International Journal of Plant & Soil Science

Volume 35, Issue 1, Page 77-85, 2023; Article no.IJPSS.96288
ISSN: 2320-7035

The Impact of Various IPM Modules on the Management of Major Insect Pests of Sesame in Madhya Pradesh's Bundhelkhand Zone

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i12746

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/96288

Original Research Article

Received: 21/10/2022
Accepted: 29/12/2022
Published: 01/02/2023

ABSTRACT

The All India Coordinated Research Project Sesame Centre, College of Agriculture, JNKVV, Tikamgarh (M.P.) conducted a field experiment in 2017 *kharif* season using a Randomised block design to examine the effects of several IPM modules on the control of the main sesame insect pest. The experiment was set up using a Randomized Block Design with three replications, six treatments, and 21.6 M^2 plots for each, using the sesame variety modrate resistant TKG -22 as the test variety. All of the plots' seeds were treated with imidacloprid 600 (5g/kg seed), and all plots except for the control were intercropping with black gram (3:3) and yellow sticky trap (1 trap/plot). Profenofos 50EC (2ml/L), NSKE5% (T1 and T2), two sprays of NSKE5% + NSKE 5%, Profenofos 0.1% (2ml/l)+ NSKE 5%, and Profenofos 0.1% were used as the treatment, with the untreated

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control side receiving no treatment. The results showed that treated areas with insecticides outperformed untreated areas by a significant margin. Of the treatments, treatment T5 (imidacloprid 600FS (5g/kg seed) foliar spray of NSKE5% at 30 & profenofos 0.11% (2ml/l)45 DAS) was the most effective and recorded the lowest population of *Antigashtra* (0.17) larvae/5plant). Bud flies were greatly diminished, and the populations of the three main sucking pests—mirid bugs (0.24 bugs per three leaves/plant), white flies (0.48 Nymphs per three leaves/plant were at their lowest. In T5 (imidacloprid 600FS (5g/kg seeds + intercropping with black gram 3:3) foliar srpray of NSKE5% at 30, & profenofos 0.1% (2ml/l), the seed equivalent yield was also greatly increased. 45 DAS had the highest seed equivalent yield of 1176 kg/ha, the highest net profit of Rs. 78667, and the highest B:C ratio (6.11); T4 had the highest seed equivalent yield of 1075 kg/ha, the net profit of Rs.70297, and the highest B:C ratio (5.48).

Keywords: IPM module; sesame pests; abiotic factors; neem product; bud fly; Antigastra catalaunalis.

