INTERNATIONAL JOURNAL OF PLANT PROTECTION
VOLUME 13 | ISSUE 1 | APRIL, 2020 | 18-23

● ISSN-0974-2670 | Visit us : *www.researchjournal.co.in*

IJPP

RESEARCH PAPER

DOI : 10.15740/HAS/IJPP/13.1/18-23

Persistence toxicity and field evaluation of Spinetoram 12 SC against *Spodoptera litura* Fabricius on okra

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ARITCLE INFO

Received : 31.07.2019
Revised : 08.02.2020
Accepted : 23.02.2020

KEY WORDS :
Spinetoram 12 SC, Okra, Persistence toxicity, Field efficacy, *Spodoptera litura*

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ABSTRACT

Spodoptera litura (Fabricius) is a destructive defoliating polyphagous pest on various crops throughout India especially in vegetable crops. Experiments were undertaken to investigate the persistence of spinetoram 12 SC against larval stage of *S. litura* in the laboratory and to evaluate the effectiveness in the field in two seasons. The results of persistence toxicity revealed that there was continuous larval reduction upto 14 DAT under the laboratory condition in different doses of biological green insecticide spinetoram (36, 45 and 54 g a.i/ha). This reinforces the need to reapply spinetoram 10 – 14 days after the first application (peak of biological activity) for effective control. The order of relative efficacy (ORE) of the insecticides based on the persistent toxicity index (PTI) values was spinetoram 12 SC 54 g a.i./ha > spinetoram 12 SC 45 g a.i./ha > cypermethrin 25 EC 50 g a.i/ha > emamectin benzoate 5 SG 8.5 g a.i/ha > spinetoram 12 SC 36 g a.i./ha > quinalphos 25 EC 200 g a.i/ha. In field experiments spinetoram 12 SC was significantly effective at 45 and 54 g a.i./ha when sprayed thrice at 15 days interval and minimized the incidence of *Spodoptera litura*.

How to view point the article : Visnupriya, M. **and** Muthukrishnan, N. (2020). Persistence toxicity and field evaluation of Spinetoram 12 SC against *Spodoptera litura* Fabricius on okra. *Internat. J. Plant Protec.*, **13**(1) : 18-23, **DOI : 10.15740/HAS/IJPP/13.1/18-23,**

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] commonly known as lady's finger is cultivated in rainy and summer seasons in an area of 0.36 million hectares with a total annual production of 3.42 million tonnes in India. Although there are larger areas under cultivation, productivity remains low. There are many factors for the stagnant or low productivity, and insect pests are one of the major direct causes for yield reduction. Nearly 72 insect pests attack okra (Mandal *et al.*, 2006). Among these shoot and fruit borer, *E. vittella; Spodoptera litura* Fab., *Aphis gossypii* Glover; *Amrasca devastans* (Dist.) and *Bemisia tabaci* (Gennadius) are quite serious (Kumar *et al.*, 2008). Among insect pests, the leaf feeder, *S. litura* is a potential polyphagous pest which attacks cotton, groundnut, rice, tomato, okra, tobacco, citrus, cocoa, potato, rubber, castor, millets, sorghum, maize etc., in India and causes extensive economic damage (Vinod Kumari and Singh, 2009).

Synthetic insecticides provide dramatic effect initially, and hence chemical control methods are still largely in use among farmers. Earlier, conventional insecticides like endosulfan (Shivalingaswamy *et al.*, 2008 and Rath and Mukherjee, 2009), malathion and hostothion (Kumar and Gill, 2010), chlorpyriphos (Kuttalam *et al.*, 2008), azadirachtin 1%, phosalone and quinalphos (Anonymous, 2011), synthetic pyrethroids and endosulfan alternatively with NSKE 4% (Anonymous, 2009), and fenvalerate, methomyl, azinphos methyl, carbaryl and pyrethrin/rotenone (Anonymous, 2012) were reported in management of pests on vegetable crops.

