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INFESTATION OF SUCKING INSECT PESTS ON FIVE COTTON CULTIVARS AND THEIR IMPACTS ON VARIETAL AGRONOMIC TRAITS, BIOCHEMICAL CONTENTS, YIELD AND QUALITY

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ABSTRACT

The five cotton cultivars viz., CB1, CB3, CB5, CB8, and C12 were evaluated under field conditions to compare their resistance levels against the aphid species *Aphis gossypii* (Hemiptera: Aphididae) and the jassid species *Amrasca devastans* (Hemiptera: Cicadellidae). The effects of plant characteristics that could explain some of the varietal resistance levels were tested by measuring infestation levels, biochemical content, leaf trichome density, agronomic traits, yield, and quality of seed and fiber. In comparison with other varieties, CB1 and CB3 showed the least leaf and boll infestation, and possessed higher numbers of trichomes. CB12 had the lowest number of trichomes and exhibited the highest percentages of leaf and boll infestation. Biochemical analyses indicated that the highest percentage of starch occurred in CB8, and that of protein in CB5. Both starch and protein content were lowest in CB12. Aphid and jassid infestation reduced the starch and protein content of all cultivars. CB3 was the best performing variety in terms of size and weight of bolls; ginning out-turn (GOT); number of branches, leaves, and bolls per plant; and number of locules per boll. Seed cotton yields and lint indices were highest in CB1 and CB3 and lowest in CB12. CB12 was also the worst performing variety in terms of plant height, micronaire value, percentage of GOT and germination, number of leaves and bolls per plant, and boll length, width and weight. The findings of this study clearly demonstrate that, among the cultivars evaluated, CB12 is the most susceptible to aphid and jassid infestation.

Keywords: Aphid, jassid, *Gossypium hirsutum*, plant characteristics

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INTRODUCTION

Cotton is considered to be the best fiber crop, and is commercially grown in more than 50 countries of the world. Climate, variety, pest infestation, harvest frequency, and ginning influence cotton productivity and quality (Azad et al., 2011). Due to the high demand for cotton fiber from the textile industry in Bangladesh, the government has been subsidizing the cultivation of upland cotton (*Gossypium hirsutum* L.) since 1977. However, the farmers are not showing interest in cotton cultivation due to insect pest infestation.

The aphid species *Aphis gossypii* Glover (Hemiptera: Aphididae) and jassid species *Amrasca devastans* (Hemiptera: Cicadellidae) concurrently attack cotton plants in Bangladesh and have been reported to be the most destructive cotton pests, causing damage throughout the season (Tithi et al., 2010). They are commonly found on the lower leaf surfaces of the terminal bud and other parts of plants, and both the species cause similar damage symptoms by feeding on leaves and developing bolls (Deguine et al., 2000; Sharma and Singh, 2011). These sucking insect pests secrete honeydew on feeding sites, which enhances sooty mold development, thus creating lint processing problems (Hossain et al., 2012).

Jassids deplete cell contents of the foliage by feeding on sap, and inject toxins into plant tissues along with their saliva, which causes "hopper burn" symptoms in plants (Raj, 2003). Aphid- and jassid-infested plants suffer from impaired photosynthesis and transportation of nutrients and water, reducing yield quantity and quality (Amin et al., 2009). These sucking insects not only directly damage cotton plants but also act as vectors of viral diseases.

The management of sucking insect pests in the cotton fields of Bangladesh involves spraying with soap-water solutions, botanical extracts, different oils, and various insecticides, and also by treating seeds with chemicals such as imidacloprid (Hossain et al., 2013). However, these products are sometimes unavailable and ineffective, and are time consuming and expensive to manufacture. Furthermore, foliar applications of insecticides can cause mortality of beneficial predator and pollinator species (Boyd and Boethel, 1998; Azad et al., 2010).

Many host plants protect themselves from herbivore insect attack, and host plant defense mechanisms are very significant considerations in integrated pest management (IPM) programs against the sucking insects (Tsai and Wang, 2001). Cotton varieties with higher densities of leaf trichomes exhibit resistance to insects (Bhat et al., 1984). Resistant varieties easily overcome insect infestation without application of synthetic chemicals, thus reducing production costs and saving the environment from pesticide contamination (Nault et al., 2004).

The nutrient content of crop varieties significantly affects their resistance or susceptibility by influencing the feeding efficiency, survival, growth and development, and population dynamics of pest insects (Amin et al., 2011). Singh and

Agarwal (1988) reported that cotton genotypes containing lower amounts of reducing sugars, proteins, and free amino acids exhibited resistance to the leafhopper (*Amrasca biguttula biguttula* Ishida).