1. INTRODUCTION

As the "queen of oilseeds," sesame (*Sesame indicum* Lin.) is one of the oldest oilseed crops in existence. It is grown throughout all of India's crop growing seasons, including kharif, late kharif, rabi, and summer [1]. One of the earliest crops growing in India is sesame. India is the first in the world for area under cultivation, accounting for 30% of global production. The principal states for sesame agriculture include Gujrat, Rahsthan, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, West Bengal, Orisha, Punjab, and Tamilnadu [2]. Food, edible oil, biomedicine, and health care all use sesame. Sesame has a strong antioxidant effect as well due to the presence of lignin and tocopherol. The seeds contain high levels of proteins and necessary amino acids, including methionine, which has anti-aging properties. Vitamins E, A, and B complex, as well as calcium and phosphorus, are abundant in the seed. Sesame oil lowers cholesterol and guards against coronary heart disease. Because sesame oil has high nutritional, therapeutic, skin-care, and cooking properties. It becomes more significant due to the high quality edible oil, protein, calcium, and phosphorus [3]. With a total yield of 0.81 million tonnes and a fairly low average productivity of 456 kg ha-1 compared to the global average of 518 kg ha-1, it is grown on 1.78 million ha in India [4]. Sesame's low productivity is primarily attributable to its rain-fed cultivation on marginal and sub-marginal fields with subpar management techniques. One of the main causes of low productivity is damage from insect pests. 29 distinct types of insect pests attack the crop at various stages of plant growth [5]. Among these, the leaf roller and capsule borer are the two most problematic insects in India's entire sesame growing region. It harms the crop in all three stages, namely the vegetative, floral, and mature stages. At an earlier growth stage, they fold the leaves together and feed inside. Newly hatched larvae feed on the young leaves and shoot tips. then consume blossom, pods, and seeds. Sesame is grown during the kharif season in Madhya Pradesh's Bundhelkhand region. August through October are the months with the highest *Antigastra* activity. As a result, *Antigastra*, a major pest of sesame, causes a 43.1% economic loss in the Bundelkhand region [6]. The most harmful pest of the sesame crop is *Antigastra catalaunalis* (Lepidoptera: Pyralidae), which can cause losses of up to 90% [7] and up to 80.42% [8]. Nymph and adults of Jassid (*Oriosius albicinctus* Distant), Mirrid bug (*Nesidiocoris tenuis* Rent.), and White fly (*Bemisia tabaci Gennadius*) are sucking insect pests that feed on the cell sap of leaves, flowers, and pods. This causes the leaf margin to curl inward, which slows the plant's growth and ultimately lowers the yield. Jassid and white flies, respectively, are in charge of spreading phyllody and leaf curl disease in sesame. Given these facts, the current study on the prevalence of *Antigatra*, Jassaid, Mirrid bugs, and white flies was done. These pests attack crops beginning at the seedling stage and continue through pod maturity, inflicting harm to all plant components including leaves, flowers, and pods, Intercropping with black gram, green gram, cluster bean, sorghum, and pearl millet is proven to be extremely beneficial in minimising the leaf Webber damage [9,1,10,11]. The larvae of the sesamum leaf roller and capsule borer produced between 27 and 40 percent of the damage reported by [12] while Saxena and Jakhmola [13] documented yield loss of between 10 and 60 percent. Sesame leaf roller and capsule borer incidence was estimated to cause avoidable grain yield loss in Madhya Pradesh that ranged from 6.2 to 43.1% [14]. The estimated preventable loss in Inodisha from sesamum leaf webber was 79.75% [15].

2. MATERIALS AND METHODS

In order to investigate the most practical Integrated Pest Management (IPM) Module for the control of the main insect pests of sesame, the current experiment was carried out at the All India Coordinated Research Project on Oilseeds Sesame Trials, Department of Entomology, JNKVV, College of Agriculture, Tikamgarh during the *kharif* season of 2017. With six (06) treatments and three (03) replications, the field experiment was set up using a Randomized Block Design (RBD). To grow nice and healthy crops, the variety "TKG-22" was sowed as normal with all other agronomic procedures. Each subplot was 21.6 m2 in size (5.4X 4 m). TKG-22 was chosen as the test (National Check) cultivar for sesame. This variety, which was issued by JNKVV, COA, and Tikamgarh, is grown throughout the state throughout both the kharif and rabi seasons. It is appropriate for upland and medium climates. In a 3:3 ratio, sesame was intercropped with the black gram variety Aajad-1. On July 1, 2017, the sesame variety TKG-22 was sowed with a spacing of 30 x 10 cm. For growing the crops, all advised agronomic practises were used. Insecticide was applied to the seeds in all plots other than the control, and the effectiveness of both the seed treatment alone and the combination of foliar spray of insecticides was examined. To achieve thorough coverage of the plants, all treatments were administered as foliar sprays in the early morning using a high volume hand compression sprayer and 500 litres of spray per hectare. The spray tank was thoroughly cleaned before each insecticide application to prevent chemical admixture. When spraying, enough care is taken to prevent insecticide drift. With the exception of the maximal protection level at T5 treatment, the insecticide was administered as pests began to arrive in economic quantities, or after ETL level at 30 days after sowing. Ten randomly selected plants from each treatment were used to gather information on the populations of sesame leaf roller and capsule borer. Pre-foliar spray counts of the *Antigastra* larval population were taken one day before the first spray, and post-foliar counts were taken 7 th and 14 th days after the spray. Additionally, observations were made during the vegetative (30 DAS), flowering (45 DAS), and capsule (60 DAS) stages of crop development. The percentage of damaged plants, flowers, and capsules was calculated by comparing the number of damaged and healthy plants, flowers, and capsules to each plant. Also calculated were the percentage reductions in plant, flower, and capsule damage compared to the control. With the Gomez, [16] approach, statistical analysis of all the recorded data was controlled and subjected to analysis of variance in a randomised block design.

