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Efficacy of Synthetic Insecticides against sucking insect pests in cotton, *Gossypium hirsutum* L.

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Abstract
A field experiment was conducted to evaluate synthetic insecticides against the sucking insect pest's *viz.,* leafhopper, aphid, whitefly and thrips of cotton at Agricultural College and Research Institute, Killikulam, Tuticorin District, Tamil Nadu, using cotton variety SVPR 2 during 2014 - 2015. The incidence of leafhopper, *A. devastans* on the plants treated with synthetic insecticides ranged from 1.30 (Diafenthiuron 50 WP) to 13.45 (Quinalphos 25 EC) numbers per three leaves. The insecticidal sprays reduced the aphid population from 20 (Flubendiamide 20 WG) to cent per cent (Diafenthiuron 50 WP, imidacloprid 17.8 SL, thiamethoxam 25 WG, triazophos 40 EC, carbosulfan 25 EC and chlorpyriphos 20 EC) over untreated check. Fipronil 5 SC was the most effective insecticide (3.15/3 leaves) with 83.06 per cent reduction in thrips population compared to the mean of untreated check (18.60/3 leaves). The incidence of whitefly, *B. tabaci* on the plants treated with synthetic insecticides ranged from 0.40 (Fipronil 5 SC) to 6.40 (Phosalone 35 EC) numbers per three leaves.

Keywords: Efficacy, Synthetic Insecticides, Sucking Insects, Cotton

Introduction
Cotton (*Gossypium hirsutum* L.) is one of the most commercially important fiber crops in the world. It is an important raw material for the Indian textile industry and plays a key role in the national economy in terms of both employment generation and foreign exchange. In India, cotton is cultivated in 119.78 lakh hectare with a production of 365 lakh bale of seed cotton [2]. Insect pest attack is one of the most important limiting factors in the successful cultivation of this crop. Amongst various causes of low yield, losses due to insect pests are one of the important factors in cotton. Many insect pests are encountered on cotton crop from germination to harvesting. Among the important key pests of cotton the sucking pests *viz.,* leafhopper, *Amrasca Amrasca devastans* Distant, aphid, *Aphis gossypii* (Glover), whitefly *Bemisia tabaci* (Gennadius) and thrips, *Thrips tabaci* (Linnman) cause severe damage and serious threat to the crop at early stage of the crop growth and can also affect the crop stand and yield of cotton. Some sucking pests are cosmopolitan, polyphagus, widely distributed in tropical, subtropical and temperate regions and are also vectors for a number of viral diseases in large number of plants [6]. Therefore chemical control is necessary to keep the population of sucking pests below ETL. In the present study, some new insecticides have been used to test their efficacy against the sucking pests.

Materials and Methods
A field experiment was conducted to evaluate nineteen synthetic insecticides *viz.,* acephate 75 SP, acetamiprid 20 SP, carbosulfan 25 EC, chlorantraniliprole 18.5 SC, chlorpyriphos 20 EC, diafenthiuron 50 WP, dimethoate 30 EC, fipronil 5 SC, flonicamid 50 WG, flubendiamide 20 WG, imidacloprid 17.8 SL, malathion 50 EC, monocrotophos 36 WSC, phosalone 35 EC, profenofos 50 EC, quinalphos 25 EC, spiromesifen 22.9 SC, thiamethoxam 25 WG and triazophos 40 EC against the sucking insect pests of cotton at Agricultural College and Research Institute, Killikulam, Tuticorin District, Tamil Nadu, using cotton variety SVPR 2 during 2014 - 2015. An untreated check was also maintained. The experiment was laid out in RBD and with three replications. The insecticidal sprays were given at 25, 40 and 55 DAS on cotton. The nymphal and adult population of *A. devastans*, *A. gossypii*, *B. tabaci* and *T. tabaci* were recorded on ten plants selected at random per plot at 30 and 60 DAS. In each plant three leaves, one each from top, middle and bottom strata were observed and mean per leaf was calculated.

