Journal of Biopesticides, 2(2): 223- 227 (2009)

Efficiency of Spinetoram as a biopesticide to Onion Thrips (*Thrips tabaci* Lindeman) and Green Peach Aphid (*Myzus persicae* Sulzer) under laboratory and field conditions

M. F. Mahmoud[1], M. A. M. Osman[1], I. M. Bahgat[2] and G. A. El-Kady[1]

ABSTRACT

Spinetoram toxicity was evaluated under laboratory conditions against primary stages and adult of onion thrips, *Thrips tabaci* Lindeman and green peach aphid, *Myzus persicae* Sulzer. Seventy two hours after treatment, lethal concentrations LC_{10}, LC_{20}, LC_{50} and LC_{90} for onion thrips adults were 3.171, 5.439, 15.370 and 74.490 μg/ml, respectively, while they were 18.043, 26.782, 57.304 and 181.991 μg/ml for larvae. Under the same conditions, they were 2.993, 4.882, 12.520 and 52.368 μg/ml for peach aphid adults and 5.431, 8.371, 19.264 and 68.335 μg/ml for nymphs, respectively. Thus, the adult stage of both insects was more susceptible to spinetoram than primary stages and the toxicity slope was steepest for adults and flattest for primary stages. Field bioassays were also carried out under a greenhouse conditions and apricot trees. Spinetoram was sprayed at the rates of 37.5, 75, 150, 300 and 400 μg/ml and these doses caused reduction of infestations of both insects.

INTRODUCTION

Green peach aphid (*Myzus persicae* Sulzer), is one of the major pests of vegetable crops and stone fruits (Hill, 1983). It is distributed worldwide and it is a pest of over 400 plant species (Cloyd and Sadof, 1998). Onion thrips (*Thrips tabaci* Lindeman) is also an important pest of field and greenhouse crops all over the world. It feeds on many cultivated and spontaneous plants including beans, broccoli, cabbage, carnation, carrot, cauliflower, Chinese broccoli, cotton, cucumber, garlic, head cabbage, leek, melon, onion, orchids, papaya, peas, pineapple, rose, squash, tobacco, tomato, and turnip (Clausen, 1978). Onion thrips and green peach aphid cause direct damages to crops through feeding on plants and transmission of harmful plant viruses. They are difficult to control with insecticides because of their small sizes and cryptic habits (Lewis, 1997).

Spinetoram is a new member of spinosyn insecticides (Dow AgroSciences, 2006) and having unique mode of action (Group V insecticides). The spinosyns spinosad and spinetoram (Dow AgroSciences, Indianapolis, IN) are the most effective insecticides to suppress *Frankliniella occidentalis*, and they are reduced risk insecticides that do not suppress populations of *Orius insidiosus* at labeled rates (Funderburk *et al*,. 2000; Reitz *et al.*, 2003; Srivastava *et al.*, 2008). It is derived from fermentation of *Saccharopolyspora spinosa* as are other spinosyns, which is followed by chemical modification of spinosyns J and L (Mertz and Yao, 1990). Spinetoram provide long-lasting control of a broad spectrum of insect pests in a variety of crops. In fact, it has shown activity against Lepidoptera, Thysanoptera, and other insect orders such as Diptera. It is applied at low rates (10 μg/ml) and has low impact on most beneficial insects such as ladybirds, lacewings, big-eyed bugs, or minute pirate bugs Copping and Menn (2001), De Amicis *et al*. (1997), El-Kady *et al*. (2007), Kirst *et al*. (1992), Mahmoud and Osman (2007) and Williams *et al.* (2003). It acts as a stomach and contact poison and degrades rapidly in the environment (Cisneros, 2002). It is moderately toxic for birds and mammals (Bret *et al*., 2002) and it is classified by the U.S. Environmental Protection Agency (EPA) as an environmentally and toxicologically reduced risk product (Dow AgroSciences, 2008). An immediate effect of its ingestion is the cessation of feeding, followed 24 h later, by paralysis and death. Its mode of action involves the nicotinic acetylcholine and GABA receptors (Watson, 2001). The objective of this study was to evaluate the toxicity of spinetoram against onion thrips and green peach aphid under laboratory and field conditions.