Preparation of NSKE5%: We took 3 kg of freshly harvested neem seed kernels, lightly crushed them, and wrapped them loosely with cotton linen. Overnight, it was submerged in a container with 10 litres of water. Following this, it was filtered, yielding 6 litres of extract. 9.5 litres of water were used to dilute 500 ml of this extract. Adding soap solution at a rate of 10 ml per litre before spraying helped the extract adhere effectively to the leaf surface.

Table 1. The detailed of Experiment Treatments are

S. no.	Seed treatments	Intercropping	Trap	Foliar application	
				30 DAS	45 DAS
T1	Seed treatment with imidacloprid 600 Fs @5g/kg seed	Inter cropping with black gram(3:3)	Yellow sticky trap @1 trap per plot	Profenofos 0.1% @2 ml /liter	-
T2	Seed treatment with imidacloprid 600 Fs @5g/kg seed	Inter cropping with black gram(3:3)	Yellow sticky trap @1 trap per plot	NSKE5%	-
T3	Seed treatment with imidacloprid 600 Fs @5g/kg seed	Inter cropping with black gram(3:3)	Yellow sticky trap @1 trap per plot	NSKE5%	NSKE5%
T4	Seed treatment with imidacloprid 600 Fs @5g/kg seed	Inter cropping with black gram(3:3)	Yellow sticky trap @1 trap per plot	Profenofos 0.1% @2 ml /liter	NSKE5%
T5	Seed treatment with imidacloprid 600 Fs @5g/kg seed	Inter cropping with black gram(3:3)	Yellow sticky trap @1 trap per plot	NSKE5%	Profenofos 0.1% @2 ml /liter
T6	Control	-	-	-	-

Spraying for maximum protection every 15 days beginning 30 days after sowing (DAS)

Table 2. Information on the pesticides tested

S. No.	Chemical Name	Trade Name	Package Available	Price in Ruppes
1.	Profenofos50EC	Kemcron	1 Liter	625
2.	Neem Seed Kernel Extract (NSKE)	-	25kg	1000

Table 3a. Effectiveness of several IPM modules on the occurrence of leaf roller and capsule borer, as well as Bud fly, in sesame during the 2017 Kharif season

Treatments	*Antigastra catalaunalis*							*Desineura lini*	
	Population /plant			Per cent damage				Flower (45 DAS)	
	PTC	Plant (30 DAS)	Flower (45 DAS)	PTC	Plant (30 DAS)	Flower (45 DAS)	Capsule (60 DAS)	Population/ plant	Per cent damage
T_1	0.35(0.92)	0.20(0.84)	0.60(0.96)	47.5(43.5)	27.5(31.4)	8.40(16.7)	2.52(8.90)	1.15(1.28)	6.30(14.2)
T_2	0.40(0.95)	0.50(0.99)	0.63(1.05)	55.0(47.9)	32.5(34.7)	10.13(18.50)	2.07(8.20)	2.35(1.58)	7.10(14.7)
T_3	0.63(1.05)	0.48(0.99)	0.75(1.11)	55.0(47.9)	27.5(30.6)	9.56(17.9)	1.76(7.10)	1.60(1.31)	6.90(15.2)
T_4	0.48(0.98)	0.25(0.86)	0.40(0.95)	45.0(42.1)	25.0(29.7)	7.66(16.0)	1.29(6.50)	0.55(1.00)	6.50(14.4)
T_5	0.33(0.91)	0.08(0.75)	0.25(0.86)	52.5(46.4)	22.5(27.7)	3.97(9.7)	1.27(6.30)	0.45(0.97)	5.30(12.8)
T_6	0.48(0.98)	0.55(1.02)	0.78(1.12)	62.5(52.3)	55.0(47.9)	25.0(29.7)	10.67(21.5)	4.25(2.18)	12.4(22.0)
SEm±	0.05	0.03	0.04	3.45	3.82	2.33	1.23	0.24	1.42
CD at 5 %	NS	0.9	0.12	NS	11.50	6.80	3.57	0.69	4.06

** Figure within parentheses are squire root transformed values, "PTC- Pre treatment count*

Table 3b. Effectiveness of several IPM modules on the occurrence of leaf roller and capsule borer, as well as Bud fly, in sesame during the 2017 Kharif season

