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Field evaluation of Methoxyfenozide 24% SC against early shoot borer, *Chilo infuscatellus* Snellen and Internode borer, *Chilo sacchariphagus indicus* (Kapur) in sugarcane

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Abstract
Field experiments were conducted to find out the efficacy of Methoxyfenozide 24% SC w/v (21.8% w/w) against early shoot borer (ESB), *Chilo infuscatellus* and Internode borer, *Chilo sacchariphagus indicus* in sugarcane at Agricultural Research Station, Bidar, during 2013-14 and 2014-15 Rabi-Summer. Methoxyfenozide 24% SC at different doses ranging from 375, 500 and 625 ml/ha was tested for their efficacy against early shoot borer and internode borer incidence. The results revealed 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.

Keywords: *Chilo infuscatellus*, *Chilo sacchariphagus indicus*, Methoxyfenozide 24% SC, sugarcane

1. Introduction
Sugarcane is one of the most important high value cash and industrial crop cultivated in India which is a major source of white sugar and gur. Sugarcane crop is currently facing severe crises in the country and both farming community and the industry are striving for its sustainable existence and growth. The major challenges faced by the crop are lower than average per area production, low sugar recovery and higher cost of production. The sugarcane crop yield is affected by large number of insect pests such as lepidopteran borers, termites, white grubs, scale insects, Pyrilla, whiteflies, mealybugs etc in India. Among them, early shoot borer, *Chilo infuscatellus* Snellen (Crambidae: Lepidoptera) 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. It destroys 26-65 per cent of mother shoots (Khan and Krishnamurthy Rao, 1959) and causes losses from 22 to 33 per cent in cane yield, 12 per cent in sugar recovery and 27 per cent in jiggery (Patil and Hapse, 1981) [8]. Infestation and subsequent damage by inter node borer *Chilo sacchariphagus indicus* is matter of concern. Among all the pests, Gupta (1993) reported more than 45 per cent of yield losses in sugarcane are due to infestation by borer pests alone. Keeping in view the economics, importance of the pest and the crop, field studies were carried out to determine the effective dose of Methoxyfenozide 24% SC for the management of early shoot borer and internode borer of sugarcane at Agricultural Research Station, Bidar.

2. Materials and methods
A field experiment was conducted to test the efficacy of the different doses of Methoxyfenozide 24% SC against lepidopteran insect pests infesting Sugarcane. The experiment was carried out at Agricultural Research Station Bidar during the year 2013-14 and 2014-15 Rabi- Summer. The experiment was laid out in Randomized block design with seven treatments replicated thrice [as detailed in table]. The plot size was 7.5x 4 mts. Sugarcane Var, Co-94012 was sown at cm 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.
Observations on incidence of early shoot borer, *Chilo infuscatellus* or per cent dead heart was recorded at one day before spray and 7, 10, 15 and 30 days after each spray on randomly selected 10 plants /plot. The data was transformed to arcsine values and subjected for Statistical analysis.

Observations on incidence of internode 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: $\frac{\text{Affected canes}}{\text{Total canes}} \times 100$
3. Per cent internode borer intensity: $\frac{\text{Affected nodes}}{\text{Total nodes}} \times 100$
4. Per cent internode borer infestation: $\frac{\text{Percent incidence X Per cent intensity}}{100}$

The cane yield was recorded plot wise at the time of harvest and converted to hectare basis and subjected for statistical analysis.

3. Results and Discussion

The efficacy of different doses of Methoxyfenozide 24% SC against early shoot borer, *Chilo infuscatellus* Snellen and internode borer *Chilo sacchariphagus indicus* of sugarcane has been presented in table 1 and 2.

During 2013-14, the incidence of early shoot borer ranged from 16.33 to 18.57 and there was no significant difference 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 1.80 per cent was recorded in Methoxyfenozide 24% SC @ 625 ml/ha and was found on par with Methoxyfenozide 24% SC @ 500ml/ha with 1.83 per cent shoot borer incidence. These two treatments were followed by Fipronil 5% SC@ 2000 ml/ha with 2.61 per cent shoot borer incidence. The Methoxyfenozide 24% SC at different doses was found superior compared to untreated check.

Ten days after imposing the treatments, The lowest per cent early shoot borer damage of 1.95 per cent was recorded in Methoxyfenozide 24% @ 625 ml/ha and was found on par with Methoxyfenozide 24% SC @ 500ml/ha with 1.98 per cent shoot borer incidence. These two treatments were followed by Fipronil 5% SC @ 2000 ml/ha with 2.80 per cent shoot borer incidence. The untreated check recorded highest per cent early shoot borer incidence.

