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Saritha R
Principal Scientist, Regional Agricultural Research Station, Anakapalle, Andhra Pradesh, India

Sujatha V
Scientist, Agricultural Research Station, Peddapuram, East Godavari, Andhra Pradesh, India

Haseena SK
Scientist, Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh, India

Sirisha ABM
Scientist, Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh, India

Corresponding Author:
Saritha R
Principal Scientist, Regional Agricultural Research Station, Anakapalle, Andhra Pradesh, India

Bio-efficacy of insecticides for management of sucking pests in sesame

Saritha R, Sujatha V, Haseena SK and Sirisha ABM

Abstract
An experiment was laid out to evaluate the bio-efficacy of various insecticides against sucking pests in sesame, at Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh, during *kharif* and *rabi*-summer, 2018. All the insecticide interventions were significantly superior to check in reducing the population of sucking pests. Seed treatment with imidacloprid (7.5 grams per kg of seed) was found efficacious till 30 days of sowing and registered least population of thrips (4.83), leaf hoppers (1.66) and aphids (1.03) per plant. Among different insecticides tested, persistent and significant reduction in pest incidence was noticed when the imidacloprid 17.8 SL (0.25 ml/l) and diafenthiuron 50WP (1.25g/l) applied as foliar spray at 30 and 60 DAS. Application of midacloprid 17.8 SL (0.25 ml per liter) foliar spray was effective in controlling thrips (0.43), leaf hoppers (0.43) and aphids (0.43) population per plant which was on par with diafenthiuron 50WP (1.25g/l) which recorded thrips (0.60), leaf hoppers (0.53) and aphids (0.43) per plant at 60 DAS. These findings were further augmented with higher yield from imadacloprid 17.8 SL (0.25 ml/l) foliar spray, which achieved the 81.08% higher yield with benefit-cost ratio of 3.25 followed by diafenthiuron 50WP (1.25g/l) which recorded 65.54% increase in yield.

Keywords: sesame, sucking pests, insecticidal management, benefit-cost ratio

Introduction
Sesame (*Sesamum indicum* L.) is an annual crop belonging to the family *Pedaliaceae* and is one of the world's oldest oil seed grown for its oil-rich seeds which have diverse uses. Due to the high oil content (38-54 percent), protein (18-25 percent), calcium, phosphorous and oxalic acid (Prasad *et al*., 2002) [1]. India is the world's leading producer of sesame with largest cultivation area. The annual sesame cultivation area in India is about 1.79 mha (45% of the world cultivation area) and the total production is 8.02 lakh tones with the productivity of 448 kg/ha. Within India sesame is cultivated in the states of Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh, Maharashtra, Gujarat, Tamil Nadu and Orissa and Karnataka. Andhra Pradesh along with West Bengal, Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat, and Telangana contributes to more than 85 percent production. The acerage of sesame in Andhra Pradesh is 0.61 lakh hectares with production of 0.2 lakh tonnes and productivity of 321 kg/ha (Anonymous) [2]. The major reasons for low productivity of sesame are its rainfed cultivation in marginal and sub marginal lands, poor management of pests and diseases
Apart from input starved conditions, insect pests are one of the major factor for lower yields, especially sucking pests that harm the crop directly by sap sucking and indirectly by virus and mycoplasma transmission (Ahirwar *et al*, 2010) [3]. Leaf hoppers and white flies act as vectors for incidence of phyllody and leaf curl disease in sesame (Ahirwar *et al*, 2010) [3]. Conventional insecticides, mostly neuro-active chemicals have been utilized for management of insect pests, however, their injudicious use has led to problems like pesticide resistance, residue in products, pest resurgence and environmental safety. In view of undesirable effects of unilateral reliance on traditional chemicals, new insecticides from new groups with different modes of action need to be evaluated. Owing to high target specificity, low risk to non-target organisms and environmental safety, the newer insecticides play a greater role in in integrated pest management. In this context, it was felt imperative to evaluate the bio-efficacy of certain new insecticides in comparison to the present recommendation of monocrotophos to suppress the sucking pests. The economic feasibility of these new insecticides in terms of low cost and higher yields is also studied.

