



Prevalence and Impact of Sucking Insect Pests on Cotton Crop

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ABSTRACT

Background: Cultivation of cotton, the staple fiber crop, is expanding in Bangladesh. The crop suffers from the infestation of the sucking insect pests *i.e.*, aphid and jassid. This study investigated the physiomorphic traits, yield and quality of cotton plants regarding the abundance of aphid and jassid.

Methods: The study was conducted in Gazipur, Bangladesh with the cotton varieties namely CB12, CB13, CB14, CB15 and HC1. Abundance of the insect pests was recorded through weekly inspection of the field.

Result: The tested cotton varieties showed differences in physiomorphic traits, yield and quality attributes. Statistically, aphid and jassid showed the lowest abundance on CB14 and HC1 varieties, respectively and the variety CB14 revealed the lowest plant deformities and resulted the highest yield and quality attributes. Aphid and jassid populations revealed a negative correlation with leaf trichomes and phytochemical contents but showed a positive correlation with the number of leaves plant⁻¹.

Key words: Abundance, Aphid, Jassid, Morphological traits, Phytochemicals.

INTRODUCTION

Cotton is a staple textile with versatile usage and its fiber has excellent thermal conductivity and anti-static properties (Majumdar *et al.*, 2010). The Cotton Development Board of Bangladesh has released some varieties of *Gossypium hirsutum* recently, which are cultivated in Bangladesh. The yield of cotton in Bangladesh is low (2.4 Mt/ha) due to climatic conditions, unavailability of suitable variety and insect pest infestation (Azad *et al.*, 2011).

The sucking insects, aphid *Aphis gossypii* Glover (Hemiptera: Aphididae) and jassid *Amrasca devastans* Distant (Hemiptera: Cicadellidae) prevail in the cotton fields of Bangladesh throughout the season and cause severe damage (Amin *et al.*, 2009; Azad *et al.*, 2011). The nymph and adult of the sucking insects suck sap from cotton leaves, squares, flowers and developing bolls and secrete honeydew, which facilitates the development of sooty mold fungus. These insects act as a vector of viruses and toxin injected by jassid into the cotton plants cause hopper burn symptoms. Severely infested plants produce cripple bolls and low-grade lint and create a plucking and ginning problem (Hossain *et al.*, 2012).

Inherent crop characteristics such as hair and trichomes, cuticle thickness and phytochemicals, such as reducing sugars, proteins, proline and presence of toxic allelo-chemicals influence the foraging, feeding, oviposition, growth and development of the herbivore insects and affect their abundance (Zalucki *et al.*, 2002; Amin *et al.*, 2020b). Singh and Agarwal (1988) observed that cotton genotypes containing lower amounts of reducing sugars, proteins and free amino acids exhibited resistance to leafhoppers.

To maximize the quality and quantity of cotton yield, it is crucial to overcome pest incidence and keep healthy ecosystem conditions. Cultivation of resistant varieties is the prime consideration of ecological pest management and this purpose is increasing daily (Al-Chaabi *et al.*, 2000). With

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this viewpoint, this study was done to determine the incidence and impact of sucking insects, specifically aphid and jassid, on five cotton varieties, namely, CB12, CB13, CB14, CB15 and HC1.

MATERIALS AND METHODS

Cotton plants

The cotton varieties CB12, CB13, CB14, CB15 and HC1 were sown on August 2, 2018 in the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh (25°25' N and 89°5' E). Seeds of the cotton varieties were sown in 3.0 m × 3.0 m plots, replicated five times and arranged in a randomized complete block design. The spacing between blocks and plots was 1.5 m and 1.0 m, respectively. Each plot contained five rows and each row had five plants. Fertilizing and intercultural operations were done on a necessity basis and the plants were grown without insecticide spray to allow insect infestation.

Sucking pests

Data of the aphid and jassid's abundances were collected at the cotton plant boll formation stage. Ten plants for each variety were randomly selected to collect data and the numbers of nymphs and adult aphids on the apical leaf and the numbers of nymphs and adult jassids on the fifth leaf from the top of the plants were recorded. Observations were done using a magnifying glass (FD 75, Ballon Brand, China).

