Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(5): 2238-2241
Received: 01-07-2017
Accepted: 02-08-2017

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Bioefficacy of Fipronil 5% SC against early shoot borer (*Chilo infuscatellus* Snellen) and root borer (*Emmalocera depressella* Swinhoe) in sugarcane

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Abstract
Field evaluation on efficacy of fipronil 5% SC against early shoot borer (*Chilo infuscatellus* Snellen) and root borer (*Emmalocera depressella* Swinhoe) in sugarcane was conducted during 2013. Among the treatments, fipronil 5% SC @ 150 g a.i./ha was found most effective against early shoot borer and root borer where minimum dead hearts (4.29, 3.20 and 2.23%) were recorded after first, second and third spraying, respectively. Fipronil 5% SC @ 100 g a.i./ha was registered the next best treatment in reducing dead hearts after first (4.66%), second (3.74%) and third (2.59%) application followed by fipronil 5% SC @ 90 g a.i./ha (5.05, 3.93 and 2.76%) and fipronil 5% SC @ 75 g a.i./ha (5.18, 4.08 and 3.11%), respectively. Fipronil 5% SC @ 150 g a.i./ha recorded the highest reduction of dead hearts over control (48.75, 65.81 and 78.22%) after three sprays with maximum yield (81.21 t/ha). Thus, fipronil 5% SC @ 150 g a.i./ ha may be useful in the control of early shoot borer and root borer in sugarcane.

Keywords: Bioefficacy, Insecticide, Sugarcane, *Chilo infuscatellus*, *Emmalocera depressella*

1. Introduction
Sugarcane is one of most important high value cash and industrial crop cultivated in India which is a major source of white sugar and gur. Sugarcane being a long duration crop, its production and productivity is affected by many factors *viz*, soil type, selections of variety, fertilizer management, irrigation management and damage caused by pests [3]. During entire cropping period it suffers the attack of a wide range of insect pests from planting to till harvesting, out of these the borers *i.e*., root, shoot, top, internode and Plassey borer are caused heavy losses to the quality as well as quantity of the crop [9]. Among them, the early shoot borer, *Chilo infuscatellus* Snellen and root borer, *Emmalocera depressella* Swinhoe are the most notorious and destructive insects conflicting considerable damage to the canes mainly at formative phase [5]. The young larvae of *C. infuscatellus* generally enters in between the first leaf sheath and stem and feeds on the soft inner tissues of the sheath like a leaf miner for a few days. After that, it enter the cane laterally through one or more holes in the stalks (shoot) and bores downwards as well as upwards killing the growing point. Thus, it cuts of the central leaf spindle, which eventually dries forming a 'dead heart' symptoms. On pulling, these dead-hearts come out easily. The base of the dead heart gets rotten and emits offensive smell. On the other hand, the larvae of *E. depressella* rarely bore into the root. They attack only that part of the stem which is below the ground level feeding on the inner contents of the
stalks by making semicircular tunnels. Larvae cut the leaf whorl resulting drying up on inner whorl of leaves and formation of dead hearts which can not easily pulled out but there is no foul smell from the head heart. The yield loss due to *C. infuscatellus* ranges from 30-75 per cent in early stages of the crop (May- June) in subtropical India [8]. Economic losses due to early shoot borer reported from from 22-23 per cent in yield, 12 per cent in sugar recovery [1] and 27 per cent in Jaggary [13]. Yield losses due to *E. depressella* in millable canes at the 100% level of incidence was estimated to be 2.5%, the maximum loss being 12% [6]. Although heavy infestations of the borer in eastern U.P. resulted in cane yield losses of up to 70% [7]. Several newer insecticides are recommended for the management of these pests by many workers [2, 3, 4, 9, 11, 12]. Keeping above aspects in mind, the present investigation reports the effectiveness of some insecticides against sugarcane early shoot borer and root borer.

2. Materials and Methods
2.1 Experimental location
Supervised field experiments were conducted at University Experimental Farm, 'C' Unit, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal during 2013.

