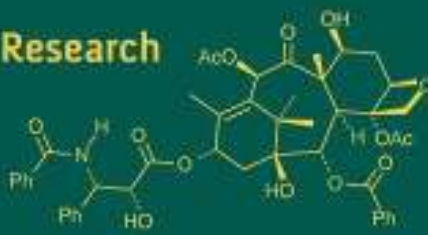
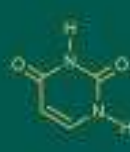
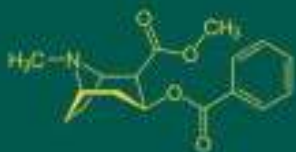


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(11): 343-346
www.biochemjournal.com
Received: 15-09-2024
Accepted: 25-10-2024

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Evaluation of insecticides against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in maize during *kharif*

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DOI: <https://doi.org/10.33545/26174693.2024.v8.i11Se.2923>

Abstract

India has invaded by an insect pest, Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) during 2018 which has become a major threat by causing severe damage to maize. The goal of the present investigation was to evaluate different insecticides against fall armyworm. The results showed that at three and five days after two sprays, fall armyworm larval density and percent leaf damage was significantly lower among treatments viz., spinetoram 11.7 SC, chlorantraniliprole 18.5 SC and emamectin benzoate 5 SG compared with the untreated control. The cost economics also showed that they were economically viable insecticides.

Keywords: Chlorantraniliprole, emamectin benzoate, fall armyworm, spinetoram, *Spodoptera frugiperda*

Introduction

India has invaded by a insect pest, Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), that has become a major threat by causing severe damage to maize. Among them, the most preferred host plants are maize, rice, sorghum and sugarcane (Bueno *et al.*, 2010) [2]. A total of 353 *S. frugiperda* larval host plants recorded belonging to 76 plant families, principally Poaceae (106), Asteraceae (31) and Fabaceae (31) (Montezano *et al.*, 2019) [9]. The fall armyworm, *S. frugiperda* is a major pest of maize (*Zea mays*). The developing larvae eat different parts of the host plant, depending on the stage of the crop. Young larvae skeletonize the leaf lamina in a typical 'window-pane' damage at the early whorl stage. Later larval instars make larger holes, causing ragged whorl leaves, and produce sawdust-like larval droppings, while fresh feeding produces big lumps. Fall armyworm can also destroy silks and developing tassels, thereby limiting fertilization of the ear. Maize plants may have the cobs attacked by larvae boring through the kernels. Damage to cobs may lead to fungal infection and aflatoxins, and loss of grain quality (Anon, 2020) [1]. It was previously restricted only to the America (Cruz *et al.*, 1999) [3]. A severe outbreak of FAW in maize was reported from African countries such as Sao Tome, Nigeria, Benin and Togo in 2016 (Goergen *et al.*, 2016) [8]. Subsequently, the pest has spread rapidly to over 44 countries in sub-Saharan Africa causing significant damage to crops (Prasanna *et al.*, 2018) [10]. Recently this dreaded pest has been reported from Karnataka in India on maize crop (Ganiger *et al.*, 2018; Sharanabasappa *et al.*, 2018) [7, 11]. Similarly, the occurrence of this pest in severe form was noticed in maize growing areas of Raichur. The *S. frugiperda* from India is alarming because of its polyphagous nature. Therefore, the invasion, ensuing future spread and the possibility of the emergence of new hybrid races of *S. frugiperda* pose a significant risk to national food security. Thus, curtailing the spread and establishment of this pest in India and also Indian subcontinent is a need of the hour. The goal or ambition of the present investigation was to study the bio-efficacy of conventional and newer insecticides in the field for its management.

Materials and Methods

A field experiment was conducted at Main Agricultural Research Station, Raichur to evaluate the effect of different insecticides to manage fall armyworm during *kharif* 2019-2020.