Results and Discussion
Leafhopper, *A. devastans*
The data on the incidence of leafhopper, *A. devastans* is presented in the Table 1 indicated that variability in leafhopper population due to the treatments as well as the interaction effect of treatments and periods of observation was significant. When

the overall mean over two periods of observation is considered, the incidence of leafhopper on the plants treated with synthetic insecticides ranged from 1.30 (Diafenthiuron 50 WP) to 13.45 (Quinalphos 25 EC) numbers per three leaves. The leafhopper population on the plants treated with diafenthiuron 50 WP was significantly lower than all other treatments except**,** fipronil 5 SC (2.00 numbers per three leaves). Diafenthiuron 50 WP and fipronil 5 SC were equal between themselves and they reduced the incidence by 90.71 and 85.71 per cent, respectively compared to untreated check. In addition to them, flonicamid 50 WG, thiamethoxam 25 WG, imidacloprid 17.8 SL, monocrotophos 36 WSC, acetamiprid 20 SP and chlorpyriphos 20 EC were also able to reduce the leafhopper population by more than 50 per cent in cotton.

Table 1: Evaluation of synthetic insecticides against leafhopper, *A. devastans* on cotton

Treatment	Dose (lit^{-1})	Leafhopper population (No. / 3 leaves) Days after sowing (DAS)			(+) / (-) over UTC (%)
		30	60	Mean	
Acephate 75 SP	2 g	4.20 A (2.16) bcd	14.60 B (3.88) jk	9.40 (3.02) gh	-32.85
Acetamiprid 20 SP	0.2 g	3.20 (1.92) ab	9.30 (3.13) fghi	6.25 (2.53) def	-55.35
Carbosulfan 25 EC	2 ml	5.80 (2.51) bcd	9.90 (3.22) ghi	7.85 (2.87) fg	-43.92
Chlorantraniliprole 18.5 SC	0.3 ml	7.30 (2.76) def	15.00 (3.92) k	11.15 (3.34) hij	-20.36
Chlorpyriphos 20 EC	2.5 ml	12.60 (3.62) gf	0.00 (0.71) a	6.30 (2.16) cd	-55.00
Diafenthiuron 50 WP	1.6 g	1.30 (1.33) a	1.30 (1.34) b	1.30 (1.34) a	-90.71
Dimethoate 30 EC	1.5 ml	10.90 (3.37) fg	10.50 (3.32) hijk	10.70 (3.34) hij	-23.57
Fipronil 5 SC	3 ml	1.30 (1.34) a	2.70 (1.79) bc	2.00 (1.56) ab	-85.71
Flubendiamide 20 WG	0.2 g	11.20 (3.41) fg	12.30 (3.58) ijk	11.75 (3.49)ij	-16.07
Flonicamid 50 WG	0.2 g	1.30 (1.34) a	5.60 (2.47) de	3.45 (1.90) bc	-75.36
Imidacloprid 17.8 SL	0.2 ml	4.60 (2.25) bcd	6.20 (2.59) def	5.40 (2.42) de	-61.43
Malathion 50 EC	2 ml	6.10 (2.57) cde	9.50 (3.16) fghi	7.80 (2.86) fg	-44.28
Monocrotophos 36 WSC	2 ml	4.00 (2.12) bc	7.00 (2.73) defgh	5.50 (2.43) de	-60.71
Phosalone 35 EC	3 ml	4.60 (2.26) bcd	10.4 (3.30) hij	7.50 (2.78) efg	-46.42
Profenophos 50 EC	2 ml	13.00 (3.67) fgh	6.90 (2.72) defgh	9.95 (3.20) ghij	-28.92
Quinalphos 25 EC	2 ml	19.40 (4.45) h	7.50 (2.82) efgh	13.45 (3.63) j	-3.93
Spiromecifen 22.9 SC	1.2 ml	11.70 (3.49) fg	6.40 (2.62) defg	9.05 (3.06) gh	-35.36
Thiamethoxam 25 WG	0.2 g	6.40 (2.62) fg	4.20 (2.16) cd	5.30 (2.39) de	-62.14
Triazophos 40 EC	2 ml	9.80 (3.20) ef	10.50 (3.15) fghi	10.15 (3.18) ghi	-27.50
Untreated check	-	15.60 (4.01) gh	12.40 (3.57) ijk	14.00 (3.79) k	-
Mean	-	7.71 (2.72) A	8.11 (2.81) A	7.91 (2.77)	-

Mean of three replications. Figures in parentheses are √X+0.5 transformed values. In a column/row, means followed by a common letter are not significantly different at 5 % level (LSD).

