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Efficacy of some novel insecticide against maize stem borer, *Chilo partellus* (Swinhoe) in maize

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Abstract
A field experiment was carried out to study the efficacy of some novel insecticide against maize stem borer, *Chilo partellus* (Swinhoe) at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during *Kharif* 2016. The imidacloprid 17.8 SL was found most effective treatment followed by carbaryl SL, dimethoate 30% EC @ 1000 ml/ha (3.9 per cent) and acephate 75% @ 500 ml/ha 3.71 per cent infestation, which was at par each other respectively. The highest infestation was recorded in control plot (24.8 per cent). This was significantly higher than rest of the treatments and responsible for economic damage in maize crop. The highest grain yield (38.1 q/ha) was obtained from the imidacloprid 17.8 SL treated plot with maximum cost benefit ratio (1:8.75) followed by from carbaryl SL treated plot (36.8 q/ha) with cost benefit ratio (1:5.93).

Keywords: novel insecticide, maize stem borer, *Chilo partellus* (Swinhoe)

Introduction
Maize, Zea *mays* (L.) is cultivated globally and being one of the most important cereal crops worldwide. Insect- pests are the major factors responsible for low productivity of maize in India. Out of them, *Chilo partellus* (Swinhoe) is a serious pest of maize throughout India during *kharif* season causing grain yield loss of 24.3 to 36.3 per cent.
In India, the stem borer is one of the most serious insect pests of maize at the pre-harvest stage. (Sarup *et al*., 1987) [20]. Maize production is severely hampered by maize stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae). The young stem-borer larvae are small, spotted and yellowish. When full grown, they are 20 to 25 mm long and spotted with colored stripes along the back of the body. Pupation takes place in the stem in a small chamber. The straw colored moth (15 mm), deposits white scale like eggs in overlapping rows, usually on the under-side of the leaves (Alejandro, 1987). Stem-borer starts to infest the crop at 3 to 4 weeks after planting and continue up to maturity stage (Sarup *et al.*, 1978, Subasinghe and Amarasena, 1988) [19, 22].

Method and material
The present study was carried out at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during *Kharif* 2016. The experiment was laid out in a Randomized Block Design (R.B.D.) with, eight treatments and replicated thrice. The maize seeds of variety 'Kanchan (K-25)' was sown in plots size 5 x 3 m^2 at a row distance of 60 cm and plant to plant of 20 cm, respectively. The treatment included 7 novel insecticide formulation, viz. Imidacloprid @ 250 ml/ha, Cypermethrin @ 250-400 ml/ha, Carbaryl @ 1000 ml/ha, Dimethoate @ 1000 ml/ha, Acephate @ 500 ml/ha, Lambdacyhalothrin @ ml/ha and Indoxacarb @ 500 ml/ha. The two sprays were applied at 7 DAE and 21 DAE, to compare the efficacy of insecticide treatments along with untreated control. Infestation symptoms of stem borer damage or shoot holes in the inner rows were counted first time at 25 DAS and second time at 45 DAS. Leaf injury rating from ten selected plants in each plot was scored based on 1-9 scale. Leaf injury was recorded twice, 25 and the second at 45 days after sowing from each plot. The plants falling into different categories were multiplied with the rating value of that category and total score was obtained by summing up the values under different categories. Leaf injury index was calculated by dividing the total score of each treatment by the plant stand. The dead heart due to attack of stem borer were counted from three inner rows at 25 and 45 DAS and their percentage was calculated on the basis of total plants observed. Ten plants were uprooted at random from each plot at harvesting time. They were dissected and tunnel length was measured with the help of scale in centimeter.

Per cent stem tunneling was calculated on the bases of total tunneled length divided by plant height of affected plant. Average per cent stem tunneling per plot was calculated by dividing total length by number of plants taken for tunneling observation.

Result and discussion

Effect of different treatments on infestation of *Chilo Partellus* (Swinhoe)

The results obtained on the different type of damages caused by maize stem borer *Chilo Partellus* (Swinhoe) at different stages of crop growth.

