RESEARCH ARTICLE

EFFICACY OF CLOTHIANIDIN 50 WDG AGAINST TERMITES IN SUGARCANE

B. Vinothkumar*, R. Shanmugapriya, S. Sangamithra and S. Kuttalam

Abstract

Two field experiments were conducted to study the efficacy of clothionidin 50WDG against termites *Odontotermes obesus* Rambur (Isoptera: Termitidae) of sugarcane at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during 2015 -2017. The experiments were conducted in a randomized block design with seven treatments replicated thrice with a plot size of 8 x 5 m. Applications of insecticides were made at the time of planting. Germination of sugarcane setts recorded at 30 days after planting (DAP) and termite infestation was observed at 60, 120 DAP and at harvest and the per cent infestation was calculated. Results revealed that, the per cent germination data indicated that the clothianidin 50 WDG @ 150 g a.i. ha^{-1} treatment recorded higher germination and it was on par with clothianidin 50 WDG @ 125 g a.i. ha^{-1}. The above two treatments showed significantly higher germination per cent than all other treatments including standard checks and untreated control recorded the least germination per cent. The termite damage was minimum in the plots treated with the test chemical clothianidin 50 WDG @ 150 g a.i. ha^{-1} at all the days of observation and it was on par with the clothianidin 50 WDG @ 125 g a.i. ha^{-1}. The above two treatments resulted significantly superior in controlling termite damage over other treatments. Clothianidin 50 WDG @ 125 g a.i. ha^{-1} and 250 g a.i. ha^{-1} does not have any phytotoxicity effect on sugarcane. The study on the impact of clothianidin 50 WDG on natural enemies in the sugarcane agroecosystem revealed that, insecticidal treatments in the planting did not adversely affect the population of natural enemies in the crop. Clothianidin 50 WDG at 150 g a.i. ha^{-1} registered significantly more cane yield followed by clothianidin 50 WDG at 125 g a.i. ha^{-1}. Effect of clothianidin 50 WDG on yield parameters were recorded at the time of harvest and results indicated that commercial cane sugar (CCS) yield followed similar trend like cane yield whereas, Brix unit and POL per cent (Sucrose per cent) did not show any significant difference among the treatments. Hence it is concluded that, clothianidin 50 WDG @ 150 g a.i. ha^{-1} remained on par with clothianidin 50 WDG @ 125 g a.i. ha^{-1} have effectively controlled the termite infestation in sugarcane ecosystem.

Key words: Clothianidin, termites, bioefficacy, phytotoxicity, yield parameters

Introduction

Termites (Order - Isoptera) occur throughout the tropics and feed on a vast range of hosts and are known as important pests on crops and trees as well as destroyers of buildings and woods. As many as 13 species of termite are reported to cause damage to sugarcane in India. Termite infestation caused 30-60% destruction of buds (Teotia *et al.,* 1963; Roonwal, 1981). Avasthy (1967) reported it as 40%, which results in yield loss of 33%. Subterranean termites are the major problem attacking sugarcane crop from its germination through shoot emergence and finally it affects the quality of canes. At germination stage, the losses up to 90 - 100% have been recorded (Salihah *et al*., 1988). Kolo *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. Termite may attack any part of sett, but in the hard-rinded varieties, they prefer to attack the ends, eye buds and root bands (Chaudhary *et al.*,

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1986; Mill, 1992). At the sowing stage, termites enter the buds through some abrasion or injury or directly through the cut ends. The infestation during the germination of eye buds results in complete destruction of the mother shoot and tillers (Sudhansu *et al.,* 2017).

Among various control measures, chemical control stands first in termite management. Chemical insecticides are used as the frontline defence sources against termite management. Most of the insecticides used on agricultural crops belong to a limited number of chemically different classes. Of them, the most important organic insecticides used against termites belong to organophosphates, carbamates and synthetic pyrethroids which is having high persistence in the crop leading to residue problem. So, the efforts in the past resulted in the development of less persistent chemicals with novel mode of action to overcome the ecological constraints like resurgence, resistance and residues. At present, the Golden Age of insecticide research has met with selective, neuro active and easily degradable compounds. These newer molecules always have a higher stability and superiority over the conventional pesticides to control the pest population density in classical manner at field level. In this array, clothionidin 50 WDG is one of the novel and superior chemical belongs to neonicotinoid group introduced by FMC India Pvt Ltd., with an aim to replace the highly effective broad spectrum compounds, which were restricted due to their high mammalian toxicity and other side effects on non-target organisms.

