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Bioefficacy of Spinetoram 6% + Methoxyfenozide 30% SC against Early shoot borer, *Chilo infuscatellus* Snellen and internode borer, *Chilo sacchariphagus* indicus (Kapur) in sugarcane

M. Shobharani*, Arunkumar Hosamani, Sidramappa and N. M. Sunilkumar

Agricultural Research Station, Bidar, University of Agricultural Sciences, Raichur, Karnataka, India
**Corresponding author*

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A B S T R A C T

A field experiment was conducted to test the efficacy of different doses Spinetoram 6% + Methoxyfenozide 30% SC against early shoot borer (ESB), *Chilo infuscatellus* and Internode borer, *Chilo sacchariphagus indicus* in sugarcane at Agricultural Research Station, Bidar, during 2017-18 and 2018-19 Summer. The different doses of Spinetoram 6% w/v + Methoxyfenozide 30% SC ranged from 140, 150 and 160 ml/ha, Methoxyfenozide 24% SC @ 187.5 ml/ac, Spinetoram 12% SC @ 75 ml/ac, Fipronil 5% SC @ 800 ml/ac and Chlorantraniliprole 0.4 % GR @ 7500 g/ac were tested for their efficacy against early shoot borer and internode borer incidence. Among all the treatments Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac and 150 ml/ac were found to be very effective in managing the early shoot borer incidence and inter node borer incidence and recorded 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 with respect to the area under sugarcane cultivation and ranks fifth in the world with respect to sugar production. The production and productivity of the sugarcane is affected by many factors *viz*, soil type, selections of variety, fertilizer management, irrigation management and prevalence of pests and diseases. Among them, insect pests are the major constraints 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. Compared to all other pests, borers are the major destructive pest which causes more than 45 per cent of yield losses in sugarcane (Gupta *et al*., 1993). Among the borers, early shoot borer, *Chilo*

infuscatellus (Snellan) (Pyralidae; Lepidoptera) cause economic losses (Avasthy and Tiwari, 1986) from 22-23 per cent in yield, 12 per cent in sugar recovery and27 per cent in Jaggary. The pest is mainly injuries to young cane up to 8 weeks after planting. The caterpillars after hatch out from eggs get scattered and enter into the young shoots by making the holes just above ground levels and tunnels downwards. The central shoot dries up causing „dead hearts". It is a characteristic sign of the presence of the pest within the plants. The dead heart can be easily pulled out of the central shoot, roots inside the stem and emits an offensive smell of being pulled out (Patil and Hapse, 1981). Further infestation and subsequent damage due to internode borer, *Chilo sacchariphagus indicus* results both in yield loss and factory loss (David and Ananthanarayana, 1963). Keeping in view the economics, importance of the pests and the crop, field studies were carried out to determine the effective dose of Spinetoram 6% + Methoxyfenozide 30% SC for the management of early shoot borer and internode borer of sugarcane at ARS, Bidar.

Materials and Methods

A field experiment was conducted to test the efficacy of different doses Spinetoram 6% w/v (5.66%w/w) + Methoxyfenozide 30% w/v (28.3%w/w) SC against lepidopteran insect pests infesting Sugarcane. The experiment was carried out at Agricultural Research Station Bidar for two consecutive years (2017 and 2018) during summer season. The experiment was laid out in Randomized block design with eight treatments replicated thrice. The plot size was 6 x 6 mts. Sugarcane Var, Co-6027 was sown at 90×30cm spacing and all the recommended package of practices was followed to raise the crop, except plants protection measures. First spray was done at initiation of pest infestation in all the experimental plots and second spray was given 30 days after first spray.

Observations on number of dead hearts caused by early shoot borer (*Chilo infuscatellus*) out of the total number of tillers observed in all the entries at one day before treatment imposition and 7, 15 and 30 days after imposition of treatment on randomly selected 10 plants /plot. After each count, the dead hearts were pulled out to avoid counting them later on. The data was transformed to arcsine values and subjected for Statistical analysis.

Observations on the incidence of inter node borer, *Chilo sachariphagus indicus* was recorded at the time of harvest in 25 randomly selected canes in each plot by counting number of internodes and damaged internodes per cane. Then it was converted into percentage damage of internodes per plot. The data was transformed to arcsine values and subjected for Statistical analysis.

Pest incidence and pest intensity were calculated using following formulae:

1. Percent ESB incidence:

$$\frac{\text{No. of dead hearts per hill}}{\text{Total No. of tillers per hill}} \times 100$$

2. Per cent internode borer incidence:

$$\frac{\text{Affected canes}}{\text{Total canes}} \times 100$$

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 efficacy of different doses of Spinetoram 6% w/v + Methoxyfenozide 30% SC in comparison with other insecticides for the management of early shoot borer, *Chilo infuscatellus* Snellen and internode borer *Chilo sacchariphagus indicus* of sugarcane has been pooled (2017 and 2018) and presented in table 1.