MATERIAL AND METHODS

Biological material

Onion thrips and green peach aphid life stages were collected, using 5 cm long transparent glass tube aspirators, from untreated onion crop or apricot trees at

Table 1. Toxicity of spinetoram against life stages of *M. persicae* and *T. tabaci* under laboratory conditions

Toxicity index	*M. persicae*		*T. tabaci*	
	Adults	Nymphs	Adults	Larvae
LC_{10}	2.99(1.52-5.89)*	5.43(3.41-8.64)	3.17(1.10-9.16)	18.04(11.48-28.34)
LC_{20}	4.88(2.84-8.37)	8.37(5.81-12.05)	5.43(2.37-12.44)	26.78(19.28-3.18)
LC_{50}	12.52(9.24-16.95)	19.26(15.60-23.77)	15.37(9.92-23.81)	57.30(43.16-76.06)
LC_{90}	52.36(38.18-71.81)	68.33(50.70-92.10)	74.49(41.98-132.15)	181.99(93.99-352.37)
Slope values	3.03	2.67	3.40	2.45

* Data are means of the minimum and maximum value of LC_{10}, LC_{20}, LC_{50} or LC_{90} for *M. persicae* and *T. tabaci*

the Experimental Farm, Faculty of Agriculture, University of Suez Canal. For each species, 10 adults, larvae or nymphs were collected and transported to the laboratory.

Laboratory bioassay

In a laboratory bioassay, five leaf disks of onion and apricot (22 mm diameter) were cut and dipped in serial concentrations (37.5, 75, 150, 300 and 400 μg/ml) of spinetoram 12% EC for 30 second and air dried. The leaf disks were kept fresh by placing them in Petri dishes on pieces of wet cotton. Twenty five individuals (adults and primary stages) of *T. tabaci* and *M. persicae* were transferred on each disk with a fine soft brush. All Petri dishes were incubated at 27±1°C and 60±5% R.H and five dishes were observed, for each treatment, after seventy two hours.

Field trials

Field experiments were conducted in the farm of the Faculty of Agriculture, Suez Canal University, to evaluate the field efficiency of spinetoram 12% EC against *T. tabaci* on onion crop and *M. persicae* on apricot trees. The experimental region was divided into plots of 0.42 ha. The treatment was arranged in a randomized complete blocks design with four replicates each. Five concentrations of spinetoram (37.5, 75, 150, 300 and 400 μg/ml) were applied with a motor sprayer. The volume of mixture applied was about 760 l/ha. Leaf samples were taken. Ten leaves were sampled from each treatment, every 3 days after treatment, examined with a stereomicroscope and the number of *T. tabaci* and *M. persicae* individuals (adults, larvae or nymphs) was noted.

Statistical analysis

Lethal concentrations LC_{10}, LC_{20}, LC_{50}, LC_{90} and slope values were calculated by using the probit analysis program of Schoofs and Willhite (1984). Field data were statistically analyzed by ANOVA (SAS Institute, 1999). If there were significant differences ($p \leq 0.05$), means were compared using LSD test. Efficacy of spinetoram was estimated with the Henderson's formula (1955): $100 \times [(1-Ta\times Cb)/(Tb\times Ca)]$, where Ta = number of insects after treatment Tb= number of insects before treatment Ca = number of insects in the control after treatment and Cb = number of insects in the control before treatment.

RESULTS

LC_{10}, LC_{20}, LC_{50} and LC_{90}'s are presented in Table 1 with the corresponding slope for spinetoram against adults and primary stages. The highest slope values were observed for adult stage of onion thrips and green peach aphid (3.03 and 3.40, respectively) while the lowest slope values were recorded for the primary stages (larvae and nymphs) (2.67 and 2.45, respectively). Thus, under laboratory conditions, adults of green peach aphid and onion thrips are more susceptible to spinetoran than larval or nymphal stage.

