Madras Agric. J., 100 (4-6): 605-608, June 2013
https://doi.org/10.29321/MAJ.10.001366

Persistence Toxicity and Field Evaluation of Spinetoram 12 SC against Shoot and Fruit Borer, *Leucinodes orbonalis* Guenee in Brinjal

N. Muthukrishnan*, M. Visnupriya, W. Babyrani and C. Muthiah
Department of Entomology, Agricultural College and Research Institute, Madurai - 625 104.

Shoot and fruit borer, *Leucinodes orbonalis* (Guenee) is a persistent pest on brinjal throughout India. Experiments were undertaken to investigate the persistence of spinetoram 12 SC against larve in the laboratory and to evaluate the effectiveness in the field in two seasons from 2011 to 2012. The results revealed that there was continuous larval reduction up to 14 DAT under 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. 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 and increased fruit yield.

Key words: Spinetoram 12 SC, Brinjal, Persistence, Field efficacy, *Leucinodes orbonalis*

Brinjal or eggplant, *Solanum melongena* L. is native to India and cultivated almost throughout the year in all parts of the world. This commercial crop is infested by more than 23 pests (Muthukrishnan *et al.,* 2005) from the time of planting to harvest. Among them, shoot and fruit borer, *L. orbonalis* Guenee (Lepidoptera: Pyralidae) is the key pest throughout Asia (Ghosh *et al.,* 2003). In India, this pest has a countrywide distribution and has been categorized as the most destructive and serious pest causing huge losses in brinjal (Patil, 1990). The pest has been reported to inflict losses to the tune of 20.7 – 60.0% in Tamil Nadu (Raja *et al.,* 1999), 70% in Andhra Pradesh (Sasikala *et al.,* 1999) 80% in Gujarat (Jhala *et al.,* 2007) and 41% in Himachal Pradesh (Lal *et al.,* 1976).

Insecticides have been used extensively for the control of these insect-pests for quicker remedy. The insecticides used mostly are organophosphates, carbamates and synthetic pyrethroids. However, insectides such as quinalphos, monocrotophos, carbaryl, carbofuran and fenvalerate have been reported to fail in controlling the shoot and fruit borer effectively, consequently, increasing cost of production (Radhika *et al.,* 1997).

Insecticides with different active compounds and modes of action can be more effective than those have been so far used in controlling *L. orbonalis*. In this line, the biological insecticide molecule spinetoram 12 SC, a multi–component tetracyclic macrolide which belongs to the new spinosyn compounds (Anon., 2006) with unique mode of action (Group V insecticides) and an ecotoxicological profile similar to spinosad can be a promising candidate. Spinetoram has shown outstanding efficacy against major lepidopteran pests, western flower thrips and leaf miner (Dharne and Bagde, 2011). However, there are no reports on persistence and field effect of spinetoram 12 SC against the shoot and fruit borer of brinjal. Therefore, this study was undertaken with the objectives to investigate the persistence of spinetoram 12 SC and other insecticides against larval stage of *L. orbonalis* in the laboratory and to evaluate their effectiveness for controlling the pest in the field in two seasons.

*Corresponding author email: nmuthu64@yahoo.com

Materials and Methods

Persistence of spinetoram 12 SC against L. orbonalis under laboratory condition

The persistent toxicity was studied against fourth instar larvae, the most active and damaging stage of *L.orbonalis* (Atwal and Dhaliwal, 2007) on fruits during 2012. Laboratory culture of *L.orbonalis* was initiated by collecting infested fruits from farmer's field. Mass culturing of brinjal shoot and fruit borer was done as per the standard procedure described by Patil (1990). After rearing for two generations in laboratory, the culture was used for experiment.

Insecticide 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, chorpyriphos 20 EC 2.0 ml and thiodicarb 75 WP 2.0 g in one liter of water and sprayed on 120 days old potted brinjal plants to the point of run off. Tender fruits from each plot were harvested at 1, 3, 5, 7, 9, 11, 14 and 21 days interval after the treatment. Fruits were placed in plastic bottles and 20 starved fourth instar larvae were released on the treated fruits. After infestation, the containers were placed in a climatic chamber (temperature 25 ± 1^{0}C, relative humidity 70 ± 10%). Larval mortality was assessed

24 hrs after their confinements by cutting open the fruits 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.