The experiment was laid in a Randomized Block Design (RBD) with three replications and seven treatments. The treatments used were spinosad 45 SC @ 0.20 ml/l, chlorantraniliprole 18.5 SC @ 0.20 ml/l, flubendiamide 39.35 SC @ 0.075 ml/l, emamectin benzoate 5 SG @ 0.20 g/l, spinetoram 11.7 SC @ 0.50 ml/l, azadirachtin 10000 ppm @ 2.00 ml/l and untreated control. The whole area was divided into individual treatments of 5.4 x 3.3 m² and seeds of hybrid maize ('Dhanvantari') was sown in the main field with a spacing of 60 x 30 cm². All the management practices except the plant protection measures against fall armyworm were adopted as per the recommended package of practices. Observations on fall armyworm larval population and percent leaf damage was recorded one day before and on 3, 5, 7 and 15 days after imposition of treatments. Initiation of treatments were taken up on the appearance of fall armyworm using manually operated knock sack sprayer twice during the experimentation. Observations were taken from five randomly tagged plants before treatment imposition. The percent leaf damage caused by larvae of fall armyworm was estimated through visual scoring in 0-9 scale as described by Davis and Williams (1992) [4]. The percent leaf damage caused by larvae of fall armyworm was calculated using the formula mentioned below.

$$\text{Leaf damage (\%)} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

The data obtained in the experiments in the current investigation for parameters such as the number of fall armyworm larvae were subjected to square root transformation and percent leaf damage was subjected to arcsine transformation. Transformed values were analyzed using ANOVA for a randomized complete block design (RCBD). Reduction in pest population and leaf area damage over untreated control was calculated by using the formula mentioned below.

$$\text{Reduction over control (\%)} = \frac{\text{Control} - \text{Treatment}}{\text{Control}} \times 100$$

Results and Discussion

Number of larvae

The first spray was initiated when the activity of *S. frugiperda* larva was noticed and the crop was at 20 days old. All treatments, including untreated control, ranged from 3.13 to 4.47 larvae per plant and were statistically non-significant. At three days after spray the population ranged from 0.93 to 3.53 larvae per plant. The best treatment reported with the lowest number of larvae was spinetoram 11.7 SC (0.93 larva/plant), which was found to be superior and statistically at par with chlorantraniliprole 18.5 SC (1.07 larvae/plant) and emamectin benzoate 5 SG (1.20 larvae/plant). The untreated control recorded the highest number of larvae (3.53 larvae/plant). The larvae were substantially increased at five, seven and fifteen days later when collated to three days after the spray, except in untreated control. The insecticides spray was repeated at fifteen days interval. A day before the second spray there was not much variation noticed across the treatments and was ranged from 2.33 to 3.13 larvae per plant. However, there was considerable variation in the larval population of *S. frugiperda* among the treatments at three days after second spray which ranged from 0.80 to 3.67. Among all

other treatments, the plot sprayed with spinetoram 11.7 SC (0.80 larva/plant), chlorantraniliprole 18.5 SC (0.87 larva/plant) and emamectin benzoate 5 SG (0.93 larva/plant) were superior and equivalent with each other (Table 1). The result determined from the present study is similar to the findings of Deshmukh *et al.* (2020) [5] who recorded chlorantraniliprole 18.5 SC, emamectin benzoate 5 SG and spinetoram 11.7 SC were the effective insecticides in managing fall armyworm larvae. Dileep and Mohan (2020) [6] found spinetoram 11.7 SC was an effective insecticide in managing the larval population of fall armyworm up to 97.32 percent.

Percent leaf damage

Pre-treatment count on the number of damaged leaves were made. The leaf damage due to feeding ranged from 58.10 to 61.92 percent and were equivalent to each other. However, the treatments have shown a variation of 28.59 to 65.76 percent after three days. The highest injury was experienced in the untreated plot (65.76%) succeeded by azadirachtin 10000 ppm (51.03%) which were statistically at par with each other. The least damage was recorded in spinetoram 11.7 SC (28.59%), succeeded by chlorantraniliprole 18.5 SC (32.37%) and emamectin benzoate 5 SG (36.47%). Five, seven and fifteen days later, considerable progress in the percent leaf damage was noticed compared to previous observations. The insecticides application was repeated at fifteen days interval, the leaf damage ranged from 39.92 to 85.95 percent and there was not much variation observed among the treatments. Three days post spray, reasonable changes were experienced from 25.21 to 87.71 percent across the treatments. Apparently, the percent was highest in the untreated control (87.71%). The treatment chlorantraniliprole 18.5 SC has experienced the lowest leaf damage of 25.21 percent succeeded by spinetoram 11.7 SC and emamectin benzoate 5 SG with 25.69 and 28.35 percent, successively (Table 2). The present findings are in accordance with the observations made by Sisay *et al.* (2019) [12] and Dileep and Mohan (2020) [6] who reported the lowest percent leaf damage when sprayed with spinetoram 11.7 SC. The minimum percent leaf damage was noticed by Thumar *et al.* (2020) [13] with the application of spinetoram 11.7 SC, emamectin benzoate 5 SG and chlorantraniliprole 18.5 SC.

