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Evaluation of Chrysoperla Carnea for Population Management of Jassid Amrasca Devastans in B.t. Cotton Crop

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Abstract
Evaluation of *Chrysoperla carnea* [Steph.], for the management of jassid in B.T. Cotton crop was carried out in Randomized Complete Block Design (RCBD) with 4 replications. There were four treatments: T1= *Chrysoperla carnea* (natural enemy), T2= Confidor (insecticide), T3= B.T. control and T4= NIAB-78(non Bt.) control plot. The treatments were applied at fortnightly intervals stating from 2nd week of June. The jassid population was found infesting cotton crop. The data showed that the maximum population (2.38jassid/leaf) was recorded in T4, whereas minimum jassid population (1.76jassid/leaf) was recorded in T2. Over all maximum mean population of *C. carnea* (0.39/plant) was recorded in T1 and the minimum population was recorded (0.06/plant) in T2. The maximum seasonal mean of bolls (20.84bolls/plant) was recorded in T4 followed by T2 (20.13bolls/plant).
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INTRODUCTION

Cotton *Gossypium hirsutum* L., is one of the most important fiber and cash crops of Pakistan, On a whole, Cotton is a major crop in parts of African tropics, Australia, China, Egypt, India, Mexico, Pakistan, Sudan, United States and warmer regions of central and South America (Bhatti and Soomro, 1996). Cotton was cultivated by the inhabitants of the Indus Valley civilization by the 5th millennium BCE – 4th millennium BCE. (Moseley and Gray, 2008).

White Gold contributes to the income of every tenth household in the country. More than two thirds of cotton producers own someone all of their land, whereas one fifth are shared croppers with no field of their own. Earnings from cotton sales accounts for 40 per cent and 45 percent of the household income of landowners and sharecroppers, respectively. As a result, among cotton farmers, 40 per cent of landowners and two thirds of sharecroppers are in the lowest two fifths of the consumption distribution. Households depending on sharecropping and selling labour for their livelihood include about one fifth of the rural population and have the highest incidence of poverty. Small and marginal farmers also face risks due to the high incidence of pest infestation and the equally high financial and health hazards resulting from the use and overuse of pesticides for plant protection. About eighty percent of all pesticides consumed in Pakistan are used on cotton fields (Siegmann, 2005).

Different approaches are applied by the farmers to control the insect pests including the cultivation of Bt cotton. Bt cotton was among the first genetically modified (GM) crops to be used in commercial agriculture. A gene from the soil bacterium *Bacillus thuringiensis* (Bt) was transferred to the cotton genome. This gene encodes the production of a protein that is toxic to certain lepidopteran insects. Cotton is attacked by a variety of insect species, and the crop is the single largest insecticide consumer worldwide (Matthews and Tunstall, 1994) In the USA and China, Bt cotton was commercialized in the mid 1990s, and today the technology covers about 30–40 per cent of the cotton area in both countries. Recent studies show that USA and Chinese Bt adopters realize significant pesticide and cost savings in most cotton-producing regions (Carpenter *et al*. 2002) transgenic plants have shown good results against targeted insect pests, but they are infested by the other insect pests.

The green lacewing, *C. carnea* (Steph) is a potential predatory biological control agent that can be used in augmentation programs for sustainable crop pest suppression. It attacks a variety of soft-bodied insects and mites found on various agro-ecosystems. This predator is widely distributed in India, Europe, USSR, North America, South America, Tanzania, Sudan, Egypt, Kenya and Nigeria. The predator has a significant potential for commercialization and use against a variety of pests in combination with other insect pest management tactics (cultural, mechanical, host plant resistance, chemical and microbial insecticides). The predatory potential of the predator varies depending on the prey species (Gautam and Tesfaye 2002). In present study green lacewing, *C. carnea* is used as biological control agent against the jassid in Bt cotton.

Objectives

1. Comparative population development of Jassid pests on NIAB-78 and Bt cotton.
2. Evaluation of efficiency of *Chrysoperla carnea* (STEPH.) in population reduction of Jassid in Bt cotton.

MATERIALS AND METHODS

The study was carried out to evaluate *Chrysoperla cornea* for the management of Jassid in Bt-Cotton crop, at Sindh Agriculture University, Tando Jam.

The study started from the 2nd week of June and continued up to the last week of September. The process of recording data continued up to 16 week, up to that 20 observations were recorded, the experiment was carried out in four treatments with four replications in a ½ acre. Each treatment plot size was 5445sq ft.