Field data presented in Tables 2 and 3 showed the efficacy of spinetoram against adults and primary stages of *T. tabaci* and *M. persicae*. Data indicated that spinetoram had a high efficacy towards both insects in the field trials. According to our results, we noticed that the efficacy of spinetoram against nymphal stage of green peach aphid was higher than it against its adult stage at all rates of spraying. However, it is noticed that the situation was the reverse when spinetoram was applied against onion thrips; the efficacy was higher against adult stage than larval stage. It was observed that the efficacy increased with increasing rate of spraying. In fact, after 21 or 24 days after treatment (DAT), the efficacy against *M. persicae* was 7.7, 32.2, 35.1, 73.0 and 77.4% for adults and 0.03, 10.9, 23.2, 92.9 and 95.4% for nymphal stage when spraying at rate 37.5, 75, 150, 300 and 400 μg/ml, respectively. Furthermore, the efficacy against *T. tabaci* was 24.7, 42.8, 63.8, 66.0 and 79.0% for adults and 4.7, 19.0, 21.9, 44.7 and 8.5% for larval stage.

DISCUSSION

Efficacy of spinetoram was high against primary and adult stages of onion thrips and green peach aphid under laboratory and field conditions. El-Kady *et al*. (2007) found that the mobile stages of *Tetranychus urticae* were more susceptible to spinetoram. The toxicity index values showed such superior efficiency of spinetoram at LC_{50} (100%) for immature, male and female stages. Spinetoram is used on over 200 different crops and labeled against Lepidoptera and certain Thysanoptera Bret *et al.* (1997), Dow AgroSciences (2006), El-Kady *et al*. (2007). Spinosyns and Spinosoides have some broad spectrum activity and their efficacy has been reported against some other insects in the orders of Coleoptera, Diptera, Homoptera, Hymenoptera, Isoptera, Orthoptera, Siphonaptera, as well as mites (Salgado 1998). Mahmoud and Osman (2007) stated that Spinosad gave the best control and continued to dive significant reductions in populations of *T. tabaci* on onion crop till 21 DAT compared to Dipel 2x, Agrin, BioGuard, BioFly, Match, Neemix and Mectin. Lewis (1997) stated that *T. tabaci* adults are the preferred target when using insecticides because they are easier to hit, with the mist sprayers, than larvae and they are also generally more sensitive to the products. Jones *et al*. (2005) found Spinosad to be harmless to *Amblyseius cucumeris*, but of moderate toxicity for *Orius insidiosus*, the biological control agents of western flower thrips *Frankliniella occidentalis*. Field efficacy trials with spinetoram have been conducted globally on a variety of crops. In fact, spinetoram has shown outstanding efficacy against codling moth (*Cydia pomonella*), oriental fruit moth (*Grapholita molesta*), armyworms (*Spodoptera* spp.), cabbage looper (*Trichoplusia ni*), thrips such as western flower thrips (*Frankliniella occidentalis*) and onion thrips (*Thrips tabaci*), leaf miners (*Liriomyza* spp.) and many other pests Grouse and Sparks (1998). Typical field application rates range from approximately 20-120 g active ingredient/ha depending on crop and pest (Flinn *et al.*, 2004). Screening the literature, no comparable studies with aphids were found to uphold the results, but similar data were reported with other insect species. In fact, in Egypt, Temerak (2007) used the spinosyn products, spinosad and spinetoram to combat egg masses of cotton leaf worm; he indicated that Radiant SC12% (spinetoram) was 5 and 7 times stronger than spintor SC24% in the field and laboratory, respectively. Flinn *et al*. (2004) stated that spinosad was very effective in suppressing *Rhizopertha dominica* and *Tribolium castaneum* Herbst populations in stored wheat. In the same way, Toewss *et al*. (2003) concluded that Spinosad has excellent contact activity against adults of stored-product insects. Kristensen and Jespersen (2004) reported that spinosad was relatively slow acting, but highly toxic to houseflies, *Musca* spp Similarly, Pineda *et al*. (2004) recorded that spinosad and methoxyfenozide were potentially effective compounds for the control of *Spodoptera littoralis*. Stark *et al.* (2004), on the other hand, found that spinosad was remarkably similar in toxicity to all 3 economically important fruit fly species, the Mediterranean fruit fly (*Ceratitis capitata*), the melon fly (*Bactrocera cucurbitae*) and the oriental fruit fly (*Bactrocera dorsalis*). Spinosad also effectively prevented breeding of *Culex* mosquitoes and chironomids (Bond *et al*., 2004). Spinetoram shares a mode of action with Spinosad. While Spinosad resistance is rare in agroecosystems, users should be aware that resistance

