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EFFICACY OF NOVEL INSECTICIDES AGAINST LEAF WEBBER AND CAPSULE BORER, *ANTIGASTRA CATALAUNALIS* (DUPONCHEL) INFESTING SESAME

Sumit Kalathiya[1], Chandaragi M. K.[2*], Bindu K. Panickar[3] and Manisha S. Shinde[4]
[1]Department of Agricultural Entomology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar – 385506, Gujarat, India
[2]Centre for Oilseeds Research, S. D. Agricultural University, Sardarkrushinagar – 385506, Gujarat, India
[3]Pulses Research Station, S. D. Agricultural University, Sardarkrushinagar – 385506, Gujarat, India
[4]Polytechnic in Agriculture, SDAU, Deesa–385535, Gujarat, India
*Corresponding author E-mail: mallu3731@gmail.com
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ABSTRACT

The field experiment was carried out at Agronomy Instructional Farm, S.D. Agricultural University, Sardarkrushinagar during *kharif*, 2023. Among the seven insecticides evaluated, significantly lower larval population (0.44 and 0.50 larvae/plant), web infestation (0.38 and 0.44 webs/plant) and capsule damage (3.36 and 4.36%) was obtained from treatments, chlorantraniliprole 18.5% SC @ 0.0037 per cent and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent. The highest sesame seed yield was recorded from the plots treated with chlorantraniliprole 18.5% SC @ 0.0037 per cent (672 kg/ha) and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (632 kg/ha). The maximum (1: 7.35) ICBR was obtained from emamectin benzoate 5% SG @ 0.0020 per cent followed by chlorantraniliprole 18.5% SC @ 0.0037 per cent (1: 6.46) and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (1: 4.78), respectively.
***Keywords* :** *A. catalaunalis*, sesame, efficacy, insecticides and capsule.

Introduction

Sesame (*Sesamum indicum* L.) is important oilseed crop and popularly known as "Queen of Oilseeds". Sesame belongs to Tubiflorae order and Pedaliaceae family. It is one of the ancient oilseed crops originated in Africa and also one of the earliest domesticated plants. India produces a wide range of sesame varieties with different grades each peculiar to the region. Sesame is harvested twice a year and is available around the year. Sesame has been classified in different seed colours are *viz*., white, yellow, red, brown and black. The most important sesame growing countries are India, China, Sudan, Burma and Mexico (Ogbonna and Umar-Shaba, 2012). In India, sesame is grown in Rajasthan, Gujarat, Uttar Pradesh, Orissa, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal. India contributes the highest sesame acreage of about 15.23 lakh hectares with production of 8.02 lakh tones and productivity of 527 kg/ha. In Gujarat sesame was cultivated in 1.96 lakh hectares with production of 1.43 lakh tones and productivity 732 kg/ha (Anon., 2023). In Gujarat major sesame growing area are in Surendranagar, Banaskantha, Bhavnagar, Kachchh, Rajkot, Amreli and Mehsana. Among the insect pests attacking in sesame, sesame leaf webber and capsule borer *A. catalaunalis* is the key pest causing extensive damage to foliage and fruiting bodies in Gujarat (Bhadauria *et al*., 2000). It is found all over the world where this crop is grown. The larvae of this pest roll together a few top leaves and feed on them in the early stage of the crop and after pod formation the larvae get entry inside the pod and gets damaged (Pandey *et al*., 2019). This pest causes 10-70 per cent infestation of leaves, 34-62 per cent of flower buds or flowers and 10-44 per cent of pods resulting in 72 per cent yield loss (Ahirwar *et al*., 2010). One to three larvae are enough to defoliate a fully-grown plant within 24 to 48 hours. Among the various methods of pest management, the use of insecticide forms the first line of defense against the insect pests among the farmers. Due to internal feeder, ii is difficult to manage by use of biopesticides/ botanical insecticides. The studies with respect to chemical insecticides against various insect pests on different crops have been proved and found significantly effective at safer dose. Therefore, present studies are under taken with newer and effective insecticides for management of *A. catalaunalis* on sesame.

