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Comparative efficacy and economics of selected insecticides against maize stem borer, *Chilo partellus* (Swinhoe)

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Abstract
The field experiment was conducted in *kharif* season of 2023-2024 at Central Research Farm (CRF), SHUATS, Uttar Pradesh, India. The experiment was laid in Randomized Block Design with eight treatments each replicated thrice *viz*., Imidacloprid 17.8%SL (T_1), Azadirachtin 00.03% EC (Neem oil) (T_2), Emamectin benzoate 5%SG (T_3), Spinosad 45% SC (T_4), Nisco sixer plus (T_5), Chlorpyriphos 50%+ Cypermithrin 5% EC (T_6), Profenofos 40% + cypermethrin 4% EC (T_7) and control plot (T_8). The data on larval population of *Chilo partellus* after first and second spray revealed that all the treatments were significantly superior over control. Among all treatments, Profenofos 40% + cypermethrin 4% EC (5.13 and 2.17) recorded lowest larval population of *Chilo partellus* after both sprays followed by Chlorpyriphos 50%+ Cypermithrin 5% EC (5.48 a n d 2. 60), Spinosad 45% SC (6.04 and 2.97), Imidacloprid 17.8%SL (6.33 and 3.37), Emamectin benzoate 5% SG (6.73 and 3.77), Nisco sixer plus (7.13 and 4.17), Azadirachtin 00.03%EC (Neem oil) (7.53 and 4.62) was the least effective among all treatments respectively. While, the highest yield 60.56q/ha was obtained from the treatment Profenofos 40% + Cypermethrin 4% EC as well as C:B ratio 1:2.74 followed by Chlorpyriphos 50%+ Cypermethrin 5% EC (49.32 and 1:2.23), Spinosad 45% SC (42.3 and 1:1.92), Imidacloprid 17.8%SL (41.4 and 1:1.86), Emamectin benzoate 5% SG (40.29 and 1:1.85), Nisco sixer plus (37.5 and 1:1.69), Azadirachtin 00.03%EC (Neem oil) (36.26 and 1:1.68) and c o n t r o l (25.4 and 1:1.24).

Keywords: Botanicals, *Chilo partellus*, maize, insecticides, yield, economics

Introduction

The most important crop in the world, maize (*Zea mays* L.) is widely grown as a cereal grain that was domesticated in Central America. With a greater range of adaptation, it is among the most adaptable developing crops. Due to its greatest genetic production potential, maize is referred to as the "queen of cereals" throughout the world (Kumar *et al*. 2011) [6].

India is the world's fifth largest producer of maize, accounting for 3 percent of worldwide production. Currently, 55% of total maize production is used for food, 14% for cattle, 18% for poultry feed, 12% for starch, and 1% for seed. (Kumar *et al*. 2017) [8]. It is also produced in Andhra Pradesh (20.9%), Maharashtra (9.1%), Karnataka (16.5%), Rajasthan (9.9%), Bihar (8.9%), Uttar Pradesh (6.1%), and Madhya Pradesh (5.7%) (Rameash *et al*. 2012) [10].

In India, there are 9.43 million hectares of maize planted, with an average productivity and production of 2.5 and 22.23 million tons per hectare, respectively. Given, that maize is the third most important grain after wheat and rice, and that it is now grown on 1.026 million hectares of land with 2.986 million tons of grain and an average national yield of 2893 kg/ha, Pakistan has ample advantages to cultivate this crop (Kumar *et al*. (2017) [8].

About 250 insect and mite pest species have been found to be affecting this crop, with just half a dozen being economically significant, threatening to limit crop yield. Among the many insect pests, the maize stem borer, *Chilo partellus*, is the most important pest, accounting for 90-95% of overall damage during the *Kharif* season. *Chilopartellus* (Lepiodoptera: Crambidae) is the most damaging pest to maize (Kumar and Alam 2017) [8].

The invasion of this insect has resulted in yield losses ranging from 24% to 75% in some places. Maize stem borer causes crop losses ranging from 24% to 84%. Stemborer yield losses in maize vary greatly across locations, ranging from 25-40% depending on pest population density and crop phenological stage at infestation (Khan *et al*. 2015) [4].

Materials and Methods

The experiment was carried out at the Central Research Farm of Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj. The research field is located on the right side of Rewa Road at 25 °27' North Latitude and 80°51' East Longitude, approximately 98m above mean sea level. Prayagraj has a typical subtropical climate, as does the eastern region of Uttar Pradesh. Summer and winter weather extremes can be found here. Summer maximum temperatures reached 49°C, while winter minimums were 2.5 ºC. The research trail was laid out in *kharif* 2023-2024 using a Randomised Block Design (RBD), with eight distinct treatments replicated three times. The plot measured 2 x 1 square meters. Maize seeds of variety 'Suvarna' were sown in plots with a row to row and plant to plant distance of 45 × 30 cm.

