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Field efficacy of certain insecticides against maize stem borer [*Chilo partellus* (Swinhoe)]

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Abstract
The present investigation entitled "Field efficacy of certain insecticides against Maize stem borer [*Chilo partellus* (Swinhoe)]" was conducted at the Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. during *Kharif* 2018. Among all the treatments studied, lowest per cent infestation of stem borer was recorded in Carbofuran (7.98), followed by Spinosad (9.71), Chlorpyriphos + Cypermethrin (11.10), Chlorpyriphos (11.45), Fipronil (12.14), Imidacloprid (12.84) and Dimethoate (14.92). The treatment Dimethoate (14.92) was least effective among all the treatments. The best and most economical treatment was T_4 Carbofuran 3%G (1:1.96) followed by T_3 Spinosad (1:1.80), T_1 Chlorpyriphos 50%EC+ Cypermethrin 5%EC (1:1.68), T_2 Fipronil 0.3% Gr (1:1.59), T_5 Imidacloprid 17.8 %SL (1:1.59), T_6 chlorpyriphos 20% EC (1:1.52), T_7 Dimethoate 30% EC (1:1.32) as compared to T_8 Control (1:1.21). All the treatments were found significantly superior to untreated control in reducing the maize stem borer infestation.

Keywords: Maize stem borer, *Chilo partellus*, efficacy, insecticides, cost benefit ratio

Introduction
Maize (*Zea mays* L.) belongs to family Poaceae. It is the third most important staple food of India after wheat and rice. Maize was introduced to India from Central America in the beginning of seventeenth century. It is a miracle crop with very high yield potential. It is one of the most important cereal grains grown worldwide in a wide range of environments because of its greater adaptability. Due to its high yield potential among all the cereals, maize is referred as "Queen of cereals."

Maize is one of the main source of cereals for food, in addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that include starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries, more recently as bio-fuel etc. The production of maize is constantly increasing because of the rising demand from the industries.

Production of maize is expected to be 18.73 million tonnes which is marginally lower by 0.52 million tonnes than that of last year's record production Annual report 2017-2018 [1]. In India average area of maize is 9.43 million hectare with an average production of 22.23 million tonnes having average productivity of 2.5 t/ha Kumar and Alam 2017 [6]. In Uttar Pradesh, it is grown in an area of 8.47 lakh hectare with a production of 11.17 lakh tons and the productivity was 1326 kg/ha in 2016-17. In Uttar Pradesh maize is largely grown in Bulandshahr, Farrukhabad, Meerut, Bahraich, Gonda, Jaunpur, Etawah, Mainpuriand Kheri districts.

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 25 to 78 percent Rani *et al*., 2018 [8]. Infestation by *C. partellus* on maize starts with ovi-position on the leaves. The stem borers initially damage by feeding on the leaf tissues, followed by tunneling and feeding within the stem. Parallel 'shot hole' symptom on leaves are also formed. When the infestation is severe, the larvae, either in the leaf whorl or in the stem, can cut through the meristematic tissues, the central leaves dry up to produce the 'dead heart' symptom, resulting in the death of the plant.

Materials and Methods
Field experiment was conducted at the Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. during *Kharif* 2018.

Trial was laid out in a randomized block design consisting of eight treatments including control. Each treatment was replicated thrice and SRMH-445 hybrid maize was sown with spacing of 60 cm between row to row and 20 cm between plant to plant by placing 1-2 seeds per hill at depth of 4 cm. Application of treatments for the management of the *Chilo partellus* was initiated as soon as 5-10% ETL of infestation observed in experimental field. The observations were made by counting the total number of plants and number of infested plants (number of Dead hearts, pin holes and Leaf scrapping symptom present on the leaves) from each plot. While recording observations on stem borer the middle whorl of the plant was gently plucked and observed the pest. The observations were made a day before followed by 3^{rd}, 7^{th} and 14^{th} days after spraying. Observations were recorded without disturbing the plants to minimize the observational errors. The percentage of the infestation of the insect population was calculated according to the following equation:

Percent Infestation = [No. of infected plants / Total number of plants] × 100 (Kumar and Alam 2017) [5]

Results and Discussions

Among all the treatments studied, lowest per cent infestation of stem borer was recorded in Carbofuran (7.98), followed by Spinosad (9.71), Chlorpyriphos + Cypermethrin (11.10), Chlorpyriphos (11.45), Fipronil (12.14), Imidacloprid (12.84) and Dimethoate (14.92). The treatment Dimethoate (14.92) was least effective among all the treatments. All the treatments were found significantly superior to untreated control in reducing the maize stem borer infestation.

