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Bioefficacy Of Newer Insecticides Against Sucking Pest Complex Of Transgenic Cotton

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ABSTRACT
Studies on bio-efficacy of newer insecticides against major sucking pests of cotton results indicated that among all insecticides diafenthiuron 50% WG @ 300 g.a.i/ha and imidacloprid 17.8 SL @ 25 g.a.i/ha was found most effective in reducing aphid population. Minimum incidence of jassids was found in dinotefuron 20% SG @ 200 g.a.i/ ha treated plots followed by flonicamid 50 WG @ 75 g.a.i/ha. The insecticides fipronil 5%SC @ 50 g.a.i/ha and dinotefuron 20% SG @ 200 g.a.i/ ha were found most effective against thrips. The insecticides Buprofezin 25 EC @ 250 g.a.i/ha, fipronil 5%SC @ 50 g.a.i/haand diafenthiuron 50% WG @ 300 g.a.i/ha were found effective against whiteflies after 1st, 2nd and 3rd spray.
Key words:Cotton, sucking pest complex, bioefficacy, insecticides

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INTRODUCTION

Cotton is a commercial cash crop of India and is grown in three agro-climatic zones. Cotton (*Gossypium* Spp.), in a way is a gift of the Indian subcontinent to human civilization. By far, cotton is the most important natural fibre or vegetable wool has been in the cultivation commercially for domestic consumption and export needs in about 111 countries worldwide and hence called "King of fibres. India accounts for about 26% of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 10.9mha to 12.8 mha constituting about 38% to 41% of the world area under cultivation (CAB & ICAC, April 2017). Although India stands first in acreage of cotton however the yield is well below the other cotton growing countries. Though there are several reasons attributed to this low yield, losses due to pests assumes significant importance as cotton crop is a heaven for insects. As many as 1326 species of insect pests have been reported on this crop throughout the world. Among that cotton is subjected to severe damage by 162 spp. of pests right from germination to the final picking (Dhaliwal and Arora, 1998). A complex of sucking pests viz., green leaf hoppers, *Amrasca biguttala biguttala* (Ishida), thrips, *Thrips tabaci* (Linnman), aphids, *Aphis gossypii* (Glover). Whitefly, *Bemicia tabaci* (Gennailius), red cotton bug, *Dysdersus koenigii* (Fabricius) and Dusky cotton bug, *Oxycarenus hyalinipennis* (Costa) *Bt* cotton is specially developed for the bollworms but sucking pests are emerging as prime insect pests causing severe losses in yield. Hence it is necessary to reduce the losses caused by sucking pests with suitable chemical control methods for sucking pests in *Bt* cotton.

MATERIALS AND METHODS

Field experiment was laid out in a randomized block design (RBD) at during *kharif*, 2015-2016 and 2016-17 seasons. The experiment consisted of 9 treatments replicated thrice. A cotton hybrid, RCH-2 BGIIwas raised in plots of 4.5x4.2 metre with 90 x 60 cm row to row and plant to plant spacing. All agronomic practices were followed as per the recommended package of practices except plant protection to get good crop. Thetreatments were imposed when the sucking pest population crossed ETL a total of three sprays were taken up. Observations were recorded a day before and 1, 3, 7 and 14 days after each spray from five randomly selected and tagged plants in each plant three leaves were selected from top, middle and bottom of the plant and expressed as mean number of hopper per three leaves. While Natural enemies were recorded from whole five tagged plants in each treatment and were expressed as number per plant. The data was subjected to statistical analysis after square root transformation of the data.

RESULTS AND DISCUSSION

The results pertaining to the bioefficacy of newer insecticides against sucking pest complex of cotton are presented in table 1 to 4.

Cotton Aphid-

After first spray-

The mean leafhopper population prior to insecticidal application was non-significant among the various treatments. After the first spray, aphids population varied from 2.55 to 12.23 per three leaves. The lowest population of leafhopper was recorded in diafenthuron (300) g a.i/ha (2.55/three leaves) followed by imidacloprid (25) (4.13/three leaves), dinotefuron (40) g a.i/ha (4.27/three leaves) and spiromesifen 22.95 % SC (96) (4.77/three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years Table 1 indicated that diafenthuron 50% WP (79.14 %), imidacloprid 17.8%SL (66.23 %) and dinotefuron 520% SG (65.08 %) were the most effective insecticides for reduction in aphid population on cotton which were at par with each other. The next best treatments were spiromesifen 22.95 % SC (60.99 %) and fipronil 5% SC (57.89 %). These were followed by flonicamid 50% WG, buprofezin 24 % EC and sulfaxaflor 24 % SC.

