INTERNATIONAL JOURNAL OF PLANT PROTECTION
VOLUME 12 | ISSUE 2 | OCTOBER, 2019 | 87-93

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

IJPP

RESEARCH PAPER

DOI : 10.15740/HAS/IJPP/12.2/87-93

Antifeedant activity and field evaluation of spinetoram 12 SC against termite, *Odontotermes obesus* on sugarcane

■ N. Muthukrishnan **and** M. Visnupriya*
Department of Agricultural Entomology, Tamil Nadu Agricultural University, **Coimbatore (T.N.) India**

ARITCLE INFO

Received : 10.04.2019
Revised : 15.08.2019
Accepted : 01.09.2019

KEY WORDS :
Sugarcane, Spinetoram 12 SC, Antifeedant activity, *Odontotermes obesus*, Sett treatment, Soil drenching

ABSTRACT

In this experiment a new insecticide molecule, spinetoram 12 SC was taken up to evaluate its antifeedant and repellent activity in laboratory and efficacy in the field with different mode of application against termite control. Laboratory experiments were conducted in Insectary, Agricultural College and Research Institute, Madurai. Field experiments were laid out in Randomized Block Design at farmer's field located in Mandhikanmai village, Kalayarkoil Block, Sivagangai district during 2014 – 2015 and to study the effect of sett treatment and soil drenching of spinetoram 12 SC with variety CO 86032. At the time of planting, sugarcane setts were treated with various doses of spinetoram 12 SC (90, 120, 150 and 180 g a.i./ha) and covered with soil. After planting in 35 days old sugarcane soil drenching treatment was also effected with the same dose of sett treatment. Imidacloprid 20 SL, Rynaxypyr 20 SC and chlorpyrifos 20 EC were standard checks. The cumulative mean food consumption was minimum 0.71 g, 0.78 g, 1.02 g, 1.23 g, 1.44 g and 1.56 g in various concentrations of spinetoram *viz*., 360, 300, 240, 180, 120 and 60 ppm, respectively. The highest mean per cent repellent action was noticed in spinetoram 360 ppm and 300 ppm (93.4 and 91.2%, respectively) at 12 HAT. Field experiments were inferred that spinetoram 12 SC 180 and 150 g a.i./ha were significantly effective in minimizing number of termite colony per plot, number of termites per colony and per cent sett damage in both sett treatment and soil drenching methods.

How to view point the article : Muthukrishnan, N. **and** Visnupriya, M. (2019). Antifeedant activity and field evaluation of spinetoram 12 SC against termite, *Odontotermes obesus* on sugarcane. *Internat. J. Plant Protec.*, **12**(2) : 87-93, **DOI : 10.15740/HAS/IJPP/12.2/87-93,**

***Corresponding author:**
Email : haivinuento@gmail.com

INTRODUCTION

Sugarcane is the very essential sugar - producing crop of the world, which is under attack of many insect pests (David and Nandagopal, 1986). Borers and termites are the most important insect pests of sugarcane worldwide. Thirteen species of termites (Termitidae : Isoptera) occur in India on sugarcane. Subterranean termites are the major problem which affect the sugarcane crop from its germination through shoot emergence and finally on the quality of canes. At germination stage, the termite losses upto 90 - 100 per cent have been recorded in sugarcane (Salihah *et al*.

1988; Sattar and Salihah, 2002). *Microtermes mycophagous, Microtermes obesi, Microtermes unicolor, Eremotermes paradoxalis, Odontotermes obesus* are the species mostly recorded from sugarcane agro-ecosystems (Ahmed *et al*., 2007). Termite is the only pest attacking sugarcane setts besides being one of the few sugarcane pests killing the attacked cane of any age. Singh and Krishnan (1946), Teotia *et al.* (1963) and Roonwal (1981) reported 30-60 per cent destruction of buds due to termite attack while Avasthy (1967) reported it to be 40, which results in an yield loss of 33 per cent. Koto *et al.* (2000) reported that termites live in the soil and damage sugarcane by excavating through the cane setts, leading to the death of buds and young shoots.

