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Impact of various IPM modules in the management of major insect pests of sesame under Bhubaneswar agro climatic condition

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Abstract
An experiment was conducted at Central Research Station, Department of Entomology, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar during the *kharif* season of 2017 in a Randomized Block Design to study the Impact of various IPM modules in the management of major insect pests of sesame under Bhubaneswar agro climatic condition. The experiment was organized in Randomized Block Design with three replications and eight treatments having 12m^2 plots each and sesame variety "Prachi" was taken as a test variety. The seeds of all the plots were treated with imidacloprid 600 FS (5g/kg seed) plus intercropping with Black gram (3:3) and Yellow sticky trap@ 1 trap per plot was done except control. The treatments taken were single foliar spraying of profenofos 50 EC(2ml/l), NSKE 5%, two spraying of NSKE 5%, profenofos 0.1% (2ml/l) + NSKE 5%, NSKE 5% + profenofos 0.1% (2ml/l), two spraying of profenofos 0.1% (2ml/l) and imidacloprid (3ml/10 l) + chlorpyrifos (2ml/l) respectively besides untreated control. The results revealed that treatment T_7 with imidacloprid (3ml/10 l) and chlorpyrifos (2ml/l) applied alternatively at 15 days interval starting from 30 DAS was found best in suppressing the major pest including shoot webber and capsule borer, *Antigastra catalaunalis*, leaf hopper, *Orosius albicinctus* and mirid bug etc.

Keywords: *Antigastra catalaunalis,* IPM modules, sesame pests, abiotic factors, neem products, gall fly

Introduction
Sesame (*Sesamum indicum* L.) is one of oldest oilseed crop grown in India. India ranks first in the area under cultivation representing 30% of the world production. Gujarat, Rajasthan, Maharashtra, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Karnataka, West Bengal, Orissa, Punjab and Tamil Nadu are the major states of sesame cultivation (Singhal,1999) [1]. Sesame is used as food, edible oil, bio-medicine and health care. Due to the presence of tocopherol and lignins sesame has remarkable antioxidant function also. The seeds are rich in proteins and essential amino acids, especially methionine which have an anti-ageing property. The seed is rich source of vitamins E, A & B complex including calcium and phosphorus. Sesame oil has reducing effect on cholesterol and prevents coronary heart diseases. Due to excellent nutritional, medicinal, skin care and cooking qualities of sesame oil it is known as "Queen of oils". It is grown throughout the year and being a short duration crop, fits well in to various cropping systems.

Sesame crop is grown in an area of about 17.78 lakh hectares with an annual production of 8.11 lakh tonnes and an average productivity of 456 kg/ha (Anonymous,2011). It gains importance because of quality edible oil, protein, calcium and phosphorus (Seegler, 1983) [3].

Rai (1976) [4] reported that sesamum was infested by 29 insect pests in Delhi. Ahuja and Bakhetia (1995) [5] found 65 insect species and one mite species damaging this crop at different stages of plant growth. Insect pests are one of the major constraints in sesame production. Among the pest leaf Webber and capsule borer (*Antigastra catalaunalis*), gall fly (*Asphondylia sesami*), sphingid moth (*Acherontia styx*), leaf hopper (*Orosius albicinctus*) and white fly (*Bemisia tabaci*) are the most important pests throughout India. In Odisha leaf Webber and capsule borer, leaf hopper and gall fly are the major pests. Leaf Webber and capsule borer only causing 25.38% yield loss in Kharif season (Annual report 2014-15, AICRP on sesame & Niger) [6].

Sesame leaf Webber and capsule borer, *Antigastra catalaunalis* (Lepidoptera: Pyralidae) is the most harmful pest of sesame crop with causes losses up to 90% (Ahuja and Bakhetia, 1995) [5] and causes losses up to 80.42% (Wazire & Patel, 2016) [7].

It attack the crop from seedling stage and continues till maturity of pod and causing severe damage to all the plant parts such as leaf, flower and pod. Intercropping with pigeon pea (Nath%., 2003) [8] and black gram, green gram, cluster bean, sorghum and pearl millet (Ahirwar%., 2009; Ahuja%., 2009) [9, 10] (Behera%., 2013) [11] found to be quite effective in reducing the leaf Webber damage.

