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Research Paper

Efficacy of Selected Chemicals Against American Fall Armyworm *Spodoptera Frugiperda* (J.E. Smith) in Maize at Rampur, Chitwan

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ABSTRACT
The Fall armyworm (FAW) Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae) native to the Americas is one of the important invasive polyphagous pests. Cereal production is threatened by several factors, namely climatic variability and invasive pests including S. frugiperda, which is a dangerous pest of cereals detected in East Africa in 2016. It was first reported in Nawalpur, Nepal on 9 May 2019. Maize yield has declined as high as 34 percent by the Fall armyworm since it affects all the development stages of Maize, from seedling to ear development stage. Since the pests are harmful and also economically important, it is therefore necessary to develop an effective strategy for the management of these pests. For this, field research was laid out in three replicated RCBD designs at AFU, Rampur, and Chitwan. 7 treatments were used; Spinosad 45% SC, Spinetoram 11.7% SC, Chlorantraniliprole 18.5% SC, Novaluron 10% EC, Azadirachtin 3000 ppm, Azadirachtin 1500 ppm, and untreated control. The highest yield of Maize was recorded with Spinetoram at 11.7% SC (5.1 t/ha) followed by Spinosad at 45% SC. Compared to untreated plots, synthetic chemicals stand out significantly in controlling FAW and also in terms of less percentage of damaged leaves. Since the infestation of pests is alarming, careful consideration is a must, with all the safety precautions and appropriate handling.

KEYWORDS: *Biological Parameters, Management, Pest, Strategy, Treatments*

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I. INTRODUCTION

Maize (*Zea mays* L.) also known as the "Queen of Cereals" (Dhaka, et .al., 2010) is a most versatile crop used as food, feed, fodder, and in recent years as a source of biofuel (Ranum et al., 2014). Globally, it is cultivated in more than 170 countries representing an area of 196 million ha, production of 1148 million MT with a productivity of 5.85t/ha (FAO STAT, 2020). It is the second most important crop in Nepal in terms of area (957,650 ha), having an annual production of (2,835,674) metric tons with an average productivity of 2.96 t/ha (MOALD, 2021). Similarly, the contribution of Maize to total edible production (5355232 tons) is 26.82% and to the total requirement (542663S1 tons) is 26.47% (Pandey & Koirala, 2017).

The maize productivity of Nepal is 2.96 t/ha against the world average of 5.85 t/ha (MOALD, 2021) and (FAO STAT, 2020). Several factors are responsible for this low productivity, out of which insect pests and diseases are among the major constraints (Prasanna, 2012; Ramirez-Cabral et al., 2017; Bastola et al., 2021). The Fall armyworm (FAW) *Spodoptera frugiperda* native to the Americas is one of the important invasive polyphagous pests (Sharanabasappa et al., 2018; Yigezu & Wakgari, 2020). Cereal production is threatened by several factors, namely climatic variability and invasive pests including *S. frugiperda*, which is a dangerous pest of cereals detected in Africa in 2016 (Tendeng et al., 2019). It was first reported in Nepal from Nawalpur district (N 27°42'16.67", E 084°22'50.61") on 9th May 2019 (Bajaracharya et. al., 2020). It is one of the most serious pests attacking annual crops in tropical regions due to its wide host range (Praveen & Mallapur, 2019). This

moth larvae may feed on diverse plant species, making it one of the most harmful insect pests, wreaking havoc on economically important cultivated grasses including Maize, rice, sorghum, and sugarcane, as well as other crops (Cock et al., 2017). A total of 353 FAW larval host plant species from 76 plant families were reported by Montezano et al., (2019).

In Nepal, the potential yield loss caused by FAW is estimated to be 20-25%, which in figures translates to the loss of more than half a million tons of annual Maize production worth around $200 million (CIMMYT, 2020). Almost all the stages of Maize are susceptible to this insect (Ontrols & Plantas, 2010) causing severe losses when whorls are destroyed thus reducing the photosynthetic area and compromising the grain yield. When conditions are suitable, FAW does not enter diapause which is a key feature of FAW biology that favors multiple generations overlap within a single crop cycle (Maize & Report, 2018). Maize yield declines have been recorded as high as 34 percent due to the feeding of the Fall armyworm (Lima et al., 2010).

FAW larvae have an impact on Maize at all stages of development, from seedling to ear development. Because of its polyphagous nature, rapid dispersing behavior across large geographical areas, and year-round persistence, the Fall armyworm is a more damaging pest than any other invasive pest (Dhar et al., 2019). FAW larvae scrape and skeletonize the top epidermis of opening leaves, resulting in a silvery translucent membrane and papery patches. As a result of the damage, pinhole symptoms occur on the leaves. Late instar damage (from the third instar onwards) results in significant leaf defoliation and the emergence of large quantities of fecal pellets in whorls (Janwa et al., 2021).

Due to its rapid spread and distinctive ability to cause significant damage across a variety of crops, it poses a serious threat to the food and nutrition security as well as the livelihoods of hundreds of millions of farming households in Nepal especially, when layered with other drivers of food insecurity. If the pest is left unrestrained, its impact on farmers and the economy will be immense. Since the pest is harmful and economically important, it is therefore necessary to develop effective strategies for managing pests against which sustainable crop production can be achieved.

II. MATERIALS AND METHODS

The experiment was conducted in the agronomy farm of Agriculture and Forestry University (AFU) located at Bharatpur Metropolitan City Ward no. 17, Chitwan from April 2021 to August 2021. The research site is located at latitude 27°64' North; longitude 84°35' East and an altitude of 179 meters from the mean sea level. It lies in the inner Terai region of Nepal having a sub-tropical climate.

