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Performance of Imidacloprid, Thiomethoxam, Acetamaprid and a Biocontrol Agent (*Chrysoperla carnea*) Against Whitefly, Jassid and Thrips on Different Cotton Cultivars

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Abstract: This experiment was conducted at Post Graduate Agriculture Research Station in the field of Department of Agricultural Entomology, University of Agriculture, Faisalabad, Pakistan. Three insecticides, [Crown (imidacloprid) 25% WP, Actara (Thiomethoxam) 24 WG and Asault (acetamiprid) 20% SL) and a predator (C*hrysoperla carnea*) were evaluated on five cotton cultivars (Super-98, BH-163, V.H-159, NIAB-884 and NIAB-101). In case of insecticide, percentage reduction in population of three insect pests was recorded 24, 72 and 168 h post application; whereas, for C. *carnea*, population reduction was recorded one week after eggs release of *C. cornea*. All the tested insecticides cause significant population reduction of the three insect pests to 7 days post treatment on all tested cotton cultivars. However, Crown, Actara and Asualt proved to be highly effective against Jassid and whitefly. While against thrips the performance of Actara was less than the Crown and Asualt. The *C cornea* causes intermediate population reduction of whitefly, jassid and thrips. In conclusion, the preference of Imidacloprid, Thiomethaxam and Acetamaprid was not affected by cotton cultivars. However, the performance of *C. carnea* varied significantly and was highly affected in NIAB-101 and NIAB-884.

Key words: Cotton · Sucking Insect Pests · Selective Insecticides · Resistant Varieties

INTRODUCTION

In spite of drastic increase in acreage under cotton cultivation, yield of cotton is very low because of severe pest complex [1]. About 162 species of insect pests attack on various growth stages of cotton [2]. Amongst these species, jassid *Amarasca devastans* Dist. (Hemiptera: Cicadellidae), whitefly, *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae), cotton thrips, *Thrips tabaci* Lind. (Thysanoptera: Thripidae) and cotton aphid, *Aphis gossypii* Glover (Hompotera: Aphididae) are the important sucking insect pest complex. According to an estimate bollworms and sucking pest complex cause about 20-40% yield losses in Pakistan [3]. However, [4] reported approximately 56.02 % crop losses due to insect pest attack [4]. Jassid (*A. devastans)* is reported to cause 24.45% reduction in cotton yield [5]. Whitefly causes great damage by sucking the cell sap, secreting the honey dews and transmitting the viral diseases to cotton [6-8]. Combined attack by thrips (14.6 per leaf) and jassid (4.6 per leaf) caused a 37.6% loss in the yield of seed cotton [9].

Chemical control, being rapid method of pest control, is an important practice of integrated pest management (IPM) program to overcome losses caused by insect pest to crop [10-12]. However, injudicious and continuous application of conventional insecticides on cotton crop resulted in the development of varying level of resistance against *B. tabaci* [13-15] and *A. devastans* [3]. Neonicotinoids insecticides like diafenthiuron, acetamiprid imidacloprid and thiamethoxam managed the development of resistance to *B. tabaci*, *A.devastans* other sucking insect pests against conventional insecticides in different parts of USA and Israel on different crops [16]. The present studies were conducted to test the hypothesis if the performance of insecticides and *Chrysoperla carnea* varies on the different cotton varieties against jassid, thrips and whitefly.

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MATERIALS AND METHODS

The study was carried out to determine the effectiveness of some insecticides viz., Crown® (imidacloprid) 25% WP @ of 80g/acre, Actara® (thiomethaxam) 24 WG @ 24g/acre, Asualt® (acetameprid) @ 125 mL/acre and a biocontrol agent, *Chrysoperla carnea* @ 75000 brown eggs/acre against *Amarasca devastans* Dist. (Hemiptera: Cicadellidae), whitefly, *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae), cotton thrips, *Thrips tabaci* Lind. (Thysanoptera: Thripidae On five cotton varieties i.e. super-98, BH-163, VH-159, NIAB-884 and NIAB 101. These cotton cultivars were sown in 2005 at Post Graduate Agriculture Research Station (PARS), University of Agriculture, Faisalabad, Pakistan. The plant to plant and row to row distance was maintained 9 inches and 2.5 inches, respectively. The experiment was in randomized complete block design with three repeats. There were five treatments including Crown, Actara, Asualt, *C. carnea* and control. The plot size was 6m x 5m. The insecticide treatments were applied with a Knapsack sprayer as a foliar spray at aforementioned dose rate. In case of biocontrol, brown-eggs of *C. carnea* were purchased from the Biocontrol Laboratory, Department of Agricultural Entomology, University of Agriculture, Faisalabad and released into field at the rate of 75000 brown-eggs/acres. The Data on the population of jassid, whitefly and thrips were recorded 24 h before as well as 24, 72 and 168 h after each insecticide spray and 168 h after eggs release from leaves of 5 five selected plants of each treatment. The population data was transformed into percentage population reduction by the following formula:

$$\text{Percentage population reduction} = A\text{-}B/Ax100$$

Where Pretreatment population is denoted by A while post treatment population is denoted by B

