

Original Research Article

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Evaluation of New Insecticide Molecules for the Management of Early Shoot Borer (*Chilo infuscatellus* (Snellen) on Sugarcane

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ABSTRACT

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An experiment was conducted for two successive years during 2013-14 and 2014-15 at Agricultural Research Station, Bidar and Kalburgi, to assess the chemical control of sugarcane early shoot borer (*Chilo infuscatellus* (Snellen)). Nine insecticides namely, Chlorantraniliprole 0.4 GR, Fipronil 0.3 GR, Cartaphydrochloride 4G, Chlorantraniliprole 18.5 SC, Fipronil 5 SC, Flubendiamide 480 SC, Emamectin benzoate 0.5 SG, Chlorpyrifos 20 EC and compared with untreated control using randomized block design with three replications. Significant differences were noticed among the treatments. Among the different insecticides evaluated, Chlorantraniliprole 18.5 SC and Chlorantraniliprole 0.4 GR, were proved superior by recording lowest per cent incidence of early shoot borer and highest cane yield.

Introduction

Sugarcane (*Saccharum officinarum* L.) is one of the most important cash and industrial crop in India. Among sugarcane growing countries in the world, India ranks first in the world in the area under sugarcane cultivation and ranks fifth in the world in terms of sugar production. In India, sugarcane occupies an area of 5.01 m ha and produces 338.96 m tonnes of cane with an average productivity of 66.99 tones ha. About 35 million farmers in the country depend on the sugarcane for their live hood. Sugarcane yield is markedly influenced by many factors like soil fertility, climate, variety, and cultural practices, prevalence of pests and diseases and

environmental stress. Regardless of pronounced development in sugarcane research and expansion in sugar industry, our national average cane yield is 70.3 tons per hectare, whereas the potential between 100-120t/ha.

One of the major constraints in maintaining sustainability is losses due to insect pests, as sugarcane is known to be attacked by as many as 212 insect pests and 76 non insect pests in India right from germination to harvest. Among them, borers are the major destructive pests which cause 8 to 10 percent cane yield losses at farmer's level and 10 to 15 percent sugar recovery losses in sugar industries. Among the pest, Gupta (1993) reported more

than 45 per cent of yield losses in sugarcane are due to infestation by borer pests alone. Among them, the early stem borer *Chilo infuscatellus* is the most notorious and destructive one. The early shoot borer damages cane crop mainly at formative phase. The young larvae bore down the spindles as also upwards destroying the apical meristem. Consequently the cut of spindle dries up and develops into a conspicuous "dead heart" that can be pulled out easily and emit a rancid odour. The killing of mother shoots and tillers are resulted in to gap. The shoot Borer, *Chilo infuscatellus* (Snellan) cause economic losses (Avasthy and Tiwari, 1986) from 22-23 per cent in yield, 12 per cent in sugar recovery and 27 per cent in Jaggary. The damage by *Chilo infuscatellus* ranges from 30 -75 per cent in early stages of the crop (May- June) in subtropical India (Krishnamurthy Rao, 1954). The neglected crop therefore, may suffer heavy losses in tonnage due to this borer species. Keeping in view the economics, importance of the pest and the crop, field studies were carried out to find out the insecticides for management of early shoot borer in sugarcane.

Materials and Methods

A field experiment was conducted for two successive years during 2014 and 2015 rabi-summer at two locations, Agricultural Research Station, Bidar and Kalburgi, to assess the chemical control of sugarcane early shoot borer (*Chilo infuscatellus* (Snellen)). The experiment was laid out in Randomized block design with ten treatments replicated thrice. The Sugarcane Var, Co 86032 was sown at cm 90×30cm spacing with plot size of 7.5 x 4 mts. and all the recommended package of practices were followed to raise the crop, except plants protection measures. First spray and soil application of insecticides was done at initiation of pest infestation in all the experimental plots. The spraying of

insecticides was carried out during morning hours by hand operated knapsack sprayer and granular insecticides were applied in the soil.

