Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(6): 1347-1351

Received: 01-09-2017
Accepted: 04-10-2017

Ram Kumar
M.Sc. (Ag.), Ph.D Scholar, Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Pusa, Bihar, India

Tanweer Alam
Junior scientist-cum-Assistant Professor, Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Pusa, Bihar, India

Correspondence
Ram Kumar
M.Sc. (Ag.), Ph.D Scholar, Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Pusa, Bihar, India

Bio-efficacy of some newer insecticides against maize stem borer, *Chilo partellus* (Swinhoe)

Ram Kumar and Tanweer Alam

Abstract
The present field experiment was conducted to study the bio-efficacy of chlorantraniliprole 20 SC, novaluron 10 EC, flubendiamide 480 SC, deltamethrin 2.8 EC and carbofuran 3G against maize stem borer, *Chilo partellus* at research farm of Tirhut College of Agriculture, Dholi, Muzaffarpur (Bihar) during *Kharif* 2016. The minimum and maximum mean per cent infestation (10.60 and 72.60) as well as mean per cent dead heart (3.75 and 23.50) were recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha and untreated control, respectively. The highest benefit: cost ratio (13.96:1) was evinced in insecticidal treatment flubendiamide 480 SC @ 0.2 ml/l in sequence with carbofuran 3G @ 7 kg/ha. All the treatments were found significantly superior to untreated control in reducing the maize stem borer infestation and increasing the yield.

Keywords: Bio-efficacy, insecticides, *Chilo partellus*

1. Introduction
Maize (*Zea mays* L.) is the third most important staple food of India after wheat and rice, grown virtually in every suitable agro-ecological region of the world at different degree of success [1]. Due to its highest yield, potential among all the cereals maize is referred as "Queen of cereals" [1]. 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 [2]. Inspite of increase in acreage, maize production in India remained almost stagnant with constant yield level [4]. 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 [13]. Among the various insect pests, maize stem borer, *Chilo partellus* is the key pest contributing 90-95 per cent of the total damage in *Kharif* season [6]. Maize is most vulnerable to *Chilo partellus* (Lepidoptera: Crambidae) which causes severe losses to it [17]. For the management of *Chilo partellus*, application of effective chemicals with different mode of action at proper crop stage is significant as the pest is internal feeder. The applications of various insecticides with different mode of action strengthen insecticide resistance management strategy. Thus to demonstrate these promising tools of pest management at farmers field and economic comparison of different insecticidal treatment is necessary. The present investigation was, therefore, undertaken with the objective: Ascertaining the field efficacy of some newer insecticides against *Chilo partellus* (Swinhoe).

2. Materials and Methods
In order to ascertain the field efficacy of below mentioned insecticides used as foliar spray and granules against maize stem borer, C*hilo partellus* (Swinhoe) on maize, a field trial in RBD was conducted at the research farm of Tirhut College of Agriculture, Dholi, Muzaffarapur (Bihar) during *Kharif* 2016.

Table 1: Treatment details

Treatment No.	Insecticides	Dose
T_1	Chlorantraniliprole(20 SC)	0.3 ml/l
T_2	Novaluron (10 EC)	0.1 ml/l
T_3	Flubendiamide (480 SC)	0.2 ml/l
T_4	Deltamethrin (2.8 EC)	0.4 ml/l
T_5	Carbofuran 3G	7 kg/ha
T_6	T_1 + Carbofuran 3G	
T_7	T_2 + Carbofuran 3G	
T_8	T_3 + Carbofuran 3G	
T_9	T_4 + Carbofuran 3G	
T_{10}	Control	

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. The spray formulations were prepared from the commercially available material except carbofuran 3G and all the treatments were applied with manually operated knap sack sprayer whereas carbofuran 3G is applied manually with hands. 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. Observation on the number of infested plants and dead heart from four middle rows in each plot were recorded after each spray. The data thus obtained were merged together to obtain cumulative plant infestation/dead heart caused by maize stem borer. Based on these observations, mean per cent plant infestation as well as dead heart were computed. Treatment effect on pest infestation was further determined by using the formula:

$$\text{per cent plant infestation} = \frac{\text{Number of infested plants/plot}}{\text{Total number of plants/plot}} \times 100$$

Mean (%) reduction in plant infestation/dead heart over untreated control was calculated as follows:

$$\frac{P_1 - P_2 \ldots\ldots P_9}{P_1} \times 100$$

Where,

P_1= plant infestation/dead heart in untreated plot

P_2....P_9= plant infestation/dead heart in treated plot

After harvesting, plot wise seed yield was recorded and converted into quintal per ha. The additional yield over untreated control was also calculated for assessing the yield performance of different treatments by using following formula:

Y_2....Y_9-Y_1

Where,

Y_1= seed yield in untreated control

Y_2....Y_9= seed yield in different treatments.