Effect of spinetoram 12 SC against L. orbonalis under field condition

Field experiments were conducted at farmers' field in Madurai district, Tamil Nadu, India. They were laid out during the year 2011 and 2012 in a randomized block design having plot size of 5 x 5m at Pannikundu, Thirumangalam block and Kokkulam, Chekkanoorani block respectively. The seedlings were transplanted on 18th August, 2011 and on 5th February, 2012. Brinjal (cv. CO 2) was raised as per recommended package of practices except insect – pest management. Bioefficacy of seven insecticidal treatments comprising new molecule spinetoram 12 SC at the rate of 54, 45 and 36 g a.i/ha along with standard insecticides emamectin benzoate 5 SG 8.5 g a.i/ha, chlorpyriphos 20 EC 200 g a.i/ha and thiodicarb 75 WP 750 g a.i/ha was determined during both the years and each treatment was replicated thrice. Three sprays of each insecticide were applied with the help of knapsack hand sprayer up to the point of runoff at fortnightly intervals starting from flower initiation. Observations on the per cent shoot infestation and per cent fruit infestation by *L. orbonalis* on number basis per plot from ten randomly selected plants were recorded one day before first spray and on 1, 3, 7 and 10 days after each spray. Fruit yield was represented as yield/ha. Data were subjected to analysis of variance (ANOVA) after transformation (arc sine for per cent data and square root for population data) of data as per Gomez and Gomez (1984). The observations on phytotoxicity symptoms (leaf injury, wilting, vein clearing, necrosis, epinasty and hyponasty) were recorded on 7th day after each spray by using visual scoring system.

Results and Discussion

Persistence of spinetoram 12 SC against L. orbonalis

Results revealed that spinetoram at 36, 45 and 54 g a.i./ha applied on brinjal plants with fruits, recorded cent per cent mortality of fourth instar larvae up to 3 DAT (day after treatment) and 5 DAT in spinetoram at 45 and 54 g a.i./ha respectively (Table 1) . The biological persistence evaluated at 7 DAT of three spinetoram doses showed a population reduction ranging from 50 to 90 per cent, and it was higher than that of other standard insecticides. Evaluations at 9, 11, 14 and 21 DAT revealed continuous larval reduction to different spinetoram doses. This necessitated the need to reapply spinetoram 10 – 14 days after the first application (peak of biological activity) for effective control of *L. orbonalis.*

Emamectin benzoate, chlorpyriphos and thiodicarb recorded 78.72, 63.76 and 73.46 per cent mortality, respectively at 5 DAT. In the case of chlorpyriphos no mortality was observed at 11 DAT. There was reduction in the mortality of larvae as the time increased and the toxicity persisted for 14 days in thiodicarb, while it was 11 days for emamectin benzoate at 8.5 g a.i./ha. The order of relative efficacy (ORE) of the insecticides based on the persistent toxicity index (PTI) values was; spinetoram 54 g a.i./ ha > spinetoram 45 g a.i./ha > thiodicarb > emamectin benzoate > spinetoram 36 g a.i./ha > chlorpyirphos. Elbarky *et al.* (2008) reported that spinetoram (Radiant 12 SC) exhibited high mortality (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 is a short residual time of spinetoram.

Field evaluation of spinetoram 12 SC against shoot and fruit damage due to L. orbonalis

Data presented in Table 2 on shoot and fruit infestation revealed that mean shoot and fruit infestation on 1, 3, 7 and 10 days after treatment varied from 6.9 to 15.7 and 11.7 to 24.6 per cent respectively in the first season. The mean shoot and fruit infestation levels were minimum (6.9 and 11.7% with 82.3 and 80.2% reduction over control) in spinetoram 54 g a.i/ha followed by spinetoram 45 g a.i/ha (7.3 and 12.3% with 81.2 and 79.2% reduction respectively) and spinetoram 36 g a.i/ ha (11.5 and 18.6% with 70.4 and 68.6% reduction respectively). Emamectin benzoate (12.1 and 20.4% with 68.9 and 65.5% reduction respectively) and thiodicarb (12.6 and 21.4% with 67.6 and 63.8% reduction respectively) were the next best treatments in reducing shoot and fruit damage. However, shoot and fruit damage was maximum in chlorpyriphos (15.7 and 24.6% with 59.7 and 58.4% reduction respectively) as against untreated control (38.9 and

Table 1. Persistent toxicity of spinetoram 12 SC to brinjal fruit and shoot borer, larvae