In recent times, some new insecticide molecules offer multiple advantages over earlier ones in terms of greater levels of safety, better performance and reduced environmental impact. One such new insecticide molecule is spinetoram, that has shown outstanding efficacy against codling moth (*Cydia pomonella* L.), oriental fruit moth (*Grapholita molesta* Busck), cabbage looper (*Trichoplusia ni* Hubner), thrips such as western flower thrips (*Frankliniella occidentalis* Pergande) and onion thrips (*Thrips tabaci* Lindeman), leaf miners (*Liriomyza* spp), chilli thrips (*Scirtothrips dorsalis* Hood), fruit borer (*H. armigera*) and many other pests (Dharne and Bagde, 2011). However, there are no reports on persistence and field evaluation of spinetoram 12 SC against the *S. litura* on okra. Therefore, this study was undertaken with the objectives to investigate the persistence toxicity of spinosyn, spinetoram 12 SC and other insecticides against *S. litura* in the laboratory and to evaluate their effectiveness for controlling the pest in the field.

MATERIAL AND METHODS

Persistence of spinetoram 12 SC against *S. litura* under laboratory condition:

Pot culture experiments were conducted in the Insectary of Agricultural College and Research Institute, Madurai to assess the persistent toxicity of spinetoram 12 SC on leaf eating caterpillar *S. litura* in okra. The persistent toxicity was studied against third instar larvae, the most active and damaging stage of *Spodoptera litura* on leaves. Laboratory culture of *S. litura* was initiated by collecting all stages of larvae and egg masses from farmer's field. Mass culturing of *S. litura* was done as per the standard procedure described by Britto (1980). After rearing for two to three generations in laboratory, the culture was used for experiment.

Thirty days old potted okra plants were used for the study. Insecticidal solutions were prepared by dissolving spinetoram 12 SC 0.6 ml, 0.75 ml and 0.9 ml, emamectin benzoate 5 SG 0.34 g, quinalphos 25 EC 1.6 ml and cypermethrin 25 EC 0.4 ml in one liter of water which was equivalent to the field doses. Potted okra plants were sprayed with the insecticides at the respective concentrations at 30 days after sowing (DAS) by using a hand operated sprayer to the point of run-off. After application, treated okra leaves were collected from the plants starting from first day after treatment (DAT) (2h after spray) and continued 3, 5, 7, 9, 11, 14 and till the mortality due to insecticides on *S. litura* declined to practically negligible level. In each treatment, treated leaf samples were placed in plastic cups separately and laboratory reared third instar larvae of *S. litura* of 20 numbers were released on treated leaves.

After infestation, the containers were placed in a climatic chamber (temperature 25 ± 1^{0}C, relative humidity 70 ± 10%). There were three replications for each insect. Larval mortality was assessed 24 hrs after their confinements under a binocular microscope. Moribund larvae were considered as dead. The per cent mortality was calculated and data were corrected by Abbott's (1925) formula. The product (PT) of average residual toxicity (T) and the period (P) for which the toxicity persisted was used as an index of persistent toxicity. The procedure by Saini (1959) and elaborated further by Pradhan (1967) and Sarup *et al.* (1970) was utilized to calculate the persistent toxicity.

Field evaluation of spinetoram 12 SC against *S. litura* on okra:

Two field experiments were conducted at farmers' field in Madurai district, Tamil Nadu, India, in the plots of size of 5 x 5 m. The experiments were laid out in a Randomized Block Design at Soorakundu, Melur block and Kokkulam, Chekkanoorani block respectively. Standard agronomic practices as per the recommendations of Tamil Nadu Agricultural University (TNAU) were adopted to maintain healthy okra plants (Hybrid Splender No. 10). Newer green insecticide molecule spinetoram 12 SC was assessed at various doses (36, 45 and 54 g a. i. / ha) and compared with standard checks (emamectin benzoate 5 SG @ 8.5 g a.i/ha, quinalphos 25 EC @ 200 g a.i/ha and cypermethrin 25 EC @ 50 g a.i/ha) against leaf feeder, *S. litura*. There were three applications at 20 days interval based on ETL of target pest. Thorough coverage of plants (to a run off point) with the spray fluid of 500 l/ha was ensured by using high volume knapsack sprayer with hydraulic cone nozzle. Larval numbers of *S. litura* were assessed from 10 randomly selected plants on pre-treatment, 1, 3, 7 and 10 DAT after 1st, 2nd and 3rd sprays. The overall mean number of larvae was calculated for each treatment after application.