The benefit cost (B: C) ratio was calculated on the basis of prevailing market price of maize, insecticides and spraying cost. Benefit cost ratio was calculated as follows:

$$\text{B: C Ratio} = \frac{\text{Benefit over control}}{\text{Cost of treatment}} \times 100$$

3. Results and Discussion

The data on mean per cent plant infestation in maize (cv. Ganga Safed-2) due to maize stem borer (*C. partellus*), summarized in Table 2 and illustrated in Fig. 1, revealed a significant variation among different treatments under test. The mean per cent plant infestation due to stem borer was found in the range of 2.2 and 72.6 per cent. The minimum and maximum per cent plant infestation were found in treatments chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha (2.20%) and untreated control (72.60%). The foliar application of chlorantraniliprole 20 SC @ 0.3 ml/l, novaluron 10 EC @ 0.1 ml/l, flubendiamide 480 SC @ 0.2 ml/l and deltamethrin 2.8 EC @ 0.4 ml/l recorded 10.60, 27.62, 10.40 and 13.75 per cent infestation, respectively. Among the sequential treatments chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha evinced minimum per cent plant infestation 2.20. The single application of carbofuran 3G @ 7 kg/ha recorded 12.80 per cent plant infestation. Among the various foliar applications, flubendiamide 480 SC @ 0.2 ml/l showed 10.40 per cent plant infestation and was *at par* with chlorantraniliprole 20 SC @ 0.3 ml/l (10.60%) and carbofuran 3G @ 7 kg/ha (12.80%). However, foliar application of chlorantraniliprole 20 SC @ 0.3 ml/l followed by granular application of carbofuran 3G @ 7 kg/ha recorded minimum per cent plant infestation (2.20 %) and was *at par* with flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (3.52%). Novaluron 10 EC @ 0.1 ml/l was found least effective in minimizing stem borer infestation. All the insecticidal treatments maintained their superiority over untreated control in reducing *C. partellus* infestation but differed among themselves.

It was evident from Table 2 and Fig. 1, that the insecticides were found to exercise varying degree of reduction in per cent infestation. Treatments of foliar application followed by granular application *i.e*., chlorantraniliprole 20 SC @ 0.3 ml/l and carbofuran 3G @ 7 kg/ha, novaluron 10 EC @ 0.1 ml/l and carbofuran 3G @ 7 kg/ha, flubendiamide 480 SC @ 0.2 ml/l and carbofuran 3G @ 7 kg/ha and deltamethrin 2.8 EC @ 0.4 ml/l and carbofuran 3G @ 7 kg/ha brought about higher reduction in pest infestation to the extent of 96.96, 95.15, 93.97 and 84.38 per cent, respectively over untreated control. Application of chlorantraniliprole 20 SC @ 0.3 ml/l, novaluron 10 EC @ 0.1 ml/l, flubendiamide 480 SC @ 0.2 ml/l and deltamethrin 2.8 EC @ 0.4 ml/l as foliar spray, resulted relatively lower performance in pest infestation reduction to the extent of 85.40 to 61.95 per cent over untreated control. Of these, chlorantraniliprole 20 SC @ 0.3 ml/l (85.40%) and flubendiamide 480 SC @ 0.2 ml/l (85.67%) were found most effective in reducing pest infestation. Further, deltamethrin 2.8 EC @ 0.4 ml/l and novaluron 10 EC @ 0.1 ml/l occupied third and fourth positions, respectively in respect of their field efficacy. Application of carbofuran alone showed reduction in pest infestation to the extent of 82.36 per cent over untreated control. Among all the insecticidal treatments, novaluron 10 EC @ 0.1 ml/l recorded least effect (61.95%) in reducing pest infestation over untreated control. The foliar applications in sequence with granular application were found more effective in reducing per cent infestation in comparison to two spraying of different insecticides alone.