Moreover, unlike for most other pests of sugarcane, insecticide is the only tool available to manage termite. For the control of termites, many methods have been adopted, among which chemicals were dominated means of the control since long. However, chemicals are expensive and have many harmful effects. The insecticides in liquid or dry formulation *viz*., Chloropyriphos, imidacloprid and fipronil are being applied as sett treatment in furrows at the time of sowing of sugarcane. The success of such treatment with insecticides is highly variables. In order to find alternates to conventional insecticides it is thought that termites should be deterred at the time of feeding for successful shoot emergence. Many of the chlorinated hydrocarbon insecticides recommended up till now for the control of termites in sugarcane are banned now. Hence there is an urgent need to have an alternate safer insecticide which is less hazardous to the environment. In this background a new insecticide molecule, spinetoram 12 SC belonging to spinosyn group was taken up in the present study to evaluate its antifeedant and repellent activity in laboratory and efficacy in the field with different mode of application against termite control.

MATERIAL AND METHODS

Evaluation for antifeedant activity:

Cardboard sheets weighing 2.5g was taken and moistened with distilled water and shade dried for one hour. Then the sheets were thoroughly immersed in spinetoram 12 SC stock solution (360, 300, 240, 180, 120 and 60 ppm). Rynaxypyr 20 SC @ 200 ppm and chlorpyriphos 20 EC @ 1000 ppm were the standard check. The treated sheets were placed in the petridish and 100 numbers of workers/soldiers were released and covered. For anti-feedent activity, once in a day the food materials were weighed to assess the quantity food consumed by the live workers and soldiers and was expressed in g.

Evaluation for repellent activity:

Eighteen units (17.5 × 13.5 × 4.0 cm) of six chambered transparent plastic containers with six chambers in two rows were used. Small opening (0.5 cm diameter) was made at the bottom of all inner walls, connecting the chambers. A filter paper of (Whatman#1) one-fourth portions was provided to each of the chambers in all containers. This filter paper was treated with spinetoram 12 SC solution with concentrations of 360, 300, 240, 180, 120 and 60 ppm. The controls were similarly prepared in which filter papers receive only ethanol. Containers were uncovered and kept at ambient condition for solvent evaporation. Then 250µl of double distilled water was added to each filter paper. About 100 numbers of workers of *Odontotermes obesus* were released in the every chamber of container. Containers were kept at laboratory conditions (26° C and 80% RH) covered with their lids and an opaque black sheet to eliminate the effect of light. For repellent activity, observations on number of termites attracted (% attraction) in each and every container were taken at 1, 2, 4, 6, 12 and 24h and containers were rotated after each observation.

Evaluation of spinetoram 12 SC against sugarcane termites through sett treatment and soil drenching method:

Field experiments were laid out in Randomized Block Design at farmer's field located in Mandhikanmai village, Kalayarkoil Block, Sivagangai district during 2014 – 2015 and to study the effect of sett treatment and soil drenching of spinetoram 12 SC with variety CO 86032. The plot size was 8 x 5m and the spacing adopted was 75 cm between furrows. The seed rate adopted was 67,000 two budded setts/ha^{-1}. At the time of planting, sugarcane setts were treated with various doses of spinetoram 12 SC (90, 120, 150 and 180 g a.i./ha) and covered with soil. After planting in 35 days old sugarcane soil drenching treatment was also effected with various doses of spinetoram 12 SC (90, 120, 150 and 180 g a.i./ha). Imidacloprid 20 SL, Rynaxypyr 20 SC and chlorpyrifos 20 EC were standard checks. There was

an untreated check as well. Each treatment replicated thrice. After application, the data on live termites and colonies by visual examination were carried out by random digging in each plot on pre - and 3, 7, 10, 15 and 30 days after treatment. After 15 days of sowing, germination and bud damage were also recorded. Bud damage was recorded from places in a plot where there was gap of > 1 m between two seedlings. Per cent sett/ cane damage due to termites based on scale 1- 10 (1 being low and 10 high damage) was observed on pre- and 3, 7, 10, 15 and 30 days after treatment.