In the present research work lowest percent infestation was recorded in carbofuran treated plot (7.98%) similar findings were also reported by Kumar and Kumar (2017) [4] reported that carbofuran treated plot shown lowest percent infestation of chilo partellus (7.70%) while the infestation in control plot was 23.12%. Kumar and Alam (2017) [5] reported 9.25% infestation in carbofuran treated plots while the infestation in control plot was 49.55%. Similar findings were also reported by Neupane *et al*., (2016) [7] 10.80% infestation in carbofuran treated plots while the infestation in control plot was 17.20%.

Spinosad treated plot showed (9.71%) percent infestation of *Chilo partellus* similar findings were also reported by Krishna and kumar (2018) [3] noticed (8.64%) infestation of *Chilo partellus* in spinosad treated plot while the infestation in control plot was 21.81%. Similarly Neupane *et al*., (2016) [7] reported that 5.30% infestation in spinosad treated plots, while the infestation in control plot was 17.20%. Mean percent infestation of Dimethoate treated plot is (14.92%) which is also found similar to (15.07%) reported by Krishna and kumar (2018) [3] while the infestation in control plot was 21.87%. Similarly Dinesh *et al*., (2018) [2] observed 11.70% percent infestation in Dimethoate plot while the infestation in control plot was 22.80%. Percent infestation of Fipronil treated plot is (12.14%) which is also found similar to 11.00% reported by Neupane *et al*., (2016) [7] while the infestation in control plot was 17.20%. Similarly Kumar and Kumar (2017) [4] reported 13.38% infestation in fipronil treated plot while the infestation in control plot is 22.92%. Mean percent infestation of imidacloprid treated plot is (12.84%) similar findings were reported by Neupane *et al*., (2016) [7] (7.60%) infestation in imidacloprid plot while the infestation in control plot was 17.20%. Similarly Krishna and kumar (2018) [2] reported 12.77% infestation in imidacloprid treated plot while the infestation in control plot is 18.84%. Similar findings were also reported by Kumar and Kumar (2017) [4] 19.47% infestation in Imidacloprid treated plot while the infestation in control plot is 26.90%. Chlorpyriphos 50% EC + Cypermethrin 5% EC treated plots shown (11.10)% infestation similar findings were reported by Neupane *et al*., (2016) [7] reported (6.60%) infestation in treated plot while the infestation in control plot is 17.20%. Similarly Krishna and Kumar (2018) [3] reported 10.13% infestation in Chlorpyriphos 50%EC + Cypermethrin 5%EC treated plot while the infestation in control plot is 21.87%.

11.45% percent infestation was found in Chloropyriphos 20%EC treated plot. Similar findings were also reported by Neupane *et al*., (2016) [7] reported 8.80% percent infestation in Chloropyriphos 20% EC treated plot while the infestation in control plot is 17.20% Similarly Dinesh *et al*., (2018) [2] reported 11.70% infestation in Chloropyriphos 20%EC treated plot while the infestation in control plot is 22.80%.

It was evident from Table 2 that the yields among the treatments were significant. The highest yield was recorded in T_4 Carbofuran 3% G (46.40 q/ha) followed by T_3 Spinosad (42.30 q/ha), T_1 Chlorpyriphos 50%EC +Cypermethrin 5%EC (39.80 q/ha), T_2 Fipronil 0.3% Gr (38.10 q/ha), T_5 Imidacloprid 17.8 %SL (37.50), T_6 chlorpyriphos 20% EC (36.20), T_7 Dimethoate 30% EC (31.42 q/ha), T_0 Control (27.80). Highest yield was recorded in Carbofuran 3% G (46.40 q/ha) Similar findings were in conformity with Rani *et al.*, (2018) [8] reported that the higher crop yield was observed in carbofuran treated plot (5.89 tonnes/ha). Yield recorded in Spinosad treated plot is (42.30 q/ha), similarly Neupane *et al*., (2016) [7] reported 4.52 (tones/ha). Chlorpyriphos 50%EC +Cypermethrin 5%EC is the 3rd best treatment recorded a yield of (39.80 q/ha) similar findings reported by Krishna and kumar (2018) [3] (38.60q/ha). Yield recorded in Fipronil 0.3% Gr is (38.10 q/ha) similar findings reported by Kumar and Kumar (2017) [4] reported (37.44 q/ha). Imidacloprid 17.8%SL treated plot recorded a yield of (37.50 q/ha. Krishna and kumar (2018) [3] reported (29.60q/ha). Chlorpyriphos 20% EC treated plot recorded a yield of (36.20) similarly (4.13t/ha) yield was reported by Neupane *et al*., (2016) [7], Dimethoate 30% EC plot recorded an yield of (31.42 q/ha) similarly Krishna and kumar (2018) [3] reported (27.50 q/ha). In Control plot (27.80 q/ha) yield is recorded.

