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Mamta Devi Choudhary
Department of Entomology,
SKN College of Agriculture
SKN Agricultural University,
Jobner, Jaipur, India

KC Kumawat
Department of Entomology,
SKN College of Agriculture
SKN Agricultural University,
Jobner, Jaipur, India

RG Samota
Department of Entomology,
SKN College of Agriculture
SKN Agricultural University,
Jobner, Jaipur, India

Tejpal Bajaya
Department of Plant Pathology,
SKN College of Agriculture
SKN Agricultural University,
Jobner, Jaipur, India

Correspondence
Mamta Devi Choudhary
Department of Entomology,
SKN College of Agriculture
SKN Agricultural University,
Jobner, Jaipur, India

Evaluation of sequences of integrated pest management practices against sesame Leaf and Capsule Borer, *Antigastra catalaunalis*

Mamta Devi Choudhary, KC Kumawat, RG Samota and Tejpal Bajaya

Abstract

Investigations on "Evaluation of sequences of integrated pest management practices against sesame leaf and capsule borer, *Antigastra catalaunalis.*" were conducted at Agronomy farm and Department of Entomology, S.K.N. College of Agriculture, Jobner during *Kharif*, 2015 and 2016. *A. catalaunalis* were recorded as major insect pests of sesame during both the years of study. Total eleven treatments including untreated control were tested against *A. catalaunalis* for their efficacy. The integrated pest management modules *viz.* T_2 (Hand picking+destruction of larvae/infested plant part+spinosad 45 SC+NSKE), T_4 (Hand picking+destruction of larvae/infested plant part+indoxacarb 14.5 SC+NSKE), T_1 (Hand picking+destruction of larvae/infested plant part+acephate 75 SP+NSKE) and standard check (carbaryl) were found effective in the management of *A. catalaunalis*. The highest seed yield of 8.21 q ha^{-1} was recorded in the plots treated with T_2 (picking+destruction of larvae/infested plant part+spinosad 45 SC SC+NSKE) followed by T_4 (Hand picking+destruction of larvae/infested plant part+indoxacarb 14.5 SC+NSKE), (8.18 q ha^{-1}) and T_1 (Hand picking+destruction of larvae/infested plant part+acephate 75 SP+NSKE) (8.16q ha^{-1}). The highest B: C ratio was recorded in T_9 (Greengram+ HPDL/DIPP+NSKE+ *Chrysoperla zastrowi arabica* (two releases) (8.69), followed by T_8 (Greengram+ HPDL/DIPP+NSKE+ *Trichogramma chilonis* (two releases) (6.31).

Keywords: Sesame, *Antigastra catalaunalis* (Dup.), IPM Modules

Introduction

Sesame, *Sesamum indicum* (Linn.) (family: Pedaliaceae) is the oldest oilseed crop of world cultivated throughout the India. East Africa and India are considered to be the native home of sesame (Bedigian, 1985 and Nayar and Mehra, 1970) [8, 21]. Its seeds contain 52- 57 per cent oil and 25 per cent protein (Smith *et al.*, 2000). The important sesame growing countries are India, china, sudan, Burma and Mexico. In India, the cultivation is mainly confined to Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh, Odisha, Gujarat, Tamil Nadu and Karnataka. In India, production of sesame was estimated to be 8.11 lakh tonnes during 2015-16 (Anonymous, 2015a) [5, 6]. The total area under cultivation of sesame in Rajasthan was about 3.30 lakh hectares with annual production to the tune of 9.49 thousand tonnes and average productivity of 288 kg (Anonymous, 2015b) [5, 6]. The pests attack tolls a heavy loss (25- 90%) in seed yield (Ahuja and Kalyan, 2002) [3]. Among 67 insect pests damaging sesame crop, the leaf insect pests, *viz.*, leaf and capsule borer, *Antigastra catalaunalis* (Dup.); jassid, *Orosius albicinctus* Distant; whitefly, *Bemisia tabaci* (Genn.) and mirid bug, *Nesidiocoris tenuis* (Reuter) are considered to be key pests (Ahirwar *et al.*, 2009) [1]. The *A. catalaunalis* is an important pest because this attacks the crop in all the growth stages after about two weeks of emergence (Suliman *et al.*, 2004) [26]. The attack is more severe during dry seasons and after initiation of flowering. It feeds on tender foliage by webbing the top leaves, bores into the pods and shoots (Narayanan and Nadarajan, 2005) [19]. 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 pods resulting in upto 72 per cent loss in yield (Ahirwar *et al.*, 2010) [2]. The chemical control has been suggested by many workers to combat with the insect pests of sesame crop (Goel and Kumar, 1991; Kumar *et al.*, 1994; Selvanarayanan and Baskaran, 1996; Tripathi *et al.*, 2007; Suliman *et al.*, 2013) [, 11, 16, 17, 23, 28, 27] but due to one or other reasons, could not become panacea in protection of the crop. As the chemical control solely could not become fool proof strategy due to one or the other reasons, the IPM by involving suitable techniques and bioagents were aimed to be studied in order to solve the problem. The insect natural enemies have received much less attention as natural control agents. The sesame ecosystem normally harbours beneficial insects, predators and parasites in numbers that frequently provide partial to satisfactory insect pest suppression.