Grain yield

The yield ranged from 22.70 to 43.70 q/ha. The treatment with the highest yield was noticed in spinetoram 11.7 SC (43.70 q/ha) which was equivalent with chlorantraniliprole 18.5 SC (42.91 q/ha), emamectin benzoate 5 SG (40.64 q/ha), flubendiamide 39.35 SC (35.02 q/ha) and spinosad 45 SC (32.47 q/ha). Azadirachtin 10000 ppm (28.66 q/ha) was at par with control plot (22.70 q/ha) (Table 3). The benefit cost ratio was highest in spinetoram 11.7 SC (2.50), chlorantraniliprole 18.5 SC (2.52) and emamectin benzoate 5 SG (2.42). The untreated control recorded least benefit cost ratio of 1.38 (Table 3). The present findings are in consonance with the findings of Deshmukh *et al.* (2020) [5] who reported chlorantraniliprole 18.5 SC as an effective insecticide that recorded the highest yield (62.33 q/ha) followed by emamectin benzoate 5 SG (61.80 q/ha) and spinetoram 11.7 SC (58.67 q/ha). In addition, the present findings are similar to the results of Dileep and Mohan (2020) [6] who reported the highest yield in the treatment sprayed with spinetoram 11.7 SC (33.48 q/ha).

Table 1: Efficacy of different insecticides on larval population of *Spodoptera frugiperda* in maize during kharif 2019

Tr. No	Treatment details	Number of larvae per plant										Pooled mean	Reduction over control (%)
		First spray					Second spray						
		DBS	3DAS	5DAS	7DAS	15DAS	DBS	3DAS	5DAS	7DAS	15DAS		
T ₁	Spinosad 45 SC	3.13 (2.03)	1.80 (1.67) ^{cd}	1.93 (1.69) ^{ab}	2.13 (1.77) ^{bc}	2.27 (1.79) ^{abc}	2.93 (1.97)	1.40 (1.54) ^{bc}	1.47 (1.57) ^{bc}	1.53 (1.59) ^{ab}	1.40 (1.53)	1.84 (1.68) ^d	47.43
T ₂	Chlorantraniliprole 18.5 SC	4.00 (2.23)	1.07 (1.44) ^{ab}	1.13 (1.46) ^a	1.13 (1.46) ^a	1.20 (1.48) ^{ab}	2.33 (1.81)	0.87 (1.37) ^{ab}	0.87 (1.37) ^a	1.00 (1.41) ^a	0.80 (1.33)	1.12 (1.45) ^a	68.00
T ₃	Flubendiamide 39.35 SC	3.87 (2.20)	1.57 (1.60) ^{bcd}	1.67 (1.63) ^{ab}	1.73 (1.64) ^{abc}	1.87 (1.68) ^{abc}	2.73 (1.93)	1.33 (1.53) ^{bc}	1.40 (1.55) ^{abc}	1.47 (1.57) ^{ab}	1.20 (1.46)	1.63 (1.62) ^c	53.43
T ₄	Emamectin benzoate 5 SG	4.47 (2.33)	1.20 (1.48) ^{abc}	1.27 (1.50) ^a	1.33 (1.53) ^{ab}	1.40 (1.52) ^{ab}	2.4 (1.84)	0.93 (1.39) ^{ab}	1.00 (1.41) ^{ab}	1.13 (1.46) ^a	1.07 (1.43)	1.27 (1.50) ^b	63.71
T ₅	Spinetoram 11.7 SC	3.47 (2.11)	0.93 (1.38) ^a	1.00 (1.41) ^a	1.07 (1.44) ^a	1.07 (1.41) ^a	2.33 (1.82)	0.80 (1.34) ^a	0.87 (1.36) ^a	0.93 (1.39) ^a	0.73 (1.31)	1.03 (1.42) ^a	70.57
T ₆	Azadirachtin 10000 ppm	3.93 (2.21)	2.33 (1.82) ^d	2.47 (1.86) ^{bc}	2.60 (1.89) ^{cd}	2.60 (1.89) ^{bc}	3.13 (2.03)	1.93 (1.71) ^c	2.07 (1.75) ^c	2.13 (1.76) ^b	2.00 (1.72)	2.37 (1.83) ^e	32.29
T ₇	Untreated control	3.67 (2.16)	3.53 (2.12) ^e	3.60 (2.14) ^c	3.67 (2.15) ^d	3.53 (2.13) ^c	3.6 (2.14)	3.67 (2.16) ^d	3.73 (2.17) ^d	3.80 (2.18) ^c	2.07 (1.75)	3.50 (2.12) ^f	--
S. Em. (±)		0.11	0.07	0.1	0.09	0.14	0.08	0.07	0.06	0.09	0.12	0.02	--
C. D. @ 5%		NS	0.22	0.31	0.27	0.43	NS	0.20	0.20	0.27	NS	0.05	--