Observations on incidence of early shoot borer, *Chilo infuscatellus* or per cent dead heart was recorded at one day before spray or soil application and 7, 15 and 30 days after each spray or soil application on randomly selected 10 plants /plot. The data was transformed to arcsine values and subjected for Statistical analysis. The cane yield was recorded plot wise at the time of harvest and converted to hectare basis and subjected for statistical analysis.

Results and Discussion

The results of the experiment carried out at Agricultural Research Station, Bidar for two consecutive years 2013-14 and 2014-15 is pooled and presented in the table 1. The results of the experiment reveals that, the incidence of early shoot borer ranged from 18.83 to 20.74 per cent early shoot borer damage. Further it was observed that, there was no significant difference with respect to the per cent early shoot borer damage at one day before spraying (DBS), indicating the uniform infestation throughout experimental field.

Among all the treatments, at 15 Days After Spraying (DAS) Chlorantraniliprole 18.5 SC @ 150 ml/ac and Chlorantraniliprole 0.4 GR @ 8 kg/ac found to be significantly superior compared to all other treatments and recorded 4.02 and 4.30 per cent dead hearts respectively. These two treatments were followed by Fipronil 0.3 GR @ 8kg/ac and Cartaphydrochloride 4G @ 5kg/ac which are next in the order of efficacy with 6.22 and 6.47 per cent dead hearts respectively with no significant difference among them. The next best treatments in order of their efficacy were Chlorantraniliprole 18.5 SC @ 60 ml/ac,

Fipronil 5 SC @ 2ml/lit, Flubendiamide 480 SC @ 0.075 ml/lit, Emamectin benzoate 0.5 SG @ 0.2g/lit, and Chlorpyrifos 20 EC @ 2 ml/lit with 9.54, 9.65, 13.13, 13.20 and 14.92 per cent dead hearts respectively. The dead hearts percentage was significantly low in all the insecticidal treatments as compare to untreated control which recorded 23.98 per cent dead hearts, when observations were recorded at 15 DAS.

The data on early shoot borer incidence recorded at 30 DAS showed the same trend in their efficacy in managing the incidence of early shoot borer.

The early shoot borer incidence recorded at forty five days after treatment showed the lowest early shoot borer incidence in the plots treated with Chlorantraniliprole 18.5 SC @ 150 ml/ac and Chlorantraniliprole 0.4 GR @ 8 kg/ac and were found consistently to be the most promising treatment by recording significantly lowest 1.26 and 1.39 per cent dead hearts respectively. The treatment with Cartaphydrochloride 4G @5kg/ac and Fipronil 0.3 GR @ 8kg/ac are the next in the order of efficacy with 3.99 and 4.11 per cent dead hearts respectively with no significant difference among them. The next best treatments in the order of their efficacy were Chlorantraniliprole 18.5 SC @ 60 ml/ac, Fipronil 5 SC @ 2ml/lit, Emamectin benzoate 0.5 SG @ 0.2g/lit, Flubendiamide 480 SC @ 0.075 ml/lit and Chlorpyrifos 20 EC @ 2 ml/lit with 7.04, 7.40, 11.87, 12.16 and 15.41 percent dead hearts respectively. However, untreated control plot recorded the highest per cent dead heart of 29.85 per cent.

Yield

The significantly highest cane yield was recorded in Chlorantraniliprole 0.4 GR @ 8 kg/ac and Chlorantraniliprole 18.5 SC @ 150 ml/ac with 92.47 tonns/ha and 92.10 tonns/ha

respectively. The next best treatments were Fipronil 0.3 GR @ 8kg/ac and Cartaphydrochloride 4G @5kg/ac which recorded 84.24 and 83.05 tonns/ha cane yield respectively. These two treatments were followed by Chlorantraniliprole 18.5 SC @ 60 ml/ac, Fipronil 5 SC @ 2ml/lit, Emamectin benzoate 0.5 SG @ 0.2g/lit, Flubendiamide 480 SC @ 0.075 ml/lit and Chlorpyrifos 20 EC @ 2 ml/lit with the cane yield of 74.84, 74.54, 69.87, 67.47 and 67.07 tonns/ha respectively (Table 1). However, untreated control plot recorded the lowest yield of 61.88 tonns/ha.

