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Bio efficacy of different insecticides against leaf webber and capsule borer, *Antigastra catalaunalis* (Dup.) on sesame

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Abstract
The present experiment was carried out on bio efficacy of different insecticides against leaf webber and capsule borer, *Antigastra catalaunalis* (Dup.) at research farm College of Agriculture, Bikaner (Rajasthan) during *Kharif*, 2019. Two sprays of different insecticides were carried out against *A. catalaunalis* of sesame. The results revealed that the treatments of spinosad 45% SC was found most effective followed by indoxacarb 14.5% SC and emamectin benzoate 5% SG. The treatments of flubendiamide 2% WG, novaluron 10% EC and thiodicarb 75% WP were existed moderately effective while treatment of lambda-cyhalothrin 2.5% EC, quinalphos 25% EC and profenophos 50% EC were observed as less effective against leaf webber.

Keywords: Sesame, *Antigastra catalaunalis*, Bio efficacy, Insecticides

Introduction
Sesame (*Sesamum indicum* L.) commonly called as Til, is one of most ancient and important oilseed crops cultivated over 5000 years by human beings. It belongs to family Pedaliaceae and described as 'Queen of Oilseed crops' for its high oil content (46-52%) and high protein content (18-20. The leaf webber and capsule borer, *Antigastra catalaunalis* (Dup) as one of the major pest of sesame in India, that caused economic losses in crop yield. This pest is active from germination to till the harvest of the crop, so called this pest as Key pest of sesame (Thakur and Ghorpade, 2006) [11]. The larvae web together the top leaves or bore into tender shoots and capsules and feed on them. The damage results in webbed leaves at top with young caterpillars, bored shoots, flower buds and pods in case of severe infestation the yields are drastically reduced. This insect pest causes 10-70 per cent infestation of leaves, 34-62 per cent of flower buds/ flowers and 10-44 per cent infestation of capsules resulting in upto 72 per cent loss in yield (Ahirwar *et al.*, 2010) [2]. Among the many factors for the low productivity of this crop in India one of the most important one is infestation caused by the sesame leaf and capsule borer, *A. catalaunalis* which causes a heavy seed yield loss upto 90 per cent (Ahuja and Kalyan, 2002) [3].The sesame crop is attacked by a large number of insect pests of which the leaf roller and capsule borer (*Antigastra catalaunalis* Dup.) is the most serious pest in India. It occurs regularly and infests the crop during seedling, flowering and maturity stages of crop growth and causes up to 90 percent yield losses (Cheema and Singh, 1987) [4]

Now a days a large number of newer insecticides with novel mode of action are available in market. These insecticides are required only in small quantities as compared to older class of compounds. Efficacy of these chemicals need to be studied for the effective and economical control of this pest. Keeping all these points in view, the present study was undertaken to investigate the efficacy of different insecticides against *A. catalaunalis*.

Materials and Methods
The present investigations were conducted at research farm College of Agriculture, Bikaner during *Kharif*, 2019. The experiment was conducted in simple randomized block design with ten treatments and three replications. The seeds of sesame variety RT-351 were sown on 23rd July, 2019 in plots size 3.0 x 1.8 m, keeping row to row and plant to plant distance of 30 cm and 10 cm, respectively. The recommended package of practices was followed to raise the crop. The spraying was done by using pre-calibrated knapsack sprayer in the morning hours with care to prevent the drift of spray fluid reaching the adjacent plots by keeping a screen in between the plots. The sprayer was cleaned with water before changing the insecticide treatment. Two applications of insecticide was carried out at an interval of 15 days. The first spray of all the treatments taken in experiment was done in 7th September, 2019 when the pest population has reached ETL *i.e.*, 2 larvae / m^2 for *A. catalaunalis*.

The population of leaf webber and capsule borer, *A. catalaunalis* was recorded from five randomly selected and tagged plants. Timely visits of the experimental field were made to observe the occurrence of *A. catalaunalis*. The population of *A. catalaunalis* was counted in early morning hours at weekly interval from appearance to harvesting of the crop regularly before and post treatment observation were recorded at 3rd, 7th, 10th and 15th days after the application of insecticides. Similar observations were taken after second application of insecticides.