The treatments employed in the experiment were Imidacloprid 17.8% SL (1.5ml/l), Azadirachtin 00.03% EC (Neem oil) (0.5ml/l), Emamectin benzoate 5% SG (0.2gm/l), Spinosad 45% SC (0.2ml/l), Nisco sixer plus(2ml/l), Chlorpyriphos 50% + Cypermethrin 5% EC (1.5ml/l), Profenofos 40% + Cypermethrin 4% EC (1.5ml/l) and control. During the experiment, two sprays were performed at 15- day intervals to evaluate pesticide efficacy when the *Chilo partellus* larval population reached the ETL threshold.

The insect population was counted from randomly selected plants in each plot, and the population per five plants was calculated. The mean of three replications was obtained for each treatment and compared to the untreated plot. The population of *Chilo partellus* was counted before and after one day of spraying, as well as on the third, seventh-, and fourteenth-days following insecticide application. Healthy cobs were harvested, and their weight from each treatment was converted into marketable output in quintals per hectare. Finally, the cost benefit ratio was estimated using the current market prices of yield, pesticides, and spraying costs (Charitha and Kumar (2023) [2].

$$\text{Larval population} = \frac{\text{Total no of larva}}{\text{5 randomly selected plants}}$$

$$\text{Cost benefit Ratio} = \frac{Gross\ returns}{\text{Total cost incurred}}$$

Results and Discussion

The results (Table -1) after the first and second sprays demonstrated that all treatments were significantly superior to the control. The data on the mean larvae population of maize stem borer *Chilo partellus* 3rd, 7th, and 14th day after the first spray revealed that all of the chemical treatments were considerably superior to the control. Among all the treatments lowest larval population of *Chilo partellus* was recorded in Profenofos 40% + Cypermethrin 4% EC (5.13), Chlorpyriphos 50% + Cypermethrin 5% EC (5.48), Spinosad 45% SC (6.04), Imidacloprid 17.8% SL (6.33), Emamectin benzoate 5% SG (6.73), Nisco sixer plus (7.13), Azadirachtin 00.03% EC (Neem oil) (7.53) and control (12.53).

The data on the mean larval population of maize stem borer *Chilo partellus* 3rd, 7th, and 14th days after the second spray showed that all treatments outperformed the control. Among all treatments, the lowest larval population of *Chilo partellus* was reported in Profenofos 40% + Cypermethrin 4% EC (2.17), Chlorpyriphos 50% + Cypermethrin 5% EC (2.60), Spinosad 45% SC (2.97), Imidacloprid 17.8% SL (3.37), Emamectin benzoate 5% SG (3.78), Nisco sixer plus (4.17), Azadirachtin 00.03%EC (Neem oil) (4.62) and control (15.73).

The highest yield and cost benefit ratio was recorded in Profenofos 40% + Cypermethrin 4% EC (60.56q/ha) and (1:2.74) followed by Chlorpyriphos 50% + Cypermethrin 5% EC (49.32q/ha and 1:2.23), Spinosad 45% SC (42.3q/ha and 1:1.92), Imidacloprid 17.8% SL (41.4q/ha and 1:1.86), Emamectin benzoate 5% SG (40.29q/ha and 1:1.85), Nisco sixer plus (37.5q/ha and 1:1.69), Azadirachtin 00.03%EC (Neem oil) (36.26 and 1:1.68) and control (25.4q/ha and 1:1.24).

The data on the mean larval population in the first and second spray in Profenofos 40% + Cypermethrin 4% EC were (5.13) and (2.17). These results were supported by Srujana *et al*. (2021) [15] and Kamakshi *et al*. (2023) [3]. Chlorpyriphos 50% + Cypermethrin 5% EC was also found to be very effective (5.48) and (2.60). These findings are supported by Ravikumar *et al*. (2022) [11] and Thumar *et al*. (2020) [16]. Spinosad 45% SC (6.04) and (2.97). The findings are supported by Reddy and Kumar (2019), and Kumar *et al*. (2017) [8]. Imidacloprid 17.8% SL (6.33) and (3.37), these results are supported by Prakesh *et al*. (2017) [9] and Reddy and Kumar (2021) [13].

The cost benefit ranged between 1:2.74 and 1:1.24. Maximum cost benefit ratio (1:2.74) and yield (60.56q/ha) was obtained in Profenofos 40% + Cypermethrin 4% EC treated plants, which is supported by Kamakshi *et al*. (2023) [3] and Srujana *et al*. (2021) [15], followed by cost benefit ratio (1:2.23) and yield (49.32q/ha) were reported in Chlorpyriphos 50% + Cypermethrin 5% EC treated plants, and the results were supported by Ahir *et al*. (2021) [1] and Thumar *et al*. (2020) [16]. Spinosad 45% SC and Imidacloprid 17.8% SL were also had a profitable yield of (42.3q/ha) and (41.4q/ha) and cost benefit ratio (1:1.92) and (1:1.86) these findings are supported by Reddy and Kumar (2019) [12], Shirisha *et al*. (2021) [15] and Singh and Yadav (2023) [14], Reddy and Kumar (2021) [13].