Values in parenthesis are $\sqrt{x+0.5}$ transformed

DAS – Days After Spray, DBS – Days Before Spray

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT

Table 2: Efficacy of different insecticides on percent leaf damage caused by *Spodoptera frugiperda* in maize during kharif 2019

Tr. No	Treatment details	Leaf damage per plant (%)										Pooled mean	Reduction over control (%)
		First spray					Second spray						
		DBS	3 DAS	5 DAS	7 DAS	15 DAS	DBS	3 DAS	5 DAS	7 DAS	15 DAS		
T ₁	Spinosad 45 SC	61.02 (51.34)	43.77 (41.37) ^{ab}	47.00 (43.25) ^{bc}	51.69 (45.95) ^{cd}	54.64 (47.66) ^{bc}	59.02 (50.32)	41.05 (39.82) ^{bc}	45.87 (42.59) ^{bc}	49.82 (44.88) ^{bc}	31.48 (34.06) ^{bc}	45.67 (42.49) ^d	41.16
T ₂	Chlorantraniliprole 18.5 SC	59.73 (50.63)	32.37 (34.45) ^{ab}	33.02 (35.02) ^a	35.69 (36.54) ^{ab}	35.59 (36.58) ^a	39.92 (39.13)	25.21 (29.88) ^a	29.59 (32.89) ^a	31.48 (34.06) ^a	15.85 (23.26) ^a	29.85 (33.08) ^a	61.54
T ₃	Flubendiamide 39.35 SC	60.79 (51.22)	43.84 (41.43) ^{ab}	45.48 (42.38) ^{bc}	49.22 (44.53) ^{bcd}	54.95 (47.88) ^{bc}	57.54 (49.36)	34.70 (36.01) ^{abc}	37.71 (37.87) ^{ab}	42.80 (40.79) ^{ab}	27.35 (31.06) ^{abc}	42.01 (40.38) ^c	45.88
T ₄	Emamectin benzoate 5 SG	59.89 (50.69)	36.47 (37.03) ^{ab}	37.87 (37.87) ^{ab}	40.42 (39.44) ^{abc}	43.36 (41.15) ^{ab}	46.6 (43.02)	28.35 (32.03) ^{ab}	31.74 (34.21) ^a	36.95 (37.32) ^a	20.02 (26.44) ^{ab}	34.40 (35.88) ^b	55.68
T ₅	Spinetoram 11.7 SC	58.10 (49.67)	28.59 (32.06) ^a	31.38 (34.01) ^a	33.94 (35.53) ^a	36.78 (37.26) ^a	40.25 (39.34)	25.69 (30.27) ^a	28.27 (31.95) ^a	31.58 (33.99) ^a	16.77 (24.01) ^a	29.13 (32.63) ^a	62.47
T ₆	Azadirachtin 10000 ppm	61.92 (51.90)	51.03 (45.54) ^{bc}	53.12 (46.81) ^c	56.09 (48.49) ^d	61.15 (51.46) ^c	67.73 (55.55)	49.27 (44.56) ^c	53.62 (47.07) ^c	56.54 (48.78) ^c	38.64 (38.31) ^c	52.44 (46.38) ^e	32.44
T ₇	Untreated control	60.97 (51.32)	65.76 (54.31) ^c	71.29 (57.6) ^d	75.11 (60.32) ^e	81.04 (64.77) ^d	85.95 (68.15)	87.71 (70.00) ^d	89.38 (70.96) ^d	91.48 (73.05) ^d	59.19 (50.35) ^d	77.62 (61.87) ^f	0.00
	S. Em (±)	1.59	3.78	2.32	2.81	2.98	3.49	3.02	2.61	2.25	2.98	0.51	--
	CD @ 5%	NS	11.64	7.15	8.67	9.18	NS	9.29	8.03	6.92	9.19	1.57	--

