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Efficacy of newer insecticides against sucking pest complex in summer sesame

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Abstract
Experiment was undertaken during summer 2018 at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh to determine the efficacy of newer insecticides against sucking pest complex in summer sesame. The results showed that treatment spinosad 45 SC @ 0.0135 per cent and fipronil 5 SC @ 0.01 per cent were found most effective for control of thrips. Treatment dinetofuran 20 SG @ 0.008 per cent, acetamiprid 20 SP @ 0.008 per cent and imidacloprid 17.8 SL @ 0.005 per cent were found most superior against jassid while the treatment diafenthiuron 50 WP @ 0.05 per cent and spiromesifen 240 SC @ 0.24 per cent were found effective in management of whitefly. The highest yield 900 kg /ha obtained from the plot treated with dinetofuran 20 SG @ 0.008 per cent which was statistically at par with fipronil 5 SC @ 0.01 per cent, diafenthiuron 50 WP @ 0.05 per cent and flonicamid 50 WG @ 0.015 per cent with 876.39 kg /ha, 861.08 kg /ha and 840.65 kg /ha respectively. Maximum yield loss could be avoided with dinetofuran 20 SG @ 0.008 per cent (90.53 %), fipronil 5 SC @ 0.01 per cent (85.53 %), diafenthiuron 50 WP @ 0.05 per cent (82.29 %) and flonicamid 50 WG @ 0.015 per cent (77.96 %).

Keywords: Sesame, insecticides, thrips, jassid, whitefly

1. Introduction
Sesame (*Sesamum indicum* L.) is an important and very ancient oilseed crop in India next to groundnut and rapeseed-mustard. Sesame is rich in oil (46 to 54 %) and protein (12 to 20 %). The rest of the seeds are used in confectionery and in religious ceremonies. Nearly 73 per cent of the oil is used for edible purpose, 8.3 per cent for hydrogenation and 4.2 per cent for industrial purpose in the manufacture of paints, pharmaceuticals and insecticides [1]. It is called as the "Queen of oilseeds" because of its excellent qualities of the seed, oil and meal. Its oil is an excellent vegetable oil because of its high contents of antioxidants such as sesamin, sesamol and sesamolin and its fatty acid composition [15]. In India, this crop is grown in area of about 15.66 lakh ha area with the production of about 7.43 lakh tones and productivity 478 kg per ha [4]. It is the fourth important oilseed crop in Indian agriculture after groundnut, rape seed and mustard. In Gujarat, sesame is cultivated in an area of 0.78 lakh ha with a production of 0.48 lakh tons and productivity of 613 kg per ha [5]. This crop is generally cultivated as sole or mixed crop during *kharif*, semi-*rabi* and summer season. The production and productivity of sesame is greatly affected by biotic and abiotic factors. Among them, insect pests are one of the important limiting factors affecting the production of sesame both in quality and quantity [8&1]. The pests attack tolls a heavy loss (25 to 90%) in seed yield [2]. One of the major constraints in the production of sesame is damage caused by the insect pests, particularly the sucking pests viz., Jassid *Orosius albicinctus* (Dist.), mirid bug *Nesidiocoris tenuis* (Rent.) and whitefly *Bemisia tabaci* (Genn.), which sucks the cell sap from leaves, flower and pods [1]. Thrips and aphid also cause serious damage on sesame during summer cultivation. Jassid is also vector of phyllody disease of sesame. Sesame attacked by many sucking pests. Hence, single commonly used pesticides not provide effective management of these pests. Therefore, in sesame crop, it is prime need to find out such pesticides which was effectively control the various sucking pest attacking this crop. So these insecticides which were used for the control of sesame sucking pest were tested under field condition for management.

2. Materials and Methods
In order to study the efficacy of different insecticides against sucking pest, the experiment was summer 2018 at the Instructional Farm, Department of Agronomy, College of Agriculture,

Junagadh Agricultural University, Junagadh. Sesame variety G.Til-3 was sown at a spacing of 30 cm x 10 cm in February, 2018. All the recommended agronomical practices were adopted to grow the crop. Spraying was done using knapsack sprayer of eleven different insecticides viz., imidacloprid 17.8 SL @0.005%, flonicamid 50 WG @0.015%, spiromesifen 240 SC @0.24%, acetamiprid 20 SP @0.008%, spinosad 45 SC @0.0135%, dinotefuran 20 SG @0.008%, fenazaquin 10 EC @0.02%, fipronil 5 SC @0.01%, diafenthiuron 50 WP @0.05%, ethion 50 EC @0.1%, thiamethoxam 25 WG @0.01% for the control of sucking pest. First spray was carried out at the time of pest infestation and second spray was carried out after 15 days of first spray. A pre-treatment counts a day before and post treatment counts at 1, 3, 5 and 7 days after application of treatment was recorded. For recording observation, five plants were selected from net plot area of each plot and tagged then observation on number of thrips, jassid and whitefly were recorded from upper, middle and bottom leaves of each plant. With a view to ascertain the effect of different insecticides on the basis of yield, harvested seed of sesame was weighed separately from each net plot. The yield was converted on hectare basis. The percentage increase in yield over control was calculated by using following formula.

$$\text{Yield increased (Per cent)} = 100 \times \frac{T - C}{C}$$

Where,
T = Yield from treated plot (kg /ha)
C = Yield from untreated plot (kg /ha)

Statistical analysis
The data was subjected to statistical analysis for drawing conclusion. Statistical analysis was carried out using ANOVA technique given by Panse and Sukhatme (1985).