The degree of susceptibility or resistance of crop varieties can aid in detecting and monitoring pest infestations, variety selection, and crop breeding. The pest infestation levels of different varieties of a particular crop species indicate their degree of resistance, and agronomic characteristics and biochemical content affect pest infestation, crop yield, and quality, which are essential criteria in selecting resistant varieties in the development of IPM strategies. Cultivation of resistant varieties is a key factor in successful cotton production in Bangladesh. Therefore, the relative resistances of five cotton cultivars (released by Cotton Development Board of Bangladesh) to aphids and jassids were evaluated along with several associated characteristics.

MATERIALS AND METHODS

Cultivation of cotton cultivars

The study was conducted in the research fields of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU, 25°25′N, 89°5′E), Gazipur, Bangladesh from July 2013 to June 2014 with the five cotton cultivars CB1, CB3, CB5, CB8 and CB12. The study location is a subtropical region having a dry season (February to May), a wet season (June to September) and a short winter (December and January). Annual mean relative humidity, rainfall, and temperature are 65.8%, 237.6 cm, and 24.5°C, respectively. The five cotton cultivars were cultivated following the recommendations of the Cotton Development Board of Bangladesh, excluding insecticide use. Treatments were assigned to a randomized complete block design (RCBD) comprising 4.0m × 4.0m plots. The spacing between all blocks and plots was 1.0m × 1.0m. Cotton seeds were sown 50cm apart on 02 July 2013 in rows. The distance from row to row was 1.0m and each plot contained 32 plants.

Recording of infestation

After emergence of seedlings, field inspections were carried out weekly to record the population build up and aphid and jassid infestations. Due to a difficulty in differentiating the two insect pests, the infestation level of both was characterized in a single metric. At each inspection, three plants from each plot were randomly selected and the total number of leaves and the number of infested leaves on these plants were counted. Data collection was started from the first signs of infestation and continued for 5 weeks. When the plants produced a sufficient number of bolls, five plants were randomly selected from each cultivar and the total number of bolls and the number of infested bolls per plant were recorded. Each infested boll was opened and the total number of locules and the number of infested locules were counted. This procedure was carried out three times at 7-day intervals.

Determination of starch content during the vegetative phase

The starch content of uninfested and infested twigs of each of the five cotton cultivars was determined following the method of McCready et al. (1950). Infested and uninfested plant samples (500mg) of each cultivar were cut into small pieces and dipped into a flask containing 10mL of 80% ethanol. The samples were centrifuged at 2000 × *g* for 20 min. The supernatant (1.0mL) from each sample was collected in a tube, then phenol solution (5%, 1.0mL) and sulfuric acid (96%, 5.0mL) were rapidly added. The tube was gently agitated during addition of the acid, and allowed to stand in a water bath at 26–30°C for 20 min to facilitate total sugar recovery. Extracted soluble sugar was suspended in 5.0mL water and subsequently 6.5mL of 52% perchloric acid. The contents were centrifuged for 20 min at 2000 × *g*, and the resulting supernatant was decanted, collected, and the total volume was made up to 100mL with distilled water. This mixture was then filtered through Whatman filter paper (no. 42). A 1.0mL aliquot of each filtrate was analyzed for glucose content. Samples were measured at 630nm in a spectrophotometer and glucose concentration was determined using a standard curve prepared using known concentrations of glucose. Glucose concentrations were multiplied by 0.9 to calculate plant starch content.

Determination of protein content at vegetative stage

Percentages of protein in uninfested and infested twigs of each of the five cotton cultivars were determined using the conventional Kjeldahl method. Chopped, oven dried, infested and uninfested samples of each variety (1.0g) were weighed using a digital balance (MR 220 no. 971373; Mettler, Berlin, Germany) and transferred to Kjeldahl flasks. For each sample, concentrated H_2SO_4 (20mL) was added in presence of 3-4g catalyst mixture (K_2SO_4–$CuSO_4$, 5:1). The flask was continuously heated until the solution became clear. The flask was then allowed to cool and 150mL distilled water was added. A few zinc granules were added to the mixture. One hundred milliliters of 40% NaOH was then poured into the flask, which was immediately attached to a distillation set. An Erlenmeyer flask containing methyl red and methyl blue indicator was placed underneath prior to collecting the distillate. Approximately 150mL of distillate was collected and titrated with standardized 0.1 N HCl. The nitrogen content was calculated using the equation:

$$\%N = \frac{(T-B)\times N\times 1.4}{S} \times 100$$

Where, T is the sample titer (mL), B is the blank titer (mL), N is the concentration of HCl (0.1 N) and S is sample weight. The percentage of N in each sample was multiplied by 6.25 to obtain the percentage protein content.