	T	P	T x P
Significance	0.01	NS	0.01
CD (p=0.05)	0.43	-	0.60

Aphid, *A. gossypii*

The insecticidal sprays reduced the aphid population from 20 (Flubendiamide 20 WG) to cent per cent (Diafenthiuron 50 WP, imidacloprid 17.8 SL, thiamethoxam 25 WG, triazophos 40 EC, carbosulfan 25 EC and chlorpyriphos 20 EC) over untreated check (Table 2). Significant difference among the periods of observation was observed; interactions were also significant. Carbosulfan 25 EC, diafenthiuron 50 WP, imidacloprid 17.8 SL, thiamethoxam 25 WG, triazophos 40 EC, spiromesifen 22.9 SC, dimethoate 30 EC, fipronil 5 SC and monocrotophos 36 WSC

were equal among themselves and better than all other treatments, except chlorantraniliprole 18.5 SC which was on a par with former treatments. Malathion 50 EC, profenofos 50 EC, quinalphos 25 EC and flubendiamide 20 WG were found to be less effective with less than 50 per cent reduction in aphid population on cotton. Similar was the trend at 60 DAS. The variability due to the treatments could not be observed at 30 DAS.

Table 2: Evaluation of synthetic insecticides against aphid, *A. gossypii* on cotton

Treatment	Dose (lit^{-1})	Aphid population (No. / 3 leaves) Days after sowing (DAS)			(+) / (-) over UTC (%)
		30	60	Mean	
Acephate 75 SP	2 g	0.20 A (0.83) a	0.00 A (0.71) a	0.10 A (0.77) a	-97.33
Acetamiprid 20 SP	0.2 g	0.00 (0.71) a	0.30 (0.89) a	0.15 (0.80) a	-96.00
Carbosulfan 25 EC	2 ml	0.00 (0.71) a	0.00 (0.71) a	0.00 (0.71) a	-100.00
Chlorantraniliprole 18.5 SC	0.3 ml	0.00 (0.71) a	0.70 (1.09) a	0.35 (0.90) ab	-90.67
Chlorpyriphos 20 EC	2.5 ml	0.00 (0.71) a	0.00 (0.71) a	0.00 (0.71) a	-100.00
Diafenthiuron 50 WP	1.6 g	0.00 (0.71) a	0.00 (0.71) a	0.00 (0.71) a	-100.00
Dimethoate 30 EC	1.5 ml	0.30 (0.89) a	0.00 (0.71) a	0.15 (0.80) a	-96.00
Fipronil 5 SC	3 ml	0.00 (0.71) a	0.50 (0.96) a	0.25 (0.84) a	-93.33
Flubendiamide 20 WG	0.2 g	0.00 (0.71) a	6.00 (2.54) e	3.00 (1.62) c	-20.00
Flonicamid 50 WG	0.2 g	0.00 (0.71) a	1.70 (1.48) b	0.85 (1.09) b	-77.33
Imidacloprid 17.8 SL	0.2 ml	0.00 (0.71) a	0.00 (0.71) a	0.00 (0.71) a	-100.00
Malathion 50 EC	2 ml	0.70 (1.04) a	3.50 (2.0) c	2.10 (1.52) a	-44.00
Monocrotophos 36 WSC	2 ml	0.00 (0.71) a	0.60 (1.03) a	0.30 (0.87) a	-92.00
Phosalone 35 EC	3 ml	0.00 (0.71) a	5.30 (2.40) de	2.65 (1.55) c	-29.33
Profenophos 50 EC	2 ml	0.00 (0.71) a	3.90 (2.10) cd	1.95 (1.40) c	-48.00
Quinalphos 25 EC	2 ml	0.00 (0.71) a	4.00 (2.12) cde	2.00 (1.41) c	-46.67
Spiromecifen 22.9 SC	1.2 ml	0.00 (0.71) a	0.00 (0.71) a	0.10 (0.77) a	-97.33
Thiamethoxam 25 WG	0.2 g	0.20 (0.83) a	0.00 (0.71) a	0.00 (0.71) a	-100.00
Triazophos 40 EC	2 ml	0.00 (0.71) a	0.00 (0.71) a	0.00 (0.71) a	-100.00
Untreated check	-	1.00 (1.22) a	6.50 (2.64) f	3.75 (1.73) d	-
Mean	-	0.16 (0.79) A	1.65 (1.28) C	0.88 (1.02) B	-

Mean of three replications. Figures in parentheses are √X+0.5 transformed values. In a column/row, means followed by a common letter are not significantly different at 5 % level (LSD).