The data obtained one just before and after 3, 7, 10 and 15 days after spray were taken into consideration to find out the per cent reduction in of larvae of leaf webber and capsule borer, *A. catalaunalis* was calculated as per method given by Henderson and Tilton (1955) [6] referring it to be a modification of Abbott's formula (1925).

$$\text{Percent reduction} = 100\left[1 - \frac{T_a \times C_b}{T_b \times C_a}\right]$$

Where,

T_a = Number of insects after treatment

T_b = Number of insects before treatment

C_a = Number of insects in untreated control after treatment

C_a = Number of insects in untreated control before treatment

The statistical analysis (analysis of variance) of the data was carried out by transforming the per cent reduction data into angular transformation values (Gomez and Gomez, 1976) [5].

Results and Discussion

First Spray

Three day after first spray, it was recorded that all the treatments were remained significant superior over control. The maximum per cent reduction was noticed in the treatment of spinosad (77.74%) followed by indoxacarb (75.75%) and emamectin benzoate (73.87%) these treatments were comparable to each other in terms of efficacy. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 62.54, 58.98 and 57.16 per cent reduction respectively. The minimum per cent reduction was observed in the treatment of profenophos followed by quinalphos and lambda-cyhalothrin, with 38.99, 41.71 and 44.90 per cent reduction larvae, respectively.

All the treatments were found significantly superior over control after seven days of first spray. The maximum per cent reduction of larval population was observed in the treatment of spinosad (83.18%) followed by indoxacarb (81.77%) and emamectin benzoate (79.93%) however, no significant difference exist among them. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 67.74, 63.86 and 61.26 per cent reduction respectively. The least per cent reduction of larvae was noticed in the treatment of profenophos followed by quinalphos and lambda-cyhalothrin with 42.71, 44.84 and 47.52 per cent reduction, respectively.

Ten days after application of different treatments *viz.*, spinosad, indoxacarb and emamectin benzoate revealed that per cent reduction of larvae were 78.89, 76.96 and 75.58 per cent respectively. These treatments were at par and significant superior over rest of the treatments. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 63.51, 59.24 and 55.85 per cent reduction respectively. The minimum per cent reduction was evident in profenophos followed by quinalphos and lambda-cyhalothrin with 39.43, 41.67 and 42.90 per cent reduction, respectively, these three treatments shown a non-significant difference between each other whereas significantly inferior to other treatments.

After fifteen days of first spray spinosad, indoxacarb and emamectin benzoate showed maximum reduction in larval population, *viz.*, 60.66, 58.73 and 56.13 per cent respectively, however these were comparable to each other. The least per cent reduction was noticed in the treatment of profenophos (21.47 %) followed by quinalphos (23.72 %) and lambda-cyhalothrin (31.65 %) treated plots and they were found at par to each other.

The present results are in conformity to that of Jyothi *et al* (2019) [7] who reported that profenophos was less effective as compared to spinosad against *A. catalaunalis* whereas, the highest reduction was recorded in the plots treated with spinosad, indoxacarb and emamectin benzoate. The present results are also corroborate with Sasikumar and Kumar (2015) [10] who reported that spinosad was most effective insecticide against leaf webber and capsule borer, *A. catalaunalis*. The present result gets supports from the observation Wazire and Patel (2016) [13] and Naveen *et al* (2019) [8] who reported that spinosad was most effective insecticide against leaf webber and capsule borer, *A. catalaunalis.* The minimum reduction of leaf webber and capsule borer, *A. catalaunalis* population was recorded in plots treated with profenophos, followed by quinalphos and lamda cyhalothrin. These treatments were at par to each other. The decreasing pattern of the efficacy was found to be in order of Spinosad, indoxacarb, emmamectin benzoate, flubendiamide, novaluron, thiodicarb, lamda-cyhalothrin, quinalphos and profenophos.

