest degree of % reduction for all investigated predators, followed by spinosad and Runner, where they recorded general reductions for all investigated predators of 77.44, 49.36 and 42.20% reductions in 2004 season, and 70.71, 49.22 and 35.05% in 2005 cotton season, respectively. Results revealed that spinosad and Runner can be used in the integrated program for the control of the pink bollworm. Spinosad can be used at low or high infestations, while Runner can be applied at the beginning of the season at lower infestations.

Key words: The pink bollworm, coccinellids, spinosad, methoxyfenozide, toxicity index, neonate larvae, pupation, fecundity, and topical application.

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saund.) is one of the most destructive pests of cotton crop in Egypt. It attacks all the fruiting parts; squares, flowers and bolls, causing severe reduction in the quantity and quality of the cotton yield.

Pink bollworm, like other pests in different cultivations was subjected for along time to varieties of conventional synthetic insecticides. However, the pressure of insecticide selection causes serious resistance problems in the control of these pests. Therefore, there is a need for different insecticides having different modes of action to avoid such resistance phenomina.

Spinosad is an alternative and a reduced-risk insecticide with a novel mode of action. A comprehensive ecological risk assessment for spinosad used in US cotton crops was presented within a framework of tiered levels of refinement following the guidelines of the US EPA for ecological risk assessments Cleveland, *et al.* (2002). Spinosad is a naturally derived biorational insecticide with an environmentally favourable toxicity profile (Bond *et al.*, 2004). It is an insecticide based on an aerobic fermentation product of the bacterium *Saccharopolyspora spinosa* on nutrient media. It was discovered during the 1980s (Mertz *et al.* 1990). Spinosad (a mixture of spinosyns A and D belong to a new class of polyketide-macrolide insecticides. In many countries, spinosad is used in control of lepidopteran pests in cotton, and other crops (Wyss *et al.* 2003). It acts by disrupting binding of acetylcholine in nicotinic acetylcholine receptors at the postsynaptic cell (Salgado 1997).

IGRs are claimed to be safer for benficial organisms than conventional insecticides, and they have been successfully used in IPM programs against many tree and small fruit pests (Knight 2000, and Palli and Retnakaran 2001). The dibenzoylhydrazine ecdysteroid agonists are a class of insect growth regulator (IGR) insecticides. One of these compounds, Runner, is highly selective against lepidopterous larvae (Palli and Retnakaran 2001), has low mammalian toxicity (Dhadialla and Jansson 1999), and has low activity against natural enemies (Suh *et al.* 2000, and Mc-Cravy *et al.* 2001). This IGR insecticide cause a premature and fatal ecdysis when ingested by larval stages of Lepidoptera (Smagghe *et al.* 1999) and its ovicidal activity against some Lepidoptera has been reported (Carlson *et al.* 2001).

Comparison of new products with currently available insecticides also provides a measurement of relative efficacy. In this study we reported results of relative effectiveness of spinosad

and methoxyfenozide (Runner) compared with the recommended conventional insecticide chlorpyrifos ethyl (Dursban) against Pink bollworm, *Pectinophora gossypiella* infesting cotton green bolls. Side effect on some important predators in cotton fields at Sharkia Governorate has been also investigated.

MATERIALS AND METHODS

Efficiency of Spinosad and Runner Against the Pink Bollworm *pectinophora gossypiella* (saund.), and Predators Populations on Cotton Fields

Efficiency of spinosad and Runner against the pink bollworm infestation in cotton field

Spinosad and Runner at the rates of 50 and 200 ml/feddan respectively were used in comparison with the recommended conventional insecticide Dursban at the rate of 1000 ml/feddan to evaluate their efficiency in reducing the infestation of cotton field with pink bollworm.

Field experiments were carried out at Zagazig district, Sharkia Governorate, Egypt during 2004 and 2005 cotton growing seasons. The experimental area was cultivated with the Egyptian cotton variety, Giza 85 on 18 and 15 March during the two seasons.

The experimental area was divided into plots of two kerats (350 m^2) represented one replicate, Four replicates were considered for every treatment one plant was left control.

Spray program started when the average of infestation of green bolls with pink bollworm reached about 5%. Three sprays at two weeks intervals were applied for all tested compounds. Spray programs begin on 18 and 23 July during 2004 and 2005, respectively. A knapsack motor sprayer was used with 200 liters insecticide solution per feddan.