The pooled data presented in the table 1. reveal that the incidence of early shoot borer ranged from 18.26 to 18.99 per cent and there was no significant differences with respect to the per cent early shoot borer incidence at one day before spraying (DBS). However, at 7 Days after imposing the treatments, The lowest per cent early shoot borer damage of 1.84 per cent was recorded in Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac and was found on par with Spinetoram 6% + Methoxyfenozide 30% SC @ 150 ml/ac with 2.67 per cent early shoot borer incidence. These two treatments were followed by Methoxyfenozide 24% SC @ 187.5 ml/ac, Chlorantraniliprole 0.4 % GR @ 7500 g/ac, with 2.72 and 2.80 per cent shoot borer incidence respectively. The Spinetoram 6% + Methoxyfenozide 30% SC at different doses was found superior compared to untreated check. However, untreated control recorded highest per cent early shoot borer incidence of 9.91 per cent.

At Fifteen and thirty days after spraying, same trend was followed with respect to the early shoot borer incidence as that of seven days after imposing the treatment.

Incidence of Inter node Borer

The lowest per cent inter node borer incidence of 11.34 per cent was recorded in Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac and this treatment was followed by Spinetoram 6% + Methoxyfenozide 30% SC @ 150 ml/ac and Methoxyfenozide 24% SC @ 187.5 ml/ac with 14.00 and 15.34 per cent inter node borer incidence respectively. These two treatments were followed by Chlorantraniliprole 0.4 % GR @ 7500 g/ac and Spinetoram12% SC @ 75 ml/ac with17.33 and 17.33 per cent incidence of inter node borer respectively. Spinetoram 6% + Methoxyfenozide 30% SC @ 140 ml/ac, Fipronil 5% SC @ 800 ml/ac recorded 17.67 per cent, 18.50 per cent inter node borer incidence, respectively. The Spinetoram 6% + Methoxyfenozide 30% SC at different doses was found superior compared to untreated check (22.00 per cent) (Table 1).

The activity of the natural enemies was reduced in the treated plots compared to the untreated control

There was no record of any phytotoxic symptoms (leaf injury on tips and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty) on the sugarcane plants treated with various dosages of Spinetoram 6% + Methoxyfenozide 30% SC (Table3) at 1, 3, 7, 15, and 30 days after imposing treatments.

Yield

The highest cane yield was recorded in Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac with 86.53 tonns/ha and was followed by Spinetoram 6% + Methoxyfenozide 30% SC @ 150 ml/ac and Methoxyfenozide 24% SC @ 187.5ml/ac with 82.46 t/ha and 81.36 t/ha respectively. These two treatments were followed by Chlorantraniliprole 0.4 % GR @ 7500 g/ac with 80.79 t/ha. Spinetoram12% SC @ 75 ml/ac, Fipronil 5% SC @ 800 ml/ac and Spinetoram 6% + Methoxyfenozide 30% SC @ 140 ml/ac recorded 75.28 t/ha, 74.73 t/ha and 74.75 t/ha respectively. The Spinetoram 6% + Methoxyfenozide 30% SC at different doses was found superior compared to untreated check (Table 1). Untreated control recorded lowest cane yield of 53.40 t/ha.

The incidence of early shoot borer was highest during 2017 compared to 2018 which ranged from 19.29 to 20.38 per cent and 16.78 to 17.78 per cent respectively and sugarcane yields were highest during 2017 compared to 2018. During both the seasons, Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac and 150 ml/ac recorded lowest per cent early shoot borer and internode borer incidence and recorded highest cane yield. Hence

Spinetoram 6% + Methoxyfenozide 30% SC can be effectively used for the management of early shoot borer and internode borer.

There is no reviews regarding the management of early shoot borer and internode borer using Spinetoram 6% + Methoxyfenozide 30% SC in sugarcane, but there are reports on individual products in different crops.

During the study, Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac and 150 ml/ac were found to be very effective in managing the early shoot borer incidence and inter node borer incidence and recorded highest cane yield. These results are in accordance with Shobharani *et al*., (2019) who reported that, Methoxyfenozide 24% SC @ 625 ml/ha and Methoxyfenozide 24% SC @ 500ml/ha recorded highest percent reduction of shoot borer incidence at thirty days after imposing the treatment and highest cane yield respectively, under the field condition. Further, Methoxyfenozide is considered highly effective for lepidopteran pest with no harm to other orders of arthropods and natural enemies (Dhadialla *et al*., 1998; Smagghe and Degheele, 1998). There are reports that, Methoxyfenozide (ecdyson receptor agonist) significantly reduced the spotted bollworm population and bolls infestation. The possible reason might be due to their effect on insect blood cells like other reported insecticides to affect the blood cells in different insects (Iqbal *et al*., 2002; Zibaee *et al*., 2012). Pavviya and Muthukrishnan (2017) reported that there was a significant least incidence of *Aproaerema modicella* was noticed in methoxyfenozide treated plots with higher pod yields of groundnut.

