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Bio efficacy of different novel insecticides against aphid, *A. gossypii* in transgenic cotton

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Abstract
Field efficacy of some new insecticides were assessed against cotton aphid, *A. gossypii during kharif* 2011-12 at Regional Agricultural Research Station, Lam, Guntur. *Bt* cotton hybrid RCH-2 was selected for this experiment. A total of 9 insecticides were tried against the aphid population. Out of all the insecticides tried after three sprays, imidacloprid 70%WG showed the best result with 69.4% mortality followed by diafenthiuron 50%WP and fipronil 80%WG with 66.2% 60.1% mortality respectively and buprofezin 25%SC worked least with 44.7% mortality. However out of all the insecticides treated plots, fipronil 5% SC treated plot gave highest yield with 13.5q/ha followed by fipronil 80%WG with 13.4q/ha and diafenthiuron 50%WP 12.7q/ha.

Keywords: Cotton, aphid, imidacloprid 70%WG, fipronil 5%SC

Introduction
Cotton, the most important commercial crop of India, is subjected to the ravages of a number of insect pests. Sucking pests have become quite serious from seedling stage, their heavy infestation at times reduces the crop yield to a great extent. The estimated loss due to sucking pests is up to 21.20% [1] among the sap feeders aphids *Aphis gossypii* (Glover), Leafhoppers *Amrasca biguttula biguttula* (Ishida), *thrips Thrips* tabaci (Linn) and whitefly *Bemisia tabaci* are deadly pests. Cotton growers in India depend heavily on synthetic pesticides
to combat sucking pests. Atleast 2-3 sprays are directed against sucking pests. Due to continuous and indiscriminate use of synthetic insecticides, there is resistance and hence the efficacy has become less reliable. To overcome this problem discovery of novel substances with different biochemical targets are needed.
A number of broad-spectrum insecticides, with a comparatively longer residual effect, are being sprayed, as a common practice by the farmers. In India, at least 2-3 sprays are directed against the sucking pests [2]. This practice wipes off the useful fauna from the field and lead to complex pest problem and flare up of one or other pest, in such situation, there is every need to suggest more selective insecticide, which have less deleterious effects on the beneficials
Several potent insecticides have been recommended for managing sucking pests, but the use of insecticides have resulted in the development of resistance, resurgence, secondary pest out breaks, disruption of natural enemy complex and environmental pollution [3]. The newer molecules have a higher stability and superiority over the conventional insecticides to control the pest population density at field level [4]. Fipronil 5% SC @ 50-75 gm a.i. ha^{-1} dose was found optimum against aphids, leafhoppers and thrips of cotton [5]. Imidacloprid 70 WG @ 40 g a.i. ha^{-1} provided good protection against aphids, thrips, whiteflies and leafhoppers of cotton [6]. Likewise, spirotetramat 150 OD @ 75 g a.i. ha^{-1} was effective in checking the population of aphid [7]. The investigation was therefore undertaken for the suitable management practices to combat the aphid damage.

Materials and methods
The experiment was laid out in Randomized Block Design with ten treatments including control and replicated thrice with plot size of 6.3 m X 5.4 m. Standard agronomic practices were adopted to raise a good crop of cotton. Treatment particulars are presented in table-1

Seed treatment
For delinted seed, 5 ml of gum per kg seed was evenly distributed through thorough shaking in a polythene bag into which 5 g of imidacloprid 70 WS was added for uniform coating over the

seed. Then the treated seed was shade dried for about 10 minutes and used for sowing.

Application of treatments

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. 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 sprayer and the accessories were thoroughly washed before changing the insecticides and also rinsed with the spray fluid of the chemical to be applied next. The first spraying was given at 60 DAS when the incidence of sucking pest population was sufficiently built up in the experimental plots. A total of three sprays were given during the course of season at ten days interval.

Recording observations

The incidence of sucking pests viz., aphids, leafhoppers, whiteflies and thrips were recorded by counting the number of nymphs and adults per three leaves, per plant on five randomly selected plants per plot at 3, 7 and 10 days after treatment. The seed cotton yield from each plot was recorded twice separately in kg/plot and converted into q/ha.

