Original Article
DOI: https://doi.org/10.70749/ijbr.v4i4.3067

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Comparative Study of Chemical Insecticides for the Management of Fall Armyworm in Maize Under Fields Conditions

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ARTICLE INFO

Keywords: Maize, Insect Pest Infestation, Crop Yield and Fall Armyworm.

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Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 04-02-2026 Revised: 09-04-2026
Accepted: 17-04-2026 Published: 26-04-2026

ABSTRACT

The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is a destructive transboundary lepidopterous pest affecting more than 78 countries worldwide by infesting a wide array of agronomic and horticultural crops such as maize. Maize is an important cereal crop worldwide. Maize crop production is hampered by various factors including the insect pest infestation. The current research was executed to probe out the efficacy of Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC), Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC), Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC), and Spinetoram against fall armyworm, *Spodoptera frugiperda* in maize crop. Results revealed that after application average population per plant were found reduced with increase in post-treatment period and comparatively lower fall armyworm count (1.15 mean FAW plant^{-1}) after 72 hrs was recorded in case of Chlorantraniliprole 12% + Thiamethoxam 12%, spinetoram (1.18), Bifenthrin + Abamectin (1.20), Chlorantraniliprole 10% + Thiamethoxam (1.30) and control pod (7.6), respectively. Results showed that after 72hrs of application the maximum control of fall armyworm by Chlorantraniliprole 12% + Thiamethoxam 12% (85.0%), followed by Spinetoram (84.6%), Bifenthrin 8.7% + Abamectin 2.8% (84.3%), Chlorantraniliprole 10% + Thiamethoxam 20%) (82.9%) and control (0.0). Hence, use of new chemistry insecticide system can be effective for the control of fall armyworm leading to maximization of crop yield and productivity.

INTRODUCTION

Agriculture is the main driving force for economy of Pakistan and plays a vital role in the gross domestic product (GDP). Maize ranks as the 3rd most important cereal after wheat and rice whereas overall 4th high yielding agricultural crop of Pakistan (Tariq and Iqbal, 2010). It is also called as queen of cereal (Manasa *et al*., 2018). Soil with 6.5–7.5 pH best suits for the production of Maize crop. It is potential source of dietary substances like starch (72%), fatty acid (10%), proteins (10%), sugar (3%) and vitamins (3–5%) (Adnan and Bilal, 2020). It is also being used as fodder for animals and extraction of cooking oil (Erenstein *et al*. 2022). Maize is being cultivated on an area of 1.3 million hectares in variety of climatic zones ranging 30 meters above from the sea level all over the Pakistan (Rizwanullah *et al*., 2023).

Maize crop yield is reducing yearly owing to different abiotic and biotic aspects (Deressa *et al*. 2024). Among biotic factors, insect pests and pathogens are of serious concern in maize production worldwide (Cui *et al*., 2024) including Indonesia, Pakistan, India, Thailand, China, Africa, Brazil, Nepal, Vietnam and Philippines (KiZarkani *et al*., 2020). Reproductive as well as non-reproductive phases of maize are extremely vulnerable to be attacked by numerous insect pests (Kharwal *et al*., 2024). During the past few years, a new Spodoptera species, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) had described in several maize growing zones worldwide, resulting in massive yield losses (Assefa *et al*. 2018; Overton *et al*. 2021) even in Pakistan (Yousaf *et al*., 2022). *S. frugiperda* can feed on around 353 host plants belonging to 76 families causing notable crop production loss (Wang *et al*., 2020). This species is turning into a severe menace to the food security worldwide, hence, there is dire necessity of an efficient insect control tactic to

control this most destructive insect pests to safeguard the Pakistan economy by reducing yield loss in maize crop.

Management of fall armyworm in Pakistan and other developing countries is mainly done through conventionally used synthetic insecticides (Jalali *et al*., 2024). They are not cognizant regarding destiny of conventionally used insecticides. Repeated and overdose of synthetic insecticides has resulted in environmental hazards, mortality of beneficial insects, residue in crop produce, development of new biotypes, resistance and resurgence in insect pests (Ayilara *et al*., 2023). Therefore, newly develop formulations of insecticides with novel mode of action may be potential alternates to counter these issues. New chemistry insecticides have gained much attention these days. These insecticides are safer for human and surroundings and derived from different chemical groups. Among these, Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC), Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC), Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC), and Spinetoram 120 SC.

MATERIALS AND METHODS

Study site

Field efficacy was executed in RCBD design at Research Farm, University of Agriculture, Faisalabad during Kharif season 2024–2025. There were overall five treatments together with control plot and each treatment was repeated in thrice.

