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National Academy of Agricultural Science (NAAS)
Rating : 3.03

Evaluation of Insecticides for the Management of Cotton Aphid, *Aphis gossypii* Glover

V. Ravi Kumar[1], N.V.V.S.D. Prasad[2], T. Madhumathi[3]

Abstract: *Eight insecticides were evaluated to find out their efficacy against aphids and natural enemies on cotton. Among the insecticides evaluated, flonicamid 10 WG (15 g a.i./ha) had shown greater control against aphids throughout the crop period and was less harmful to natural enemies. Dinotefuran 20 SG (40 g a.i./ha) was found to be effective after flonicamid 10 WG where as bifenthrin 10 EC (75 g a.i./ha) was ineffective against aphids at all stages of the crop. Highest number of bolls and seed cotton yield was observed in flonicamid 10 WG treated plot which had shown significantly better performance over all other treatments.*

Key words: *Cotton, aphids, insecticide evaluation, flonicamid*

INTRODUCTION

Cotton is ravaged by an array of insect pests comprising of bollworms and sap sucking aphids. These aphids cause 22.85% reduction in cotton yield (Satpute *et al.,* 1990)[7]. Cotton aphids (*Aphis gossypii* Glover) occur each year on cotton. Moderate to high populations can reduce lint yield and quality. Yield reductions exceeding 100 lb lint/acre have been reported by Fuchs and Minzenmayer (1995)[3] when populations exceeded 50 aphids per leaf for 3 weeks. Because aphids reproduce rapidly, they are capable of developing insecticide resistance very quickly. Insecticide resistance in cotton aphid populations causes uncertainty among growers, consultants, and county agents as to the effectiveness of insecticides for cotton aphid control. This study was conducted in order to provide data on the relative performance of old and new insecticides against the cotton aphid.

MATERIALS AND METHODS

Evaluation of insecticides: The experiment to evaluate the insecticides to manage aphids on cotton crop was conducted at Regional Agricultural Research Station, Lam farm, Guntur, Andhra Pradesh during *kharif* season in the year 2013-14. The experiment was laid out in Randomized Block Design with eight insecticides monocrotophos 36 SL (360 g a.i./ha), acephate 75 SP (562.5 g a.i./ha), imidacloprid 17.8 SL (35.6 g a.i./ha), diafenthiuron 50 WP (300 g a.i./ha), fipronil 5 SC (50 g a.i./ha), dinotefuran 20 SG (40 g a.i./ha), flonicamid 10 WG (15 g a.i./ha), bifenthrin 10 EC (75 g a.i./ha) for foliar application and a control treatment which were replicated thrice. RCH 2 cotton hybrid was selected for this purpose with the spacing of 105 × 60 cm with plot size of 5.25×4.8 m^2. Standard agronomic practices were adopted to raise a good cotton crop.

Preparation of spray fluid for foliar application: A measured quantity of insecticidal solution /powder was mixed with a little quantity of water and stirred well, after which the remaining quantity of water was added to obtain the required concentration of spray fluid.

[1] Ph.D Scholar, Department of Entomology, Agricultural College, Bapatla, ANGRAU
[2] Senior scientist, RARS Lam, Guntur, ANGRAU
[3] Professor, Department of Entomology, Agricultural College, Bapatla, ANGRAU
E-mail: vanamaravikumar76@gmail.com

Foliar application of treatments: Sprayings were given by using a hand compression knapsack high volume sprayer, during morning hours. The plot in each treatment was sprayed with respective insecticides ensuring uniform coverage of insecticide. The first spraying was given at 50 days after sowing when the incidence of aphids population was sufficiently built up in the experimental plots. A total of four sprays were given during the course of season at 10 days interval.

Recording observations: Incidence of aphids per three leaves top, middle and bottom, natural enemies per plant were recorded with the help of 4X magnifying lens on 5 randomly selected plants per each treatment at 3rd and 7th day after treatment. Number of bolls per each plant and the kapas yield from each plot were recorded separately in kg/plot for two pickings and converted into q/ha.