After second spray-

After the second spray, mean aphids population varied from 3.32 to 13.53 per three leaves. The lowest population of aphid was recorded in diafenthuron (300) g a.i/ha (3.32/three leaves) followed by imidacloprid (25) (5.12/three leaves), and dinotefuron 20% SG (40) (5.60/ three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years indicated that diafenthuron 50% WP (75.46 %), imidacloprid 17.8%SL (62.15 %) and dinotefuron20% SG (58.61 %) were the most effective insecticides for reduction in aphid population on cotton which were at par with each other. The next best treatments were Spiromesifen 22.95 % SC (51.44 %) and fipronil 5% SC (51.14 %). These were followed by flonicamid 50% WG, buprofezin 24 % EC and sulfaxaflor 24 % SC.

Third spray-

After the third spray, mean aphids population varied from 1.22 to 9.16 per three leaves. The lowest population of aphid was recorded in diafenthuron (300) g a.i/ha (1.22/three leaves) followed by imidacloprid (25) (2.02/three leaves), and dinotefuron 20% SG (40) (2.82/ three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years indicated that diafenthuron 50% WP (86.68 %), imidacloprid 17.8%SL (77.94 %) and dinotefuron 520% SG (74.67 %) were the most effective insecticides for reduction in aphid population on cotton which were at par with each other. The next best treatments were spiromesifen 22.95 % SC (69.21 %) and fipronil 5% SC (68.01 %). These were followed by flonicamid 50% WG, buprofezin 24 % EC and sulfaxaflor 24 % SC.

Cotton Jassid-

After first spray-

The mean leafhopper population prior to insecticidal application was non-significant among the various treatments. After the first spray, mean leafhopper population varied from 2.69 to 12.53 per three leaves. The lowest population of leafhopper was recorded in dinotefuron (40) g a.i/ha (2.69/three leaves) followed by flonicamid 50% WG (3.97/three leaves) and diafenthuron 50% WPg a.i/ha (4.19/three leaves) with more than 78 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years Table 2 indicated that dinotefuron 20% SG (78.53 %), flonicamid 50% WG (68.31 %) and diafenthuron 50% WP (66.56 %) were the most effective insecticides for reduction in jassid population on cotton which were at par with each other. The next best treatments were fipronil 5% SC (62.72 %) and buprofezin 24 % EC (61.29 %). These were followed by sulfaxaflor 24 % SC, spiromesifen 22.95 % SC and imidacloprid 17.8%SL.

After second spray-

After the second spray, mean leafhopper population varied from 1.96 to 11.63 per three leaves. The lowest population of leafhopper was recorded in dinotefuron (40) g a.i/ha g a.i/ha (1.96/three leaves) followed by flonicamid 50% WG (2.89/three leaves) and diafenthuron 50% WPg a.i/ha (3.13/three leaves) with more than 78 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years indicated that dinotefuron 20% SG (83.14 %), flonicamid 50% WG (75.15 %) and diafenthuron 50% WP (73.08 %) were the most effective insecticides for reduction in jassid population on cotton which were at par with each other. The next best treatments were fipronil 5% SC (69.56 %) and buprofezin 24 % EC (69.09 %). These were followed by sulfaxaflor 24 % SC, spiromesifen 22.95 % SC and imidacloprid 17.8%SL.

Third spray-

After the third spray, mean leafhopper population varied from 1.12 to 12.04 per three leaves. The lowest population of leafhopper was recorded in dinotefuron (40) g a.i/ha g a.i/ha (1.12/three leaves) followed by flonicamid 50% WG 1.76/three leaves) and diafenthuron 50% WPg a.i/ha (1.99/three leaves) with more than 78 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years indicated that dinotefuron 20% SG (90.69 %), flonicamid 50% WG (85.38 %) and diafenthuron 50% WP (83.47 %) were the most effective insecticides for reduction in jassid population on cotton which were at par with each other. The next best treatments were fipronil 5% SC (78.07 %) and buprofezin 24 % EC (77.49 %). These were followed by sulfaxaflor 24 % SC, spiromesifen 22.95 % SC and imidacloprid 17.8%SL.

Cotton thrips-

After first spray-

After the first spray, mean thrips population varied from 3.71 to 12.84 per three leaves. The lowest population of thrip was recorded in fipronil (3.71/three leaves) followed by Flonicamid(5.21/three leaves) and dinotefuron (5.40/three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years Table 3 indicated that fipronil 5% SC (71.10 %), Flonicamid 50% WG (59.42 %) and dinotefuron 20% SG (57.94 %) were the most effective insecticides for reduction in thrips population on cotton which were at par with each other. The next best treatments were imidacloprid 17.8%SL (51.47 %) and diafenthuron 50% WP (48.98 %).