Materials and Methods

An experimental study was carried out at Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh during *kharif* and *rabi*-summer 2017-18 for determining the bio-efficacy of certain insecticides against sucking pests and their economic feasibility. The RBD (Randomized Block Design) was employed to design the experiments with nine treatments including control as detailed in Table 1with three replications and individual plot size of 6.0 m X 3.6 m. The variety YLM-66 was sown adopting the recommended package of practices. The seed rate of 6 kg/ha was used and fertilizers applied were FYM @ 10 t/ha and NPK as 40:20:20 with N in two equal splits as basal and at 30 days after sowing (DAS). The *kharif* crop has been raised as rainfed while three life-saving irrigations have been provided during the *rabi*-summer. Seeds of first treatment were treated were treated with 70WS imidacloprid (7.5 g/kg seed). Two foliar sprays were administered at 30 and 60 DAS in all the remaining treatments except for total control (unsprayed check). Two checks were applied in addition to five new insecticides, one was chemical check (foliar spray of monocrotophos 36SL @1.6 ml / l at 30 and 60 DAS) and the other was unsprayed check. The insecticides were applied in the early hours of the day with a battery-operated sprayer.

Table 1: Details of different treatments imposed

Treatment no.	Treatment particulars
T_1	Imidacloprid 70WS (7.5 g/kg): seed treatment
T_2	Imidacloprid 17.8 SL (0.25 ml/l): foliar spray
T_3	Fipronil 5SC (2ml/l): foliar spray
T_4	Cyatraniliprole 10OD (1ml/l): foliar spray
T_5	Diafenthiuron 50WP (1.25g/l): foliar spray
T_6	Thiacloprid 240SC (0.25 ml/l): foliar spray
T_7	Spinosad 45EC (0.3 ml/l): foliar spray
T_8	Monocrotophos 36SL (1.6ml/l): foliar spray (check)
T_9	Unsprayed (check)

Population of Sesame Sucking Pests

Population data for thrips, leaf hoppers, aphids in the sesame crop were recorded at three plant canopy levels (lower, middle and top). From each plot, 10 plants were selected randomly and data on sucking pest population was collected and calculated the mean population. Observations were recorded one day before the insecticide spray to record the pest load (pre-treatment) and the third day after the insecticide spray to observe the efficacy of insecticide in pest reduction (post-treatment).

Crop Yield

Sesame crop yield data was collected from each plot for different treatments as well as the total estimated yield per hectare was computed according to the following formula (Bondre *et al.*, 2017). [4]

Yield, kg/ha = Factor × Seed yield (per plot)

Where,

$$\text{Factor} = \frac{10000}{\text{Net plot size}}, \text{m}^2$$

Benefit-cost Ratio

Benefit cost ratio (B: C ratio) was calculated with respect to different treatments imposed for managing sucking pests according to following formula (Bondre *et al.*, 2017) [4].

$$\text{B: C ratio} = \frac{\text{Net Profit}}{\text{Cost of Treatment}}$$

Statistical analysis

Population data of sucking pests under different treatments have been subjected to $\sqrt{n+0.5}$ transformation. The recorded population data was subjected to analysis of variance followed by Panse *et al.*, 1984 [5]. Similarly, data on crop yield was also statistically analyzed.

Results and Discussion

During the *kharif*, *rabi*-summer seasons, the bio-efficiency of certain insecticide treatments for the managing sucking pests such as thrips, leaf hoppers and aphids in sesame was investigated. The results were analysed, compared and reported as given under.

Bio efficacy of various insecticides against thrips in sesame

The bio-efficacy of various insecticide treatments on thrip incidence at 30 & 60 DAS has been studied and the findings are summarized in Table 2. It can be found that in treatment T_1 (seed treatment with imidacloprid 70WS @7.5 g/ kg seed) the initial incidence of thrips (4.83) was significantly lower compared to all other treatments. The pest load was uniform and statistically on par with each other in all other treatment including control at 30 DAS. Post-treatment data at 30 DAS showed that the population of thrips per plant ranged from 1.06 to 4.66 and insecticidal treatments were found to be significantly superior than unsprayed control (7.30 per plant). Among the treatments, T_5 i.e., foliar spray of diafenthiuron50WP (1.25g/l) recorded the lowest thrip population (1.06/plant) followed by T_2, T_7, T_6 and T_4 with statistically no significant difference. Further, at 60 DAS, it was observed that though population build up was there in all treatments, the buildup of thrips was slow in T_2, T_3, T_5 and T_7(2.33 to 3.93 per plant). It was clearly indicated that seed treatment with imidacloprid 70WS @7.5 g / kg seed was successful in reducing the pest load until 30 DAS only. After imposition of treatments, thrips population reduced significantly in all the treatments compared to unsprayed check and seed treatment. The lowest population of thrips (0.43/plant) was reported in T_2 (imidacloprid 17.8 SL @ 0.25 ml/l foliar spray) followed by T_5 (diafenthiuron 50WP @1.25 g/l foliar spray) reported 0.60 thrips per plant. Results revealed that T_2 (imidacloprid foliar spray 17.8S(0.25 ml/l)) treatment was found to be effective in minimizing the thrips population in sesame. These results are in accordance with the results reported by Bandre *et al.*, 2017[4] and Pandy *et al.*, 2018 [6].

