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## Efficacy of selected insecticides against fall army worm [*Spodoptera frugiperda* (J. E. Smith)] on maize (*Zea mays* L.)

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### Abstract

A field experiment was conducted during *kharif* 2022 at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh India. The experiment was conducted in Randomized Block Design with eight treatments and replicated thrice *viz.*, Chlorantraniliprole 18.5% EC (T<sub>1</sub>), Emamectin benzoate 5% SG (T<sub>2</sub>), Spinosad 45% SC (T<sub>3</sub>), Spinetoram 11.7% SC (T<sub>4</sub>), Nisco sixer plus (T<sub>5</sub>), Azadirachtin 0.1% EC (T<sub>6</sub>), *Metarhizium anisopliae* (1 x 10<sup>8</sup>) CFU (T<sub>7</sub>) and control plot (T<sub>8</sub>). Results revealed that among the different treatments Spinetoram 11.7% SC (1.889) proved to be the most effective treatment followed by Emamectin benzoate @ 5% SG (2.045), Chlorantraniliprole 18.5% EC (2.300), Spinosad 45% SC (2.456), Nisco Sixer plus (2.834), *Metarhizium anisopliae* (1 x 10<sup>8</sup>) CFU (3.600), whereas Azadirachtin 0.1% EC (4.100) was found to be least effective against this pest. Among all the treatments, the cost benefit ratio has been analyzed, in which the highest was Spinetoram 11.7% SC (1:2.74) and marketable yield (42.4 q/ha) followed by Emamectin benzoate 5% SG (1:2.53 and 38.50 q/ha), Chlorantraniliprole 18.5% EC (1:2.07 and 34.20 q/ha), Spinosad 45% SC (1:1.94 and 31 q/ha), Nisco Sixer plus (1:1.65 and 28.30 q/ha), *Metarhizium anisopliae* (1 x 10<sup>8</sup>) CFU (1:1.56 and 26.10 q/ha) and the lowest was Azadirachtin 0.1% EC (1:1.51 and 24.4 q/ha) have been recorded.

**Keywords:** botanicals, biopesticides, efficacy, fall armyworm, insecticides

### Introduction

Maize, *Zea mays* L. is a member of the family: Poaceae also known as corn. It is one of the most flexible growing crops with greater adaptability to different agro-climatic conditions. Because of higher genetic yield potential among the cereals, this crop is globally popular as the "Queen of cereals" (Reddy *et al.*, 2021)<sup>[17]</sup>. Maize kernel is an edible and nutritive part of the plant. The composition of maize kernel is presented It also contains vitamin C, vitamin E, vitamin K, vitamin B<sub>1</sub> (thiamine) etc. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it. (Kumar and Jhariya, 2013)<sup>[9]</sup>.

The major maize growing states are Karnataka (14.8%), Maharashtra (10.9%), Madhya Pradesh (10.8%), undivided Andhra Pradesh (10.4%), Rajasthan (10.6%), Uttar Pradesh (8.3%), Bihar (7.9%), Gujarat (5.0%) and Tamil Nadu (3.6%), accounting for nearly 80% of the total maize area of the country. (Rakshit *et al.*, 2018)<sup>[15]</sup>.

In past few years a new pest fall armyworm became an invasive challenge across the world. However, the relatively high damage by fall armyworm is occasionally reported (Porter *et al.*, 2000)<sup>[14]</sup>. The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is a polyphagous migratory insect pest that is able to cause considerable economic losses in over 80 different crops. The pest is native to the tropical and sub-tropical regions of North, Central, and South America, where it has been considered a key pest in maize and several other crops for decades. Fall armyworm was detected for the first time on the African continent in January 2016 in Nigeria, and by 2019 had been reported in almost all of sub-Saharan Africa, as well as in South- and Southeast Asia, causing substantial yield. (Divya *et al.*, 2021)<sup>[6]</sup>.

The FAW moth populations are capable of migrating very fast (almost 100 km per night and nearly 500 km before laying eggs) and thus, can invade new areas quickly (Johnson, 1987)<sup>[8]</sup>. The pest completes its life cycle in about 30-45 days (depending on weather conditions). In cooler temperatures the life cycle may extend up to 60-90 days. The female moth lays on an average about 1500 eggs attaching them to the foliage. The egg stage lasts for only 2 to 3 days in warmer weather. The FAW in general has six larval instars (stages) before it goes for pupation.

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The entire larval stage lasts for 14 to 30 days depending on the weather conditions especially temperature and humidity (Padhee and Prasanna, 2019)<sup>[12]</sup>.

Maize is most vulnerable to fall army worm, *Spodoptera frugiperda*, which causes severe losses to it. Though, application of effective chemicals and biopesticides with different mode of action at proper crop stage is significant for its management.