Second Spray

In the second application, the bio-efficacy of various insecticides against sesame leaf webber has been presented in table 4.10 and figure 4.6 indicated that three days after the second application, the per cent reduction was maximum in the treatment of spinosad (78.12%) followed by indoxacarb (76.16%) and emamectin benzoate (73.39%) these treatments were comparable to each other in terms of efficacy. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 61.10, 60.33 and 58.02 per cent reduction respectively. The least per cent reduction was observed in the treatment of profenophos followed by quinalphos and lambda-cyhalothrin, with 39.67, 41.86 and 42.25 per cent, respectively.

After seven days of second application, the maximum percent reduction was observed in the treatment of spinosad (84.14%) followed by indoxacarb (82.93%) and emamectin benzoate (80.16%). However, these treatments were comparable to each other. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 67.97, 63.75 and 61.55 per cent reduction respectively. The least per cent reduction of larvae was noticed in the treatment of profenophos followed by quinalphos and lambda-cyhalothrin with 42.83, 45.53 and 47.81 per cent reduction, respectively, which were at par with each other.

Ten days after application of different treatments *viz.*, spinosad, indoxacarb and emamectin benzoate revealed that reduction of larvae were 79.58, 77.83 and 76.19 per cent respectively, did not differ to each other. These treatments were at par and significant superior over rest of the treatments. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 64.01, 59.96 and 57.08 per cent reduction respectively. However, both these treatments were comparable to each other and found moderately effective in reducing leaf webber infestation. The minimum per cent reduction was observed in profenophos followed by quinalphos and lambda-cyhalothrin with 40.26, 42.27 and 43.79 per cent reduction, respectively, these three treatments shown a non-significant difference between each other whereas significantly inferior to other treatments. The order of effectiveness after ten days of application was Spinosad > Indoxacarb > Emamectin benzoate > Flubendiamide > Novaluron > Thiodicarb > Lambda-cyhalothrin > Quinalphos > Profenophos.

After fifteen days of second application, all the treatments were found significantly superior over control. The highest per cent reduction in larval population was noticed in the treatment of spinosad (60.26%) followed by indoxacarb (57.81%) and emamectin benzoate (54.92%) however, no significant difference exist among them. The next effective treatments were flubendiamide followed by novaluron and thiodicarb with 45.74, 39.70 and 38.04 per cent reduction respectively. The least per cent reduction of larvae was observed in the treatment of profenophos followed by quinalphos and lambda-cyhalothrin with 21.47, 22.97 and 29.40 per cent reduction, respectively.

Padamja *et al* (2000) [9] who reported that quinalphos was effective insecticide for the control of leaf webber and capsule borer, *A. catalaunalis.* The decreasing order of leaf webber and capsule borer, *A. catalaunalis* reduction was seen in the treatments of spinosad, indoxacarb, emamectin benzoate, flubendiamide, novaluron, thiodicarb, lamda-cyhalothrin, quinalphos and profenophos. Varma *et al* (2003), found emmamectin benzoate and Thiodicarb as moderately effective insecticide against leaf webber and capsule borer, *A. catalaunalis* corroborates the present investigation. The data showed that the treatments of flubendiamide, novaluron and thiodicarb formed the second group in reducing population of leaf webber and capsule borer, *A. catalaunalis* on sesame. These finding are in agreement with that of Sasikumar and Kumar. (2015) [10] who reported that spinosad and lambda-cyhalothrin was most effective insecticide for the control of *A. catalaunalis.*

Table 1: Bio-efficacy of different insecticides against larva of *A. catalaunalis* on sesame during *Kharif,* 2019 (First spray).