Table 2: Bio-efficacy of insecticides against thrips in Sesame

Treatment	Thrips observed (population per plant)			
	30DAS		60 DAS	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
T1	4.83(2.41)	4.66(2.37)	6.16(2.67)	6.33(2.70)
T2	7.66(2.94)	1.20(1.47)	2.33(1.82)	0.43(1.16)
T3	7.30(2.87)	2.13(1.76)	3.86(2.20)	1.16(1.46)
T4	7.26(2.87)	2.10(1.75)	5.33(2.51)	2.40(1.84)
T5	6.80(2.79)	1.06(1.43)	3.93(2.21)	0.60(1.26)
T6	7.40(2.89)	1.56(1.59)	5.16(2.48)	2.00(1.73)
T7	7.20(2.86)	1.30(1.51)	4.60(2.36)	1.46(1.56)
T8 (chemical check)	7.36(2.89)	2.56(1.88)	5.53(2.55)	2.20(1.78)
T9(unsprayed check)	6.93(2.81)	7.30(2.88)	5.80(2.60)	6.33(2.70)
C.D (P=0.05)	0.22	0.28	0.19	0.20
CV	8.6	8.7	8.4	6.7

Bio efficacy of various insecticides against leaf hoppers in Sesame

The effect of various insecticidal treatments on leafhopper incidence at 30 and 60 DAS has been studied and the findings are stated in Table 3. It can be observed that the initial incidence of leaf hoppers (1.66) was significantly lower in the treatment T_1 (seed treatment with imidacloprid 70WS @7.5 g/kg seed) compared to all other treatments. The pest load was uniform and statistically on par with each other in all other treatment including control at 30 DAS. Post-treatment results at 30 DAS showed that the population of leaf hoppers per plant ranged from 0.46 to 1.83 and insecticide treatments were found to be significantly higher than unsprayed control (3.80 per plant). Among the treatments, the lowest leaf hoppers population (0.46/plant) observed in T_2 (imidacloprid spray 17.8 SL @ 0.25 ml / l), followed by T_5, T_3 and T_7 with statistically no significant difference. Further, at 60 DAS, it was observed that though population build up was uniform in all treatments (2.83 to 4.73 per plant) except for unsprayed check (5.70 per plant). After treatment was imposed, the population of leaf hoppers decreased considerably in all insecticide treatments compared to unsprayed check and seed treatment. The lowest population of leaf hoppers (0.43/plant) was observed in T_2 (imidacloprid foliar spray 17.8 SL @ 0.25 ml/l) followed by T_5 (Diaphenthiuron 50 WP foliar spray@1.25 g/l) registering 0.53 leaf hoppers per plant. Results revealed that the treatment T_2 (foliar spray of imidacloprid 17.8 SL (0.25 ml/l)) found effective in suppressing the leaf hoppers population in sesame, effectively. These results are in consensus with the results of Mote *et al.*, 1995[7], Patil *et al.*, 2003[8] and Zhang *et al.*, 2011[9].