Abraham%., (1977) [12] reported 27-40% of the damage was caused by the larvae of sesamum leaf webber and capsule borer. Saxena and Jakhmola (1993) [13] recorded that the shoot webber and pod borer was causing 10-60% loss in yield. Avoidable grain yield loss due to incidence of sesamum leaf roller and capsule borer was reported to vary from 6.2 to 43.1% in Madhya Pradesh (Gupta%., 2002) [14]. In Odisha, the avoidable loss due to sesamum leaf webber was estimated to be 79.75% (Patnaik%., 2002) [15].

3. Materials and Methods

The present experiment was conducted at Central Research Station, Department of Entomology, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar during the *kharif* season of 2017 in a Randomized Block Design to study the cost effective Integrated Pest Management (IPM) module for the management of major insect pests of sesame. The field experiment was laid out in Randomized Block Design (RBD) with eight (8) treatments and three (3) replications. The variety "Prachi" was sown along with all other agronomical practices as usual to raise good and healthy crop. Each subplot measured 12 m^2 (4.0 m × 3.0 m). Sesamum variety "Prachi" was taken as the test cultivar. This variety released by OUAT is grown in many parts of the state both during kharif and pre Rabi seasons. It is suitable for medium and upland conditions. The black gram variety "Prasad" (B3-8-8) was grown as intercrop with sesame in 3:3 ratio. Sesame var, 'Prachi' was sown on 26th September, 2017 with a spacing of 30 cm × 10 cm. All the recommended agronomic practices were adopted for raising the crop.

Seed of all the plots except control were treated with insecticides and their response as a seed treatment alone and with the combination of foliar spray of insecticides was tested. All the treatments were applied in the form of foliar sprays by means of high volume hand compression sprayer using 500 litre of spray solution per hectare to ensure thorough coverage of plants and the application was done in the early morning. Before spray of each insecticide, the spray tank was washed carefully to avoid chemical mixture. Sufficient care was taken to avoid drifting of the insecticides while spraying. The insecticides were applied after the appearance of pests in economic proportions i.e., beyond ETL level at 45 days after sowing except the maximum protection level at T_7 treatment. The data on population of sesame leaf roller/capsule borer was recorded from randomly selected ten plants in each treatment. The pre foliar spray count of larval population of *Antigastra* was recorded one day before first spray and post foliar counts of larval populations were recorded on 7th and 14th day after each sprays. The observations were also recorded at vegetative (30 DAS), flowering (50 DAS) and capsule (70 DAS) stage of crop growth and percent plant, flower and capsule damage were worked out by counting the total number of damaged and healthy plants, flowers and capsules per plant. The percent reduction of larval population, plant, flower and capsule damage over the control were also worked out. Statistical analysis of all the recorded data were subjected to analysis of variance in Randomized Block Design with the procedure laid out by Gomez and Gomez (1984) [25].

Preparation of NSKE

3 kilogram of freshly neem seed kernel was taken and crushed the kernel gently and tied it loosely with a cotton cloth. It was soaked in a vessel containing 10 litres of water over night. After this, it is filtered, on filtering 6 litre of extract was obtained. 500 ml of this extract diluted with 9½ litres of water. Before spraying soap solution @ 10 ml/litre was added to help the extract stick well to the leaf surface.