Statistical analysis:

The data from field and laboratory experiments were scrutinized by RBD and CRBD analysis of variance (ANOVA), respectively after getting transformed into $\sqrt{x+0.5}$, logarithmic and arcsine percentage values where appropriate (Gomez and Gomez, 1984). The per cent mortality in laboratory studies was corrected using Abbot's formula (Abbott, 1925). 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).

RESULTS AND DISCUSSION

Antifeedant effect of spinetoram 12 SC on *Odontotermes obesus*:

From the data presented in Table 1 it was observed that spinetoram 360 ppm recorded the lowest range of food consumption (0.22 g to 1.27 g). At one day after treatment (DAT), spinetoram 360 ppm recorded minimum food consumption (0.22 g) on workers of *Odontotermes obesus*. This was followed by spinetoram 300 ppm (0.24 g), 240 ppm (0.37 g), 180 ppm (0.45 g), 120 ppm (0.62 g) and 60 ppm (0.74 g). The standard check rynaxypyr and chlorpyriphos recorded 0.33 and 0.88 g food consumption, respectively. Same trend was observed in the various concentrations of spinetoram in all periods of observation (2, 3, 4 and 5 days after treatment). The cumulative mean food consumption was minimum 0.71 g, 0.78 g, 1.02 g, 1.23 g, 1.44 g and 1.56 g in various concentrations of spinetoram *viz*., 360, 300, 240, 180, 120 and 60 ppm, respectively. The standard check rynaxypyr 200 ppm recorded 0.92g, chlorpyriphos 1000 ppm recorded 1.58 g and untreated check recorded 1.98 g of food consumed.

Repellent effect of spinetoram 12 SC on *Odontotermes obesus*:

The mean per cent repellent action of spinetoram on *Odontotermes obesus* is presented in Table 2. During initial period of observation that is, at 2 HAT the mean per cent repellent action ranged from 67.0 per cent to 27.0 per cent in various concentrations of spinetoram. The highest repellent activity was recorded in spinetoram 360 ppm (67.0%) and it was followed by spinetoram 300 ppm (63.6%) which was on par with rynaxypyr 200 ppm (63.1%) followed by spinetoram 240 ppm (57.1%), 180 ppm (54.8%), 120 ppm (42.8%) and 60 ppm (27.0%).

Table 1 : Antifeedant effect of spinetoram 12 SC on sugarcane termite, *Odontotermes obesus*

Sr. No.	Treatment	Dose (ppm)	Mean weight of food consumed *(g)					Mean
			1 DAT	2 DAT	3 DAT	4 DAT	5 DAT	
1.	Spinetoram 12 SC	60	0.74^{e}	1.12^{e}	1.55^{e}	1.91^{f}	2.49^{f}	1.56^{e}
2.	Spinetoram 12 SC	120	0.62^{d}	0.95^{d}	1.42^{d}	1.78^{e}	2.41^{f}	1.44^{d}
3.	Spinetoram 12 SC	180	0.45^{c}	0.77^{c}	1.12^{c}	1.60^{d}	2.19^{e}	1.23^{c}
4.	Spinetoram 12 SC	240	0.37^{b}	0.59^{b}	1.00^{bc}	1.34^{c}	1.78^{d}	1.02^{bc}
5.	Spinetoram 12 SC	300	0.24^{a}	0.41^{a}	0.88^{ab}	0.97^{ab}	1.40^{b}	0.78^{ab}
6.	Spinetoram 12 SC	360	0.22^{a}	0.38^{a}	0.75^{a}	0.91^{a}	1.27^{a}	0.71^{a}
7.	Rynaxypyr 20 SC	200	0.33^{b}	0.51^{b}	0.93^{b}	1.20^{b}	1.62^{c}	0.92^{b}
8.	Chlorpyriphos 20 EC	1000	0.88^{f}	1.16^{e}	1.59^{e}	2.04^{f}	2.23^{e}	1.58^{e}
9.	Untreated check	-	1.00^{g}	1.50^{f}	2.12^{f}	2.54^{g}	2.76^{g}	1.98^{f}
	S.E.±		0.04	0.06	0.03	0.12	0.04	0.04
	C.D. (P=0.05)		0.10	0.13	0.09	0.24	0.11	0.09