	T	P	T x P
Significance	0.01	0.01	0.01
CD (p=0.05)	0.27	0.08	0.38

Thrips, *T. tabaci*

Influence of insecticidal sprays on the incidence of thrips, *T. tabaci* was realized among the treatments (Table 3). Significant difference among the periods of observation was evident. Interaction between the treatment and period of observation was also significant. Overall mean over two periods of observation clearly shown that fipronil 5 SC was the most effective insecticide (3.15/3 leaves) with 83.06 per cent reduction in thrips population compared to the mean of untreated check (18.60/3 leaves). Profenofos 50 EC (7.15/3 leaves), flonicamid 50 WG (7.25/3 leaves) and imidacloprid 17.8 SL (9.95/3 leaves) were the next best treatments. Fipronil 5 SC, profenofos 50 EC, flonicamid 50 WG and imidacloprid 17.8 SL were able to reduce the population of thrips by more than 45 per cent. Similar was the trend at almost all the periods of observation.

Table 3: Evaluation of synthetic insecticides against thrips *T. tabaci* on cotton

Treatment	Dose (lit^{-1})	Thrips population (No. / 3 leaves) Days after sowing (DAS)			(+) / (-) over UTC (%)
		30	60	Mean	
Acephate 75 SP	2 g	25.1 B (5.04) fg	7.5 A (2.83) def	16.3 (3.9) f	-12.36
Acetamiprid 20 SP	0.2 g	15.9 (4.05) de	5.5 (2.45) d	10.7 (3.25) cd	-42.47
Carbosulfan 25 EC	2 ml	29.7 (5.49) g	4.9 (2.32) cd	17.3 (3.91) f	-6.99
Chlorantraniliprole 18.5 SC	0.3 ml	15.5 (4.0) cd	16.0 (4.06) ghi	15.75 (4.03) f	-15.32
Chlorpyriphos 20 EC	2.5 ml	28.8 (5.41) g	0.0 (0.71) a	14.4 (3.06) bc	-22.58
Diafenthiuron 50 WP	1.6 g	9.95 (3.22) b	9.8 (3.20)efg	9.87 (3.21) cd	-46.93
Dimethoate 30 EC	1.5 ml	27.0 (5.24) fg	5.5 (2.45) d	16.25 (3.84) f	-12.63
Fipronil 5 SC	3 ml	3.8 (2.07)a	2.5 (1.73)bc	3.15 (1.90) a	-83.06
Flubendiamide 20 WG	0.2 g	26.0 (5.14) fg	6.0 (2.55) d	16.0 (3.85) f	-13.98
Flonicamid 50 WG	0.2 g	10.1 (3.23) bc	4.4 (2.21) bcd	7.25 (2.72) b	-61.02
Imidacloprid 17.8 SL	0.2 ml	17.7 (4.27) de	2.2 (1.64) b	9.95 (2.95) bc	-46.50
Malathion 50 EC	2 ml	24.1 (4.95) fg	6.5 (3.31) fgh	15.30 (3.80) f	-17.74
Monocrotophos 36 WSC	2 ml	15.8 (4.02) d	5.6 (2.47) d	10.7 (3.24) cd	-42.47
Phosalone 35 EC	3 ml	18.1 (4.30) de	10.6 (3.31) gh	14.35 (3.81) f	-22.85
Profenophos 50 EC	2 ml	8.7 (3.03) b	5.6 (2.47) d	7.15 (2.75) b	-61.56
Quinalphos 25 EC	2 ml	21.6 (4.70) ef	6.7 (2.68) def	14.15 (3.69) ef	-23.92
Spiromecifen 22.9 SC	1.2 ml	11.0 (3.39) bcd	14.4 (3.86) ghi	12.7 (3.62) de	-31,72
Thiamethoxam 25 WG	0.2 g	15.0 (3.93) cd	6.3 (2.61) de	10.65 (3.27) cde	-42.74
Triazophos 40 EC	2 ml	16.9 (4.17) de	12.2 (3.51) ghi	14.55 (3.84) f	-21.77
Untreated check	-	16.9 (4.14) de	20.3 (4.56) j	18.60 (4.35) g	-
Mean	-	17.88 (4.19) B	7.62 (2.71) A	12.75 (3.45)	-

Mean of three replications. Figures in parentheses are √X+0.5 transformed values. In a column/row, means followed by a common letter are not significantly different at 5 % level (LSD).