First application

The analyzed data on incidence of *Chilo Partellus* (Swinhoe) is presented in table and fig. The mean per cent infestation was also recorded on 5 and 15 days after first application (25 days after showing). Table data revealed that on 5 days after first application of insecticides, the mean percent infestation varied from 3.5 to 11.6 per cent in which all the treatments were found effective and significantly superior over control. The most effective treatment was imidacloprid 17.8 SL @ 250 ml/ha (3.5 per cent). The next effective treatments in order of effectiveness were carbaryl SL @ 1000 ml /ha (4.55 per cent), followed by acephate 75% @ 500 ml /ha (5.3 per cent), and it was statistically at par with dimethoate 30% EC @ 1000 ml/ha (5.7 per cent). The other treatments were not as effective as imidacloprid in reducing the incidence of larvae in maize crop. Cypermethrin 25% EC@ 250 ml /ha (6.4 per cent), lambdacyhalothrin 5 EC@ 500 ml /ha (7.5 per cent) and indoxacarb 14.5 SC @ 500 ml /ha with infestation of 8.50 per cent, the maximum larval infestation of 11.6 per cent was recorded with unsprayed control. This was significantly higher than other protected treatments.

Similarly, the data recorded on 15 days after application of insecticides, imidacloprid 17.8 SL @ 250 ml/ha (4.2 per cent) was found to be most effective treatment. The other effective treatments were carbaryl SL @ 1000 ml /ha (6.0 per cent) followed by dimethoate 30% EC @ 1000 ml/ha (7.24 per cent) and acephate 75% @ 500 ml /ha7.8 per cent infestation, which was at par each other respectively. Other treatments were significantly superior over control. The highest infestation was recorded in control plot (16.8 per cent). This was significantly higher than rest of the treatments and responsible for economic damage in maize crop.

Second application

The result from the statically analyzed data on mean per cent infestation by of *Chilo Partellus* (Swinhoe) on 5 days after treatment revealed that all the treatments were effective in reducing stem borer infestation and significantly superior over control. The minimum percent infestation were found in imidacloprid 17.8 SL @ 250 ml/ha (3.7 per cent) and followed by carbaryl SL @ 1000 ml /ha (4.8 per cent). Dimethoate 30% EC @ 1000 ml/ha (5.9 per cent) and acephate 75% @ 500 ml /ha5.54 per cent infestation were at par followed by order of efficacy with cypermethrin 25% EC@ 250 ml /ha (6.9 per cent), lambdacyhalothrin 5 EC@ 500 ml /ha (8.74 per cent) and indoxacarb 14.5 SC @ 500 ml /ha with infestation of 8.8 per cent, the maximum larval infestation of 19.5 per cent was recorded with unsprayed control. This was significantly higher than other protected treatments.

The data recorded on 15 days after second insecticide treatment, revealed that all the protected treatments were found effective against maize stem borer and had similar trend of effectiveness as after first spray. The most effective treatments were imidacloprid 17.8 SL @ 250 ml/ha (2.3 per cent) was found to be most effective treatment. The other effective treatments were carbaryl SL @ 1000 ml /ha (3.0 per cent) followed by dimethoate 30% EC @ 1000 ml/ha (3.9 per cent) and acephate 75% @ 500 ml /ha3.71 per cent infestation, which was at par each other respectively. Other treatments were significantly superior over control. The highest infestation was recorded in control plot (24.8 per cent). This was significantly higher than rest of the treatments and responsible for economic damage in maize crop.

Leaf injury rating (LIR)

The data on leaf injury rating at 25 DAS and 45 DAS is presented in Table. It is evident from the data on leaf injury rating at 25 DAS during *kharif*, 2016 that the minimum leaf injury rating of 1.38 was recorded in plot treated with imidacloprid 17.8 SL @ 250 ml/ha followed by carbaryl SL @ 1000 ml /ha, acephate 75% @ 500 ml/ha, dimethoate 30% EC @ 1000 ml/ha, cypermethrin 25% EC @ 250 ml /ha, lambdacyhalothrin 5 EC@ 500 ml/ha and indoxacarb 14.5 SC @ 500 ml /ha with leaf injury rating of 2.4,3.9,4.5,6.3,6.38 and 6.4 respectively. The highest leaf injury rating (7.9) was recorded with untreated control.

Almost similar trend of leaf injury rating were recorded during after 45 DAS *kharif*, 2016. The data revealed that the minimum leaf injury rating of 1.52 was recorded in plot treated with imidacloprid 17.8 SL @ 250 ml/ha followed by carbaryl SL @ 1000 ml /ha (2.5), acephate 75% @ 500 ml /ha (4.42), dimethoate 30% EC @ 1000 ml/ha (4.7), cypermethrin 25% EC@ 250 ml /ha (6.6), lambdacyhalothrin 5 EC@ 500 ml /ha (6.9) and indoxacarb 14.5 SC @ 500 ml /ha (7.1). The highest leaf injury rating (8.2) was recorded with untreated control.