Table 3: Bio-efficacy of insecticides against leaf hoppers in Sesame

Treatment	Leafhoppers observed (population per plant)			
	30DAS		60 DAS	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
T1	1.66(1.62)	1.46(1.56)	3.30(2.07)	3.33(2.07)
T2	3.46(2.11)	0.46(1.22)	2.83(1.95)	0.43(1.19)
T3	3.60(2.13)	1.06(1.43)	4.73(2.38)	1.46(1.56)
T4	4.00(2.23)	1.83(1.67)	4.33(2.30)	1.93(1.70)
T5	4.00(2.23)	0.60(1.31)	3.80(2.18)	0.53(1.23)
T6	4.26(2.29)	1.60(1.60)	4.46(2.33)	1.80(1.67)
T7	3.80(2.18)	1.20(1.47)	4.50(2.34)	1.43(1.55)
T8 (chemical check)	3.93(2.21)	1.56(1.59)	3.06(2.01)	1.23(1.49)
T9(unsprayed check)	3.90(2.21)	3.80(2.18)	5.70(2.58)	5.73(2.59)
C.D (P=0.05)	0.27	0.28	0.20	0.26
CV	7.2	10.5	8.3	9.1

Bio-efficacy of various insecticides against aphids in Sesame

Bio-efficacy of various insecticidal treatments for suppressing aphids on sesame was studied and the results are reported in Table 4. It can be observed that the initial incidence of aphids (1.03) was significantly lower in T_1 treatment (imidacloprid 70WS seed treatment @7.5 g/kg seed) compared to all other treatments. In all other treatments, including control, the pest load was uniform (2.26-2.80 per plant) and statistically on par with each other at 30 DAS. Post-treatment data after first spray at 30 DAS showed that the aphid population per plant ranged from 0.46 to 0.83 and insecticide treatments (except T_4 and T_8) were found to be significantly superior than unsprayed check (2.83 per plant). Among the treatments, T_2 and T_5 *i.e.*, imidacloprid 17.8 SL foliar spray @ 0.25 ml/l and diafenthiuron 50WP (@1.25g/l observed lowest population of aphids (0.46 /plant) followed by T_7, T_6, and T_4 with statistically no significant difference. Further, at 60 DAS, it was observed that the population build up was statistically uniform in all the treatments (2.90 to 3.66 per plant) except for the chemical check (4.53 per plant) and unsprayed check (5.20 per plant). After spraying, aphids population reduced significantly in all the treatments with foliar sprays compared to unsprayed check and seed treatment. Lowest aphids population (0.43/plant) was observed in the treatment T_2 (foliar spray of imidacloprid 17.8 SL @ 0.25 ml/l) and T_5 (foliar spray of diafenthiuron 50WP @1.25 g/l). Results revealed that the treatment T_2 (Foliar spray of imidacloprid 17.8 SL (0.25 ml/l)) found effective in suppressing the aphids population in sesame, effectively. Seed treatment with imidacloprid 70WS @7.5 g / kg seed was clearly indicated to have been successful in reducing the pest load to only 30

DAS. These results are in consistence with Bandre *et al.*, 2017 [4] and Pandy *et al.*, 2018 [6].

The comprehensive analysis of various treatments for the management of major sucking pests, such as thrips, leafhopper and aphids, showed that imidacloprid (T_1) seed treatment successfully protected the crop from sucking pests up to one month from sowing. At 30 days after sowing, the treatment T_2 reported least thrips population(4.83 per plant), leaf hoppers(1.66 per plant) and aphids (1.03 per plant), whereas in all other treatments, the population ranged between 6.80 to 7.66, 3.46 to 4.26 and 2.26 to 2.80 per plant for thrips, leaf hoppers and aphids, respectively. The pest populations later increased in this treatment and were on par with unsprayed check. The imidacloprid 17.8 SL foliar spray @ 0.25 ml / l (T_2) was found to be most effective and reliable in minimizing the population of sesame-sucking pests up to crop maturity. This results are in agreement with the findings of Panday *et al.*, (2018) [6] and Zhang *et al.*, 2011[9].

Table 4: Bio-efficacy of insecticides against aphids in Sesame

Treatment	Aphids observed (population per plant)			
	30DAS		60 DAS	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
T1	1.03(1.42)	1.40(1.53)	3.66(2.15)	4.26(2.29)
T2	2.46(1.86)	0.46(1.20)	2.90(1.97)	0.43(1.19)
T3	2.43(1.85)	0.73(1.31)	3.33(2.11)	1.03(1.42)
T4	2.73(1.92)	1.13(1.46)	2.96(1.98)	1.40(1.54)
T5	2.70(1.92)	0.46(1.21)	3.16(2.03)	0.43(1.19)
T6	2.40(1.84)	0.53(1.23)	3.26(2.06)	1.13(1.45)
T7	2.80(1.94)	0.83(1.35)	3.43(2.09)	1.13(1.46)
T8 (chemical check)	2.26(1.80)	0.80(1.34)	4.53(2.35)	1.80(1.67)
T9 (unsprayed check)	2.76(1.93)	2.83(1.96)	5.20(2.48)	5.90(2.62)
C.D(P=0.05)	0.25	0.18	0.19	0.20
CV	7.7	7.5	8.4	7.2

