International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 675-679

Received: 04-09-2017
Accepted: 07-10-2017

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Effect of some newer insecticides on damage intensity of *Chilo partellus* in *Kharif* maize

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Abstract
The present experiment was carried out to assess the effectiveness of various insecticides against maize stem borer, *Chilo partellus* at research farm, Tirhut College of Agriculture, Dholi, Muzaffarpur (Bihar) during *Kharif* 2016 under field condition. The application of chlorantraniliprole 20 SC @ 0.3 ml/l as spray followed by carbofuran 3G @ 7 kg/ha as whorl application at fortnightly interval starting from 15 days after sowing recorded highest plant height, number of cobs per plant and grain yield but did not differ statistically from flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha. Maximum plant height (175.0 cm), mean number of cobs per plant (1.50) and mean grain yield (45.4 q/ha) was recorded in maize with spraying of chlorantraniliprole 20 SC @ 0.3 ml/l followed by application of carbofuran 3G @ 7 kg/ha which might be due to effective reduction of pest attack. Among all the insecticides, novaluron 10 EC @ 0.1 ml/l was least effective but was significantly superior over untreated control in respect of all the above mentioned parameters.

Keywords: Damage intensity, *Chilo partellus*, *Kharif* maize

Introduction

Maize is the one of the most important cereal crop in global cultivation, after wheat and rice, with an annual global production estimated at 1.017 billion tons cultivated on 185 million hectares [5]. Due to its highest yield potential among all the cereals maize is referred as "Queen of cereals" [2]. The average area of maize in India is 9.43 million hectare with an average production of 22.23 million tonnes having average productivity of 2.5 t/ha [3]. Like other cereal crops, maize is also prone to a wide range of biotic and abiotic factors, the incidence of insect pests being one of them. In India maize crop is attacked by 139 species of insect pests causing varying degree of damage. However, only about a dozen of these are quite serious cause damage from sowing till storage [11]. Damage caused by stem borers is one of the main causes of low yields of maize [5]. Stem borer can cause severe damage at different stages of plant growth from seedling to maturity. When infestation is severe, there is a physiological disruption of plant growth; hence tasselling, silking and grain formation are severely affected [1]. Among the various insect pests, maize stem borer, *Chilo partellus* is the most dominant contributing 90-95 per cent of the total damage in *Kharif* season [5]. Maize is most vulnerable to *Chilo partellus* (Lepidoptera: Crambidae) which causes severe losses to it [13]. Since, *Chilo prtellus* is an internal borer it is difficult to control. Though, application of effective chemicals with different mode of action at proper crop stage is significant for its management. The applications of various insecticides with different mode of action strengthen insecticide resistance management strategy. Therefore, keeping in view the above facts the present investigation was carried out with the aim to develop a new management strategy for control of pest at farmer's field economically.

Materials and Methods

In order to study the bio efficacy of some newer insecticides against maize stem borer, *Chilo partellus* a field trial in RBD was conducted at the research farm of Tirhut College of Agriculture, Dholi, Muzaffarapur (Bihar) during *Kharif* 2016. There were altogether ten treatments and each treatment was replicated thrice. The maize variety Ganga safed-2 was grown as a test crop and sowing was done on 27th July 2016. The seed was sown at row to row and plant to plant spacing of 60×25 cm in a plot size of 4×3 m^2.

All the crop raising practices were followed to maintain healthy crop growth and no insecticides other than those included in the trial were applied. The treatments were applied twice. First application was done at 15 days after sowing as foliar spray in all treatments. While second application was done at 30 days after sowing, in this application treatments T_1 to T_4 is applied as spray whereas, treatments T_5 to T_9 was applied in granular form as whorl application.

The tunnel length was recorded by random selection of five plants from each plot at the time of harvest. The selected plants stem were split open and the total length of stem and length of tunnel made by maize stem borer larvae were measured. The number of exit holes present on entire stem was also recorded.

Influence of foliar application of different newer insecticides and granular application of carbofuran 3G on plant growth of maize was assessed by taking mean plant height (cm) as the growth parameter. For plant height a sample of five randomly selected plants from each plot were taken into account. The height of plants (cm) was recorded from soil level to the base of the tassel by measuring tape. The observation was recorded after complete cob formation.