The data was subjected to ANOVA technique and Duncan's multiple range tests (DMR) at 5% level of significance.

RESULTS

Performance of insecticides application and release of C. cornea against jassid on different cotton cultivars: The population of jassid, recorded after 24, 72 and 168 h, was > 5 jassids/leaf, which was above its ETL (1/Leaf). The performance of evaluated insecticides was not affected on the entire cotton cultivars. After 24 h of insecticide application, the Crown and Actara caused more than 90% population reduction of Jassid on all varieties; however, Asualt caused insignificant population reduction (89%) on the variety NIAB-101. Similarly, 72 h post insecticide application, Crown caused more than 90% population reduction and performed comparatively better on all varieties, except on NIAB-101 (83%). Likewise, Actara performed comparative better (but not significantly) on VH-159 and NIAB-884, causing more than 90 % population reduction; whereas, the same also revealed satisfactory performance causing more than 80% but less than 90 % mortality on Super-98 and BH-163. The variety NIAB-101 reduced the performance of Actara, which caused only 75% reduction in population of jassid. The performance of Asualt was comparatively better on VH-159 and NIAB-101, where it caused more than 90% population reduction. Asualt gave satisfactory results on Super-98, BH-163 and NIAB-884 causing more than 80% but less than 90% population reduction of jassid. Crown, 168 h post application, was the most effective causing more than 90% population reduction on Super-98, VH-159 and NIAB-884; while on the rest of cultivars, it caused more than 80% but less than 90% population reduction. These results indicated that Super-98, VH-159 and NIAB-884 least affected the performance of Crown, but BH-163 and NIAB-101 reduced its performance to some extent. After 168 h of application by Actara, its performance significantly reduced as it caused 88% and 87% population reduction on Super-98 and VH-159, respectively; whereas more than 70% and less than 80% population reduction on BH-163, NIAB-884 and NIAB-101. Asualt caused≥ 90% population reduction on the cultivar Super-98 while on the rest of cultivars it caused≥80% population reduction of jassid. The performance of Asualt was also found satisfactory on all cotton cultivars. *C.carnea* performed better on the cultivar super-98 and BH-163 reducing 50 and 66% jassid population, respectively. However, NIAB-884 and NIAB-101 highly affected the performance of *C. carnea* which caused 28 and 5% population reduction on these two varieties, respectively.

Performance of insecticides application and release of C. cornea against whitefly on different cotton cultivars: The performance of tested insecticides was affected by the cultivars against whitefly. Crown 24 h post application caused maximum population reduction (91%) on the cultivar NIAB-884 while the NIAB-101 reduced the effectiveness of crown and it showed only 44% of population reduction. Similarly, Crown perform better on

Table 1: Mean of population fluctuations (% reduction over respective control) of jassid, 24'72,168 h post insecticides application and week after the release of *C. carnea* on different cotton cultivars.

	24 h					72 h					168 h				
	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101
Control	6.7 A	5.2 A	7.0 A	7.7 A	7.7 A	7.5 A	7.2 A	8.2 A	9.0 A	6.0 A	11.6 A	7.2 A	8.5 A	7.5 A	5.3 A
Crown	0.03B	0.26 B	0.03 B	0.13 B	0.36 B	0.16 B	0.52 B	0.45 B	0.63 B	0.96 B	0.90 B	1.20 B	0.36 C	0.63 B	0.68 B
	(99.5%)	(94%)	(99.6%)	(98%)	(95%)	(98%)	(93%)	(94.5%)	(93%)	(83%)	(92%)	(83%)	(95.6%)	(92%)	(87%)
Actara	0.06 B	0.06 B	0.26 B	0.26 B	0.33B	0.98 B	1.20 B	0.75 B	0.56 B	1.50 B	1.53BC	1.76 B	1.13 C	1.73 B	1.63 B
	(99%)	(99%)	(96%)	(96.5%)	(95.6%)	(86%)	(83%)	(91%)	(94%)	(75%)	(88%)	(75%)	(87%)	(77%)	(69%)
Asualt	0.166 B	0.10 B	0.13 B	0.13 B	0.79 B	0.79 B	0.65 B	0.72 B	1.0 B	0.50 B	1.12BC	1.41 B	1.04 B	1.04 B	1.0 B
	(97.5)	(98%)	(98%)	(98%)	(89%)	(89%)	(86%)	(91%)	(89)	(92%)	(90%)	(80%)	(88%)	(86%)	(81%)
C. carnea											3.83 B	3.56 B	5.17 B	5.40 B	5 A
											(66%)	(50)	(39%)	(28%)	(5%)