Treatments	***Mean population Antigastra catalaunalis* larvae /plant**					Bud fly	
	PTC	Plant (30 DAS)	Flower (45 DAS)	Mean	Percentage reduction over control	Population/ plant	Percentage reduction over control
T_1	0.35 (0.92)	0.20 (0.84)	0.60 (0.96)	0.40	40.29	1.15(1.28)	72.94
T_2	0.40 (0.95)	0.50 (0.99)	0.63(1.05)	0.57	14.92	2.35(1.58)	44.70
T_3	0.63 (1.05)	0.48 (0.99)	0.75 (1.11)	0.62	7.46	1.60(1.31)	62.35
T_4	0.48 (0.98)	0.25 (0.86)	0.40 (0.95)	0.33	50.74	0.55(1.00)	87.05
T_5	0.33 (0.91)	0.08 (0.75)	0.25 (0.86)	0.17	74.63	0.45(0.97)	89.41
T_6	0.48 (0.98)	0.55 (1.02)	0.78 (1.12)	0.67	-	4.25(2.18)	-
SEm±	0.05	0.03	0.04			0.24	
CD at 5 %	NS	0.9	0.12			0.69	

* Figure within parentheses are squire root transformed values, "PTC- Pre treatment count;
Values Days following application (DAS), Non significantly (NS), Date of Before spraying (DBS) only two sprayings for the treatment
Percentage reduction over control= Starting e of control valu –Final valueX 100
Starting control value

Table 4. Effectiveness of several IPM modules on the occurrence of leaf roller and capsule borer, as well as Bud fly, in sesame during the 2017 Kharif season

Treatments	Percent damage *Antigastra catalaunalis*							Bud fly *Desineura lini*	
	PTC	Plant (30 DAS)	Percentage reduction over control	Flower (45 DAS)	Percentage reduction over control	% Capsule damage 60DAS	Percentage reduction over control	% damage Flower (45 DAS)	Percentage reduction over control
T_1	47.5(43.5)	27.5(31.4)	50	8.40(16.7)	66.40	2.52(8.90)	76.38	6.30(14.2)	49.19
T_2	55.0(47.9)	32.5(34.7)	40.90	10.13(18.50)	59.48	2.07(8.20)	80.59	7.10(14.7)	42.74
T_3	55.0(47.9)	27.5(30.6)	50	9.56(17.9)	61.76	1.76(7.10)	83.50	6.90(15.2)	44.35
T_4	45.0(42.1)	25.0(29.7)	54.54	7.66(16.0)	69.36	1.29(6.50)	87.91	6.50(14.4)	47.58
T_5	52.5(46.4)	22.5(27.7)	50.09	3.97(9.7)	84.12	1.27(6.30)	88.09	5.30(12.8)	57.25
T_6	62.5(52.3)	55.0(47.9)	-	25.0(29.7)	-	10.67(21.5)		12.4(22.0)	-
SEm±	3.45	3.82		2.33		1.23		1.42	
CD at 5 %	NS	11.50		6.80		3.57		4.06	

* Figure within parentheses are squire root transformed values, "PTC- Pre treatment count
Values Days after Spraying (DAS), Non significantly (NS), Date of Before spraying (DBS)

- only two sprayings for the treatment

Table 5. Evaluation of sucking pest population in different bio-intensive module in sesame in kharif 2017