Treatment	Corrected per cent mortality at intervals (days)								P	T	PTI	RE	ORE
	1	3	5	7	9	11	14	21					
Spinetoram12SC 36 g a.i/ha	96.36	81.49	66.56	50.97	36.21	21.66	0.00	0.00	11	58.88	647.68	1.13	5
Spinetoram12SC 45 g a.i/ha	100	100	87.81	79.21	52.39	36.41	12.03	0.00	14	66.84	935.76	1.63	2
Spinetoram12SC 54 g a.i/ha	100	100	100	90.41	59.66	42.36	18.91	0.00	14	73.05	1022.70	1.78	1
Emamectin benzoate 5SG 8.5 g a.i/ha	98.63	86.13	78.72	54.32	45.29	28.47	0.00	0.00	11	65.26	717.86	1.25	4
Chlorpyriphos 20EC 200 g a.i/ha	95.71	80.59	63.76	48.23	30.22	0.00	0.00	0.00	9	63.70	573.30	1.00	6
Thiodicarb 75WP 750 g a.i/ha	100	90.08	73.46	65.69	41.36	31.29	14.62	0.00	14	59.50	833.00	1.45	3

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

59.3% respectively).

During the second season, (Table 2) the mean shoot and fruit damage 1, 3, 7 and 10 DAT ranged from 9.8 to 21.1 and 9.0 to 19.3 per cent respectively. Spinetoram 54 and 45 g a.i/ha were equally effective and significantly superior in reducing the damage to 9.8 and 10.2 per cent shoot damage (80.4 and 79.6% reduction over control) and 9.0 and 9.6 per cent fruit damage respectively (81.1 and 79.8% reduction). Lower dose of spinetoram 36 g a.i/ha (15.4 and 16.1% with 69.2 and 66.2% reduction respectively), emamectin benzoate (17.4 and 16.5% with 65.2 and 65.4% reduction respectively) and thiodicarb (18.3 and 18.1% with 63.4 and 62.0% reduction respectively) resulted in moderate control of shoot and fruit damage on brinjal. Chlorpyriphos however registered higher shoot and fruit damage of 21.1 and 19.3 per cent with per cent reduction of 57.8 and 59.5 respectively.

Table 2. Effect of spinetoram 12 SC on shoot and fruit damage due to *L. orbonalis* and fruit yield on brinjal

Treatment	Damage (%)								Yield			
	Sep 2011-Jan 2012		Mar 2012-July 2012		Sep 2011-Jan 2012		Mar 2012-July 2012		Sep 2011-Jan 2012		Mar 2012-July 2012	
	Mean shoot damage (%)	% reduction over control	Mean shoot damage (%)	% reduction over control	Mean fruit damage (%)	% reduction over control	Mean fruit damage (%)	% reduction over control	Fruit yield (q/ha)	% increase over control	Fruit yield (q/ha)	% increase over control
Spinetoram12 SC 36 g a.i./ha	11.5$_{c}$	70.4	15.4$_{b}$	69.2	18.6$_{c}$	68.6	16.1$_{c}$	66.2	115.9$_{c}$	42.6	125.1$_{b}$	45.2
Spinetoram12 SC 45 g a.i./ha	7.3^{b}	81.2	10.2$_{a}$	79.6	12.3$_{b}$	79.2	9.6$_{b}$	79.8	122.5$_{b}$	50.7	130.9$_{ab}$	51.9
Spinetoram12 SC 54g a.i./ha	6.9$_{a}$	82.3	9.8$_{a}$	80.4	11.7^{a}	80.2	9.0$_{a}$	81.1	129.4$_{a}$	59.0	133.7^{a}	55.1
Emamectin benzoate 5SG 8.5 g a.i/ha	12.1$_{d}$	68.9	17.4^{c}	65.2	20.4$_{d}$	65.5	16.5$_{d}$	65.4	108.4$_{d}$	33.3	123.9$_{b}$	43.7
Chlorpyriphos 20 EC 200g a i/ha	15.7^{f}	59.7	21.1$_{d}$	57.8	24.6$_{f}$	58.4	19.3$_{f}$	59.5	98.1$_{f}$	20.7	105.3$_{c}$	22.1
Thiodicarb 75WP 750 g a.i/ha	12.6$_{e}$	67.6	18.3$_{c}$	63.4	21.4$_{e}$	63.8	18.1$_{e}$	62.0	104.6$_{e}$	28.7	123.6$_{b}$	43.4
Untreated check	38.9$_{g}$	-	49.6$_{e}$	-	59.3$_{g}$	-	47.1^{g}	-	81.4$_{g}$	-	86.5$_{d}$	-
CD at 5%	0.30	-	1.24	-	0.1	-	0.29	-	0.014	-	0.026	-
SEd	0.14	-	0.57	-	0.05	-	0.13	-	0.006	-	0.012	-

Data are means of three replications.