2.2 Experimental Layout

The experiment was laid out in a Randomized Block Design (RBD) with seven treatment combinations including untreated control and three replications having plot size of 6m x 5.5m. Sugarcane variety cv. Swapan (COB 99161) was planted as per recommended agronomic package of practices free from pesticide application. Planting was done at a distance of 90 cm between plants and 60 cm between rows on in the main field. The treatments used in the experiments were four different doses of fipronil 5% SC @ 75, 90, 100 and 150 g a.i./ha, chlorpyrifos 20% EC @ 300 g a.i./ha and cypermethrin 10% EC @ 70 g a.i./ha. A total of three sprayings was done at 30 days interval between planting to vegetative stage of the crop. Spraying was done with a high volume pneumatic knapsack sprayer fited with hollow cone nozzle using spray fluid @ 500 litres/ha.

2.3 Observations

The observations on dead heart formed due to early shoot borer and root borer were taken 1 day before application (pre-treatment) and 7, 15 and 30 days after each application. The mean percent dead hearts per plot was worked out after each spray. To record the incidence of targeted insects, two rows were discarded on all sides as border rows. The seasonal incidence of early shoot borer and root borer were counted on the basis of the per cent dead hearts from germination up to vegetative stage. The weekly observations on dead hearts on ten hills selected randomly for each plot were counted and total number of tillers/hill were also recorded for early shoot borer and root borer infestation. Cane yield was taken from each plot separately. The percent incidence (dead hearts) was calculated using the following formula:

% incidence = (No. of dead hearts per hill / Total number of tillers per hill) × 100

2.4 Statistical analysis

The data were subjected to necessary transformation and the critical difference (CD) at 5% level of significance was worked out using statistical methods of MS-Excel.

3. Results and Discussion

The efficacy of different insecticidal treatments against early shoot borer and root borer of sugarcane has been presented in table 1, 2 and 3. The amount of dead hearts formed by the attack of early shoot borer and root borer in the pretreatment count which was done prior to first application was found non-significant whereas prior to second and third application it was found significant. All the treatments were significantly effective in reducing infestation of early shoot borer and root borer and thus reducing the formation of dead hearts significantly as compared to untreated control. Among the treatments, fipronil 5% SC @ 150 g a.i./ha recorded the most promising insecticide providing 5.50, 4.07 and 3.30% dead hearts after first spray; 4.33, 3.37 and 1.91% after second spray; and 3.40, 2.15 and 1.13% after third spray at 7, 15 and 30 days after treatment, respectively. The next best treatment was found with fipronil 5% SC @ 100 g a.i./ha (5.93, 4.57 and 3.56%; 4.34, 3.88 and 2.40%; 3.71, 2.78 and 1.82% dead hearts) followed by fipronil 5% SC @ 90 g a.i./ha (6.26, 4.74 and 3.71%; 4.86, 4.04 and 2.58%; 4.03, 3.00 and 1.98% dead hearts) at 7, 15 and 30 days after first, second and third spray, respectively. Cypermethrin 10% EC @ 70 g a.i./ha recorded the maximum percent dead heart at 7 (7.08, 5.29 and 4.80%), 15 (6.01, 4.63 and 3.91%) and 30 days (5.13, 4.45 and 3.25%) after first, second and third application and was found least effective in comparison to other chemicals tested. While observing the mean figure of the three post treatment observation dates (Table 1, 2 and 3), fipronil 5% SC @ 150 g a.i./ha recorded lowest percent dead hearts (4.29, 3.20 and 2.23%) with 48.75, 65.81 and 78.22% reduction over control at first, second and third application, respectively. Fipronil 5% SC @ 100 g a.i./ha was the second best treatment registered minimum mean percent dead hearts (4.66, 3.74 and 2.59%) with 44.32, 60.04 and 74.71% reduction over control followed by fipronil 5% SC @ 90 g a.i./ha (5.05, 3.93 and 2.76% dead hearts) with 39.67, 58.01 and73.05% reduction over control during the three spray applications, respectively. The next best treatment proved its effectiveness than untreated control was fipronil 5% SC @ 75 g a.i./

Table 1: Effect of Fipronil 5% SC on Early Shoot Borer & Root Borer in Sugarcane during 2013 (First Application).