Clothianidin, C(E)-N-((2-chloro-5- thiazolyl) methyl)-N- Dimethyl-N-nitroguanidine, is the newest member of the chloronicotinyl insecticide family, has recently been registered in India for foliar spray and seed treatment applications (Jeschke *et al.,* 2003). Clothianidin has a high activity against a broad range of insects, including sucking insects, chewing insects, and some lepidopterans (Jeschke *et al.,* 2003). Clothianidin, has been found by former Agro Division, Takeda Chemical Industries, Ltd. (Sumitomo Chemical Co. Ltd., at present) and co-developed with Bayer CropScience. During the studies on neonicotinoid insecticides, nitenpyram (an open-chain nitromethylene derivative) was prepared first, showing a potent activity against Hemiptera and Thysanoptera pests, and its modification led to clothianidin (a nitroguanidine derivative). Clothianidin exhibits excellent control efficacies in small amounts for a wide variety of insect pests such as Hemiptera, Thysanoptera, Coleoptera, Lepidoptera, and Diptera for the long term, with excellent systemic action and by a variety of application methods. The structural features of clothianidin are a thiazole ring and an open-chain guanidine skeleton (Uneme, 2011). Clothianidin binds in high affinity to the insect nicotinic receptors (Tomizawa and Casida, 2005). Interestingly, clothianidin shows an enhanced agonist efficacy relative to that of imidacloprid at the cholinergic neurons cultured from the central nervous system of third-instar *Drosophila* larvae (Brown *et al.,* 2006). With this background, the studies were carried out to assess the efficacy of clothianidin 50 WDG against termites in sugarcane.

Materials and Methods

Two field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during 2015 – 2017 in a Randomized Block Design (RBD) with three replications. Applications of insecticides were made at the time of planting. The target dose rate was mixed in required quantity of water and sprayed (using pneumatic knapsack sprayer by removing nozzle) over the planted setts in the furrows for the insecticide to spread thoroughly around the planting zone. The treatment details are given as follows; T_1 - Untreated control, T_2 - Clothianidin 50 WDG @ 100 g a.i. ha^{-1}, T_3 - Clothianidin 50 WDG @ 125

g a.i. ha^{-1}, T_4 - Clothianidin 50 WDG @ 150 g a.i. ha^{-1}, T_5 - Clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1}, T_6 - Imidacloprid 17.8 SL @ 70 g a.i. ha^{-1} and T_7 - Bifenthrin 10 EC @ 100 g a.i. ha^{-1}.

Germination of sugarcane setts was recorded at 30 days after planting (DAP) in each treatment. Number of tillers were counted per 5 meter linear row at 60 and 120 DAP and converted in to tillers numbers per hectare. Termite infestation was observed in sugarcane at 60 days after application (DAA), 120 DAA and at harvest and the per cent infestation was calculated by using the formula,

$$\text{Termite infestation} = \left(\frac{\text{Number of sampling unit with presence of termite}}{\text{Total sampling point}}\right) \text{X } 100$$

Termite control was calculated using the formula,

$$\text{Termite control} = \left(\frac{\text{Infestation in control} - \text{Infestation in Treatment}}{\text{Infestation in control}}\right) \text{X } 100$$

Cane yield was recorded in each plot and total yield was converted to tonnes per hectare. Important sugarcane quality parameters for assessing cane maturity are the juice Brix, pol or sucrose percentage and purity. Juice Brix refers to the total solids content present in the juice expressed in percentage. Brix includes sugars as well as non-sugars. Brix is measured in the field on standing cane crop using a Hand Refractometer. The HR Brix readings were separately taken from both top and bottom. A narrow range indicates ripeness of the cane, while a wide difference indicates that the cane is yet too ripe. While, if the bottom portion of the cane has lower Brix value than the top, it means that the cane is over-ripened and reversion of sugar is taking place. Mean Brix value was taken for calculation. Juice sucrose or POL per cent is the actual cane sugar present in the juice. It is determined by using a polarimeter, hence sucrose per cent is also referred to as pol per cent. Purity refers to the percentage of sucrose present in the total solids content in the juice. A higher purity indicates the presence of higher sucrose content out of the total solids present in juice. The purity percentage along with sucrose percent aids in determining maturity time. Purity is calculated using formula PR = (Sucrose % / Brix %) x 100. The commercial cane sugar (CCS) refers to the total recoverable sugar percent in the cane. This is calculated by the following formula:

$$\text{CCS (tons ha}^{-1}) = [\text{Yield (tons/ha) x Sugar Recovery (\%)}] /100$$