RESULTS AND DISCUSSIONS

Efficacy of insecticides against aphids and natural enemies on cotton after first application: The data after three days of first application (Table 1) showed that flonicamid 10 WG recorded less population of aphids (4.13/3 leaves/plant), followed by dinotefuran 20 SG (5.07/3 leaves/plant) and diafenthiuron 50 WP (6.27/3 leaves/plant) where as imidacloprid 17.8 SL (10.13/3 leaves/plant) and bifenthrin 10 EC (10.60 /3 leaves/plant) recorded highest aphid population. Spider population was also non significant. Coccinellids population was high in control plot (1.73/plant) than all other treatments (Table 2). The data after seven days of first application (Table 1) showed that flonicamid 10 WG recorded less population of aphids (4.80/3 leaves/plant), followed by dinotefuran 20 SG (5.73/3 leaves/plant) where bifenthrin 10 EC (12.53/3 leaves/plant) recorded highest aphid population.

Efficacy of insecticides against aphids and natural enemies on cotton after second application: The aphid population data after three days of second application (Table 1) showed that flonicamid 10 WG recorded less population (4.53/3 leaves/plant), followed by dinotefuran SG (5.47/3 leaves/plant) and diafenthiuron 50 WP (6.80/3 leaves/plant) where as imidacloprid 17.8 SL (11.07/3 leaves/plant) and bifenthrin 10 EC (12.07/3 leaves/plant) recorded highest aphid population. Spider population was more in untreated plot (1.00/plant). Among the insecticidal treatments, flonicamid 10 WG (0.93/plant) recorded highest spider population which was on par with fipronil 5 SC (0.80/plant). Acephate 75 SP (0.60/plant) recorded lowest spider population. Coccinellids population in control (1.87/plant) and fipronil 5 SC (1.67/plant) treated plots was high than all other treatments. Dinotefuran 20 SG (1.40/3 leaves/plant) recorded lowest population of coccinellids, however it was on par on par with remaining treatments (Table 2). The data after seven days of second application (Table 1) showed that flonicamid 10 WG recorded less population of aphids (5.60/3 leaves/plant) where as imidacloprid 17.8 SL (13.07/3 leaves/plant) and bifenthrin 10 EC (13.73/3 leaves/plant) recorded highest aphid population.

Efficacy of insecticides against aphids and natural enemies on cotton after third application : The chemicals which could control the pest population in the first and second foliar application had shown the same pattern of results in the third foliar application. Flonicamid 10 WG recorded less population (4.93/3 leaves/plant) of aphids and bifenthrin 10 EC (13.07/3 leaves/plant) recorded highest aphid population but less than the control plot (24.47/3 leaves/plant) after three days of third application (Table 1). Spider and coccinellids population was more in control plot. Among the insecticidal treatments, flonicamid 10 WG (1.07/plant) recorded highest spider population where as coccinellids population was recorded high in fipronil 5 SC (1.67/plant) (Table 2). The data after seven days of third application (Table 1) showed that flonicamid 10 WG recorded less population of aphids (5.40/3 leaves/plant) and bifenthrin 10 EC (14.33/3 leaves/plant) recorded highest aphid population.

Efficacy of insecticides against aphids and natural enemies on cotton after fourth application: The data after three days and seven days of fourth application followed the same trend of chemical control of aphid population as observed in the previous sprays (Table 1). Spider population was more in control plot (1.33/plant) which was on par with flonicamid 10 WG (1.20/plant). Coccinellids

population was high in control (1.87/plant) and fipronil 5 SC (1.47/plant) than all other treatments (Table 2).

Cumulative efficacy of four sprays at 7 DAT against aphids on cotton: The cumulative efficacy of all the four sprays of different insecticides against aphids at seven days after sprays showed that the treatment flonicamid 10 WG recorded lowest population of aphids (4.92/3 leaves/plant) in all the sprayings and was significantly superior to all the other treatments including untreated check (Table 4.17). The present findings are in agreement with Morita *et al.* (2007)[5] who reported that flonicamid was very effective against aphids, regardless of differences in species, stages and morphs as this compound inhibited the feeding behaviour of aphids within 0.5 h of treatment. Fonseca *et al.* (2011)[2] carried out an experiment to evaluate the efficacy of flonicamid against *Aphis gossypii* on cotton crop and reported foliar application was effective in control of the pest. A study was conducted by Bartual *et al.* (2012)[1] to manage the aphids *Aphis gossypii* and *Aphis punicae*, and the study revealed that new generation insecticide flonicamid was very effective in controlling aphids. Rouhani *et al.* (2013)[6], reported that flonicamid at 0.1 mg/ml had the highest mortality against aphids.