Table 1

Treatments descriptions

Treatments	Product Name	Dose / Acre
1	Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC)	100 ml
2	Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC)	80 ml
3	Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC)	250 ml
4	Spinetoram 120 SC	80 ml
5	Check Plot	_

Field Efficacy

The recommended dose rates of the new chemistry insecticides; Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC), Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC), Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC), and Spinetoram 120 SC were applied in research plots arranged under Randomized Block Design (RBD). All the treatments and control were replicated in thrice. Before applying the insecticides, it was ensured that no spraying activity was done earlier in research trial site. The insecticides were sprayed with the help of hand knapsack provided. FAW larvae were counted a day after the spraying activity and then afterward 72 hours and 7 days of application of the insecticides. The fAW data was collected after 72 hours and 7 days after the insecticide application.

Statistical Analysis

Data for percent field trials were subjected to a one-way analysis of variance (ANOVA) by keeping insecticide as the main factor. Means were separated by using Tukey's honest significant difference test ($\alpha = 0.05$).

RESULT

Efficacy of the insecticides against FAW

As shown in fig 1, mean incidence of *S. frugiperda* population all the treatment proved effective over control. Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC) proved the most effective (6.02 mean FAW /plant) followed by Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC) (6.39 counts/plant), Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC) (6.75 Faw/leaf), Control (6.89 FAW/leaf) and Spinetoram 120SC (7.01) by post-treatment period of 1 day after application.

Table 2

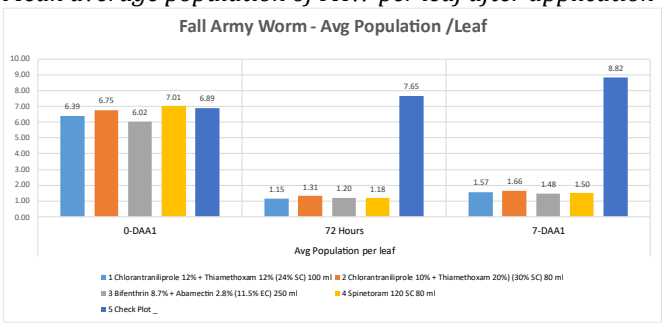
Average Population Per Leaf

Treatments	Product Name	Dose / Acre	Avg Population per leaf		
			0-DAA1	72 Hours	7-DAA1
1	Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC)	100 ml	6.39	1.15	1.57
2	Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC)	80 ml	6.75	1.31	1.66
3	Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC)	250 ml	6.02	1.20	1.48
4	Spinetoram 120 SC	80 ml	7.01	1.18	1.50
5	Check Plot	_	6.89	7.65	8.82

After 72 hours the post application the average population per leaf the minimum 1.15 mean FAW leaf^{-1}) was recorded in case of Chlorantraniliprole 12% + Thiamethoxam 12%, spinetoram (1.18), Bifenthrin + Abamectin (1.20), Chlorantraniliprole 10% + Thiamethoxam (1.30) and control pod (7.6), respectively. And 7- Day after application the average population per leaf the minimum population occurred by (1.48) Bifenthrin + Abamectin, followed by (1.50) spinetoram, (1.57) Chlorantraniliprole 12% + Thiamethoxam 12%, (1.66) Chlorantraniliprole 10% + Thiamethoxam 20%, and (8.82) control pot.

Figure 1

Mean average population of FAW per leaf after application



Comparative effects of different new chemistry insecticides against *Spodoptera frugiperda*

Treatment means sharing similar lettering were not significantly different ($p > 0.05$). DBS = days before spray, DAS = Days after spray,

Table 3

efficacy of FAW after 72 hrs and 7-DAA1

Treatments	Product Name	Dose / Acre	% Efficacy over Control	
			72 Hours	7-DAA1

1	Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC)	100 ml	85.0	82.2
2	Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC)	80 ml	82.9	81.2
3	Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC)	250 ml	84.3	83.2
4	Spinetoram 120 SC	80 ml	84.6	83.0
5	Check Plot	_	0.0	0.0