B: C ratio

Chlorantraniliprole 0.4 GR @ 8 kg/ac and Chlorantraniliprole 18.5 SC @ 150 ml/ac recorded highest B:C ratio of 3.70 and 3.63 respectively (Table 2). The next best treatments were and Cartaphydrochloride 4G @5kg/ac and Fipronil 0.3 GR @ 8kg/ac which recorded B: C ratio of 3.48 and 3.47 respectively. These two treatments were followed by Fipronil 5 SC @ 2ml/lit, Chlorantraniliprole 18.5 SC @ 60 ml/ac, Emamectin benzoate 0.5 SG @ 0.2g/lit, Chlorpyrifos 20 EC @ 2 ml/lit and Flubendiamide 480 SC @ 0.075 ml/lit with 3.02, 2.97, 2.73, 2.65 and 2.61 B: C ratio respectively. However, untreated control plot recorded the lowest B: C ratio of 2.45.

ARS, Kalburgi

The results of the experiments conducted at farmers field near ARS, Kalburgi is presented in the table 2. The incidence of early shoot borer during 2013-14 and 2014-15 ranged from 21.75 to 24.15 per cent. Further it was observed that, there was no significant difference with respect to the per cent early shoot borer damage at one day before spraying (DBS), indicating the uniform infestation throughout experimental field.

Table.1 Evaluation of new molecules against Early Shoot borer on Sugarcane of 2013-14 and 2014-15 at ARS, Bidar (Pooled)

Sl. No.	Treatments	Early shoot borer incidence (% deadheat)				Yield (t/ha)
		1DBS	15 DAS	30 DAS	45 DAS	
1	Chlorantraniliprole 0.4 GR (8 Kg/ac)	19.06 (25.84)	4.30 (11.90)	1.10 (5.96)	1.39 (6.73)	92.47
2	Fipronil 0.3 GR (8 Kg/ac)	19.12 (25.90)	6.22 (14.29)	3.17 (10.15)	4.11 (11.65)	84.24
3	Cartap hydrochloride 4G (5 Kg/ac)	19.80 (26.35)	6.47 (14.66)	4.00 (11.49)	3.99 (11.46)	83.05
4	Chlorantraniliprole 18.5%SC (60 ml/ac)	18.83 (25.68)	9.54 (17.95)	7.91 (16.29)	7.04 (15.35)	74.84
5	Fipronil 5SC (2 ml/lt)	20.74 (27.03)	9.65 (17.89)	8.07 (16.43)	7.40 (15.74)	74.54
6	Chlorantraniliprole 18.5%SC (150 ml/ac)	20.41 (26.79)	4.02 (11.53)	1.09 (5.97)	1.26 (6.42)	92.10
7	Flubendiamide 480 SC (0.075 ml/lt)	19.79 (26.35)	13.13 (21.10)	10.09 (18.49)	11.87 (19.95)	67.47
8	Chlorpyriphos 20 EC (2 ml/lt)	19.90 (26.46)	14.92 (22.68)	12.08 (20.30)	15.41 (23.05)	67.07
9	Emamectin benzoate 0.5 SG (0.2g/lt)	20.21 (26.65)	13.20 (21.21)	9.70 (18.10)	12.16 (20.35)	69.87
10	Untreated check	20.40 (26.77)	23.98 (29.29)	27.35 (31.48)	29.85 (32.82)	61.88
	SEm±	1.27	1.26	1.54	0.70	1.15
	CD (0.05)	3.77	3.74	1.54	2.08	3.43

Values are mean of three replications; Figures in the parenthesis are arc sin transferred value.

Table.2 Cost economics of different molecules tested against Early Shoot borer on Sugarcane (ARS, Bidar)