Statistical analysis:

The data from various field experiments were scrutinized by RBD analysis of variance (ANOVA) after getting transformed into $\sqrt{x+0.5}$, logarithmic and arcsine percentage values where appropriate (Gomez and Gomez, 1984). Critical difference values were calculated at five per cent probability level and treatment mean values were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1951). The corrected per cent reduction over untreated check in field population was calculated by (Henderson and Tilton, 1955) formula:

$$\text{Corrected per cent reduction} = \left[1 - \frac{T_a \times C_b}{T_b \times C_a}\right] \times 100$$

where,

T_a = Number of insects in the treatment after spraying

T_b = Number of insects in the treatment before spraying

C_a = Number of insects in the untreated check before spraying

C_b = Number of insects in the untreated after spraying

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Persistent toxicity of spinetoram 12 SC to *S. litura* on okra plants:

When spinetoram 12 SC was applied at 54 g a.i./ha and 45 g a.i./ha, cent per cent mortality of 3rd instar larvae of *S. litura* was observed upto 3 DAT (Table 1). Spinetoram 12 SC 45 g a.i/ha was registerd 91.9, 74.3 and 55.4 per cent mortality at 5, 7 and 9 DAT, respectively. Persistence for spinetoram 12 SC 36 g a.i./ha was upto 11 DAT and 14 DAT for 45 and 54 g a.i/ha. More than 50 per cent mortality was observed in spinetoram 12 SC at 36, 45 and 54 g a.i./ha upto 7 and 9 DAT, respectively where as that was upto 5 DAT for quinalphos 25 EC at 200 g a.i/ha and cypermethrin 25 EC at 50 g a.i/ha. There was a reduction in the mortality of *S. litura* larvae as the time increased and there was no mortality after 21 DAT. The order of relative efficacy (ORE) of the insecticides based on the persistent toxicity index (PTI) values was spinetoram 12 SC 54 g a.i./ha > spinetoram 12 SC 45 g a.i./ha > cypermethrin 25 EC at 50 g a.i/ha > emamectin benzoate 5 SG at 8.5 g a.i/ha > spinetoram 12 SC 36 g a.i./ha > quinalphos 25 EC at 200 g a.i/ha.

These results are in accordance with the findings of Visnupriya and Muthukrishnan (2019) who reported that more than 50 per cent mortality of *H. armigera* larva was observed in spinetoram 12 SC at 45 and 54 g a.i./ha and indoxacarb 14.5 SC at 75 g a.i/ha upto 11 DAT whereas that was upto 7 DAT for spinetoram 12 SC 36 g a.i/ha and novaluron 10 EC at 75 g a.i/ha. The

Table 1 : Persistent toxicity of spinetoram 12 SC to *S. litura* on okra

Treatments and doses (g a.i/ha)	Corrected per cent mortality at different intervals (days)								P	T	PTI	RE	ORE
	1	3	5	7	9	11	14	21					
Spinetoram12SC 36 g a.i/ha	100	93.3	85.7	62.3	40.2	23.0	0.0	0.0	11	67.4	741.5	1.54	4
Spinetoram12SC 45 g a.i/ha	100	100	91.9	74.3	55.4	41.8	22.9	0.0	14	69.5	972.7	2.02	2
Spinetoram12SC 54 g a.i/ha	100	100	95.6	81.3	63.8	45.4	36.0	0.0	14	74.6	1044.1	2.17	1
Emamectin benzoate 5 SG 8.5 g a.i/ha	100	92.6	84.9	69.7	53.2	38.6	0.0	0.0	11	73.2	805.0	1.67	3
Quinalphos 25 EC 200 g a.i/ha	82.1	70.7	59.8	35.7	19.1	0.0	0.0	0.0	9	53.5	481.3	1.00	6
Cypermethrin 25 EC 50 g a.i/ha	92.3	80.5	73.3	45.9	30.7	19.5	11.2	0.0	14	50.5	706.9	1.47	5