Means sharing similar letters are not significantly different by DMR Test at P = 0.05

Table 2: Mean of population fluctuations (% reduction over respective control) of whitefly, 24'72,168 h post insecticides application and week after the release of *C. carnea* on different cotton cultivars.

	24 h					72 h					168 h				
	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101
Control	1.8 A	1.7 A	1.70 A()	0.46 A	0.43 A	1.06 A	1.63 A	1.53 A	1.367 B	1.10 A	4.73 A	9.63 A	6.76 A()	3.96 A()	3.36 A
Crown	0.26 B	0.13 B	0.15B	0.16 B	0.06 B	0.33 B	0.15 B	0.17 B	0.1667 B	0.08 B	0.43 B	0.43 B	0.43 B	0.36 B	0.31 C
	(85%)	(92%)	(91%)	(65%)	(82%)	(68%)	(90%)	(89%)	(88%)	(92%)	(91%)	(95%)	(94%)	(91%)	(92%)
Actara	0.23 B	0.33 B	0.33 B	0.13 B	0.13 B	0.32 B	0.30 B	0.32 B	0.20 B	0.31 B	1.04 B	0.56 B	0.46 B	0.60 B	0.54 C
	(87%)	(82%)	(81%)	(71%)	(69%)	(70%)	(82%)	(79%)	(85%)	(71%)	(78%)	(94%)	(93%)	(85%)	(84%)
Asualt	0.63 B	0.03 B	0.40 B	0.06 B	0.06 B	0.37 B	0.032B	0.41 B	0.23 B	0.35 B	1.06 B	0.66 B	0.50 B	0.90 B	1.2 BC
	(65%)	(98%)	(76%)	(87%)	(86%)	(65%)	(98%)	(73%)	(83%)	(68%)	(78%)	(93%)	(93%)	(79%)	(64.3%)
C. carnea											3.5A	5.27 A	4.47 A	1.70 B	2.50 A
											(25%)	(45%)	(34%)	(57%)	(26%)

Means sharing similar letters are not significantly different by DMR Test at P = 0.05

Table 3: Mean of population fluctuations (% reduction over respective control) of thrips, 24, 72, 168 h post insecticides application and one week after the release of *C. carnea* on different cotton cultivars.

	24 h					72 h					168 h				
	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101	Super- 98	BH- 163	VH-159	NIAB- 884	NIAB- 101	Super- 98	BH- 163	VH-159	NIAB- 884	Super- 98
Control	1.4 A	1.45A	1.4 A	1.4 A	0.9 A	5.4 A	3.2 A	1.7 A	2.1 A	2.3 A	6.4 A	4.4 A	3.3 A	3.7 A	3.3 A
Crown	0.60 B	0.54 B	0.15BC	0.13 B	0.5 BC	0.70 B	0.60 B	0.16 BC	0.13 B	1.1 BC	3.13 B	1.03 C	1.2 B	0.86 C	1.5 B
	(57%)	(62%)	(89%)	(91%)	(44%)	(87%)	(81%)	(90.5%)	(90.7%)	(52%)	(51%)	(76.5%)	(62.7%)	(76.7%)	(54%)
Actara	0.36 B	0.33 C	0.35 C	0.36 B	0.8 AB	0.45 B	0.45 C	0.5 C	0.37 B	0.61 C	3.1 B	3.40 AB	2.2 AB	2.8AB	2.7 AB
	(74%)	(77%)	(75%)	(74%)	(11%)	(92%)	(86%)	(71%)	(82%)	(73%)	(52%)	(23%)	(33%)	(24%)	(18%)
Asualt	0.20 B	0.3 B	0.4 C	0.23 B	0.30 C	0.40 B	0.35 B	0.5 B	0.40 B	1.6 AB	3.16 B	2.7 ABC	2.0 B	2.2 B	2.60 B
	(86%)	(79%)	(71%)	(83.5%)	(67%)	(94%)	(89%)	(71%)	(81%)	(30%)	(51%)	(39%)	(39%)	(41%)	(21%)
C. carnea											4.3 A	3.6 AB	2.5 A	3.2 A	3.0 A
											(33%)	(18%)	(24%)	(14%)	(9%)