After second spray-

After the second spray, mean thrips population varied from 1.80 to 13.15 per three leaves. The lowest population of thrip was recorded in fipronil (1.80/three leaves) followed by Flonicamid(2.59/three leaves) and dinotefuron(2.93/ three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years indicated that fipronil 5% SC (86.31 %), flonicamid 50% WG (80.30 %) and dinotefuron 20% SG (77.71 %) were the most effective insecticides for reduction in thrips population on cotton which were at par with each other. The next best treatments were imidacloprid 17.8%SL (76.27 %) and diafenthuron 50% WP.

.**Third spray-**

After the third spray, mean leafhopper population varied from 0.73to 11.62 per three leaves. The lowest population of thrip was recorded in fipronil (0.73/three leaves) followed by Flonicamid(1.31/three leaves) and dinotefuron (1.56/ three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years indicated that fipronil 5% SC (93.71 %), Flonicamid 50% WG (88.72 %) and dinotefuron 20% SG (86.57 %) were the most effective insecticides for reduction in thrips population on cotton which were at par with each other. The next best treatments were imidacloprid 17.8%SL (84.85 %) and diafenthuron 50% WP These were followed by buprofezin 24, buprofezin 24 and sulfaxaflor 24 % SC.

Cotton whitefly-

After first spray-

The mean leafhopper population prior to insecticidal application was non-significant among the various treatments.After the first spray, mean whiteflies population varied from 2.98 to 12.11 per three leaves. The lowest population of whitefly was recorded in buprofezin 24 % EC(2.98/three leaves) followed by fipronil 5% SC(3.92/three leaves) and dinotefuron (4.04/three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years Table 4 indicated that buprofezin 24 % EC (75.39 %), fipronil 5% SC (67.63 %) and dinotefuron20% SG (66.63 %) were the most effective insecticides for reduction in whitefly population on cotton which were at par with each other. The next best treatments were diafenthuron 50% WP (65.15 %) and flonicamid 50% WG (61.27 %). These were followed by imidacloprid 17.8%SL spiromesifen 22.95 % SC and sulfaxaflor 24 % SC.

After second spray-

After the second spray, mean whiteflies population varied from 2.35 to 13.17per three leaves. The lowest population of whitefly was recorded in buprofezin 24 % EC (2.35/three leaves) followed by fipronil 5% SC(3/three leaves) and dinotefuron (3.23/three leaves) with more than 75 per cent reduction over untreated check, respectively. Whereas, The pooled data of two years Table 4 indicated that buprofezin 24 % EC (82.15 %), fipronil 5% SC (77.22 %) and dinotefuron 20% SG (75.47 %) were the most effective insecticides for reduction in whitefly population on cotton which were at parwith each other. The next best treatments were diafenthuron 50% WP (74.03 %) and flonicamid 50% WG (71.29 %). These were followed by imidacloprid 17.8%SL spiromesifen 22.95 % SC and sulfaxaflor 24 % SC.

Third spray-

After the third spray, mean whiteflies population varied from 1.12to 10.73 per three leaves. The lowest population of whitefly was recorded buprofezin 24 % EC (1.12/three leaves) followed by fipronil 5% SC(1.67/three leaves) and dinotefuron (1.94/three leaves) with more than 75 per cent reduction over

untreated check, respectively. Whereas, The pooled data of two years indicated that buprofezin 24 % EC (89.46 %), fipronil 5% SC (84.43 %) and dinotefuron 20% SG (81.91 %) were the most effective insecticides for reduction in whitefly population on cotton which were at par with each other. The next best treatments were diafenthuron 50% WP (80.24 %) and flonicamid 50% WG (76.98 %). These were followed by imidacloprid 17.8%SL spiromesifen 22.95 % SC and sulfaxaflor 24 % SC.