Dinotefuran 20 SG (5.97/3 leaves/plant) recorded the lesser population of aphids and significantly superior to the remaining treatments. The present findings are in agreement with Xiao-Bin *et al* (2011)[9] who conducted studies to manage the imidacloprid-resistant cotton aphid *Aphis*

Table 1
Efficacy of insecticides against aphids on cotton

Treatments	*Aphids no./3 leaves/plant*									
		First spray		*Second spray*		*Third spray*		*Fourth spray*		*Cumulative efficacy of four sprays at 7 DAT*
	Before spray	*3 DAT*	*7 DAT*	*3 DAT*	*7 DAT*	*3 DAT*	*7 DAT*	*3 DAT*	*7 DAT*	
T_1:Monocrotophos 36 SL	15.13 (3.89)	7.07 $(2.66)^{bc}$	8.00 $(2.83)^{b}$	7.33 $(2.71)^{c}$	9.20 $(3.03)^{c}$	8.40 $(2.90)^{bc}$	9.53 $(3.09)^{cd}$	7.20 $(2.68)^{bc}$	6.60 $(2.57)^{c}$	8.33 $(2.89)^{c}$
T_2:Acephate 75 SP	14.80 (3.85)	9.07 $(3.01)^{cd}$	11.00 $(3.32)^{cd}$	9.80 $(3.13)^{de}$	11.60 $(3.14)^{de}$	10.80 $(3.29)^{de}$	11.93 $(3.45)^{def}$	10.27 $(3.20)^{de}$	8.60 $(2.93)^{d}$	10.78 $(3.28)^{e}$
T_3:Imidacloprid 17.8 SL	14.73 (3.84)	10.13 $(3.18)^{d}$	11.93 $(3.45)^{d}$	11.07 $(3.33)^{ef}$	13.07 $(3.61)^{de}$	12.20 $(3.49)^{e}$	13.07 $(3.61)^{ef}$	11.67 $(3.42)^{ef}$	9.20 $(3.03)^{d}$	11.82 $(3.44)^{f}$
T_4:Diafenthiuron 50 WP	14.33 (3.79)	6.27 $(2.50)^{b}$	7.20 $(2.68)^{b}$	6.80 $(2.61)^{bc}$	8.33 $(2.89)^{bc}$	7.87 $(2.80)^{b}$	8.80 $(2.97)^{bc}$	7.07 $(2.66)^{b}$	6.27 $(2.50)^{bc}$	7.65 $(2.77)^{c}$
T_5:Fipronil 5 SC	14.53 (3.81)	8.20 $(2.86)^{c}$	9.87 $(3.14)^{c}$	9.00 $(3.00)^{d}$	10.53 $(3.25)^{cd}$	9.80 $(3.13)^{cd}$	10.93 $(3.31)^{cde}$	9.27 $(3.04)^{cd}$	8.07 $(2.84)^{cd}$	9.85 $(3.14)^{d}$
T_6:Dinotefuran 20 SG	13.47 (3.67)	5.07 $(2.25)^{ab}$	5.73 $(2.39)^{a}$	5.47 $(2.34)^{ab}$	6.40 $(2.53)^{ab}$	6.07 $(2.46)^{a}$	6.93 $(2.63)^{ab}$	5.60 $(2.37)^{ab}$	4.80 $(2.19)^{ab}$	5.97 $(2.44)^{b}$
T_7:Flonicamid 10 WG	14.00 (3.74)	4.13 $(2.03)^{a}$	4.80 $(2.19)^{a}$	4.53 $(2.13)^{a}$	5.60 $(2.37)^{a}$	4.93 $(2.22)^{a}$	5.40 $(2.32)^{a}$	4.40 $(2.10)^{a}$	3.87 $(1.97)^{a}$	4.92 $(2.22)^{a}$
T_8:Bifenthrin 10 EC	13.40 (3.66)	10.60 $(3.26)^{d}$	12.53 $(3.54)^{d}$	12.07 $(3.47)^{f}$	13.73 $(3.71)^{e}$	13.07 $(3.61)^{e}$	14.33 $(3.79)^{f}$	12.93 $(3.60)^{f}$	10.07 $(3.17)^{d}$	12.67 $(3.56)^{f}$
T_9:Control	13.93 (3.73)	14.27 $(3.78)^{e}$	15.87 $(3.98)^{e}$	18.53 $(4.31)^{g}$	21.20 $(4.60)^{f}$	24.47 $(4.95)^{f}$	26.13 $(5.11)^{g}$	23.47 $(4.84)^{g}$	19.00 $(4.36)^{e}$	20.55 $(4.53)^{g}$
F-test	NS	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SEm±	0.11	0.09	0.09	0.09	0.12	0.11	0.12	0.12	0.12	0.04
CD (P=0.05)	0.34	0.27	0.27	0.28	0.37	0.32	0.36	0.37	0.35	0.12
CV(%)	5.26	5.62	5.11	5.44	6.62	5.82	6.25	6.93	7.14	2.32