Means sharing similar letters are not significantly different by DMR Test at P = 0.05

the cultivar VH-159 while, rest of varieties, Super-98 and BH-163 the performance of insecticide was intermediate with 57 and 65% population reduction. Actara worked well on all evaluated varieties and caused more than 70% population reduction except on NIAB-101 where it caused 11% population reduction of whitefly. Asualt proved effective against whitefly on the cultivars Super-98 and NIAB-884 causing more than 80% population reduction while on the cultivars BH-163 and VH-159 it caused more than 70% population reduction. On the cultivar NIAB-101 the performance of Actara was not good it caused only 67% population reduction. The Crown, 72 h after application, performed well on the cultivars VH-159 and NIAB-884 and caused more than 90% population reduction of whitefly. However, it cause more than 80% population reduction on the cultivars Super-98 and BH-163 While on the cultivar NIAB-101 its performance was not satisfactory. The performance of Actara against whitefly varies with the cultivars. It showed excellent performance on the cultivar Super-98 reducing the population more than 90% while on the rest of varieties BH-163 and NIAB-884 it caused more than 80% population reduction. On the cultivar VH-159 it causes the least population reduction of whitefly. Asualt proved to be most effective insecticide against whitefly among the evaluated insecticides. It caused more than 90% population reduction on the cultivar Super-98, while on the cultivars BH-163 and NIAB-884 it causes more than

80% population reduction. However, on the rest of cultivars (NIAB-101 and VH-159) it performance was not satisfactory. Crown, 168 h after application worked better on the cultivars BH-163 and NIAB-884 caused less than 80 but more than 70% population reduction of whitefly. While on the rest of tested cultivars similar population reduction was observed that was about 50%. Actara showed maximum population reduction on the cultivar super-98 (50%) but is showed least performance on the cultivars BH-163, VH-159, NIAB-884 and NIAB101 with 23, 33, 24 and 18% population reduction respectively. Similarly, the Asualt also worked better on the cultivar Super-98 and on the rest of evaluated cultivars its performance was not satisfactory and cause the population reduction ranges from 21-41%. *C.carnea* against whitefly was found ineffective on the all the tested cultivars (BH-163, VH-159, NIAB-884 and NIAB-101) but on the Super-98 it showed better result results to some extent.

Performance of insecticides application and release of C. cornea against Thrips on different cotton cultivars: All evaluated insecticides, Crown, Actara and Asualt, 24 h after application, have shown excellent performance against thrips on all cotton varieties. Among insecticides Crown proved to be highly effective with more than 90% population reduction on varieties B.H.163 and V.H. 159. Similarly, on the other two varieties it caused less than 90% but more than 80% population reduction. However, its performance on the cultivar NIAB-884 was not satisfactory with 65% population reduction. Actara worked well on the cultivars Super-98, BH-163 and VH-159 causing more than 80% population reduction while on the cultivars, NIAB-884 and NIAB-101 it causes least population reduction of thrips which was less than 80% but more than 70% on both varieties. Among insecticides Asualt proved to highly effective against thrips causing 98% population reduction on the cultivar BH-163. However, it also performed better on the cultivars NIAB-101 and NIAB-884 causing more than 80% population reduction while on the cultivars Super-98 and VH-159 it causing population reduction less than 80% but more than 60%.Crown, 72 h post application was found to be highly effective on the cultivars BH-163 and NIAB-101 causing ≥ 80% population reduction. Actara showed maximum population reduction on the cultivars BH-163 and NIAB-884 ≥ 90% while on rest of cultivars it caused less than 80% but more than 70% population reduction. Asualt again proved to be highly effective on the cultivar BH-163 causing 98% population reduction of thrips. Similarly, on rest of varieties like NIAB-884 and VH-159 it causes less than 80 but more than 70% population reduction. However, on the cultivars Super-98 and NIAB-101 it performance was not satisfactory where it causes only more than 60% population reduction of thrips. Crown, 168 h post application, among all tested insecticide performed well and reduced the thrips population more than 90% on all evaluated cultivars. Actara worked better on the cultivars VH-159 and BH-163 causing the more than 90% population reduction but its performance was reduced on the cultivar Super-98 that affects its activity against thrips and causing the population reduction up to 78%. On the varieties, NIAB-884 and NIAB-101 it causes more than 80% reduction in population. The effectiveness of Actara was higher on the cultivars BH-163 and VH-159 causing more than 90% reduction in population of thrips. On other cultivars its activity was about more or less 80%. After the 168 h of application, Asualt performed very well on the cultivars VH-159 and BH-163 and reduces the population up to 90%. It also worked better on the rest of cultivars causing the population reduction ranging from 78% while it efficacy was affected on the cultivar NIAB-101 with 65% population reduction. One week after the release of *C. carnea*, it showed intermediate effects on the thrips population on all tested varieties but its performance was some what better on cultivar NIAB-884 causing more than 50% population reduction. While *C. carnea* affects on rest of cultivar was not better against thrips.