During the April season, 6 rows of 4.5m length of plot size were used whereby spacing was 75 cm × 20 cm for Rampur composite variety. The fertilizer concentration was 120:60:40 kg NPK/ha. There were altogether 7 treatments in 3 replications in RCBD design. The detail is shown below;

T1: Novaluron 10% EC (Rimon) @2 ml/liter of water
T2: Azadirachtin 1500 ppm @5ml/ liter of water
T3: Chlorantraniliprole 18.5%SC (Allcora) @0.4ml/liter of water
T4: Azadirachtin 3000 ppm @3ml/ liter of water
T5: Spinetoram 11.7% SC (delegate) @ 0.4 ml/liter of water
T6: Spinosad 45% SC (Tracer) biological insecticide @ 0.5ml/liter of water
T7: Control (without application)

Required insecticides were bought from a nearby insecticide retailer. For liquid insecticides, the required amounts of insecticide concentrate were prepared before spraying it in the field. For this, the required quantity of insecticide was taken and poured into the knapsack sprayer with a small amount of water in the sprayer. Then, the mixture was shaken to make it homogenous and finally total amount of water was added that is required to spray. Treatments were applied at 30 DAS at 10 days intervals and a total of three sprays were made. After each application of treatments, the sprayer was washed or rinsed three times with clean water before introducing new treatments. Spraying was done in the evening hours and the whole plant surface especially the whorl portion was wetted with a spray liquid. Control plots were sprayed with clean water.

Fifteen plants per plot were selected randomly in the net plot area as a sample unit for the study. Sample plants were tied with a red cotton thread at the base of the plants. The observations were made on several leaves, the number of damaged leaves, scoring scale, number of egg mass per plant, number of live larvae per plant, number of dead larvae per plant, number of natural enemies per plant, and total yield per plot. For yield calculation, parameters field weight per plot, sample weight per plot, field moisture percentage, 1000 grain weight, cob length, cob diameter, and cob weight were measured. The scoring scale was followed as used by (Bajracharya et al., 2020).

Table 1. Scoring -scale (0-5) for assessment of foliar damage due to Fall armyworm

Score	Damage symptom/description
0	No visible feeding symptoms in upper leaves and whorl.
1	Papery window damage symptoms on upper leaves and whorl.
2	Few small holes on the upper leaves and whorl.
3	Ragged holes on upper leaves and partially whorl damaged.
4	The whorl and upper leaves are extensively damaged.
5	Whorl destroyed and plant drying due to extreme defoliation.

For statistical analysis, R-Studio version 1.4.1717 was used. All the recorded data were subjected to Analysis of Variance and Duncan's Multiple Range Tests (DMRT) for the mean separations from the reference of Gomez and Gomez (1984). Microsoft Office package 2016 i.e. Microsoft Word, and Microsoft excel was used for data entry and management. Analysis was done at a 5% level of significance to test the significant difference for each parameter.

III. Results

The percentage of leaf damage was significant in all treatments after the first spray ($p<0.05$). Similarly, treatment of Azadirachtin of both 3000 ppm and 1500 ppm were statistically similar with untreated control. At three days after the first spray, lower leaf damage by fall armyworm infestation was recorded in Chlorantraniliprole 18.5% SC (12.62 %) followed by Spinetoram 11.7% SC treated plots (12.72%), Novaluron 10 % EC (17.01 %), Spinosad 45 % SC (18.51 %) and Azadirachtin 3000 ppm (20.10 %) respectively, which were not significantly different. Control treatment was not significantly different from all other treatments. Maximum leaf damage percentage by FAW was recorded in Azadirachtin 1500 ppm and lowest recorded in Chlorantraniliprole 18.5 % SC sprayed plot.

At six days after the first spray, lower leaf damage by fall armyworm infestation was recorded in Spinetoram 11.7% SC (4.21 %) followed by Spinosad 45 % SC treated plots (7.23 %), Chlorantraniliprole 18.5% SC (8.94 %), and Novaluron 10 % EC (17.71 %), Azadirachtin 3000 ppm (25.12 %), Azadirachtin 3000 ppm (37.32 %) and untreated control (31.89 %). Azadirachtin 3000 ppm and 1500 ppm, and the control treatment were statistically similar but significantly different from other treatments. Maximum leaf damage percentage by FAW was recorded in Azadirachtin 1500 ppm and lowest recorded in Spinetoram 11.7 % sprayed plot.

Table 2. Effect of different treatments on Percentage damaged leaves per plant observed on Maize after first spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	26.93(31.26)	17.01(24.27)^{b}	17.71(23.96)^{ab}	7.24(14.91)
Azadirachtin 1500 ppm @ 5ml/l	34.58(35.81)	31.23(33.76)^{a}	37.32(37.55)^{a}	26.81(28.46)
Chlorantraniliprole 18.5%SC @0.4ml/l	25.93(30.58)	12.62(20.39)^{b}	8.94(16.14)^{bc}	17.49(21.9)
Azadirachtin 3000 ppm @ 3ml/l	29.26(32.71)	20.1(26.34)^{b}	25.12(29.87)^{a}	22.52(27.05)
Spinosad 45% SC @ 0.5ml/l	27.06(31.30)	18.51(24.97)^{b}	7.23(10.3)^{c}	0.4(2.53)
Spinetoram 11.7% SC @ 0.5ml/l	28.55(32.22)	12.72(20.48)^{b}	4.21(7.08)^{c}	10.81(13.6)
Control	25.43(30.24)	21.02(27.1)^{ab}	31.89(34.36)^{a}	23.48(28.26)
LSD at 0.05	ns	6.96	12.93	ns
SEM (±)		2.26	4.19	
F-value		4.05 *	8.04 **	
CV %		15.46	31.95	
Grand The mean	28.25	19.03	18.91	15.54

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; *: significant; **: highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not

significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate arcsine transformation

The percentage of leaf damage was significant in all treatments after the second spray ($p<0.05$). Three days after the second spray, lower leaf damage by fall armyworm infestation was recorded in Spinosad 45% SC (0 %) followed by Novaluron 10% EC treated plots (1.13%), Chlorantraniliprole 18.5% SC (1.24 %), Spinetoram 11.7% SC (5.25 %) respectively, which were not significantly different. Control treatment was significantly different with Azadirachtin 3000 ppm (20.88 %) but, was statistically at par with Azadirachtin 1500 ppm (31.1 %). Maximum leaf damage percentage by FAW was recorded in control plots (31.4 %) and lowest recorded in sprayed plot Spinosad 45% SC.