Materials and Methods

A field experiment was laid-out during kharif 2023 in Randomized Block Design (RBD) at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar with eight treatments and were replicated thrice. First spray was applied at the time of appearance of pest on sesame and second spray was applied 15 days after the first spray. Knapsack sprayer was used for spraying with spray volume of 500 l/ha.A sesame variety GT 3 was sown with a spacing of 45 cm × 10 cm, between rows and plants, respectively. For each treatment, a gross plot size of 4.0 m × 2.25 m with Net plot size of 3.80 m x 1.35 m was maintained. Seven insecticidesviz.,chlorantraniliprole18.5%SC, spinetoram11.7%SC, emamectin benzoate 5% SG, spinosad 45 %SC, flubendiamide 39.35% SC, chlorpyriphos 50% + cypermethrin 5% EC and chlorantraniliprole 9.30% + lambdacyhalothrin 4.6 % ZC were tested in comparison with untreated control against sesame leaf webber and capsule borer. The observations on the number of larvae per plant, no. of webs per plant and capsule damage caused by A. catalaunalis was made a day before and after 1, 3, 7, 10 and 14 days after treatment imposition. The per cent capsule damage was calculated by the following formula

$$\text{Capsule damage (\%)} = \frac{\text{No. of damaged capsules}}{\text{Total no. of capsules}} \times 100$$

The crop harvest was made at physiological maturity and grain yields were recorded treatment wise. On the basis of yield the economics of each treatment was calculated. Increase in yield over control and avoidable losses were also calculated as per formula given by Khosla (1977).

$$\text{Increase in yield over control (\%)} = \frac{\text{Yield in treatment - Yield in control}}{\text{Yield in control}} \times 100$$

$$\text{Avoidable loss (\%)} = \frac{\text{Highest yield in treated plot - Yield in treatment}}{\text{Highest yield in treated plot}} \times 100$$

Results and Discussion

The data on larval population, web infestation and capsule damage of leaf webber and capsule borer are recorded after 1, 3, 7, 10 and 14 days of spray, pooled over periods and pooled over sprays are presented in Table 1, 2 and 3. Larval population, web infestation and capsule damage was found homogenous in all the evaluated treatments before spray as treatment differences were non-significant.

Effect on larval population

Data on effect of insecticides on larval population (Table 1) revealed that significantly lowest (0.44 larvae/plant) larval population was observed in chlorantraniliprole 18.5% SC @ 0.0037 per cent and it was at par with chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC@ 0.0056 per cent (0.50 larvae/plant). However, the treatments emamectin benzoate 5% SG @ 0.0020 per cent (0.87 larvae/plant) and spinosad 45% SC @ 0.0149 per cent (0.96 larvae/ plant) were found at par with each other. There were followed by spinetoram 11.7% SC @ 0.0117 per cent (1.06larvae/plant) and chlorpyriphos 50% + cypermethrin 5% EC@ 0.1100 per cent (1.16 larvae/ plant) which was at par with each other and recorded higher larval population. While, flubendiamide 39.35% SC @ 0.0098 per cent (1.24 larvae/ plant) observed higher larval population and found least effective among the insecticides evaluated. Untreated control (2.85 larvae/plant) recorded significantly higher larval population of leaf webber and capsule borer. The chemical insecticide, chlorantraniliprole 18.5 SC @ 0.0069 per cent was more effective (0.71 larvae/plant) against larval population of leaf webber and capsule borer on sesame (Rabari *et al*., 2024). Similarly, Omprakash *et al*. (2022) noted that out of seven insecticides evaluated against *A. catalaunalis* on sesame, chlorantraniliprole 18.5 SC and spinosad 45 SC were most effective (90.28 and 80.23% larval reduction over control) against larval population of leaf webber and capsule borer on sesame. Further, significantly lowest (0.55 larvae/plant) larval population was observed in chlorantraniliprole 18.5 SC @0.005 % (Sharma, 2022).

Effect on web infestation

Data on pooled over sprays is presented in Table 2 indicated that all insecticide treatments were found significantly superior over untreated control (1.69webs/plant). Among the various insecticides, chlorantraniliprole 18.5% SC @ 0.0037 per cent and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent were found significantly superior than the rest of the insecticide treatments and recorded lowest (0.38and 0.44 webs/plant) web infestation. It was followed by emamectin benzoate 5% SG @ 0.0020 per cent (0.73webs/plant) and spinosad 45% SC @ 0.0149 per cent (0.78webs/plant) were next nearly similar in order of their effectiveness. The next best treatment wasspinetoram 11.7% SC @ 0.0117 per cent and chlorpyriphos 50% + cypermethrin 5% EC@ 0.1100 per cent with 0.85 and 0.87 webs per plant, respectively and it was at par with each other. Higher (0.92webs/plant) web infestation was recorded in flubendiamide 39.35% SC @ 0.0098 per cent. Among all the treatments, significantlyhighest (1.69 webs/plant) web infestation was recorded in untreated control. The results of Sharma (2022) revealed that chlorantraniliprole 18.5 SC, 0.005 per cent showed the lowest leaf damage (7.71%) and Omprakash *et al.* (2022) revealed that significantly lowest leaf damage was found in chlorantraniliprole 18.5% SC (8.16%) followed by spinosad 45% SC (9.98%).