Where, Sugar Recovery (%) = [Sucrose % in juice - 0.4 (Brix % - Sucrose % in juice)] x 0.73

The effect of F9252 at X and 2x doses on the natural beneficial fauna of sugarcane ecosystem were assessed at 30, 60 and 120 days after application. The experiments were conducted in a randomized block design with three replications and the plot size of 40m^2. Symptoms of phytotoxicity *viz.,* leaf injury, wilting, vein clearing, necrosis, yellowing, stunting, epinasty and hyponasty were observed from at 5, 10, 15, 20, 30 and 60 days after application as per Central Insecticide Board Registration Committee (CIBRC) protocol. Phytotoxicity symptoms was assessed on visual rating from 0-10 *viz*., 0 - No phytotoxicity; 1 - 1-10 %; 2 - 11-20 %; 3 - 21-30 %; 4 - 31-40 %; 5 - 41-50 %; 6 - 51-60 %; 7 - 61-70 %; 8 - 71-80 %; 9 - 81-90 % and 10 - 91-100 %. Per cent leaf injury was calculated using the formulae

$$\text{Termite control} = \left(\frac{\text{Infestation in control} - \text{Infestation in Treatment}}{\text{Infestation in control}}\right) \text{X } 100$$

Results and Discussion

The results of the two field trials conducted for evaluation of clothianidin 50 WDG against termites of sugarcane revealed that, at 30 days after planting (DAP) the plots treated with clothianidin 50 WDG @ 150 g a.i. ha^{-1} recorded higher per cent germination of 85.20 and 84.30% during first and second season, respectively which is on par

Table 1. Effect of clothianidin 50 WDG on germination of sugarcane

Treatments	Dose g a.i. ha^{-1}	Germination Per cent @ 30 DAP	
		First season	Second season
Untreated check	-	54.30	51.15
Clothianidin 50 WDG	100	67.00	65.20
Clothianidin 50 WDG	125	83.00	81.00
Clothianidin 50 WDG	150	85.20	84.30
Clothianidin 50 WDG (Dantotsu)	125	82.50	78.70
Imidacloprid 17.8 SL	70	69.90	64.50
Bifenthrin 10 EC	100	70.10	67.30
SEM		3.96	3.60
CD @ 5%		12.22	11.10

DAP-Days after planting

with clothianidin 50 WDG @ 125 g a.i. ha^{-1} of test chemical and commercial formulation (Dantotsu). All the treatments were found significantly superior than the untreated control which recorded least germination per cent of 54.30 and 51.15%, respectively for first and second season (Table 1). The data on tiller count revealed that, the higher tiller count of 206.00 and 363.20 thousand tillers per ha was recorded in clothianidin 50 WDG @ 150 g a.i. ha^{-1} treatment at 60 and 120 DAP, respectively during first season and it is statistically on par with two treatments *viz*., clothianidin 50 WDG and clothianidin 50 WDG (Dantotsu) at 125 g a.i. ha^{-1} and these treatments were significantly superior to all other treatments. At second season also clothianidin 50 WDG @ 150 g a.i. ha^{-1} and 125 g a.i. ha^{-1} recorded higher tillering count than all other treatments (Table 2).

The results of efficacy of insecticides on termite infestation clearly indicated that, clothianidin 50 WDG @ 150 g.a.i.ha^{-1} recorded the least termite infestations 4.93, 9.93 and 16.40 per cent at 60 DAP, 120 DAP and at harvest, respectively and it was on par with treatments, clothianidin 50 WDG (test chemical) and clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1} during first season (Table 3). The calculated data on the per cent control reflected the above trend by registering highest per cent control of 83.93, 76.69 and 69.40 per cent at 60 DAP, 120 DAP and at harvest respectively by