Table 1: Field efficacy of certain insecticides against Maize stem borer [*Chilo partellus* (Swinhoe)]

S.NO	Treatments	Per cent infestation				
		1DBS	3DAS	7DAS	14DAS	Mean
T_1	Chlorpyriphos50% EC + Cypermethrin5%EC	18.74 (25.60)	13.54^{bc} (21.56)	10.41^{bcd} (18.78)	9.37^{cd} (17.66)	11.10^{cd} (19.41)
T_2	Fipronil 0.3% Gr	19.79 (26.39)	14.58^{bc} (22.42)	11.45^{bcd} (19.74)	10.41^{bc} (18.78)	12.14^{bcd} (20.34)
T_3	Spinosad 45SC	21.87 (27.84)	11.45^{c} (19.74)	9.37^{cd} (17.66)	8.33^{cd} (16.70)	9.71^{de} (18.12)
T_4	Carbofuran 3%G	22.91 (28.55)	10.41^{c} (18.78)	7.29^{d} (15.59)	6.24^{d} (14.15)	7.98^{e} (16.31)
T_5	Imidacloprid 17.8%SL	17.70 (24.74)	14.58^{bc} (22.42)	12.49^{bc} (20.60)	11.45^{bc} (19.74)	12.84^{bc} (20.97)
T_6	Chlorpyriphos 20%EC	16.66 (23.80)	12.49^{bc} (20.43)	11.45^{bcd} (19.64)	10.41^{bc} (18.78)	11.45^{cd} (19.76)
T_7	Dimethoate 30%EC	19.79 (26.31)	16.66^{ab} (24.07)	14.58^{b} (22.35)	13.54^{b} (21.56)	14.92^{b} (22.70)
T_8	Control	17.70 (24.86)	19.79^{A} (26.39)	22.91^{A} (28.58)	24.99^{a} (29.96)	22.56^{a} (28.33)
F-test		NS	S	S	S	S
S. Ed. (±)		3.54	3.92	4.11	1.90	3.30
C.D. (P = 0.05)		-	3.69	4.07	4.00	2.23

Figures in parentheses are Arc sin transformed values
DBS : Day Before Spray, DAS : Day After Spray

Table 2: Economics of cultivation

S. No:	Treatment	Yield of q/ha	Cost of yield / Rs/q	Total cost of yield	Common cost (Rs)	Treatment cost [Rs]	Total cost (Rs)	C:B ratio
01	Chlorpyriphos 50% EC+ Cypermethrin 5%EC	39.80	1600 Rs/q	63680	36681	1020	37701	1:1.68
02	Fipronil 0.3% Gr	38.10	1600 Rs/q	60960	36681	1485	38166	1:1.59
03	Spinosad 45 SC	42.30	1600 Rs/q	67680	36681	770	37451	1:1.80
04	Carbofuran 3%G	46.40	1600 Rs/q	74240	36681	1050	37731	1:1.96
05	Imidacloprid 17.8% SL	37.50	1600 Rs/q	60000	36681	850	37531	1:1.59
06	Chlorpyriphos 20%EC	36.20	1600 Rs/q	57920	36681	1050	37731	1:1.52
07	Dimethoate 30%EC	31.42	1600 Rs/q	50272	36681	1181	37862	1:1.32
08	Control	27.80	1600 Rs/q	44480	36681	0	36681	1:1.21

Conclusion

Among the various insecticides evaluated against stem borer, spray revealed that Carbofuran 3%G was found to be more effective than other treatments, followed by Spinosad, Chlorpyriphos 50% EC+ Cypermethrin5 %EC, Chlorpyriphos 20%EC, Fipronil 0.3%GR, Imidacloprid 17.8%SL and Dimethoate 30%EC. Least effective among the chemical treatments is Dimethoate 30%EC but significant and superior over control.

Among the treatments studied, the best and most economical treatment was T_4 Carbofuran 3%G (1:1.96) followed by T_3 Spinosad (1:1.80), T_1 Chlorpyriphos 50%EC+ Cypermethrin 5%EC (1:1.68), T_2 Fipronil 0.3% Gr (1:1.59), T_5 Imidacloprid 17.8 %SL (1:1.59), T_6 chlorpyriphos 20% EC (1:1.52), T_7 Dimethoate 30% EC (1:1.32), T_0 Control (1:1.21).

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