LAYOUT OF THE PLOT

T_1 = Biology control, (*Chrysoperla carnea*)
T_2 = Confidor (Insecticide)
T_3 = Bt – Control
T_4 = NIAB– 78 Control

R_1	R_2	R_3	R_4
T_1	T_3	T_4	T_2
T_4	T_2	T_1	T_3
T_2	T_1	T_3	T_4
T_3	T4	T_2	T_1

Comparative population development of Jassid, *Amrasca devastans,* were recorded in NIAB-78 and Bt cotton. The *Chrysoperla carnea* cards were purchased from Biological control laboratory, Nuclear Institute of Agriculture (NIA) Tandojam and Entomology section, Agriculture Research Institute, Tandojam. The predators were released in the field at fortnight interval.

Efficiency of *C. carnea* was compared with Confidor, one of the most popular insecticides widely used for the control of sucking insect pests by the farmers. The treatments were applied at fortnightly interval. Pre-treatment data were recorded 24 hours before application and post treatment data were taken after three and seven days of application of treatments. The data were recorded by selecting five plants at random from each treatment. From each plant five leaves were observed for recording the population of sucking insects i.e., one from top, 2 from middle and 2 from bottom portion of plant and whole plant was observed for recording predator population. Crop yield parameters were also recorded. Finally collected data were analyzed using ANOVA.

RESULTS

Jassids, *Amrasca devastans* (Dist.)

Jassids population started its appearance on cotton crop in the 2nd week of June and continued till the last week of September. When the temperature started to increase the pest population also increased. The maximum Jassid population (6.23/ leaf) was recorded in T3 (B.T control plot) in the 3rd week of June, while the minimum pest population (0.03/leaf) was recorded in the last week of August in T1 (in which natural enemies *Chrysoperla* cards) were released to suppress the pest population through biological control (Table-1).During the first week of August rainfall started which intermittently continued for many days and reduced the pest population. The over all, minimum Jassid population (1.67/leaf) was recorded in T2 (Confidor insecticide) plot, whereas the maximum pest population (2.38/leaf) was found in T4 (NIAB-78 control) plot (Table- 7). The analysis of data showed that there was a significant ($P<0.05$) in population of jassid on different treatments.

Table-1: Mean Population of Jassid, *Amrasca devastans* (Dist.) in different treatments on cotton crop under field conditions

Mean population of jassid/leaf					
Observation Date	**T1**	**T2**	**T3**	**T4**	**Mean**
15.06.16	5.65	3.66	2.96	6.13	4.60B
19.06.16	5.19	2.34	6.23	5.43	4.80A
23.06.16	2.91	2.42	2.98	1.99	2.58E
30.06.16	4.51	2.78	3.59	5.49	4.10C
04.07.16	4.85	2.01	5.21	4.67	4.19BC
08.07. 16	3.46	3.85	3.77	4.07	3.79CD
15.07. 16	2.43	3.90	4.30	11.2	3.36D
19.07. 16	5.21	1.62	4.41	5.14	4.10C
23.07. 16	2.56	4.46	4.25	5.46	4.18BC
31.07. 16	1.34	0.30	2.24	2.06	2.23E
10.08. 16	0.71	0.64	0.90	0.36	0.65F
14.08. 16	0.66	0.53	0.47	0.34	0.50FG
18.08. 16	0.73	0.53	0.72	0.40	0.60FG

Mean population of jassid/leaf					
Observation Date	**T1**	**T2**	**T3**	**T4**	**Mean**
25.08. 16	0.73	0.54	0.56	0.32	0.54FG
29.08. 16	0.03	0.19	0.34	0.29	0.21G
02.09. 16	0.37	0.35	0.40	0.31	0.36FG
09.09. 16	0.82	0.78	0.55	0.87	0.76F
13.09. 16	0.58	0.35	0.49	0.97	0.60FG
17.09. 16	0.51	0.52	0.44	0.25	0.43FG
24.09. 16	0.49	0.51	0.59	0.31	0.48FG
Mean	2.19	1.76	2.27	2.38	2.15

* Means followed by same letters are not significantly (P< 0.05) different from each other by LSD.

Table-2 Mean Population of Jassid, *Amrasca devastans* (Dist.) after application of different IPM options on cotton crop under field conditions.

Application	**Mean population of jassid/leaf**											
	Pre Treatment				**Post Treatment 3D**				**Post Treatment 7D**			
	T1	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**
1	5.65	3.66	2.96	6.13	5.19	2.34	6.23	5.43	2.91	2.42	2.98	1.99
2	4.51	2.78	3.59	5.49	4.85	2.01	5.21	4.67	3.46	3.85	3.77	4.07
3	2.43	3.90	4.30	11.2	5.21	1.62	4.41	5.14	2.56	4.46	4.25	5.46
4	0.71	0.64	0.90	0.36	0.66	0.53	0.47	0.34	0.73	0.53	0.72	0.40
5	0.73	0.54	0.56	0.32	0.03	0.19	0.34	0.29	0.37	0.35	0.40	0.31
6	0.82	0.78	0.55	0.87	0.58	0.35	0.49	0.97	0.51	0.52	0.44	0.25
Mean	2.47	2.05	2.14	4.06	1.17	1.23	2.85	2.80	1.85	2.02	2.09	2.08

Table-3 Overall mean population of pests in different treatments on cotton crop under field conditions.