Effect on capsule damage

The data pooled over sprays is presented in Table 3shows that all insecticide treatments were found significantly superior over untreated control (18.34% capsule damage). Among the various insecticides, chlorantraniliprole 18.5% SC @ 0.0037 per cent was found significantly superior than the rest of insecticide treatments and recorded lowest (3.36%) capsule damage. It was followed by chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (4.36%). Next most effective insecticide was emamectin benzoate5% SG @ 0.0020 per cent with 5.59 per cent capsule damage. While, spinosad 45% SC @ 0.0149 per cent (7.71%) and spinetoram 11.7% SC @ 0.0117 per cent (8.32%) were at par with each other and significantly more effective than remaining insecticides. It was followed by chlorpyriphos 50% + cypermethrin 5% EC@ 0.1100 per cent(9.31%). Among all the evaluated insecticides, flubendiamide 39.35% SC @ 0.0098 per cent was found least effective with 10.82 per cent capsule damage. Chlorantraniliprole 18.5 SC@0.0069 per cent recorded minimum (3.25%) capsule damage (Rabari *et al.*, 2024). Similarly, revealed that chlorantraniliprole 18.5% SC noted lowest (6.17%) capsule damage followed by spinosad 45% SC (8.17%) (Omprakash *et al.* (2022) and chlorantraniliprole 18.5 SC, 0.005 per cent was recorded least (2.87%) capsule damage (Sharma, 2022).

Impact on yield of sesame

Data on the seed yield of sesame are presented in Table 4. All insecticidal treatments recorded significantly higher yields than control plot. Among the different treatments, chlorantraniliprole 18.5% SC @ 0.0037 per cent was recorded significantly the highest seed yield (672 kg/ha) as compared to rest of the treatments and it was at par with chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (632 kg/ha) and emamectin benzoate5% SG @ 0.0020 per cent (608 kg/ha).The plots treated with spinosad 45% SC @ 0.0149 per cent (575 kg/ha) and spinetoram 11.7% SC @ 0.0117 per cent (547 kg/ha) has recorded the average seed yield. Among the evaluated insecticides, lower seed yield was obtained in flubendiamide 39.35% SC @ 0.0098 per cent (496 kg/ha) and chlorpyriphos 50% + cypermethrin 5% EC@ 0.1100 per cent(530 kg/ha). Control plot recorded 352 kg per ha seed yield which was significantly lowest as compared to the rest of the treatments.

Increase in yield over control

An increase in yield over control (Table 4) in sesame crop was worked out for different insecticide treatments and indicated that maximum (90.91%) increase in yield was found in treatment chlorantraniliprole 18.5% SC @ 0.0037 per cent. The second and third most effective insecticides in terms of per cent increase in yield over control were chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (79.64%) and emamectin benzoate 5% SG @ 0.0020 per cent (72.73%) followed by spinosad 45% SC @ 0.0149 per cent (63.54%) and spinetoram 11.7% SC @ 0.0117 per cent (55.49%). Among the tested insecticides, a minimum increase in yield was found in plots treated with flubendiamide 39.35% SC @ 0.0098 per cent (41.10%) andchlorpyriphos 50% + cypermethrin 5% EC @ 0.1100 per cent (50.57%).

Avoidable loss

Avoidable loss in sesame yield due to leaf webber and capsule borer was worked out by applying the formula suggested by Khosla (1977). It can be seen from the data that the maximum seed yield (672 kg/ha) was obtained in the treatment chlorantraniliprole 18.5% SC @ 0.0037 per cent which proved as the best treatment. The avoidable losses due to leaf webber and capsule borer in sesame varied from 5.90 to 47.62 per cent amongst various treatments. The avoidable losses in sesame yield were minimum in the plots treated with chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (5.90%) followed by emamectin benzoate 5% SG @ 0.0020 per cent (9.52%). On other hand, the highest avoidable loss in sesame yield was noted in the untreated control (47.62%). Highest seed yield (801 kg/ha) and incremental yield over control (335 kg/ha) was recorded in chlorantraniliprole 18.5% SC (Omprakash *et al.*, 2022). Similarly, Sharma (2022) also revealed that chlorantraniliprole 18.5 SC, 0.005 per cent noted highest seed yield (692 kg/ha) and maximum per cent increase in yield over control (104.73%) among the treated insecticides.