Table 1: Treatments

Tr. No.	Seed treatment	Intercropping	Trap	Foliar application	
				45 DAS	60 DAS
T_1	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% (2ml/litre)	-
T_2	Seed treatment with imidacloprid 600 FS (5g/kg seed)	Inter Cropping with Black gram (3:3)	Yellow sticky trap @ 1 trap per plot	NSKE 5%	-
T_3	Seed treatment with imidacloprid 600 FS (5g/kg seed)	Inter Cropping with Black gram (3:3)	Yellow sticky trap @ 1 trap per plot	NSKE 5%	NSKE 5%
T_4	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% (2ml/litre)	NSKE 5%
T_5	Seed treatment with imidacloprid 600 FS (5g/kg seed)	Inter Cropping with Black gram (3:3)	Yellow sticky trap @ 1 trap per plot	NSKE 5%	Profenofos 0.1% (2ml/litre)
T_6	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% (2ml/litre)	Profenofos 0.1% (2ml/litre)
T_7*	Seed treatment with imidacloprid 600 FS (5g/kg seed)	Inter Cropping with Black gram (3:3)	Yellow sticky trap @ 1 trap per plot	imidacloprid (3ml/10 litre)	Chlorpyrifos (2ml /litre)
T_8	Control	-	-	-	-
***Maximum protection spraying at 15 days interval starting from 30 days after sowing (DAS) alternatively**					

Table 2: The details of pesticide tested

Sl. No	Chemical Name	Trade Name	Pkg available	Price in Rupees
1	Profenofos 50 EC	Kemcron	1 Litre	625
2	Chlorpyrifos	Kemtrek	1 Litre	300
3	Neem Seed Kernel Extract (NSKE)	-	25kg	1000
4	Imidacloprid 17.8% SL	M-CON	1 Litre	1120

4. Results and Discussion

Pre and Post foliar spray observations on population of *Antigastra* larvae per plant, percentage damage by Shoot webber and capsule borer, population of leaf hopper per plant and mirid bug were recorded to evaluate the efficacy of different IPM modules against the incidence of shoot webber and capsule borer (*Antigastra catalaunalis*), leaf hopper and mirid bug. Pre foliar spraying observations was taken one day before spraying (DBS) and post foliar spraying observations were taken at 7th and 14th day after spraying for *Antigastra* larvae per plant, population of leaf hopper per plant and mirid bug per plant. Pre and Post foliar spray observations on percentage damage by shoot webber and capsule borer was recorded at 1 day before spraying (1 DBS) and 7 DAS (days after spraying) while capsule damage were recorded at 67 DAS.

Table 3: Efficacy of different IPM modules on the incidence of shoot webber and capsule borer in sesame during *kharif*, 2017

Treatment	Mean population of shoot webber and capsule borer larvae per plant					Mean	Percentage reduction over control
	First spray			Second spray			
	1 DBS	7 DAS	14 DAS	7 DAS	14 DAS		
T_1*	1.54 (1.43)	0.86 (1.17)	0.92 (1.19)	0.70* (1.09)	0.17* (0.82)	0.66	64.70
T_2*	1.70 (1.48)	1.32 (1.35)	1.42 (1.38)	1.04* (1.24)	0.40* (0.95)	1.04	44.38
T_3	1.52 (1.42)	1.36 (1.36)	1.40 (1.37)	0.76 (1.12)	0.13 (0.79)	0.91	51.33
T_4	1.60 (1.45)	0.96 (1.21)	0.72 (1.10)	0.40 (0.95)	0.10 (0.77)	0.54	71.12
T_5	1.86 (1.54)	1.58 (1.44)	0.94 (1.20)	0.22 (0.85)	0.00 (0.71)	0.68	63.63
T_6	1.64 (1.46)	0.80 (1.14)	0.45 (0.97)	0.16 (0.81)	0.00 (0.71)	0.35	81.28
T_7	0.40 (0.95)	0.10 (0.77)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.02	98.93
T_8	1.96 (1.56)	2.20 (1.64)	2.30 (1.67)	2.10 (1.61)	0.90 (1.18)	1.87	
SE_m (±)	0.048	0.045	0.069	0.039	0.030		
C.D.(P=0.05)	0.14	0.13	0.21	0.11	0.09		

Figures in the parentheses are ($\sqrt{x + 0.5}$) values DAS-Days after spraying NS- Non Significant DBS- Day before spraying
*Treatment facing only one spraying

Table 4: Effect of different IPM modules on plant damage by shoot webber and capsule borer in sesame during *kharif*, 2017