Sl. No.	Treatments	Dose (g a.i./ha)	Pre count (%)	Percent dead hearts				Reduction over control (%)
				7 DAS	15 DAS	30 DAS	Mean	
T_1	Fipronil 5% SC	75	8.26 (16.70)	6.23 (14.45)	5.14 (13.09)	4.16 (11.77)	5.18 (13.11)	38.11
T_2	Fipronil 5% SC	100	8.18 (16.62)	5.93 (14.09)	4.34 (12.03)	3.71 (11.10)	4.66 (12.41)	44.32
T_3	Fipronil 5% SC	150	8.25 (16.69)	5.50 (13.57)	4.07 (11.63)	3.30 (10.46)	4.29 (11.89)	48.75
T_4	Fipronil 5% SC	90	8.66 (17.11)	6.26 (14.48)	4.86 (12.73)	4.03 (11.58)	5.05 (12.94)	39.67
T_5	Chlorpyrifos 20% EC	300	8.59 (17.04)	6.81 (15.13)	5.60 (13.68)	4.87 (12.74)	5.76 (13.85)	31.18
T_6	Cypermethrin 10% EC	70	8.38 (16.83)	7.08 (15.43)	6.01 (14.19)	5.13 (13.09)	6.07 (14.24)	27.48
T_7	Untreated control	-	8.50 (16.95)	8.12 (16.56)	8.30 (16.75)	8.70 (17.15)	8.37 (16.82)	-
S. Em (±)			0.22	0.08	0.19	0.15	0.38	-
C.D. at 0.05%			NS	0.24*	0.60*	0.47*	1.17*	

Figures in parentheses are angular transformed values; *Significant at 0.05 level; DAS = Days after spray

Table 2: Effect of Fipronil 5% SC on Early Shoot Borer & Root Borer in Sugarcane during 2013 (Second Application).

Sl. No.	Treatments	Dose (g a.i./ha)	Pre count (%)	Percent dead hearts				Reduction over control (%)
				7 DAS	15 DAS	30 DAS	Mean	
T_1	Fipronil 5% SC	75	7.46 (15.85)	4.95 (12.85)	4.19 (11.82)	3.10 (10.14)	4.08 (11.60)	56.41
T_2	Fipronil 5% SC	100	6.92 (15.26)	4.57 (12.34)	3.88 (11.36)	2.78 (9.60)	3.74 (11.10)	60.04
T_3	Fipronil 5% SC	150	6.67 (14.96)	4.33 (12.01)	3.37 (10.57)	1.91 (7.92)	3.20 (10.18)	65.81
T_4	Fipronil 5% SC	90	7.12 (15.48)	4.74 (12.57)	4.04 (11.59)	3.00 (9.97)	3.93 (11.38)	58.01
T_5	Chlorpyrifos 20% EC	300	7.61 (16.01)	5.08 (13.03)	4.50 (12.25)	4.18 (11.79)	4.59 (12.36)	50.96
T_6	Cypermethrin 10% EC	70	7.81 (16.23)	5.29 (13.30)	4.63 (12.43)	4.45 (12.18)	4.79 (12.63)	48.83
T_7	Untreated control	-	9.60 (18.04)	9.12 (17.58)	9.33 (17.79)	9.64 (18.08)	9.36 (17.82)	-
S. Em (±)			0.11	0.13	0.13	0.23	0.45	-
C.D. at 0.05%			0.33*	0.41*	0.40*	0.69*	1.37*	

Figures in parentheses are angular transformed values; *Significant at 0.05 level; DAS = Days after spray

Table 3: Effect of Fipronil 5% SC on Early Shoot Borer & Root Borer in Sugarcane during 2013 (Third Application).