Economics

The economics of various insecticides (Table 5) evaluated against sesame leaf webber and capsule borer indicated that maximum (27632/ha) net realization was obtained in case of chlorantraniliprole 18.5% SC @ 0.0037 per cent followed by chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent(24178/ha), emamectin benzoate 5% SG @ 0.0020 per cent (22106/ha), spinosad 45% SC @ 0.0149 per cent(19256/ha) and spinetoram 11.7% SC @ 0.0117 per cent(16838/ha). The lowest net realization was found with chlorpyriphos 50% + cypermethrin 5% EC @ 0.1100 per cent (15370/ha) and flubendiamide 39.35% SC @ 0.0098 per cent (12434/ha). Highest (1: 7.35) ICBR recorded emamectin benzoate 5% SG @ 0.0020 per cent and it was followed by chlorantraniliprole 18.5% SC @ 0.0037 per cent (1: 6.46), chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (1: 4.78) and chlorpyriphos 50% + cypermethrin 5% EC @ 0.1100 per cent (1: 3.39). The ICBR of (1: 1.43) wasobserved in the treatment spinosad 45% SC @ 0.0149 per cent. The treatmentsflubendiamide 39.35% SC @ 0.0098 per cent(1: 0.95) and spinetoram 11.7% SC @ 0.0117 per cent(1: 0.30) were showed the lowest ICBR. These findings are in agreement with results of Sharma (2022) who revealed that the highest seed yield (692 kg/ha), net monetary return (40710/ha) and maximum benefit: cost ratio (1: 15.42) was recorded in chlorantraniliprole 18.5 SC. Correspondingly, Omprakash *et al.* (2022) found that the highest (1: 3.22) return was obtained with the treatment profenophos 50 EC followed chlorantraniliprole 18.5 SC (1: 3.12).

Conclusion

Among the seven insecticides evaluated, significantly low larval population (0.44 and 0.50 larvae/plant), web infestation (0.38 and 0.44 webs/plant) and capsule damage (3.36 and 4.36%)was obtained from treatments, chlorantraniliprole 18.5% SC @ 0.0037 per cent and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent. The highest sesame seed yield was recorded from the plots treated with chlorantraniliprole 18.5% SC @ 0.0037 per cent (672 kg/ha) and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent(632 kg/ha). The maximum (1: 7.35) ICBR ratio was obtained in emamectin benzoate 5% SG @ 0.0020 per cent followed by chlorantraniliprole 18.5% SC @ 0.0037 per cent (1: 6.46) and chlorantraniliprole 9.30% + lambda cyhalothrin 4.6% ZC @ 0.0056 per cent (1: 4.78), respectively.

Table 1: Bio-efficacy of different insecticides against *A. catalaunalis* in sesame during *kharif* 2023