Treatment effect on yield attributing characters of maize was assessed when the crop reached maturity. For this purpose, five randomly selected plants from each plot were harvested and observations with regards to mean number of cob per plant were recorded. After harvesting, plot wise seed yield was recorded and converted into quintal per ha.

Results and Discussion

The damage is caused chiefly by caterpillars of *C. partellus* which start feeding on the whorl of leaves and then enter into the stem, feeding on the inner tissue resulting into the formation of tunnel, exit holes on stem and dead heart [7, 12, [11]]. The response of different treatments to *C. partellus* was determined on the basis of mean tunnel length. As it is evident from the data given in Table 1 and depicted in Fig. 1, the mean tunnel length among different treatments ranged from 1.5 to 23.7 cm. The minimum tunnel length (1.5 cm) was recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha which was proved significantly superior over all the other treatments. Two foliar applications of different insecticides *viz*., chlorantraniliprole 20 SC @ 0.3 ml/l, flubendiamide 480 SC @ 0.2 ml/l, deltamethrin 2.8 EC @ 0.4 ml/l and novaluron 10 EC @ 0.1 ml/l showed 3.5, 4.7, 5.2 and 6.5 cm tunnel length, respectively. The tunnel length in different treatment due to foliar application in sequence with granular application *i.e*., chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha (1.5 cm), flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (1.8 cm) and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (2.2 cm) novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha (5.6 cm). Single application of carbofuran 3G @ 7 kg/ha recorded 3.9 cm tunnel length. Among the various foliar applications, chlorantraniliprole 20 SC @ 0.3 ml/l showed 3.5 cm tunnel length and was *at par* with carbofuran 3G @ 7 kg/ha (3.90 cm) and flubendiamide 480 SC @ 0.2 ml/l (4.7 cm). Out of the different insecticidal treatments with foliar application followed by granular application, chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha recorded minimum tunnel length (1.5 cm) and was *at par* with flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (1.8 cm) and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (2.2 cm). Spraying of novaluron 10 EC @ 0.1 ml/l was found least effective (6.5 cm) on the basis of tunnel length. All the treatments were found significantly superior over untreated control but they differed among themselves.

As the insecticides under test, affected the plant growth particularly in respect to plant height and tunnel length made by the caterpillar, the response of these treatments to *C. partellus* was further determined by considering two parameters *i.e*., plant height and amount of pest injury (tunnel length).

Data pertaining to these parameters as depicted in Table 1 and Fig. 1, clearly revealed that the average per cent stem tunnelling varied from 0.85 to 17.28. chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha maintained its superiority over rest of the treatments in reducing the mean per cent stem tunnelling (0.85%). The per cent stem tunnelling recorded in foliar application of insecticidal treatments were chlorantraniliprole 20 SC @ 0.3 ml/l (2.16%), flubendiamide 480 SC @ 0.2 ml/l (2.88%), deltamethrin 2.8 EC @ 0.4 ml/l (3.40%) and novaluron 10 EC @ 0.1 ml/l (4.46%). Mean per cent stem tunnelling due to various treatments in sequence with carbofuran 3G *i.e*., chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha, novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha, flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha were 0.85, 3.75, 1.08 and 1.43, respectively. Among the foliar applications, chlorantraniliprole 20 SC @ 0.3 ml/l was the best and showed 2.16 per cent stem tunnelling which was *at par* with carbofuran 3G @ 7 kg/ha (2.88 %) and flubendiamide 480 SC @ 0.2 ml/l (2.40 %). However, among the insecticidal treatments with foliar application followed by granular application, minimum per cent stem tunnelling (0.85) was recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha and was *at par* with flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (1.08%) and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (1.43%). Spraying with novaluron 10 EC @ 0.1 ml/l was least effective (4.46%) in lowering percent stem tunnelling.