Treatment	**Jassid Per Leaf**
T1	2.19B
T2	1.76C
T3	2.27AB
T4	2.38A

* Means followed by same letters are not significantly (P< 0.05) different from each other by LSD.

IV.Green lacewing, *Chrysoperla carnea* (Steph.)

Green lacewing *Chrysoperla carnea* (Steph.) is an important predator of aphid, whitefly, thrips and jassid. It is also called aphid lion. The *C. carnea* was recorded from the 2nd week of June till the last week of September when the 1st picking was taken, their maximum activities were recoded during 1st week of August. The maximum population (0.85/plant) was recorded in T1 in which natural enemies (*C. carnea* cards) were released as a pest management option (Table-8) the minimum population (0.05/plant) was recorded in the various treatments T2, T3 and T4 (Confidor treatment), (B.T. control) and (NIAB-78) plots respectively. The over all mean population of *C. carnea* shown in (Table-10) indicated that the maximum *C. carnea* population was recorded (0.34/plant) in T1 (*C. carnea* natural enemies) plot, whereas the minimum population was recorded as (0.06/plant) in T2 (Confidor insecticide) plot. The analysis of data showed that there was a significant (P<0.05) difference in population development of *C. carnea* on different treatments.

Table-4 Mean Population of green lacewing, *Chrysoperla carnea* (Steph.) in different treatments on cotton crop under field conditions.

Mean population of green lacewing/plant					
Observation Date	**T1**	**T2**	**T3**	**T4**	**Mean**
15.06.16	0.30	0.25	0.20	0.15	0.23ABC
19.06. 16	0.55	0.05	0.10	0.25	0.24ABC
23.06. 16	0.40	0.10	0.20	0.10	0.19BCDE
30.06. 16	0.55	0.10	0.25	0.20	0.28AB
04.07. 16	0.85	0.05	0.15	0.15	0.30A
08.07. 16	0.50	0.10	0.20	0.20	O.25ABC
15.07. 16	0.35	0.10	0.10	0.15	0.17CDEF
19.07. 16	0.55	0.05	0.15	0.20	0.24ABC
23.07. 16	0.45	0.05	0.10	0.15	0.18BCDE
31.07. 16	0.35	0.05	0.10	0.15	0.16CDEF
10.08. 16	0.30	0.10	0.15	0.05	0.15CDEF
14.08. 16	0.40	0.05	0.15	0.25	0.21ABC
18.08. 16	0.35	0.05	0.15	0.20	0.17CDEF
25.08. 16	0.35	0.00	0.20	0.25	0.20BCD
29.08. 16	0.55	0.00	0.20	0.20	0.23ABC
02.09. 16	0.15	0.00	0.05	0.05	0.06G
09.09. 16	0.15	0.05	0.10	0.05	0.09FG
13.09. 16	0.35	0.05	0.05	0.00	0.11DEFG
17.09. 16	0.25	0.00	0.00	0.05	0.09FG
24.09. 16	0.30	0.05	0.00	0.05	0.10EFG
Mean	0.39	0.06	0.13	0.14	0.18

* Means followed by same letters are not significantly (P< 0.05) different from each other by LSD.

Table-5 Mean Population of green lacewing, *Chrysoperla carnea* (Steph.) after release of predator on cotton crop under field conditions.

Application	**Mean population of green lacewing/plant**											
	Pre Treatment				**Post Treatment 3D**				**Post Treatment 7D**			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
01	0.30	0.25	0.20	0.15	0.55	0.05	0.10	0.25	0.40	0.10	0.20	0.10
02	0.55	0.10	0.25	0.20	0.85	0.05	0.15	0.15	0.50	0.10	0.20	0.20
03	0.45	0.10	0.10	0.15	0.45	0.05	0.15	0.20	0.45	0.05	0.10	0.15
04	0.30	0.01	0.15	0.20	0.40	0.05	0.15	0.15	0.35	0.05	0.15	0.20
05	0.35	0.00	0.20	0.25	0.55	0.00	0.20	0.20	0.15	0.00	0.05	0.05
06	0.15	0.05	0.10	0.05	0.35	0.05	0.00	0.05	0.25	0.00	0.00	0.05
Mean	0.35	0.10	0.16	0.16	0.52	0.04	0.12	0.16	0.35	0.05	0.11	0.12

Table-6 Overall mean population of green lacewing, *Chrysoperla carnea* (Steph.) in different treatments on Cotton crop under field conditions.