Numerical and phytochemical characteristics of cotton plants

At the plants' boll maturation stage, ten plants of each variety were randomly selected to collect the data of the number of branches, sympodial branches, leaves and bolls plant⁻¹ and trichomes leaf⁻¹. The fifth leaf from the top of a branch of the selected plants was collected to count the trichome density. The number of trichome per leaf was observed under a stereo microscope (BOE3200, BOECO, Germany). Plant heights (length from top to base) were measured using an mm-scale tape measure. Ten bolls were randomly collected for each variety and the boll diameters were measured using a slide caliper and the weights of the bolls were weighed using a digital balance (CANRY, China). The bolls were exposed and the numbers of locules per boll were counted.

Reducing and total sugar content of the leaf was estimated following Burtrand's method (Chandrabu *et al.*, 2016). Then, non-reducing sugar content was calculated by subtracting reducing sugar content from total sugar content. Micro Kjeldahl method was used to estimate the nitrogen content of leaves and results obtained were multiplied by 6.25 to get the protein percentage (Maehre *et al.*, 2018). A digital pH (Lutron PH-207) meter was used to measure the pH levels in the leaves.

Yield and quality attributes

After bursting the bolls, the bolls were plucked manually and kept separately in polythene bags and then sun-dried. The cotton seeds were separated after proper drying and

the weights were measured using a digital balance. The seed cotton yield of each plot was converted into t/ha.

Yield-quality characters such as ginning out-turn (GOT%), seed index, lint index and micronaire value were estimated with ten replications of each variety. The bolls were ginned with a single roller electric gin in the Regional Cotton Research and Extension Center laboratory, Gazipur, Bangladesh. Boll sample data included: percentage GOT (% GOT: percentage of lint obtained from 100 g of seed cotton), seed index (weight of 100 seeds), lint index (amount of fiber retained on 100 seeds) and micronaire (fiber fineness and maturity). Micronaire values were tested using a cotton micronaire testing machine (Zhenjiang KDL Machinery Co. Ltd., Jiangsu, China).

Data analysis

One-way analysis of variance (ANOVA) followed by Tukey HSD posthoc test was used to analyze data for abundance of aphid and jassid and morphological traits, yield and quality characteristics. Correlation matrix following principal component analysis was performed to observe the relationship between the abundance of insects with the morphological characteristics and biochemical contents of the cotton plants. All the analyses were performed using IBM SPSS v.21.0 software (IBM SPSS statistics v.21.0, Georgia, USA).

RESULTS AND DISCUSSION

Variations in insect pest abundance

The mean abundance of aphid and jassid on the cotton varieties ranged from 4.6 ± 0.9 to 31.3 ± 6.2 leaf⁻¹ and 2.4 ± 0.7 to 5.6 ± 1.1 leaf⁻¹, respectively and the results differed significantly (Fig 1). The varieties HC1 and CB14 revealed significantly the highest and the lowest number of aphid populations, respectively. Jassid population was the highest on CB15 and the lowest on HC1 cotton variety. The results are in close conformity with Amjad *et al.* (2009) who found