Methoxyfenozide is a second generation moult accelerating compound, similar to tebufenozide in its mode of action (Carlson *et al*., 2001). Methoxyfenozide is five to ten fold more potent than tebufenozide (*Ishaaya* et al., 1995), due to its better binding with lepidopteran receptors and have longer residual efficacy as compared to tebufenozide. It has much lower ability to bind with receptors in non lepidopteran species, making it a highly selective insecticide. Methoxyfenozide is considered highly selective for lepidopteran pest with no harm to other orders of arthropods and natural enemies make them fit well into IPM and IRM programs (Dhadialla *et al*., 1998; Smagghe and Degheele, 1998).

The other combination product, Spinetoram is a second generation insecticide of the spinosyn class, derived from fermentation of *Saccharopolyspora spinosa*, but fermentation is followed by chemical modification to create this unique active ingredient (Sparks *et al*., 2007; Lewer *et al*., 2007). It affects nicotinic acetylecholine receptors and γ-aminobutyric acid (GABA) receptors existing on postsynaptic membranes in insect nervous systems, thereby causing abnormal neural transmission. Sunilkumar *et al*., 2012, reported that, Spinetoram 12% SC @ 60 g *a.i* /ha was highly effective in checking the larval population of *Spodoptera litura* and also in giving highest yield of soybean. Sanjeevi Kumar and Muthukrishnan (2017) reported that, Spinetoram 12 SC@ 45 g alone and in combination with quinalphos 25 EC 350 g a.i./ha, carbendazim 50 WP 125 g a.i./ha and urea (2%) were significantly effective in minimizing the *L. boeticus* when sprayed thrice at 15 days interval and increases the grain yield.

The third best treatment, Methoxyfenozide 24% SC @187.5 ml/ac was also found effective in managing the borer pests infesting sugarcane. These results are in accordance with Shobharani *et al*., (2019) who reported that, Methoxyfenozide 24% SC @ 625 ml/ha and 500ml/ha recorded highest percent reduction of shoot borer incidence at thirty days after imposing the treatment and highest cane yield respectively, under the field condition.

Table.1 Bioefficacy of Spinetoram 6% + Methoxyfenozide 30% SC against Early shoot borer, Chilo infuscatellus Snellen and internode borer, Chilo sacchariphagus indicus (Kapur) in sugarcane during 2017 and 2018 (Pooled data)

Sl. No.	Treatments	(ml or g/ac)	Early shoot borer incidence (% Dead heart)				Incidence of INB (%)	Yield (t/ha)
			1DBT	7DAT	15DAT	30DAT		
T1	Spinetoram 6% + Methoxyfenozide 30% SC	140	18.41 (25.38)	4.86 (12.71)	3.64 (10.97)	6.20 (14.40)	17.67 (24.84)	74.75ef
T2	Spinetoram 6% + Methoxyfenozide 30% SC	150	18.59 (25.52)	2.67 (9.40)	2.25 (8.60)	2.18 (8.46)	14.00 (21.83)	82.46b
T3	Spinetoram 6% + Methoxyfenozide 30% SC	160	18.39 (25.38)	1.84 (7.79)	2.08 (8.28)	1.51 (7.02)	11.34 (19.67)	86.53a
T4	Spinetoram 12% SC	75	18.51 (25.45)	5.14 (13.06)	3.75 (11.14)	7.13 (15.46)	17.33 (24.59)	75.28e
T5	Methoxyfenozide 24% SC	187.5	18.84 (25.71)	2.72 (9.49)	2.63 (9.33)	2.76 (9.55)	15.34 (23.04)	81.36bc
T6	Fipronil 5% SC	800	18.99 (25.81)	5.62 (13.70)	4.51 (12.21)	9.54 (17.96)	18.50 (25.44)	74.73efg
T7	Chlorantraniliprole 0.4% GR	7500	18.45 (25.40)	2.80 (9.62)	2.70 (9.39)	2.88 (9.75)	17.33 (24.59)	80.79bcd
T8	UTC		18.26 (25.28)	9.91 (18.30)	8.21 (13.73)	10.42 (18.79)	22.00 (27.95)	53.40h
SEm±			-	0.54	0.47	0.42	0.81	1.12
CD(0.05)			NS	1.63	1.43	1.28	2.46	3.39

Values are mean of three replications: Figures in the parenthesis are arc sine transformed values:
DBT- Day before treatment imposition: DAT- Days After Treatment imposition, INB-Internode Borer Incidence

In the present study, Chlorantraniliprole 0.4 % GR @ 7500g/ac also proved effective in managing the sugarcane borers. These results are in line with shobharani *et al*., (2018) who reported that Chloranthriniliprole 0.4 GR @ 8 kg/ac also found effective and on par with the Chloranthriniliprole 18.5 SC @ 150 ml/ac in managing the early shoot borer damage. Further, Umashankar *et al*., (2018) reported that the treatment with Chlorantraniliprole 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*., (2016) 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.

Spinetoram 6% + Methoxyfenozide 30% SC @ 160 ml/ac and 150 ml/ac were found be very effective in controlling the early shoot borer incidence and internode borer incidence and recorded highest cane yield. Application of Spinetoram 6% + Methoxyfenozide 30% SC at different doses did not cause any phytotoxic effect on the sugarcane crop.

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