Tr. No.	Treatments	Conc. (%)	No. of larvae / plant													
			Before spray	First spray					Pooled over period	Second spray					Pooled over period	Pooled over sprays
				1 DAS	3 DAS	7 DAS	10 DAS	14 DAS		1 DAS	3 DAS	7 DAS	10 DAS	14 DAS		
1	Chlorantraniliprole 18.5% SC	0.0037	1.65^{a} (2.22)	1.18^{c} (0.89)	1.01^{c} (0.51)	0.96^{c} (0.42)	1.01^{c} (0.52)	1.11^{c} (0.74)	1.05^{e} (0.60)	0.97^{d} (0.44)	0.87^{d} (0.26)	0.83^{d} (0.19)	0.86^{c} (0.24)	0.89^{d} (0.29)	0.88^{e} (0.27)	0.97^{f} (0.44)
2	Spinetoram 11.7% SC	0.0117	1.62^{a} (2.13)	1.32^{bc} (1.23)	1.26^{b} (1.08)	1.21^{b} (0.97)	1.29^{b} (1.16)	1.40^{b} (1.45)	1.29^{cd} (1.16)	1.27^{b} (1.12)	1.19^{b} (0.91)	1.15^{b} (0.82)	1.18^{b} (0.88)	1.23^{b} (1.01)	1.20^{bc} (0.94)	1.25^{cd} (1.06)
3	Emamectin benzoate 5% SG	0.0020	1.56^{a} (1.92)	1.27^{bc} (1.12)	1.16^{bc} (0.84)	1.14^{bc} (0.79)	1.24^{b} (1.03)	1.37^{b} (1.36)	1.23^{d} (1.01)	1.19^{bc} (0.93)	1.10^{bc} (0.71)	1.06^{bc} (0.63)	1.09^{b} (0.69)	1.12^{bc} (0.75)	1.11^{d} (0.73)	1.17^{e} (0.87)
4	Spinosad 45% SC	0.0149	1.59^{a} (2.03)	1.30^{bc} (1.19)	1.20^{bc} (0.93)	1.19^{b} (0.91)	1.26^{b} (1.08)	1.38^{b} (1.40)	1.26^{d} (1.09)	1.24^{b} (1.03)	1.15^{b} (0.82)	1.12^{b} (0.75)	1.14^{b} (0.80)	1.17^{b} (0.87)	1.16^{cd} (0.85)	1.21^{de} (0.96)
5	Flubendiamide 39.35% SC	0.0098	1.57^{a} (1.98)	1.42^{b} (1.51)	1.34^{b} (1.30)	1.31^{b} (1.22)	1.35^{b} (1.31)	1.45^{b} (1.59)	1.37^{b} (1.38)	1.33^{b} (1.28)	1.24^{b} (1.04)	1.19^{b} (0.92)	1.25^{b} (1.07)	1.30^{b} (1.18)	1.26^{b} (1.09)	1.32^{b} (1.24)
6	Chlorpyriphos 50% + Cypermethrin 5% EC	0.1100	1.63^{a} (2.16)	1.40^{b} (1.46)	1.31^{b} (1.20)	1.26^{b} (1.10)	1.32^{b} (1.23)	1.43^{b} (1.54)	1.34^{bc} (1.30)	1.31^{b} (1.21)	1.22^{b} (0.98)	1.18^{b} (0.89)	1.23^{b} (1.00)	1.24^{b} (1.03)	1.23^{bc} (1.01)	1.29^{bc} (1.16)
7	Chlorantraniliprole 9.30% + Lambda cyhalothrin 4.6% ZC	0.0056	1.61^{a} (2.10)	1.20^{c} (0.94)	1.04^{c} (0.57)	0.99^{c} (0.48)	1.03^{c} (0.57)	1.15^{c} (0.81)	1.08^{e} (0.67)	1.02^{cd} (0.54)	0.92^{cd} (0.35)	0.87^{cd} (0.26)	0.90^{c} (0.31)	0.94^{cd} (0.38)	0.93^{e} (0.36)	1.00^{f} (0.50)
8	Untreated control	-	1.59^{a} (2.01)	1.63^{a} (2.15)	1.66^{a} (2.27)	1.70^{a} (2.40)	1.77^{a} (2.63)	1.84^{a} (2.87)	1.72^{a} (2.46)	1.86^{a} (2.95)	1.92^{a} (3.18)	1.96^{a} (3.35)	1.99^{a} (3.46)	2.01^{a} (3.53)	1.95^{a} (3.30)	1.83^{a} (2.85)
S.Em.±		T	0.09	0.06	0.06	0.06	0.06	0.06	0.026	0.06	0.06	0.07	0.06	0.06	0.025	0.019
		P	-	-	-	-	-	-	0.022	-	-	-	-	-	0.022	0.015
		S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010
		T × P	-	-	-	-	-	-	0.062	-	-	-	-	-	0.063	0.043
		T × S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.027
		P × S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.021
		T×P×S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.061
C. D. at 5%		T	NS	0.19	0.18	0.18	0.19	0.20	0.07	0.18	0.19	0.20	0.19	0.19	0.07	0.053
C. V. %			10.03	8.16	8.47	8.65	8.45	8.07	8.35	8.12	9.03	9.70	9.21	8.94	8.99	**8.35**

DAS: Days after spray, Figures in parentheses are retransformed values; those outside are square root transformed values

Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance

Table 2: Bio-efficacy of different insecticides against *A. catalaunalis* in sesame during *kharif* 2023