Before and weekly after spray 100 green cotton bolls were collected randomly (25 bolls X 4replicates) from every treatment, as well as from the control treatment. Green cotton bolls were externally and internally inspected and the numbers of larvae were recorded. The reduction in numbers of larval contents per 100 green cotton bolls were calculated according to Henderson and Tilton equation (1955).

Reduction %=1- (A/B×C/D) ×100

Where:

A= Number of larvae in treatment after application.

B= Number of larvae in treatment before application.

C= Number of larvae in control before application.

D= Number of larvae in control after application.

Insecticides used

1. Spinosad (Spintor 24% SC) it is a metabolite of the actinomycete, *Saccharopolyspora spinosa*, occurring in mixture of spinosyn A & D used at the rates of 50 ml/feddan.
2. Methoxyfenozide (Runner24 %SC), it is an insect growth regulator (IGR), used at the rate of 200 ml/feddan.
3. Chlorpyrifos ethyl (Dursban 48% EC) it is organophosphate compound used at the rate of 1 L /feddan.

Efficiency of spinosad and Runner against predators' populations on cotton fields

The harmful effect of the tested compounds against some predators was investigated. The numbers of predators, Ladybird beetles, *Coccinella spp.* and *Scymnus spp.*: Staphylinid beetle, *Paederus alfierii*; anthocorid bugs, *Orius* spp.; aphid lion, *Chrysoperla carnea* and true spiders were counted in 25 cotton plants for every replicate, i.e.; 100 cotton plants for every treatment, before and weekly after insecticide ecapplications. At the end of the season the mean weekly numbers for each predator were secorded and the reduction percentages were estimated according to Henderson and Tilton equation (1955).

RESULTS AND DISCUSSION

Efficiency of Spinosad and Runner Against the Pink Bollworm Infestation in Cotton Fields

First season (2004)

As shown in Table 1 the percent reductions in larval contents per 100 green cotton bolls showed that spinosad was the most efficient compound against the pink bollworm *P. gossypiella*, followed by Dursban then Runner.

The mean reductions after the first spray were 82.13, 78.56 and 66.03%, and after the second spray

Table 1. Efficiency of spinosad and Runner against the pink bollworm infestation in cotton field, Sharkia Governorate, 2004

Treatments	Rate / feddan	No. of larvae before spray	No. of larvae and reductions	Numbers and reductions of larvae/ 100 green bolls after spray									% Average seasonal reduction
				1st spray			2nd spray			3rd spray			
				1 week	2 weeks	Mean reduction	1 week	2 weeks	Mean reduction	1 week	2 weeks	Mean reduction	
Spinosad	50 ml	6	Numbers	3	5	82.13	5	5	88.82	7	9	89.86	86.94
			% Reductions	81.81	82.46		87.17	90.48		90.07	89.66		
Runner	200 ml	4	Numbers	4	6	66.03	9	12	65.55	18	25	59.30	63.62
			% Reductions	63.64	68.42		65.38	65.71		61 70	56.89		
Dursban	1000 ml	5	Numbers	3	5	78.56	6	8	81.63	8	11	85.60	81.93
			% Reductions	78.18	78.94		81.54	81.71		86.38	84.82		
Control	-----	4	Numbers	11	19	------	26	35	------	47	58	------	------

were 88.82, 81.63 and 65.55%, while the third spray resulted in 89.86, 85.60 and 59.30% reductions, for spinosad, Dursban and Runner, respectively.

Generally, the mean seasonal % reduction recorded 86.94, 81.93 and 63.62%after the treatment with Spinosad, dursban and Runner, respectively.

Second season (2005)

Data in Table 2 indicate that the efficacy of the tested compounds followed the same trend of the first season. For instance, the percent reduction in green bolls infestation with pink bollworm larvae attained 83.25,85.07 and 61.08% after the fist spray, and 90.83,79.22 and 58.67% after the 2nd spray;81.78,82.29 and 53.45% after the 3rd spray with Spinosad,Dursban and Runner, respectively. The corresponding mean seasonal % reduction reached 84.79, 82.29 and 57.76%.

Generally spinosad in the two experimental seasons proved to be the most potent However, it can be used in the integrated program for the control of the pink bollworm *Pectinophora gossypiella* (Saund.), in any time of the season i.e.: at the low or high infestation. Mean while, Runner is preferable for use at the beginning of the season.