Table 1: Particulars of insecticides used

S. No.	Chemical name	Chemical class	a.i. ha^{-1}
T_1	Diafenthiuron 50% WP	Thiourea	375
T_2	Fipronil 5% SC	Phenylpyrazole	50
T_3	Spirotetramat150 OD	Ketoenols	90
T_4	Imidacloprid 70% WG	Neonicotinoids	21
T_5	Fipronil 80% WG	Phenylpyrazole	50
T_6	Buprofezin 25% SC	Insect growth regulator	150
T_7	Spiromesifen 240 SC	Spirocyclic tetronic acids	40
T_8	Thiacloprid 21.7% SC	Neonicotinoids	24
T_9	Acephate 75% SP	Organophosphate	750

Results and discussions

Mean data on aphids at 3 DAT ranged from 4.3 to 16.1/three leaves (Table-2, 3, Fig. 1). Imidacloprid 70% WG @ 21 g a.i. ha^{-1}(4.3/ three leaves) was the effective treatment and it was on par with diafenthiuron 50% WP @ 375 g a.i. ha^{-1} (4.8/three leaves), fipronil 5% SC @ 50 g a.i. ha^{-1} (5.4/three leaves) and fipronil 80% WG @ 50 g a.i. ha^{-1}(5.7/three leaves). The treatments, acephate 75% SP @ 750 g a.i. ha^{-1} (6.5/three leaves), thiacloprid 21.7% SC @ 24 g a.i. ha^{-1} (7.2/three leaves), spirotetramat 150 OD @ 90 g a.i. ha^{-1} (7.7/three leaves), spiromesifen 240 SC @ 40 g a.i. ha^{-1}(8.1/three leaves) and buprofezin 25% SC @ 150 g a.i. ha^{-1} (8.8/three leaves) which were on par with each other and significantly superior over untreated control.

Similar trend was observed at 7 DAT and 10DAT also. 7 DAT population ranged from 4.6 to 16.6/three leaves, imidacloprid 70% WG (4.6/ three leaves) was the effective treatment and it is at par with diafenthiuron 50% WP @ 375 g a.i. ha^{-1} (5.2/three leaves), fipronil 5% SC @ 50 g a.i. ha^{-1} (5.7/ three leaves), fipronil 80% WG @ 50 g a.i. ha^{-1}(6.0/ three leaves) and acephate 75% SP @ 750 g a.i. ha^{-1} (6.8/three leaves). The treatments, thiacloprid 21.7%SC @ 24 g a.i. ha^{-1} (7.5/three leaves), spirotetramat 150 OD @ 90 g a.i. ha^{-1} (8.0/three leaves), spiromesifen 240 SC @ 40 g a.i. ha^{-1}(8.3/three leaves) and buprofezin 25% SC @ 150 g a.i. ha^{-1} (9.2/three leaves) were on par with each other and superior over untreated control.

The aphid population ranged from 5.0 to 17.3/three leaves at 10DAT. Lowest population was recorded in imidacloprid 70% WG @ 21 g a.i. ha^{-1} (5.2/ three leaves) followed by diafenthiuron 50% WP @ 375 g a.i. ha^{-1} (5.7/three leaves), fipronil 5% SC @ 50 g a.i. ha^{-1} (6.8/three leaves), fipronil 80% WG @ 50 g a.i. ha^{-1} (6.8/ three leaves) and acephate 75% SP @750 g a.i. ha^{-1} (7.4/three leaves) and these are at par with each other. The treatments, thiacloprid 21.7% SC @ 24 g a.i.ha^{-1} (8.1/three leaves), spirotetramat 150 OD @ 90 g a.i. ha^{-1} (8.4/three leaves), spiromesifen 240 SC @ 40 g a.i. ha^{-1}(8.7/three leaves) and buprofezin 25% SC @150 g a.i. ha^{-1} (9.5 /three leaves) were on par with each other and superior over untreated control

The per cent reduction of aphid population at 10 DAT indicated that imidacloprid 70% WG @ 21 g a.i. ha^{-1} (69.4%) was the most effective treatment followed by diafenthiuron 50% WP @ 375 g a.i. ha^{-1} (66.2%), fipronil5% SC @ 50 g a.i. ha^{-1} (62.1%), fipronil 80% WG @ 50 g a.i. ha^{-1}(60.1%), acephate 75% SP @ 750 g a.i. ha^{-1} (56.4%), thiacloprid 21.7% SC @ 24 g a.i. ha^{-1} (52.7%), spirotetramat 150 OD @ 90 g a.i. ha^{-1} (50.6%), spiromesifen 240 SC @ 40 g a.i. ha^{-1}(49.0%) and buprofezin 25% SC @150 g a.i. ha^{-1}(44.7%).