3. Results and Discussion
The observations on insect-pests were recorded 24 hours before spraying and 1, 3, 5 and 7 days after spraying. The results of the experiment are discussed as under.

3.1 Thrips (*Thrips tabaci*)
3.1.1 First spray
The data on mean thrips count of pooled over periods presented in Table 1 indicated that all the treatments were significantly superior over the control. Spinosad 45 SC @ 0.0135 per cent emerged as significantly superior which gave 1.09 thrips per three leaves though it did not significantly differ with fipronil 5 SC @ 0.01 per cent (1.26 /3 leaves). The next best effective treatments were thiamethoxam 25 WG @ 0.01 per cent (1.99 /3 leaves), acetamiprid 20 SP @ 0.008 per cent (2.10 /3 leaves), dinetofuran 20 SG @ 0.008 per cent (2.38 /3 leaves), imidacloprid 17.8 SL @ 0.005 per cent (3.10 /3 leaves), diafenthiuron 50 WP @ 0.05 per cent (3.29 /3 leaves) and flonicamid 50 WG @ 0.015 per cent (3.44 /3 leaves) found moderate in their effectiveness. Treatment fenazaquin 10 EC @ 0.02 per cent found least effective and recorded 4.86 thrips per three leaves though it found statistically at par with ethion 50 EC @ 0.1 per cent (4.75 /3 leaves) and spiromesifen 240 SC @ 0.24 per cent (4.56 /3 leaves).

3.1.2 Second spray
It is evident from the pooled data presented in Table 1 indicated that all the insecticidal treatments played significant role in minimizing the thrips population. Spinosad 45 SC @ 0.0135 per cent emerged as significantly superior which gave 0.91 thrips per three leaves though it did not significantly differ with fipronil 5 SC @ 0.01 per cent (1.02 /3 leaves). The next best effective treatments were thiamethoxam 25 WG @ 0.01 per cent (1.63 /3 leaves), acetamiprid 20 SP @ 0.008 per cent (1.87 /3 leaves), dinetofuran 20 SG @ 0.008 per cent (1.97 /3 leaves), imidacloprid 17.8 SL @ 0.005 per cent (2.60 /3 leaves), diafenthiuron 50 WP @ 0.05 per cent (2.77 /3 leaves) and flonicamid 50 WG @ 0.015 per cent (2.91 /3 leaves). Treatment fenazaquin 10 EC @ 0.02 per cent found least effective and recorded 4.15 thrips per three leaves though it did not differ significantly with ethion 50 EC @ 0.1 per cent (3.99 /3 leaves) and spiromesifen 240 SC @ 0.24 per cent (3.80 /3 leaves).
Spinosad 45 SC @ 187.5 ml /ha and fipronil 5 SC @ 1000 ml /ha proved to be best treatments showing maximum reduction of thrips population [6]. Spinosad 45 SC @73 g. a.i. ha^{-1} and fipronil 5 SC @ 50 g. a.i. ha^{-1} were the most superior and persistent treatments against management of thrips as compared to other evaluated insecticides [16]. Thus, the present findings are more or less same in confirmation with the reports of earlier workers.

3.2 Jassid (*Orosius albicinctus*)
3.2.1 First spray
The data on mean number of jassid count of pooled over periods presented in Table 2 indicated that all the treatments were significantly superior over the control. Treatment dinetofuran 20 SG @ 0.008 per cent emerged as significantly superior which gave 0.83 jassid per three leaves however it was found at par with acetamiprid 20 SP @ 0.008 per cent (0.95 /3 leaves) and imidacloprid 17.8 SL @ 0.005 per cent (1.01 /3 leaves). The next best effective treatments were thiamethoxam 25 WG @ 0.01 per cent (1.57 /3 leaves), diafenthiuron 50 WP @ 0.05 per cent (1.66 /3 leaves), flonicamid 50 WG @ 0.015 per cent (1.86 /3 leaves) and fipronil 5 SC @ 0.01 per cent (2.01 /3 leaves) which found moderate in their effectiveness. Treatment spinosad 45 SC @ 0.0135 per cent found least effective and recorded 3.33 jassid per three leaves though it did not differ significantly with fenazaquin 10 EC @ 0.02 per cent (3.22 /3 leaves), ethion 50 EC @ 0.1 per cent (3.05 /3 leaves) and spiromesifen 240 SC @ 0.24 per cent (2.94 /3 leaves).