Sl. No.	Treatments	Yield t/ha	Common cost of cultivation	Treatment cost	Total cost	Gross return	Net return	Treatment benefit Rs.	B:C ratio
1	Chlorantraniliprole 0.4 GR (8 Kg/ac)	92.47	43000	4200	47200	221928	174728	69216	3.70
2	Fipronil 0.3 GR (8 Kg/ac)	84.24	43000	2200	45200	202164	156964	51452	3.47
3	Cartap hydrochloride 4G (5 Kg/ac)	83.05	43000	1450	44450	199308	154858	49346	3.48
4	Chlorantraniliprole 18.5%SC (60 ml/ac)	74.84	43000	2300	45300	179616	134316	28804	2.97
5	Fipronil 5SC (2 ml/lt)	74.54	43000	1500	44500	178884	134384	28872	3.02
6	Chlorantraniliprole 18.5%SC (150 ml/ac)	92.10	43000	4700	47700	221028	173328	67816	3.63
7	Flubendiamide 480 SC (0.075 ml/lt)	67.47	43000	1850	44850	161916	117066	11554	2.61
8	Chlorpyriphos 20 EC (2 ml/lt)	67.07	43000	1100	44100	160968	116868	11356	2.65
9	Emamectin benzoate 0.5 SG (0.2g/lt)	69.87	43000	1900	44900	167688	122788	17276	2.73
10	Untreated check	61.88	43000	0	43000	148512	105512	0	2.45

Table.3 Evaluation of new molecules against Early Shoot borer on Sugarcane (2013-14 and 2014-15) at ARS, Kalburgi (Pooled)

Sl. No.	Treatments	Early shoot borer incidence (% Dead heart)				Yield (t/ha)
		1DBS	15 DAS	30 DAS	45 DAS	
1	Chlorantraniliprole 0.4 GR (8 Kg/ac)	23.90 (29.27)	5.05 (12.99)	1.24 (6.38)	1.56 (7.17)	94.89 a
2	Fipronil 0.3 GR (8 Kg/ac)	24.00 (29.33)	7.53 (15.92)	3.85 (11.32)	4.95 (12.86)	87.75 b
3	Cartap hydrochloride 4G (5 Kg/ac)	24.15 (29.43)	7.85 (16.27)	4.95 (12.86)	5.39 (13.42)	86.95 b
4	Chlorantraniliprole 18.5%SC (60 ml/ac)	22.78 (28.51)	11.23 (19.58)	9.68 (18.12)	8.70 (17.15)	79.55 c
5	Fipronil 5SC (2 ml/lt)	23.90 (29.27)	10.91 (19.29)	8.86 (17.31)	7.80 (16.22)	79.79 c
6	Chlorantraniliprole 18.5%SC (150 ml/ac)	23.40 (28.93)	5.33 (13.34)	1.28 (6.48)	1.38 (6.73)	95.61 a
7	Flubendiamide 480 SC (0.075 ml/lt)	23.03 (28.68)	14.93 (22.73)	11.28 (19.62)	13.68 (21.70)	76.23 d
8	Chlorpyriphos 20 EC (2 ml/lt)	22.90 (28.59)	17.33 (24.60)	13.85 (21.85)	18.25 (25.29)	74.84 d
9	Emamectin benzoate 0.5 SG (0.2g/lt)	23.48 (28.98)	15.33 (23.05)	11.32 (19.66)	14.20 (22.14)	75.08 d
10	Untreated check	21.75 (27.80)	23.86 (29.24)	28.05 (31.98)	31.35 (34.05)	69.01 e
SEm±		0.81	0.53	0.59	0.57	0.98
CD (0.05)		NS	1.58	1.78	1.70	3.01

Values are mean of three replications; Figures in the parenthesis are arc sin transferred value.

Table.4 Cost economics of different molecules tested against Early Shoot borer on Sugarcane (ARS, Kalburgi)

Sl. No.	Treatments	Yield t/ha	Common cost of cultivation	Treatment cost	Total cost	Gross return	Net return	Treatment benefit Rs.	B:C ratio
1	Chlorantraniliprole 0.4 GR (8 Kg/ac)	94.89	43000	4200	47200	227724	180524	57912	3.82
2	Fipronil 0.3 GR (8 Kg/ac)	87.75	43000	2200	45200	210600	165400	42788	3.66
3	Cartap hydrochloride 4G (5 Kg/ac)	86.95	43000	1450	44450	208668	164218	41606	3.69
4	Chlorantraniliprole 18.5%SC (60 ml/ac)	79.55	43000	2300	45300	190920	145620	23008	3.21
5	Fipronil 5SC (2 ml/lt)	79.79	43000	1500	44500	191484	146984	24372	3.30
6	Chlorantraniliprole 18.5%SC (150 ml/ac)	95.61	43000	4700	47700	229464	181764	59152	3.81
7	Flubendiamide 480 SC (0.075 ml/lt)	76.23	43000	1850	44850	182940	138090	15478	3.08
8	Chlorpyrifos 20 EC (2 ml/lt)	74.84	43000	1100	44100	179616	135516	12904	3.07
9	Emamectin benzoate 0.5 SG (0.2g/lt)	75.08	43000	1900	44900	180180	135280	12668	3.01
10	Untreated check	69.01	43000	0	43000	165612	122612	0	2.85