It is clearly evident from the results, the treatment imidacloprid70%WG @ 21 g a.i. ha^{-1} has recorded the lowest population of aphids with highest percentage reduction during first, second and third spray 57.0%, 70.7% and 80.0%, respectively. Imidacloprid is a chloronicotinyal insecticide exhibiting both systemic and contact activity primarily against sucking insects. It has a novel mode of action, binding to nicotinergic acetylcholine receptor. The observations in confirmity with findings of [8], who reported that imidacloprid 70% WG at 35 g a.i. ha^{-1} caused the highest reduction in the population of aphids in cotton at 1, 3, 5 and 7 days after first and second spray. Cent per cent mortality of aphids was observed up to 7 and 9 DAT when imidacloprid 17.8% SL was applied at 25 g a.i. ha^{-1} [(9)]. Imidacloprid (Confidor350 SC) @ 26.25 g a.i. ha^{-1} was found superior in reducing the population of aphids 18.60 to 5.81/three leaves at three days after first application [10, 6]. reported that two sprays of imidacloprid 70 WG (Admire) @ 40 g/ha rendered very good protection of crop against the early season sucking pests.

The next best treatments are diafenthiuron 50% WP, fipronil 5% SC and fipronil 80% WG and they are at par with each other. The efficacy of diafenthiuron 50% WP aginst aphid was scanty, however, [11] reported that diafenthiuron 50SC @ 400 g a.i. ha^{-1} was found most effective and recorded maximum reduction in population of whitefly [5]. reported that treatment with fipronil 5% SC @ 50-75 g a.i. ha^{-1} was effective in lowering the population of thrips, aphids and jassids infesting cotton.

Acephate 75% SP and thiacloprid 21.7% SC were on par with

each other in suppressing the aphid on cotton. [12] reported the highest percent reduction of aphids (93.3%) with acephate (0.15%) on okra. [13] revealed that imidacloprid and thiacloprid gave the best control of *A. gossypii* at 3 days after application, with at least 96% control.

Spirotetramat 150 OD was next best treatment for controling of aphid and it is in conformity with the reports of [14, 7] who reported that spirotetramate 150 OD proved to be effective in registering the significantly lowest number of aphids population.

Table 2: Bioefficacy of different novel insecticides against aphid, *A. gossypii*

