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# Bioefficacy of new insecticide molecules against sugarcane early shoot borer, *Chilo infuscatellus* (Snellen) (Pyralidae; Lepidoptera)

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**Abstract**
An experiment was conducted at Regional Sugarcane and Jaggary Research Station, Kolhapur during 2015-16 to evaluate relative efficacy of new insecticide molecules against sugarcane early shoot borers *Chilo infuscatellus* (Snellen). Eight insecticides namely, Fipronil 0.3% GR, Chlorantraniliprole 0.4% GR, Chlorantraniliprole 18.5% SC, Fipronil 5% SC, Spinosad 45% SC, Flubendiamide M/M 39.35% SC, Phorate 10% CG, Carbofuran 3% CG were compared with untreated (Check plot). Significant differences were noticed among the treatments. All chemicals recorded significantly less cumulative incidence per cent against early shoot borer (8.20 to 27.36%); more average millable canes (74.19 to 97.22 thousand / ha) and cane yield 87.04 to 118.98 t /ha) as compared to untreated control (32.55%, 71.06 thousand / ha and 81.02 t/ha respectively). The soil application of chlorantraniliprole 0.4 GR at the time of planting and 60 days after planting followed by spraying of chlorantraniliprole 18.5% SC at 30 and 60 days after planting are statistically at par and recorded least early shoot borer incidence (8.20 and 11.60%), maximum average millable canes (97.22 and 94.56 thousand / ha) and cane yield (118.98 and 112.96 t/ha). The next best superior treatments found for reducing early shoot borer incidence were Fipronil 0.3% GR and Carbofuran 3% CG.

**Keywords:** Bio-efficacy, early shoot borer, chlorantraniliprol, fipronil

## Introduction
Sugarcane, *Saccharum officinarum* L. is a tropical plant and important commercial crop of the country. India was the 2nd largest producer of sugar in the world after Brazil in 2015-16. India's share in the world production of sugar was 15 per cent in 2015-16. Among sugarcane growing countries in the world, India ranks second by contribution 50.32 lakh ha area, 3565.61 lakh tones cane production, 25.46 lakh tones in sugar production with an yield 70.86 tonnes per ha (Anonymous, 2017) [2]. In Maharashtra, sugarcane is grown on 10.22 million hectares with annual production of 649 million tones and productivity 76.8 tones per hectare (Anonymous, 2016) [1]. About 35 million farmers in the country depend on the sugarcane for their livelihood. Sugar industry is the second largest agro-based industry comprising of 642 sugar factories in India, whereas 203 in Maharashtra. The major challenges faced by sugarcane crop are lower yield per unit area, low sugar recovery and higher cost of production. The productivity of sugarcane is affected by various factors *viz.*, soil type, varietal selection, fertilizer and irrigation management and pest and disease incidence. Among these factors, the early shoot borer, *Chilo infuscatellus* (Snellen) is worst pest in Maharashtra, which is responsible for severe damage in early growth stage and yield loss particularly in late sown canes. Avasthy and Tiwari (1986) [3] reported that early shoot borer, *Chilo infuscatellus* (Snellen) (Pyralidae: Lepodoptera) cause economic losses from 22-23 per cent in yield, 12 per cent in sugar recovery and 27 per cent in jaggary. It is mainly injuries to young cane up to 12 to 16 weeks after planting. Its caterpillars destroy about 20 per cent of the young shoots during April-June annually (Dhaliwal, 2004) [5]. The caterpillars after hatch out from eggs get scattered and enters into the young shoots by making the holes just above ground levels and tunnels inside. The cutting off central leaf spindle which dries up forming a 'dead hearts.' The dead heart can be easily pulled out of the central shoot and emits an offensive smell.
In Maharashtra, most of farmers could not plant suru sugarcane on recommended time (i.e. up to 15th February of the year) due to late harvest of rabi crop *viz*., wheat, gram etc. Therefore, farmers have to plant sugarcane in late February or March of the year. Late planting with high temperature, increases the incidence of early shoot borer in sugarcane.