S. No.	Treatments	Formulation	Conc. (%) /Dose	Per cent reduction days after treatment				Mean
				Third day	Seventh day	Ten day	Fifteenth day	
1.	Emamectin benzoate	5% SG	0.002%	73.87	79.93	75.58	56.13	71.38
				(59.31)*	(63.55)	(60.51)	(48.53)	
2.	Novaluron	10%EC	0.0075%	58.98	63.86	59.24	43.29	56.34
				(50.19)	(53.16)	(50.35)	(41.14)	
3.	Quinalphos	25%EC	0.025%	41.71	44.84	41.67	23.72	37.99
				(40.19)	(42.00)	(40.17)	(29.10)	
4.	Thiodicarb	75% WP	0.15%	57.16	61.26	55.85	40.19	53.61
				(49.16)	(51.57)	(48.38)	(39.33)	
5.	Flubendiamide	20% WG	0.002%	62.54	67.74	63.51	47.58	60.34
				(52.29)	(55.47)	(52.87)	(43.61)	
6.	Profenophos	50% EC	0.05%	38.99	42.71	39.43	21.47	35.65
				(38.61)	(40.80)	(38.89)	(27.47)	
7.	Indoxacarb	14.5% SC	0.0145%	75.75	81.77	76.96	58.73	73.30
				(60.69)	(64.98)	(61.47)	(50.08)	
8.	Spinosad	45% SC	0.0135%	77.74	83.18	78.89	60.66	75.12
				(62.00)	(66.14)	(62.93)	(51.18)	
9.	Lambda-cyhalothrin	2.5% EC	0.008%	44.90	47.52	42.90	31.65	41.74
				(42.02)	(43.57)	(40.87)	(34.19)	
10.	Untreated control	-	-	0.00	0.00	0.00	0.00	
	S.Em +			2.32	2.68	2.41	1.64	
	CD (5%)			6.89	7.97	7.16	4.87	

*Figures in the parentheses are angular transformed value.

Table 2: Bio-efficacy of different insecticides against larva of *A. catalaunalis* on sesame during *Kharif,* 2019 (second spray).

S. No.	Treatments	Formulation	Conc(%) /Dose	Per cent reduction days after treatment				Mean
				Third day	Seventh day	Ten day	Fifteenth day	
1.	Emamectin benzoate	5% SG	0.002%	73.39	80.16	76.19	54.92	71.17
				(58.95)*	(63.78)	(60.99)	(47.83)	
2.	Novaluron	10%EC	0.0075%	60.33	63.75	59.96	39.70	55.93
				(50.98)	(53.07)	(50.77)	(39.03)	
3.	Quinalphos	25%EC	0.025%	41.86	45.53	42.27	22.97	38.16
				(40.27)	(42.40)	(40.51)	(28.59)	
4.	Thiodicarb	75% WP	0.15%	58.02	61.55	57.08	38.04	53.67
				(49.63)	(51.74)	(49.10)	(38.07)	
5.	Flubendiamide	20% WG	0.002%	61.10	67.97	64.01	45.74	59.71
				(51.47)	(55.62)	(53.17)	(42.55)	
6.	Profenophos	50% EC	0.05%	39.67	42.83	40.26	21.47	36.06
				(38.99)	(40.86)	(39.37)	(27.47)	
7.	Indoxacarb	14.5% SC	0.0145%	76.16	82.93	77.83	57.81	73.68
				(61.06)	(65.85)	(62.10)	(49.54)	
8.	Spinosad	45% SC	0.0135%	78.12	84.14	79.58	60.26	75.53
				(62.29)	(66.78)	(63.45)	(50.95)	
9.	Lambda-cyhalothrin	2.5% EC	0.008%	45.25	47.81	43.79	29.40	41.56

				(42.26)	(43.73)	(41.41)	(32.83)	
10.	Untreated control	-	-	0.00	0.00	0.00	0.00	
	S.em.±			2.36	2.62	2.43	1.61	
	C.D.at 5 %			7.02	7.77	7.22	4.78	

*Figures in the parentheses are angular transformed value.

Conclusion
The overall efficacy of insecticides tested against sesame leaf webber in terms of per cent reduction in larval population revealed that the treatments of spinosad (0.0135%) was found most effective followed by indoxacarb (0.0145%) and emamectin benzoate (0.002%). The treatments of flubendiamide (0.002%), novaluron (0.0075%) and thiodicarb (0.15%) were existed moderately effective while treatment of lambda-cyhalothrin (0.008%), quinalphos (0.025%) and profenophos (0.05%) were observed as less effective against leaf webber.

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