Figures were transformed by arc sine transformation (shoot and fruit damage) and logarithmic transformation (fruit yield) during analysis. Original values are given in table. Means within columns lacking common lower case superscript are significantly different ($p<0.05$)

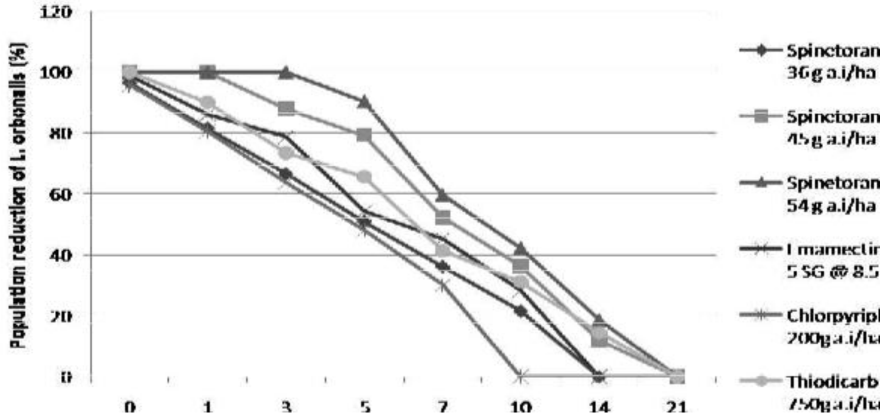

Fig. 1. Persistence of spinetoram 12 sc against larvae

The present observations on the effectiveness of spinetoram 12 SC are in conformity with those of Anandkumar *et al.* (2002) and Sandip Patra *et al*. (2009) who reported that spinosad 50 g a.i/ha recorded the highest protection over control in shoot and fruit infestation and the highest fruit yield which was significantly superior over other treatments in brinjal. Sinha and Sharma (2008) also reported the effectiveness of spinosad against brinjal shoot and fruit borer, *L. orbonalis.* Naik *et al.* (2008) observed that spinosad @ 0.015% was the most effective in reducing shoot infestation of *L. orbonalis* besides recording higher brinjal fruit yield and Gautam *et al.* (2008) reported that spinosad and emamectin benzoate were the most effective treatments in reducing singnificantly the infestation of *L. orbonalis* in brinjal. Sinha and Nath (2011) reported that spinosad 45 SC recorded the lowest mean shoot infestation (13.7%), lowest population of whiteflies (6.70/3 leaves), leaf hoppers (5.63/3 leaves) and highest fruit yield (153. 23 q/ha) in brinjal.

Effect of spinetoram 12 SC on fruit yield

In field experiments, data on marketable yield of brinjal fruits ranged from 81.4 to 129.4 q / ha and from 86.5 to 133.7 q / ha respectively in all treatments

(Table 2). The highest yield in both seasons was registered in spinetoram 12 SC @ 54 g ai/ha (129.4 and 133.7 q/ha) followed by spinetoram 12 SC @ 45 g a.i /ha (122.5 and 130.9 q/ha) and spinetoram 12 SC @ 36 g a.i / ha (115.9 and 125.1 q/ha) respectively. These were followed by emamectin benzoate (108.4 and 123.9 q/ha), thiodicarb (104.6 and 123.6 q/ha) and chlorpyriphos (98.1 and 105.3 q/ha), compared to untreated check which registered only 81.4 and 86l.5 q/ha fruit yield in first and second seasons respectively. Sandip Patra *et al.* (2009) and Sinha and Nath (2011) reported that spraying of spinosad resulted in the highest fruit yield in brinjal compared to other insecticides which was similar to the present observations on fruit yield of brinjal due to application of spinetoram. Thus spinetoram 12 SC was very effective against *L. orbonalis larval* with enhanced fruit yield in brinjal.