It is also noticeable from Table 2 and Fig. 1, that the mean dead heart per cent caused by *C. partellus* in different treatments varied widely from 1.0 to 23.5 per cent. All the insecticidal treatments maintained their superiority over

untreated control in reducing the dead heart caused by *Chilo partellus*. The foliar application of chlorantraniliprole 20 SC @ 0.3 ml/l, novaluron 10 EC @ 0.1 ml/l, flubendiamide 480 SC @ 0.2 ml/l and deltamethrin 2.8 EC @ 0.4 ml/l showed 3.75, 13.55, 4.0 and 6.35 per cent dead heart, respectively. Spraying of novaluron 10 EC @ 0.1 ml/l showed highest dead heart per cent among all the insecticidal treatments. The per cent dead heart in treatments with foliar spray in sequence with granular application were observed as: chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha (1.0%), flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (1.20%), deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (1.70%) and novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha (3.40%). Single application of carbofuran 3G @ 7 kg/ha recorded 5.70 per cent dead heart. Among foliar spray treatments, chlorantraniliprole 20 SC @ 0.3 ml/l recorded 3.75 per cent dead heart and was *at par* with flubendiamide 480 SC @ 0.2 ml/l 4.0 per cent. The treatments chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha recorded minimum per cent dead heart (1.0) and was *at par* with flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (1.20%) and deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (1.70%).

It is evident from the data illustrated in Table 2 and depicted in Fig. 1, that the extent of reduction in dead heart per cent over untreated control caused by *C. partellus* had been brought down effectively due to the application of different treatments. Further, the reduction in dead heart over untreated control due to different treatments varied widely. Based on reduction in mean per cent dead heart over untreated control, 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 (95.74%) > flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha (94.89%) > deltamethrin 2.8 EC @ 0.4 ml/l followed by carbofuran 3G @ 7 kg/ha (92.76%) > chlorantraniliprole 20 SC @ 0.3 ml/l (84.00%) > novaluron 10 EC @ 0.1 ml/l followed by carbofuran 3G @ 7 kg/ha (85.53%) > flubendiamide 480 SC @ 0.2 ml/l (82.97%) > carbofuran 3G @ 7 kg/ha(75.74%) > deltamethrin 2.8 EC @ 0.4 ml/l (72.97%) > novaluron 10 EC @ 0.1 ml/l (42.34%). Among all the insecticidal treatments, chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha and flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha occupied first and second position, respectively and excelled over all the other insecticides in reducing dead heart formation. The foliar application of insecticides followed by granular application of carbofuran 3G @ 7 kg/ha was better in performance than foliar application only with respect to reduction in per cent dead heart formation.

Several workers assessed the efficacy of various insecticides applied as foliar and granular application against *C. partellus* on maize in different parts of the maize growing area of the country [3, 7, 9, 12, 16]. The results obtained with chlorantraniliprole 20 SC and carbofuran 3G among the various insecticides in the present investigation is in close proximity with the reports of [7, 9]. The present findings are not in line with several workers, [9] revealed that carbofuron 3G was the most effective followed by fipronil 4G. [10] also reported that granular insecticides carbofuran 3G was found to be superior in their efficacy against *C. partellus.* These findings are in also not agreement with that of [15] found that cypermethrin was the most effective against *Chilo partellus* (Swinhoe).

Field efficacy of foliar and granular insecticides under investigation was finally assessed and compared based on benefit realized in monetary term and the data pertaining to the economics are presented in Table 3 and illustrated in Fig 2. The gross income accrued in different treatments, chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha showed highest price of additional yield (Rs. 41905.5/ha), while it was lowest (Rs. 12694.5/ha in foliar application with novaluron 10 EC @ 0.1 ml/l. Remaining treatments occupied intermediate positions with wide difference in this respect. The net profit derived from different treatments got affected due to different level of cost involved in these treatments which ranged from Rs. 1620/ha to Rs. 3084/ha. Minimum cost was incurred in deltamethrin 2.8 EC @ 0.4 ml/l and maximum in chlorantraniliprole 20 SC @ 0.3 ml/l. The net profit derived under different treatments varied widely and was highest (Rs. 39081.5/ha) in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha, whereas it was lowest (Rs. 10790.5/ha) in novaluron 10 EC @ 0.1 ml/l. Among the remaining treatments, flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha occupied second position by earning net income of (Rs. 35529.5/ha). Consequently, benefit: cost ratio of insecticides used as foliar spray followed by granular application differed remarkably. It was highest (13.96:1) in case of flubendiamide 480 SC @ 0.2 ml/l in sequence with carbofuran 3G @ 7 kg/ha and lowest in novaluron 10 EC @ 0.1 ml/l (5.66:1).