Also, in summer season due to scarcity of water, the interval between two irrigations gets expanded, which ultimately leads to increase in early shoot borer incidence. Therefore the efforts are made to find out the effective new molecules for management of early shoot borer in sugarcane.

**Materials and Methods**

In order to assess the chemical control of sugarcane early shoot borer on sugarcane, an experiment was conducted at Regional Sugarcane and Jaggary Research Station, Kolhapur during the crop season 2015-2016. The sugarcane variety Co-86032 (Nira) was planted as per recommended package of practises except plant protection measures. A three replicated randomized block design was laid out with a net plot size 8 x 6 $m^2$. Eight insecticides namely Fipronil 0.3% GR, Chlorantraniliprole 0.4% GR, Chlorantraniliprole 18.5% SC, Fipronil 5% SC, Spinosad 45% SC, Flubendiamide 39.35 M/M% SC, Phorate 10% CG, Carbofuran 3% CG were tried and compared with an untreated (Check) plot. First application of these insecticides was done at planting in case of granular insecticide and at 30 days after planting in case of spraying. Second application was made on 60 days after planting. Observations on the incidence of early shoot borer was recorded on 45, 60, 90 and 120 DAP and per cent shoot borer incidence was worked out. After each count, the dead hearts were pulled out to avoid counting them later on. The per cent incidence of early shoot borer was worked out by using following formula:

Per cent incidence of early shoot borer = Number of dead hearts / Total number of shoots X 100

The cumulative per cent incidence was worked out by relating the progressive total of infested tillers i.e. dead hearts in proportion to the total number of tillers (Sithanantham, 1973) [10] at 120 days after planting. Also, number of millable canes (NMC) and cane yield were recorded at harvest. The data were subjected to statistical analysis following the method of Panse and Sukhatme (1985) [8].

**Benefit cost analysis of the treatments**

In order to find out the cost/benefit analysis of the treatment versus control, total yield was converted into yield per hectare. The yield /ha were then multiplied with unit price of the cane to get gross income of the treatment. The incremental returns were obtained by subtracting the gross income from the check plot income. The cost of treatment was calculated on hectare basis. The net benefit was obtained by subtracting the total cost of the treatment from the gross income of the treatments. Cost benefit ratio were calculated through gross income divided by total cost. Greater the C: B ratio indicates the efficiency of the treatment.

**Results and Discussions**

The results on the per cent mean early shoot borer incidence at 45, 60, 90 and 120 days after planting and cumulative incidence along with number of millable canes (NMC) and cane yield are presented in Table1.

The per cent cumulative incidence of early shoot borer, *Chilo infuscatellus* (Snellen) ranged from 8.20 to 27.36 in different treatments, whereas it was 32.55 per cent in untreated control plot. Significant differences were noticed among treatments. The treatment with soil application of Chlorantraniliprole 0.4% GR @18.75 kg / ha at the time of planting and 60 days after planting recorded least cumulative incidence of early shoot borer (8.20%) and highest per cent reduction over control (74.81%). This was followed by Chlorantraniliprole 18.5% SC (11.60% and 64.36%), Fipronil 0.3% GR (15.42% and 52.63%), Carbofuran 3% CG (19.37% and 40.49%), Fipronil 5% SC (20.60% and 36.71%), Spinosad 45% SC (22.04% and 32.29%), Flubendiamide M/M 39.35% SC (22.75% and 30.11%) and Phorate 10% CG (27.36% and 15.94%). These results are in accordance with the observations of Pandey (2014) [7], Padmasri *et al.* (2014) [6] and Umashankar *et al.* 2018 [11] who reported that Chlorantraniliprole 0.4% GR and Chlorantraniliprole 18.5% SC are most effective insecticides against early shoot borer incidence.