### Materials and Methods

The experiment was conducted at the experimental research plot of the Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences, during the *Kharif* season of 2022, in a Randomized Block Design with eight treatments replicated three times using variety Sonal seeds in a plot size of 2m×2m at a spacing of 60cm × 20 cm with a recommended package of practices excluding plant protection.

Pest population was estimated by observing five plants selected randomly from each treatment for presence of egg masses and larvae at one day prior to insecticide application and at 3<sup>rd</sup>, 7<sup>th</sup> and 14<sup>th</sup> days after each application. The percent infestation over control against fall armyworm was calculated by considering the mean of three observations recorded at 3<sup>rd</sup>, 7<sup>th</sup> and 14<sup>th</sup> days after first and second spraying.

The healthy marketable yield obtained from different treatments was collected separately and weighed. The cost of insecticides used in this experiment was recorded during *kharif* season. The cost of botanicals used was obtained from nearby market. The total cost of plant protection consisted of cost of treatments, sprayer rent and labour charges for the spray. There are two sprays throughout the research period and the overall plant protection expenses was calculated. Total income was realized by multiplying the total yield per hectare by the prevailing market price, while the net benefit is obtained by subtracting the total cost of plant protection from total income. Benefit over the control for each sprayed treatment was obtained by subtracting the income of the control treatment from that of each sprayed treatment. The B:C ratio was calculated by formula:

**Gross return** = Marketable yield × Market price

**Net return** = Gross return – Total cost

$$\text{Cost benefit ratio} = \frac{\text{Gross return}}{\text{Total no of Cost}}$$

### Results and discussion

The results of the field trail with insecticides revealed that among the treatments treated against maize fall army worm after 1<sup>st</sup> spray Spinetoram 11.7% SC (2.44) was found significantly superior in reducing the fall army worm population which was followed by Emamectin benzoate 5% SG (2.57), Chlorantraniliprole 18.5% SC (2.71), Spinosad 45% SC (2.86), Nisco sixer plus (3.42), *Metarhizium*

*anisopliae* (1x10<sup>8</sup> CFU/ml) (4.33), Azadirachtin 0.1% SC (3.93) and Control (7.06). After 2<sup>nd</sup> spray, all the insecticides were found superior over untreated control. Among all the treatments Spinetoram 11.7% SC (1.33) was found superior in reducing the fall army worm population which was followed by Emamectin benzoate 5% SG (1.51), Chlorantraniliprole 18.5% SC (1.88), Spinosad 45% SC (2.04), Nisco Sixer plus (2.24), *Metarhizium anisopliae* (1x10<sup>8</sup> CFU/ml) (2.86), Azadirachtin 0.1% SC (3.60) and Control (9.71). The overall mean analysis showed that Spinetoram 11.7% SC (1.88) and Emamectin benzoate 5% SG (2.04) were significantly superior than other treatments followed by Chlorantraniliprole 18.5% SC (2.30), Spinosad 45% SC (2.45), Nisco sixer plus (2.83), *Metarhizium anisopliae* (1x10<sup>8</sup> CFU/ml) (3.60), Azadirachtin 0.1% SC (4.10) and Control (8.37). The treatments were found to be significant with each other.

The highest yield was recorded in Spinetoram 11.7% S C (42.4 q/ha) followed by Emamectin benzoate 5% SG (38.50 q/ha), Chlorantraniliprole 18.5% SC (34.20 q/ha), Spinosad 45% SC (31 q/ha), Nisco sixer plus (28.30 q/ha), *Metarhizium anisopliae* (1x10<sup>8</sup> CFU/ml) (26.10 q/ha), Azadirachtin 0.1%SC (24.4 q/ha) and Control (18.24 q/ha).

When cost benefit ratio worked out, interesting result was achieved, among the treatment studied best and most economical treatment Spinetoram 11.7% SC (1:2.74) followed by Emamectin benzoate 5% SG (1:2.53), Chlorantraniliprole 18.5% SC (1:2.07), Spinosad 45% SC (1:1.94), Nisco sixer plus (1:1.65), *Metarhizium anisopliae* (1x10<sup>8</sup> CFU/ml) (1:1.56), Azadirachtin 0.1%SC (1:1.51) and Control (1:1.25).