Table 2. Effect of clothianidin 50 WDG on sugarcane tillering

Treatments	Dose g a.i. ha^{-1}	Tiller count (000 ha^{-1})			
		First season		Second season	
		60 DAP	120 DAP	60 DAP	120 DAP
Untreated check	-	119.20	231.00	130.50	242.00
Clothianidin 50 WDG	100	153.10	291.60	167.40	303.60
Clothianidin 50 WDG	125	198.70	349.00	211.00	362.40
Clothianidin 50 WDG	150	206.00	363.20	220.10	374.20
Clothianidin 50 WDG (Dantotsu)	125	192.30	342.70	201.30	358.00
Imidacloprid 17.8 SL	70	148.30	284.60	159.60	295.60
Bifenthrin 10 EC	100	158.70	289.40	170.00	300.40
SEM		8.59	15.62	9.23	16.20
CD @ 5%		26.48	48.13	28.45	49.93

DAP-Days after planting

Table 3. Effect of clothianidin 50 WDG on termite damage in sugarcane

Treatments	First season						Second season					
	60 DAA		120 DAA		At harvest		60 DAA		120 DAA		At harvest	
	PD	PRC	PD	PRC	PD	PRC	PD	PRC	PD	PRC	PD	PRC
Untreated check	30.67 (33.60)	-	42.60 (40.72)	-	53.60 (47.05)	-	29.60 (32.93)	-	39.20 (38.74)	-	51.00 (45.55)	-
Clothianidin 50 WDG @ 100 g a.i. ha^{-1}	8.93 (17.33)	70.88	16.87 (24.18)	60.40	26.13 (30.67)	51.25	7.20 (15.52)	75.68	15.20 (22.88)	61.22	24.40 (29.53)	52.16
Clothianidin 50 WDG @ 125 g a.i. ha^{-1}	5.67 (13.74)	81.51	10.67 (19.02)	74.95	17.33 (24.54)	67.67	4.53 (12.26)	84.70	9.20 (17.61)	76.53	16.20 (23.68)	68.24
Clothianidin 50 WDG @ 150 g a.i. ha^{-1}	4.93 (12.80)	83.93	9.93 (18.33)	76.69	16.40 (23.84)	69.40	3.67 (11.02)	87.60	8.20 (16.60)	79.08	15.40 (23.06)	69.80
Clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1}	6.20 (14.40)	79.78	10.33 (18.73)	75.75	18.00 (25.08)	66.42	4.20 (11.81)	85.81	9.67 (18.10)	75.33	16.53 (23.96)	67.59
Imidacloprid 17.8 SL @ 70 g a.i. ha^{-1}	10.00 (18.40)	67.39	17.40 (24.61)	59.15	27.60 (31.64)	48.51	8.07 (16.47)	72.74	15.60 (23.22)	60.20	26.07 (30.65)	48.88
Bifenthrin 10 EC @ 100 g a.i. ha^{-1}	9.47 (17.88)	69.12	16.20 (23.68)	61.97	26.80 (31.11)	50.00	7.67 (16.04)	74.09	14.93 (22.67)	61.91	25.00 (29.94)	50.98
SEM	0.64	-	0.88	-	1.15	-	0.59	-	0.82	-	1.10	-
CD 5%	1.97	-	2.70	-	3.55	-	1.80	-	2.53	-	3.40	-

Figures in the parentheses are arc sine transformed value; DAA-Days after application; PD – Percent damage; PRC – Percent reduction over control

Table 4. Effect of clothianidin 50 WDG on natural enemies in sugarcane

Treatments	Natural enemies population (number/plant)					
	First spray			Second spray		
	30 DAA	60 DAA	120 DAA	30 DAA	60 DAA	120 DAA
Untreated check	**3.27 *(1.94)	4.80 (2.30)	8.60 (3.01)	**3.53 *(2.00)	6.00 (2.54)	7.13 (2.76)
Clothianidin 50 WDG @ 100 g a.i. ha^{-1}	2.67 (1.78)	5.13 (2.37)	9.13 (3.10)	2.87 (1.83)	5.47 (2.44)	6.93 (2.72)
Clothianidin 50 WDG @ 125 g a.i. ha^{-1}	3.00 (1.87)	5.87 (2.52)	9.93 (3.22)	3.67 (2.04)	6.40 (2.62)	7.67 (2.85)
Clothianidin 50 WDG @ 150 g a.i. ha^{-1}	2.67 (1.78)	4.93 (2.33)	9.00 (3.08)	3.07 (1.89)	5.53 (2.45)	6.80 (2.70)
Clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1}	3.13 (1.90)	5.67 (2.48)	9.87 (3.22)	3.40 (1.97)	6.60 (2.66)	7.20 (2.77)
Imidacloprid 17.8 SL @ 70 g a.i. ha^{-1}	2.67 (1.78)	4.93 (2.33)	8.93 (3.06)	3.27 (1.94)	5.80 (2.50)	6.87 (2.71)
Bifenthrin 10 EC @ 100 g a.i. ha^{-1}	2.20 (1.64)	3.60 (2.02)	8.33 (2.97)	3.00 (1.87)	4.93 (2.33)	7.27 (2.79)
CD @ 5%	NS	NS	NS	NS	NS	NS