Therefore, the use of predators, parasitoids and pathogens may prove to be better choice among various groups of bioagents for the management of *A. catalaunalis* on sesame. A perusal of available literature revealed that very little attention has been paid to quantify the response of natural enemies against *A. catalaunalis* on sesame crop.

Materials and Method

The experiment was laid out in simple randomized block design with three replications. Each plot was measured 2.5 x 1.5 m^2 and the crop was sown at row to row and plant to plant distance of 30 cm and 10 cm, respectively. The sesame variety RT- 125 was taken in this experiment and was grown on 12^{th} July, 2015 and 2016. The recommendations as per package of practices were followed to raise the crop. In this experiment, ten sequences of insecticidal molecules, biopesticides, bioagents and other tactics were used and a control was maintained for comparison. First spray was done on 16^{th} August using a knap sack sprayer and second application was made three weeks after first application. The re-build up of population was observed at this stage. The spray solution used for spraying the crop was 500 and 600 l ha^{-1} in first and second spray, respectively.

Result and Discussion

During first year (*Kharif*, 2015), the T_2 (Hand picking + destruction of caterpillar/ infested plant part+ spinosad 45 SC+ NSKE), T_4 (Hand picking+ destruction of caterpillar/ infested plant part+ indoxacarb 14.5 SC+ NSKE) and T_1 (Hand picking+destruction of caterpillar/ infested plant part+acephate 75 SP+ NSKE) revealed population of *A. catalaunalis* ranging from 1.18- 1.51 per five plants which was significantly lower over rest of the integrated pest management (IPM) practices and were found at par among themselves (Table-1). The least effective group comprised T_9 (Intercropping with green gram+ Hand picking+ destruction of caterpillar/ infested plant part+ NSKE+ *Chrysoperla zastrowi arabica*), T_8 (Intercropping with green gram+ Hand picking+ destruction of caterpillar/ infested plant part+ NSKE+ *Trichogramma chilonis*), T_7 (Hand picking+ destruction of caterpillar/ infested plant part+ NSKE+ *Trichogramma chilonis*) and T_6 (Hand picking+ destruction of caterpillar/ infested plant part+ NSKE+ *Chrysoperla zastrowi arabica*) which revealed population of *A. catalaunalis* from 3.45- 4.57 per five plants. Rest of the sequences, T_{10} (Standard check, carbaryl 50 WP), T_3 (Hand picking+ destruction of caterpillar/ infested plant part+ vertimec 1.9 EC+ NSKE) and T_5 (Hand picking+ destruction of caterpillar/ infested plant part+ *Btk* 8 L+ NSKE) ranked in the middle order of efficacy. All the sequences of IPM were found significantly superior over control.

In the second year (*Kharif*, 2016), the lowest population of *A. catalaunalis* was recorded in T_2, T_4 and T_1 (1.20- 1.89/ five plants), IPM sequences were found at par each other and significantly superior over other IPM sequences tested. Maximum population of *A. catalaunalis* was recorded in T_6 (4.76/ five plants) and differed significantly over control, T_{11} (7.50/ five plants).

In the pooled data (*Kharif*, 2015 and 2016), the lowest population of *A. catalaunalis* was observed in T_2 (1.19/ five plants), T_4 (1.37/ five plants) and T_1 (1.70/ five plants). Maximum population of 4.67 per five plants was observed in T6 which differed significantly over control, T_{11} (7.29/ five plants). The efficacy of IPM sequences with regards to the population of *A. catalaunalis* in decreasing order was T_2, T_4, T_1, T_{10}, T_3, T_5, T_9, T_8, T_7, and T_6. The efficacy of IPM sequences with regards to the population of *A. catalaunalis* in decreasing order was T_2, T_4, T_1, T_{10}, T_3, T_5, T_9, T_8, T_7, and T_6. The IPM practices comprising intercropping of sesame with pearlmillet reduced the damage with increased profitability of the crop as pointed out by Baskaran *et al.* (1991) [7]. Gupta (2002) reported effective management of *A. catalaunalis* with two foliar sprays of neem oil at 1 per cent and liquid soap+ intercropping of sesame with *Phaseolus mungo* [*Vigna mungo*] cultivar. Jawahar- 2 and pigeon pea cultivar, Jagrati in 3:1 row ratio. Ahiwar *et al.* (2009) [1] reported that larval population of *A. catalaunalis* was significantly reduced in IPM practices comprising intercropping as against sesame sole crop.