Six days after the second spray, no leaf damage by fall armyworm infestation was recorded in Spinetoram 11.7% SC (0 %) and Spinosad 45 % SC treated plots (0 %). Similarly, Chlorantraniliprole 18.5% SC (0.56 %), and Novaluron 10 % EC (2.37 %), were not significantly different but significantly different with Azadirachtin 3000 ppm (14.63 %), Azadirachtin 1500 ppm (27.89 %) and control (29.75 %). Azadirachtin 3000 ppm plots were significantly different from Azadirachtin 1500 ppm and control treatments but, later were statistically similar to each other. Maximum leaf damage percentage by FAW was recorded in control plots and lowest recorded in Spinetoram 11.7 % and Spinosad 45 % SC sprayed plot.

At nine days after the second spray, Spinetoram 11.7% SC, Spinosad 45 % SC, Chlorantraniliprole 18.5% SC, and Novaluron 10 % EC treated plots showed no leaf damage (0%) which were significantly different from control plots. Whereas Azadirachtin 1500 ppm (18.05 %) and Azadirachtin 3000 ppm (13.21 %) plots were statistically at par with each other but, later significantly different from the control plots (22.24 %) (Table 3).

Table 3. Effect of different treatments on Percentage damaged leaves per plant observed on Maize after the second spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	7.24(14.91)	1.13(5.21)^{c}	2.37(5.58)^{c}	0(0.67)^{c}
Azadirachtin 1500 ppm @ 5ml/l	26.81(28.46)	31.1(33.79)^{a}	27.89(31.78)^{a}	18.05(24.96)^{ab}
Chlorantraniliprole 18.5%SC @0.4ml/l	17.49(21.9)	1.24(5.5)^{c}	0.56(2.87)^{c}	0(0.72)^{c}
Azadirachtin 3000 ppm @ 3ml/l	22.52(27.05)	20.88(27.03)^{b}	14.63(22.47)^{b}	13.21(21.15)^{b}
Spinosad 45% SC @ 0.5ml/l	0.4(2.53)	0(0.71)^{c}	0(0.57)^{c}	0(0.67)^{c}
Spinetoram 11.7% SC @ 0.5ml/l	10.81(13.6)	5.25(5.25)^{c}	(0.57)^{c}	0(0.48)^{c}
Control	23.48(28.26)	31.4(31.4)^{ab}	29.75(32.97)^{a}	22.24(28.01)^{a}
LSD at 0.05	ns	6.1265	5.73	4.83
SEM (±)		1.98	1.86	1.57
F-value		52.69 ***	62.76 ***	68.75 ***
CV %		22.14	23.29	24.83
Grand The mean	15.54	11.83	10.74	7.64

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; *: significant; **: highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate arcsine transformation

Percentage leaf damage was significant in all treatments after third spray ($p<0.05$). At three days after the third spray, no leaf damage by fall armyworm infestation was recorded in Spinosad 45% SC, Novaluron 10% EC, Chlorantraniliprole 18.5% SC and Spinetoram 11.7% SC, which were statistically similar but different to the control plots. The control treatment was statistically similar to Azadirachtin 3000 ppm (16.5 %) and Azadirachtin 1500 ppm (23.17 %). Maximum leaf damage percentage by FAW was recorded in control plots (25.85 %) and lowest recorded in the chemical sprayed plot.

Six days after the second spray, no leaf damage by fall armyworm infestation was recorded in Spinosad 45% SC, Novaluron 10% EC, Chlorantraniliprole 18.5% SC and Spinetoram 11.7% SC which were not significantly different but significantly different with Azadirachtin 3000 ppm (21.79 %), Azadirachtin 1500 ppm (24.12 %) and control (31.02 %). Control plots were significantly different with Azadirachtin 3000 ppm and Azadirachtin 1500 ppm plots. Maximum leaf damage percentage by FAW was recorded in control plots and lowest recorded in chemical sprayed plots.

Nine days after the third spray, Spinetoram 11.7% SC, Spinosad 45 % SC, Chlorantraniliprole 18.5% SC, and Novaluron 10 % EC treated plots showed no leaf damage (0%) which were significantly different from control plots. Whereas Azadirachtin 1500 ppm (22 %) and Azadirachtin 3000 ppm (23.58 %) plots were statistically similar to each other but, significantly different from the control plots (29%) (Table 4).