Table 2. Efficacy of spinetoram (μg/ml) against life adult and nymphs of *M. persicae* in the field (percentage of control)

DAT	Adults					Nymphs				
	37.5	75	150	300	400	37.5	75	150	300	400
3	74.9 e	77.8 cd	100.0 d	100.0 d	100.0 c	94.5 f	100.0 d	100.0 e	100.0 c	100.0 c
6	56.0 d	100.0 e	100.0 d	100.0 d	100.0 c	73.6 e	100.0 d	100.0 e	100.0 c	100.0 c
9	56.6 d	100.0 e	100.0 d	100.0 d	100.0 c	63.8 d	100.0 d	93.8 de	100.0 c	100.0 c
12	32.9 c	81.6 d	84.5 c	100.0 d	100.0 c	36.7 c	94.0 d	90.9 de	100.0 c	100.0 c
15	26.3 c	40.8 ab	55.4 b	96.3 cd	100.0 c	10.9 b	62.7 c	75.4 d	100.0 c	100.0 c
18	25.0 c	38.1 bc	59.2 b	91.4 bc	92.8 bc	12.1 b	37.1 b	59.2 c	97.8 bc	100.0 c
21	12.6 ab	40.9 ab	35.0 a	85.3 b	83.3 ab	0.07 a	12.6 a	38.6 b	96.0 b	98.0 b
24	7.7 a	32.2 a	35.1 a	73.0 a	77.4 a	0.03 a	10.9 a	23.2 a	92.9 a	95.4 a
F	13.007	13.514	40.622	31.447	5.823	44.512	45.288	29.609	7.166	17.333
$P \leq 0.05$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Means followed by the same letters, in the same column, are not significantly different (LSD at $p \leq 0.05$).
DAT: Days after treatment

Table 3. Efficacy of spinetoram (µg/ml) against adult and larval stages of *T. tabaci* in the field (percentage of control)

DAT	Adults					Larvae				
	37.5	75	150	300	400	37.5	75	150	300	400
3	82.8 b	100.0 d	90.4 c	100.0 b	98.0 de	56.1 d	76.1 d	43.3 a	93.0 d	64.7 d
6	88.0 b	96.0 cd	84.8 b	98.6 b	100.0 e	58.4 cd	82.4 d	84.0 cd	98.4 d	55.2 cd
9	84.1 b	95.8 cd	95.0 c	98.2 b	100.0 e	47.5 cd	86.0 d	91.6 d	99.1 d	55.0 cd
12	74.0 b	95.0 cd	95.0 c	96.9 b	100.0 e	28.0 bc	84.0 cd	88.0 d	97.0 d	34.0 bc
15	73.8 b	88.4 bcd	95.3 c	95.7 b	95.3 cd	30.0 ab	70.6 c	89.3 d	94.6 d	36.9 ab
18	58.6 a	80.0 bc	94.4 c	91.0 ab	94.0 c	34.0 a	64.0 b	74.4 c	82.0 c	42.0 a
21	45.6 a	72.0 b	79.2 b	84.0 ab	88.8 b	18.4 a	48.8 b	48.8 b	64.8 b	34.4 a
24	24.7 a	42.8 a	63.8 a	66.0 a	79.0 a	4.7 a	19.0 a	21.9 a	44.7 a	8.5 a
F	11.778	6.578	23.75	2.562	3.63	8.950	36.572	49.183	35.453	10.784
$P \leq 0.05$	0.0000	0.0001	0.0000	0.0325	0.0109	0.0000	0.0000	0.0000	0.0000	0.0000

Means followed by the same letters, in the same column, are not significantly different LSD at $p \leq 0.05$); DAT: Days after treatment.

to Spinosad will negatively affect Spinetoram's activity. Dow AgroSciences (2008) strongly supports the principles of insecticides resistance management and encourage all users to incorporate these principles, including rotation of insecticides with different modes of action, into their pest management programs. In conclusion, all doses of Spinetoram tested under field conditions showed high reduction of infestations of different stages of onion thrips and green peach aphid.