*Mean of 3 replications
DAT- Days after treatment
Figures in parentheses are $\sqrt{0+0.5}$ transformed values
Means followed by same letter(s) are not significantly different at 5% level by DMRT

The highest mean per cent repellent action was noticed in spinetoram 360 ppm and 300 ppm (93.4 and 91.2%, respectively) at 12 HAT. This was followed by standard check rynaxypyr 200 ppm, spinetoram 240 ppm, 180 ppm, 120 ppm and 60 ppm which was recorded 91.9, 83.8, 76.7, 73.6 and 65.1 per cent repellent action, respectively. Overall mean per cent repellency was more in spinetoram 360 ppm which recorded 82.7 per cent and it was significantly higher than other concentrations of spinetoram. This was followed by spinetoram 300 ppm (80.8%), rynaxypyr (80.4%), spinetoram 240 ppm (73.5%), 180 ppm (70.1%), 120 ppm (62.6%) and 60 ppm (50.1%). Standard check chlorpyriphos 1000 ppm recorded 72.5 per cent. Untreated check recorded 2.6 per cent repellency. Neurotoxin, metabolic inhibitors or chitin synthesis inhibitors are used in termite baits (Evans and Iqbal, 2014). Chitin synthesis inhibitors like hexaflumuron, diflubenzuron, triflumuron, lufenuron and noviflumuron inhibit the molting process of termites and cause delayed mortality (Su and Scheffrahn, 1996; Vahabzadeh *et al.,* 2007 and Xing *et al.,* 2014). An exclusion hypothesis was the idea behind treatments in which synthetic pyrethroids or organophosphates were used for soil treatments to prevent infestation of the structures by repelling termites (Forschler, 2009) which is accordance with our present investigation.

Evaluation of spinetoram 12 SC against sugarcane termites through sett treatment:

Table 3 presents the efficacy of spinetoram on number of colonies per plot, number of termites per colony and per cent sett damage through sett treatment method. The treatments employed were spinetoram at 90, 120, 150 and 180 g a.i/ha, imidacloprid 70 g a.i/ha, rynaxypyr 125 g a.i/ha and chlorpyriphos 1000 g a.i/ha.

The lowest mean number of colonies was recorded in spinetoram 180 and 150 g a.i/ha (0.40 and 0.49 colonies per plot). The next best treatment was spinetoram 120 g a.i/ha with 0.60 followed by rynaxypyr 125 g a.i/ha (0.62). Spinetoram 90 g a.i/ha and imidacloprid 70 g a.i/ha were recorded mean number of colonies as 0.68 and 0.70, respectively. The highest colonies per plot were recorded in chlorpyriphos 1000 g a.i/ha (0.93). In untreated check the mean number of colonies was 1.45. Spinetoram 180 g a.i/ha was recorded the maximum per cent reduction (72.4%) of number of colonies. It was followed by spinetoram 150 g a.i/ha (66.2%), 120 g a.i/ha (58.6%), rynaxypyr (57.2%), spinetoram 90 g a.i./ha (53.1%) and imidacloprid (51.7%). The minimum per cent reduction was observed in chlorpyriphos 1000 g a.i/ha (35.8%).

Regarding mean number of termites per colony was recorded very low in spinetoram 180 and 150 g a.i/ha (10.4 and 12.0 termites per colony). The next best treatment was spinetoram 120 g a.i/ha with 14.6 termites per colony followed by rynaxypyr 125 g a.i/ha with 16.3 termites per colony. Chlorpyriphos 1000 g a.i/ha was recorded more number termites per colony (24.3 termites/ colony). Untreated check was recorded 49.2 termites per colony. Spinetoram 180 g a.i/ha was recorded the maximum per cent reduction (79.2) of number of termites followed by spinetoram 150 g a.i/ha (76.0%), 120 g a.i/ ha (70.8%), rynaxypyr (67.4%), spinetoram 90 g a.i./ha

Table 2 : Repellent effect of spinetoram 12 SC on sugarcane termite, *Odontotermes obesus*

