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Research Article

Behavioral response of cotton (*Gossypium hirsutum)* against the infestation of different sucking insect pests in Southern Punjab, Pakistan

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Abstract

The present study was accomplished with aim to identify changes in cotton sucking pest population during different seasons in Southern Punjab, Pakistan. The study spanned three years (2014-2016) beginning from cotton sowing to harvesting season each year. Three species of sucking pests were under observation namely Jassid (*Amrasca biguttula*), dusky bug (*Oxycarenus laetus*), and thrips (*Thrips tabaci*). Their common predators were also noted like *Geocoris*, *Chrysoperla* and *Argiope*. Population of adults and counts of eggs of pests and predators were recorded. Cotton behaves variably against these pest populations during the study. Significant infestation was observed on Non Bt as compared to Bt variety. One-way analysis of variance was performed to analyze the data. The adults of *Amrasca biguttula*, *Oxycarenus laetus* and *Thrips tabaci* varied across the years, variety and seasons. Among the predators *Geocoris* and *Argiope* population varied due to these factors throughout the study period except *Chrysoperla*. No significant difference was observed in the total number of eggs of different sucking pests yearly, on varieties and different months at experimental site.

Keywords: Prey and Predator; Resistance; Sucking pests; Transgenic cotton

Introduction

Agriculture is the lifeline of Pakistan's economy accounting for 19.5 percent of the gross domestic product, employing 42.3 percent of the labour force and providing raw material for several value-added sectors. It thus plays a central role in national development, food security and poverty reduction. The rapid growth of Pakistan's urban areas indicates that demand for high-value perishable products such as fruits, vegetables, dairy, and meat is rising. China Pakistan Economic corridor will help to improve the supply chain and agribusiness benefits by tapping value-added product innovation. Cotton is one of the most

important commercial crops in the world. Among the cotton growing countries, India has the largest area of 9.0 million hectare grown under diverse agro ecological areas listed 1326 species of insects and mites recorded on cotton. In Pakistan 159 species of mites and bugs were reported. The great majority of these are of little or no economic importance so far as cotton is concerned, and some, although collected on cotton have not been observed to feed on it. Many are sporadic casual or accidental visitors to the crop. Fortunately, only a relatively small number of insects are of major economic important, but individually or by their combined effect they can cause significant yield loss. Among the phytophagous cotton pests, 24 have attained the pest status and the important can be classified as sap feeding insects, leaf feeding insects and mites. Thrips are generally one of the main early season cotton pests **[15]**. They initially damage the cotyledons and then several other parts and the types of damage vary according to the parts of the plant attacked. Most damage occurs during early vegetative stage of the crop, when nutritional quality of tissues is ideal for these insects. Both adult and nymphs usually remain on the under surface of leaves, lacerate the tissues and suck the cell sap. The affected leaves become thickened, blistered and bronzed due to continuous feeding. Feeding on developing bolls, makes them turn brown due to development of necrotic patches **[13]**. Thickening of boll rind can also be noticed when bolls are attacked, boll opening is affected **[13]**.Thrips populations are checked by certain predatory thrips. The predators on thrips include *Anthocoridae, Lygaidae* and mites **[14]**. But their role is very limited. The cotton whitefly, an occasional pest of cotton in India has emerged as a major pest of cotton. Severe outbreak was first observed in Guntur region of Andhra Pradesh during 1984-85seasonss and now continuous to be in all the cotton growing regions of India **[7]** and Pakistan. In addition to direct pest it also acts as a vector of cotton leaf curl virus in north zone. The nymphs and adults remain in colonies on the under surface of leaves and suck the plant sap. Due to continuous feeding chlorotic spots develop on the leaves which later coalesce and the leaves become reddish, brittle and finally drop prematurely. This results in reduced nutrition to the plant leading to stunting, shedding of fruiting bodies and reduction in boll size. The bolls are also forced to burst prematurely loading to poor quality lint. The 'honeydew' excreted by whitefly drops on the upper surface of lower leaves and bolls which favor the development of black sooty mold on the leaves, which in turn reduces photosynthesis and physiology of leaves. Heavy fungal growth on honeydew leads to premature leaf drop **[5]**. Honeydew on open bolls causes stickiness of cotton which interferes with picking, ginning and spinning thus the lint value is reduced. In addition to *Bemisia tabaci* the spiraling whitefly, *Aleurodichus disperses* also attack cotton and cause similar damage as cotton whitefly. *A. dispersus* is more common in summer cotton rather than winter cotton **[6]**. Dusky cotton bugs (*Oxycarenus laetus*) also called as cotton stainers occur on cotton during peak boll formation stages of cotton. They are generally gregarious, bright red colored. They are not serious pests but at time cause considerable damage to developing seeds impairing seed viability as well as staining the kapas **[18]**.Knowing, the importance of the sucking insect pests attacked on the cotton, the present research was designed to find the behavioral response of the cotton against these pests.