Table 4. Effect of different treatments on Percentage damaged leaves per plant observed on Maize after third spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	0(0.67)^{c}	0(0.57)^{b}	0(0.67)^{d}	0(0.67)^{c}
Azadirachtin 1500 ppm @ 5ml/l	18.05(24.96)^{ab}	23.17(28.7)^{a}	24.12(24.12)^{b}	22(23.67)^{b}
Chlorantraniliprole 18.5%SC @0.4ml/l	0(0.72)^{c}	0(0.67)^{b}	0(0.72)^{d}	0(0.72)^{c}
Azadirachtin 3000 ppm @ 3ml/l	13.21(21.15)^{b}	16.5(23.9)^{a}	21.79(21.79)^{c}	23.58(23.04)^{b}
Spinosad 45% SC @ 0.5ml/l	0(0.67)^{c}	0(0.67)^{b}	0(0.72)^{d}	0(0.72)^{c}
Spinetoram 11.7% SC @ 0.5ml/l	0(0.48)^{c}	0(0.67)^{b}	0(0.72)^{d}	0(0.72)^{c}
Control	22.24(28.01)^{a}	25.85(30.11)^{a}	31.02(31.02)^{a}	29(30.84)^{a}
LSD at 0.05	4.83	6.175	2.23	1.55
SEM (±)	1.57	2.004	0.72	0.50
F-value	68.75 ***	52.45 ***	352.43 ***	733.57 ***
CV %	24.83	28.49	11.03	7.59
Grand The mean	7.64	10.74	10.99	10.65

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate arcsine transformation

Statistical analysis of a number of dead larvae after the first spray showed non-significant results at all days i.e. three, six and nine days after the spray. Similar results were obtained in second and third sprays also (Table 5).

Table 5. Effect of different treatments on the mean dead larval number per plant observed on Maize after the first spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	0(0.71)	0(0.71)	0.02(0.72)	0(0.71)
Azadirachtin 1500 ppm @ 5ml/l	0(0.71)	0(0.71)	0(0.71)	0.02(0.72)
Chlorantraniliprole 18.5%SC @0.4ml/l	0(0.71)	0.02(0.72)	0(0.71)	0(0.71)
Azadirachtin 3000 ppm @ 3ml/l	0(0.72)	0.02(0.72)	0(0.71)	0(0.71)
Spinosad 45% SC @ 0.5ml/l	0(0.71)	0(0.71)	0.02(0.72)	0(0.71)
Spinetoram 11.7% SC @ 0.5ml/l	0(0.72)	0.02(0.72)	0(0.71)	0(0.71)
Control	0(0.71)	0(0.71)	0(0.71)	0(0.71)
LSD at 0.05	ns	ns	ns	ns
SEM (±)				
F-value				
CV %				
Grand The mean	0.00	0.01	0.01	0.003

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate $\sqrt{(x+0.5)}$ transformation

The mean live larval number was not significant at three and nine days after the first spray at ($p<0.05$). At six days after the first spray no live larvae were observed in Spinetoram 11.7% SC, Spinosad 45% SC, Chlorantraniliprole 18.5%SC and Novaluron 10% EC which, was significantly different from other treatments. Azadirachtin 1500 ppm (0.29) was significantly different with Azadirachtin 3000 ppm (0.19). Similarly, highest live larval number were observed in control treatment (0.42) (Table 6).

Table 6. Effect of different treatments on the mean live larval number per plant observed on Maize after first spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	0.47(0.98)	0.06(0.75)	$0(0.71)^d$	0(0.71)
Azadirachtin 1500 ppm @ 5ml/l	0.27(0.88)	0.42(0.96)	$0.29(0.89)^b$	0.29(0.89)
Chlorantraniliprole 18.5%SC @0.4ml/l	0.19(0.83)	0.03(0.73)	$0(0.71)^d$	0.08(0.76)
Azadirachtin 3000 ppm @ 3ml/l	0.18(0.82)	0.19(0.83)	$0.16(0.81)^c$	0.19(0.83)
Spinosad 45% SC @ 0.5ml/l	0.13(0.79)	0(0.71)	$0(0.71)^d$	0(0.71)
Spinetoram 11.7% SC @ 0.5ml/l	0.11(0.78)	0.02(0.72)	$0(0.71)^d$	0(0.71)
Control	0.02(0.72)	0.06(0.75)	$0.42(0.96)^a$	0.14(0.8)
LSD at 0.05	ns	ns	0.06714	ns
SEM (±)			0.02179	
F-value			22.08 ***	
CV %			4.80	
Grand The mean	**0.19**	**0.11**	**0.12**	**0.10**

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan"s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate $\sqrt{(x+0.5)}$ transformation

The mean live larval number was significant at three and six days after the second spray ($p<0.05$). At three days after the second spray no live larvae were observed in Spinetoram 11.7% SC, Spinosad 45% SC, Chlorantraniliprole 18.5%SC and Novaluron 10% EC which, was significantly different from other treatments. Azadirachtin 1500 ppm (0.22) was significantly not different from Azadirachtin 3000 ppm (0.17) and control treatment (0.21). Similarly, the highest live larval number was observed in Azadirachtin 1500 ppm (0.22).

Six days after the second spray no live larvae were observed in Spinetoram 11.7% SC, Spinosad 45% SC, Chlorantraniliprole 18.5% SC, and Novaluron 10% EC. Similarly, Azadirachtin 1500 ppm (0.08) live larvae and Azadirachtin 3000 ppm (0.06) larvae which were statistically similar to the above-mentioned treatments but, significantly different from the untreated control (0.19) (Table 7).