S. No.	Treatments	First spray				Second spray				Third spray			
		3DAT*	7DAT*	10DAT*	% reduction over control at 10DAT **	3DAT*	7DAT*	10DAT*	% reduction over control at 10DAT **	3DAT*	7DAT*	10DAT*	% reduction over control at 10DAT **
T1	Diafenthiuron 50% WP	6.1 (2.67)^{ab}	6.6 (2.76)^{ab}	7.1 (2.85)^{ab}	55.3 (48.09)^{ab}	5.3 (2.50)^{ab}	5.5 (2.56)^{ab}	5.8 (2.61)^{ab}	65.9 (54.34)^{ab}	3.1 (2.03)^{ab}	3.3 (2.08)^{ab}	4.3 (2.29)^{ab}	77.0 (61.51)^{ab}
T2	Fipronil 5% SC	6.9 (2.82)^{ab}	7.1 (2.85)^{ab}	7.5 (2.91)^{ab}	53.3 (47.01)^{ab}	5.9 (2.62)^{ab}	6.1 (2.67)^{ab}	6.8 (2.79)^{ab}	60.8 (51.39)^{abc}	3.5 (2.11)^{ab}	3.8 (2.19)^{ab}	5.1 (2.46)^{abc}	73.2 (58.98)^{abc}
T3	Spirotetramat150 OD	8.5 (3.09)^{b}	8.9 (3.14)^{b}	9.1 (3.18)^{b}	42.8 (40.83)^{ab}	8.3 (3.04)^{b}	8.5 (3.09)^{b}	8.7 (3.12)^{b}	48.7 (44.27)^{bc}	6.3 (2.71)^{bc}	6.6 (2.76)^{bc}	7.5 (2.91)^{def}	59.8 (50.79)^{def}
T4	Imidacloprid 70% WG	5.6 (2.57)^{a}	6.1 (2.67)^{a}	6.7 (2.78)^{a}	57.0 (49.12)^{a}	4.7 (2.38)^{a}	4.9 (2.42)^{a}	5.1 (2.46)^{a}	70.7 (57.34)^{a}	2.7 (1.93)^{ab}	2.9 (1.98)^{a}	3.7 (2.18)a	80.0 (63.56)^{a}
T5	Fipronil 80% WG	7.1 (2.84)^{ab}	7.5 (2.91)^{ab}	7.9 (2.98)^{ab}	50.7 (45.40)^{ab}	6.5 (2.73)^{ab}	6.7 (2.78)^{ab}	7.0 (2.83)^{ab}	58.8 (50.13)^{abc}	3.7 (2.16)^{ab}	3.9 (2.21)^{ab}	5.5 (2.56)^{abcd}	70.6 (57.24)^{abcd}
T6	Buprofezin 25% SC	9.1 (3.17)^{b}	9.5 (3.24)^{b}	9.9 (3.31)^{b}	37.6 (37.78)^{b}	8.9 (3.14)^{b}	9.2 (3.19)^{b}	9.5 (3.25)^{b}	43.7 (41.23)^{c}	8.5 (3.08)^{c}	8.9 (3.15)^{c}	9.0 (3.16)^{f}	51.5 (45.89)^{f}
T7	Spiromesifen 240 SC	8.7 (3.11)^{b}	9.1 (3.18)^{b}	9.3 (3.21)^{b}	41.6 (40.15)^{ab}	8.4 (3.07)^{b}	8.7 (3.12)^{b}	8.9 (3.15)^{b}	48.2 (43.98)^{bc}	7.1 (2.85)^{c}	7.5 (2.84)^{bc}	7.9 (2.99)^{def}	57.5 (49.40)^{ef}
T8	Thiacloprid 21.7%SC	8.1 (3.01)^{b}	8.4 (3.07)^{ab}	8.9 (3.14)^{ab}	44.3 (41.74)^{ab}	7.8 (2.97)^{b}	8.1 (3.01)^{b}	8.5 (3.08)^{b}	50.8 (45.46)^{bc}	5.7 (2.58)^{bc}	6.1 (2.66)^{b}	6.9 (2.82)^{cdef}	63.3 (52.74)^{cdef}
T9	Acephate 75%SP	7.7 (2.96)^{ab}	7.9 (2.98)^{ab}	8.3 (3.04)^{ab}	47.2 (43.35)^{ab}	7.2 (2.86)^{b}	7.6 (2.93)^{b}	7.9 (2.99)^{b}	53.9 (47.30)^{abc}	4.5 (2.34)^{b}	5.1 (2.46)^{b}	6.1 (2.67)^{bcde}	67.6 (55.34)^{bcde}
T10	Control (untreated)	14.5 (3.94)^{c}	15.1 (4.01)^{c}	15.9 (4.11)^{c}		16.3 (4.16)^{c}	16.7 (4.21)^{c}	17.1 (4.26)^{c}		17.5 (4.30)^{d}	17.9 (4.35)^{d}	18.9 (4.46)^{g}	
	F-TEST	sig	sig	sig	sig	Sig	sig	sig	sig	sig	sig		
	SEm	0.13	0.15	0.14	3.10	0.15	0.16	0.16	3.33	0.13	0.14	0.07	1.30
	CD(P=0.05)	0.40	0.45	0.42	9.22	0.46	0.48	0.42	9.90	0.39	0.43	0.38	6.72

*Figures in parentheses are square root transformed values. Sig: Significant.
**Figures in parentheses are angular transformed values. NS: Non-significant.
Numbers followed by same superscript are not statistically different. DAT: Days after treatment.