The present findings are more or less similar with earlier workers like Muhammad *et al*., (2004) evaluated seven insecticides *viz.* acetamiprid 20 SP @ 150 g/acre, imidacloprid 200 SL @ 250 ml/acre, bifenthrin 10 EC @ 250 ml/acre, carbosulfan 25 EC @ 500 ml/acre, thiamethoxam 25 WG @ 24 g/acre, diafenthiuron 50 WP @ 200 ml/acre and methamidophos 60 SL @ 500 ml/acre for their efficacy against jassid, whitefly andthrips in cotton they observed that imidacloprid and acetamiprid against jassid, acetamiprid and thiamethoxam against whitefly and acetamiprid, imidacloprid and methamidophos against thrips found most effective. Ramalkshmi *et al.* (2012) studied the bioefficacy of novel insecticides *viz*., fipronil 5% SC @ 50 g a.i. ha^{-1} , fipronil 80% WG @50 g a.i. ha-1, diafenthiuron 50% WP @ 375 g a.i. ha-1, buprofezin 25% SC @150g a.i. ha-1, acephate 75SP @ 750 g a.i. ha-1 and imidacloprid 70% WG @ 21 g.a.i. ha-1 for their efficacy against cotton leafhopper. Among all treatment fipronil found effective and next best treatments were diafenthiuron and buprofezin followed by acephate and imidacloprid. Dipak *et al*. (2013) studied the effect of newer insecticides against whiteflies and jassid. The most effective insecticides in controlling the whitefly population was clothianidin 40 g ha-1 followed by acetamiprid at 40g ah-1. In case of jassid, dinotefuron proved best at 40 g ha-1 followed by cloyhianidin at 40 g ha-1 and highest cotton yield was observed in dinotefuron at 40 g ha-1 treated plot followed by same at 30 g ha-1. Vijay Kumar *et al.* (2014) evaluated insecticides against sucking pests and predatory complex of *Bt* cotton viz., pyriproxyfen10EC @ 75, 100, and 125 g a.i. ha-1, diafenthiuron 50WP @ 300 g a.i. ha^{-1}, ethion 50EC @ 1000 g a.i. ha^{-1}, imidacloprid 17.8 SL @ 25 g a.i. ha^{-1}, acetameprid 20SP @ 20 g a.i. ha-1. Study indicated that diafenthiuron 50WP and ethion 50 EC found effective in reducing whitefly population and imidacloprid 17.8 SL as well as acetamiprid 20 SP found effective against jassid, is reported. Kadam *et al.* (2014) studied the bioefficacy of newer neonicotinoids against sucking pests of *Bt* cotton. The results revealed that significantly lowest population of sucking pests was recorded in nitepyram 10 WSG @ 100 g a.i. ha-1, dinotefuron 20 % SG @ 50 g a.i ha and clothianidin 50 % WDG @ 20 g a.i. ha-1 as compare to acetameprid 20 SP @ 20 g a.i. ha-1, imidacloprid 17.8 SL @ 25 g a.i. ha-1 and thiamethoxam 25 % WS @ 25 g a.i. ha-1, were recorded. Sontakke and mohapatra (2014) studied the bioefficacy of buprofezin 25 SC against, *Scirtothrips dorsalis* (Hood) and yellow mite of chilli at different doses viz., 75 g a.i. ha-1 and 150 g a.i. ha-1 along with treated samples and treated checks i.e., ethion and profenofos were field evaluated during *kharif* 2009 and 2010. Study indicated that buprofezin 25 SC in both doses was more effective in checking both thrips and mite and even at higher doses was safe to the natural enemies. Sreenivas *et al*. (2015) studied on the bioeficacy of dinotefuron 20 per cent SG was carried out against *Bt* cotton sucking pests at 15, 20, 25 and 30 g a.i. ha-1 as compared with standard check viz., imidocloprid 17.8 SL and thiamethoxam 25 WG. The study indicated that dinotefuron 20% SG @ 30 g.a.i. ha-1 performed significantly superior by recording lowest population of jassid, thrips, aphids and whiteflies/ 3 leaves as compared to imidocloprid 17.8 SL and thiamethoxam 25 WG.

Mandal *et al*. (2015) evaluated the efficacy of few new groups of insecticides against sucking pests of cotton viz., cotton jassid and whitefly. The insecticides viz., imidacloprid 17.8% SL, spiromesifen 24 % SC and buprofezin 25% SC were applied two times at 15 days interval. Among the treatments, the most effective insecticide in controlling the jassid population was buprofezin @ 300 g-ha followed by imidacloprid @ 36 g-ha and least effective was spiromesifen @ 100 g-ha. But in case of whitefly, the most effective insecticide was spiromesifen @ 150 g-ha followed by buprofezin @ 300 g-ha and least effective was buprofezin @ 150 g-ha. Present findings were in agreement with Halappa *et al.* (2014) conducted the field experiment in two successive crop seasons (*kharif*) during 2012 to 2013 with *Bt* cotton to study the bioefficacy of different insecticides against leafhopper, *Amarasca biguttula biguttula* (Ishida). Dinotefuran 20 SG (0.25g/l), fipronil 5 SC (1 ml/l), diafenthiuron 50 WP (0.75 g/l) and buprofenzin 25 EC (1ml/l) were found most effective against leafhopper with 79.57, 76.59, 76.23 and 73.69 per cent reduction over untreated check respectively. Similar results were obtained by Ghelani *et al.* (2014) evaluated **t**en insecticides against major sucking pests infesting the *Bt* cotton. They observed that among the insecticides, tested flonicamid 0.02 per cent was found more effective against all major sucking pests. Zewain *et al.* (2013) evaluated three insecticides, viz. sulfoxaflor 24% SC at following three doses (100, 200 and 300 ml/ha), for their efficacy against whitefly (*Bemisia tabaci* Genn) on cucumber. Sulfoxaflor @ 200 and 300 ml/ha and Proteus at its field recommended dose caused significant mortality of whitefly up to three days after first application