P – Period of toxicity persistence (days)
T – Mean per cent mortality
PTI – Persistent toxicity index
RE – Relative efficacy
ORE – Order of relative efficacy

findings of Brevault *et al.* (2009) also coincide with our results that the persistence was higher for spinosad 45 SC @ 36 g a.i/ha (8.9 days) and persistence was lower for indoxacarb @ 25 g a.i/ha (5.2 days) and endosulfan @ 750 g a.i/ha (2.7 days) in cotton plants. According to Elbarky *et al.* (2008) spinetoram (Radiant 12 SC) exhibited high mortality in *S. littoralis* (100 % and 95.7 %) after zero and 1 days, respectively then decreased gradually to 58.1 per cent after 7 days of treatment which indicated that there was relatively short residual time of spinetoram.

Field evaluation of spinetoram 12 SC against *S. litura* on okra:

S. litura larval population varied from 5.1 to 6.1 per plant before imposing treatments (Table 2). Data indicated that larval numbers ranged from 2.1 to 11.1 per plant due to treatments. Spinetoram 54 and 45 g a.i./ ha were superior and equally effective in reducing the population to 2.1 and 2.4 per plant and registered 81.1 and 78.4 per cent reduction, respectively over control. The other spinetoram treatment of 36 g a.i./ha (3.7 larvae/ plant and 66.7% reduction over control); indoxacarb (3.6 larvae/plant and 67.6% reduction over control); novaluron (3.9 larvae/plant and 64.9% reduction over control) and quinalphos (5.3 larvae/plant and 52.3% reduction over control) followed in order. Untreated control recorded the highest mean of 11.1 larvae per plant.

Data pertaining to larval population during the second season for 1, 3, 7 and 10 DAT after three sprays presented in Table 2 indicated that mean larval population observations of 1, 3, 7 and 10 DAT ranged from 1.4 to 7.5 larvae per plant due to treatments. Spinetoram 54 and 45 g a.i./ha were significantly superior and registered the lowest larval population of 1.4 (81.4 % reduction over control) and 1.7 (77.4 % reduction over control) per plant, respectively. Spinetoram 36 g a.i./ha also contributed moderate reduction in the larval population (2.5 larvae/ plant with 66.8% reduction over control). Indoxacarb and novaluran registered larval population of 2.6 (65.4% reduction) and 2.8 (62.8% reduction) per plant, respectively. Quinalphos however registered higher larval population 3.5 larvae per plant with 53.5 per cent reduction over control.

The present results are in line with the findings of Visnupriya and Muthukrishnan (2017) who reported that spinetoram 12 SC was significantly effective at 45 and 54 g a.i./ha when sprayed thrice at 15 days interval and minimized the incidence of fruit borer, *Helicoverpa armigera* and increased the fruit yield. Sunilkumar *et al.* (2012) also reported that spinetoram 12 SC at 60 g a.i/ha were highly effective in checking the larvae of *S. litura* in soybean. The most effective insecticides for army worm (*Spodoptera* spp) control were spinetoram, spinosad and indoxacarb; followed by novaluron and metaflumizone. The least effective were pyridalyl (Dakshina Seal *et al.*, 2007). Cook *et al.* (2004) also reported that spinosad, indoxacarb and pyridalyl significantly reduced beet armyworm (*S. exigua*) compared to the control. Similar results of effectiveness of spinosad against *S. exigua* in cotton were documented

Table 2 : Effect of spinetoram 12 SC against *S. litura* on okra (Pooled mean data for two season)