In connection, Antonio *et al.* (1997) found that spinosad demonstrated great speed in controlling beet armyworm (*Spodoptera exigua*) in cotton. Adamczyk *et al.* (1999) found that methoxyfenozide and spinosad are effective in controlling early fall armyworm instars on cotton. Spinosad was used in parallel with lambda-cyhalothrin, and thiodicarb against the cotton bollworm, *Helicoverpa zea*, and the results indicated that could be used for control of *H. zea*. Brickle *et al.* (2001) spinosyns (spinosyns A and D) are in parallel with that of many pyrethroid insecticides against pest insects Sparks *et al.* (2001). Emara et *al.* (2002) studied in field trials different spray programs of insecticides to combat the pink bollwom (PBW), *Pectinophora gossypiella* and the spiny bollwom (SBW) *Earias insulana* in Behira Governorate during 2000 and 2001. The best rotation program with two week intervals was chlorpyrifos ethyl WG at 640 g. followed by Es-fenvalerate 5 % EC at 600 ml followed by spinosad 24 %SC at 50 ml tank mixed with 1L. Williams *et al.* (2004) found that the efficacy of spinosad

Table 2. Efficiency of spinosad and Runner against the pink bollworm infestation in cotton field, Sharkia Governorate, 2005

Treatments	Rate / feddan	No. of larvae before spray	No. of larvae and reductions	Numbers and reductions of larvae/ 100 green bolls after spray									% Average seasonal reduction
				1st spray			2nd spray			3rd spray			
				1 week	2 weeks	Mean reduction	1 week	2 weeks	Mean reduction	1 week	2 weeks	Mean reduction	
Spinosad	50 ml	4	Numbers	1	3	83.29	1	4	90.83	5	8	81.78	84.79
			% Reductions	88.64	77.94		91.79	89.87		84.38	79.17		
Runner	200 ml	5	Numbers	4	7	61.08	9	14	58.67	18	23	53.45	57.76
			% Reductions	63.63	58.52		62.50	54.83		55.00	52.08		
Dursban	1000 ml	6	Numbers	2	3	85.07	5	9	79.22	7	12	82.29	82.19
			% Reductions	84.85	85.29		82.63	75.81		85.41	79.17		
Control	-----	5	Numbers	11	17	------	24	31	------	40	48	------	------

applied at 0.3 and 1.0 g (AI)/ha was very similar to that of chlorpyrifos for control of *Spodoptera frugiperda* (J.E. Smith) in maize, *Zea mays* L. David *et al.* (2005) found that spinosad resulted in good control *for H. armigera* in grain crops., methoxyfenozide, was slower acting than spinosad but demonstrated potential for *Heliothis armigera* management. Pineda *et al.* (2006) stated that spinosad and methoxyfenozide represent an important choice to be used in integrated pest management where *Spodoptera littoralis* is a major pest.

Side Effect of Spinosad and Runner Against the Predators' Population on Cotton Field

The hazardous effect of spinosad and Runner in comparing with Dursban on most abound ant six predators on cotton fields i.e.; Ladybird beetles, *Coccinella spp.* and *Scymnus spp.*; staphylinid beetle, *Paedsrus alfierii*; anthocorid bugs, *Orius spp.*; aphid lion, *Chrysoperia carnea* and true spiders, were determined. Tables 3 and 4 show the pre- and post-treatment numbers and the mean season âl reduction of the predators' populations.

Coccinella spp.

The conventional insecticide Dursban treatmcnt caused the highest reduction in the numbers of the predatory stages of *Coccinella spp.*, attained 81.02 and 80.73% seasonal reduction in 2004 and 2005 cotton seasons, respectively.

Natural insecticide spinosad and the IGR insecticide Runner caused lower percent age reductions *in Coccinella spp* numbers. The figures were 47.70 and 40.00% in 2004 season, and 49.12 and 27.26% in 2005, respectively.

Chrysoperla carnea

As shown in Tables 3 and 4, aphid lion, *Chrysoperla carnea* was the most abundant predator on experimental cotton fields during the two seasons, The average numbers recorded weekly were 16.50 and 18.50 insects in 2004 and 2005 seasons, respectively.

The tested compounds arranged in descending order according to their hazard effect against *Chrysoperla carnea* were as follow; Dursban, spinosad and Runner as they recorded 75.50, 48.94 and 33.08% seasonal reduction in 2004; 67.95, 55.70 and 43.26% in 2005 season, respectively.