Table 3: Mean efficacy of different novel insecticides against *A. gossypii*

S. No.	Treatments	Aphids			
		3DAT*	7DAT*	10DAT*	% reduction over control at 10DAT **
T_1	Diafenthurion50%WP	4.8 (2.40)^{ab}	5.2 (2.46)^{a}	5.7 (2.58)^{ab}	66.2 (54.67)^{ab}
T_2	Fipronil 5% SC	5.4 (2.52)^{ab}	5.7 (2.57)^{ab}	6.4 (2.72)^{abc}	62.1 (52.17)^{bc}
T_3	Spirotetramat 150OD	7.7 (2.95)^{de}	8.0 (3.00)^{de}	8.4 (3.07)^{ef}	50.6 (45.39)^{def}
T_4	Imidacloprid 70% WG	4.3 (2.29)^{a}	4.6 (2.36)^{a}	5.2 (2.47)^{a}	69.4(56.69)^{a}
T_5	Fipronil 80% WG	5.7 (2.58)^{abc}	6.0 (2.63)^{abc}	6.8 (2.79)^{bcd}	60.1(50.93)^{c}
T_6	Buprofezin25%SC	8.8 (3.13)^{e}	9.2 (3.19)^{e}	9.5 (3.24)^{f}	44.7 (41.95)^{f}
T_7	Spiromesifen 240SC	8.1 (3.01)^{de}	8.3 (3.05)^{de}	8.7 (3.12)^{ef}	49.0 (44.44)^{ef}
T_8	Thiacloprid 21.7% SC	7.2 (2.85)^{cde}	7.5 (2.91)^{cde}	8.1 (3.01)^{ef}	52.7 (46.57)^{de}
T_9	Acephate 75% SP	6.5 (2.72)^{bcd}	6.8 (2.79)^{bcd}	7.4 (2.90)^{cde}	56.4 (48.74)^{cd}
T_{10}	Control (untreated)	16.1 (4.13)^{f}	16.6 (4.19)^{f}	17.3 (4.27)^{g}	
	F-TEST	**sig**	**sig**	**sig**	**sig**
	SEm	**0.05**	**0.05**	**0.05**	**0.69**
	CD (P=0.05)	**0.29**	**0.29**	**0.29**	**3.56**

*Figures in parentheses are square root transformed values. Sig: Significant.
**Figures in parentheses are angular transformed values. NS: Non significant.
Numbers followed by same superscript are not statistically different. DAT: Days after treatment

Table 4: Seed cotton yield

S. No.	Treatments	YIELD(q/ha)
T1	Diafenthurion50%WP	12.7
T2	Fipronil 5% SC	13.5
T3	Spirotetramat 150 OD	9.3
T4	Imidacloprid 70% WG	11.1
T5	Fipronil 80% WG	13.4
T6	Buprofezin25%SC	12.2
T7	Spiromesfin 240 SC	10.1
T8	Thiacloprid 21.7% SC	8.6
T9	Acephate 75% SP	11.4

T10	Control (untreated)	7.2
	F-TEST	sig
	SEm	0.40
	CD(P=0.05)	2.07

Conclusion

It is evident from the present investigation that the plot treated with Imidacloprid 70%WG showed the best result with 69.4% mortality followed by diafenthiuron 50%WP and fipronil 80%WG with 66.2% 60.1% mortality respectively. All the plots showed increased yield over control however fipronil 5% SC treated plot gave highest yield with 13.5q/ha followed by fipronil 80%WG with 13.5q/ha and diafenthiuron 50%WP 12.7q/ha. Hence it could be recommended for safe and economic use in cotton for effective control of aphid.

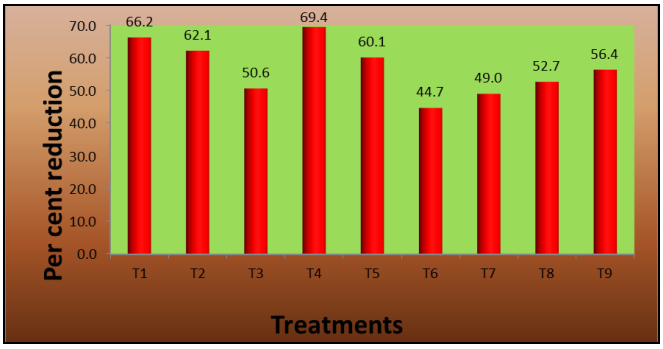

Fig 1: Mean per cent reduction of aphids over control at 10 days after treatment

T1: Diafenthiuron 50% WP -375 g a.i. ha^{-1}
T2: Fipronil 5% SC - 50 g a.i. ha^{-1}
T3: Spirotetramat 150% OD - 90 g a.i. ha^{-1}
T4: Imidacloprid 70% WG -21 g a.i. ha^{-1}
T5: Fipronil 80% WG -50 g a.i. ha^{-1}
T6: Buprofezin 25% SC -150 g a.i. ha^{-1}
T7: Spiromesifen 240% SC - 40 g a.i. ha^{-1}
T8: Thiacloprid 21.7% SC - 24 a.i. ha^{-1}
T9: Acephate 75% SP -750 g a.i. ha^{-1}

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