Table 7. Effect of different treatments on the mean live larval number per plant observed on Maize after the second spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	0(0.71)
Azadirachtin 1500 ppm @ 5ml/l	0.29(0.89)	$0.22(0.85)^a$	$0.08(0.76)^b$	0.08(0.76)
Chlorantraniliprole 18.5%SC @0.4ml/l	0.08(0.76)	$0(0.71)^b$	$0(0.71)^b$	0(0.71)
Azadirachtin 3000 ppm @ 3ml/l	0.19(0.83)	$0.17(0.82)^a$	$0.06(0.75)^b$	0.06(0.75)
Spinosad 45% SC @ 0.5ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	0(0.71)
Spinetoram 11.7% SC @ 0.5ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	0(0.71)
Control	0.14(0.8)	$0.21(0.84)^a$	$0.19(0.83)^a$	0.08(0.76)
LSD at 0.05	ns	0.1069	0.05402	ns
SEM (±)		0.034	0.0175	
F-value		3.98 *	7.02 **	

CV %		7.85	4.09	
Grand The mean	0.10	0.09	0.05	0.04

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; *: significant; **: highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

The mean live larval number was significant in all treatments after the third spray at ($p<0.05$). At three days after the third spray no live larvae were observed in Spinetoram 11.7% SC, Spinosad 45% SC, Chlorantraniliprole 18.5%SC and Novaluron 10% EC which, was significantly different from other treatments. Similarly, Azadirachtin 1500 ppm (1.1), Azadirachtin 3000 ppm (0.82), and untreated control (1.24) live larvae were statistically similar to each other. The highest live larval population was observed in the control treatment.

At six days after the third spray no live larvae were observed in Spinetoram 11.7% SC, Spinosad 45% SC, Chlorantraniliprole 18.5% SC, and Novaluron 10% EC. Similarly, Azadirachtin 1500 ppm (0.78), Azadirachtin 3000 ppm (0.8), and untreated control (1.04) live larvae were statistically similar to each other. The highest live larval population was observed in the control treatment.

Nine days after the third spray also no live larvae were observed in Spinetoram 11.7% SC, Spinosad 45% SC, Chlorantraniliprole 18.5% SC, and Novaluron 10% EC. Similarly, Azadirachtin 1500 ppm (0.8), Azadirachtin 3000 ppm (0.82), and untreated control (1.06) live larvae were statistically similar to each other. The highest live larval population was observed in the control treatment (Table 8).

Table 8. Effect of different treatments on the mean live larval number per plant observed on Maize after the third spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	$0(0.71)^b$
Azadirachtin 1500 ppm @ 5ml/l	0.08(0.76)	$1.1(1.26)^a$	$0.78(1.13)^a$	$0.8(1.14)^a$
Chlorantraniliprole 18.5%SC @0.4ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	0(0.71)b
Azadirachtin 3000 ppm @ 3ml/l	0.06(0.75)	$0.82(1.15)^a$	$0.8(1.14)^a$	$0.82(1.15)^a$
Spinosad 45% SC @ 0.5ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	$0(0.71)^b$
Spinetoram 11.7% SC @ 0.5ml/l	0(0.71)	$0(0.71)^b$	$0(0.71)^b$	$0(0.71)^b$
Control	0.08(0.76)	$1.24(1.32)^a$	$1.04(1.24)^a$	$1.06(1.25)^a$
LSD at 0.05	ns	0.3489	0.3425	0.3425
SEM (±)		0.1132	0.111	0.11
F-value		6.66 **	5.13 **	5.13 **
CV %		20.84	21.15	21.15
Grand The mean	0.04	0.39	0.33	0.33

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

Higher ear number was recorded in Spinetoram 11.7% SC (44.33) followed by Spinosad 45% SC (40) and Chlorantraniliprole 18.5%SC (39), which were statistically at par with Spinetoram. The lowest ear number was recorded in the untreated control (27) which was statistically at par with Azadirachtin 1500 ppm (31). Azadirachtin 3000 ppm (35) was statistically similar to Novaluron 10% EC (37).

Statistical analysis showed that average grain yield showed a significant difference at ($p<0.05$) with untreated control. Grain yield was recorded highest for Spinetoram 11.7% SC (5.1t/ha), which is statistically at par with Spinosad 45% SC (5.01 t/ha) and Chlorantraniliprole 18.5%SC (4.39 t/ha). Similarly, Novaluron 10% EC (4.16 t/ha) was statistically at par with Chlorantraniliprole 18.5%SC (4.39 t/ha). Similarly, in yield of Azadirachtin 1500 ppm (3.57 t/ha) was statistically at par with Azadirachtin 3000 ppm (3.79 t/ha) and untreated control 2.98 t/ha (Table 9).

Table 9: Effect of different treatments on the mean yield per plot of Maize at Rampur, Chitwan, 2021

Treatment	**Ear Number**	**Yield t/ha**
Novaluron 10% EC @2 ml/l	37.33^{bc}	4.16^{bc}
Azadirachtin 1500 ppm @ 5ml/l	31^{cd}	3.57^{cd}
Chlorantraniliprole 18.5%SC @0.4ml/l	39^{ab}	4.39^{abc}
Azadirachtin 3000 ppm @ 3ml/l	35.33^{bc}	3.79^{cd}
Spinosad 45% SC @ 0.5ml/l	40^{ab}	5.01^{ab}
Spinetoram 11.7% SC @ 0.5ml/l	44.33^{a}	5.1^{a}
Control	27.67^{d}	2.98^{d}
LSD at 0.05	6.283	0.85007
SEM (±)	2.039	0.2758
F-value	7.61 **	7.74 **
CV %	9.70	11.53
Grand The mean	36.38	4.14

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan¨s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

The mean scoring scale was significant in all treatments after the first spray ($p<0.05$). Three days after the first spray, lower damage score by fall armyworm infestation was recorded in Spinetoram 11.7% SC (0.11) which is significantly different from other treatments. Similarly, Spinetoram 11.7% SC followed by Chlorantraniliprole 18.5%SC (0.54) which is statistically at par with Spinosad 45% SC (0.69), Novaluron 10% EC (0.78) and Azadirachtin 3000 ppm (0.85). Higher damage score was recorded in Azadirachtin 1500 ppm (1.38) which was statistically at par with untreated control (1.16) and Azadirachtin 3000 ppm, which was significantly different from Azadirachtin 1500 ppm (1.38) and untreated control (1.16).