Damage indices

In *Kharif* 2015, lowest leaf damage due to infestation of *A. catalaunalis* (2.05- 2.10%) was recorded in T_2 (Hand picking+ destruction of caterpillar/ infested plant part+ spinosad 45 SC+ NSKE) and T_4 (Hand picking+ destruction of caterpillar/ infested plant part+ indoxacarb 14.5 SC+ NSKE), these IPM sequences were at par each other (Table-2). The leaf damage was highest in the T_6 (Hand picking+ destruction of caterpillar/ infested plant part+ NSKE+ *Chrysoperla zastrowi arabica*),T_7 (Hand picking+ destruction of caterpillar/ infested plant part+ NSKE+ *Trichogramma chilonis*), *viz*., 3.25- 3.65 per cent which differed significantly over control (27.65% damage). The other IPM sequences resulted in the middle order.

In *Kharif* 2016, the minimum leaf damage (2.00- 2.50%) occured in T_2 (Hand picking+ destruction of caterpillar/ infested plant part+ spinosad 45 SC+ NSKE), T_4 (Hand picking+ destruction of caterpillar/ infested plant part+ indoxacarb 14.5 SC+ NSKE) and T_1 (Hand picking+destruction of caterpillar/ infested plant part+acephate 75 SP+NSKE). The maximum leaf damage (3.35- 4.50%) was observed in T_6, T_7 and T_9 which were statistically at par each other and differed significantly over control (29.54%). The rest of the IPM sequences ranked in the middle order.

In the pooled data, the minimum leaf damage was observed in T_2, T_4 and T_1 (2.03- 2.73%), these IPM sequences were found significantly superior over rest of the sequences. It was maximum in the sequenceT_7 and T_6 (4.03-4.63%). The remaining IPM sequences were ranked in the middle order. The effectiveness of IPM sequences in decreasing order was: T_2, T_4, T_1, T_{10}, T_3, T_8, T_5, T_9, T_7, and T_6.

In *Kharif* 2015, the minimum capsule damage of 2.10- 2.50 per cent was observed in plots having IPM sequences T_2 (Hand picking+ destruction of caterpillar/ infested plant part+ spinosad 45 SC+ NSKE), T_4 (Hand picking+ destruction of caterpillar/ infested plant part+ indoxacarb 14.5 SC+ NSKE) and T_1 (Hand picking+destruction of caterpillar/ infested plant part+acephate 75 SP+NSKE) which were found at par each other and significantly superior over rest of the IPM sequences (Table-2). The maximum capsule damage (3.45- 4.05%) was observed in T_6, T_7 and T_9 which were statistically at par each other and differed significantly over control (39.05%). The rest of the IPM sequences ranked in the middle order.

In *Kharif* 2016, the minimum capsule damage of 2.05- 2.35 per cent was observed in plots treated with IPM sequences, T_2 (Hand picking+ destruction of caterpillar/ infested plant part+ spinosad 45 SC+ NSKE), T_4 (Hand picking+ destruction of caterpillar/ infested plant part+ indoxacarb 14.5 SC+ NSKE) and T_1 (Hand picking+destruction of caterpillar/ infested plant part+acephate 75 SP+NSKE) which were found at par each other and significantly superior over rest of the IPM sequences. The maximum capsule damage was observed in T_6 (4.00%), T_7 (3.50%) and T_9 (3.25%) which were statistically at par each other and differed significantly over control (41.01%). The rest of the IPM sequences ranked in the middle order.

In the pooled data, the minimum capsule damage was observed in T_2, T_4 and T_1 (2.03- 2.43%), these IPM sequences were found significantly superior over rest of the sequences. It was maximum in the sequenceT_7 and T_6 (3.50-4.03%). The remaining IPM sequences were ranked in the middle order. The effectiveness of IPM sequences against *A. catalaunalis* in decreasing order was: T_2, T_4, T_1, T_{10}, T_3, T_8, T_5, T_9, T_7, and T_6. Nath *et al.* (2003) reported that IPM practice comprising intercropping of sesame with pearl millet significantly reduced the incidence of insect pests except *S. obliqua*.