Materials and Methods

Study site and plan of study

The study was planned to record number of adults and their eggs regarding three sucking pests of cotton jassid (*Amrasca biguttula*),

dusky cotton bugs (*Oxycarenus laetus*) and thrips (Thrips tabaci) along with their predating insects *Geocoris, Chrysoperla* and *Argiope* from the cotton growing areas in Multan region, beginning from sowing to harvesting season on fortnightly basis during 2014-2016. Cotton varieties (IUB-33, Lalazar, Sitara, MNH988, and NIAB Non Bt) were grown in ten different randomly selected plots in the experimental area. Local agronomic practices were adopted. Seeds were purchased from local market at the rate of Rs.300/kg for Bt and Rs 250/Kg for non-Bt varieties. Before sowing, the seeds were treated with 95% conc. H_2SO_4 to remove the fuzz on cotton seeds. Raised beds were prepared at the distance of 2.5ft from each other. Two to three seeds were placed on these raised beds at the distance of 25cm from each other. Irrigation was supplied time to time when needed, urea and diamonium phosphate (DAP) were used as fertilizers. No pesticides were used.

Recording of the data

Counting number of adults and eggs of three types of cotton sucking pests was started when plumule of plant erupted the soil and leaves began to appear. Ten plots were randomly selected where cotton was grown. Signboards were placed and plants in each field were tagged at suitable places inside the fields for enumeration purpose.

Statistical analysis of the data

The data of insect and egg counts were edited and fed into MS Excel sheet to check any error and omissions. Further the data were analyzed by one way analysis of variance (ANOVA) and means were tested for significant differences using Statistix (Version 8.1) software at 5% level of significance.

Results

The analysis of variance presented as under explained the effect of year, cotton variety and season (month) on sucking pests and their predators. The average number of Jassid (*Amrasca biguttula*), dusky bugs (*Oxycarenus laetus*) varied due to year, variety and month significantly. Among predators average number of *Geocoris* and *Argiope* was also affected significantly by variety, month and year. However, average number of *Chrysoperla* was not influenced by these factors significantly. Average number of eggs of the sucking pests of cotton was also influenced by year, variety and month factors significantly as shown in (Table 1).

Table 1. Analysis of variance table for eggs and adults of *Amrasca biguttula* (jassid), *Oxycarenus laetus* (dusky bugs) and *Thrips tabaci* (thrips) and their predators of cotton

Varible	*Amrasca biguttula*		*Oxycarenus laetus*		*Thrips tabaci*		Adult Predators		
	Eggs	Adults	Eggs	Adults	Eggs	Adults	*Geoc*	*Chryso*	*Argiope*
Year	15.61***	11.86***	4.12*	10.55***	14.16***	24.10***	4.86*	1.88ns	3.89*
Variety	17.13***	30.54***	3.66*	11.18***	21.95***	23.62***	0.33ns	1.12ns	0.29ns
Month	5.23***	33.15***	7.62**	5.19***	2.92*	33.56***	6.65**	4.90**	5.67

! Given values are from ANOVA showing significance difference, *, significant; **, Highly Significant; ***, very highly significant; ns, non-significant