Acknowledgement

The authors are grateful to M/S. Dow Agro Science India Pvt. Ltd, Mumbai for providing financial help during the course of investigation.

References

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

Anandkumar, V., Nagangoud, A. and Patil, B.V. 2002. Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.). *In: Proc. National Seminar on "Integrated Pest Management in the Current Century",* November, 29-30, Department of Agricultural Entomology, B.C.K.V., West Bengal, India. 238-248p.

Anonymous. 2006. Dow Crop Science Spinetoram. *Technical Bulletin.* 1-4.

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:** 23-26.

Elbarky, N.M., Hassan, F. Dahi and Yasser, A. El-Sayed. 2008. Toxicological evaluation and biochemical impacts for Radiant as a new generation of spinosyn on *Spodoptera littoralis* (Boisd.) larvae. *Egypt. Acad. J. Biolog. Sci.*, **1:** 85-97.

Gautam, C.P.N., Verma, R.A., Gautam, R.D. and Aslam Khan, M.D. 2008. Comparative efficacy of insecticides, bio-pesticides and botanicals against *Leucinodes orbonalis* infesting brinjal. *Ann. Pl. Protec. Sci.,* **16:** 309-311.

Ghosh, S.K., Laskar, N. and. Senapati, S.K. 2003. Estimation of loss in yield of brinjal due to pest complex under *Terai* region of West Bengal. *Environment and Ecology,* **21:** 764-769.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. John Wiley and Sons, New Delhi. 680p.

Jhala, R.C., Pate, M.G., Chanda, A.J. and Patel, Y.C. 2007. Testing IPM strategy for *Leucinodes orbonalis* in farmer's field. *In: Proc. National Symposium on Frontiers of Entomological Research* (*Eds.*: Subrahmanyam, B. and Ramamurthy, V. V). 5 - 7, November 2007, New Delhi. 256p.

Lal, O.P., Sharma, R.K., Verma, T.S., Bhagchandani, P. M. and Chandra, J. 1976. Resistance in brinjal to shoot and fruit borer, *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae). *Veg. Sci.,* **3:** 111-115.

Muthukrishnan, N., Ganapathy, N., Nalini, R. and Rajendran, R. 2005. Pest Management in Horticultural Crops, Hindustan Graphics, Madurai. 373p.

Naik, V., Chinna Babu, Rao P., Arjuna, Krishnayya, P.V. and Srinivasa Rao, V. 2008. Seasonal incidence and management of *Leucinodes orbonalis* Guenee on brinjal. *Ann. Pl. Protec. Sci.,* **16:** 122-127

Patil, P.D. 1990. Technique for mass rearing of the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. *J. Entomol. Res.,* **14:** 164-172.

Pradhan, S. 1967. Strategy of integrated pest control. *Indian J. Ent*. **29:** 105-122.

Radhika, S., Reddy, K.D. and Subbarathnam, G.V. 1997. Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.) with insecticides. *J. Res.,* **25:** 16-14.

Raja, J., Rajendran, B. and Pappiah, C.M. 1999. Management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.). *Veg Sci.,* **26:** 167-169.

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, India.

Sandip Patra, Chatterjee, M.L., Shanowly Mondal, and Samanta, A. 2009. Field evaluation of some new insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.). *Pesticide Res. J.,* **21:** 58-60.

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

Sasikala, J., Rao, P.A. and Krishnayya, P.V. 1999. Comparative efficacy of ecofriendly methods involving egg parasitoid, *Trichogramma japonicum*, mechanical control and safe chemical against *Leucinodes orbonalis* Guenee infesting brinjal. *J. Entomol. Res.,* **23:** 369-372.

Sidhu, A.S. and Dutta, A.S. 2007. Current status of brinjal research in India. *In:* International Conference on Indigenous Vegetables and Legumes. Prospects for Fighting Poverty, Hunger and Malnutrition SHS. *Acta Horticulturae,* **752:** 243-248.

Sinha, S.R. and Sharma, R.K. 2008. Pest management in brinjal through intercropping and newer molecules. *In*: *Proc. Second Congress Insect Science*, Punjab Agricultural University, Ludhiana, 21-22 February, 2008. 205-206pp.

Sinha, S.R. and Nath, V. 2011. Management of *Leucinodes orbonalis* through insecticides in brinjal. *Ann. Pl. Protec. Sci.,* **17:** 328-331.

Received: December 12, 2012; Accepted: June 12, 2013