Effect of different treatments on dead heart formation by stem borer, *Chilo partellus* (Swinhoe)

To record the data on dead heart formation, the observation were taken from three inner rows in each plot. The dead hearts were counted at 25 and 45 DAS. The percentage of dead hearts was calculated at 45 DAS on the basis of total observed plants (Table.).

The mean number of statistically analyzed data on dead hearts varied from 2.5 to 5.28 in different insecticidal treatments at 25 DAS during *kharif*, 2016 while it was 7.22 in control treatment. All the treatments were found significantly superior as compared to untreated control. The minimum dead hearts (2.5) was found with the treatment of with imidacloprid 17.8 SL @ 250 ml/ha followed by carbaryl SL @ 1000 ml /ha, acephate 75% @ 500 ml /ha, dimethoate 30% EC @ 1000 ml/ha, cypermethrin 25% EC@ 250 ml /ha, lambdacyhalothrin 5 EC@ 500 ml /ha and indoxacarb 14.5 SC @ 500 ml /ha with % dead heart of 3.0, 3.7, 4.01, 4.33, 5.0 and 5.28 respectively. The highest % dead heart (7.22) was recorded with untreated control, significantly higher than rest of the treatments.

The data on average number of dead hearts, ranged from 2.7 to 8.1 in different treatments including untreated control at 45 DAS during *kharif*, 2016. All the treatments were found significantly superior as compared to the untreated control. The minimum dead hearts (2.7) was recorded with treatment of imidacloprid 17.8 SL @ 250 ml/ha followed by carbaryl SL @ 1000 ml/ha, acephate 75% @ 500 ml /ha, dimethoate 30% EC @ 1000 ml/ha, cypermethrin 25% EC@ 250 ml /ha,

lambdacyhalothrin 5 EC@ 500 ml /ha and indoxacarb 14.5 SC @ 500ml /ha with mean number of dead heart of 3.33, 4.0, 4.34, 5.0, 5.67 and 6.11 respectively. The highest average number of dead heart (8.1) was recorded with untreated control, significantly higher than rest of the treatments.

Effect of different treatments on stem tunneling by *Chilo partellus*

Stem tunnel length (cm) during *kharif*, 2016

The average length of tunnel in maize plants made by *Chilo partellus* (Swinhoe) among the different treatments ranged from 2.37 to 12.7 cm per plant. The minimum tunnel length 2.37 cm was observed in imidacloprid 17.8 SL @ 250 ml/ha followed by the treatment of carbaryl SL @ 1000 ml /ha, acephate 75% @ 500 ml /ha, dimethoate 30% EC @ 1000 ml/ha, cypermethrin 25% EC@ 250 ml /ha, lambdacyhalothrin 5 EC@ 500 ml /ha and indoxacarb 14.5 SC @ 500 ml /ha with average stem tunnel of 2.98, 3.52, 3.88, 4.55, 6.20 and 6.67cm, respectively. The longest tunnel of 12.7 cm per plant was recorded in untreated control.