Comparison of means showed that highest average number of dusky bugs (*Oxycarenus laetus*) was found in 2015, followed by 2014 and 2016, respectively (Table 2). Their highest and lowest average number was noted in Sitara and Lalazar cotton varieties (Table 3). Yearly population size was compared, 2016 population was the highest and 2014 the lowest in size with significant differences. Similarly, highest population of jassid (*Amrasca biguttula*) was observed in 2016 and lowest in 2014. Comparison of means for thrips (*Thrips tabaci*) count showed that their average population count

was lowest in 2014 and highest in 2015. The significant differences between yearly population counts were apparent (Table 2).Minimum number of eggs of jassid (*Amrasca biguttula*) was counted in 2014 and highest number of eggs was counted in 2016.Highest to lowest egg counts of dusky bugs (*Oxycarenus laetus*) were observed in 2016, followed by 2015 and 2014, Likewise highest to lowest egg counts of thrips order was 2016 < 2014 < 2015. Significant differences were observed among these egg numbers. The lowest eggs count of thrips (*Thrips tabaci*) was observed in 2015 and highest were observed in 2016 (Table 2).

Table 2. Means number of eggs and adults of *Amrasca biguttula* (jassids*), Oxycarenus laetus* (dusky bugs) and *Thrips tabaci* (thrips) during three years (2014, 2015 and 2016)

Variable	*Amrasca biguttula*		*Oxycarenus laetus*		*Thrips tabaci*	
	Mean ±SE		Mean ±SE		Mean ±SE	
	Eggs	Adults	Eggs	Adults	Eggs	Adults
2014	2.20 ±0.60	25.22 ±2.22	1.70 ±0.25	5.49 ±0.71B	2.00 ±0.55	25.47 ±2.47
2015	3.73 ±1.50	36.33 ±1.89	2.83 ±0.37	9.73 ±0.51A	1.77 ±0.25	51.89 ±3.57
2016	8.25 ±1.90	43.99 ±2.01	2.94 ±0.47	4.50 ±1.21B	6.30 ±1.95	50.52 ±3.29

Means bearing different letters are significantly different from eachothers

Table 3. Means number of eggs and adults of *Amrasca biguttula* (jassids*), Oxycarenus laetus* (dusky bugs) and *Thrips tabaci* (thrips) in different cotton varieties

Variety	*Amrasca biguttula*		*Oxycarenus laetus*		*Thrips tabaci*	
	Mean ± SE		Mean ± SE		Mean ± SE	
	Eggs	Adults	Eggs	Adults	Eggs	Adults
IUB-33	2.01A ±0.78	33.86B ±2.87	1.69A ±0.39	4.49 ±0.92B	1.96A ±0.71	37.19 ±2.17
Lalazar	2.85A ±0.79	22.54B±2.17	2.17A ±1.59	4.44 ±0.72B	1.22A ±0.21	39.27 ±3.19
MNH-988	2.85A ±0.79	17.52A ±1.97	2.17A ±1.59	5.91 ±1.12B	2.31A ±1.61	21.08 ±2.47
NIAB NonBT	10.30B ±2.79	57.06C ±4.87	2.74A ±2.39	6.15 ±2.00B	9.34B ±3.71	64.76 ±5.02
Sitara	5.61A ±1.01	44.92A ±3.21	3.68A ±1.99	11.88±2.62A	1.93A ±0.70	50.84 ±4.17