Tr. No.	Treatments	Conc. (%)	No. of webs / plant													
			Before spray	First spray					Pooled over period	Second spray					Pooled over period	Pooled over sprays
				1 DAS	3 DAS	7 DAS	10 DAS	14 DAS		1 DAS	3 DAS	7 DAS	10 DAS	14 DAS		
T_1	Chlorantraniliprole 18.5% SC	0.0037	0.86[a] (0.24)	0.88[b] (0.27)	0.89[c] (0.30)	0.90[c] (0.32)	0.92[c] (0.34)	0.94[c] (0.39)	0.91[d] (0.33)	0.95[c] (0.40)	0.96[d] (0.42)	0.98[d] (0.45)	1.00[d] (0.50)	1.01[d] (0.51)	0.98[d] (0.46)	0.94[e] (0.38)
T_2	Spinetoram 11.7% SC	0.0117	0.87[a] (0.26)	1.01[ab] (0.51)	1.07[b] (0.65)	1.11[b] (0.72)	1.13[b] (0.78)	1.17[b] (0.86)	1.10[bc] (0.77)	1.17[b] (0.88)	1.20[b] (0.93)	1.21[b] (0.97)	1.23[b] (1.03)	1.25[b] (1.06)	1.21[bc] (0.96)	1.16[bc] (0.85)
T_3	Emamectin benzoate 5% SG	0.0020	0.87[a] (0.26)	0.92[b] (0.35)	1.00[bc] (0.51)	1.08[b] (0.66)	1.10[b] (0.71)	1.12[b] (0.75)	1.04[c] (0.58)	1.13[b] (0.77)	1.15[bc] (0.82)	1.17[bc] (0.88)	1.20[bc] (0.94)	1.21[bc] (0.96)	1.17[c] (0.87)	1.11[d] (0.73)
T_4	Spinosad 45% SC	0.0149	0.85[a] (0.22)	0.95[b] (0.40)	1.06[b] (0.63)	1.09[b] (0.68)	1.11[b] (0.72)	1.14[b] (0.79)	1.07[bc] (0.64)	1.15[b] (0.82)	1.17[bc] (0.86)	1.19[bc] (0.91)	1.21[bc] (0.96)	1.22[bc] (1.00)	1.19[c] (0.92)	1.13[cd] (0.78)
T_5	Flubendiamide 39.35% SC	0.0098	0.91[a] (0.34)	1.04[ab] (0.57)	1.10[b] (0.70)	1.14[b] (0.79)	1.16[b] (0.84)	1.21[b] (0.96)	1.13[b] (0.78)	1.22[b] (0.98)	1.23[b] (1.01)	1.26[b] (1.08)	1.28[b] (1.13)	1.30[b] (1.19)	1.26[b] (1.09)	1.19[b] (0.92)
T_6	Chlorpyriphos 50% + Cypermethrin 5% EC	0.1100	0.89[a] (0.30)	1.02[ab] (0.54)	1.09[b] (0.68)	1.12[b] (0.75)	1.14[b] (0.80)	1.18[b] (0.88)	1.11[b] (0.73)	1.19[b] (0.92)	1.21[b] (0.95)	1.23[b] (1.02)	1.25[b] (1.07)	1.28[b] (1.13)	1.23[bc] (1.01)	1.17[bc] (0.87)
T_7	Chlorantraniliprole 9.30% + Lambda cyhalothrin 4.6% ZC	0.0056	0.86[a] (0.23)	0.89[b] (0.28)	0.90[c] (0.32)	0.92[c] (0.35)	0.94[c] (0.38)	0.96[c] (0.43)	0.92[d] (0.35)	0.97[c] (0.44)	0.99[cd] (0.48)	1.01[cd] (0.52)	1.03[cd] (0.55)	1.04[cd] (0.58)	1.01[d] (0.52)	0.97[e] (0.44)
T_8	Untreated control	-	0.90[a] (0.31)	1.14[a] (0.79)	1.28[a] (1.13)	1.37[a] (1.38)	1.43[a] (1.55)	1.49[a] (1.71)	1.34[a] (1.30)	1.52[a] (1.82)	1.58[a] (2.00)	1.62[a] (2.14)	1.67[a] (2.29)	1.70[a] (2.38)	1.62[a] (2.12)	1.48[a] (1.69)
S.Em.±		T	0.05	0.05	0.05	0.05	0.05	0.05	0.021	0.05	0.06	0.06	0.06	0.06	0.022	0.016
		P	-	-	-	-	-	-	0.018	-	-	-	-	-	0.020	0.013
		S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.008
		T × P	-	-	-	-	-	-	0.051	-	-	-	-	-	0.058	0.037
		T × S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.023
		P × S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.018
		T×P×S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.052
C. D. at 5%		T	NS	0.15	0.15	0.16	0.16	0.16	0.06	0.17	0.17	0.18	0.18	0.19	0.06	0.046
C. V. %			10.07	8.59	8.08	8.38	8.11	8.04	8.24	8.13	8.33	8.41	8.11	8.54	8.31	7.84