Sr. No.	Treatments	Dose (ppm)	Mean per cent repellent action*					Mean
			2 HAT	4 HAT	6 HAT	12 HAT	24 HAT	
1.	Spinetoram 12 SC	60	27.0^{f}	36.3^{e}	51.9^{e}	65.1^{f}	70.4^{f}	50.1^{f}
2.	Spinetoram 12 SC	120	42.8^{e}	54.6^{d}	62.1^{d}	73.6^{e}	79.8^{e}	62.6^{e}
3.	Spinetoram 12 SC	180	54.8^{d}	62.7^{c}	71.4^{c}	76.7^{d}	85.0^{d}	70.1^{d}
4.	Spinetoram 12 SC	240	57.1^{c}	61.0^{b}	75.4^{b}	83.8^{c}	90.2^{bc}	73.5^{c}
5.	Spinetoram 12 SC	300	63.6^{b}	69.4^{a}	86.1^{a}	91.2^{b}	93.5^{ab}	80.8^{b}
6.	Spinetoram 12 SC	360	67.0^{a}	70.3^{a}	86.9^{a}	93.4^{a}	95.8^{a}	82.7^{a}
7.	Rynaxypyr 20 SC	200	63.1^{b}	69.0^{a}	85.4^{ab}	91.9^{b}	92.5^{b}	80.4^{b}
8.	Chlorpyriphos 20 EC	1000	56.8^{c}	60.4^{b}	75.2^{b}	82.1^{cd}	88.4^{c}	72.5^{c}
9.	Untreated check	-	0.00^{g}	0.00^{f}	0.00^{f}	2.66^{g}	10.38^{g}	2.6^{g}
	S.E.±		1.12	2.21	1.14	1.21	0.85	2.12
	C.D. (P=0.05)		2.26	4.45	2.29	2.42	1.71	4.25

*Mean of 3 replications
**HAT-Hours after treatment
Figures in parentheses are x + 0.5 arc sin transformed values
Means followed by same letter(s) are not significantly different at 5% level by DMRT

(66.0%) and imidacloprid (62.0%). The minimum per cent reduction was observed in chlorpyriphos 1000 g a.i/ha (51.4%).

Mean per cent sett damage inferred that spinetoram 12 SC 180 and 150 g a.i./ha were significantly effective in minimizing sett damage to 13.7 and 15.5 per cent and registered 77.4 and 74.3 per cent reduction followed by rynaxypyr (17.4% and 71.3% reduction), spinetoram 12 SC at 120 g a.i/ha (20.3% and 66.5% reduction). Imidacloprid 70 g a.i/ha (23.3% and 61.6% reduction) and spinetoram 90 g a.i/ha (24.8% and 59.1% reduction) were the next best treatment. Chlorpyriphos 1000 g a.i/ha (34.8% and 42.5% reduction) however was not so effective in minimizing termite infestation and thereby per cent sett damage. The early attack of termites to setts cause failure in germination and may cause as high as 33 per cent loss in yield (Ananthanarayana and David, 1986). Our present research results are in agreement with Manager-Singh *et al.* (2002) who investigated the effect of sett and soil treatments with insecticides on bud damage (caused by termite infestation) and germination of sugarcane cv. COS 767. Maximum bud damage was observed in the control (32.21% and 31.66%). Among the treatments, sett dipping in 0.2 per cent solution of imidacloprid recorded the minimum bud damage of 6.84 per cent, which was at par with soil application of phorate 10 G at 2.5 kg a.i./ha, chlorpyrifos 20 EC at 1 kg a.i./ha and chlorpyrifos 15 G at 2.5 kg a.i./ha. These treatments resulted in 56.76 per cent – 59.14 per cent increase in germination.

Evaluation of spinetoram 12 SC against sugarcane termites through soil drenching:

Table 4 presents the efficacy of spinetoram on number of termite colonies on sugarcane plots, number termites in individual colony and per cent sett damage in each treatment through soil drenching method. There was no that much difference in efficacy among the treatments after 3 days of first soil drenching. Higher efficacy of spinetoram 180 g a.i/ha against colony formation was observed after soil drenching, on 7 DAT. On 15 DAT spinetoram was recorded significant effect in all the doses. After second soil drenching on 7 DAT, spinetoram was recorded significant effect in all the doses. The same trend was followed in 15 and 30 DAT also.