Among all the treatments, at 15 Days After Spraying (DAS) Chlorantriliniprole 0.4 GR @ 8 kg/ac and Chlorantriliniprole 18.5 SC @ 150 ml/ac were found to be significantly superior over all other treatment and recorded 5.05 and 5.33 per cent dead hearts respectively. The treatment with Fipronil 0.3 GR @ 8kg/ac and Cartaphydrochloride 4G @5kg/ac was next in order of efficacy with 7.53 and 7.85 per cent dead hearts respectively with no significant difference among them. The next best treatments in order of their efficacy were Fipronil 5 SC @ 2ml/lt, Chlorantriliniprole 18.5 SC @ 60 ml/ac, Flubendiamide 480 SC @ 0.075 ml/lt, Emamectin benzoate 0.5 SG @ 0.2g/lt, and Chlorpyriphos 20 EC @ 2 ml/lt with 10.91, 11.23, 14.93, 15.33 and 17.33 per cent dead hearts respectively. The dead hearts percentage was significantly low in all the insecticidal treatments as compared to untreated control when observations recorded at 15 DAS with 23.86 per cent. The data on per cent dead hearts recorded at 30 DAS followed the same trend as that of 15 DAS.

The early shoot borer incidence recorded at forty five days after treatment showed the lowest early shoot borer incidence in the plots treated with Chlorantriliniprole 18.5 SC @ 150 ml/ac and Chlorantriliniprole 0.4 GR @ 8 kg/ac and were found consistently to be the most promising treatment by recording significantly lowest 1.38 and 1.56 per cent dead hearts respectively.

The treatment with Fipronil 0.3 GR @ 8kg/ac and Cartaphydrochloride 4G @ 5kg/ac are the next in the order of efficacy with 4.95 and 5.39 per cent dead hearts respectively with no significant difference among them. The next best treatments in the order of their efficacy were Fipronil 5 SC @ 2ml/lt, Chlorantriliniprole 18.5 SC @ 60 ml/ac, Flubendiamide 480 SC @ 0.075 ml/lt, Emamectin benzoate 0.5 SG @ 0.2g/lt, and

Chlorpyriphos 20 EC @ 2 ml/lt with 7.80, 8.70, 13.68, 14.20 and 18.25 per cent dead hearts respectively. However, untreated control plot recorded the highest per cent dead heart of 31.35 per cent.

Yield

The significantly highest cane yield was recorded in Chlorantriliniprole 18.5 SC @ 150 ml/ac and Chlorantriliniprole 0.4 GR @ 8 kg/ac with 95.61 tonns/ha and 94.89 tonns/ha respectively. The next best treatments were Fipronil 0.3 GR @ 8kg/ac and Cartaphydrochloride 4G @5kg/ac which recorded 87.75 and 86.95 tonns/ha cane yield respectively.

These two treatments were followed by Fipronil 5 SC @ 2ml/lt, Chlorantriliniprole 18.5 SC @ 60 ml/ac, Flubendiamide 480 SC @ 0.075 ml/lt Emamectin benzoate 0.5 SG @ 0.2g/lt, and Chlorpyriphos 20 EC @ 2 ml/lt with the cane yield of 79.79, 79.55, 76.23, 75.08 and 74.84 tonns/ha respectively (Table 3). However, untreated control plot recorded the lowest yield of 69.01 tonns/ha.