**Table 1:** Bio-efficacy of newer insecticides against early shoot borer, *Chilo infuscatellus* (Snellen) on Co-86032

| Tr No | Treatments | Mean Early Shoot Borer Incidence (%) (Days After Planting) | | | | | Average Millable Canes (000/ha) | Average Cane Yield (t/ha) |
|---|---|---|---|---|---|---|---|---|
| | | 45 | 60 | 90 | 120 | Cumulative Incidence | | |
| $T_1$ | Soil application of Fipronil 0.3% GR @ 25 kg / ha at the time of planting and 60 days after planting. | 6.34 (14.47) | 8.45 (16.83) | 3.26 (10.36) | 2.34 (8.78) | 15.42 (23.04) | 90.97 | 107.89 |
| $T_2$ | Soil application of Chlorantraniliprole0.4% GR @18.75 kg / ha at the time of planting and 60 days after planting. | 3.04 (9.31) | 3.55 (10.61) | 2.29 (8.59) | 1.03 (5.76) | 8.20 (16.45) | 97.22 | 118.98 |
| $T_3$ | Soil application of Phorate 10% CG @ 15 kg/ha at the time of planting and 60 days after planting. | 14.54 (22.24) | 13.98 (21.89) | 7.90 (16.26) | 5.40 (13.35) | 27.36 (31.49) | 74.19 | 87.04 |
| $T_4$ | Soil application of Carbofuran 3% CG @ 33 kg / ha at the time of planting and 60 days after planting. | 8.84 (17.27) | 12.17 (20.32) | 3.52 (10.78) | 2.35 (8.80) | 19.37 (26.08) | 87.38 | 100.93 |
| $T_5$ | Spraying of Chlorantraniliprole 18.5% SC @ 375 ml/ha at 30 and 60 days after planting. | 4.04 (11.44) | 4.41 (11.95) | 3.14 (10.16) | 2.26 (8.54) | 11.60 (19.76) | 94.56 | 112.96 |
| $T_6$ | Spraying of Fipronil 5% SC @ 375 ml/ha at 30 and 60 days after planting | 9.44 (17.86) | 12.24 (20.42) | 4.48 (12.10) | 2.67 (9.39) | 20.60 (26.91) | 86.00 | 98.61 |
| $T_7$ | Spraying of Spinosad 45% SC @ 90 ml / ha at 30 and 60 days after planting. | 7.85 (16.05) | 12.33 (20.50) | 6.33 (14.53) | 2.31 (8.74) | 22.04 (27.90) | 80.90 | 94.26 |
| $T_8$ | Spraying of Flubendiamide M/M 39.35% SC @ 250 ml / ha at 30 and 60 days after planting. | 14.41 (22.30) | 10.08 (18.42) | 5.82 (13.89) | 2.26 (8.63) | 22.75 (28.45) | 79.75 | 92.13 |
| $T_9$ | Untreated Control | 13.40 (21.33) | 20.47 (26.85) | 9.52 (17.92) | 7.38 (15.64) | 32.55 (34.76) | 71.06 | 81.02 |
| | S. E. ± | 1.70 | 1.37 | 8.40 | 7.74 | 1.61 | 3.12 | 3.06 |
| | C.D. at 5% | 5.10 | 4.12 | 2.51 | 2.31 | 4.84 | 9.34 | 9.18 |
| | CV | 17.46 | 12.81 | 11.42 | 13.77 | 10.73 | 6.38 | 5.35 |

Figures in the parenthesis are arcsine transformed values.

Significant differences noticed among treatments regarding NMC (thousand per hectare) and average cane yield (tonne per hectare). Highest AMC were observed in treatment with soil application of Chlorantraniliprole 0.4% GR and it was 97.22 thousand per hectare. However, this treatment was at par with Chlorantraniliprole 18.5% SC (94.56 thousand per ha), Fipronil 0.3% GR (90.97 thousand per ha), and Carbofuran 3% CG (87.38 thousand per ha). The treatment with soil application of Chlorantraniliprole 0.4% GR @18.75 kg / ha at the time of planting and 60 days after planting recorded significantly highest yield (118.98 t / ha) over rest of treatments except the treatment spraying of Chlorantraniliprole 18.5% SC @ 375 ml/ha at 30 and 60 days after planting (112.96 t / ha), while the untreated control recorded 81.02 ton/ha. These results are in accordance with Pandey (2014) [7] and Umashankar *et al.* (2018) [11], who reported higher cane yield in Chlorantraniliprole 0.4% GR and Padmasri *et al.* (2014) [6] reported higher cane yield in Chlorantraniliprole 18.5% SC.