The lowest mean number of colonies was recorded in spinetoram 180 and 150 g a.i/ha (0.58 and 0.64 colonies per plot). The next best treatment was rynaxypyr with 0.68 followed by spinetoram 120 g a.i/ha with 0.79. Spinetoram 90 g a.i/ha and imidacloprid 70 g a.i/ha were recorded mean number of colonies as 0.95 and 0.97, respectively. The highest colonies per plot were recorded in chlorpyriphos 1000 g a.i/ha (1.11). In untreated check the mean number of colonies was 2.21. Spinetoram 180 g a.i/ha was recorded the maximum per cent reduction (73.8) of number of colonies. It was followed by spinetoram 150 g a.i/ha (71.1%), 120 g a.i/ha (64.3%),

Table 3 : Evaluation of spinetoram 12 SC against *Odontotermes obesus* (Rambur) on sugarcane through sett treatment at Mandhikanmai, Sivagangai district (April 2013 – February 2014)

Treatments	Dose (g a.i/ha)	Number of colonies per plot on days after treatment			Number of termites per colony on days after treatment			Per cent sett damage on days after treatment		
		Pre treatment count	Mean	Per cent reduction over control	Pre treatment count	Mean	Per cent reduction over control	Pre treatment count	Mean	Per cent reduction over control
Spinetoram 12 SC	90	0.81	0.68^{d}	53.1	23.4	17.0^{d}	66.0	21.5	24.8^{d}	59.1
Spinetoram 12 SC	120	0.84	0.60^{c}	58.6	22.8	14.6^{c}	70.8	21.0	20.3^{c}	66.5
Spinetoram 12 SC	150	0.83	0.49^{b}	66.2	23.0	12.0^{b}	76.0	21.1	15.5^{ab}	74.3
Spinetoram 12 SC	180	0.80	0.40^{a}	72.4	21.2	10.4^{a}	79.2	20.0	13.7^{a}	77.4
Imidacloprid 20 SL	70	0.87	0.70^{d}	51.7	22.7	19.0^{e}	62.0	21.0	23.3^{d}	61.6
Rynaxypyr 20 SC	125	0.84	0.62^{c}	57.2	22.6	16.3^{d}	67.4	21.3	17.4^{b}	71.3
Chlorpyriphos 20 EC	1000	0.88	0.93^{e}	35.8	23.1	24.3^{f}	51.4	21.7	34.8^{e}	42.5
Untreated check	-	0.86	1.45^{f}	-	23.7	49.2^{g}	-	21.9	60.4^{1}	-
S.E.±	-	-	0.002	-	-	1.12	-	-	1.12	-
C.D. (P=0.05)	-	-	0.004	-	-	2.24	-	-	2.24	-

Data are mean values of three replications

Figures were transformed by square root transformation and the original values are given

Means within columns lacking common lower case superscript are significantly different (P<0.05)

rynaxypyr (69.3%), spinetoram 90 g a.i./ha (57.1%) and imidacloprid (56.2%). The minimum per cent reduction was observed in chlorpyriphos 1000 g a.i/ha (49.8%).

The efficacy of spinetoram through soil drenching on number of termites per colony on sugarcane is presented in Table 4. The lowest mean number of termites per colony was recorded in spinetoram 180 and 150 g a.i/ha (11.4 and 12.3 termites per colony). The next best treatment was rynaxypyr 125 g a.i/ha with 13.6 termites per colony followed by spinetoram 120 g a.i/ha with 15.7 termites per colony. Spinetoram 90 g a.i/ha and imidacloprid 70 g a.i/ha were recorded mean number of termites per colony as 17.0 and 17.4, respectively. The highest termites per colony were recorded in chlorpyriphos 1000 g a.i/ha (25.2 termites/colony). In untreated check the mean number of termites per colony was 53.2. Spinetoram 180 g a.i/ha was recorded the maximum per cent reduction (78.3) of number of termites. It was followed by spinetoram 150 g a.i/ha (76.6%), 120 g a.i/ha (70.2%), rynaxypyr (74.2%), spinetoram 90 g a.i./ha (66.9%) and imidacloprid (67.7%). Minimum per cent reduction was observed in chlorpyriphos 1000 g a.i/ha (52.1%).