Table 3. Side effect of spinosad and runner on predacious populations in cotton fields, Sharkia Governorate, 2004

Treatments	Rate /feddan	Predators	No. before spray	No. of predators/ 100 cotton plants						General meen/week	% Seasonal reduction
				1st spray		2nd spray		3rd spray			
				1 week	2 weeks	1 week	2 weeks	1 week	2 weeks		
Spinosad	50 ml.	*Coccinella spp.*	12	8	6	4	3	1	0	3.66	47.70
		C. carnea	18	18	20	11	8	5	3	10.83	48.94
		P. alfierii	5	3	1	0	1	0	0	0.83	54.64
		Scymnus spp.	9	9	9	6	6	3	2	5.83	37.29
		Orius spp.	11	7	6	2	2	0	0	2.83	52.97
		Tru spiders	14	10	10	6	7	8	4	7.66	48.56
		Total	69	55	52	29	27	17	9	31.50	49.36
Runner	200 ml.	*Coccinella spp.*	10	8	7	4	2	0	0	3.5	40.00
		C. carnea	15	17	19	12	10	7	6	11.83	33.08
		P. alfierii	8	5	3	0	1	0	0	1.50	48.77
		Scymnus spp.	11	14	12	6	3	2	2	6.50	42.79
		Orius spp.	8	5	5	3	2	0	1	2.66	39.22
		Tru spiders	11	11	9	8	6	4	3	6.83	41.63
		Total	63	60	55	33	24	13	12	32.83	42.20
Dursban	1000 ml.	*Coccinella spp.*	15	5	3	0	2	0	0	1.66	81.02
		C. carnea	15	6	9	4	4	1	2	4.33	75.50
		P. alfierii	6	1	1	0	0	0	0	0.33	84.97
		Scymnus spp.	13	7	7	3	3	0	0	3.33	75.20
		Orius spp.	9	3	2	0	1	0	0	1.00	79.69
		Tru spiders	10	5	5	4	1	2	2	3.16	70.29
		Total	68	27	27	11	11	3	4	13.83	77.44
Control	---	*Coccinella spp.*	12	14	12	8	4	4	0	7.00	-----
		C. carnea	14	22	29	22	15	10	11	16.50	-----
		P. alfierii	5	5	3	1	0	2	0	1.83	-----
		Scymnus spp.	10	16	15	9	11	6	5	10.33	-----
		Orius spp.	7	7	7	5	3	0	1	3.83	-----
		Tru spiders	13	11	13	17	15	15	12	13.83	-----
		Total	61	75	79	62	48	37	29	55.00	-----

Table 4. Side effect of spinosad and Runner on predacious populations in cotton fields, Sharkia Governorate, 2005

Treatments	Rate /feddan	Predators	No. before spray	No. of predators/ 100 cotton plants						General meen/week	% Seasonal reduction
				1st spray		2nd spray		3rd spray			
				1 week	2 weeks	1 week	2 weeks	1 week	2 weeks		
Spinosad	50 ml.	*Coccinella spp.*	15	10	10	6	2	0	0	4.66	49.12
		C. carnea	17	13	13	7	3	2	3	5.16	55.70
		P. alfierii	5	2	2	1	0	0	0	0.83	60.00
		Scymnus spp.	15	15	11	4	2	0	0	5.33	39.63
		Orius spp.	8	4	2	0	0	0	0	1.00	53.70
		Tru spiders	13	9	7	3	3	2	4	4.66	56.41
		Total	73	53	45	21	10	4	7	23.33	49.22
Runner	200 ml.	*Coccinella spp.*	12	12	10	7	1	0	2	5.33	27.26
		C. carnea	24	18	16	10	4	2	6	9.33	43.26
		P. alfierii	6	3	3	1	1	0	0	1.33	46.58
		Scymnus spp.	11	12	10	5	1	2	1	5.16	20.31
		Orius spp.	6	2	2	1	0	0	0	0.83	58.76
		Tru spiders	16	14	11	10	7	5	5	8.66	34.19
		Total	75	61	52	34	14	9	14	30.66	35.05
Dursban	1000 ml.	*Coccinella spp.*	17	6	5	1	0	0	0	2.00	80.73
		C. carnea	22	8	10	4	2	2	3	4.83	67.95
		P. alfierii	4	0	2	0	0	0	0	0.33	80.12
		Scymnus spp.	13	6	5	2	0	0	0	2.16	71.77
		Orius spp.	5	0	1	0	0	0	0	0.16	88.14
		Tru spiders	12	6	6	3	3	1	2	3.20	67.57
		Total	73	26	29	10	5	3	5	13.00	70.71
Control	---	*Coccinella spp.*	15	20	18	9	3	4	1	9.16	------
		C. carnea	27	38	29	17	7	8	12	18.50	------
		P. alfierii	4	3	4	2	1	0	0	1.66	------
		Scymnus spp.	15	22	16	9	4	2	0	8.83	------
		Orius spp.	8	6	5	2	0	0	0	2.16	------
		Tru spiders	16	18	14	15	11	12	9	13.16	------
		Total	85	107	86	54	26	26	22	53.50	------