Figures in parentheses are square root transformed values. NS: Non Significant, Sig: Significant

Table 2
Efficacy of insecticides against natural enemies on cotton after insecticide application

Treatments	Natural enemies/plant							
	after first application at 3 DAT		after second application at 3 DAT		after third application at 3 DAT		after fourth application at 3 DAT	
	Spiders	Coccinellids	Spiders	Coccinellids	Spiders	Coccinellids	Spiders	Coccinellids
T_1:Monocrotophos 36 SL	0.80 (0.89)	1.07 (1.03)^{b}	0.67 (0.82)^{bc}	1.53 (1.24)^{bc}	0.8 (0.89)^{cd}	1.53 (1.24)^{bcd}	0.87 (0.93)^{cd}	1.33 (1.15)^{b}
T_2:Acephate 75 SP	0.80 (0.89)	1.20 (1.10)^{b}	0.60 (0.77)^{c}	1.60 (1.26)^{bc}	0.73 (0.86)^{d}	1.33 (1.15)^{e}	0.80 (0.89)^{d}	1.27 (1.13)^{b}
T_3:Imidacloprid 17.8 SL	0.87 (0.93)	1.13 (1.06)^{b}	0.80 (0.89)^{abc}	1.60 (1.26)^{bc}	0.87 (0.93)^{bcd}	1.60 (1.26)^{bc}	0.87 (0.93)^{cd}	1.33 (1.15)^{b}
T_4:Diafenthiuron 50 WP	0.80 (0.89)	1.33 (1.15)^{b}	0.67 (0.82)^{bc}	1.53 (1.24)^{bc}	0.80 (0.89)^{cd}	1.47 (1.21)^{cde}	0.80 (0.89)^{d}	1.33 (1.15)^{b}
T_5:Fipronil 5 SC	0.87 (0.93)	1.20 (1.10)^{b}	0.80 (0.89)^{abc}	1.67 (1.29)^{ab}	1.07 (1.03)^{abc}	1.67 (1.29)^{b}	1.00 (1.00)^{abc}	1.47 (1.21)^{b}
T_6:Dinotefuran 20 SG	0.73 (0.86)	1.27 (1.13)^{b}	0.73 (0.86)^{abc}	1.40 (1.18)^{c}	0.87 (0.93)^{bcd}	1.4 (1.18)^{de}	0.93 (0.97)^{bcd}	1.27 (1.13)^{b}
T_7:Flonicamid 10 WG	0.80 (0.89)	1.27 (1.13)^{b}	0.93 (0.97)^{a}	1.60 (1.26)^{bc}	1.07 (1.03)^{abc}	1.67 (1.29)^{b}	1.20 (1.10)^{abc}	1.47 (1.21)^{b}
T_8:Bifenthrin 10 EC	0.87 (0.93)	1.33 (1.15)^{b}	0.67 (0.82)^{bc}	1.53 (1.24)^{bc}	0.80 (0.89)^{cd}	1.33 (1.15)^{e}	0.80 (0.89)^{d}	1.27 (1.13)^{b}
T_9:Control	0.87 (0.93)	1.73 (1.32)^{a}	1.00 (1.00)^{a}	1.87 (1.37)^{a}	1.27 (1.13)^{a}	2.07 (1.44)^{a}	1.33 (1.15)^{a}	1.87 (1.37)^{a}
F-test	NS	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SEm±	0.04	0.05	0.05	0.03	0.05	0.02	0.06	0.04
CD (P=0.05)	NS	0.14	0.14	0.09	0.15	0.07	0.17	0.10
CV(%)	6.87	7.27	6.87	6.17	8.98	5.37	10.18	5.16