Six days after the first spray, a lower score was recorded in Spinetoram 11.7% SC (0.02) which is statistically at par with Spinosad 45% SC (0.27) and Chlorantraniliprole 18.5% SC (0.35). A higher score was recorded in Azadirachtin 1500 ppm (1.78) which is statistically at par with untreated control (1.4) and Azadirachtin 3000 ppm (1.11).

At nine days after the first spray, no significant difference among the treatments was observed (Table 10).

Table 10. Effect of different treatments on scoring scale per plant observed on Maize after first spray at Rampur, Chitwan, 2021

Treatment	Pre-spray	3 DAS_p	6 DAS_p	9 DAS_p
Novaluron 10% EC @2 ml/l	0.82(1.15)	0.78(1.13)^{bc}	0.73(1.11)^{bc}	0.08(0.76)
Azadirachtin 1500 ppm @ 5ml/l	1.32(1.35)	1.38(1.37)^{a}	1.72(1.49)^{a}	1.22(1.31)
Chlorantraniliprole 18.5%SC @0.4ml/l	0.82(1.15)	0.54(1.02)^{c}	0.35(0.92)^{cd}	0.69(1.09)
Azadirachtin 3000 ppm @ 3ml/l	1.01(1.23)	0.85(1.16)^{abc}	1.11(1.27)^{ab}	0.96(1.21)
Spinosad 45% SC @ 0.5ml/l	0.89(1.18)	0.69(1.09)^{bc}	0.27(0.88)^{cd}	0.02(0.72)
Spinetoram 11.7% SC @ 0.5ml/l	0.62(1.06)	0.11(0.78)^{d}	0.02(0.72)^{d}	0.36(0.93)
Control	1.3(1.34)	1.16(1.29)^{ab}	1.4(1.38)^{a}	1.19(1.3)
LSD at 0.05	ns	0.2269	0.2510	ns
SEM (±)		0.0736	0.0814	
F-value		6.86 **	12.21 ***	
CV %		11.35	12.68	
Grand The mean	0.97	0.76	0.74	0.60

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are

not significantly different at 5% by DMRT (Duncan"s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

The mean scoring scale was significant in all treatments after the second spray ($p<0.05$). Similarly, treatment consisting of crops was statistically similar to untreated control. Three days after the second spray, a lower damage score by fall armyworm infestation was recorded in Spinosad 45% SC (0) followed by Spinetoram 11.7% SC (0.06) treated plots, Novaluron 10% EC (0.02) and Chlorantraniliprole 18.5%SC (0.09), which were significantly not different among each other but, different from other treatments. A higher damage score was recorded in Azadirachtin 1500 ppm (1.35) which was statistically similar to untreated control (1.43) and Azadirachtin 3000 ppm (1.01).

Six days after the second spray, no damage score was recorded in Spinosad 45% SC (0) followed by Spinetoram 11.7% SC (0) treated plots, Chlorantraniliprole 18.5%SC (0.09) and Novaluron 10% EC (0.09), which were significantly not different among each other but, different from other treatments. A higher damage score was recorded in Azadirachtin 1500 ppm (1.54) which was statistically similar to untreated control (1.52) but, significantly different from Azadirachtin 3000 ppm (0.82).

Nine days after the second spray, no damage score was recorded in Spinosad 45% SC Spinetoram 11.7% SC, Chlorantraniliprole 18.5% SC and Novaluron 10% EC which were significantly not different from each other but, different from other treatments. Azadirachtin 3000 ppm (0.62) showed a significant difference with untreated control (1.16) but, was statistically at par with Azadirachtin 1500 ppm (1.09) (Table 11).

Table 11. Effect of different treatments on scoring scale per plant observed on Maize after second spray at Rampur, Chitwan, 2021

Treatment	Pre-spray	3 DAS_p	6 DAS_p	9 DAS_p
Novaluron 10% EC @2 ml/l	0.08(0.76)	$0.02(0.72)^{b}$	$0.09(0.77)^{c}$	$0(0.71)^{c}$
Azadirachtin 1500 ppm @ 5ml/l	1.22(1.31)	$1.35(1.36)^{a}$	$1.54(1.43)^{a}$	$1.09(1.26)^{ab}$
Chlorantraniliprole 18.5%SC @0.4ml/l	0.69(1.09)	$0.09(0.77)^{b}$	$0.02(0.72)^{c}$	0(0.71)c
Azadirachtin 3000 ppm @ 3ml/l	0.96(1.21)	$1.01(1.23)^{a}$	$0.82(1.15)^{b}$	$0.62(1.06)^{b}$
Spinosad 45% SC @ 0.5ml/l	0.02(0.72)	$0(0.71)^{b}$	$0(0.71)^{c}$	$0(0.71)^{c}$
Spinetoram 11.7% SC @ 0.5ml/l	0.36(0.93)	$0.06(0.75)^{b}$	$0(0.71)^{c}$	$0(0.71)^{c}$
Control	1.19(1.3)	$1.43(1.39)^{a}$	$1.52(1.42)^{a}$	$1.16(1.29)^{a}$
LSD at 0.05	ns	0.2958	0.2468	0.1939
SEM (±)		0.0960	0.0801	0.0629
F-value		11.03 ***	17.88 ***	19.16 ***
CV %		16.75	14.0	11.80
Grand The mean	0.65	0.48	0.48	0.35

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan"s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

Three days after the third spray, no damage scores were recorded in Spinosad 45% SC Spinetoram 11.7% SC, Chlorantraniliprole 18.5% SC and Novaluron 10% EC which were significantly not different from each other but, different from other treatments. A higher damage score was recorded in the untreated control (0.19) which was statistically similar to Azadirachtin 1500 ppm (0.12) and Azadirachtin 3000 ppm (0.02) (Table 12).