Treatments	Population /three leaves														
	Jassid					Mirid bug					White fly				
	PTC	30 DAS	45 DAS	Mean	%reduction over control	PTC	30 DAS	45 DAS	Mean	%reduction over control	PTC	30 DAS	45 DAS	Mean	% reduction over control
T1	0.24 (0.86)	0.10 (0.77)	0.53 (1.01)	0.32	52.94	0.48 (0.98)	0.13 (0.79)	0.65 (1.07)	0.39	55.17	1.00 (1.22)	0.48 (0.98)	1.15 (1.28)	0.82	46.40
T2	0.29 (0.87)	0.18 (0.82)	0.38 (0.93)	0.28	58.82	0.38 (0.93)	0.23 (0.82)	0.55 (1.02)	0.39	55.17	0.85 (1.16)	0.55 (1.02)	1.03 (1.23)	0.79	48.37
T3	0.22 (0.83)	0.20 (0.83)	0.33 (0.90)	0.27	60.29	0.43 (0.96)	0.38 (1.03)	0.50 (1.00)	0.44	49.43	0.83 (1.14)	0.58 (1.03)	0.68 (1.08)	0.63	58.82
T4	0.19 (0.83)	0.20 (0.84)	0.40 (0.94)	0.30	55.88	0.55 (1.02)	0.20 (0.78)	0.38 (0.93)	0.29	66.67	1.05 (1.24)	0.53 (1.00)	0.90 (1.17)	0.72	52.94
T5	0.20 (0.82)	0.18 (0.82)	0.13 (0.79)	0.16	76.47	0.58 (1.03)	0.28 (0.89)	0.20 (0.84)	0.24	72.41	1.23 (1.30)	0.63 (1.06)	0.33 (0.91)	0.48	44.42
T6	0.28 (0.86)	0.53 (1.01)	0.83 (1.15)	0.68	-	0.63 (1.06)	0.65 (1.42)	1.08 (1.25)	0.87	-	0.93 (1.19)	1.10 (1.26)	1.95 (1.56)	1.53	-
SEm±	0.04	0.04	0.05	0.045		0.07	0.13	0.06	0.095		0.07	0.05	0.07	0.06	
CDat 5%	0.13	0.13	0.14	0.135		0.21	0.38	0.17	0.275		0.20	0.16	0.20	0.19	

*** Figure within parentheses are squire root transformed values, "PTC- Pre treatment count**
Values Days After spraying (DAS), Non significantly (NS), Date of Before spraying (DBS)

- only two sprayings for the treatment

Table 6. Evaluation of the sesame yield's economic and cost-effective IPM module

Treatments	Black gram yield (Kg/ha)	Sesame seed yield (Kg/ha)	Seed equivalent yield Rs/ha	Additional profit(Rs/ha)	Additional cost (rs/ha)	Net profit (Rs/ha)	Incremental cost: Benefit ratio	% increase in seed yield over control	Value of Increased yield over control
T1	486	648	982	78560	15013	63547	4.23	31.11	18640
T2	462	601	919	73520	14560	58960	4.01	22.70	13600
T3	509	625	975	78000	15120	62880	4.16	30.17	18080
T4	520	717	1075	86000	15663	70337	4.49	43.52	26080
T5	532	810	1176	94080	15393	78687	5.11	57.00	34160
T6	416	463	749	59920	13500	46420	3.43	-	-
SEm±			**41**						
CD at 5%			**123**						

*** Figure within parentheses are squire root transformed values, "PTC- Pre treatment count**

Values: Days After Spraying (DAS), Non significantly (NS), Date of Before Spraying (DBS)

- only two sprayings for the treatment

Table 7. Economic analysis of a cost-effective IPM module for controlling the main insect pests of sesame Kharif 2017

Treatments	Black gram yield (kg /ha)	Sesame yield (kg /ha)	Seed equivalent yield (Kg/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	NMR (Rs/ha)	B:C ratio
T1; Seed treatment with imidacloprid 600FS @5g/kg seed + Intercropping with Black gram (3:3)followed by foliar spray of profenofos 0.1% @2ml /liter at 30DAS	486	648	982	15013	78570	63557	5.23
T2; Seed treatment with imidacloprid 600FS @5g/kg seed + Intercropping with Black gram (3:3)followed by foliar spray of NSKE 5% at 30 DAS	462	601	919	14560	73490	58930	5.04
T3; Seed treatment with imidacloprid 600FS @5g/kg seed + Intercropping with Black gram (3:3)followed by foliar spray of NSKE 5% at 30 & 45 DAS	509	625	975	15120	77995	62875	5.15
T4; Seed treatment with imidacloprid 600FS @5g/kg seed + Intercropping with Black gram (3:3)followed by foliar spray of Profenofos 0.1% @ 2ml/liter at 30 DAS and NSKE 5 % at 45 DAS	520	717	1075	15663	85960	70297	5.48
T5; Seed treatment with imidacloprid 600FS @5g/kg seed + Intercropping with Black gram (3:3)followed by NSKE 5% at 30 DAS and Profenofos 0.1% @ 2ml/liter at 45 DAS	532	810	1176	15393	94060	78667	6.11
T6 - Intercropping with Black gram (3:3)	416	463	749	13500	59920	46420	4.43
SEm±			**41**				
CD at 5%			**123**				