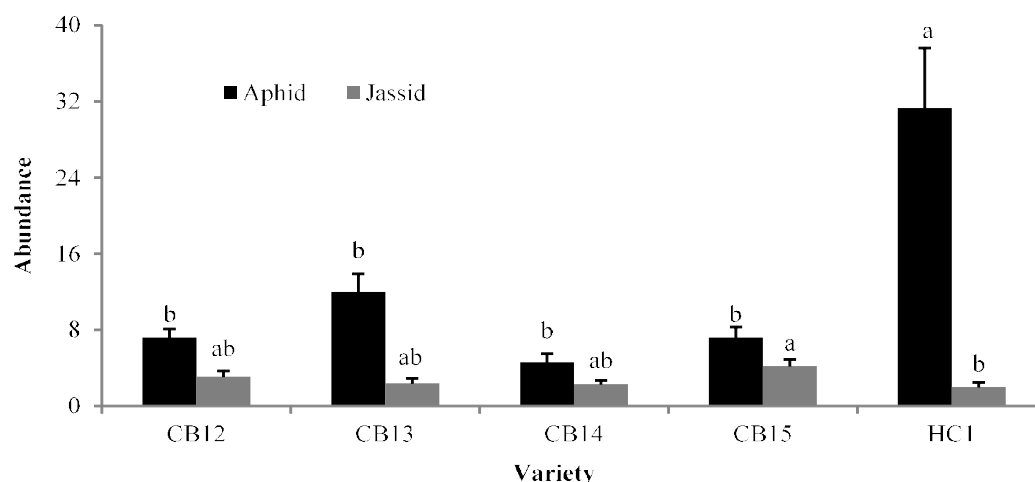


Fig 1: Abundance (number/leaf) of sucking insects on five cotton varieties. Data expressed as mean \pm standard error (SE). Bars with common letter(s) are not significantly different according to Tukey honestly significant difference test at $p < 0.05$.

significant variations of the abundance of aphid and jassid on different cotton varieties.

Plant responses to pests

Differences in plant characteristics such as leaf bronzing, leaf curl, leaf dropping, boll browning, hopper burn symptom and plant dwarfism due to aphid and jassid incidence are shown in Table 1. Results showed that CB15 had extreme leaf and boll bronzing, severe leaf curling and dwarf growth and high leaf dropping with excessive hopper burn symptom. CB12, CB13 and HC1 showed moderate to high response and CB14 depicted minute response to the above symptoms.

Numerical plant characteristics

The cotton varieties showed significant variations in plant agronomic characteristics such as the plant height, branch, leaf and sympodia and boll plant⁻¹, locules boll⁻¹, boll diameter and weight (Table 2). Results showed that plant height, number of branch, sympodial branch and boll plant⁻¹ and boll weight were the highest in CB14 with a mean value of 144.4±2.0 cm, 17.2±0.5, 10.1±0.5 and 33.8±0.9 and 14.4±0.8 g, respectively. Statistically, CB12 had the smallest height (118.6±1.8 cm) and CB13 had the lowest number of branches (14±0.8 plant⁻¹). HC1 and CB15 had the highest and the lowest number of leaves (122.8±2.8 and 59.9±1.4 plant⁻¹, respectively). Statistically, HC1 had the lowest number of locules boll⁻¹, boll diameter, boll weight, number of boll and sympodial branch plant⁻¹ (3.5±0.2, 2.81±0.1 cm, 9.4±0.3 g, 20.2±0.8 and 5.7±0.5, respectively). Amin *et al.*

(2017) reported significant variations among different varieties of cotton.

Aphid and jassid's populations had a significant negative correlation with ventral trichomes on CB12, CB15 and HC1 varieties and dorsal trichomes on CB14 and HC1 varieties, respectively (Table 3). Leaves plant⁻¹ had a significant positive correlation with the aphid population on CB12 and CB14 varieties and with jassid population on CB12 and CB15 varieties. The abundance of aphid showed a significant positive correlation with the abundance of jassid on CB12, CB14 and CB15 varieties. The result conformed with that of Amin *et al.* (2017) who reported the number of trichomes on the midrib of the cotton varieties showed significant negative correlations with the populations of aphid and jassid.

Phytochemical characteristics

The phytochemicals of leaves among the varieties varied significantly (Table 4). The moisture content was the highest and lowest in CB12 and HC1 with a mean value of 64.12±1.0% and 56.29±0.6%, respectively. Statistically, the highest amount of reducing sugar, total sugar content and protein was recorded for CB15 (2.50±0.05, 2.78±0.11 and 29.5±0.3, respectively). Statistically the lowest amount of reducing, total sugar and protein was found for CB14 variety (0.08±0.04, 0.11±0.03 and 25.4±0.2, respectively). pH was the maximum in CB13 with a mean value of 6.34±0.1. The lowest pH was recorded in HC1 (5.68±0.0). According to Singh and Agarwal (1988), reducing sugar ranged from 0.04 to 2.55 and moisture content ranged from 71.5% to 74.33%

Table 1: Deformities of the cotton varieties due to infestation of aphid and jassid.