3.2.2 Second spray
It can be seen from the pooled data presented in Table 2 showed that all the treatments were significantly superior over control. Treatment dinetofuran 20 SG @ 0.008 per cent found significantly superior with 1.09 jassid per three leaves though it did not significantly differ with acetamiprid 20 SP @ 0.008 per cent (1.17 /3 leaves) and imidacloprid 17.8 SL @ 0.005 per cent (1.23 /3 leaves). The next best effective treatments were thiamethoxam 25 WG @ 0.01 per cent (2.01 /3 leaves), diafenthiuron 50 WP @ 0.05 per cent (2.06 /3 leaves), flonicamid 50 WG @ 0.015 per cent (2.25 /3 leaves) and fipronil 5 SC @ 0.01 per cent (2.41/3 leaves). Treatment spinosad 45 SC @ 0.0135 per cent found least effective and recorded 4.02 jassid per three leaves though it was at par with fenazaquin 10 EC @ 0.02 per cent (3.83 /3 leaves), ethion 0.05 per cent (3.68 /3 leaves) and spiromesifen 240 SC @

0.24 per cent (3.46 /3 leaves).

Earlier, imidacloprid registered highest mortality of jassid followed by diafenthiuron, acetamiprid and thiamethoxam [12]. Treatment with dinotefuran 20 SG @0.008 per cent and 0.006 per cent, fipronil 5 SC @0.015 per cent, acetamiprid 20 SP @0.004 per cent and flonicamid 50 WG @ 0.02 per cent successfully checked the incidence of jassid [9]. Treatment of dinotefuran 0.01 per cent found to be the most effective for jassid which was followed by the imidacloprid 0.006 per cent [7]. So, the results obtained in the present investigation are said to be in agreement with those of earlier reports.

3.3 Whitefly (*Bemisia tabaci*)

3.3.1 First spray

The data on mean whitefly count of pooled over periods presented in Table 3 indicated that all the treatments were significantly superior over untreated control. Treatment diafenthiuron 50 WP @ 0.05 per cent was found the most effective with 1.08 whitefly per three leaves. However, it was statistically at par with spiromesifen 240 SC @ 0.24 per cent (1.18 /3 leaves). The other treatments acetamiprid 20 SP @ 0.008 per cent (1.97 /3 leaves), thiamethoxam 25 WG @ 0.01 per cent (2.13 /3 leaves), dinetofuran 20 SG @ 0.008 per cent (2.43 /3 leaves), imidacloprid 17.8 SL @ 0.005 per cent (3.43 /3 leaves), flonicamid 50 WG @ 0.015 per cent (3.65 /3 leaves) and fipronil 5 SC @ 0.01 per cent (3.96 /3 leaves) were found mediocare in their effectiveness. Treatment fenazaquin 10 EC @ 0.02 per cent (5.42 /3 leaves) found least in their effectiveness as compare to other treatments and it was found at par with ethion 50 EC @ 0.1 per cent (5.24 /3 leaves) and spinosad 45 SC @ 0.0135 per cent (5.08 /3 leaves).

3.3.2 Second spray

The data on mean number of whitefly count of pooled over periods presented in Table 3 showed that all the treatments were significantly superior over control. Treatment diafenthiuron 50 WP @ 0.05 per cent was found the most effective which gave 0.97 whitefly per three leaves. However, it was statistically at par with spiromesifen 240 SC @ 0.24 per cent (1.06 /3 leaves). The other treatments acetamiprid 20 SP @ 0.008 per cent (1.65 /3 leaves), thiamethoxam 25 WG @ 0.01 per cent (1.82 /3 leaves), dinetofuran 20 SG @ 0.008 per cent (2.05 /3 leaves), imidacloprid 17.8 SL @ 0.005 per cent (2.64 /3 leaves), flonicamid 50 WG @ 0.015 per cent (2.78 /3 leaves) and fipronil 5 SC @ 0.01 per cent (2.92 /3 leaves) were found mediocare in their effectiveness. Treatment ethion 50 EC @ 0.1 per cent (4.17 /3 leaves) found least effective as compare to other treatments in controlling whitefly and it was found at par with fenazaquin 10 EC @ 0.02 per cent (3.88 /3 leaves) and spinosad 45 SC @ 0.0135 per cent (3.70 /3 leaves).

Earlier, the population of whitefly was lowest in spiromesifen treated plot [3]. Imidacloprid and acetamiprid were the most effective against whitefly [13]. Spiromesifen 240 SC @ 0.4 ml/lit found most effective against whiteflies and acetamiprid 20 SP @ 0.2 g/lit, imidacloprid 200 SL @ 0.3 ml/lit and thiamethoxam 25 WG @ 0.2 g/lit were found promising against whiteflies [11]. Diafenthiuron 0.05 per cent found to be the most effective which was at par with the spiromesifen 0.026 per cent [7]. Thus, the present findings are more or less same in confirmation with the reports of earlier workers.