**Sale price of sesame seed @Rs80/kg and Balck gram @Rs 55/kg*

3. RESULTS AND DISCUSSION

To determine the effectiveness of various IPM modules against the incidence of leaf roller and capsule borer, leaf hopper, white fly, and Mirrid. bug, pre- and post-foliar observations on the population of *Antigastra* larvae/plant, percentage damage by leaf roller and capsule borer, population grub/plant *Dasenura* sesame, and population of leaf hopper per plant were recorded. Antigastra larvae per plant, leaf hopper population per plant, and mirid bug population per plant were the subjects of pre foliar spraying observation, which was conducted one day prior to spraying (DBS), and post foliar spraying observation, which was conducted at 30 (DAS) and 45 days after spraying (DAS) and capsule damage was documented at 60 DAS, while capsule borer was noted at 1 DBS and 30 DAS (days after spraying). The results shown in (Table:3b) showed that all treatments were found to be significantly better than the untreated (T6) among the treatment T5 (with seed treatment imidacloprid 600FS (5g/kg seed)+ Intercropping with black gram (3:3) NSKE 5% at 30 and 45 DAS respectively, and Profenofos 0.1% @2ml/liter at 45 DAS lowest population of *Antigastra* (0.17 larvae /plant at 30 and 45 DAS respectively in comparison to other treatments, and a mean reduction of 74.63% in larval population over control. Treatment T4 was the next-best treatment in terms of lowest mean larval population (0.33 larvae/plant) and registered a mean reduction in larval population of 50.74% over control (seed treatment with imidacloprid 600FS @5g /kg seed + intercropping with black gram (3:3). The highest larval population was found in treatment T3 (Seed treatment with imidacloprid 600FS @5g/kg seed + Intercropping with Black gram (3:3) followed by foliar spray of NSKE 5% at 30 & 45 DAS), where foliar spraying of NSKE 5% was the only application, and registering a mean reduction in larval population of 7.46% over control. Our findings are consistent with the fact that all pesticides considerably reduced the larvae population up to the 14th DAS [17]. Pandey [18] also reported that (seed treatment with imidacloprid + foliar spray of profenofos 0.1% 2ml/liter) recorded lowest larval population (0.15 larvae per plant) and showed a highest reduction in mean larval population (93.03%). The reduction in larval population was 90% at the first days after spraying and 44.8% to 52.5% at the 14th days after spraying. According to Afzal [19], the population of leaf roller and capsule borer was significantly reduced when curacron 500 EC (Profenofos) was treated at 1500ml/ha. This result was also supported by Tripathi's [20] findings, which were similar to our own. The results shown in (Table 4) showed that treatment T5 (seed treatment imidacloprid 600FS 5g/kg seed)+ Intercropping with black gram (3:3) NSKE5% at DAS and Profenofos 0.1% @ 2ml /liter at 45 DAS were considerably better than the untreated control (T6). *Antigastric* pill percentage decrease over control and lowest percent damage plant blossom, respectively, was 50.09% (84.12%). T4 (seed treatment with imidacloprid 600 FS @ 5g/kg seed + intercropping with black gram (3:3) followed by foliar spray of profenofos 0.% 2 ml/liter at 30DAS and NSKE5% at 45DAS) was the next better treatment with respect to lowest percent damage at 30 and 45DAS. This treatment had a mean percentage reduction of 54.54%, 69.36, and 87.91% in reduction percentage Our findings are consistent with those of Ahirwar [21]. They claimed that natural and indigenous products including neem oil seed karnel extract, neem leaf extract, garlic + red pepper extract, cow urine, and cow butter milk dramatically reduced the incidence of both nymph and adult leaf hoppers as compared to control. The results shown in (Table 3b and Table 4) showed that all treatments were found to be significantly superior to the untreated control (T6). This was especially true for treatment T5 (Seed treatment with imidacloprid 600FS 5g/kg seeds)+ Intercropping with black gram (3:3) NSKE 5% at 30 DAS and Profenofos 0.1% @ 2ml/liter at 45 DAS. Lowest population of *Dasineura* sesame mean population (0.455/plant and 89.41% reduction over control), and most severe flower damage (5.30/plant and 57.25% reduction over control, respectively) Compared to other treatments, T4 (Seed treatment with imidacloprid 600 FS @ 5g/kg seed + Intercropping with black gram (3:3) showed a mean percentage% damage reduction of 6.50 percent. The next superior treatment in terms of lowest damage percent at 45 DAS was foliar spray of Profenofos 0.1% @ 2ml/liter at 30DAS, followed by NSKE 5% at that time (47.58%). The results from Nayak et al., [22], Pandey et al., [18], and Gupta et al., [6] support the current finding.