On the basis of the above findings it is obvious that the application of flubendiamide 480 SC @ 0.2 ml/l followed by carbofuran 3G @ 7 kg/ha, chlorantraniliprole 20 SC @ 0.3 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 proved most economical. However, insecticidal treatment as foliar spray only *viz*., chlorantraniliprole 20 SC @ 0.3 ml/l, novaluron 10 EC @ 0.1 ml/l, flubendiamide 480 SC @ 0.2 ml/l, deltamethrin 2.8 EC @ 0.4 ml/l and granular application of carbofuran 3G @ 7 kg/ha only were less economical. Several workers conducted a similar experiment with different treatments found varied results, [5] reported that the treatments of imidacloprid and cypermethrin 10EC recorded the highest yield of 40.00 and 37.16q/ha. [1] found that indoxacarb 14.5 SC @ 500 ml/ha ranked first with highest cost: benefit ratio of 1:10.74 which was followed by endosulfan, imidacloprid, maize+cowpea (intercropping), Neemarin and *T. Chilonis* with 1:10.74, 1:9.76, 1:8.81, 1:7.63 and 1:4.43 benefit: cost ratio, respectively. [14] found that the maximum cost: benefit ratio was obtained in plot treated with furadan (carbofuran 3G). [8] also reported that, the best and most economical treatment was carbofuran (1:1.91), followed by cypermethrin (1:1.88), fipronil (1:1.70), indoxacarb (1:1.59), cartap (1:1.41), profenophos (1:1.32), imidacloprid (1:1.20) as compared to Control (1:1.11).

Table 2: Effect of insecticides on damage caused by maize stem borer, *Chilo partellus* in maize during *Kharif* 2016

Treatment No.	Insecticides/Dose	Mean (%) Plant infestation	Mean (%) dead heart	Mean (%) reduction over control	
				Plant infestation	Dead heart
T_1	Chlorantraniliprole(20 SC) @ 0.3 ml/l	10.60 (18.98)*	3.75 (11.15)*	85.40	84.00
T_2	Novaluron (10 EC) @ 0.1 ml/l	27.62 (31.68)	13.55 (21.57)	61.95	42.34
T_3	Flubendiamide (480 SC) @ 0.2 ml/l	10.40 (18.74)	4.00 (11.51)	85.67	82.97
T_4	Deltamethrin (2.8 EC) @ 0.4 ml/l	13.75 (21.73)	6.35 (14.58)	81.06	72.97
T_5	Carbofuran 3G @ 7 kg/ha	12.80 (20.89)	5.70 (13.78)	82.36	75.74
T_6	T_1 + Carbofuran 3G	2.20 (8.49)	1.00 (5.43)	97.96	95.74
T_7	T_2 + Carbofuran 3G	11.34 (19.65)	3.40 (10.61)	84.38	85.53
T_8	T_3 + Carbofuran 3G	3.52 (10.49)	1.20 (6.28)	95.15	94.89
T_9	T_4 + Carbofuran 3G	5.10 (12.99)	1.70 (7.48)	93.97	92.76
T_{10}	Control	72.60 (58.44)	23.50 (28.98)	-	-
SEm (±)		(0.96)	(0.40)		
CD (P=0.05)		(2.86)	(1.20)		

*Figures in parentheses are the values of angular transformation.

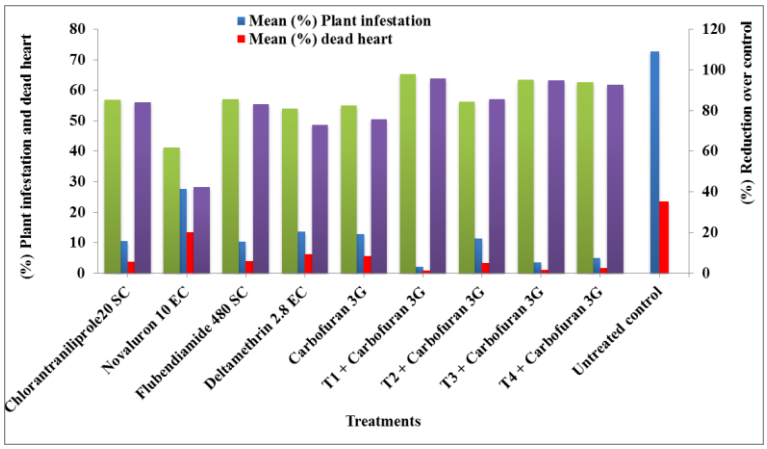

Fig 1: Effect of insecticides against *Chilo partellus* (Swinhoe) infesting maize during *Kharif* 2016