The results on the mean number of exit holes made by *Chilo partellus* (Swinhoe) per plant as influenced by foliar and granular application of insecticides under test are also presented in Table 1 and fig. 1. A perusal of the data revealed that the minimum number of exit holes (0.2/plant) was recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha and maximum in untreated control (7.0/plant). Based on mean number of exit holes per plant, various treatments are arranged in descending order of their relative effectiveness as Chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha (0.2) > Flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (0.4) > deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (0.5) > chlorantraniliprole 20 SC @ 0.3 ml/l (1.4) > novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha (1.6) > flubendiamide 480 SC @ 0.2 ml/l (1.7) > carbofuran 3 G @ 7 kg/ha (1.8) > deltamethrin 2.8 EC @ 0.4 ml/l (1.9) > novaluron 10 EC @ 0.1 ml/l (2.2). Among all the insecticidal treatments, novaluron 10 EC @ 0.1 ml/l spray was least effective (2.2/plant) in reducing exit hole made by *C. partellus*. All the treatments were significantly superior over untreated control. The present findings are in agreement with the reports of [8] who reported that foliar and granular application of different insecticides proved better in lowering per cent stem tunnelling ranging between 0.99 to 17.27 per cent.

The results obtained on effect of insecticides on growth and yield attributing characters of maize have been presented in Table 2 and illustrated in Fig. 2, it is apparent from the data that the average height of maize plants ranged from 137.5 to 175.0 cm during the entire crop season of *Kharif* 2016 due to the influence of various insecticidal treatments. All the treatments performed better in enhancing the height of plants over untreated control. The maximum plant height (175.0 cm) was recorded in treatment chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha and minimum in untreated control (137.5 cm). The mean plant height in flubendiamide 480 SC @ 0.2 ml/l, chlorantraniliprole 20 SC @ 0.3 ml/l, deltamethrin 2.8 EC @ 0.4 ml/l and novaluron 10 EC @ 0.1 ml/l recorded 165.0 cm, 162.0 cm, 153.0 cm and 146.0 cm, respectively. The treatments in sequence *i.e*., chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha, novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha, flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha exhibited mean plant height 175.0 cm, 169.0 cm, 158.0 cm and 151.0 cm, respectively. The single application of carbofuran 3 G @ 7 kg/ha recorded 162.0 cm mean plant height. Among the various foliar treatments, flubendiamide 480 SC @ 0.2 ml/l recorded 165.0 cm mean plant height of maize and was *at par* with chlorantraniliprole 20 SC @ 0.3 ml/l (162.0 cm), carbofuran 3 G @ 7 kg/ha (162.0 cm), deltamethrin 2.8 EC @ 0.4 ml/l (153.0 cm) and novaluron 10 EC @ 0.1 ml/l (146.0 cm). However, application of chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha recorded maximum plant height (175.0 cm) and was *at par* with flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (169.0 cm) and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (158.0 cm), whereas novaluron 10 EC @ 0.1 ml/l was found least effective (146 cm).

The response of yield attributing parameters *viz*., number of cobs of maize (cv. Ganga Safed-2) per plant was also influenced by the foliar spray of different treatments under test during the crop season, *Kharif* 2016. It is apparent from the data (Table 2. Fig. 2) that all the treatments, irrespective of their doses, showed positive influence on mean number of cobs per plant in treated maize crop. The number of cobs per plant varied between 0.6 to 1.5, with minimum in untreated control and maximum in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha. Based on mean number of cobs per plant, various treatments were arranged in descending order of their relative effectiveness as chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha (1.5) > flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (1.4) > deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (1.3) > chlorantraniliprole 20 SC @ 0.3 ml/l (1.3) > flubendiamide 480 SC @ 0.2 ml/l (1.3) > novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha (1.2) > deltamethrin 2.8 EC @ 0.4 ml/l (1.2) > carbofuran 3 G @ 7 kg/ha (1.1) > novaluron 10 EC @ 0.1 ml/l (0.9) per plant. deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha recorded (1.3) cob per plant and was *at par* with chlorantraniliprole 20 SC @ 0.3 ml/l (1.3) and flubendiamide 480 SC @ 0.2 ml/l (1.3).