B: C ratio

Chlorantriliniprole 0.4 GR @ 8 kg/ac and Chlorantriliniprole 18.5 SC @ 150 ml/ac recorded highest B:C ratio of 3.82 and 3.81 respectively (Table 3). The next best treatments were and Cartaphydrochloride 4G @5kg/ac and Fipronil 0.3 GR @ 8kg/ac which recorded B: C ratio of 3.69 and 3.66 respectively. These two treatments were followed by Fipronil 5 SC @ 2ml/lt, Chlorantriliniprole 18.5 SC @ 60 ml/ac, Flubendiamide 480 SC @ 0.075 ml/lt Chlorpyriphos 20 EC @ 2 ml/lt and Emamectin benzoate 0.5 SG @ 0.2g/lt, with 3.30, 3.21, 3.08, 3.07 and 3.01 B:C ratio respectively. However, untreated control plot recorded the lowest B: C ratio of 2.85.

The results of the present study reveals that the incidence of Early Shoot Borer per cent was more during 2014-15 compared to 2013-14 and also it was also observed that yield levels were low during 2013-14 compared to 2014-15. Further, no Phytotoxicity symptoms were noticed on the crop after imposing the treatments.

Looking in to the results of two seasons and two location data, Chlorantriliniprole 18.5 SC @ 150 ml/ac can be very effectively used for managing the Early Shoot Borer in sugarcane as they have recorded lowest percent incidence of early shoot borer and highest cane yield. The present findings are in accordance with Bhawar *et al.*, 2016 who reported that, Rynoxpyr 20 SC was very effective and significantly superior over all other treatments in reducing the dead hearts to minimum level of 3.13 per cent. Sheeba Jasmine *et al.*, (2012) and Gaje Singh *et al.*, (2009) also postulated that rynaxpyr was most effective treatment recording the lowest incidence of sugarcane early shoot borer (15.43%). The present findings are in accordance with the results of Padmasri *et al.*, 2014 as they have reported that, Chlorantriliniprole 18.5 SC @0.36 ml/l of water recorded the lowest per cent (11.07) early shoot borer incidence. The present findings are also in agreement with the observations of Singh *et al.*, (2009) reported Rynaxpyr 20 Sc @100 g.a.i/ha was found to be the best with minimum of 0.12 per cent infestation by early shoot borer and gave maximum yield of 77.13 t/ha. Jaipal *et al.*, (2010) recorded similar observations and reported that the mean incidence of shoot borer was lowered by 60 per cent due to Rynaxpyr 20 SC treatment given as root drench and registered significantly increased cane yield over the untreated control as well as the standard recommended insecticides Carbofuran. Pandey, 2014 reported that Chlorantriliniprole 20 SC was most effective

as it exhibited least dead hearts of 2.85% with the decrease of 83.43 % in the incidence over control.

Further Chlorantriliniprole 0.4 GR @ 8 kg/ac also found effective and on par with the Chlorantriliniprole 18.5 SC @ 150 ml/ac in managing the early shoot borer damage. These results are in line with Umashankar *et al.*, 2018 reported that the treatment with Chlorantriliniprole 0.4G @ 0.09 g a.i. /ha recorded lowest cumulative incidence (2.79 %) and highest per cent reduction over the control (85.78 %). Bhawar *et al.*, 2015 also reported that the treatment with Fertera 0.4 G @ 30 g ai/ha was found effective by recording 3.64 per cent dead heart.

The next best treatments were Fipronil 0.3 GR @ 8kg/ac and Cartaphydrochloride 4G @5kg/ac which recorded lowest per cent dead hearts without any significant difference among them. These findings are in accordance with Bhawar *et al.*, 2015, who found that Fipronil 0.3 G @ 7.5 g a.i/ha recorded 5.25 per cent dead hearts and found on par with Cartaphydrochloride 4G @ 750 g a. i./ha recording 5.44 per cent dead hearts and. Bhawar *et al.*, (2016) who also reported that Flubendiamide 39.35SC and Cartap hydrochloride 4G were most effective in reducing the ESB attack.

Among all the treatments, Chlorantriliniprole 0.4 GR @ 8 kg/ac or Chlorantriliniprole 18.5 SC @ 150 ml/ac can be very effectively used for managing the Early Shoot Borer in sugarcane.

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