Quantifying agronomic traits

Plant height, number of branches, number of sympodial branches, number of leaves and bolls per plant, number of locules per boll, and boll length, width, and weight were considered agronomic traits of the cultivars. Mature bolls were randomly collected from second node branches and classified as fresh and infested. For each variety, 15 normal and 15 infested bolls were selected. These were weighed using a digital balance (AG204, Mettler Toledo, Switzerland), and their widths and lengths were measured using a digital slide caliper (CD-S15C, Mituoyo, China). At first harvest, 15 plants of each cultivar were randomly selected, and for each the number of leaves, branches, and sympodial branches was counted, and plant height (length from top to base) was measured using an mm-scale tape measure.

Quantifying seed cotton yield and crop quality

All open bolls (seed cotton) from each plot were handpicked, sun dried, and then separately bagged in brown paper bags. Seed cotton yield was measured using a balance (CANRY, China) and expressed in kg ha^{-1}. The bolls were ginned with a single roller electric gin in the laboratory of the Regional Cotton Research and Extension Centre, Gazipur, Bangladesh. Boll sample data included the following: ginning out-turn (%GOT: percentage of lint obtained from 100g 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).

Germination test

The percentage of seed germination indicates the seed quality of the cultivars. A germination test was conducted in homogenous environmental conditions in the laboratory at 25°C. Trays, each 30cm × 30cm × 5cm (L × W × D), were used for this purpose. A single sheet of paper was placed in the bottom of each tray to cover drainage holes. The trays were filled with clean, moist sand, and fresh sand was used for each test.

Seeds of each variety were randomly collected from their respective bags and counted. For each variety, 100 seeds were sown on each of five replicate trays in 10 rows of 10 seeds (500 seeds per variety). Seeds were sown at 2-3cm depth and watered every second day. Only normal seedlings were counted after 10 days when the majority of seedlings had emerged. Diseased, discolored, or malformed seedlings were excluded from counts. The total number of normal, vigorous, and healthy seedlings for each cultivar was used to determine germination percentage. Normal seedlings, abnormal seedlings, and non-germinated seeds were defined and detected according to the protocol adopted by the International Seed Testing Association (ISTA).

Data analysis

Data were analyzed using one-way analysis of variance (ANOVA). The t-statistic was employed to test for differences between uninfested and infested samples in protein and starch content and boll length, width, and weight for each cultivar. Data were expressed as the mean±SD and the Turkey's HSD post hoc test was used to test for differences between means.

RESULTS

There were significant differences in leaf infestation percentages among the five cotton cultivars (Figure 1, $F_{4,70} = 193.9$, $p < 0.001$). The percentage of infested leaves was significantly higher in CB12 than those of the other cultivars. There were significant differences among cotton cultivars in their boll infestation percentages (Figure 1, $F_{4,70} = 3.6$, $p < 0.05$). The highest percentage of boll infestation was in CB12, which also had the highest percentage of leaf infestation. There were no significant differences among cultivars in the percentage of locules infested (Figure 1, $F_{4,70} = 0.9$, $p = 0.5$).

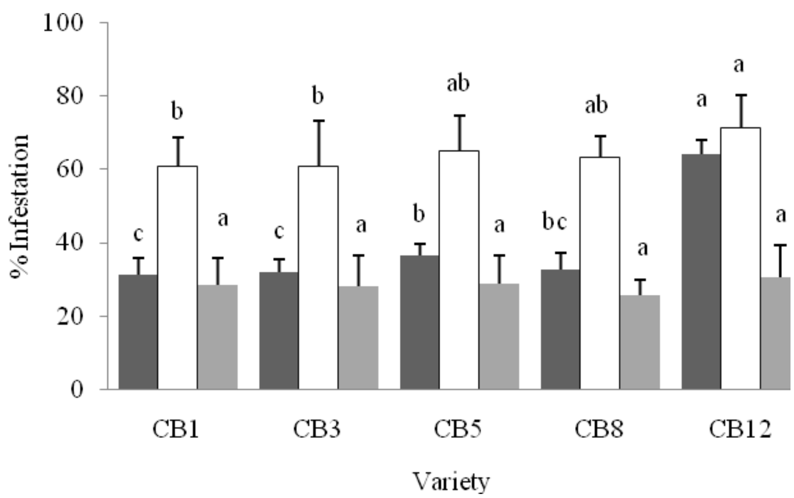

Figure 1. Infestation percentages (■leaf, □boll, and ■locule) of five cotton cultivars exposed to aphid and jassid infestation (mean±SD). Bars with common letter(s) for each parameter are not significantly different (Tukey's HSD post hoc analysis, $p \leq 0.05$).