Treatment	Percentage damage by shoot webber and capsule borer at				
	1 DBS (Flower damage)	52 DAS (Flower damage)	Percentage reduction over control	67 DAS (Capsule damage)	Percentage reduction over control
T_1*	11.46 (19.78)	6.33 (14.56)	48.95	8.20* (16.61)	25.18
T_2*	11.06 (19.41)	10.28 (18.70)	17.09	8.96* (17.41)	18.24
T_3	10.84 (19.22)	10.36 (18.77)	16.45	8.04 (16.47)	26.64
T_4	11.95 (20.22)	6.75 (15.02)	45.56	7.20 (15.54)	34.30
T_5	10.40 (18.81)	10.60 (18.09)	14.51	9.50 (17.90)	13.32
T_6	11.82 (20.09)	6.68 (14.92)	46.12	8.20 (16.58)	25.18
T_7	7.20 (15.56)	5.76 (13.70)	53.54	7.56 (18.28)	31.02
T_8	12.20 (20.42)	12.40 (20.62)		10.96 (19.27)	
SE_m (±)	0.521	0.830		1.004	
C.D.(P=0.05)	1.57	2.51		3.04	

Figures in the parentheses are arc-sine transformed values DAS-Days after sowing NS- Non Significant DBS-Days before spraying
*Treatment facing only one spraying

Table 5: Efficacy of different IPM modules on the incidence of leaf hopper in sesame during *kharif*, 2017

Treatment	Population of leaf hopper/ leaf					Mean	Percentage reduction over control
	First spray			Second spray			
	1 DBS	7 DAS	14 DAS	7 DAS	14 DAS		
T_1*	1.20 (1.30)	0.20 (0.84)	0.50 (1.00)	0.90* (1.18)	0.18* (0.82)	0.44	73.80
T_2*	1.10 (1.26)	0.52 (1.01)	0.85 (1.16)	1.20* (1.30)	0.50* (0.99)	0.76	54.76
T_3	0.70 (1.09)	0.34 (0.91)	0.55 (1.02)	0.73 (1.10)	0.24 (0.86)	0.46	72.61
T_4	1.20 (1.30)	0.00 (0.71)	0.23 (0.85)	0.30 (0.89)	0.12 (0.79)	0.16	90.47
T_5	1.18 (1.29)	0.65 (1.07)	0.75 (1.12)	0.15 (0.81)	0.00 (0.71)	0.38	77.38
T_6	1.30 (1.33)	0.00 (0.71)	0.32 (0.90)	0.06 (0.75)	0.00 (0.71)	0.09	94.64
T_7	0.25 (0.86)	0.00 (0.71)	0.12 (0.79)	0.00 (0.71)	0.00 (0.71)	0.03	98.21
T_8	1.30 (1.34)	1.80 (1.51)	1.94 (1.55)	2.10 (1.61)	0.90 (1.18)	1.68	
SE_m (±)	0.072	0.036	0.055	0.051	0.044		
C.D.(P=0.05)	0.21	0.10	0.16	0.15	NS		

Figures in the parentheses are ($\sqrt{x + 0.5}$) values NS- Non Significant DAS- Days after spraying DBS- Day before spraying
*Treatment facing only one spraying

Table 6: Efficacy of different IPM modules on the incidence of mirid bug in sesame during *kharif,* 2017.

Treatment	Population of mirid bug /plant					Mean	Percentage reduction over control
	First spray			Second spray			
	1 DBS	7 DAS	14 DAS	7 DAS	14 DAS		
T_1^*	0.95 (1.20)	0.10 (0.77)	0.30 (0.89)	0.55* (1.02)	0.30* (0.94)	0.31	85.23
T_2^*	0.65 (1.07)	0.55 (1.02)	0.90 (1.18)	1.30* (1.34)	0.70* (1.09)	0.86	59.04
T_3	0.90 (1.18)	0.70 (1.09)	1.00 (1.22)	0.80 (1.14)	0.40 (0.94)	0.72	65.71
T_4	0.75 (1.12)	0.20 (0.84)	0.25 (0.87)	0.20 (0.83)	0.10 (0.77)	0.18	91.42
T_5	0.80 (1.14)	0.70 (1.09)	0.55 (1.02)	0.20 (0.84)	0.10 (0.77)	0.38	81.90
T_6	0.90 (1.18)	0.25 (0.87)	0.40 (0.95)	0.15 (0.81)	0.00 (0.71)	0.20	90.47
T_7	0.25 (0.86)	0.10 (0.77)	0.05 (0.74)	0.00 (0.71)	0.00 (0.71)	0.03	98.57
T_8	0.90 (1.18)	1.80 (1.51)	2.40 (1.70)	2.60 (1.76)	1.60 (1.44)	2.10	
SE_m (±)	0.039	0.040	0.041	0.045	0.036		
C.D. (P=0.05)	NS	0.12	0.12	0.13	0.10		