Table 3: Cost-benefit analysis of insecticides used as crop protectant

Treatments/Dose	Yield (q/ha)	Additional yield over control (q/ha)	Price of additional yield (Rs/ha)	Cost of treatment (Rs/ha)	Net profit over control (Rs/ha)	B: C ratio
Chlorantraniliprole(20 SC) @ 0.3 ml/lit	36.2	21.5	29347.5	3084	26263.5	8.51:1
Novaluron (10 EC) @ 0.1 ml/lit	24.0	9.3	12694.5	1904	10790.5	5.66:1
Flubendiamide (480 SC) @ 0.2 ml/lit	31.5	16.8	22932	2524	20408	8.08:1
Deltamethrin (2.8 EC) @ 0.4 ml/lit	29.3	14.6	19929	1620	18309	11.30:1
Carbofuran 3G @ 7 kg/ha	28.2	13.5	18427.5	1764	16663.5	9.44:1
T_1 + Carbofuran 3G	45.4	30.7	41905.5	2824	39081.5	13.83:1
T_2 + Carbofuran 3G	32.0	17.4	23751	2224	21527	9.64:1
T_3 + Carbofuran 3G	42.6	27.9	38083.5	2544	35539.5	13.96:1
T_4 + Carbofuran 3G	36.5	21.8	29757	2152	27605	12.82:1
Control	14.7	-	-	-	-	-

Selling price of maize: Rs.1365/q, Cost of insectisides *viz*., Chlorantraniliprole 20 SC = Rs.16000/lit, Novaluron 10 EC = Rs. 18500/lit, Flubendiamide 480 SC = Rs.17000/lit, Deltamethrin 2.8 EC = Rs.2280/lit, Carbofuran 3G = Rs.100/kg, No. of labourers/ha = 3, Wages of each labour = Rs. 194/day, Total no. of labours = 6, Total wages = Rs. 1164/ha.

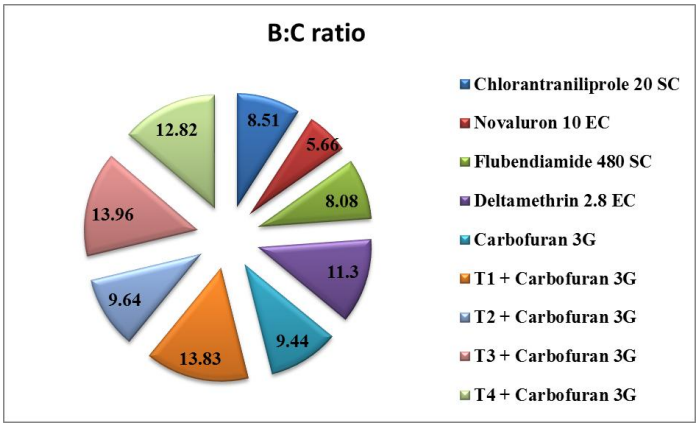

Fig 2: Economics of insecticides used for management of maize stem borer, *Chilo partellus* (Swinhoe) on maize cv. GS-2 during *Kharif* 2016

4. Conclusion

Out of various insecticides evaluated against maize stem borer, the minimum and maximum mean per cent infestation as well as mean per cent dead heart were recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha and untreated control, respectively. The least mean per cent reduction over control in plant infestation as well as dead heart was found in novaluron 10 EC @ 0.1 ml/l whereas, highest mean per cent reduction over control in plant infestation as well as dead heart was recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha. The maximum and yield was recorded in chlorantraniliprole 20 SC @ 0.3 ml/l followed by carbofuran 3G @ 7 kg/ha treated plot. However, minimum yield (q/ha) was recorded in untreated control. Among all the insecticidal treatments used for management of *Chilo partellus*, the highest benefit: cost ratio was evinced in insecticidal treatment flubendiamide 480 SC @ 0.2 ml/l in sequence with carbofuran 3G @ 7 kg/ha. In addition to the above facts, the newer insecticides used in the present study has long lasting activity with new mode of action, effective at very low dose, low residual effect and safe to non-target species. The use of insecticides in sequence with different mode of action reduces the chance of resistance development in insect and proves better in controlling the insect pest.