	T	P	T x P
Significance	0.01	0.01	0.01
CD (p=0.05)	0.44	0.14	0.62

Whitefly, *B. tabaci*

Though the variability due to the treatments as well as interaction of treatments and periods of observation was found significant, the variability due to the periods of observation was not significant (Table 4). While considering the overall mean over two periods of observation, the incidence of whitefly, *B. tabaci* on the plants treated with synthetic insecticides ranged from 0.40 (Fipronil 5 SC) to 6.40 (Phosalone 35 EC) numbers per three leaves. Fipronil 5 SC and diafenthiuron 50 WP (0.45/3 leaves) were equally better than untreated check (1.25/3 leaves); they reduced the incidence by 68 and 64 per cent compared to untreated check. Though acetamiprid 20 SP, spiromesifen 22.9 SC and quinalphos 25 EC were able to reduce the whitefly population by more than 50 per cent, they were on par with untreated check.

The insecticide application provides an immediate solution to control the insect pests and seems to be most important pest management tool in boosting agricultural production. Of the nineteen insecticides evaluated, the significant superiority was preferably towards the control of leafhopper, *A. devastans* were diafenthiuron 50 WP and fipronil 5 SC (Fig. 1). Fipronil 5 SC was found to be an efficient one compared to pyrethroids, organo phosphorus compounds and carbamate insecticides [5]. The present finding is in accordance with the report from Bharpoda *et al.* [3] with difenthiuron 50 WP at 0.05%. Contrary finding from the same author was thiamethoxam 25 WG at 0.0125% was found significantly superior in reducing the population of *A. devastans* than rest of the treatments and fipronil 5 SC harboured more insects. The present investigation clearly indicated that, diafenthiuron 50 WP was the best insecticide followed by

fipronil 5 SC and flonicamid 50 WG but thiamethoxam 25 WG occupies fourth position in the effectiveness against the population of *A. devastans* in cotton.

The data on population of aphid were pooled over periods, revealed that diafenthiuron 50 WP, imidacloprid 17.8 SL, thiamethoxam 25 WG, triazophos 40 EC, spiromesifen 22.9 SC, dimethoate 30 EC, fipronil 5 SC, monocrotophos 36 WSC and carbosulfan 25 EC were superior treatments with cent per cent control. The obtained results were in agreement with the findings of Aggarwal *et al.* [1], Udikeri *et al.* [7] and Zanwar *et al.* [8], Bharpoda *et al.* [3].

The present study brought out the effectiveness of fipronil 5 SC, profenofos 50 EC, flonicamid 50 WG and imidacloprid 17.8 SL against *T. tabaci*. The similar findings were obtained from Aggarwal *et al.* [1] and Zanwar *et al.* [8] indicating the effectiveness of insecticides. The contrary data on efficacy of diafenthiuron 50 WP was reported by Bharpoda *et al.* [3] indicating that, diafenthiuron 50 WP (at 0.05%) was found significantly most effective than rest of the treatments and imidacloprid 17.8 SL (at 0.008%) was next best insecticide.

The present study brought out that, fipronil 5 SC and diafenthiuron 50 WP effectively controlled the whitefly population and was supported by Kalyan *et al.* [4]. Similarly, Zanwar *et al.* [8] also reported that fipronil 5 SC and diafenthiuron 50 WP effectively managed the population of *B. tabaci* on cotton.

Table 4: Evaluation of synthetic insecticides against whitefly, *B. tabaci* on cotton