Field performance of various treatments was further adjudged on the basis of their grain yield at the time of harvest and the data are presented in Table 2 and illustrated in fig. 2. the grain yield of maize ranged from 14.7 q ha^{-1} (untreated control) to 45.4 q ha^{-1} (chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha treated plot). During the crop season, application of insecticides brought about a significant increase in the yield of maize. Among all the treatments under test, chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha as well as flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha at their respective doses recorded significantly higher yield. Treatments deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha and chlorantraniliprole 20 SC @ 0.3 ml/l on the other hand, performed better in increasing yield (36.5 and 36.2 q/ha, respectively) than rest of the insecticidal applications and was *at par* with novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha recording 32.0 q per ha grain yield. The foliar application of flubendiamide 480 SC @ 0.2 ml/l, carbofuran 3G @ 7 kg/ha, novaluron 10 EC @ 0.1 ml/l and deltamethrin 2.8 EC @ 0.4 ml/l recorded 29.5, 28.2, 26.3 and 24.0 q yield per ha, respectively.

The results presented above reveals that all insecticides under test brought about remarkable improvement in increasing plant height, number of cobs per plant as well as grain yield per ha. However, application of chlorantraniliprole 20 SC @ 0.3 ml/l as spray followed by carbofuran 3G @ 7 kg/ha as whorl application at fortnightly interval starting from 15 days after sowing recorded highest plant height, number of cobs per plant and grain yield but did not differ statistically from flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha. Maximum plant height (175.0 cm), mean number of cobs per plant (1.50) and mean grain yield (45.4 q/ha) was recorded in maize with spraying of chlorantraniliprole 20 SC @ 0.3 ml/l followed by application of carbofuran 3G @ 7 kg/ha which might be due to effective reduction of pest attack. Among all the insecticides, novaluron 10 EC @ 0.1 ml/l was least effective but was significantly superior over untreated control in respect of all the above mentioned parameters. Similar observation was reported by [2] that the highest grain yield (48.21q/ha) was recorded in treatment of indoxacarb 14.5 SC @ 500 ml/ha. More or less similar results have also been reported by [4] [9].

Conclusion

From the above discussed finding we concluded that the plant growth and yield attributing parameters *i.e*., mean plant height, mean numbers of cobs/plant and yield (q/ha) were recorded maximum in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha treated plot. However, the minimum mean plant height, mean numbers of cobs/plant and yield (q/ha) were recorded in untreated control. The minimum and maximum mean tunnel length, mean per cent stem tunnelling and mean number of exit holes per plant was recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha treated plot and untreated control, respectively.

Table 1: Effect of insecticides on intensity of maize stem borer damage in maize during *Kharif* 2016

Treatment No.	Insecticides/Dose	Mean tunnel length (cm)	Mean (%) stem tunneling	Mean no. of exit holes/plant
T_1	Chlorantraniliprole(20 SC) @ 0.3 ml/lit	3.5	2.16 (8.45)*	1.4 (1.53)**
T_2	Novaluron (10 EC) @ 0.1 ml/lit	6.5	4.46 (12.18)	2.2 (1.78)
T_3	Flubendiamide (480 SC) @ 0.2 ml/lit	4.7	2.88 (9.75)	1.7 (1.65)
T_4	Deltamethrin (2.8 EC) @ 0.4 ml/lit	5.2	3.40 (10.60)	1.9 (1.69)
T_5	Carbofuran 3G @ 7 kg/ha	3.9	2.40 (8.90)	1.8 (1.68)
T_6	T_1 + Carbofuran 3G	1.5	0.85 (5.30)	0.2 (1.10)
T_7	T_2 + Carbofuran 3G	5.6	3.75 (11.14)	1.6 (1.61)
T_8	T_3 + Carbofuran 3G	1.8	1.08 (5.98)	0.4 (1.19)
T_9	T_4 + Carbofuran 3G	2.2	1.43 (6.83)	0.5 (1.25)
T_{10}	Control	23.7	17.28 (24.54)	7.0 (2.82)
SEm (±)		0.40	(0.38)	(0.04)
C.D (P=0.05)		1.21	(1.15)	(0.11)

*Figures in parentheses are the values of angular transformation.
**Figures in parentheses are the values of square root transformation.