**Cost: benefit analysis of insecticidal treatment**

The results in table 2 revealed that, the maximum net returns was recorded with chlorantraniliprole 0.4% GR @18.75 kg/ha (Rs. 1,57,974/ha) followed by chlorantraniliprole 18.5% SC (Rs. 1,39,322/ha) and fipronil 0.3% GR (Rs. 1,35,838/ha) as compared to check plot (Rs. 80,123/ha). The highest cost benefit ratio was observed in chlorantraniliprole 0.4% GR than all other test insecticides (1:2:36) followed by Fipronil 0.3% GR (1:2.21) and chlorantraniliprole 18.5% SC (1:2.16). These results are in confirmation with Shobharani *et al.* (2018) [9], who recorded highest cost benefit ratio of chlorantraniliprole 0.4% GR @ 8 kg /acre followed by chlorantraniliprole 18.5% SC @ 150 ml /acre. Chaudhary *et al.* (2018) also reported highest per cent increase of yield (17.41%) over control due to application of chlorantraniliprole 0.4% GR against early shoot borer.

**Table 2:** Cost/benefit analysis of insecticides

| Tr. No. | Sugar cane Yield (Metric ton per Ha) | Additional yield over control t/ha | Additi-onal Income over control Rs/ha | Cost of cultivation except cost of insecticide Rs/ha | Cost of Insecti-cide treatment Rs/ha | Total cost of cultivation Rs/ha | Gross monitory returns Rs/ha | Net Returns Rs/ha | C:B ratio (Cost : Benefit ratio) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 (8/7) |
| $T_1$ | 107.89 | 26.87 | 61801 | 106223 | 6086 | 112309 | 248147 | 135838 | 1:2.21 |
| $T_2$ | 118.98 | 37.96 | 87308 | 106223 | 9637 | 115860 | 273654 | 157794 | 1:2.36 |
| $T_3$ | 87.04 | 6.02 | 13846 | 106223 | 3960 | 110183 | 200192 | 90009 | 1:1.82 |
| $T_4$ | 100.93 | 19.91 | 45793 | 106223 | 6612 | 112835 | 232139 | 119304 | 1:2.06 |
| $T_5$ | 112.96 | 31.94 | 73462 | 106223 | 14263 | 120486 | 259808 | 139322 | 1:2.16 |
| $T_6$ | 98.61 | 17.59 | 40457 | 106223 | 2325 | 108548 | 226803 | 118255 | 1:2.09 |
| $T_7$ | 94.26 | 13.24 | 30452 | 106223 | 5040 | 111263 | 216798 | 105535 | 1:1.95 |
| $T_8$ | 92.13 | 11.11 | 25553 | 106223 | 6392 | 112615 | 211899 | 99284 | 1:1.88 |
| $T_9$ Control | 81.02 | | | | | | | | |

## Conclusion

Bio-efficacy of insecticide molecule against sugarcane early shoot borer, *Chilo infuscatellus* (Snellen) on Nira variety reveals that, soil application of Chlorantraniliprole0.4% GR @18.75 kg / ha at the time of planting and 60 days after planting recorded least incidence at 45, 60, 90 and 120 days after planting, least cumulative incidence (8.20%) with highest per cent reduction of early shoot borer incidence (74.81%) over control. This treatment also recorded highest NMC (97.22 thousand /ha), highest cane yield (118.98 t/ha) with highest net returns and cost benefit ratio (1:2.36). This was followed by Chlorantraniliprole 18.5% SC, Fipronil 0.3% GR and Carbofuran 3% CG. On the basis of present findings, we can recommend either soil application or spraying of Chlorantraniliprole are best for management of sugarcane early shoot borer with highest monetary returns.

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