Figures in the parentheses are ($\sqrt{x + 0.5}$) values NS- Non Significant DAS- Days after Spraying DBS- Day before Spraying
*Treatment facing only one spraying

The results from table 3 revealed that all the treatments were found significantly superior over the untreated control (T_8). Among the treatments T_7 shows (0.02 larvae/plant) in comparison to other treatments and registering a mean reduction of 98.93% in larval population over control. Treatment T_6 was the next better treatment with respect to lowest larval population (0.35larvae/plant) and registering a mean reduction of 81.28% in larval population over control. In treatment T_2 where foliar spraying of NSKE 5% was only applied, shows highest larval population (1.04 larvae/plant) and registering a mean reduction of 44.38% in larval population over the control. Similar results were obtained by Tripathi%. (2007) [20] who revealed that carina (profenofos 0.05), Rocket (Profenofos + cypermethrin) 0.05% showed minimum larval count per plant (1.33 to 1.66) after 7th day of spraying.

It can also be noticed from the results, that the treatments T_4 and T_5 in which foliar spraying of profenofos 0.1% and NSKE 5% applied alternatively were found effective in lowering the pest population (0.54 larvae/plant and 0.68 larvae/plant) and registering a mean reduction of 71.12% and 63.63% in larval population over the control respectively. Our results are in conformity with the following findings, Misra (2003) [21] reported that all the insecticides significantly reduced the larval population up to 14th DAS. The reduction in larval population was 90% at 1st day after spraying and 44.8% to 52.5% at 14th days after spraying. Panday%. (2017) [22] also reported that seed treatment with imidacloprid plus foliar spray of profenofos recorded lowest larval population (0.15 larvae per plant) and showed a highest reduction in mean larval population (93.03%). Afzal%. (2002) [23] reported that curacron 500 EC (Profenofos) applied @ 1500 ml/ha was effectively reduced the population of leaf webber and pod borer.This result were also corroborated with our results.

The data from the table 4 revealed one day before spraying (1 DBS) the highest flower (12.20%) damage was recorded from the untreated control plot while the lowest flower damage (7.20%) was recorded from the maximum protection treatment (T_7).

At both flowering and capsule stages, all the treatment combinations (seed treatment + intercropping + yellow sticky trap + foliar spray of insecticides) were found significantly superior over the control. At 7 days after first spraying, among the treatment combinations, superiority of treatment T_7 was envisaged with record of lowest flower (5.76%) damage in comparison to other treatments and registering a mean reduction of 53.54% flower damage over the control. At capsule stage (at 7 days after second spraying),among the treatment combinations the treatment T_4 was found superior to others in respect to (7.20%) lowest capsule damage and registering a mean reduction of 34.30% capsule damage over the control. Control plot exhibited maximum damage at all the stages of crop growth and recorded 12.40% and 10.96% flower and capsule damage, respectively. It can be noticed from the results, the treatment T_3 in which two foliar sprayings of NSKE 5% were applied found equally effective as chemical insecticides in respect to lowest capsule (8.04%) damage and reduce the percent capsule 26.64% damage over the control. The present findings corroborates with the results of Misra (2003) [21] who studied the efficacy of Rocket (4% cypermethrin + 40% profenofos) at 440 g a.i./ha, Nurelle D (50% chlorpyrifos + 5% cypermethrin) at 550 g a.i./ha, Koranda(25% acephate + 3% fenvalerate) at 560 g a.i./ha, Spark (1% deltamethrin +35% triazophos) at 360 g a.i./ha, Virat (3% cypermethrin + 20% quinalphos) at 230 g a.i./ha, Nagata (40% ethion + 5% cypermethrin) at 450 g a.i./ha against *A. catalaunalis* on sesame. They reported that all the insecticides were effective in the reduction of infestation on twigs, flowers and pods. Rocket, Nurelle D, Koranda, Virat and Nagata were equally effective in reducing infestation on twigs up to 60%.Approximately 60% reduction in flower infestation was found with Nagata. The lowest pod damage (5.5-6.2%) was observed in plants treated with Nagata and Koranda. On an average, pod damage was reduced by 65% with Nagata and Koranda. Our results also corroborates with the results of Panday%.(2017) [22] noticed that (seed treatment with imidacloprid + foliar spray of profenophos) envisaged a record of lowest flower (0.96%) and capsule damage (1.44%) with a mean reduction of 93.34% in flower infestation and 90.59% in capsule damage over control.