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Table 1. Overall Bioefficacy of newer insecticides against aphids in field condition

Population of aphids/ 3 leaves																					
Treatment	Dose g.a.i/ha	First spray							Second spray						Third spray						
		Precount	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control
Buprofezin 24% EC	**250 ml**	11.77 (3.55)	4.69 (2.37)	3.92 (2.21)	8.42 (2.98)	5.67 (2.48)	5.68	53.55	3.89 (2.20)	3.50 (2.11)	6.0 (2.63)	13.6 (3.79)	6.75	50.11	2.92 (1.97)	1.75 (1.65)	4.51 (2.34)	3.92 (2.21)	3.28	64.19
Diafenthiuron 50 %WP	**300 gm**	12.85 (3.70)	1.64 (1.61)	1.67 (1.62)	4.83 (2.29)	2.05 (1.59)	2.55	79.14	2.07 (1.75)	1.79 (1.66)	2.5 (1.87)	6.92 (2.79)	3.32	75.46	1.05 (1.42)	0.40 (0.17)	2.12 (1.76)	1.30 (1.50)	1.22	86.68
Spiromesifen 22.95 % SC	**96 ml**	11.85 (3.57)	3.64 (2.13)	3.29 (2.05)	7.25 (2.78)	4.90 (2.31)	4.77	60.99	3.85 (2.19)	3.09 (2.01)	5.3 (2.47)	14.04 (3.73)	6.57	51.44	2.42 (1.84)	1.47 (1.56)	4.12 (2.25)	3.25 (2.06)	2.82	69.21
Imidacloprid 17.8 % SL	**25 ml**	12.92 (3.71)	2.99 (1.98)	2.42 (1.83)	6.92 (2.72)	4.17 (2.15)	4.13	66.23	2.84 (1.95)	2.17 (1.77)	3.8 (2.19)	11.67 (3.44)	5.12	62.15	1.50 (1.57)	0.84 (1.34)	3.00 (1.99)	2.75 (1.93)	2.02	77.94
Dinotefuron 20SG	**40 gm**	12.54 (3.67)	3.09 (2.01)	2.59 (1.88)	7.08 (2.75)	4.33 (2.19)	4.27	65.08	3.09 (2.01)	2.42 (1.84)	4.7 (2.37)	12.17 (3.51)	5.60	58.61	2.04 (1.73)	0.77 (1.32)	3.59 (2.13)	2.89 (1.96)	2.32	74.67
Flonicamid 50%WG	**75 gm**	13.10 (3.74)	4.20 (2.26)	3.84 (2.19)	8.08 (2.93)	5.25 (2.39)	5.34	56.33	3.94 (1.21)	3.34 (2.08)	5.8 (2.60)	13.0 (3.73)	6.52	55.94	2.75 (1.91)	1.59 (1.60)	4.75 (2.39)	3.67 (2.15)	3.19	65.17
Fipronil 5%SC	**50 ml**	12.17 (3.61)	4.17 (2.26)	3.75 (2.17)	7.75 (2.87)	4.92 (2.32)	5.15	57.89	3.80 (2.18)	3.29 (2.06)	5.5 (2.54)	13.84 (3.83)	6.61	51.14	2.50 (1.86)	1.54 (1.58)	4.34 (2.30)	3.34 (2.07)	2.93	68.01
Sulfoxaflor 24%SC	**90 ml**	11.85 (3.57)	4.75 (2.38)	4.09 (2.24)	8.75 (3.04)	5.75 (2.48)	5.84	52.24	4.19 (2.27)	3.84 (2.19)	6.3 (2.70)	14.97 (3.99)	7.33	45.82	3.17 (2.02)	2.25 (1.79)	5.09 (2.46)	4.25 (2.29)	3.69	59.71
Untreated Control		13.30 (3.75)	10.09 (3.28)	12.50 (3.66)	13.58 (3.73)	12.75 (3.60)	12.23		12.60 (3.64)	11.82 (3.55)	13.0 (3.68)	16.68 (4.21)	13.53		9.50 (3.22)	10.40 (3.34)	9.09 (3.13)	7.64 (2.87)	9.16	
S.E.±		0.187	0.202	0.131	0.155	0.167			0.126	0.051	0.161	0.274			0.113	0.122	0.147	0.159		
C.D. at 5%		N.S	0..610	0.395	0.477	0.515			0.382	0.153	0.488	N.S.			0.343	0.368	0.446	0.482		