Means bearing different letters are significantly different from eachothers

Comparison mean of jassid (*Amrasca biguttula*) population showed that the lowest number of individuals was recorded in the month of April and highest number of population was observed in September in 2014. Adult population of jassid (*Amrasca biguttula*) were lowest in April and highest in September during 2015 while During 2016 the lowest count of jassid (*Amrasca biguttula*) were recorded in April and highest population incidence were observed in September and October (Table 4).Comparison of means showed that highest average number of dusky bugs (*Oxycarenus laetus*) was found in 2015, followed by 2014 and 2016, respectively (Table 4). Variation of average number of dusky bugs (*Oxycarenus laetus*) presented that lowest and highest average population of dusky bugs (*Oxycarenus laetus*) was found during April and September (Table 4) during three years in pooled data. During 2014, 2015 and 2016, highest average population of dusky bugs (*Oxycarenus laetus*) was recorded in the months of September, 2014, September, 2015 and October, 2016 respectively (Table 4). Corresponding lowest average populations of this sucking pest were seen in the month of April, each year. When yearly population size was compared, 2016 population was the highest and 2014 the lowest in size with significant differences. Comparison of means for thrips (*Thrips tabaci*) count

showed that their highest number was noted in October 2014, October 2015 and September 2016. Lowest number was recorded in April every year. Their average population count was lowest in 2014 and highest in 2015. The significant differences between yearly population counts were apparent (Table 4). Average population number of *Chrysoperla* was found highest and lowest during August and April in 2014, August and April during 2015 and September and April during 2016, respectively. The overall highest population was recorded in September 2016 and lowest in April of every year (Table 5).The lowest number of *Argiope* was recorded during April of every year. The highest population was found in September 2014, August 2015 and July 2016. Overall order from highest to lowest count was: 2016<2015<2014 with minor change in size (Table 5).The average population count of *Geocoris* was lowest and highest in months of April and July during 2014, April and August to September 2015 and April and September during 2016, respectively. There were minor differences among yearly population size, yet 2015 had the highest and 2014 the lowest population count of this insect (Table 5).

Table 4. Means number of adults *Amrasca biguttula* (jassids), *Oxycarenus laetus* (dusky bugs) and *Thrips tabaci* (thrips) in various seasons during three years (2014, 2015, 2016)

Month	2014			2015			2016		
	Amrasca biguttula	*Oxycarenus laetus*	*Thrips tabaci*	*Amrasca biguttula*	*Oxycarenu slaetus*	*Thrips tabaci*	*Amrasca biguttula*	*Oxycarenus laetus*	*Thrips tabaci*
April	0.00H	0.00D	0.00E	0.00H	0.00D	0.00E	0.00H	0.00D	0.00E
May	0.00H	0.00DEF	1.93E	0.33H	0.33D	1.06E	0.13H	0.13EF	1.06E
June	11.47GH	11.47CDEF	12.33E	21.00FG	21.00C	45.86C	43.80C	43.80CD	61.93BC
July	34.67EF	34.67CDEF	36.13D	51.67BCD	51.67B	73.06A	54.67BC	54.67CD	68.80AB
Aug	43.27DE	43.27CDEF	43.333D	60.00ABC	60.00A	81.53A	65.33A	65.33DE	71.46AB
Sept	44.07CDE	44.07CDEF	40.60D	62.07AB	62.07A	80.00A	72.00A	72.00CD	76.06AB
Oct	43.07DE	43.07CD	43.93CD	59.27ABC	59.27A	81.73A	72.00A	72.00DE	74.33AB

Means bearing different letters are significantly different from each others

Table 5.Means number of *Geocoris*, *Chrysoperla* and *Argiope* in various seasons during three years (2014, 2015, 2016)

Month	2014			2015			2016		
	Geocoris	*Chrysoperla*	*Argiope*	*Geocoris*	*Chrysoperla*	*Argiope*	*Geocoris*	*Chrysoperla*	*Argiope*
April	0.00F	0.00E	0.00E	0.00F	0.00E	0.00E	0.00E	0.00E	0.00E
May	0.00F	0.13E	0.00E	0.00F	0.40DE	1.20BC	0.33EF	1.00BCD	0.80DE
June	0.53DEF	0.80CDE	1.20BCD	1.93AB	2.40AB	1.93BC	2.20AB	1.73ABC	1.73BCD
July	1.86ABC	1.33BCD	1.06CDE	2.20AB	2.00AB	2.13BC	1.60AB	2.20ABC	3.60AB
Aug	0.80CDEF	2.00ABC	1.33BCD	2.60A	2.33AB	1.80BC	2.20AB	2.20ABC	2.13BCD
Sept	1.46ABCD	1.00BCD	1.53BCD	2.60A	2.13AB	1.53BC	2.40A	3.06A	2.46AB
Oct	0.73CDEF	1.40BCD	1.20BCD	1.13BC	1.33BC	2.20BC	2.26AB	1.13BCD	1.53BCD