Regarding per cent sett damage during first period of observation (3 days after soil drenching), the sett damage was minimum in the treatment of spinetoram 180 g a.i/ha followed by spinetoram 150 g a.i/ha, 120 g a.i/ha, rynaxypyr and imidacloprid. In the untreated check the sett damage was maximum. Mean per cent sett damage inferred that spinetoram 12 SC 180 and 150 g a.i./ha were significantly effective in minimizing sett damage to 5.9 and 6.8 per cent and registered 80.5 and 77.6 per cent reduction followed by rynaxypyr (8.6% and 71.6% reduction), spinetoram 12 SC at 120 g a.i/ha (8.8% and 70.9% reduction). Imidacloprid 70 g a.i/ha (10.3% and 66.0% reduction) and spinetoram 90 g a.i/ha (10.4% and 65.7% reduction) were the next best treatment. Chlorpyriphos 1000 g a.i/ha (15.5% and 48.9% reduction) however was not so effective in minimizing termite infestation and thereby per cent sett damage. More than 80 per cent of the termite control firms still prefer soil treatment measures (Su, 2011). The present investigation coincides with the research of Manager-Singh *et al*. (2003) who determined the effects of certain insecticides on the incidence of termites on emerging shoots and millable canes of sugarcane cv. COV 767. Sett treatment with 0.2 per cent solution of Gaucho 70 WS (imidacloprid) and soil treatment with phorate at 2.5 kg a.i./ha, chlorpyrifos 15 G at 2.5 kg a.i./ha and chlorpyrifos 20 EC at 1 kg a.i./ha were highly effective in significantly minimizing termite infestation in sugarcane shoots and millable canes.

Applications of synthetic termiticides pose threats to non target organisms. Due to their longer residual persistence in the environment, these have been banned and new alternatives are discovered in form of natural pesticides. Hence biopesticides could be a possible candidate for effective termite control without adverse

Table 4 : Evaluation of spinetoram 12 SC against *Odontotermes obesus* (Rambur) on sugarcane through soil drenching at Mandhikanmai, Sivagangai district (April 2013 – February 2014)

Treatments	Dose (ga.i/ha)	Number of colonies per plot on days after treatment			Number of termites per colony on days after treatment			Per cent sett damage on days after treatment		
		Pre treatment count	Mean	Per cent reduction over control	Pre treatment count	Mean	Per cent reduction over control	Pre treatment count	Mean	Per cent reduction over control
Spinetoram 12 SC	90	1.13	0.95^{d}	57.1	32.1	17.4^{d}	66.9	15.0	10.4^{c}	65.7
Spinetoram 12 SC	120	1.13	0.79^{c}	64.3	32.0	15.7^{c}	70.2	15.1	8.8^{b}	70.9
Spinetoram 12 SC	150	1.13	0.64^{ab}	71.1	31.9	12.3^{ab}	76.6	15.2	6.8^{ab}	77.6
Spinetoram 12 SC	180	1.15	0.58^{a}	73.8	31.7	11.4^{a}	78.3	15.0	5.9^{a}	80.5
Imidacloprid 20 SL	70	1.14	0.97^{d}	56.2	32.0	17.0^{d}	67.7	15.2	10.3^{c}	66.0
Rynaxypyr 20 SC	125	1.18	0.68^{b}	69.3	32.4	13.6^{b}	74.2	14.9	8.6^{b}	71.6
Chlorpyriphos 20 EC	1000	1.16	1.11^{e}	49.8	32.1	25.2^{e}	52.1	15.1	15.5^{d}	48.9
Untreated check	-	1.17	2.21^{f}	-	32.7	53.2^{f}	-	15.3	30.4^{e}	-
S.E.±	-	-	0.22	-	-	0.24	-	-	0.02	-
C.D. (P=0.05)	-	-	0.45	-	-	0.52	-	-	0.05	-

Data are mean values of three replications

Figures were transformed by square root transformation and the original values are given

Means within columns lacking common lower case superscript are significantly different (P<0.05)

effects on the environment or non target species. One such green insecticide spinetoram 12 SC can be recommended for the management of termites damage in sugarcane.