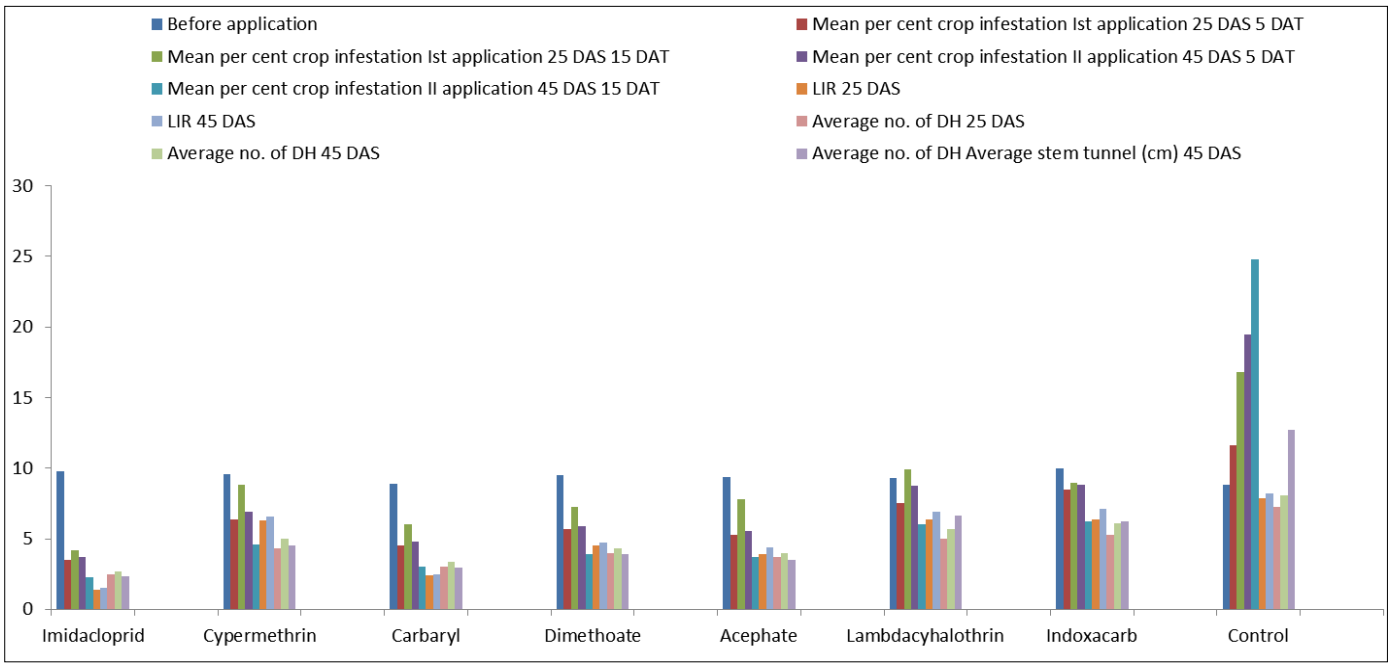

Fig 1: Effect of different insecticide treatments on mean per cent crop infestation, LIR, average no. of dead hearts and average stem tunnel (cm)

Table 1: Effect of different insecticide treatments on mean per cent crop infestation, LIR, average no. of dead hearts and average stem tunnel (cm)

Treatment No.	Name of treatment	Dose	Before application	Mean per cent crop infestation				LIR		Average no. of DH		Average stem tunnel (cm)
				Ist application 25 DAS		II application 45 DAS						
				5 DAT	15 DAT	5 DAT	15 DAT	25 DAS	45 DAS	25 DAS	45 DAS	
T_1	Imidacloprid	250 ml/ha	9.75 (17.4)*	3.50 (10.8)	4.20 (11.8)	3.70 (11.1)	2.30 (8.70)	1.38	1.52	2.50	2.70	2.37
T_2	Cypermethrin	250-400 ml/ha	9.56 (18.1)	6.40 (14.6)	8.80 (17.3)	6.90 (15.3)	4.60 (12.4)	6.30	6.60	4.33	5.00	4.55
T_3	Carbaryl	1000 ml/ha	8.90 (17.5)	4.55 (12.3)	6.00 (14.2)	4.80 (12.7)	3.00 (9.90)	2.40	2.50	3.00	3.33	2.98
T_4	Dimethoate	1000 ml/ha	9.50 (18.3)	5.70 (13.7)	7.24 (15.6)	5.90 (14.0)	3.90 (11.4)	4.50	4.70	4.01	4.34	3.88
T_5	Acephate	500 ml/ha	9.40 (17.3)	5.30 (13.3)	7.80 (16.2)	5.54 (13.6)	3.71 (11.1)	3.90	4.42	3.70	4.00	3.52
T_6	Lambdacyhalothrin	500 ml/ha	9.27 (18.2)	7.50 (15.9)	9.90 (18.4)	8.74 (17.2)	6.00 (14.2)	6.40	6.90	5.00	5.67	6.67
T_7	Indoxacarb	500 ml/ha	9.98 (17.7)	8.50 (17.3)	8.98 (17.4)	8.80 (17.3)	6.25 (14.3)	6.38	7.10	5.28	6.11	6.20
T_8	Control	-	8.80 (16.5)	11.6 (19.9)	16.8 (23.9)	19.5 (26.2)	24.8 (30.2)	7.90	8.20	7.22	8.10	12.7
SEm±1	-		-	0.30	0.35	0.27	0.29			0.24	0.33	0.15
CD (p=0.05)	-		NS	0.92	1.02	0.83	0.89			0.73	1.11	0.46

Conclusion

The treatments imidacloprid 17.8 SL @ 250 ml/ha (2.3 per cent) was found most effective treatment. The other effective treatments were carbaryl SL @ 1000 ml /ha (3.0 per cent) followed by dimethoate 30% EC @ 1000 ml/ha (3.9 per cent) and acephate 75% @ 500 ml /ha 3.71 per cent infestation, which was at par each other respectively. The minimum number of dead heart, minimum tunnel length, were found with the treatment of imidacloprid 17.8 SL @ 250 ml/ha followed by carbaryl SL @ 1000 ml /ha, during *kharif* 2016.

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