Symptom	Variety				
	CB12	CB13	CB14	CB15	HC1
Leaf bronzing	Medium high	Medium	Minute	Extreme	Medium
Leaf curl	Moderate	Moderate	Low	Severe	Low
Leaf dropping	Medium high	Medium high	Few	High	Medium
Boll browning	Medium high	Moderate	Little	Heavy	Little
Hopper burn	Moderately high	Moderate	Low	Excessive	Moderate
Plant dwarfism	Medium high	Medium high	Little	Extreme	Moderate

Table 2: Numerical characteristics of the cotton varieties exposed to aphid and jassid infestation.

Characteristics	Variety				
	CB12	CB13	CB14	CB15	HC1
Plant height (cm)	118.6±1.8 d	127.0±2.0 c	144.4±2.0 a	131.5±1.2 c	138.4±0.8 b
Branches plant ⁻¹	15±0.7 ab	14±0.8 b	17.2±0.5 a	16.2±0.5 ab	15.9±0.5 ab
Leaves plant ⁻¹	64.5±1.6 ab	67.6±1.1 b	62.4±1.4 ab	59.9±1.4 c	122.8±2.8 a
Sympodia plant ⁻¹	9.4±0.3 ab	8.4±0.4 bc	10.1±0.5 a	7.5±0.4 b	5.7±0.5 c
Locules boll ⁻¹	4.3±0.2 a	4.3±0.2 a	4.5±0.2 a	4.4±0.2 a	3.5±0.2 b
Boll diameter	3.3±0.1 a	3.4±0.0 a	3.5±0.1 a	3.3±0.1 a	2.81±0.1 b
Boll weight	12.7±0.5 a	13.4±0.7 a	14.4±0.8 a	13.8±0.5 a	9.4±0.3 b
Boll number	32.6±0.9 a	33.8±0.9 a	34.6±0.7 a	33.6±0.6 a	20.2±0.8 b

Data expressed as mean ± standard error (SE) days from sowing. Means within a row followed by the same letter(s) are not significantly different according to Tukey honestly significant difference test at $p < 0.05$.

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Table 3: Correlation matrix of the numerical traits of the cotton varieties and abundance of aphid and jassid.

CB12	VT	DT	HP	BP	LP	AA
DT	-0.032 ^{NS}					
HP	-0.51 ^{NS}	- 0.06 ^{NS}				
BP	-0.48 ^{NS}	-0.27 ^{NS}	0.30 ^{NS}			
LP	-0.45 ^{NS}	0.06 ^{NS}	0.43 ^{NS}	0.32 ^{NS}		
AA	-0.69*	-0.24 ^{NS}	0.19 ^{NS}	0.49 ^{NS}	0.75*	
JA	-0.68*	-0.08 ^{NS}	0.50 ^{NS}	0.55 ^{NS}	0.83*	0.74*
CB13						
DT	0.17 ^{NS}					
HP	-0.34 ^{NS}	-0.12 ^{NS}				
BP	-0.53 ^{NS}	-0.46 ^{NS}	0.61*			
LP	-0.40 ^{NS}	-0.29 ^{NS}	-0.53 ^{NS}	0.75*		
AA	-0.07 ^{NS}	-0.40 ^{NS}	0.17 ^{NS}	0.20 ^{NS}	0.24 ^{NS}	
JA	-0.10 ^{NS}	-0.10 ^{NS}	0.26 ^{NS}	0.16 ^{NS}	0.26 ^{NS}	0.29 ^{NS}
CB14						
DT	-0.21 ^{NS}					
HP	-0.05 ^{NS}	0.20 ^{NS}				
BP	0.11 ^{NS}	-0.11 ^{NS}	0.11 ^{NS}			
LP	0.12 ^{NS}	0.11 ^{NS}	0.21 ^{NS}	0.65*		
AA	-0.15 ^{NS}	-0.77 ^{NS}	0.33 ^{NS}	0.80*	0.56 ^{NS}	
JA	-0.44 ^{NS}	-0.55*	0.24 ^{NS}	0.07 ^{NS}	0.60*	0.58*
CB15						
DT	-0.19 ^{NS}					
HP	0.33 ^{NS}	-0.75*				
BP	-0.43 ^{NS}	0.20 ^{NS}	-0.22 ^{NS}			
LP	-0.53 ^{NS}	0.40 ^{NS}	-0.60*	0.40 ^{NS}		
AA	-0.94**	-0.34 ^{NS}	0.50 ^{NS}	0.53 ^{NS}	0.67*	
JA	-0.65*	-0.20 ^{NS}	0.02 ^{NS}	0.27 ^{NS}	0.33 ^{NS}	0.72*
HC1						
DT	0.88**					
HP	0.31 ^{NS}	0.15 ^{NS}				
BP	-0.20 ^{NS}	-0.35 ^{NS}	0.61*			
LP	0.27 ^{NS}	0.07 ^{NS}	-0.16 ^{NS}	-0.12 ^{NS}		
AA	-0.91**	-0.91**	0.34 ^{NS}	0.17 ^{NS}	0.30 ^{NS}	
JA	-0.09 ^{NS}	-0.24 ^{NS}	0.15 ^{NS}	0.03 ^{NS}	0.41 ^{NS}	0.30 ^{NS}