Seed Yield

The pooled data registered on yield of sesame showed that it was maximum in the T_2 (8.21 q ha^{-1}) followed by T_4 (8.18 q ha^{-1}), T_1 (7.84 q ha^{-1}) and T_{10} (7.20), these treatments were comparable with each other as well as best in enhanced the yield of sesame (Table- 3). The treatment of T_7 proved least effective followed by T_6 and T_8 which registered seed yield of 6.04, 6.00 and 6.18 q ha^{-1} respectively which were significantly superior over control (4.12 q ha^{-1}).

The plots treated with T_9 gave maximum benefit cost ratio of (8.69) and minimum benefit cost ratio T_7 (2.75) followed by T_5 (3.01). Behra and Jena (2013) reported that IPM practices comprising intercropping of sesame with clusterbean gave highest sesame equivalent yield (2192.38 kg/ha) followed by black gram (777.00 kg/ha). The benefit: cost ratio was 5.79 and 2.85 in case of cluster bean and black gram intercropping systems, respectively. Ahuja *et al.* (2005) reported that 2 sprays of azadirachtin at 0.03 per cent at vegetative and flowering stage of the crop, and intercropping of sesame with green gram cultivar, K-851 in 1:1 ratio decreased the damage significantly and provided higher seed yield and economic returns (incremental cost benefit ratio was 1:3.44).

Table 1: Evaluation of sequences of IPM practices against sesame leaf and capsule borer, *Antigastra catalaunalis* (Dup.) on sesame

S. No.	Sequences	Population of leaf and capsule borer, *A. catalaunalis*/ five plants		
		2015	2016	Pooled
T_1	Hand picking+destruction of larvae/infested plant part+acephate 75 SP+NSKE	1.51	1.89	1.70
		(1.42)	(1.55)	(1.48)
T_2	Hand picking+destruction of larvae/infested plant part+spinosad 45 SC+NSKE	1.18	1.20	1.19
		(1.30)	(1.30)	(1.30)
T_3	Hand picking+destruction of larvae/infested plant part+vertimec 1.9 EC +NSKE	2.96	2.96	2.96
		(1.86)	(1.86)	(1.86)
T_4	Hand picking+destruction of larvae/infested plant part+indoxacarb 14.5 SC +NSKE	1.34	1.39	1.37
		(1.36)	(1.37)	(1.35)
T_5	Hand picking+destruction of larvae/infested plant part+*Btk* 8 L+NSKE	3.05	3.01	3.03
		(1.88)	(1.87)	(1.88)
T_6	Hand picking+destruction of larvae/infested plant part+NSKE+*Chrysoperla zastrowi Arabica*	4.57	4.76	4.67
		(2.25)	(2.29)	(2.27)
T_7	Hand picking+destruction of larvae/infested plant part+NSKE+*Trichogramma chilonis*	4.09	4.12	4.11
		(2.14)	(2.15)	(2.15)
T_8	Intercropping with green gram+ Hand picking+destruction of larvae/infested plant part+NSKE+ *Trichogramma chilonis*	3.89	3.95	3.92
		(2.10)	(2.11)	(2.10)
T_9	Intercropping with green gram+ Hand picking+destruction of larvae/infested plant part+NSKE+ *Chrysoperla zastrowi Arabica*	3.45	3.68	3.57
		(1.99)	(2.04)	(2.02)
T_{10}	Standard check (carbaryl 50 WP)	2.61	2.89	2.75
		(1.76)	(1.84)	(1.80)
T_{11}	Control	7.07 2.75	7.50 2.83	7.29 2.79
	S.Em. ±	0.12	0.10	0.09
	CD (p= 0.05)	0.36	0.29	0.25

* Mean of three replications

Figures in parentheses are $\sqrt{x+0.5}$ values

Table 2: Evaluation of sequences of IPM practices against sesame leaf and capsule borer, *Antigastra catalaunalis* (Dup.) on sesame