Table 2. Overall Bioefficacy of newer insecticides against jassids in field condition

Population of jassids/ 3 leaves																					
		First spray							Second spray						Third spray					
Treatment	Dose g.a.i/ha	Precount	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control
Buprofezin 24% EC	**250 ml**	15.17 (4.01)	3.80 (2.18)	3.25 (2.03)	4.34 (2.29)	7.99 (2.99)	4.85	61.29	3.17 (2.03)	2.92 (1.97)	3.75 (2.17)	5.00 (2.44)	3.71	68.09	2.18 (1.75)	1.84 (1.67)	3.25 (2.05)	3.55 (2.13)	2.71	77.49
Diafenthiuron 50 %WP	**300 gm**	20.28 (4.60)	3.00 (1.99)	2.92 (1.93)	3.67 (2.15)	7.17 (2.85)	4.19	66.56	2.75 (1.93)	2.50 (1.85)	3.25 (1.97)	4.03 (2.28)	3.13	73.08	1.75 (1.65)	1.29 (1.50)	2.17 (1.77)	2.74 (1.92)	1.99	83.47
Spiromesifen 22.95 % SC	**96 ml**	16.91 (4.21)	4.15 (2.26)	3.87 (2.20)	4.75 (2.39)	9.07 (3.17)	5.46	56.42	3.67 (2.15)	3.34 (2.07)	4.09 (2.24)	5.50 (2.54)	4.15	64.31	2.75 (1.93)	2.24 (1.79)	3.30 (2.05)	4.04 (2.24)	3.08	74.41
Imidacloprid 17.8 % SL	**25 ml**	16.34 (4.13)	4.42 (2.32)	3.38 (2.25)	4.50 (2.32)	10.15 (3.33)	5.61	55.22	3.92 (2.21)	3.59 (2.17)	4.17 (2.27)	5.67 (2.57)	4.34	62.68	2.92 (1.97)	2.50 (1.86)	3.55 (2.12)	4.17 (2.26)	3.29	72.67
Dinotefuron 20SG	**40 gm**	16.50 (4.15)	1.84 (1.66)	1.60 (1.59)	2.50 (1.84)	4.8 (2.40)	2.69	78.53	1.77 (1.65)	1.17 (1.46)	2.09 (1.75)	2.79 (1.94)	1.96	83.14	0.92 (1.38)	0.74 (1.30)	0.97 (1.39)	1.84 (1.67)	1.12	90.69
Flonicamid 50%WG	**75 gm**	17.75 (4.32)	2.92 (1.98)	2.71 (1.91)	3.34 (2.08)	6.90 (2.81)	3.97	68.31	2.59 (1.88)	2.25 (1.79)	2.84 (1.95)	3.88 (2.20)	2.89	75.15	1.59 (1.60)	1.12 (1.44)	1.92 (1.70)	2.42 (1.75)	1.76	85.38
Fipronil 5%SC	**50 ml**	19.83 (4.43)	3.50 (2.11)	3.09 (2.00)	4.05 (2.23)	8.02 (2.99)	4.67	62.72	3.00 (1.99)	2.89 (1.96)	3.50 (2.11)	4.75 (2.39)	3.54	69.56	2.00 (1.74)	2.10 (1.75)	3.04 (2.00)	3.42 (2.09)	2.64	78.07
Sulfoxaflor 24%SC	**90 ml**	19.97 (4.54)	4.00 (2.23)	3.67 (2.15)	4.17 (2.27)	8.20 (3.02)	5.01	60.01	3.42 (2.09)	3.17 (2.03)	3.92 (2.20)	5.25 (2.49)	3.94	66.12	2.42 (1.83)	2.34 (1.80)	3.13 (2.02)	4.00 (2.23)	2.97	75.33
Untreated Control		20.95 (4.64)	13.09 (3.74)	8.25 (3.60)	13.37 (3.79)	15.4 (3.97)	12.53	61.29	12.09 (3.59)	11.67 (3.51)	11.25 (3.47)	11.50 (3.50)	11.63	68.09	10.75 (3.42)	10.12 (3.29)	12.00 (3.52)	15.28 (4.01)	12.04	
S.E.±		0.210	0.088	0.122	0.143	0.193			0.101	0.160	0.099	0.111			0.110	0.159	0.208	0.086		
C.D. at 5%		N.S	0.266	0.369	0.433	0.583			0.304	0.484	0.300	0.336			0.333	0.482	0.629	0.260		