DAS: Days after spray, Figures in parentheses are retransformed values; those outside are square root transformed values
Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance

Table 3: Bio-efficacy of different insecticides against *A. catalaunalis* in sesame during *kharif* 2023

Tr. No.	Treatments	Conc. (%)	Capsule damage (%)													
			Before spray	First spray					Pooled over period	Second spray					Pooled over period	Pooled over sprays
				1 DAS	3 DAS	7 DAS	10 DAS	14 DAS		1 DAS	3 DAS	7 DAS	10 DAS	14 DAS		
T_1	Chlorantraniliprole 18.5% SC	0.0037	8.32[a] (2.09)	8.53[d] (2.20)	8.66[e] (2.26)	9.10[e] (2.50)	10.33[e] (3.22)	11.06[e] (3.68)	9.54[g] (2.75)	11.23[e] (3.79)	11.31[e] (3.85)	11.47[e] (3.96)	11.59[e] (4.03)	12.32[e] (4.55)	11.58[g] (4.03)	10.56[g] (3.36)
T_2	Spinetoram 11.7% SC	0.0117	7.93[a] (1.91)	14.33[b] (6.13)	14.82[c] (6.54)	15.30[c] (6.97)	16.23[c] (7.81)	16.97[c] (8.52)	15.53[cd] (7.17)	17.22[c] (8.77)	17.51[c] (9.05)	17.87[bc] (9.41)	18.28[bc] (9.84)	19.07[b] (10.68)	17.99[d] (9.54)	16.76[d] (8.32)
T_3	Emamectin benzoate 5% SG	0.0020	8.28[a] (2.07)	11.59[c] (4.04)	12.10[d] (4.39)	12.46[d] (4.65)	13.34[d] (5.33)	13.78[d] (5.68)	12.65[e] (4.80)	14.06[d] (5.90)	14.18[d] (6.00)	14.49[d] (6.26)	14.95[d] (6.66)	15.71[cd] (7.34)	14.68[e] (6.42)	13.67[e] (5.59)
T_4	Spinosad 45% SC	0.0149	8.07[a] (1.97)	13.81[b] (5.70)	14.25[c] (6.06)	14.75[c] (6.48)	15.68[c] (7.30)	16.32[c] (7.90)	14.96[d] (6.66)	16.61[c] (8.17)	16.86[c] (8.41)	17.15[c] (8.70)	17.54[c] (9.08)	18.17[bc] (9.73)	17.27[d] (8.81)	16.12[d] (7.71)
T_5	Flubendiamide 39.35% SC	0.0098	7.95[a] (1.91)	15.64[ab] (7.27)	17.30[b] (8.85)	17.99[b] (9.53)	18.82[b] (10.40)	19.61[b] (11.27)	17.87[b] (9.42)	19.86[b] (11.54)	20.10[b] (11.81)	20.56[b] (12.33)	20.88[b] (12.70)	21.21[b] (13.09)	20.52[b] (12.29)	19.20[b] (10.82)
T_6	Chlorpyriphos 50% + Cypermethrin 5% EC	0.1100	8.44[a] (2.16)	15.04[ab] (6.73)	15.61[bc] (7.24)	16.32[bc] (7.89)	17.23[bc] (8.77)	18.07[bc] (9.62)	16.45[c] (8.02)	18.33[bc] (9.89)	18.58[bc] (10.15)	19.01[bc] (10.61)	19.47[bc] (11.11)	20.07[b] (11.78)	19.09[c] (10.70)	17.77[c] (9.31)
T_7	Chlorantraniliprole 9.30% + Lambda cyhalothrin 4.6% ZC	0.0056	8.17[a] (2.02)	9.80[cd] (2.90)	10.22[de] (3.15)	10.60[de] (3.38)	11.91[de] (4.26)	12.44[de] (4.64)	10.99[f] (3.63)	12.50[de] (4.69)	12.69[de] (4.82)	12.86[de] (4.96)	13.31[de] (5.30)	14.13[de] (5.96)	13.10[f] (5.14)	12.05[f] (4.36)
T_8	Untreated control	-	8.51[a] (2.19)	17.08[a] (8.63)	19.73[a] (11.39)	22.01[a] (14.05)	24.51[a] (17.21)	26.51[a] (19.93)	21.97[a] (14.00)	27.09[a] (20.74)	27.62[a] (21.50)	28.00[a] (22.04)	29.44[a] (24.16)	31.58[a] (27.42)	28.75[a] (23.14)	25.36[a] (18.34)
S.Em.±		T	0.50	0.62	0.68	0.75	0.75	0.82	0.427	0.82	0.82	0.87	0.84	0.94	0.334	0.233
		P	-	-	-	-	-	-	0.247	-	-	-	-	-	0.296	0.184
		S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.116
		T × P	-	-	-	-	-	-	0.698	-	-	-	-	-	0.839	0.520
		T × S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.329
		P × S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.260
		T×P×S	-	-	-	-	-	-	-	-	-	-	-	-	-	0.736
C. D. at 5%		T	NS	1.88	2.06	2.27	2.28	2.49	1.24	2.50	2.48	2.63	2.55	2.84	0.94	0.65
C. V. %			10.47	8.12	8.36	8.73	8.13	8.45	8.36	8.33	8.15	8.49	8.01	8.51	8.30	7.50