3.4 Yield of different insecticidal treatments

Treatment wise data on yield of sesame are presented in Table 4 revealed that the highest yield of 900 kg /ha was obtained from the treatment of dinetofuran 20 SG @ 0.008 per cent which was found statistically at par with fipronil 5 SC @ 0.01 per cent, diafenthiuron 50 WP @ 0.05 per cent and flonicamid 50 WG @ 0.015 per cent with 876.39 kg /ha, 861.08 kg /ha and 840.65 kg /ha, respectively. The insecticidal treatments of acetamiprid 20 SP @ 0.008 per cent, thiamethoxam 25 WG @ 0.01 per cent, imidacloprid 17.8 SL @ 0.005 per cent, spiromesifen 240 SC @ 0.24 per cent and spinosad 45 SC @ 0.0135 per cent were moderate in yield, by giving 729.60 kg /ha, 710.77 kg /ha, 702.19 kg/ ha, 689.35 kg /ha and 676.54 kg /ha, respectively. However treatment ethion 50 EC @ 0.1 per cent recorded lowest yield (581.03 kg /ha) and it remain statistically at par with fenazaquin 10 EC @ 0.02 per cent with yield 587.79 kg /ha.

The per cent increase over control in yield was also worked out and presented in Table 4. The chronological order of various insecticide based on the per cent increase in yield over control given in bracket was: dinetofuran 20 SG @ 0.008 per cent (90.53 %) > fipronil 5 SC @ 0.01 per cent (85.53 %) > diafenthiuron 50 WP @ 0.05 per cent (82.29 %) > flonicamid 50 WG @ 0.015 per cent (77.96 %) > acetamiprid 20 SP @ 0.008 per cent (54.45 %) > thiamethoxam 25 WG @ 0.01 per cent (50.47 %) > imidacloprid 17.8 SL @ 0.005 per cent (48.65 %) > spiromesifen 240 SC @ 0.24 per cent (45.93 %) > spinosad 45 SC @ 0.0135 per cent (43.22 %) > fenazaquin 10 EC @ 0.02 per cent (24.43 %) > ethion 50 EC @ 0.1 per cent (23.00 %).

Earlier, highest yield was recorded in the plot sprayed with fipronil 0.015 per cent, which was followed by dinotefuran 0.008 per cent, flonicamid 0.02 per cent, imidacloprid 0.005 per cent, acetamiprid 0.004 per cent [9]. Dinotefuran 20 per cent SG @ 30 g a.i/ha registered highest yield as compared to rest of the treatments [14]. Thus, the present findings are more or less similar to obtained yield by earlier report.

Table 1: Efficacy of various insecticides against thrips, *Thrips tabaci* in summer sesame

Sr. No.	Treatment	Conc. (%)	Mean number of thrips /3 leaves after first spray						Mean number of thrips /3 leaves after first spray					
			BS	1 DAS	3 DAS	5 DAS	7 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	Pooled
1	Imidacloprid 17.8 SL	0.005	2.62 (6.88)	1.82^{def} (3.31)	1.75^{cd} (3.08)	1.71^{d} (2.91)	1.77^{cd} (3.12)	1.76^{de} (3.10)	2.25 (5.08)	1.67^{de} (2.78)	1.61^{def} (2.60)	1.55^{de} (2.41)	1.62^{def} (2.62)	1.61^{ef} (2.60)
2	Flonicamid 50 WG	0.015	2.64 (6.98)	1.92^{cd} (3.70)	1.85^{c} (3.41)	1.80^{cd} (3.23)	1.84^{c} (3.40)	1.86^{cd} (3.44)	2.28 (5.20)	1.76^{cd} (3.09)	1.70^{cd} (2.91)	1.66^{cd} (2.76)	1.70^{cd} (2.88)	1.70^{cde} (2.91)
3	Spiromesifen 240 SC	0.24	2.63 (6.94)	2.16^{bc} (4.66)	2.12^{b} (4.48)	2.09^{bc} (4.35)	2.18^{b} (4.77)	2.14^{bc} (4.56)	2.36 (5.57)	1.98^{bc} (3.93)	1.94^{bc} (3.76)	1.89^{bc} (3.58)	1.96^{bc} (3.85)	1.95^{bc} (3.80)
4	Acetamiprid 20 SP	0.008	2.60 (6.78)	1.52^{fg} (2.30)	1.43^{e} (2.06)	1.39^{e} (1.92)	1.45^{e} (2.12)	1.45^{f} (2.10)	2.33 (5.41)	1.42^{ef} (2.02)	1.36^{fg} (1.86)	1.32^{ef} (1.74)	1.36^{fg} (1.85)	1.37^{fg} (1.87)
5	Spinosad 45 SC	0.0135	2.56 (6.55)	1.11^{i} (1.23)	1.04^{g} (1.08)	0.99^{f} (0.98)	1.05^{f} (1.10)	1.05^{g} (1.09)	2.25 (5.06)	1.02^{g} (1.05)	0.94^{h} (0.88)	0.90^{h} (0.81)	0.95^{i} (0.90)	0.95^{i} (0.91)