5. Acknowledgements

The authors wish to acknowledge the Chairman, Department of Entomology, Dr. Rajendra Prasad central agricultural university, Pusa for providing necessary constructive help, financial support and other technical inputs to carry out the study.

6. References

1. Ali N, Singh G, Singh SP, Dhaka SS, Ram M, Tawar KB. Efficacy of different management practices against *Chilo partellus* (Swinhoe) in *Kharif* maize in Western Uttar Pradesh. International Journal of Advanced Research. 2014; 2(11):952-956.
2. Anonymous. Agriculture statistics at a glance. 2014; Govt. of India.
3. Anuradha M. Evaluation of chlorantraniliprole (Coragen 20 SC) against maize stem borers. International Journal of Plant Protection. 2013; 6(1):155-158.
4. Arunkumara CG, Bheemanna M, Shaila HM. Field evaluation of insecticides for management of spotted stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) on maize. Journal of Entomology and Zoology Studies 2017; 5(5): 1719-1723.
5. Bhat ZH, Baba ZA. Efficacy of different insecticides against maize stem borer *Chilo partellus* (Swinhoe) and maize aphid *rhopalosiphum maidis* (fitch) infesting maize. Journal of Pakistan Entomology. 2007; 29(2):73-76.
6. Jalali SK, Singh SP. Seasonal activity of stem borers and their natural enemies on fodder maize. Entomon. 2002; 27(2):137-146.
7. Kulkarni S, Mallapur CP, Balikai RA. Bio-efficacy of insecticides against maize stem borers. Journal of Experimental Zoology. 2015; 18(1):233-236.
8. Kumar A, Kumar A, Meena RK, Punam. Field efficacy of seven insecticides against *Chilo partellus* (Swinhoe) on maize (*Zea mays* L.) in Allahabad. Journal of Entomology and Zoology Studies 2017; 5(5): 46-48.
9. Kumar R, Jindal J. Economic evaluation of biorational and conventional insecticides for the control of maize stem borer, *Chilo partellus* (Swinhoe) in *Zea mays*. Journal of Applied and Natural Science. 2015; 7(2):644-648.
10. Radha ITS, Madhumathi T, Rao PA, Rao VS. Studies on management of major insect pests on maize with different groups of insecticides. Indian Journal of Plant protection. 2006; 34(2):252-255.
11. Saleem Z, Iqbal J, Khattak SG, Khan M, Muhammad N, Khan FU, Fayyaz H. Effect of different insecticides against maize stem borer infestation at Barani agricultural research station, Kohat, KPK, Pakistan during *Kharif* 2012. International Journal of Life Sciences Research. 2014; 2(1):23-26.
12. Siddalingappa, Thippeswamy C, Hosamani V, Yalavar S. Evaluation of new insecticide molecules, botanicals and biopesticides against maize stem borer, *Chilo partellus* (Swinhoe) Lepidoptera: Crambidae. International Journal of Plant Protection. 2010; 3(1):124-126.
13. Siddiqui KH, Marwaha KK. The vistas of maize entomology in India. Kalyani Publishers, New Delhi, India.1993; pp.184.
14. Singh A, Kumar A, Dwivedi A, Mishra PK. Management of stem borer, *Chilo partellus* (Swinhoe) on maize crop. Progressive Research. 2014; 9(2):284-286.
15. Singh JP Marwaha KK. Persistence and residual toxicity of insecticides on maize leaves/whorls against freshly hatched larvae of maize stalk borer, *Chilo partellus* (Swinhoe). Indian Journal of Entomology.1996; 57: 213-218.
16. Singh P, Sharma RK. Effect of insecticides for the control of maize stem borer, *Chilo Partellus* (Swinhoe). Mysore Journal of Agriculture Sciences. 2009; 43(3):577-578.
17. Songa JM, Zohu G, Overholt WA. Relationship of stem borer damage and plant physical condition to maize yield in a semi arid zone of Eastern Kenya. Insect Science Appliances. 2001; 21(3):243-249.