DISCUSSION

The main aim of the present studies was to evaluate if the plant genotypes of same genus had any effect on the performance of insecticides and a biocontrol agent (*C. carnea*) against sucking insect pests of cotton. The results revealed that the performance of tested insecticides against jassid was not affected by the cotton genotypes as all the tested insecticides cause 80-96% mortality of jassid. However, little and insignificant variation in the efficacy of insecticides as well as in the jassid mortality may due to climatic effect and agile behavior of the jassid. Overall, performance of the tested insecticides increased up to 72 h exposure; however, very nominal/insignificant reduction in the performance of insecticides was observed after an exposure period of 168 h. The performance of *C. carnea* against jassid varied significantly among cotton genotypes. Cotton genotype NIAB-101 highly affected the performance of *C. carnea* (only 5% reduction) followed by NIAB-884

(28% reduction), VH-159 (395 reduction) BH-163 (50% reduction) and Super-98 (66% reduction). The variation in the performance of *C. carnea* against jassid on different cotton genotypes may be attributed to variation in their physico-morphic plant characteristics which hinder the movement, reduce the searching ability and ultimately affect the performance of the *C. carnea.* Crown®, Actara® and Asualt® performed better than *C. carnea* and caused > 80% mortality of jassid on all cotton genotypes. Present finding agreed with the results of [17] who reported that new chemistry insecticides, diafenthiuron, acetamiprid, imidacloprid and thiamethoxam proved effective in reducing jassid population below ETL seven days post application during 2002 and 2003. These results are also in conformity with those of the result reported by [18-20] that imidacloprid significantly controlled jassid, also confirm our results of imidalcloprid.

The results showed that the effectiveness of insecticides, tested against whitefly was not affected by the cotton cultivars because all the insecticides caused 70-90% population reduction of whitefly 24 h post application, while 72 h post application, the performance of insecticides increases against whitefly but the efficacy of insecticides decreased after 168 h of application. However, this decrease was observed on all the varieties studied in this experiment. The performance of *C. carnea* varied on the tested genotypes it perform better to some extent on the cultivar Super-98 (33% reduction) followed by VH-159 (24% reduction), BH-163 (18% reduction), NIAB-884 (14% reduction) and NIAB -101 (9% reduction). Overall the performance of *C. cornea* against whitefly on the all tested cultivars was not satisfactory. These results are found in accordance with those of [21, 22, 1] and who observed significant population reduction of whitefly with the application of acetamiprid. Similarly present studies agreed the results of [23] who reported that imidacloprid was the most effective in suppressing the whitefly population and its continuous use resulted in increased whitefly population due to development of resistance in this pest.

Cotton genotypes showed no effects on the insecticides performance against thrips as all tested insecticides performed equally on all given cotton cultivars. However, it is observed that the tested insecticides performance insignificantly increased in the exposure period of 168 h. *C. carnea* again proved ineffective against thrips on the various genotypes. However, on the genotype NIAB-884 it performed comparatively better while on the rest of genotypes like (Super-98, BH-163, VH-159 and NIAB 101) its performance was not satisfactory. It may be due to climatic conditions and physico-morphic plant characteristics which cause hindrance in the movement and affect the searching ability of the insect. The results of the present studies are in accordance with the results of [24] who found that Tamaron (methamidophos) effectively controlled thrips on cotton. Wahla [25] investigated that Tamaron (methamidophos) and Confidor (imidacloprid) effectively controlled cotton thrips. The results of the present studies are favored by the results of [26] who determined that Actara 25 WG proved an excellent controlling agent against thrips.

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