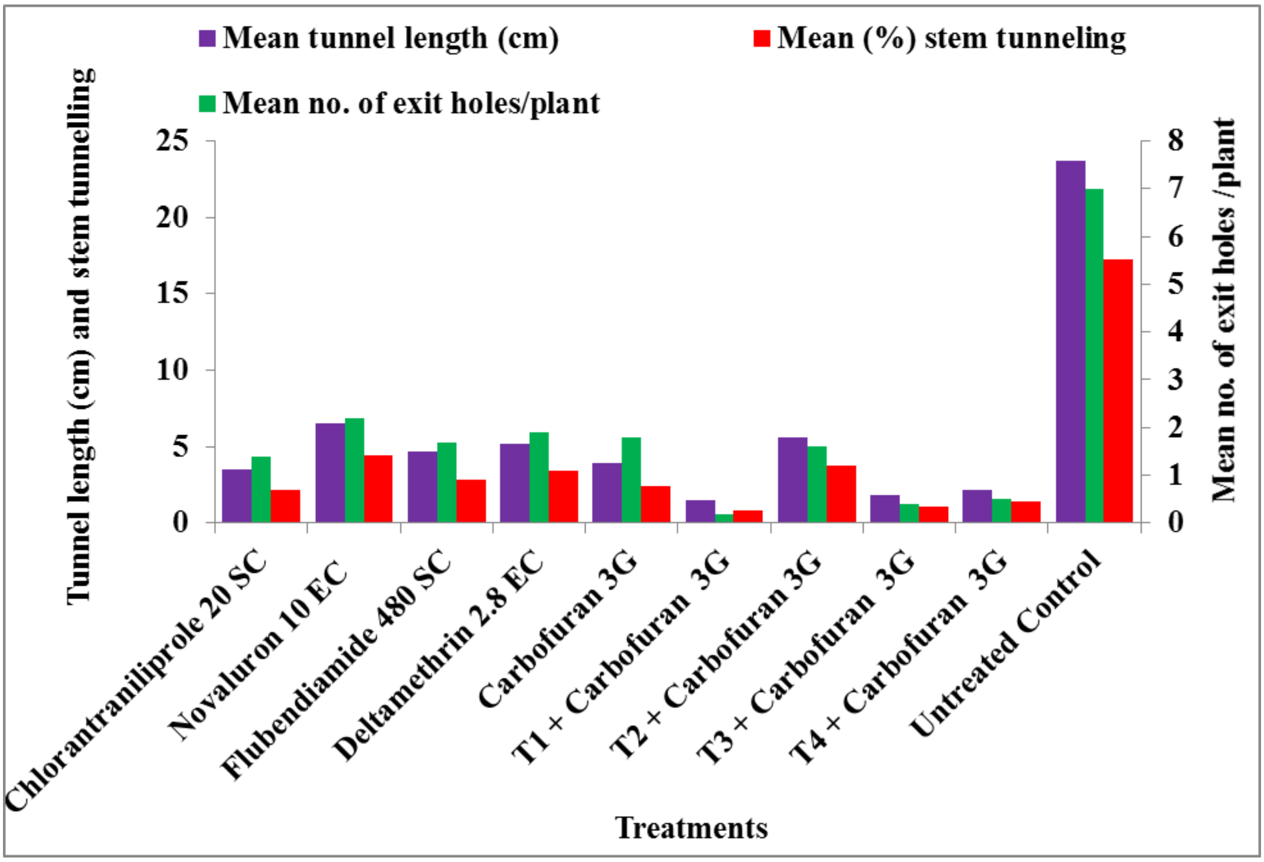

Fig 1: Effect of insecticides on the intensity of *Chilo partellus* damage on maize

Table 2: Effect of insecticides on plant growth and yield attributing parameters on maize cv. GS-2 during *Kharif* 2016