Values in parenthesis are arcsine transformed

DAS – Days After Spray, DBS – Days Before Spray

Means followed by same alphabet in columns did not differ significantly (p=0.05) by DMRT

Conclusion

This study provided valuable information about the efficacy of insecticides with novel modes of action to manage fall armyworm. In addition, these compounds provided good protection for the fall armyworm infestation and resulted in significant yield.

Acknowledgement

Authors are sincerely thankful to Department of Agril. Entomology, University of Agricultural Sciences, Raichur for providing necessary facilities to execute the research work.

References

1. Anonymous. *Spodoptera frugiperda* (fall armyworm) datasheet. Invasive species compendium; 2020. Available from: <https://www.cabi.org/isc/datasheet/29810>.

2. Bueno RCOF, Carneiro TR, Bueno AF, Pratisoli D, Fernandes OA, Vieira SS. Parasitism capacity of *Telenomus remus* Nixon (Hymenoptera: Scelionidae) on *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae) eggs. Braz Arch Biol Technol. 2010;53:133-139.
3. Cruz I, Figueiredo MLC, Oliveira AC, Vasconcelos CA. Damage of *Spodoptera frugiperda* (Smith) in different maize genotypes cultivated in soil under three levels of aluminium saturation. Int J Pest Manag. 1999;45:293-296.
4. Davis FM, Williams WP. Visual rating scales for screening whorl stage corn for resistance to fall armyworm. Mississippi Agricultural & Forestry Experiment Station, Technical Bulletin 186. Mississippi State University, MS 39762, U.S.A.; 1992.
5. Deshmukh S, Pavithra HB, Kalleshwaraswamy CM, Shivanna BK, Maruthi MS, Mota-Sanchez D. Field efficacy of insecticides for management of invasive fall

- armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on maize in India. Fla Entomol. 2020;103(2):221-227.
6. Dileep NT, Mohan MK. Bio-efficacy of selected insecticides against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Noctuidae: Lepidoptera), in maize. J Entomol Zool Stud. 2020;8(4):1257-1261.
 7. Ganiger PC, Yeshwanth HM, Muralimohan K, Vinay N, Kumar ARV, Chandrashekara K. First report on the occurrence of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae), a new pest in Karnataka, India. Curr Sci. 2018;115(4):621-623.
 8. Goergen G, Kumar PL, Sankung SB, Togola A, Tamo M. First report of outbreaks of the fall armyworm *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae), a new alien invasive pest in West and Central Africa. PLoS One. 2016;11(10):1-9.
 9. Montezano DG, Specht A, Sosa-Gomez DR, Roque-Specht VF, Sousa-Silva JC, Paula-Moraes SD, *et al.* Host plants of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in the Americas. Afr Entomol. 2019;26(2):286-300.
 10. Prasanna BM, Joseph E, Huesing RE, Peschke VM. Fall armyworm in Africa: A guide for integrated pest management. Mexico, CDMX: CIMMYT; 2018.
 11. Sharanabasappa D, Kalleshwaraswamy CM, Asokan R, Mahadeva Swamy HM, Maruthi MS, Pavithra HB, *et al.* First report of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. PMHE. 2018;24(1):23-29.
 12. Sisay B, Tefera T, Wakgari M, Ayalew G, Mendesil E. The efficacy of selected synthetic insecticides and botanicals against fall armyworm, *Spodoptera frugiperda*, in maize. Insects. 2019;10(2):45-50.
 13. Thumar RK, Zala MB, Varma HS, Dhobi CB, Patel BN, Patel MB, *et al.* Evaluation of insecticides against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) infesting maize. Int J Chem Stud. 2020;8(4):100-104.