Treatments and doses (g a.i./ ha)	*Spodoptera litura* (larva/plant)					
	I season (Mean for 1, 3, 7 and 10 DAT)			II season (Mean for 1, 3, 7 and 10 DAT)		
	Pre count	Over all mean after treatment	Per cent reduction over control	Pre count	Over all mean after treatment	Per cent reduction over control
Spinetoram 12 SC 36 g a.i./ha	5.1	3.7[b]	66.7	3.8	2.5[c]	66.8
Spinetoram 12 SC 45 g a.i./ha	6.0	2.4[ab]	78.4	3.2	1.7[ab]	77.4
Spinetoram 12 SC 54g a.i./ha	5.7	2.1[a]	81.1	3.3	1.4[a]	81.4
Indoxacarb 14.5 SC 75 g a.i./ha	5.9	3.6[b]	67.6	3.7	2.6[c]	65.4
Novaluron 10 EC 75 g a.i./ha	5.3	3.9[c]	64.9	3.6	2.8[cd]	62.8
Quinalphos 25EC 250g a.i/ha	6.1	5.3[d]	52.3	3.7	3.5[e]	53.5
Untreated check	5.9	11.1[e]	-	3.5	7.5[f]	-
C.D. (P=0.05)	-	0.09	-	-	0.04	-
S.E. ±	-	0.04	-	-	0.02	-

Data are means of three replications.
Figures were transformed by square root transformation during analysis. Original values are given in table.
Means followed by the same superscript are not significantly different (P = 0.05) by DMRT.

by Halcomb *et al.* (1998) and Mascarenhas *et al.* (1996).

Acknowledgement:

The authors express sincere thanks to M/S. Dow Agro Science India Pvt. Ltd., Mumbai for providing financial help during the course of investigation. Authors are also thankful to Tamil Nadu Agricultural University, Coimbatore and Agricultural College and Research Institute, Madurai for granting permission to publish the results.

REFERENCES

Abbott, W.S. (1925). A method of computing the effectiveness of an insecticide. *J. Econ. Entomol.*, **18** : 265-267.

Anonymous (2009). Indian horticulture database NHB. Ministry of Agriculture, Govt. of India, 154-61.

Anonymous (2011). Annual Report: Asian Vegetable Research and Development Center (AVRDC), Shanhua, Taiwan, 741 ROC.

Anonymous (2012). All India Coordinated Cotton Improvement Project, Annual Report, 2011-12.

Brévault, T., Oumarou, Y., Achaleke, J., Vaissayre, M. and Nibouche, S. (2009). Initial activity and persistence of insecticides for the control of bollworms (Lepidoptera: Noctuidae) in cotton crops. *Crop Protec.*, **28**(5): 401–406.

Britto, A.J. (1980). Juvenomimetic and antifeedant properties of some plant extracts on *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae). M. Sc (Ag.) Thesis. Tamil Nadu Agricultural University, Coimbatore. 59p.

Cook, D.R., Leonard, B.R. and Gore, J. (2004). Field and laboratory performance of novel insecticides against armyworms (Lepidoptera: Noctuidae). *Florida Entomologist.*, **87**(4): 433-439.

Dakshina Seal, R., David Schuster, J. and Klassen, W. (2007). Comparative effectiveness of new insecticides in controlling armyworms (Lepidoptera: Noctuidae) and leafminers (Diptera: Agromyzidae) on tomato. *Proceedings of Florida State Horticultural Society,* **120**: 170-177.

Dharne, P.K. and Bagde, A.S. (2011). Bio efficacy of novel insecticide, spinetoram 12 SC (11.7 w/w) against thrips, *Scirtothrips dorsalis* Hood and fruit borer, *Helicoverpa armigera* Hb. in chilli. *Pestology,* **35**(3): 23-26.

Duncan, D.B. (1951). A significance test for differences between ranked treatment means in an analysis of variance. *Virginia J. Sci.*, **2**: 171-189.

Elbarky, N.M., Hassan, F.D. and El-Sayed, Y.A. (2008). Toxicological evaluation and biochemical impacts for Radient® as a new generation of spinosyn on *Spodoptera littoralis* (Boisd.) larvae. *Egyptian Acad. J. Biol. Sci.*, **1**(2): 85-97.

Gomez, K.A. and Gomez, A.A. (1984). *Statistical procedures for Agricultural Research*. A Wiley International Science Publication, John Wiley and Sons, New Delhi. 680p.