** Mean of three replications *Figures in the parentheses are transformed value; DAA-Days after application; NS-Non Significant

Table 5. Effect of clothianidin 50 WDG on cane yield and yield parameters of sugarcane

Treatments	First season					Second season				
	Cane yield (t ha^{-1})	Brix (%)	POL (%)	Purity (%)	CCS (t ha^{-1})	Cane yield (t ha^{-1})	Brix (%)	POL (%)	Purity (%)	CCS (t ha^{-1})
Untreated check	62.05	20.43	18.58	90.94	8.08	63.00	20.38	18.45	90.53	8.13
Clothianidin 50 WDG @ 100 g a.i. ha^{-1}	75.90	20.42	18.54	90.79	9.86	79.65	20.52	18.50	90.16	10.29
Clothianidin 50 WDG @ 125 g a.i. ha^{-1}	90.00	20.37	18.33	89.99	11.51	94.00	20.40	18.23	89.36	11.91
Clothianidin 50 WDG @ 150 g a.i. ha^{-1}	92.05	20.45	19.14	93.59	12.51	96.10	20.60	18.10	87.86	12.00
Clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1}	88.52	20.44	18.15	88.80	11.14	92.90	20.33	18.34	90.21	11.90
Imidacloprid 17.8 SL @ 70 g a.i. ha^{-1}	74.60	20.35	18.54	91.11	9.70	76.12	20.42	18.22	89.23	9.64
Bifenthrin 10 EC @ 100 g a.i. ha^{-1}	75.00	20.44	18.40	90.02	9.63	78.58	20.30	18.53	91.28	10.22
SEM	4.04	-	-	1.27	0.71	4.21	-	-	1.11	0.68
CD 5%	12.43	NS	NS	2.89	1.57	12.97	NS	NS	2.34	1.23

NS-Non Significant; POL - percent sugar in cane; CCS - Commercial Cane Sugar

clothianidin 50 WDG @150 g a.i. ha^{-1} followed by, clothianidin 50 WDG (test chemical) @ 125 g a.i. ha^{-1} (81.51, 74.95 and 67.67 per cent at 60 DAP, 120 DAP and at harvest, respectively) and clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1} (79.78, 75.75 and 66.42 per cent at 60 DAP, 120 DAP and at harvest respectively) (Table 3).

During second season also same trend was observed. The data recorded on termite infestation level at different intervals and the results clearly indicated that clothianidin 50 WDG @ 150 g. a.i. ha^{-1} recorded the least termite infestations 3.67, 8.20 and 15.40 at 60 DAP, 120 DAP and at harvest respectively and it was on par with treatments like, clothianidin 50 WDG at 125 g a.i. ha^{-1} and clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1}. The calculated data on the per cent control reflected the above trend highest per cent control was recorded in clothianidin 50 WDG at 150 g a.i. ha^{-1} (87.60, 79.08 and 69.80 per cent at 60 DAP, 120 DAP and at harvest respectively) followed by, clothianidin 50 WDG at 125 g a.i. ha^{-1} (84.70, 76.53 and 68.24 per cent at 60 DAP, 120 DAP and at harvest respectively) and clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1} (85.81, 75.33 and 67.59 per cent at 60 DAP, 120 DAP and at harvest respectively) (Table 3).

The results of the study on the impact of clothianidin 50 WDG on natural enemies present in the sugarcane agroecosystem revealed that, insecticidal treatments in the planting did not adversely affect the population of natural enemies in the crop (Table 4). Trial results revealed that the clothianidin 50 WDG @ 150 g a.i. ha^{-1} registered significantly more cane yield of 96.10 t ha^{-1} followed by clothianidin 50 WDG @ 125 g a.i. ha^{-1} (94.00 t ha^{-1}) and clothianidin 50 WDG (Dantotsu) @ 125 g a.i. ha^{-1} (92.90 t ha^{-1}) during first season. During second season clothianidin 50 WDG @ 150 g a.i. ha^{-1} and 125 g a.i. ha^{-1} (both test chemical and Dantotsu) recoded the yield of 96.10, 94.00 and 92.90 t ha^{-1}, respectively. The lowest cane yield of 62.05 and 63.00 t ha^{-1} were recorded in untreated control treatment during first and second season respectively (Table 5). Effect of clothianidin 50 WDG on yield parameters were recorded at the time of harvest and results indicated that commercial cane sugar (CCS) yield followed similar trend like cane yield whereas, Brix unit and POL percent (Sucrose percent) did not show any significant difference among the treatments (Table 5).