6	Dinetofuran 20 SG	0.008	2.58 (6.67)	1.59^{efg} (2.52)	1.54^{de} (2.39)	1.50^{de} (2.26)	1.53^{de} (2.35)	1.54^{ef} (2.38)	2.32 (5.38)	1.46^{ef} (2.14)	1.42^{efg} (2.01)	1.35^{ef} (1.82)	1.39^{efg} (1.93)	1.40^{efg} (1.97)
7	Fenazaquin 10 EC	0.02	2.64 (6.96)	2.26^{b} (5.12)	2.20^{b} (4.83)	2.15^{b} (4.61)	2.24^{b} (5.03)	2.20^{b} (4.86)	2.36 (5.59)	2.06^{b} (4.23)	2.03^{b} (4.11)	2.00^{b} (3.98)	2.07^{b} (4.27)	2.04^{b} (4.15)
8	Fipronil 5 SC	0.01	2.60 (6.76)	1.19^{hi} (1.41)	1.13^{fg} (1.28)	1.07^{f} (1.14)	1.11^{f} (1.23)	1.12^{fg} (1.26)	2.29 (5.25)	1.07^{g} (1.14)	1.02^{h} (1.05)	0.96^{gh} (0.92)	1.00^{hi} (1.00)	1.01^{hi} (1.02)
9	Diafenthiuron 50 WP	0.05	2.56 (6.57)	1.89^{cde} (3.56)	1.80^{cd} (3.25)	1.76^{d} (3.10)	1.80^{cd} (3.23)	1.81^{de} (3.29)	2.34 (5.45)	1.72^{cd} (2.96)	1.65^{de} (2.74)	1.62^{d} (2.63)	1.66^{cde} (2.76)	1.66^{def} (2.77)
10	Ethion 50 EC	0.1	2.53 (6.42)	2.23^{b} (4.97)	2.17^{b} (4.66)	2.13^{b} (4.53)	2.20^{b} (4.86)	2.18^{b} (4.75)	2.31 (5.36)	2.03^{b} (4.10)	1.99^{b} (3.96)	1.95^{b} (3.81)	2.02^{b} (4.09)	2.00^{b} (3.99)
11	Thiamethoxam 25 WG	0.01	2.64 (6.95)	1.45^{gh} (2.10)	1.40^{ef} (1.97)	1.36^{e} (1.84)	1.43^{e} (2.04)	1.41^{f} (1.99)	2.28 (5.20)	1.35^{f} (1.81)	1.28^{g} (1.65)	1.20^{fg} (1.45)	1.27^{gh} (1.61)	1.28^{gh} (1.63)
12	Control	-	2.59 (6.69)	2.62^{a} (6.85)	2.56^{a} (6.54)	2.64^{a} (6.97)	2.67^{a} (7.14)	2.62^{a} (6.87)	2.42 (5.84)	2.37^{a} (5.59)	2.43^{a} (5.92)	2.42^{a} (5.87)	2.47^{a} (6.09)	2.42^{a} (5.87)
	S. Em.±	T	0.22	0.10	0.09	0.09	0.09	0.04	0.17	0.09	0.08	0.08	0.09	0.04
		P	-	-	-	-		0.03	-	-	-	-		0.02
		T x P	-	-	-	-		0.09	-	-	-	-		0.09
	C. D. at 5%	T	NS	0.29	0.26	0.27	0.26	0.13	NS	0.26	0.24	0.24	0.26	0.12
		P	-	-	-	-		0.07	-	-	-	-	-	0.05
		T x P	-	-	-	-		NS	-	-	-	-	-	NS
	C. V.%		14.39	9.51	9.09	9.37	8.56	8.85	12.87	9.43	8.94	8.90	9.26	9.16
Notes: DAS: Days After Spray; Figures in parentheses indicate retransformed values, while outside are square root transformed values.**;** DNMRT was used for treatment comparison.**;** NS = Non significant; BS= Before spray														

Table 2: Efficacy of various insecticides against jassid, *Orosius albicinctus* in summer sesame