*Significant ($p \leq 0.05$), **Highly significant ($p \leq 0.001$), ^{NS}Non-significant ($p \geq 0.05$). VT= Ventral trichome, DT= Dorsal trichome, HP= Plant height, BP= Branch/plant, LP= Leaf/plant, AA= Aphid abundance, JA= Jassid abundance.

Table 4: Comparison of phytochemical properties of leaf of the cotton varieties.

Cotton	Phytochemicals					
Variety	Moisture (%)	Reducing sugar	Non-reducing sugar	Total sugar	Protein	pH
CB12	64.12±1.0 a	1.62±0.03 b	0.94±0.07 a	2.56±0.06 a	26.6±0.4 c	5.93±0.1 ab
CB13	58.50±1.1 b	1.33±0.05 c	1.17±0.09 a	2.50±0.06 a	26.2±0.2 c	6.34±0.1 a
CB14	61.71±0.7 a	0.08±0.04 d	0.03±0.01 b	0.11±0.03 b	25.4±0.2 c	6.05±0.2 ab
CB15	57.03±0.5 b	2.50±0.05 a	0.28±0.09 b	2.78±0.11 a	29.5±0.3 a	6.03±0.1 ab
HC1	56.29±0.6 b	0.19±0.03 d	0.11±0.01 b	0.30±0.03 b	28.1±0.3 b	5.68±0.0 b

Data expressed as mean ± standard error (SE) days from sowing. Means within a row followed by the same letter(s) are not significantly different according to Tukey honestly significant difference test at $p < 0.05$.

Table 5: Correlation matrix of the phytochemical traits of the cotton varieties and abundance of aphid and jassid.

CB12	RS	NS	TS	PT	pH	AA
NS	0.20 ^{NS}					
TS	0.70*	0.56*				
PT	-0.03 ^{NS}	-0.28 ^{NS}	-0.30 ^{NS}			
pH	0.18 ^{NS}	0.51 ^{NS}	0.21 ^{NS}	0.35 ^{NS}		
AA	-0.05 ^{NS}	-0.09 ^{NS}	-0.16 ^{NS}	-0.59*	-0.50 ^{NS}	
JA	-0.48 ^{NS}	-0.35 ^{NS}	-0.49 ^{NS}	-0.43 ^{NS}	-0.59*	0.74*
CB13						
NS	-0.11 ^{NS}					
TS	-0.08 ^{NS}	0.56*				
PT	-0.28 ^{NS}	0.63*	0.64*			
pH	-0.18 ^{NS}	0.74*	0.78*	0.49 ^{NS}		
AA	-0.44 ^{NS}	-0.19 ^{NS}	-0.69*	-0.40 ^{NS}	-0.38 ^{NS}	
JA	-0.69*	-0.24 ^{NS}	-0.22 ^{NS}	-0.06*	-0.04 ^{NS}	0.29 ^{NS}
CB14						
NS	0.29 ^{NS}					
TS	0.40 ^{NS}	0.42 ^{NS}				
PT	0.24 ^{NS}	-0.27 ^{NS}	0.47 ^{NS}			
pH	0.51 ^{NS}	0.50 ^{NS}	0.06 ^{NS}	-0.12 ^{NS}		
AA	-0.09 ^{NS}	-0.04 ^{NS}	-0.08 ^{NS}	-0.20 ^{NS}	-0.52 ^{NS}	
JA	-0.31 ^{NS}	-0.02 ^{NS}	-0.24 ^{NS}	-0.44 ^{NS}	-0.33 ^{NS}	0.58*
CB15						
NS	0.43 ^{NS}					
TS	0.48 ^{NS}	0.37 ^{NS}				
PT	0.32 ^{NS}	0.19 ^{NS}	0.20 ^{NS}			
pH	0.25 ^{NS}	0.05 ^{NS}	0.02 ^{NS}	0.18 ^{NS}		
AA	-0.25 ^{NS}	-0.17 ^{NS}	-0.40 ^{NS}	-0.29 ^{NS}	-0.63*	
JA	-0.30 ^{NS}	-0.08 ^{NS}	-0.46 ^{NS}	-0.18 ^{NS}	-0.61*	0.72*
HC1						
NS	-0.09 ^{NS}					
TS	-0.03 ^{NS}	-0.54 ^{NS}				
PT	0.26 ^{NS}	0.07 ^{NS}	-0.30 ^{NS}			
pH	0.56*	-0.39 ^{NS}	-0.32 ^{NS}	-0.27 ^{NS}		
AA	-0.24 ^{NS}	-0.29 ^{NS}	-0.25 ^{NS}	0.07 ^{NS}	-0.14 ^{NS}	
JA	-0.05 ^{NS}	-0.17 ^{NS}	0.00	-0.18 ^{NS}	-0.14 ^{NS}	0.03 ^{NS}