Per Plant	
Treatments	***C. Carnea***
T1	0.39A
T2	0.06C
T3	0.13B
T4	0.14B

* Means followed by same letters are not significantly (P< 0.05) different from each other by LSD.

V. Cotton crop yield parameters

Height

The Cotton plant attended maximum height of (130.9c.m/plant) recorded in T4 (NIAB-78 control) plot in the 2nd fortnight of September (Table-11) the minimum height (74.40c.m/plant) in T3 (B.T. control) plot in the 2nd fortnight of July. The overall mean maximum height was recorded (111.10c.m/plant) in T4 (NIAB-78 control) plot; where as the minimum height (84.33c.m/plant) was recorded in (B.T. control) plot, as shown in (Table- 7).

Bolls

The maximum number of bolls (25.9/plant) was recorded in T4 (NAB-78 control plot) during the 2nd fortnight of August, where as the minimum number of bolls (0.8/plant) was recorded in T3 (B.T. control) plot during the 2nd fortnight of September (Table-11). The overall maximum number of bolls (20.84/plant) was recorded in T4 (NAB-78 control plot) whereas the minimum number of bolls was recorded (13.36/plant) in T3 (B.T. control) plot (Table-7). The analysis of data showed that there was a significant (P<0.05) difference in formation of bolls in different treatments.

Table-7 Cotton yield parameters (per plant) in different treatments under field condition.

Fortnight	Treatments	Plant Height	No. of Bolls
2nd July	T1	71.60	09.55
	T2	99.10	16.50
	T3	73.40	12.25
	T4	96.50	13.55
1st August	T1	104.8	14.50
	T2	103.6	13.65
	T3	93.90	08.85
	T4	108.8	21.45
2nd August	T1	107.9	20.65
	T2	102.9	24.40
	T3	92.90	15.95
	T4	110.0	19.40
1st September	T1	111.6	20.00
	T2	107.9	19.70
	T3	83.80	18.15
	T4	109.0	23.90
2nd September	T1	106.3	22.30
	T2	101.2	26.40
	T3	78.20	11.60
	T4	130.9	25.90

Table-8 Overall mean (per plant) of cotton yield parameters in different treatments under field conditions.

Treatments	Plant Height	No. of Bolls
T1	100.4B	17.40B
T2	102.9B	20.13A
T3	84.33C	13.36C
T4	111.10A	20.84A

* Means followed by same letters are not significantly (P< 0.05) different from each other by LSD.

DISCUSSION

In present study different pest management options were tested on Bt- cotton against sucking insect pests. Release of *C. carnea* cards in cotton reduced the population of jassid, thrips and white fly compared with control. Jassid population was slightly lower in Bt Cotton control compared with NIAB-78 control. Similarly whitefly population was lower in Bt-cotton control compared to NIAB-78 control. Hanumantharaya and Naik (2008) studied the release of *Chrysoperla carnea* grubs at 0.75 and 1.0 lakhs/ha. Starting from 43 DAS reduced the sucking pest (leaf hoppers, thrips, aphids and whiteflies) and bollworm *H. armigera* and increased the seed cotton yield. Wadhawa and Gill (2007) studied the biodiversity of natural enemies on Bt and non-Bt cotton hybrids and found that Bt cotton hybrid recorded higher population of *Chrysoperla carnea*, spiders, *Geocoris* bug, and yellow wasps. Manju *et al.* (2007) investigated the effect of Bt- cotton fed aphids on the feeding potential and development of *C. carnea* and reported no variation in the feeding potential and development period of larvae of *C. carnea* fed on aphids feeding on Bt and non Bt cotton plants. They recorded significantly higher number of natural enemies on Bt – Cotton compared with non Bt- cotton.

In present study, confidor was applied on Bt- cotton for the control of sucking insect pests, results indicated that confidor significantly reduced jassid population compared with *C. carnea* and control treatments. Confidor was not much effective against thrips and whitefly. Results further indicate that confidor was toxic to *C. carnea* and lowest population of *C. carnea* was recorded in confidor applied treatment. Ameta and Sharma (2005) recorded reduction in population of *A. gossypii*, *A. biguttula* and *T. tabacci* after application of confidor. Chaudhary *et al.* (2005) also reported that confidor was superior than Clothianidia in controlling the jassid populations in cotton.

Conclusion

Bt cotton is susceptible to thrips compared to NIAB – 78. Both the treatments (*Chrysoperla carnea* and Confidor) suppressed the insect pest's population. Confidor significantly reduced jassid population whereas it was not much effective against thrips and whitefly. The confidor was toxic to *C. carnea* (predator); lowest population was recorded in confidor treated plot.

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