Sr. no.	Treatment	Conc.(%)	Mean number of thrips /3 leaves after first spray						Mean number of thrips /3 leaves after first spray					
			BS	1 DAS	3 DAS	5 DAS	7 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	Pooled
1	Imidacloprid 17.8 SL	0.005	2.19 (4.80)	1.08^{d} (1.16)	0.99^{de} (0.98)	0.95^{de} (0.91)	1.01^{de} (1.01)	1.01^{de} (1.01)	2.34 (5.49)	1.18^{d} (1.40)	1.11^{d} (1.24)	1.05^{d} (1.11)	1.09^{d} (1.18)	1.11^{d} (1.23)
2	Flonicamid 50 WG	0.015	2.14 (4.60)	1.45^{c} (2.09)	1.37^{c} (1.88)	1.28^{c} (1.63)	1.35^{c} (1.83)	1.36^{c} (1.86)	2.43 (5.90)	1.56^{c} (2.45)	1.49^{c} (2.21)	1.44^{c} (2.08)	1.50^{c} (2.26)	1.50^{c} (2.25)
3	Spiromesifen 240 SC	0.24	2.15 (4.63)	1.76^{b} (3.11)	1.71^{b} (2.93)	1.66^{b} (2.75)	1.72^{b} (2.96)	1.71^{b} (2.94)	2.46 (6.06)	1.89^{b} (3.59)	1.84^{b} (3.39)	1.82^{b} (3.32)	1.88^{b} (3.54)	1.86^{b} (3.46)
4	Acetamiprid 20 SP	0.008	2.16 (4.65)	1.04^{d} (1.09)	0.96^{e} (0.93)	0.93^{e} (0.86)	0.96^{e} (0.93)	0.97^{e} (0.95)	2.44 (5.94)	1.15^{d} (1.32)	1.07^{d} (1.15)	1.02^{d} (1.04)	1.08^{d} (1.17)	1.08^{d} (1.17)
5	Spinosad 45 SC	0.0135	2.18 (4.75)	1.88^{b} (3.53)	1.81^{b} (3.27)	1.76^{b} (3.10)	1.85^{b} (3.40)	1.82^{b} (3.33)	2.47 (6.10)	2.04^{b} (4.17)	2.01^{b} (4.03)	1.97^{b} (3.87)	2.00^{b} (4.02)	2.01^{b} (4.02)
6	Dinetofuran 20 SG	0.008	2.14 (4.57)	0.98^{d} (0.95)	0.90^{e} (0.81)	0.85^{e} (0.72)	0.92^{e} (0.84)	0.91^{e} (0.83)	2.42 (5.86)	1.10^{d} (1.21)	1.03^{d} (1.06)	0.99^{d} (0.99)	1.05^{d} (1.10)	1.04^{d} (1.09)
7	Fenazaquin 10 EC	0.02	2.17 (4.69)	1.85^{b} (3.42)	1.79^{b} (3.21)	1.73^{b} (2.98)	1.79^{b} (3.21)	1.79^{b} (3.22)	2.48 (6.14)	1.99^{b} (3.96)	1.96^{b} (3.83)	1.92^{b} (3.68)	1.96^{b} (3.83)	1.96^{b} (3.83)
8	Fipronil 5 SC	0.01	2.12 (4.48)	1.49^{c} (2.21)	1.41^{c} (1.98)	1.35^{c} (1.82)	1.43^{c} (2.04)	1.42^{c} (2.01)	2.40 (5.77)	1.62^{c} (2.63)	1.54^{c} (2.36)	1.50^{c} (2.24)	1.55^{c} (2.40)	1.55^{c} (2.41)
9	Diafenthiuron 50 WP	0.05	2.13 (4.52)	1.37^{c} (1.88)	1.29^{c} (1.66)	1.23^{c} (1.52)	1.25^{cd} (1.56)	1.29^{c} (1.66)	2.39 (5.69)	1.50^{c} (2.25)	1.42^{c} (2.01)	1.38^{c} (1.91)	1.45^{c} (2.10)	1.43^{c} (2.06)
10	Ethion 50 EC	0.1	2.15 (4.62)	1.80^{b} (3.23)	1.75^{b} (3.07)	1.69^{b} (2.87)	1.74^{b} (3.02)	1.75^{b} (3.05)	2.50 (6.27)	1.96^{b} (3.83)	1.91^{b} (3.63)	1.87^{b} (3.48)	1.94^{b} (3.76)	1.92^{b} (3.68)
11	Thiamethoxam 25 WG	0.01	2.10 (4.42)	1.32^{c} (1.75)	1.24^{cd} (1.54)	1.20^{cd} (1.45)	1.23^{d} (1.52)	1.25^{cd} (1.57)	2.42 (5.87)	1.46^{c} (2.13)	1.40^{c} (1.97)	1.35^{c} (1.81)	1.46^{c} (2.13)	1.42^{c} (2.01)
12	Control	-	2.17 (4.71)	2.18^{a} (4.74)	2.23^{a} (4.97)	2.21^{a} (4.88)	2.20^{a} (4.84)	2.17^{a} (4.72)	2.47 (6.09)	2.43^{a} (5.90)	2.39^{a} (5.71)	2.45^{a} (6.00)	2.43^{a} (5.90)	2.42^{a} (5.88)
	S. Em.±	T	0.17	0.08		0.08	0.09	0.04	0.17	0.08	0.09	0.08	0.09	0.04
		P	-	-	-	-	-	0.02	-					0.02
		T x P	-	-	-	-	-	0.08	-					0.08
	C. D. at 5%	T	NS	0.22		0.22	0.25	0.11	NS	0.24	0.25	0.24	0.26	0.12
		P	-	-	-	-	-	0.06	-	-	-	-	-	0.05
		T x P	-	-	-	-	-	NS	-	-	-	-	-	NS
	C. V.%		13.89	8.92		9.42	10.14	9.26	12.25	8.59	9.32	8.91	9.65	9.1
	Notes: DAS: Days After Spray; Figures in parentheses indicate retransformed values, while outside are square root transformed values.**;** DNMRT was used for treatment comparison.**;** NS = Non significant; BS= Before spray													