*Significant ($p \leq 0.05$), ^{NS}Non-significant ($p \geq 0.05$). RS= Reducing sugar, NS= Non-reducing sugar, TS= Total sugar, PT= Protein, pH, AA= Aphid abundance, JA= Jassid abundance.

Table 6: Yield and quality characteristics of the cotton varieties exposed to aphid and jassid infestation from July 2018 to January 2019.

Characteristics	Variety				
	CB12	CB13	CB14	CB15	HC1
Yield (kg/ha)	723.13±2.6 c	715.63±1.5 c	784.93±2.2 a	754.67±2.3 b	316.60±5.8 d
GOT (%)	32.6±0.3 b	33.3±0.4 b	35.6±0.4 a	31.8±0.7 b	26.0±0.7 c
Seed index (g)	8.3±0.3 b	7.7±0.3 b	9.4±0.2 a	7.8±0.2 b	4.9±0.3 c
Lint index (g)	6.1±0.3 c	7.1±0.1 b	8.0±0.3 a	5.4±0.2 c	3.8±0.2 d
Micronaire (Mic)	3.8±0.1 ab	3.7±0.1 ab	3.9±0.0 a	3.6±0.1 b	2.9±0.1 c

Data expressed as mean ± standard error (SE) days from sowing. Means within a row followed by same letter(s) are not significantly different according to Tukey honestly significant difference test at $p < 0.05$.

in different cotton varieties. This finding reflects Wei *et al.* (2010) results who noted reductions in soluble sugar content in various host plants due to infestations of the sucking insect. Aphids take nutrient from host plants and reduce soluble sugar, amino acid and protein contents in the plants (Douglas 2003; Zhou *et al.*, 2013).

Aphid and jassid abundance had a significant negative correlation with protein content on CB12 and CB13 varieties, respectively (Table 5). Both insects had a significant negative correlation with pH on the CB15 variety and jassid had a significant negative correlation with pH on the CB12 variety. Aphid and jassid populations had a significant positive correlation on CB12, CB14 and CB15 varieties.

Yield and quality attributes

There were significant differences in seed cotton yield, GOT%, seed index, lint index and micronaire among the varieties (Table 6). Among the tested varieties, HC1 had the lowest yield and quality characteristics. CB14 had statistically the highest yield and quality characteristics. Sukhija *et al.* (1987) found a yield loss of 9.74 q/ha due to the infestation of sucking insect pests in cotton. Amin *et al.* (2016) observed significant differences in yield and quality attributes among the cotton varieties.

CONCLUSION

The findings of the study showed that the tested cotton varieties had variable phytochemical and morphological characteristics which influenced the abundance of aphid and jassid. Among the varieties, CB14 revealed statistically the highest yield and quality performances than other varieties in the state of aphid and jassid infestation.

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