Halcomb, J.L., Benedict, J.H. and Correa, J.C. (1998). A field study to evaluate the efficacy of selected insecticides against beetworm on transgenic cotton. *In: "Arthropod Management Tests", Entomol. Soc. Amer.* Lanham, MD. p 229-230.

Henderson, C.F. and Tilton, E.W. (1955). Test with acaricides against the brown wheat mite. *J. Econ. Entomol*., **48**: 157-161.

Kumar, M.S., Krishnamoorthy, S.V., Chandra Sekaran, S. and Stanley, J. (2008). Baseline toxicity of emamectin benzoate and spinosad to *Earias vittella* in cotton. *Ann. Pl. Protec. Sci.*, **16** : 66-69.

Kumar, Sanjeev and Gill, C.K. (2010). Incidence of tomato leaf curl virus in relation to whitefly, *Bemisia tabaci* (Gennadius) population in different insecticidal treatments on tomato crop. *J. Ins. Sci..*, **23**(3): 327-331.

Kuttalam, S., Vinothkumar, B., Kumaran, N. and Boomathi, N. (2008). Evaluation of bio efficacy of flubendiamide 480 SC against fruit borer *Helicoverpa armigera* in tomato. *Pestology*, **32**(3): 13-16.

Mandal, S.K., Sah, S.B. and Gupta, S.C. (2006). Screening of okra cultivars against *Earias vittella*. *Ann. Pl. Protec. Sci.*, **14** : 471- 72.

Mascarenhas, V.J., Leonard, B.R., Burris, E. and Graves, J.B. (1996). Beet armyworm (Lepidoptera: Noctuidae) control on cotton in Lousiana. *Florida Entomologist*, **79**(3): 336-343.

Pradhan, S. (1967). Strategy of integrated pest control. *Ind. J. Entomologist*, **29**(1): 105-122.

Rath, L.K. and Mukherjee, S.K. (2009). Field evaluation of some biopesticides alone and in alternation with endosulfan against tomato fruit borer. *J. Plant Protec. Environ.*, **6**(2): 102-104.

Saini, M.L. (1959). Bioassay of the persistence of spray residues on leaf surface of maize using just hatched larvae of *Chilo zonellus* (Swinhoe) as test insect. *Assoc. IARI Thesis*. Indian Agricultural Research Institute, New Delhi.

Sarup, P., Singh, D.S., Amarpuri, S. and Lal, Rattan (1970). Persistent and relative residual toxicity of some important pesticides to the adults of sugarcane leaf-hopper, *Pyrilla perpusilla* Walker (Lophopidae: Homoptera). *Indian J. Entomol.*, **32**(3): 256-267.

Shivalingaswamy, T.M., Kumar, A., Satpathy, S. and Rai, A.B.

(2008). Efficacy of indoxacarb against tomato fruit borer, *Helicoverpa armigera* Hubner. *Pestology,* **32**(8): 39-41.

Sunilkumar, N.M., Shivanand, T.W., Kukanur, V.S., Sunil, K., Naveen, K. and Patil, B. (2012). Evaluation of spinetoram 12 SC against *Spodoptera litura* (Fab.) in soybean. *Bioinfolet,* **9**(3): 378-381.

Vinod Kumari and Singh, N.P. (2009). *Spodoptera litura* nuclear polyhedrosis virus (NPV-S) as a component in Integrated Pest Management (IPM) of *Spodoptera litura* (Fab.) on cabbage. *J. Biopesticides,* **2**(1): 84-86.

Visnupriya and Muthukrishnan (2017). Persistence toxicity and field evaluation of green insecticide Spinetoram 12 SC w/v (11.7%w/w) against *Helicoverpa armigera* Hubner on okra. *Internat. J. Curr. Microbiol. App. Sci.,* ***6*** (11): 2547 – 2555.

Visnupriya and Muthukrishnan (2019). Persistent toxicity of newer molecule spinetoram 12 SC W/V (11.7 W/W) against *Helicoverpa armigera* Hubner and *Spodoptera litura* Fabricius on tomato. *J. Entomol. & Zool. Studies 2019;* **7**(2): 1025-1028.

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