Table 3: Efficacy of various insecticides against whitefly, *Bemisia tabaci* in summer sesame

Sr. No.	Treatment	Conc. (%)	Mean number of whitefly /3 leaves after first spray						Mean number of whitefly /3 leaves after second spray					
			BS	1 DAS	3 DAS	5 DAS	7 DAS	Pooled	BS	1 DAS	3 DAS	5 DAS	7 DAS	Pooled
1	Imidacloprid 17.8 SL	0.005	2.70 (7.30)	1.93^{d} (3.74)	1.85^{de} (3.41)	1.79^{de} (3.21)	1.84^{de} (3.38)	1.85^{de} (3.43)	2.17 (4.70)	1.70^{de} (2.88)	1.61^{efg} (2.58)	1.56^{ef} (2.44)	1.64^{de} (2.68)	1.63^{ef} (2.64)
2	Flonicamid 50 WG	0.015	2.60 (6.78)	1.99^{d} (3.95)	1.91^{d} (3.65)	1.86^{d} (3.45)	1.89^{d} (3.56)	1.91^{d} (3.65)	2.22 (4.95)	1.73^{de} (2.99)	1.65^{ef} (2.72)	1.61^{def} (2.59)	1.66^{de} (2.75)	1.67^{def} (2.78)
3	Spiromesifen 240 SC	0.24	2.64 (6.96)	1.19^{f} (1.41)	1.09^{gh} (1.19)	1.02^{g} (1.04)	1.05^{g} (1.10)	1.09^{g} (1.18)	2.16 4.65)	1.11^{g} (1.23)	1.05^{ij} (1.11)	0.96^{hi} (0.93)	0.99^{g} (0.98)	1.03^{h} (1.06)
4	Acetamiprid 20 SP	0.008	2.72 (7.38)	1.49^{e} (2.23)	1.37^{fg} (1.88)	1.34^{f} (1.79)	1.40^{f} (1.96)	1.40^{f} (1.97)	2.18 (4.76)	1.38^{f} (1.90)	1.28^{hi} (1.65)	1.20^{gh} (1.45)	1.27^{f} (1.61)	1.28^{g} (1.65)
5	Spinosad 45 SC	0.0135	2.70 (7.29)	2.31^{bc} (5.32)	2.24^{bc} (5.03)	2.20^{bc} (4.84)	2.26^{bc} (5.12)	2.25^{bc} (5.08)	2.27 5.14)	1.98^{bc} (3.91)	1.92^{bc} (3.70)	1.84^{bc} (3.38)	1.93^{bc} (3.72)	1.92^{bcd} (3.70)
6	Dinetofuran 20 SG	0.008	2.67 (7.15)	1.62^{e} (2.62)	1.57^{ef} (2.45)	1.51^{ef} (2.28)	1.54^{ef} (2.36)	1.56^{ef} (2.43)	2.18 (4.74)	1.50e^{f} (2.25)	1.43^{fgh} (2.04)	1.37^{fg} (1.88)	1.43^{ef} (2.05)	1.43^{fg} (2.05)
7	Fenazaquin 10 EC	0.02	2.64 (6.96)	2.40^{b} (5.77)	2.34^{b} (5.45)	2.27^{b} (5.15)	2.28^{b} (5.20)	2.33^{b} (5.42)	2.29 (5.23)	2.05^{b} (4.19)	1.97^{bc} (3.88)	1.92^{bc} (3.69)	2.00^{b} (4.01)	1.97b^{c} (3.88)
8	Fipronil 5 SC	0.01	2.72 (7.39)	2.06^{cd} (4.24)	1.98^{cd} (3.94)	1.93^{cd} (3.72)	1.98^{cd} (3.93)	1.99^{cd} (3.96)	2.21 (4.86)	1.78^{cd} (3.18)	1.70^{cde} (2.88)	1.64^{cde} (2.68)	1.71^{cd} (2.91)	1.71^{cde} (2.92)
9	Diafenthiuron 50 WP	0.05	2.68 (7.20)	1.14^{f} (1.30)	1.03^{h} (1.06)	0.98^{g} (0.95)	1.02^{g} (1.04)	1.04^{g} (1.08)	2.14 (4.57)	1.07^{g} (1.16)	0.99^{j} (0.98)	0.92^{i} (0.85)	0.96^{g} (0.92)	0.99^{h} (0.97)
10	Ethion 50 EC	0.1	2.58 (6.66)	2.37^{b} (5.61)	2.31^{b} (5.32)	2.24^{b} (5.04)	2.27^{b} (5.15)	2.29^{b} (5.24)	2.23 (4.96)	2.09^{b} (4.36)	2.04^{b} (4.17)	1.98^{b} (3.93)	2.06^{b} (4.23)	2.04^{b} (4.17)
11	Thiamethoxam 25 WG	0.01	2.66 (7.05)	1.56^{e} (2.42)	1.45^{f} (2.11)	1.38^{f} (1.90)	1.45^{f} (2.10)	1.46^{f} (2.13)	2.14 (4.59)	1.44^{f} (2.06)	1.36^{gh} (1.84)	1.28^{g} (1.64)	1.32^{f} (1.74)	1.35^{g} (1.82)
12	Control	-	2.64 (7.00)	2.74^{a} (7.48)	2.71^{a} (7.35)	2.65^{a} (6.74)	2.70^{a} (7.28)	2.67^{a} (7.15)	2.34 (5.48)	2.38^{a} (5.65)	2.35^{a} (5.53)	2.32^{a} (5.38)	2.36^{a} (5.57)	2.34^{a} (5.47)
	S. Em.±	T	0.22	0.09	0.09	0.09	0.10	0.04	0.188	0.08	0.08	0.08	0.08	0.04
		P		-	-	-	-	0.02	-	-	-	-	-	0.02
		T x P		-	-	-	-	0.07	-	-	-	-	-	0.08
	C. D. at 5%	T	NS	0.27	0.28	0.26	0.30	0.11	NS	0.23	0.23	0.25	0.25	0.11
		P	-	-	-	-	-	0.06	-	-	-	-	-	0.06
		T x P	-	-	-	-	-	NS	-	-	-	-	-	NS
	C. V.%		14.17	8.29	9.04	8.69	9.59	8.75	14.74	8.12	8.46	8.39	9.16	8.72