Sl. No.	Treatments	Dose (g a.i./ha)	Pre count (%)	Percent dead hearts				Reduction over control (%)
				7 DAS	15 DAS	30 DAS	Mean	
T_1	Fipronil 5% SC	75	6.40 (14.65)	3.88 (11.36)	2.98 (9.93)	2.48 (9.05)	3.11 (10.12)	69.63
T_2	Fipronil 5% SC	100	5.89 (14.05)	3.56 (10.88)	2.40 (8.90)	1.82 (7.75)	2.59 (9.18)	74.71
T_3	Fipronil 5% SC	150	5.73 (13.85)	3.40 (10.62)	2.15 (8.42)	1.13 (6.10)	2.23 (8.39)	78.22
T_4	Fipronil 5% SC	90	6.12 (14.32)	3.71 (11.10)	2.58 (9.24)	1.98 (8.09)	2.76 (9.48)	73.05
T_5	Chlorpyrifos 20% EC	300	6.69 (14.99)	4.41 (12.11)	3.61 (10.95)	2.81 (9.61)	3.61 (10.91)	64.75
T_6	Cypermethrin 10% EC	70	6.95 (15.29)	4.80 (12.65)	3.91 (11.40)	3.25 (10.39)	3.99 (11.48)	61.04
T_7	Untreated control	-	10.09 (18.52)	9.72 (18.16)	10.39 (18.79)	10.60 (19.00)	10.24 (18.66)	-
S. Em (±) C.D. at 0.05%			0.12 0.35*	0.13 0.41*	0.20 0.62*	0.28 0.86*	0.48 1.47*	-

Figures in parentheses are angular transformed values; *Significant at 0.05 level; DAS = Days after spray

ha (5.18, 4.08 and 3.11% dead heart) with 38.11, 56.41 and 69.63% reduction over control which was statistically at par with chlorpyrifos 20% EC @ 300 g a.i./ha (5.76, 4.59 and 3.61% dead heart) with 31.18, 50.96 and 64.75% reduction over control after first, second and third spray, respectively. The least effective treatment in this case was observed in cypermethrin 10% EC @ 70 g a.i./ha registering 6.07, 4.79 and 3.99% dead hearts with 27.48, 48.83 and 61.04% reduction over control during all the spray applications.

From table 4 it is evident that, fipronil 5% SC @ 150 gm. a.i./ha recorded maximum sugarcane stick yield (81.21 t/ha) with 32.65% increase over control which was closely followed by fipronil 5% SC @ 100 gm. a.i./ha (78.69 t/ha with 28.57% increase over control). Fipronil 5% SC @ 90 gm. a.i./ha recorded the cane yield of 76.47 t/ha with 24.91% increase over control whereas, chlorpyrifos 20% EC @ 300 gm a.i./ha recorded 72.86 t/ha cane yield with 19.01% increase over control. Cypermethrin 10% EC @ 70 gm a.i./ha recorded the lowest yield of cane (70.44 t/ha) with only 15.06% increase over control and was found least effective.

Table 4: Effect of Fipronil 5 % SC on yield in Sugarcane Crop during 2013

Sl. No.	Treatments	Dose (g a.i./ha)	Yield (t/ha)	Percent yield increased over control
T_1	Fipronil 5% SC	75	73.81	20.57
T_2	Fipronil 5% SC	100	78.69	28.57
T_3	Fipronil 5% SC	150	81.21	32.65
T_4	Fipronil 5% SC	90	76.47	24.91
T_5	Chlorpyrifos 20% EC	300	72.86	19.01
T_6	Cypermethrin 10% EC	70	70.44	15.06
T_7	Untreated Control	-	61.22	-

From the present investigation it is evident that, fipronil 5% SC @ 90 -150 g a.i./ha gave satisfactory control of early shoot borer and root borer and resulted to higher sugarcane stick yield. The present findings are in conformity with the findings of Sardana [14], Mann *et al.* [10] and Chand *et al.* [5] who reported that fipronil was the best insecticide both at soil application and spray against early shoot borer and rot borer. Bhavani *et al.* [4] reported that lowest cumulative incidence of early shoot borer was recorded in soil application of fipronil 0.3G @ 25 kg/ha which are similar to our findings.

4. Conclusion

It may be concluded from the present investigation that fipronil 5% SC @ 90 -150 g a.i./ha provided its effectiveness in reducing the infestation of early shoot borer and root borer in sugarcane with maximum yield of cane. Hence, the insecticide may be recommended for the management of these borers in sugarcane.

5. Acknowledgments

The authors are thankfull to Professor and Head, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia for providing necessary facilities to carry out the present investigations. We also acknowledge M/s Krishi Rasayan Exports Private Limited, New Delhi for providing the facilities and sample of the insecticides for the experiments.

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