The results of the field experiment conducted to study the phytotoxic effect of clothianidin 50 WDG revealed that clothianidin 50 WDG @ 125 g a.i. ha^{-1} (X dose) and 250 g a.i. ha^{-1} (2 X dose) applied in sugarcane did not show any phytotoxic effects like leaf injury, wilting, vein clearing, necrosis, yellowing, stunting, epinasty and hyponasty observed at 5, 10, 15, 20, 30 and 60 days after planting (Table 6). Superiority of clothianidin in suppressing the subterranean termites even at a very low concentration was earlier observed by Charoenkrun (2014) who reported that when the dosage of clothianidin was increased to 0.10 or 0.15 per cent, the wood damage caused by the termites was reduced up to 5 per cent. Clothianidin 50 WDG registered a significantly lower incidence of termites coupled with a marked increase in per cent germination of preserved setts (Sudhansu *et al.,* 2017). However, this result is close to those observed with fipronil (Regent 500 FS and 800 WG), which is active at a dose of 10 ppm on *Odontotermes nilensis* (Delgarde and Rouland-Lefevre, 2002). Alam *et al.* (2001) also reported that the short residual chemicals Regent 3GR and Regent 50SC @ 100 g a.i. ha^{-1} significantly reduced sugarcane termites. Smith *et al.* (2008) who reported that the combination of acetamiprid and bifenthrin was more toxic to termites. Santharam *et al.* (2002), reported that,

Table 6. Phytotoxicity effect of clothianidin 50 WDG on sugarcane

Treatments	Phytotoxicity rating *					
	Leaf tip injury	Wilting	Vein clearing	Necrosis & chlorosis	Epinasty	Hyponasty
Clothianidin 50 WDG @ 125 g a.i. ha^{-1}	0	0	0	0	0	0
Clothianidin 50 WDG @ 250 g a.i. ha^{-1}	0	0	0	0	0	0
Untreated check	0	0	0	0	0	0

*Observed on 5, 10,15,20,30 and 60 days after treatment

sett dip of imidacloprid 70 WS at 0.1 and 0.15 per cent and spray over setts of imidacloprid 200 SL @ 250 and 375 ml/ha resulted in increased germination of setts. These treatments protected the crop from termite damage and were equal to chlorpyriphos 20 EC @ 5 lit./ha in the efficacy. They also resulted in increased cane yield.

Clothianidin exhibits excellent control efficacies in small amounts against a large number of pest species in Homoptera, Heteroptera, Thysanoptera, Diptera, Coleoptera, Lepidoptera, Orthoptera, and Isoptera families (Ohkawara, *et al.,* 2002), the following advantages can be pointed out: wide insecticidal spectrum; potent activity at low dosage; long term control effect; excellent systemic action; wide variety of application methods; and high crop safety. Clothianidin binds in high affinity to the insect nicotinic receptors (Tomizawa and Casida, 2005). Interestingly, clothianidin shows an enhanced agonist efficacy relative to that of imidacloprid at the cholinergic neurons cultured from the central nervous system (Brown *et al.,* 2006). The present study clearly states that, clothianidin 50 WDG at 150 g a.i.ha^{-1} remained on par with 125 g a.i.ha^{-1} and have effectively controlled termite infestation, besides resulting in higher yield. It can also be concluded that clothianidin 50 WDG was safe on natural enemies observed in sugarcane. clothianidin 50 WDG @ 125 g a.i. ha^{-1} and 250 g a.i. ha^{-1} does not have any phytotoxicity effect on sugarcane. Hence, clothianidin 50 WDG at 125 g a.i. ha^{-1} can be recommended for the management of termites damage in sugarcane. The results also indicated that clothianidin 50 WDG (test chemical) @ 125 g a.i. ha^{-1} were comparable with clothianidin 50 WDG (Dantotsu) at 125 g a.i. ha^{-1} in controlling the termite infestation in sugarcane.

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