Paederus alfierii

This predator was found in low numbers in both experimental seasons at the control areas, recording 1.83 and 1.66 insects /week in 2004 and 2005 seasons, respectively.

Dursban, spinosad and Runner caused 84.97, 54.64 and 42.97% seasonal reduction in *Paedsrus alfierii* populations, in 2004 season; 80.12, 60.00 and 46.58% in 2005 season, respectively.

Scymnus spp.

Data in Tables 3 and 4 showed that Dursban treatment resulted in 75.20 and 71.77% seasonal reductions in *Scymnus spp* populations in 2004 and 2005 seasons, respectively.

Spinosad and Runner treatments caused relatively lower % reduction in *Scymnus spp.* Populations, reaching 42.79 and 37.29% in 2004; 20.31 and 39.63% in 2005 season, respectively.

Orius spp.

The numbers of these bugs were low during the two cotton seasons of 2004 and 2005, recording 3.83 and 2.16 insects/week, in control treatment, respectively.

Data in Tables 3 and 4 showed that *Orius spp.* in both experimental seasons were highly affected with Dursban treatment, which resulted in seasonal reductions of 79.69 and 88.74%, in 2004 and 2005 seasons, respectively.

Spinosad in 2004 season resulted in 52.97% seasonal reduction in the numbers of *Orius spp.* Being higher than that recorded with Runner (39.22% reduction), the contrast was clear in 2005 season, where Runner resulted in 58.76% reduction compared to 53.70% seasonal reduction recorded with spinosad.

True spiders

The mean weekly numbers of the true spiders recorded 13.83 and 13.16 spiders in 2004 and 2005 seasons, respectively.

Data in Tables 3 and 4 revealed that the harmful effect of the used insecticides on true spiders in descending order is as follow; Dursban, spinosad and Runner, recording 70.29, 48.56 and 41.63% reductions in 2004 and 67.56, 56.41 and 34.19% reductions, in 2005 season respectively.

Generally, the conventional insecticide Dursban resulted in the

highest rate of reduction in the populations of all investigated predators, followed by spinosad and Runner, where they recorded general reductions in all investigated predators of 77.44, 49.36 and 42.20% reductions in 2004 season, and 70.71, 49.22 and 35.05% in 2005 cotton season, respectively. In connection Jesusa, *et al.* (2000) tested several novel and commercial insecticides for the contact toxicity to selected beneficial insects, *Cotesia flavipes*, *Allorhogas pyralophagus*, *Catolaccus grandis and Chilocorus cacti*. Methoxyfenozide was nontoxic, while Chlorpyrifos was toxic to *C. grandis*, *C. flavipes*, and *A. pyralophagus*, but not to *C. cacti*. Nowak, *et al.* (2001) spinosad was less toxic compared to the pyrethroids initially against the parasitoid, moth, *Rhyacionia frustrana* (Comstock), but the spinosad relative mortality increased with time until it reached a level similar to the pyrethroids. However Tillman, *et al.* (2001) reported that spinosad generally did not affect the number of the natural enemies; *G. punctipes*, *H. convergens*, and *C. maculata* in the field except for one day after application. Mayes *et al.* (2003) spinosad has low toxicity to most beneficial insects. Schneider *et al.* (2003) methoxyfenozide had no effect on the lepidopteran parasitoid *Hyposoter didymator* (Thunberg) while spinosad was very toxic. Angeli *et al.* (2005) methoxyfenozide has low toxic effect on the predatory bug, Orius laevigatus.

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