Among all the treatments lowest population of maize fall army worm was recorded in Spinetoram 11.7% SC (1.889). Similar findings made by Nurnina *et al.*, (2021)<sup>[11]</sup>, Mallapur *et al.*, (2019)<sup>[10]</sup> and Deshmukh *et al.*, (2018)<sup>[5]</sup>. Emamectin benzoate 5% SG (2.045) was found to be the next best treatment which is in line with the findings of Patidar *et al.*, (2022),<sup>[13]</sup> Bharadwaj *et al.*, (2020),<sup>[3]</sup> and Thumar *et al.*, (2020)<sup>[19]</sup>. lowest larval population of fall armyworm. Chlorantraniliprole 18.5% EC (2.300) was found to be the next best treatment which is in line with the similar findings of Bommi and Kumar (2022)<sup>[4]</sup> Ramesh and Tayde (2022)<sup>[16]</sup> and Divya *et al.*, (2022)<sup>[6]</sup> by reduced maximum larval population. Spinosad 45%SC (2.456) was found to be the next best treatment which is in line with the findings of Ahir *et al.*, (2021)<sup>[1]</sup>, Mallapur *et al.*, (2019)<sup>[10]</sup> and Sharma *et al.*, (2018)<sup>[18]</sup> Nisco Sixer Plus (2.834) was found to be the next best treatment Reddy *et al.*, (2021)<sup>[17]</sup>. *Metarhizium anisopliae* (1 x 10<sup>8</sup> cfu/ml) (3.600) was found to be the next best treatment which is in line with the similar findings of Helen *et al.*, (2019)<sup>[7]</sup>, and Sharma *et al.*, (2018)<sup>[18]</sup>. Azadirachtin 0.1% EC (4.100) was found to be least effective but comparatively superior over the control, these similar findings are supported by Badhai *et al.*, (2020)<sup>[2]</sup> and Helen *et al.*, (2019)<sup>[7]</sup>.

**Table 1:** Efficacy of selected insecticides against larval population on Maize (overall mean)

S. No	Treatments	Dosage	Larval population of <i>S. frugiperda</i> /five plants							Overall mean	Yield (q/ha)	B:C ratio
			First spray				Second spray					
			IDBS	3DAS	7DAS	14DAS	3DAS	7DAS	14DAS			
T <sub>1</sub>	Chlorantraniliprole 18.5%SC	0.4ml/lit	4.600	2.933	2.533	2.667	2.267	1.533	1.867	2.300	34.20	1:2.07
T <sub>2</sub>	Emamectin benzoate 5% SG	0.4gm/lit	4.867	2.867	2.333	2.533	1.933	1.133	1.467	2.045	38.50	1:2.53
T <sub>3</sub>	Spinosad 45%SC	0.25ml/lit	5.200	3.067	2.733	2.800	2.333	1.800	2.000	2.456	31	1:1.94
T <sub>4</sub>	Spinetoram 11.7%SC	0.5ml/lit	4.533	2.733	2.133	2.467	1.733	0.933	1.333	1.889	42.4	1:2.74
T <sub>5</sub>	Nisco Sixer Plus	2ml/lit	4.400	3.667	3.000	3.600	2.467	2.067	2.200	2.834	28.30	1:1.65
T <sub>6</sub>	Azadirachtin 0.1%EC	2.5ml/lit	5.333	5.000	4.267	4.533	3.800	3.333	3.667	4.100	24.4	1:1.51
T <sub>7</sub>	<i>Metarhizium anisopliae</i> ( $1 \times 10^8$ CFU/ml)	5ml/lit	4.933	4.667	3.867	4.467	3.133	2.533	2.933	3.600	26.10	1:1.56
T <sub>8</sub>	Control	-	5.133	6.200	7.000	8.000	8.933	9.667	10.600	8.378	18.24	1:1.25
	F-test	-	NS	S	S	S	S	S	S	S	-	-
	S. Ed ( $\pm$ )	-	-----	0.134	0.089	0.126	0.126	0.774	0.382	0.077	-	-
	C.D. (P = 0.5)	-	-----	0.287	0.197	0.269	0.280	0.179	0.261	0.165	-	-

DBS – Day Before Spray

DAS – Day After Spray

### Conclusion

Result show that Spinetoram 11.7% SC (1.889) was found to be the most effective treatment in reduction against *S. frugiperda* followed by Emamectin benzoate 5% SG (2.045), Chlorantraniliprole 18.5% EC (2.300), Spinosad 45% SC (2.456), Nisco Sixer Plus (2.834), *Metarhizium anisopliae* ( $1 \times 10^8$  cfu/ml) (3.600) and Azadirachtin 0.1% EC (4.100) over control. Among all the treatments, the cost benefit ratio has been analyzed, in which the highest was, Spinetoram 11.7% SC (1:2.74) and marketable yield (42.4 q/ha) followed by Emamectin benzoate 5% SG (1:2.53 and 38.50 q/ha), Chlorantraniliprole 18.5% EC (1:2.07 and 34.20 q/ha), Spinosad 45%SC (1:1.94 and 31 q/ha), Nisco Sixer Plus (1:1.65 and 28.30 q/ha), *Metarhizium anisopliae* ( $1 \times 10^8$  CFU/ml) (1:1.56 and 26.10 q/ha) and the lowest was Azadirachtin 0.1% EC(1:1.51 and 24.4 q/ha) have been recorded.

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