Notes: DAS: Days After Spray; Figures in parentheses indicate retransformed values, while outside are square root transformed values.; DNMRT was used for treatment comparison.**;** NS = Non significant; BS= Before spray

Table 4: Yield of sesame obtained from different insecticidal treatments

Sr. No.	Treatments	Concentration (%)	Yield kg/ha	Yield increase over control (kg/ha)	Percentage increase in yield over control
1	Imidacloprid 17.8 SL	0.005	702.19^{c}	229.82	48.65
2	Flonicamid 50 WG	0.015	840.65^{ab}	368.27	77.96
3	Spiromesifen 240 SC	0.24	689.35^{c}	216.98	45.93
4	Acetamiprid 20 SP	0.008	729.60^{bc}	257.23	54.45
5	Spinosad 45 SC	0.0135	676.54^{cd}	204.17	43.22
6	Dinetofuran 20 SG	0.008	900.00^{a}	427.63	90.53
7	Fenazaquin 10 EC	0.01	587.79^{d}	115.41	24.43
8	Fipronil 5 SC	0.01	876.39^{a}	404.02	85.53
9	Diafenthiuron 50 WP	0.05	861.08^{a}	388.70	82.29
10	Ethion 50 EC	0.05	581.03^{d}	108.66	23.00
11	Thiamethoxam 25 WG	0.01	710.77^{c}	238.40	50.47
12	Control	-	472.37^{e}	-	-
S. Em.±		33.51			
C. D. at 5%		98.33			
C. V.%		8.06			

Notes:

1. Yield increased over control = Yield of treatment – Yield of control
2. Percentage yield increase over control = $100\times \frac{T-C}{C}$

Where,
T = Yield from treated plot (kg/ha)
C = Yield from untreated plot (kg/ha)

4. Conclusion

On the basis of investigation, the following conclusions could be drawn. For management of thrips spinosad 45 SC @ 0.0135 per cent and fipronil 5 SC @ 0.01 per cent were found most effective. Treatment dinetofuran 20 SG @ 0.008 per cent, acetamiprid 20 SP @ 0.008 per cent and imidacloprid

17.8 SL @ 0.005 per cent were found most superior against jassid while the treatment diafenthiuron 50 WP @ 0.05 per cent and spiromesifen 240 SC @ 0.24 per cent were found effective in management of whitefly. Highest yield was reported in Treatment dinetofuran 20 SG @ 0.008 per cent which was statistically at par with fipronil 5 SC @ 0.01 per cent, diafenthiuron 50 WP @ 0.05 per cent and flonicamid 50 WG @ 0.015 per cent.

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