Table 3
Influence of insecticides on number of bolls / plant and cotton yield

Treatment no.	Treatments	Dosage	Number of bolls/plant	Seed cotton yield(Q ha^{-1})
T_1	Monocrotophos 36 SL	360 g a.i./ha	46.89 ^{c}	20.96 ^{bc}
T_2	Acephate 75 SP	562.5 g a.i./ha	37.11 ^{d}	15.14 ^{e}
T_3	Imidacloprid 17.8 SL	35.6 g a.i./ha	29.00 ^{e}	14.51 ^{ef}
T_4	Diafenthiuron 50 WP	300 g a.i./ha	45.67 ^{c}	19.15 ^{cd}
T_5	Fipronil 5 SC	50 g a.i./ha	39.33 ^{d}	18.45 ^{d}
T_6	Dinotefuran 20 SG	40 g a.i./ha	54.00 ^{b}	21.97 ^{ab}
T_7	Flonicamid 10 WG	15 g a.i./ha	59.33 ^{a}	23.45 ^{a}
T_8	Bifenthrin 10 EC	75 g a.i./ha	26.89 ^{e}	12.63 ^{f}
T_9	Control		22.56 ^{f}	11.15 ^{f}
F-test			Sig	Sig
SEm			0.90	0.78
CD (P=0.05)			2.67	2.32
CV (%)			4.76	9.49

Sig : Significant

gossypii (Glover) and the results indicated that dinotefuran was the most effective insecticide for use against imidacloprid-resistant *A. gossypii*. The next best treatment was diafenthiuron 50 WP (7.65/3 leaves/plant). Scarpellini and Nakamura (1999)[8] reported that the control of *Frankliniella schultzei* and *Aphis gossypii* using diafenthiuron gave a satisfactory level of control of the pest. Bifenthrin 10 EC (12.67/3 leaves/plant) found to be the least effective in reducing aphid population. The present findings are in agreement with Khan (2011)[4] who reported that bifenthrin 10 EC was less effective against sucking insect pests.

Influence of insecticides on number of bolls / plant and cotton yield: Number of bolls per each plant and the kapas yield from each plot were recorded separately in kg/plot for two pickings and converted into q/ha (Table 3). The data showed that flonicamid 10 WG which was effective against aphids recorded highest number of bolls per plant (59.33) and yield (23.45 q/ha). Dinotefuran 20 SG which was on par with flonicamid 10 WG recorded 54 bolls per plant and yield of 21.97 q/ha. Monocrotophos 36 SL and diafenthiuron 50 WP were on par with each other and recorded 46.89,45.67 bolls per plant and 20.96, 19.15 Q/ha respectively. Less number of bolls (26.89) and yield (12.63 q/ha) was observed in bifenthrin 10 EC. Untreated control plot recorded lowest bolls (22.56/ plant) and yield (11.15q/ha).

CONCLUSIONS

All the insecticides tested were superior to untreated check by recording lower population of aphids. Among the insecticides tested, flonicamid 10 WG was found to be highly effective against aphids which was followed by dinotefuran 20 SG. Diafenthiuron 50 WP and monocrotophos 36 SL were also found to reduce aphids population. Fipronil 5 SC, acephate 75 SP, imidacloprid 17.8 SL and bifenthrin 10 EC were very less effective against aphids when compared with flonicamid 10 WG. The efficacy of all the treatments decreased after 7 DAT leading to slight build up of population. Among the natural enemy complex, spiders and coccinellid beetles were dominant predators. The natural enemy population was high in flonicamid 10 WG and fipronil 5 SC among the insecticides evaluated. Highest number of bolls (59.33/plant) and seed cotton yield (23.45 q/ha) was observed in flonicamid 10 WG treated plot which had shown significantly better performance over all other treatments. The information developed by this study helps producers to choose effective insecticides for controlling of cotton aphid.

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