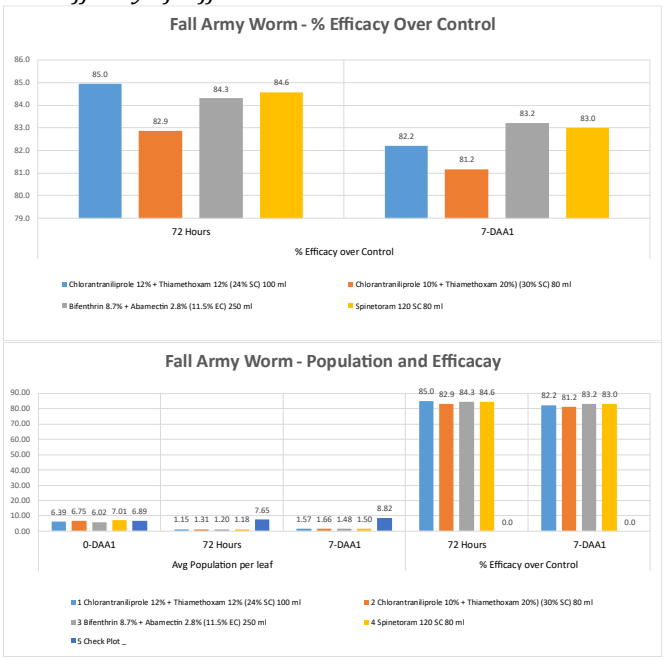
After 72 hours of application the maximum control of fall armyworm population by (85.0%) Chlorantraniliprole 12% + Thiamethoxam 12%, followed by Spinetoram (84.6%), Bifenthrin 8.7% + Abamectin 2.8% (84.3%), Chlorantraniliprole 10% + Thiamethoxam 20%) (82.9%) and control (0.0).

After 7-days of post application the highest population controlled by Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC) (83.2%), followed by Spinetoram 120 SC (83%), Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC) (82.2%), Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC) (81.2%) and control (0%), respectively.

Outcomes in Fig. 2 shows

Figure 2

Field efficacy of different insecticides



DISCUSSION

Various insecticides were evaluated against *S. frugiperda* under field conditions. Outcomes of the current research trial can serve as baseline information for the management of fall armyworm in Pakistan and worldwide. The present research trial displayed that population of pest was noted remarkably lower in all the tested treatments like Chlorantraniliprole 12% + Thiamethoxam 12% (24% SC), Chlorantraniliprole 10% + Thiamethoxam 20%) (30% SC), Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC), Spinetoram 120 SC compared with check plot. The mortality percentage of pest was enhanced with increase in exposure period. Deshmukh *et al*. (2020) evaluated the toxicity of some new chemistry insecticides against *S. frugiperda* larvae under field situations and noted similar trend of increased larval mortality of FAW over time period as was noted in our research work. Hardke *et al*. (2011) recorded 2–5% mortality response of FAW by application of that chlorantraniliprole and some other new chemistry insecticides with post-treatment period of seven days. Likewise, Khan *et al*. (2017) recorded remarkable reduction in insect infestation compared with control plot but using new chemistry insecticides in pomegranate orchards. In another research work, carried out by Daves *et al*. (2009) new chemistry insecticide, spinosad proved effective against larval stage of field crops insect pests afterward fourteen days of the insecticide application. The decrease in pest infestation owing to use of insecticides can improve the crop production. Our outcomes of the research trial are in accordance with Gutierrez-Moreno *et al*. (2019) had described that decrease in insect pest infestation improved maize crop output. It was noted that emamectin benzoate proved effective against the fall armyworm larvae. Moreover, it was also noted that larval mortality percentage can upsurge if insecticides spray ensured at initial phases of maize crop and insect pest growth as was noted in our research work. The impact of insecticides was reduced whorl stage of the crop as the larvae hide under whorl of leaves, not exposed to insecticides and can thrive. In a research work, carried out by Belay *et al*. (2012) 80% larval mortality was noted with post-treatment period of 96 hours by application of some new chemistry insecticides; Bifenthrin, Abamectin, chlorantraniliprole and Spinetoram. The infestation percentage of the fall armyworm is growing with every coming day on numerous plants particularly maize in Pakistan but yet no suitable insect control approach has been assumed (Ramzan *et al*. 2021). Farmers without concerning with entomologists are using available chemicals which can result in resistance development in this insect pests against pesticides available in market. The recurrent use of the available synthetic insecticide not only cause resistance development in insect pests but put hazards to our environment and health-related issues in human being. There is necessity to implement environmentally safe chemicals which are also safe to human health. More toxicological research trials are desired to check against the FAW.

CONCLUSION

From the present research work, it could be concluded that new chemistry insecticides especially Bifenthrin 8.7% + Abamectin 2.8% (11.5% EC) proved the most effective against fall armyworm reduction in insect infestation. Spinetoram was the next effective one against fall armyworm. There is necessity to implement environmentally safe chemicals which are also safe to human health. More toxicological research trials are desired to check against the FAW.

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