* Numbers in parenthesis are transformed values of the square root

The impact of treatments on Sesame's yield and economics

Impact of insecticidal treatments on the management of the sucking pests and its influence on the profit and yield of crop described in Table 5.The effect of all foliar treatments on the yield of sesame was shown to be substantially higher than that of unsprayed test (205,6 kg/ha) and seed treatment (T_1) (244,4 kg/ha). Among the treatments, highest crop yield (372.2 kg/ha) were obtained in treatments *viz*., T_2 (imidacloprid 17.8 SL foliar spray @ 0.25 ml/l) followed by T_5 (diafenthiuron 50WP foliar spray @ 1.25g/l) which recorded 340.3 kg/ha. The rise in yield over the control was 81.08 and 65.04 percent in these treatments. These were followed by T_7 (309.7 kg/ha), T_6 (298.6 kg/ha), T_3 (272.2), T_4 (250.0 kg/ha) and T_8 (247.2). Results are in accordance with the results of Mishra *et al*., 2003[12] Chopade *et al*, 2018[13].

Economic feasibility studies of various insecticidal treatments to combat sucking pests on sesame crops showed that, due to lower input chemicals prices, the cultivation costs were low in the treatments T_1 (Rs.12444.00), T_2 (Rs.12615.00) and T_6 (Rs.13080.00). Due to different treatment applications, the gross return from sesame seed yield ranged from Rs.27194.00 to Rs.40944.00 per hectare against Rs.22611.00 per hectare in unsprayed check. However, the benefit of increased seed yield (Rs.40944/ha) and net profit (Rs. 28329/ha) over control was highest in T_2 followed by T_5 (Rs.21818/ha) treatment. Owing to lower input cost and higher gross returns, the benefit-cost ratio was higher (3.25) with the treatment T_2. Though the treatment T_5 has given the higher gross returns (Rs.37431.00) as compared with T_6 (Rs.32847.00), the higher input cost in T_5 (Rs.15613.00) over T_6 (Rs.13080.00) resulted higher benefit cost ratio in T_6 (2.51) against T_5 (2.40). These results are in conformity with the results of Misra, 2003[14] and Bharpoda *et al*, 2014[15]. Though all the treatments proved economically feasible (BC ration greater than 1), the treatments T_2, T_6 and T_5 proved to be lucrative.

Table 5: Effect of treatments on sesame yield and economics

Treatment	Sesame yield (kg/ha)	Yield increase Over Control (%)	Gross Profit (Rs/ha)	Cultivation cost (Rs/ha)	Net Profit (Rs/ha)	Benefit-Cost Ratio
T1	244.4	18.92	26889	12444	14445	2.16
T2	372.2	81.08	40944	12615	28329	3.25
T3	272.2	32.43	29944	14380	15564	2.08
T4	250.0	21.62	27500	20800	6700	1.32
T5	340.3	65.54	37431	15613	21818	2.40
T6	298.6	45.27	32847	13080	19767	2.51
T7	309.7	50.68	34069	14700	19369	2.32
T8	247.2	20.27	27194	13180	14014	2.06
T9	205.6		22611	12000	10611	1.88
C.D (P=0.05)	16.5					
CV	7.7					

Conclusion

The comprehensive analysis of various treatments for the mitigation of major sucking pests, such as thrips, leafhopper and aphids, showed that seed treatment with imidacloprid (T_1) efficiently protected the crop from sucking pests up to a month since sowing. At 30 days after sowing, the treatment recorded least population of thrips, leaf hoppers and aphids, whereas in all other treatments, the populations were high and

on par with each other including unsprayed check. However, the pest populations slowly increased in this treatment and were on par with unsprayed check at later stages of crop. The foliar spray with imidacloprid 17.8 SL @ 0.25 ml/l (T_2) was found most effective and consistent in suppressing the population of sucking pests on sesame till crop maturity. The result was reinforced by accomplishment of highest crop yields (804 kg/ha) and higher benefit-cost ratio (3.25).

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