Fifteen days after spraying, Methoxyfenozide 24% SC @ 625 ml/ha and Methoxyfenozide 24% SC @ 500ml/ha recorded lowest per cent early shoot borer incidence of 1.67 and 1.79 per cent respectively. The untreated check recorded highest per cent early shoot borer incidence.

At thirty days after imposing the treatments, the same trend was followed.

During 2014-15 (Table. 2) same trend was followed with respect to the early shoot borer incidence at 7, 10, 15 and 30 days after imposing the treatment (Table 2).

Methoxyfenozide 24% SC @ 625 ml/ha recorded highest per cent reduction of shoot borer incidence at thirty days after imposing the treatment (93.62) and was followed by Methoxyfenozide 24% SC @ 500ml/ha which recorded 93.49 per cent reduction of shoot borer incidence at thirty days after imposing the treatment. Methoxyfenozide 24% SC @ 375ml/ha (90 g ai/ha) recorded 74.59 per cent reduction of shoot borer incidence at thirty days after imposing the treatments and was followed by Fipronil 5% SC @ 2000 ml/ha with 72.99 per cent. The lowest percent reduction of shoot borer incidence at thirty days after imposing the treatments was recorded in, Chlorpyriphos 20% EC @ 1500 ml/ha (39.61 per cent) and Monocrotophos 36% SL@ 2250 ml/ac (28.60 per cent) (Table 1). During 2014-15 same trend was followed with respect to the per cent reduction of shoot borer incidence at 30 days after imposing the treatment (Table 2).

The lowest per cent internode borer incidence of 0.03 per cent was recorded in Methoxyfenozide 24% SC @ 625 ml/ha and Methoxyfenozide 24% SC @ 500ml/ha. These two treatments were followed by Methoxyfenozide 24% SC @ 375ml/ha with 0.28 per cent shoot borer incidence. Fipronil 5% SC@ 2000 ml/ha, Monocrotophos 36% SL@ 2250 ml/ac and Chlorpyriphos 20% EC @ 1500 ml/ha recorded 0.55 per cent, 1.18 per cent and 1.59 per cent internode borer incidence respectively. The Methoxyfenozide 24% SC at different doses was found superior compared to untreated check. During 2014-15 same trend was followed with respect the per cent internode borer incidence at the time of harvest (Table 2).

During 2013-14, the highest cane yield was recorded in Methoxyfenozide 24% SC SC @ 625 ml/ha (108.46 t/ha) and Methoxyfenozide 24% SC @ 500ml/ha (106.14 t /ha). The treatments Fipronil 5% SC @ 2000 ml/ha, Methoxyfenozide 24% SC @ 375ml/ha, Chlorpyriphos 20% EC @ 1500 ml/ha and Monocrotophos 36% SL @ 2250 ml/ac recorded the cane yield of 90.23 t/ha, 88.39 t/ha and 70.11 t/ha t/ha 68.21 t/ha respectively. Untreated control recorded lowest cane yield of 61.09 t/ha. During 2014-15 same trend was followed with respect to the sugarcane yield.

The incidence of early shoot borer was highest during 2014-15 compared to the 2013-14 which ranged from 19.26 to 23.29 and 16.33 to 18.57 respectively, whereas sugarcane yields were highest during 2013-14 compared to 2014-15. This may be due to favourable climatic conditions prevailed during 2013-14 rabi-summer. During both the seasons, Methoxyfenozide 24% SC @ 625 ml/ha and Methoxyfenozide 24% SC @ 500ml/ha recorded lowest per cent early shoot borer and internode borer incidence and recorded highest cane yield. Hence Methoxyfenozide 24% 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 Methoxyfenozide 24% SC, But there are reports that Methoxyfenozide is considered highly selective for lepidopteran pest with no harm to other orders of arthropods and natural enemies (Dhadialla *et al*., 1998; Smagghe and Degheele, 1998) [4]. Further 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) [6, 11]. Pavviya and Muthukrishnan (2017) [9] 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) [3]. Methoxyfenozide is five to tenfold

more potent than tebufenozide (Ishaaya *et al*., 1995) [5], 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. It controls lepidopteran larvae, but with more activity against bollworm and diamondback moth (Dhadialla *et al*., 1998; Smagghe and Degheele, 1998) [4]. Larvae die of dehydration and starvation. 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) [4].