Treatment No.	Insecticides/Dose	Mean plant height (cm)	Mean no. of cobs/plant	Yield (q/ha)
T_1	Chlorantraniliprole(20 SC) @ 0.3 ml/l	162.0	1.3 (1.52)*	36.2
T_2	Novaluron (10 EC) @ 0.1 ml/l	146.0	0.9 (1.38)	24.0
T_3	Flubendiamide (480 SC) @ 0.2 ml/l	165.0	1.3 (1.51)	31.0
T_4	Deltamethrin (2.8 EC) @ 0.4 ml/l	153.0	1.2 (1.48)	29.3
T_5	Carbofuran 3G @ 7 kg/ha	162.0	1.1 (1.46)	28.2
T_6	T_1 + Carbofuran 3G	175.0	1.5 (1.58)	45.4
T_7	T_2 + Carbofuran 3G	151.0	1.2 (1.48)	32.0
T_8	T_3 + Carbofuran 3G	169.0	1.4 (1.54)	42.6
T_9	T_4 + Carbofuran 3G	158.0	1.3 (1.53)	36.5
T_{10}	Control	137.5	0.6 (1.26)	14.7
SEm (±)		6.15	(0.02)	2.13
C.D (P=0.05)		18.43	(0.06)	6.39

*Figures in parentheses are the values of square root transformation.

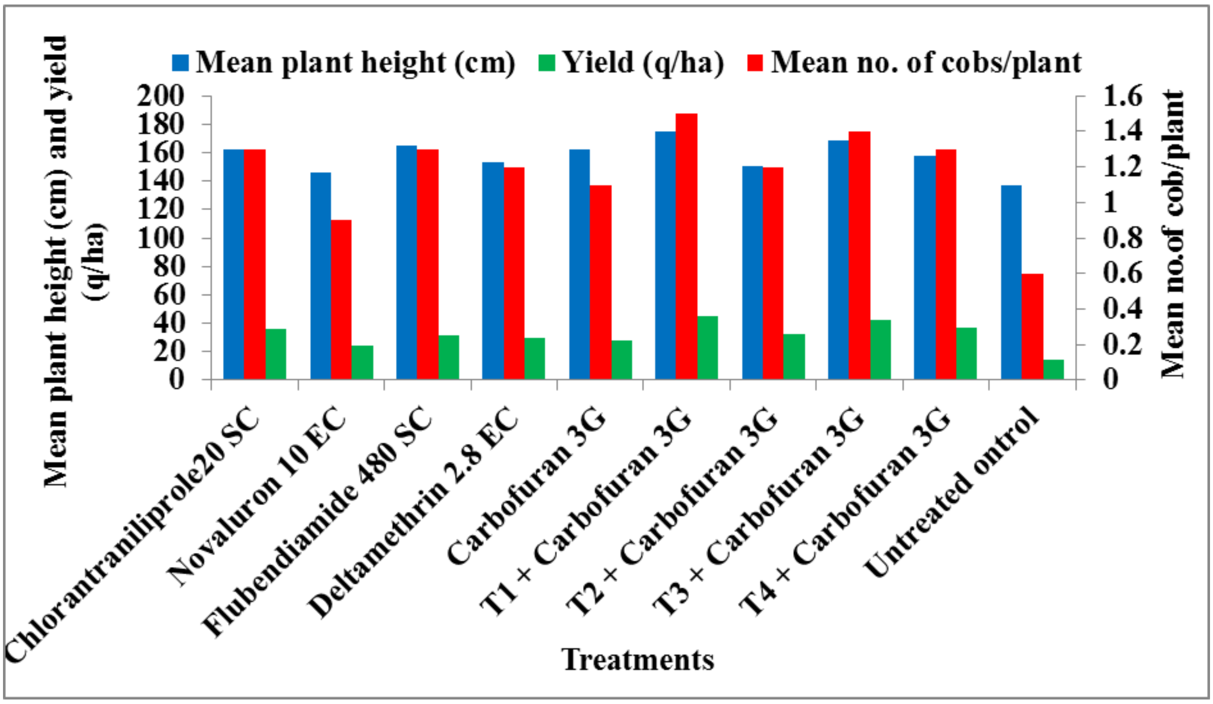

Fig 2: Effect of insecticides on plant growth and yield attributing parameters of maize

Acknowledgement

I express our sincere thanks to Chairman, Department of Entomology, Dr. Rajendra Prasad central agricultural university, Pusa for providing necessary constructive help, financial support and other technical inputs during the course of experimentation.

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