Table 1: Efficacy of selected insecticides on the larval population of *Chilo partellus* on maize after the 1st and 2nd spray

S. No.	Treatments	Number of larval Population per 5 plants											Pooled mean	Yield (q/ha)	C: B Ratio
		Dosage	First spray					Second spray							
			1DBS	3DAS	7DAS	14DAS	MEAN	1DBA	3DAS	7DAS	14DAS	MEAN			
T$_1$	Imidacloprid 17.8% SL	1.5ml/L	08.53	07.20^{de}	05.40^{e}	06.40^{e}	06.33^{cd}	06.40^{e}	04.33^{e}	02.40^{e}	03.40^{e}	03.37^{cde}	4.85	41.4	1:1.86
T$_2$	Azadirachtin 00.03%EC (Neem oil)	0.5ml/L	09.00	08.40^{b}	06.60^{b}	07.60^{b}	07.53^{b}	07.60^{b}	05.53^{b}	03.73^{b}	04.60^{b}	04.62^{b}	6.07	36.26	1:1.68
T$_3$	Emamectin benzoate 5% SG	0.2gm/L	08.93	07.60^{cd}	05.80^{d}	06.80^{d}	06.73^{bc}	06.80^{d}	04.73^{d}	02.80^{d}	03.80^{d}	03.77^{bcd}	5.25	40.29	1:1.85
T$_4$	Spinosad 45% SC	0.2ml/L	08.00	06.80^{ef}	05.33^{e}	06.00^{f}	06.04^{cde}	06.00^{f}	03.93^{f}	02.00^{f}	03.00^{f}	02.97^{def}	4.51	42.3	1:1.92
T$_5$	Nisco sixer plus	2ml/L	09.06	08.00^{bc}	06.20^{c}	07.20^{c}	07.13^{bc}	07.20^{c}	05.13^{c}	03.20^{c}	04.20^{c}	04.17^{bc}	5.65	37.5	1:1.69
T$_6$	Chlorpyriphos 50% + Cypermethrin 5% EC	1.5ml/L	08.20	06.40^{fg}	04.53^{f}	05.53^{g}	05.48^{de}	05.53^{g}	03.53^{g}	01.60^{g}	02.66^{g}	02.60^{ef}	4.04	49.32	1:2.23
T$_7$	Profenofos 40% + Cypermethrin 4% EC	1.5ml/L	08.40	06.00^{g}	04.20^{g}	05.20^{h}	05.13^{e}	05.20^{h}	03.13^{h}	01.20^{h}	02.20^{h}	02.17^{f}	3.65	60.56	1:2.74
T$_8$	Control	-	10.00	11.26^{a}	12.53^{a}	13.80^{a}	12.53^{a}	13.80^{a}	14.60^{a}	15.66^{a}	17.00^{a}	15.75^{a}	14.13	25.4	1:1.24
	F-test		NS	S	S	S	S	S	S	S	S	S	S		
	S. ED (±)		0.316	0.108	0.007	0.001	0.304	0.001	0.019	0.013	0.004	0.296	1.676		
	C.D. (P = 0.5)		-	0.685	0.181	0.072	1.149	0.072	0.286	0.240	0.135	1.133	3.642		

Conclusion

From the critical analysis of the present findings, it can be concluded that, among all the treatments Profenofos 40% + Cypermethrin 4% EC is more effective in controlling larval population of *Chilo partellus* followed by Chlorpyriphos 50% + Cypermethrin 5% EC, Spinosad 45% SC, Imidacloprid 17.8% SL, Emamectin benzoate 5% SG, Nisco sixer plus, and Azadirachtin 00.03%. Among the treatments studied, Profenofos 40% + Cypermethrin 4% EC gave the highest cost benefit ratio (1:2.74) and marketing yield (60.56 q/ha) followed by Chlorpyriphos 50% + Cypermethrin 5% EC (1:2.23 and 49.32 q/ha), Spinosad 45% SC (1:1.92 and 42.3), Imidacloprid 17.8% SL (1:1.86 and 41.4 q/ha), Emamectin benzoate 5% SG (1:1.85 and 40.29q/ha), Nisco sixer plus (1:1.69 and 37.5 q/ha), and Azadirachtin 00.03%EC (Neem oil) (1:1.68 and 36.26q/ha) respectively as such more trails are required in future to validate the findings.

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