Table 3. Overall Bioefficacy of newer insecticides against thrips in field condition

Population of thrips/ 3 leaves																					
		First spray							Second spray						Third spray					
Treatment	Dose g.a.i/ha	Precount	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control
Buprofezin 24% EC	**250 ml**	11.44 (3.52)	3.50 (2.12)	3.25 (2.05)	4.25 (2.28)	16.50 (4.17)	6.88	46.41	2.92 (1.97)	2.50 (1.85)	4.84 (2.41)	3.27 (2.06)	3.38	74.29	1.59 (1.60)	1.17 (1.46)	3.92 (2.20)	2.17 (1.77)	2.21	80.98
Diafenthiuron 50 %WP	**300 gm**	10.87 (3.43)	3.17 (2.04)	3.09 (2.01)	3.84 (2.19)	16.10 (4.12)	6.55	48.98	2.84 (1.95)	2.17 (1.77)	4.67 (2.37)	3.10 (2.02)	3.20	75.66	1.40 (1.54)	1.00 (1.40)	3.59 (2.13)	1.84 (1.67)	1.96	83.13
Spiromesifen 22.95 % SC	**96 ml**	9.91 (3.30)	3.83 (2.19)	3.66 (2.15)	4.75 (2.39)	15.90 (4.09)	7.04	45.17	3.17 (2.03)	2.92 (1.97)	5.15 (2.47)	3.52 (2.12)	3.69	71.93	1.79 (1.62)	1.34 (1.52)	4.01 (2.23)	2.44 (1.85)	2.40	79.34
Imidacloprid 17.8 % SL	**25 ml**	10.81 (3.43)	3.09 (2.01)	2.83 (1.94)	3.59 (2.13)	15.40 (4.04)	6.23	51.47	2.87 (1.95)	2.09 (1.75)	4.53 (2.34)	2.99 (1.98)	3.12	76.27	1.28 (1.59)	0.92 (1.37)	3.10 (2.01)	1.74 (1.65)	1.76	84.85
Dinotefuron 20SG	**40 gm**	10.71 (3.41)	2.59 (1.88)	2.33 (1.80)	3.17 (2.04)	13.50 (3.80)	5.40	57.94	2.70 (1.90)	1.96 (1.71)	4.09 (2.25)	2.95 (1.97)	2.93	77.71	0.95 (1.48)	0.82 (1.34)	2.84 (1.95)	1.62 (1.60)	1.56	86.57
Flonicamid 50%WG	**75 gm**	10.37 (3.36)	2.52 (1.87)	2.20 (1.78)	3.12 (2.02)	13.0 (3.72)	5.21	59.42	2.17 (1.77)	1.70 (1.64)	3.99 (2.22)	2.51 (1.86)	2.59	80.30	0.92 (1.41)	0.67 (1.28)	2.34 (1.81)	1.32 (1.51)	1.31	88.72
Fipronil 5%SC	**50 ml**	10.14 (3.33)	1.67 (1.62)	1.33 (1.51)	1.92 (1.70)	9.90 (3.26)	3.71	71.10	1.42 (1.54)	1.67 (1.62)	2.50 (1.85)	1.62 (1.61)	1.80	86.31	0.50 (1.22)	0.31 (1.14)	1.34 (1.52)	0.77 (1.32)	0.73	93.71
Sulfoxaflor 24%SC	**90 ml**	10.07 (3.32)	3.67 (2.15)	3.50 (2.11)	4.59 (2.36)	16.64 (4.18)	7.10	44.70	3.22 (2.05)	2.67 (1.91)	5.55 (2.55)	3.75 (2.17)	3.80	71.10	1.45 (1.65)	1.50 (1.56)	4.13 (2.25)	2.52 (1.87)	2.40	79.34
Untreated Control		10.79 (3.43)	10.92 (3.44)	10.25 (3.35)	11.75 (3.54)	18.42 (4.25)	12.84		12.97 (3.70)	12.17 (3.62)	14.00 (3.86)	13.44 (3.78)	13.15		12.50 (3.64)	12.00 (3.60)	13.32 (3.77)	8.67 (3.08)	11.62	
S.E.±		0.072	0.073	0.112	0.119	0.247			0.136	0.088	0.092	0.084			0.129	0.081	0.099	0.119		
C.D. at 5%		N.S.	0.220	0.339	0.359	N.S			0.412	0.265	0.279	0.118			0.390	0.244	0.299	0.360		