REFERENCES

Bond, J. G., Marina, C. F. and Williams, T. 2004. The naturally derived insecticide Spinosad is highly toxic to *Aedes* and *Anopheles mosquito* larvae. *Medical and Veterinary Entomology*, **18**: 50 - 56.

Bret, B. L., Larson, L. L., Schoonover, J. R., Sparks, T. C. and Thompson, G. D. 1997. Biological properties of Spinosad. *Down to Earth*, **52**: 6 - 13.

Cisneros, J., Goulson, D., Derwent, L. C., Penagos, D. I., Hernández, O. and Williams, T. 2002. Toxic effects of Spinosad on predatory insects. *Biological Control*, **23**: 156 - 163.

Clausen, C. P. 1978. Onion Thrips, (Thrips tabaci Lindeman). Pages 20-21. In: Parasites and Predators of Arthropod Pests and Weeds: A World Review. USDA, Agric. Handbook No. 480, 545 **PP**.

Copping, L. G. and Menn, J. J. 2001. Biopesticides: a review of their action, applications and efficacy. *Pest Management Science*, **56**: 651- 676.

Cloyd, R. A. and Sadof, C. S. 1998. Aphids: Biology and Management. *Floriculture Indiana*, **12**: 3 - 7.

DeAmicis, J. E., Dripps, C. V. Hatton, C. J. and Karr, L. L. 1997. Physical and biological properties of the spinosyns: Novel macrolide pest-control agents from fermentation. Pages 144-154. In: Hedin, Hollingworth, Masler, Miyamoto. *Phytochemicals for Pest Control*, Symposium Series 658.

Dow AgroSciences 2006. Spinetoram Technical Bulletin, 2 - 4.

Dow AgroSciences 2008. Spinetoram Technical Bulletin, 1 - 6.

Flinn, P. W., Subramanyam, B. and Arthur, F. H. 2004. Comparison of aeration and Spinosad for suppressing insects in stored wheat. Journal of Economic Entomology, **97**: 1465 - 1473.

Founderburk, J., Stavisky, J., and Olson, S. 2000. Predation of *Frankliniella occidentalis* (Thysanoptera: Thripidae) in field peppers by *Orius insidiosus* (Hemiptera: Anthocoridae). *Environ. Entomol*. **29**: 376 - 382.

El Kady, G. A., El Sharabasy, H. M. Mahmoud, M. F. and Bahgat, I. M. 2007. Toxicity of two potential bio-insecticides against moveable stages of *Tetranychus urticae* Koch. Journal of applied sciences research, **3**: 1315 - 1319.

Grouse, G. D. and Sparks, T. C. 1998. Naturally derived materials as products and leads for insect control. The spinosyns. *Reviews in toxicology*, **2**: 133 - 146.

Henderson, C. F. and Tilton, E. W. 1955. Test with acaricides against the brown wheat mite. *Journal of Economic Entomology*, **48**: 157 - 161.

Hill, D. S. 1983. *Myzus persicae* (Sulz.). Page 202. In Agricultural Insect Pests of the Tropics and Their Control, 2nd Edition. *Cambridge University Press*, 746 **PP**.

Jones, T., Scott-Dupree, C., Harris, R., Shipp, L. and Harris, B. 2005. The efficacy of Spinosad against western flower thrips *Frankliniella occidentalis,* and its impact on associated biological control agents on greenhouse cucumbers in Southern Ontario. *Pest Management Science*, **61**: 179 - 185.

Kirst, H. A., Michel, K. H., Mynderse, J. S., Chio, E. H., Yao, R. C., Nakatsukasa, W. M., Boech, L. D., Occlowitz, J. L., Paschal, J. W., Deeter, J. B. and Thompson, G. D. 1992. Discovery, isolation, and structure elucidation of a family of structurally unique fermentation-derived tetracyclic macrolides. Pages 214-225. In: *synthesis and Chemistry of Agrochemicals III*. Baker, D. R., Fenyes, J. G. and Steffans, J. J. Eds., U.S.A pages 214 – 225.