The data presented in table 5 exhibited that post spraying observations showed that all the treatments had their effect on reducing the population of leaf hopper per leaf and the highest mean population recorded from the untreated control plot T_8 (1.68 leaf hopper/leaf) followed by treatment T_2 (0.76 leaf hopper per leaf) and the other treatments (T_3, T_1 and T_5) with 0.46, 0.44, and 0.38 leaf hopper per leaf respectively.

The lowest mean population of leaf hopper (0.03 leaf hopper per leaf) in comparison to other treatments and registering a mean reduction of 98.21% was found in treatment T_7 population of leaf hopper over untreated control. Treatment T_6 was the next better treatment in respect to lowest population (0.09 leaf hopper/leaf) and showing a mean reduction of 94.64% over the control.

The results in treatment T_2 and T_3 in which NSKE 5% were applied once and twice found effective as insecticides in respect to lowest population of leaf hopper (0.76 and 0.46 leaf hopper per leaf respectively) and registering a mean reduction of 54.76% and 72.61% in population of leaf hopper over the control. Our results are in conformity with the results of Ahirwar%. (2010) [24]. They reported that the incidence of both nymph and adults of leaf hopper decreased significantly by natural and indigeneous products like Neem oil, Neem seed kernel extract, neem leaf extract, garlic bud + red pepper extract, cow urine and cow butter milk as compared to control.

The data presented in table 6 revealed that post spraying observations showed that all the treatments had their impact on reducing the population of mirid bug per plant. The highest mean population was recorded from the control plot (2.10 mirid bug per plant) followed by treatment T_2 (0.86 mirid bug per plant) and the treatments T_3, T_5 & T_1 with 0.72, 0.38 and 0.31 mirid bug per plant respectively.

Among the treatment combinations, superiority of T_7 module was envisaged with record of lowest mean population of mirid bug (0.03 miridbug/plant) in comparison to other treatments and registering a mean reduction of 98.57% in population of mirid bug over the control. Module T_6 was the next better treatment with respect to lowest population (0.20 mirid bug/plant) and registering a mean reduction of 90.47% in population of mirid bug over the control.

In treatments T_2 & T_3 where NSKE 5% were applied once and twice found effective as chemical insecticides with respect to lowest pest population of mirid bug (0.86 and 0.72 mirid bug/plant respectively) and registering a mean reduction of 59.04 and 65.71% in the population of mirid bug over the control.

5. Conclusion

In case of single foliar spraying of insecticides, the foliar spraying of profenofos 50 EC 0.1% was found most effective in reducing the insect pest population than by using botanical insecticide like NSKE 5% in controlling shoot webber and capsule borer**,** leaf hopper and mirid bug. For the management of leaf roller/capsule borer, leaf hopper, and mirid bug, the maximum protection treatment T_7 was found most effective followed by the treatment T_6.

In respect to percent, flower and capsule damage by *Antigastra*, the treatment T_7 was found most effective in reducing the flower damage by (53.54%) over control. In case of capsule damage treatment T_4 was found best in (34.30%) reduction over control.

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