It may be concluded from the present investigation that, Methoxyfenozide 24% SC @ 625 ml/ha and Methoxyfenozide 24% SC @ 500ml/ha can be recommended for the management of these early shoot borer and internode borer infesting the sugarcane.

Table 1: Bio-efficacy of Methoxyfenozide 24% SC against lepidopteron insect pests in Sugarcane during 2013-14

Sl. No.	Treatments	Early shoot borer incidence (% dead heart)						Intensity of internode borer (%)	Yield (t/ha)
		1DBS	7 DAS	10 DAS	15 DAS	30 DAS	Per cent reduction over control at 30 DAS		
1	Methoxyfenozide 24% SC @ 375 ml/ha	16.97 (24.32)	3.87 (11.33)	3.17 (10.20)	3.98 (11.48)	5.86 (13.98)	74.59	0.28 (3.03)	88.39
2	Methoxyfenozide 24% SC @ 500 ml/ha	18.57 (25.53)	1.83 (7.77)	1.98 (8.08)	1.79 (7.65)	1.50 (6.98)	93.49	0.03 (0.99)	106.14
3	Methoxyfenozide 24% SC @ 625 ml/ha	17.85 (24.98)	1.80 (7.7)	1.95 (7.88)	1.67 (7.33)	1.47 (6.89)	93.62	0.03 (0.99)	108.46
4	Fipronil 5% SC @ 2000 ml/ha	16.33 (23.83)	2.61 (9.26)	2.80 (9.60)	2.13 (8.35)	6.23 (14.42)	72.99	0.55 (4.25)	90.23
5	Monocrotophos 36% SL @ 2250 ml/ha	18.20 (25.25)	6.71 (14.99)	6.33 (14.54)	10.20 (18.58)	16.47 (23.93)	28.60	1.18 (6.23)	68.21
6	Chlorpyriphos 20% EC @ 1500 ml/ha	17.87 (25.00)	4.95 (12.82)	4.35 (11.97)	8.10 (16.51)	13.93 (21.88)	39.61	1.59 (7.24)	70.11
7	UTC	16.70 (24.12)	18.53 (25.49)	19.38 (26.10)	21.93 (27.93)	23.07 (28.70)	-	2.88 (9.77)	61.09
	CD (0.05)	0.48	0.51	0.61	0.56	0.51	-	0.18	1.11
	SEm±	NS	1.53	1.88	1.72	1.58	-	0.06	3.41

Table 2: Bio-efficacy of Methoxyfenozide 24% SC against lepidopteron insect pests in Sugarcane during 2014-15.

Sl. No.	Treatments	Early shoot borer incidence (% dead heart)						Intensity of internode borer (%)	Yield (t/ha)
		1 DBS	7 DAS	10 DAS	15 DAS	30 DAS	Per cent reduction over control at 30 DAS		
1	Methoxyfenozide 24% SC @ 375 ml/ha	23.29 (28.83)	5.31 (13.28)	4.40 (12.09)	5.37 (13.36)	7.94 (16.35)	69.79	0.23 (2.73)	64.18
2	Methoxyfenozide 24% SC @ 500 ml/ha	22.18 (28.09)	2.29 (8.56)	2.13 (8.21)	1.67 (7.42)	1.39 (6.77)	94.71	0.07 (1.52)	80.63
3	Methoxyfenozide 24% SC @ 625 ml/ha	21.90 (27.90)	2.23 (8.58)	1.97 (8.03)	1.58 (7.18)	1.23 (6.37)	95.32	0.04 (1.12)	82.02
4	Fipronil 5% SC @ 2000 ml/ac	23.13 (28.75)	4.21 (11.84)	4.41 (12.01)	4.53 (12.27)	8.22 (16.64)	68.73	0.58 (4.37)	66.14
5	Monocrotophos 36% SL @ 2250 ml/ha	19.26 (26.02)	7.59 (15.98)	7.15 (15.45)	13.27 (21.34)	17.63 (24.83)	32.94	1.76 (7.62)	58.42
6	Chlorpyriphos 20% EC @ 1500 ml/ha	20.82 (27.15)	5.78 (13.88)	5.10 (13.03)	10.03 (18.45)	15.28 (23.00)	41.87	2.10 (8.33)	60.28
7	UTC	21.17 (27.39)	23.15 (28.75)	20.58 (26.97)	24.07 (29.37)	26.29 (30.83)	-	3.54 (10.84)	54.10
	CD (0.05)	0.85	0.51	0.63	0.6	0.59	-	0.28	1.33
	SEm±	NS	1.57	1.95	1.86	1.82	-	0.09	4.10

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