Table 12. Effect of different treatments on scoring scale per plant observed on Maize after third spray at Rampur, Chitwan, 2021

Treatment	Pre-spray	3 DAS_p	6 DAS_p	9 DAS_p
Novaluron 10% EC @2 ml/l	$0(0.71)^{c}$	$0(0.71)^{b}$	$0(0.71)^{b}$	0.08(0.76)
Azadirachtin 1500 ppm @ 5ml/l	$1.09(1.26)^{ab}$	$0.12(0.79)^{ab}$	$0.09(0.77)^{ab}$	0.11(0.78)
Chlorantraniliprole 18.5%SC @0.4ml/l	0(0.71)c	$0(0.71)^{b}$	$0(0.71)^{b}$	0(0.71)
Azadirachtin 3000 ppm @ 3ml/l	$0.62(1.06)^{b}$	$0.06(0.75)^{ab}$	$0.02(0.72)^{b}$	0(0.71)
Spinosad 45% SC @ 0.5ml/l	$0(0.71)^{c}$	$0(0.71)^{b}$	$0(0.71)^{b}$	0(0.71)

Spinetoram 11.7% SC @ 0.5ml/l	0(0.71)[c]	0(0.71)[b]	0(0.71)[b]	0(0.71)
Control	1.16(1.29)[a]	0.19(0.83)[a]	0.12(0.79)[a]	0.06(0.75)
LSD at 0.05	0.1939	0.0881	0.06499	ns
SEM (±)	0.0629	0.0286	0.021094	
F-value	19.16 ***	3.0672 *	2.90 ·	
CV %	11.80	6.64	4.98	
Grand The mean	0.35	0.06	0.04	0.036

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

Non-significant results were obtained after the first spray at three, six, and nine days after the spray (Table 13).

Table 13. Effect of different treatments on the number of natural enemies per plant observed on Maize after the first spray at Rampur, Chitwan, 2021

Treatment	Pre-spray	3 DAS_p	6 DAS_p	9 DAS_p
Novaluron 10% EC @2 ml/l	0.64(1.07)	0(0.71)	0.85(1.16)	1.09(1.26)
Azadirachtin 1500 ppm @ 5ml/l	0.82(1.15)	0(0.71)	1.09(1.26)	1.27(1.33)
Chlorantraniliprole 18.5%SC @0.4ml/l	0.62(1.06)	0(0.71)	0.85(1.16)	1.11(1.27)
Azadirachtin 3000 ppm @ 3ml/l	0.4(0.95)	0(0.71)	1.19(1.3)	1.35(1.36)
Spinosad 45% SC @ 0.5ml/l	0.48(0.99)	0(0.71)	1.16(1.29)	1.11(1.27)
Spinetoram 11.7% SC @ 0.5ml/l	0.6(1.05)	0(0.71)	0.99(1.22)	0.99(1.22)
Control	0.75(1.12)	0(0.71)	1.22(1.31)	1.57(1.44)
LSD at 0.05	ns	ns	ns	ns
SEM (±)				
F-value				
CV %				
Grand The mean	0.62	0.00	1.06	1.22

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

The mean natural enemy population was significant in all treatments after the second spray ($p<0.05$). Three days after the second spray, a higher number of natural enemies were recorded in Azadirachtin 1500 ppm (2.29) followed by untreated control (2.22) which were significantly not different. The lowest number of natural enemies were recorded in Chlorantraniliprole 18.5% SC (0.56), followed by Spinetoram 11.7% SC (0.71), Spinosad 45% SC (0.92), Azadirachtin 3000 ppm (0.99) and Novaluron 10% EC (1.14) which are statistically similar to each other. Novaluron 10% EC statistically at par with untreated control and Azadirachtin 1500 ppm.

Six days after the second spray, a higher number of natural enemies were recorded in the untreated control (1.52) followed by Azadirachtin 1500 ppm (1.09) which were significantly not different but, significantly different from other treatments. The lowest number of natural enemies was recorded in Spinosad 45% SC (0.33) followed by Spinetoram 11.7% SC (0.51), Novaluron 10% EC (0.87), Chlorantraniliprole 18.5% SC (0.56) and Azadirachtin 3000 ppm respectively Novaluron 10% EC (1.14) which are statistically similar to each other. Novaluron 10% EC statistically at par with untreated control and Azadirachtin 1500 ppm.

Non-significant results were observed at nine days after the second spray (Table 14).

Table 14. Effect of different treatments on the number of natural enemies per plant observed on Maize after the second spray at Rampur, Chitwan, 2021

Treatment	Pre-spray	3 DAS_p	6 DAS_p	9 DAS_p
Novaluron 10% EC @2 ml/l	1.09(1.26)	1.14(1.28)^{ab}	0.87(1.17)^{ab}	0.62(1.06)
Azadirachtin 1500 ppm @ 5ml/l	1.27(1.33)	2.29(1.67)^{a}	1.09(1.26)^{a}	0.71(1.1)
Chlorantraniliprole 18.5%SC @0.4ml/l	1.11(1.27)	0.56(1.03)^{b}	0.92(1.19)^{b}	0.64(1.07)
Azadirachtin 3000 ppm @ 3ml/l	1.35(1.36)	0.99(1.22)^{b}	1.09(1.26)^{b}	0.73(1.11)
Spinosad 45% SC @ 0.5ml/l	1.11(1.27)	0.92(1.19)^{b}	0.33(0.91)^{b}	0.69(1.09)
Spinetoram 11.7% SC @ 0.5ml/l	0.99(1.22)	0.71(1.1)^{b}	0.51(1)^{b}	0.85(1.16)
Control	1.57(1.44)	2.22(1.65)^{a}	1.52(1.42)^{a}	1.38(1.37)
LSD at 0.05	ns	0.3909	0.2919	ns
SEM (±)		0.1268	0.0947	
F-value		4.01 *	3.24 *	
CV %		16.80	13.94	
Grand The mean	1.22	1.21	0.89	0.81