S. No.	Sequences	Leaf damage (%)			Capsule damage (%)		
		2015	**2016**	**Pooled**	**2015**	**2016**	**Pooled**
T_1	Hand picking+destruction of larvae/infested plant part+acephate 75 SP+NSKE	2.95 (9.89)	2.50 (9.10)	2.73 (9.50)	2.50 (9.10)	2.35 (8.82)	2.43 (8.96)
T_2	Hand picking+destruction of larvae/infested plant part+spinosad 45 SC+NSKE	2.05 (8.23)	2.00 (8.13)	2.03 (8.18)	2.10 (8.33)	2.08 (8.29)	2.09 (8.31)
T_3	Hand picking+destruction of larvae/infested plant part+vertimec 1.9 EC +NSKE	3.05 (10.06)	3.00 (9.97)	3.03 (10.02)	2.85 (9.72)	2.75 (9.55)	2.80 (9.63)
T_4	Hand picking+destruction of larvae/infested plant part+indoxacarb 14.5 SC +NSKE	2.10 (8.33)	2.25 (8.63)	2.18 (8.48)	2.25 (8.63)	2.05 (8.23)	2.15 (8.43)
T_5	Hand picking+destruction of larvae/infested plant part+*Btk* 8 L+NSKE	3.65 (11.01)	3.75 (11.17)	3.70 (11.09)	3.35 (10.55)	3.05 (10.06)	3.20 (10.30)
T_6	Hand picking+destruction of larvae/infested plant part+NSKE+*Chrysoperla zastrowi Arabica*	4.75 (12.59)	4.50 (12.25)	4.63 (12.42)	4.05 (11.61)	4.00 (11.54)	4.03 (11.57)
T_7	Hand picking+destruction of larvae/infested plant part+NSKE+*Trichogramma chilonis*	4.00 (11.54)	4.05 (11.61)	4.03 (11.57)	3.50 (10.78)	3.50 (10.78)	3.50 (10.78)
T_8	Intercropping with green gram+ Hand picking+destruction of larvae/infested plant part+NSKE+ *Trichogramma chilonis*	3.25 (10.39)	3.35 (10.55)	3.30 (10.47)	3.05 (10.06)	2.95 (9.89)	3.00 (9.97)
T_9	Intercropping with green gram+ Hand picking+destruction of larvae/infested plant part+NSKE+ *Chrysoperla zastrowi Arabica*	3.95 (11.46)	3.95 (11.46)	3.95 (11.46)	3.45 (10.70)	3.25 (10.39)	3.35 (10.55)
T_{10}	Standard check (carbaryl 50 WP)	3.00 (9.97)	2.75 (9.55)	2.88 (9.76)	2.75 (9.55)	2.50 (9.10)	2.63 (9.32)
T_{11}	Untreated (control)	27.65 (31.72)	29.54 (32.92)	28.59 (32.32)	39.05 (38.67)	41.01 (39.82)	40.03 (39.24)
	S.Em. ±	0.30	0.33	0.30	0.32	0.31	0.25
	CD (p= 0.05)	0.90	0.97	0.88	0.94	0.91	0.72

* Mean of three replications
Figures in parentheses are angular transformed values.

Table 3: Effect of sequences of IPM practices on the seed yield of sesame, *Sesamum indicum* (Pooled, *Kharif* 2015 and 2016)

	Sequences	Mean seed yield (q ha^{-1})		
		2015	**2016**	**Pooled B. C. ratio**
T_1	Hand picking+destruction of larvae/infested plant part+acephate 75 SP+NSKE	7.83	7.85	7.84 5.65
T_2	Hand picking+destruction of larvae/infested plant part+spinosad 45 SC+NSKE	8.21	8.21	8.21 3.51
T_3	Hand picking+destruction of larvae/infested plant part+vertimec 1.9 EC +NSKE	6.90	6.94	6.92 4.52
T_4	Hand picking+destruction of larvae/infested plant part+indoxacarb 14.5 SC +NSKE	8.17	8.19	8.18 3.55
T_5	Hand picking+destruction of larvae/infested plant part+*Btk* 8 L+NSKE	6.68	6.70	6.69 3.01
T_6	Hand picking+destruction of larvae/infested plant part+NSKE+*Chrysoperla zastrowi Arabica*	6.00	6.02	6.00 3.08
T_7	Hand picking+destruction of larvae/infested plant part+NSKE+*Trichogramma chilonis*	5.97	6.08	6.04 2.75
T_8	Intercropping with green gram+ Hand picking+destruction of larvae/infested plant part+NSKE+ *Trichogramma chilonis*	6.10	6.25	6.18 6.31
T_9	Intercropping with green gram+ Hand picking+destruction of larvae/infested plant part+NSKE+ *Chrysoperla zastrowi arabica*	6.05	6.16	6.11 8.69
T_{10}	Standard check (carbaryl 50 WP)	7.18	7.22	7.20 6.07
T_{11}	Untreated (control)	4.00	4.25	4.12 -
	S.Em.±	0.23	0.10	0.31
	CD (p = 0.05)	0.69	0.77	0.93

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