DAS: Days after spray, Figures in parentheses are retransformed values; those outside are arcsine transformed values
Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance

Table 4: Impact of insecticides on seed yield, increase in yield over control and avoidable loss in sesame

Tr. No.	Treatments	Conc. (%)	Seed yield (kg/ha)	Increase in yield over control (%)	Avoidable loss (%)
T_1	Chlorantraniliprole 18.5% SC	0.0037	672^{a}	90.91	-
T_2	Spinetoram 11.7% SC	0.0117	547^{bcd}	55.49	18.55
T_3	Emamectin benzoate 5% SG	0.0020	608^{abc}	72.73	9.52
T_4	Spinosad 45% SC	0.0149	575^{bcd}	63.54	14.34
T_5	Flubendiamide 39.35% SC	0.0098	496^{d}	41.10	26.09
T_6	Chlorpyriphos 50% + Cypermethrin 5% EC	0.1100	530^{cd}	50.57	21.13
T_7	Chlorantraniliprole 9.30% + Lambda cyhalothrin 4.6% ZC	0.0056	632^{ab}	79.64	5.90
T_8	Untreated control	-	352^{e}	-	47.62
S.Em. ±			28.31	-	-
C. D. at 5%			85.86	-	-
C. V. %			8.89	-	-

Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance

Table 5: Economics of various insecticides evaluated against *A. catalaunalis* on sesame

Tr. No.	Treatments	Conc. (%)	Qty. of material required for 2 sprays (L or kg/ha)	Cost of material (≠/ha)	Labour cost (≠)	Total cost of treatment	Seed yield (kg/ha)	Gross realization (≠/ha)	Net realization over control (≠/ha)	Net gain (≠/ha)	ICBR
T_1	Chlorantraniliprole 18.5% SC	0.0037	0.32	2202	1500	3702	672	58027	27632	23930	**1:6.46**
T_2	Spinetoram 11.7% SC	0.0117	1.00	**11450**	1500	**12950**	547	47233	16838	**3888**	1:**0.30**
T_3	Emamectin benzoate 5% SG	0.0020	0.40	1148	1500	2648	608	52501	22106	19458	1:**7.35**
T_4	Spinosad 45% SC	0.0149	0.33	**6435**	1500	**7935**	575	49651	19256	**11321**	1:**1.43**
T_5	Flubendiamide 39.35% SC	0.0098	0.25	4865	1500	6365	496	42830	12434	6069	1:**0.95**
T_6	Chlorpyriphos 50% + Cypermethrin 5% EC	0.1100	2.00	2000	1500	3500	530	45766	15370	11870	1:**3.39**
T_7	Chlorantraniliprole 9.30% + Lambda cyhalothrin 4.6% ZC	0.0056	0.40	2684	1500	4184	632	54573	24178	19994	1:**4.78**
T_8	Untreated control	-	-	-	-	-	352	30395	-	-	-

Price of sesame: 86.35/kg. Labours required: 2 labour/ha for one spray. Cost of labour: 375/day for spraying. Price of insecticides in /kg or lit, chlorantraniliprole 18.5% SC: 6883/lit, emamectin benzoate 5% SG: 2870/kg, chlorpyriphos 50% + cypermethrin 5% EC: 1000/lit, chlorantraniliprole 9.30% +lambda cyhalothrin 4.6% ZC: 6710/lit, flubendiamide 39.35% SC: 19460/lit, spinosad 45% SC: **19500**/lit, spinetoram 11.7% SC: 1**1450**/lit.

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