The minimum mean population of Jassid, Mirrid bug, and White fly was 0.16 Jassid per three leaves, 0.24 Mirrid bug per three leaves, and 0.48 White fly per three leaves at 30 and 45 DAS, respectively. The presented in (Table 5) percentage reduction over control was 76.47%, 72.41%, and 44.42% T5 (with seed treatment imidacloprid 600FS 5g/kg seed + intercropping with Black gram (3:3) NSKE 5% at 30DAS. In module T4 (Seed treatment with imidacloprid 600 FS @ 5g/kg seed + Intercropping with black gram (3:3) followed by foliar spray of Profenofos 0.1% @ 2ml/liter at 30 DAS and NSKE 5% at 45 DAS), the mean and percent reduction in control were observed, respectively. Our findings agree with those of Ahirwar et al. [21], Nayak et al. [2], Pandey et al. [18], and Gupta et al. [6].

When compared to the untreated control module T6, the Seed Equivalent Yield was significantly higher in each IPM module T1, T2, T3, T4, and T5 (Table 6). A percentage increase in seed yield was computed for each treatment based on control, with the plot that received only seed treatment recording lower seed yield than those that also received foliar sprays of NSKE5 % and profenofos 0.1%. As shown in (Table 6), T 5 was used, and the greater seed equivalent yield (1176 kg/ha) with a higher increment in seed yield (above the control) of (57.00%) and a higher B:C ratio (5.11) was noted. Treatment T4 (1075 kg/ha) with a (43.52%) increase in seed yield over control was applied after that. This was followed by seed equivalent yield T1 (982 kg/ha), which had a (31.11%) increase in seed yield over control. However, the BC ratio (4.23) in cases of neem-based and chemical insecticides caused the foliar spray of NSKE5% to have the greatest increase in seed equivalent yield (75%) over the control. In comparison to the untreated control (749 kg/ha), it was at its highest in T5 (1176 kg/ha) and T4 (1075 kg/ha).

The maximum extra profit per hectare (Rs 94080) Net income (Rs. 78667 per hectare) and incremental costs Benefit ratio (5.11; seed treatment with imidacloprid 600FS and intercropping with black Gram, 3:3)) was noted in T5. NSKE 5% foliar spray is applied at 30 DAS, and Profenofos 0.1% is applied at 45 DAS. Then came additional earnings (Rs. 86,000 per ha). Incremental cost benefit ratio and net profit (Rs. 70337/ha) (4.49) T4 (Imidacloprid 600FS seed treatment + intercropping with black gram (3:3) + profenofos 0.1% foliar spray at 30 DAS + NSKE 5% at 45 DAS). Given its effectiveness and affordability, NSKE 5% can be used to control insect pests that threaten sesame exports. According to their published findings, the results [22], Panday et al. [18], Gupta et al. [6], and Ahirwar et al. [21] are consistent with the findings.

4. CONCLUSION

Profenofos 50EC (0.1%) and NSKE 5% were found to be the most efficient foliar pesticide spraying methods for suppressing leaf roller and capsule borer, leaf hopper and Bud fly, leaf hopper, mirrid bug, and White fly. The maximum protection treatment T5 was shown to be most successful for the control of leaf roller and capsule borer, Bud fly, leaf hopper, Mirrid insect, and white fly, followed by the treatment T4. In terms of the percentage of flower and capsule damage caused by *Antigastra*, T5 was shown to be the most effective therapy, lowering flower damage by (84.12%) in comparison to control. T5 was observed to be reduced (88.09%) in the capsule damage therapy condition compared to the control. The results of Nayak et al. [22], Pandey et al. [18], and Gupta et al. [6] support the findings of the current study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/96288