Acknowledgement:

The authors are grateful 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.

Ahmed, S.M.A., Riaz and Hussain, A. (2007). Assessment of the damaged and population of termites (*Odontotermes and Unicolor*) under various methods of insecticide application. *Internat. J. Agri. Biol.,* **9** : 125-28.

Ananthanarayana, K. and David, H. (1986). Termites. In: Sugarcane Entomology in India, David, H.; Easwaramoorth, S. and Yayanthi, R. (Eds.). Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. 207-231 pp.

Avasthy, P.N. (1967). Sugarcane pests in India. *PANS (A),* **13**: 111-117.

David, H. and Nandagopal, V. (1986). Pests of sugarcane - distribution symptomatology attach and identification. In : H. David, S. Easwaramoorthy and R. Jayanthi (eds.) *Sugarcane Entomology in India*. Sugarcane Breeding Institute, Coimbatore, India. 1-29 pp.

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

Evans, T.A. and Iqbal, N. (2014). Termite (order Blattodea, infraorder Isoptera) baiting 20 years after commercial release. *Pest Management Sci.,* **71** : 897-906.

Forschler, B.T. (2009). Screening insecticides for use as soil termititcides requires a series of bioassays: lessons from trials using *Reticulitermes flavipes* (Isoptera: Rhinotermitidae), pp. 53-74. In Pesticides in household, structural and residential pest management. ACS Symposium Series Vol. 1015. American Chemical Society, Washington, DC.

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.

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

Koto, I.N., Nwasu, K.I. and Busari, L.D. (2000). Control of termites in sugarcane using insecticides. *Sugar Tech.,* **2**(4): 17-20.

Manager - Singh, Singh, N.B. and Singh, M. (2002). Effect of certain insecticides on termite infestations in planted setts of sugar cane. *Coop. Sugar,* **34**: 311–315

Manager - Singh, Singh, N.B. and Singh, M. (2003). Effect of insecticides on the infestation of termites on emerging shoots and millable canes. *Indian J. Entomol*., **65** (1) : 28–33

Roonwal, M.L. (1981). Termites of agricultural importance in India and their control. In "progress in soil biology and Ecology in India".(Vereesh, G.K.ed.). Tech. Ser. 37. Univ. Agric, Sci., Bangalore. P. 253-256.

Salihah, Z., Shah, M. and Sattar, A. (1988). Survey of sugarcane termites of Nowshehra and Charsadda Tehsils. *In: Proceedings of 8th Pakistan Congr. Zool.,* **8** : 289-97.

Sattar, A. and Salihah, Z. (2002). Delineation of foraging terrtitories of *Heterotermes indicola* (*Isoptera: Rhinotermitidae*) by using a dye, Nile Blue A. *In: Proceedings of Pakistan Congr. Zool.,* **22** :10.

Singh, S.B. and Krishnan, R. (1946). An analysis of the cause of low germination in sugarcane. *Proc. Sug. Technol. Assoc. India,* **15** : 22-26.

Su, N.Y. (2011). Technological needs for sustainable termite management. *Sociobiology,* **58**: 229- 240.

Su, N.Y. and Scheffrahn, R.H. (1996). Comparative effects of two chitin synthesis inhibitors, hexaflumuron and lufenuron, in a bait matrix against subterranean termites (Isoptera: Rhinotermitidae). *J. Econ. Entomol*., **89**: 1156-1160.

Teotia, T.P.C., Gupta, K.M., Rajani, V.G. and Gangasagar (1963). Effective control of termites and shoot borers through soil application of heptachlor in sugarcane crop. *Indian J. Sug. Cane Res. Div.,* **7** : 203-211.

Vahabzadeh, R.D., Gold, R.E. and Austin, J.W. (2007). Effects of four chitin synthesis inhibitors on feeding and mortality of the eastern subterranean termite, *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). *Sociobiology,* **50** : 833-860.

Xing, L., Chouvenc, T. and Su, N.Y. (2014). Behavioral and histological changes in the Formosan subterranean termite (Isoptera: Rhinotermitidae) induced by the chitin synthesis inhibitor noviflumuron. *J. Econ. Entomol*., **107**: 741-747.