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem(±) indicate standard error and figure in parenthesis indicate $\sqrt{(x+0.5)}$ transformation

At three days after third spray highest number of natural enemies were recorded in Azadirachtin 3000 ppm (1.22) which was statistically similar to Spinetoram 11.7% SC (1.22) followed by untreated control (1.09), Azadirachtin 1500 ppm (0.69) and Spinosad 45% SC (0.69) which were statistically at par with aforementioned treatments. Lowest number of natural enemies were recorded with Novaluron 10% EC (0.19) which was statistically at par with Chlorantraniliprole 18.5% SC (0.58), Spinosad 45% SC and Azadirachtin 1500 ppm.

Sixth and ninth day after third spray, higher number of natural enemies were recorded in untreated control which was significantly different from Novaluron 10% EC. All other treatments were statistically similar to each other except Novaluron 10% EC (Table 15).

Table 15. Effect of different treatments on the number of natural enemies per plant observed on Maize after the third spray at Rampur, Chitwan, 2021

Treatment	**Pre-spray**	**3 DAS_p**	**6 DAS_p**	**9 DAS_p**
Novaluron 10% EC @2 ml/l	0.62(1.06)	0.19(0.83)^{c}	0.19(0.83)^{b}	0.41(0.95)^{b}
Azadirachtin 1500 ppm @ 5ml/l	0.71(1.1)	0.69(1.09)^{abc}	0.96(1.21)^{a}	1.3(1.34)^{a}
Chlorantraniliprole 18.5%SC @0.4ml/l	0.64(1.07)	0.58(1.04)^{bc}	0.96(1.21)^{a}	1.51(1.42)^{a}
Azadirachtin 3000 ppm @ 3ml/l	0.73(1.11)	1.22(1.31)^{a}	0.99(1.22)^{a}	1.48(1.41)^{a}
Spinosad 45% SC @ 0.5ml/l	0.69(1.09)	0.69(1.09)^{abc}	1.32(1.35)^{a}	1.57(1.44)^{a}
Spinetoram 11.7% SC @ 0.5ml/l	0.85(1.16)	1.22(1.31)^{a}	1.3(1.34)^{a}	1.5(1.41)^{a}
Control	1.38(1.37)	1.09(1.26)^{ab}	1.49(1.41)^{a}	1.73(1.49)^{a}
LSD at 0.05	ns	0.2484	0.267	0.236
SEM (±)		0.08062	0.08675	0.076
F-value		4.82 **	4.86 **	5.58 **
CV %		12.30	12.22	9.83
Grand The mean	1.22	0.79	1.01	1.36

DAS_p: Days After Spraying of Treatment; CV: Coefficient of Variation; **: highly significant; ***: very highly significant; ns: Non-Significant; LSD: Least Significant Difference; Values with the same letters in a column are

not significantly different at 5% by DMRT (Duncan‟s Multiple Range Test); Sem (±) indicate standard error and figure in parenthesis indicate √(x+0.5) transformation

IV. CONCLUSION

Being an important and challenging pest management target, FAW requires safe, sustainable, and effective management strategies (Bateman et al., 2018). Safe and sustainable management of this invasive pest is undertaken with the use of safer chemical pesticides (green label). Among chemicals highest grain yield (t/ha) was recorded for Spinetoram 11.7% SC (5.1 t/ha) followed by Spinosad 45% SC, Chlorantraniliprole 18.5% SC, and Novaluron 10% EC. Similar results were obtained by Kumar & Mohan, (2020) where Spinetoram-treated plots recorded the highest grain yield followed by Novaluron and Chlorantraniliprole among ten insecticides assessed for the management of FAW. Field efficacy of chemicals i.e. Chlorantraniliprole 18.5 SC, followed by Emamectin benzoate 5 SG, Spinetoram 11.7 SC, Flubendiamide 480 SC, Indoxacarb 14.5 SC, Lambda-cyhalothrin 5 EC, and Novaluron 10 EC showed better results which were directly correlated with the grain yield of Maize (Deshmukh et al., 2020). There was a significant reduction in the percentage of damaged leaves and live larvae in synthetic chemicals sprayed plots compared to untreated control. Similar results were documented by Sisay et al., (2019) as there was a significant reduction in leaf damage as compared to control and a reduction in several larvae in treated plots. Bajracharya et al., (2020) also conducted action research for the evaluation of insecticides against FAW using Spinosad, Chlorantraniliprole, Emamectin benzoate, Imidacloprid, Azadirachtin, and untreated control in natural infestation conditions. Among these Spinosad, Chlorantraniliprole, and Emamectin benzoate were found effective based on percentage damage score. Similarly, Azadirachtin at 3000 and 1500 ppm did not show a significant difference in the yield of Maize as compared to chemical insecticides. It was statistically at par with untreated control.

Synthetic pesticides, as with other insect pest species, are an important management tool in FAW control in America (Andrews, 1998). FAW is one of the most common sweetcorn pests in Florida, and synthetic pesticides are used to protect both the vegetative and reproductive stages of corn (Capinera, 2020). Though synthetic insecticides are effective in controlling FAW, there is an increased risk to human health due to a lack of safety precautions and inappropriate handling (Abrahams et al., 2017). So, careful handling of chemicals is a must.

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