Treatment	Dose (lit^{-1})	Whitefly population (No. / 3 leaves) Days after sowing (DAS)			(+) / (-) over UTC (%)
		30	60	Mean	
Acephate 75 SP	2 g	1.80 B (1.51) cde	0.70 A (1.07) abcdef	1.25 (1.28) def	0.00
Acetamiprid 20 SP	0.2 g	1.10 (1.26) abc	0.00 (0.71) a	0.55 (0.98) ab	-56.00
Carbosulfan 25 EC	2 ml	1.00 (1.20) abc	0.50 (0.99) abcde	0.75 (1.09) abcde	-40.00
Chlorantraniliprole 18.5 SC	0.3 ml	0.50 (1.00) a	0.80 (1.11) bcdef	0.65 (1.05) abcd	-48.00
Chlorpyriphos 20 EC	2.5 ml	2.70 (1.79) e	0.00 (0.71) a	1.35 (1.25) def	8.00
Diafenthiuron 50 WP	1.6 g	0.70 (1.07) ab	0.20 (0.83) abc	0.45 (0.95) a	-64.00
Dimethoate 30 EC	1.5 ml	0.80 (1.13) abc	2.00 (1.58) h	1.40 (1.35) fg	12.00
Fipronil 5 SC	3 ml	0.70 (1.09) ab	0.10 (0.77) ab	0.40 (0.93) a	-68.00
Flubendiamide 20 WG	0.2 g	0.90 (1.18) abc	1.30 (1.34) efg	1.10 (1.26) def	-12.00
Flonicamid 50 WG	0.2 g	1.30 (1.34) abcd	1.80 (1.50) g	1.55 (1.42) fg	24.00
Imidacloprid 17.8 SL	0.2 ml	1.10 (1.26) abc	1.00 (1.22) defg	1.05 (1.24) cdef	-16.00
Malathion 50 EC	2 ml	2.60 (1.75) e	1.40 (1.38) fg	2.00 (1.57) g	60.00
Monocrotophos 36 WSC	2 ml	1.70 (1.49) cde	0.90 (1.18) cdefg	1.30 (1.33) efg	4.00
Phosalone 35 EC	3 ml	12.00 (3.53) f	0.80 (1.14) cdefg	6.40 (2.34) h	412.00
Profenophos 50 EC	2 ml	1.70 (1.48) cde	0.00 (0.71) a	0.85 (1.09) abcde	-32.00
Quinalphos 25 EC	2 ml	1.20 (1.28) abc	0.00 (0.71) a	0.60 (0.99) abc	-52.00
Spiromecifen 22.9 SC	1.2 ml	1.20 (1.28) abc	0.00 (0.71) a	0.60 (0.99) abc	-52.00
Thiamethoxam 25 WG	0.2 g	1.40 (1.37) bcde	0.50 (0.96) abcd	0.95 (1.17) abcdef	-24.00
Triazophos 40 EC	2 ml	1.10 (1.26) abc	0.20 (0.83) abc	0.65 (1.05) abcd	-48.00
Untreated check	-	2.50 (1.73) de	0.00 (0.71) a	1.25 (1.22) bcdef	-
Mean	-	1.90 (1.45) B	0.61 (1.01) A	1.25 (1.23)	-

Mean of three replications. Figures in parentheses are √X+0.5 transformed values. In a column/row, means followed by a common letter are not significantly different at 5 % level (LSD).

	T	P	T x P
Significance	0.01	0.01	0.01
CD (p=0.05)	0.25	0.08	0.36

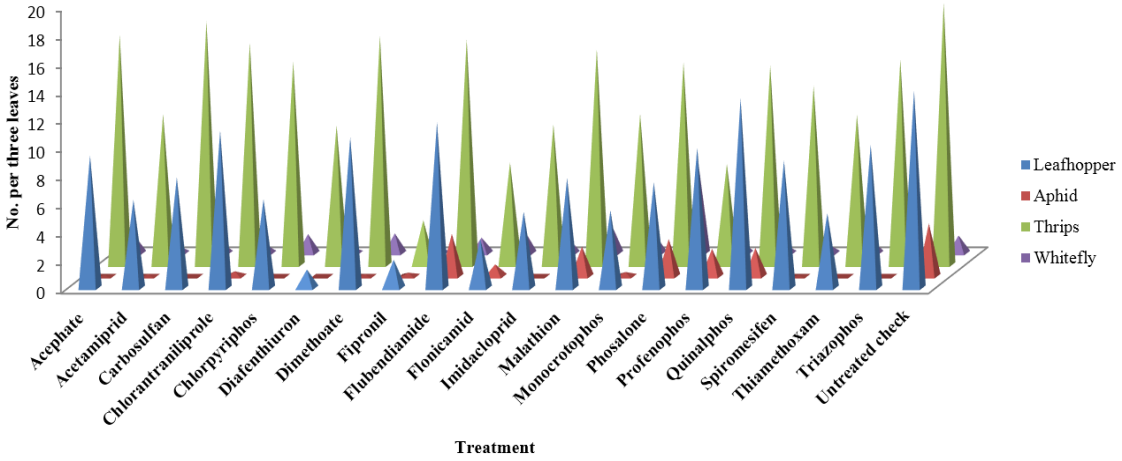

Fig 1: Influence of different synthetic insecticides on the incidence of sucking pests on cotton

Conclusion

In the present investigation, fipronil 5 SC, difenthiuron 50 WP, flonicamid 50 WG, thiamethoxam 25 WG, imidacloprid 17.8 SL and spiromesifen 22.9 SC were found more effective against sucking insect pests *viz*., leafhopper, aphid, thrips and whitefly infesting cotton. These insecticides can be recommended for the management of sucking insect pests in cotton looking to their effectiveness, economics and safety to the natural enemies.

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