Table 4. Overall Bioefficacy of newer insecticides against whiteflies in field condition

		Population of whiteflies/ 3 leaves																		
		First spray							Second spray						Third spray					
Treatment	Dose g.a.i/ha	Precount	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control	1DAS	3DAS	7DAS	14DAS	Mean	% reduction over control
Buprofezin 24% EC	**250 ml**	9.40 (3.22)	2.25 (1.80)	1.42 (1.54)	3.17 (2.02)	5.09 (2.45)	2.98	75.39	1.84 (1.66)	1.50 (1.75)	2.57 (1.88)	3.50 (2.09)	2.35	82.15	0.75 (1.31)	0.59 (1.25)	1.00 (1.41)	2.17 (1.76)	1.12	89.46
Diafenthiuron 50 %WP	**300 gm**	9.54 (3.24)	3.13 (2.03)	2.59 (1.69)	4.25 (2.28)	6.92 (2.80)	4.22	65.15	2.84 (1.95)	2.42 (1.82)	3.25 (2.05)	5.15 (2.47)	3.41	74.03	1.67 (1.63)	1.34 (1.52)	2.12 (1.75)	3.35 (2.07)	2.12	80.24
Spiromesifen 22.95 % SC	**96 ml**	9.48 (3.23)	4.79 (2.40)	3.65 (2.14)	6.00 (2.64)	8.50 (3.08)	5.74	52.60	4.17 (2.27)	3.59 (2.13)	4.50 (2.34)	6.42 (2.72)	4.67	64.54	2.59 (1.89)	2.17 (1.77)	3.50 (2.11)	4.75 (2.39)	3.25	69.71
Imidacloprid 17.8 % SL	**25 ml**	8.84 (3.10)	4.42 (2.32)	3.25 (2.05)	5.50 (2.54)	8.00 (2.99)	5.29	56.31	3.75 (2.17)	3.44 (2.10)	2.73 (1.80)	2.90 (1.97)	3.20	75.62	2.42 (1.84)	2.00 (1.72)	3.00 (1.99)	4.67 (2.37)	3.02	71.85
Dinotefuron 20SG	**40 gm**	8.59 (3.09)	2.84 (1.95)	2.34 (1.88)	3.84 (2.19)	7.12 (2.84)	4.04	66.63	2.67 (1.90)	2.17 (1.76)	3.09 (2.01)	5.00 (2.44)	3.23	75.47	1.50 (1.69)	1.17 (1.46)	1.84 (1.67)	3.25 (2.05)	1.94	81.91
Flonicamid 50%WG	**75 gm**	9.92 (3.29)	3.59 (2.13)	2.75 (1.93)	4.84 (2.41)	7.59 (2.92)	4.69	61.27	3.25 (2.05)	2.90 (1.97)	3.59 (2.13)	5.36 (2.51)	3.77	71.29	1.92 (1.70)	1.59 (1.60)	2.54 (1.87)	3.84 (2.19)	2.47	76.98
Fipronil 5%SC	**50 ml**	9.84 (3.28)	2.75 (1.93)	2.09 (1.75)	4.00 (2.23)	6.84 (2.79)	3.92	67.63	2.50 (1.86)	2.00 (1.72)	2.75 (1.93)	4.75 (2.39)	3.00	77.22	1.09 (1.43)	0.84 (1.34)	1.59 (1.59)	3.17 (2.03)	1.67	84.43
Sulfoxaflor 24%SC	**90 ml**	10.09 (3.32)	3.84 (2.19)	3.09 (2.01)	5.17 (2.47)	7.25 (2.86)	4.84	60.03	3.59 (2.13)	3.27 (2.05)	3.92 (2.21)	5.84 (2.61)	4.15	68.41	2.09 (1.75)	1.67 (1.62)	2.75 (1.93)	4.17 (2.26)	2.67	75.11
Untreated Control		10.0 (3.31)	11.09 (3.45)	10.01 (3.29)	12.50 (3.67)	14.83 (3.94)	12.11		13.59 (3.81)	13.50 (3.80)	13.42 (3.78)	12.17 (3.60)	13.17		10.42 (3.37)	10.09 (3.30)	11.75 (3.56)	10.67 (3.38)	10.73	
S.E.±		0.150	0.064	0.125	0.097	0.153			0.098	0.117	0.168	0.117			0.076	0.116	0.105	0.125		
C.D. at 5%		N.S	0.193	0.378	0.294	0.464			0.0295	0.354	0.519	0.354			0.230	0.349	0.316	0.376		

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