Means bearing different letters are significantly different from each others

Discussion

Pests always tend to destroy crops qualitatively as well as quantitatively in any crops. Sucking pests of cotton are also such agents that can cause huge loss to crops both in quality and quantity [1].The qualitative damages are irreparable and leads toward economic loss to farmers as their produce could fetch good amount of money due to poor quality. Among sucking pests, commonly known insects include jassid (*Amrasca biguttula*), dusky bugs

(*Oxycarenus laetus*), thrips (*Thrips tabaci*). Current study focused on their population dynamics and seasonal/monthly changes from sowing to harvesting of the crop in order to make strategies to reduce pest load on crops by adopting some suitable control measures [16]. Various types of sucking pests like aphids, jassid, dusky bugs, mites and white flies are playing their roles in the ecosystem and their populations change over the time period and seasons due to numerous factors. Such changes have been studied by many researchers [2-4, 10, 11, 20, 21]. Adult population of jassid varied during three years of study and seasonal changes were also apparent at sites of study. (Table 2). Changes with the passage of time depends upon the population structures and reproduction rates of the insect that ultimately depended upon the feed and space resources [7]. Egg counts of this insect also showed similar findings and were found to be highly influenced by yearly affects along with varietal differences and seasonal changes. Highest population of jassid was reported by [17] in October while [11] in August, [3] in July to September, [19] throughout the year except for July and August, [8] in October to November. The variation in results showed the differences might be due to climatic and geographical distribution and other relevant factors. Variations in dusky bug population were obvious in three years study (Table 2). Population also faced changes in different season and on various cotton varieties. Season changes also most related with change in environmental condition that usually favor or disfavor the flourishing of insects buy affecting its life cycle [9]. These factors (year, variety and season) also had great impact on counts of eggs of dusky bugs as highlighted significant varying numbers. In case of thrips, population of adults had variations due to years, variety and seasons at two of the sites. As predator play very important role in food chains for maintain populations in natural equilibrium, their own populations face fluctuations due to availability of feeding resources, competition for space and others reasons. Yet their population might face variation due to factors like year, variety of crop and season [12]. These variations were found in the experimental site for *Geocoris* populations. In study area population of *Chrysoperla* could not show significant variation for year and variety factors though it was apparent for monthly variations. Population of *Argiope* showed nearly similar results for site where year and variety had no effect and only monthly effects were introducing variations.

Conclusion

Population of adults of various types of sucking pests Jassids (*Amrasca biguttula*), dusky bugs (*Oxycarenus laetus*), and, thrips (*Thrips tabaci*) varied across years, varieties and seasons. Populations of predators (*Geocoris, and Argiope*) also varied due to these factors albeit *Chrysoperla* could not be affected at experimental location throughout the study period. No obvious difference was observed in the total number of eggs of different sucking pests yearly, on varieties and different months at experimental site. Population of Jassids (*Amrasca biguttula*) and thrips (*Thrips tabaci*) increases yearly while Dusky bugs (*Oxycarenus laetus*) decreases during three years. IUB, Lalazar and MNH showed resistance to *Amrasca biguttula*, *Oxycarenus slaetus* and *Thrips tabaci* while Non Bt NIAB were affected with these pests at experimental site.

Authors' contributions

Conceived and designed the experiments: AZ Ali, MN Akhtar, MQ Awan, AH Ali & A Farooq, Performed the experiments:AZ Ali & MN Akhtar, Analyzed the data: A Farooq & M Q Awan, Contributed materials/ analysis/ tools: AZ Ali, MN Akhtar & AH Ali, Wrote the paper: AZ Ali.

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