Kristensen, M. and Jespersen, J. B. 2004. Susceptibility of Spinosad in *Musca domestica* (Diptera: Muscidae) field populations. *Journal of Economic Entomology*, **97**: 1042-1408.

Lewis, T. 1997.Thrips as Crop Pests. *University Press.* Cambridage, 740 **PP**.

Mahmoud, M. F. and Osman, M. A. M. 2007. Relative toxicity of some bio-rational insecticides to second instar larvae and adults of onion thrips (*Thrips tabaci* Lind.) and their predator *Orius albidipennis* under laboratory and field conditions. Journal of Plant Protection research, **47**: 391 - 400.

Mertz, F. P. and Yao, R. C. 1990. *Saccharopolyspora spinosa* sp. Nov. isolated from soil collected in a sugar mill rum still. *International Journal of Systematic Bacteriology,* **40**: 34 - 39.

Pineda, S., Budia, F. and Schneider, M. I. 2004. Effects of two biorational insecticides, Spinosad and Methoxyfenozide, on *Spodoptera littoralis* (Lepidoptera: Noctuidae) under laboratory conditions. *Journal of economic entomology*, **97**: 1906 - 1911.

Raman, K. V. 1984. Monitoring aphid populations. CIP Slide Training Series *IV-International Potato Center, Lima, Peru,* 12 **PP**.

Reita, S. R., Yearby, E. L., Funderburk, J. E., Stavisky, J., Momol, M. T., and Olson, S. M. 2003. Integrated management tactics for *Frankliniella* thrips (Thysanoptera: Thripidae) in field-grown pepper. *J. Econ. Entomol*. 96: 1201-1214.

Salgado, V. L. 1997. The mode of action of Spinosad and other insect control products. *Down to Earth*, **52**: 35-44.

Salgado, V. L. 1998. Studies on the mode of action of Spinosad: Insect symptoms and physiology correlates. *Pesticide Biochemistry and Physiology*, **60**: 91-102.

SAS Institute Inc. 1999 SAS/STAT User's guide. 6.12 edition. Cary, NC, SAS Institute Inc., 943 **PP**.

Schoofs, G. M. and Willhite, C. C. 1984. A probit analysis program for the personal computer. *Journal of Applied Toxicology*, **4**: 141 - 144.

Srivastaba, M., Bosco, L., Funderburk, J., Olson, S., and Weiss, A. 2008. Spinetoram is compatible with the key natural enemy of *Frankliniella* species thrips in pepper. Plant Health Progress doi:10.1094/ PHP-2008-0118-02-RS.

Stark, J. D., Vargas, R., and Miller, N. 2004. Toxicity of Spinosad in protein bait to three economically important tephritid fruit fly species (Diptera: Tephritidae) and their parasitoids (Hymenoptera: Braconidae). *Journal of Economic Entomology*, **97**: 911 - 915.

Temerak, S. A. 2007. Susceptibility of *Spodoptera littoralis* to old and new generation of Spinosyn products in five cotton Governorates in Egypt. *Resistant Pest Management Newsletter,* **16**: 18 - 21.

Thompson, G. D., Dutton, R. and Sparks, T. C. 2000. Spinosad a case study: an example from a natural products discovery program. *Pest Management Science*, **56**: 696 - 702.

Toews, M. D., Subramanyam, B. and Rowan, J. M. 2003. Knockdown and mortality of adults of eight species of stored-product beetles exposed to four surfaces treated with Spinosad. *Journal of Economic Entomology*, **96**: 1967 - 1973.

Watson, G. B. 2001. Actions of insecticidal spinosyns on caminobutyric acid responses from small-diameter cockroach neurons, *Pesticide Biochemistry and Physiology*, **71**: 20 - 28.

Williams, T., Valle, J. and Viñuela E. 2003. Is the naturally derived insecticide Spinosad® compatible with insect natural enemies? *Biocontrol Science and Technology*, **13**: 459 - 475.

M.F. Mahmoud[1], M.A.M. Osman[1*] and I.M. Bahgat[2] and G.A. El-Kady[1]

[1]Plant Protection Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

[2]Faculty of Science, Suez Canal University, Port Said, Egypt.

*Corresponding Author: E-mail: naeim70@ hotmail.com