The number of trichomes per ventral midrib of the leaf showed significant differences among cultivars (Figure 2, $F_{4,20} = 19.3$, $p < 0.001$). Of the tested cultivars CB3 and CB1 had statistically similar as well as higher number of trichomes, while CB12 had the lowest number of trichomes. The starch content of uninfested and infested twigs differed significantly (Figure 3, fresh: $F_{4,10} = 55.9$, $p < 0.001$; infested: $F_{4,10} = 23.7$, $p < 0.001$). Of the five cultivars, CB8 and CB12 possessed the highest and lowest percentages of starch, respectively, both for uninfested and infested twigs. The *t*-statistic indicated that the starch content of uninfested and infested twigs differed significantly among varieties ($t_2 = 5.4$, $p < 0.05$; $t_2 = 5.5$, $p < 0.05$; $t_2 = 13.4$, $p < 0.05$; $t_2 = 14.7$, $p < 0.05$; $t_2 = 6.2$, $p < 0.01$, for CB1, CB3, CB5, CB8 and CB12, respectively). There was a significant difference in protein content between uninfested ($F_{4,10} = 75.2$, $p < 0.001$) and infested ($F_{4,10} = 16.5$, $p < 0.001$) twigs (Figure 4). Of the tested cultivars, CB5 contained the highest amounts of protein both in uninfested and infested twigs while the lowest amounts were in CB12. The *t*-statistic showed that the uninfested and infested twigs of each variety differed in their protein content ($t_2 = 6.9$, $p < 0.05$; $t_2 = 116.0$, $p < 0.001$; $t_2 = 12.1$, $p < 0.05$; $t_2 = 13.1$, $p < 0.05$; $t_2 = 5.2$, $p < 0.05$, for CB1, CB3, CB5, CB8, and CB12, respectively).

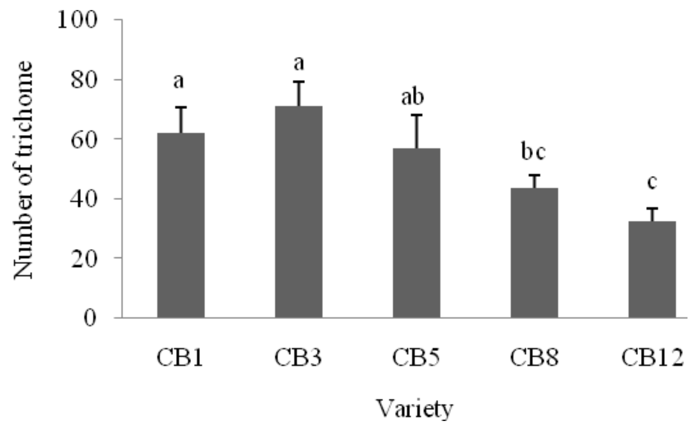

Figure 2. Number of trichomes present on the ventral midribs of five cotton cultivars (mean±SD). Bars with common letter(s) are not significantly different (Tukey's HSD post hoc analysis, $p \leq 0.05$).

Plant height, and the numbers of branches, leaves, sympodial branches, bolls per plant, and locules per boll of the varieties differed significantly (Table 1, height: $F_{4,70} = 17.6$, $p < 0.001$; branches: $F_{4,70} = 6.5$, $p < 0.001$; leaves: $F_{4,70} = 17.0$, $p < 0.001$; sympodial branches: $F_{4,70} = 4.2$, $p < 0.01$; bolls: $F_{4,70} = 3.8$, $p < 0.01$; locules: $F_{4,70} = 3.8$, $p < 0.05$). Of the five cultivars, CB5 had the greatest plant height, whereas CB3 had the highest number of branches, leaves, bolls per plant, and locules per boll. The number of sympodial branches per plant was highest for CB1. CB12 had the lowest plant height as well as the lowest number of branches, leaves, and bolls per plant. The number of sympodial branches per plant was lowest for CB5. There were significant differences between the lengths of uninfested bolls ($F_{4,70} = 3.3$, $p < 0.05$) and infested bolls ($F_{4,70} = 15.0$, $p < 0.001$) of the cotton cultivars (Table 1). CB12 had both the lowest uninfested and infested boll lengths. The t-statistic showed significant differences between uninfested and infested boll lengths for the varieties CB3 (t_{14} =

2.4, $p < 0.05$), CB5 ($t_{14} = 2.2$, $p < 0.05$) and CB12 ($t_{14} = 4.6$, $p < 0.001$), but not for CB1 ($t_{14} = 2.0$, $p = 0.06$) and CB8 ($t_{14} = 0.8$, $p = 0.41$).

Table 1. Agronomic characters of five cotton varieties exposed to aphid and jassid infestation

Characteristic	Cultivar				
	CB1	CB3	CB5	CB8	CB12
Plant height (cm)	122.2±5.2 bc	126.9±4.2 ab	129.3±5.0 a	131.9±6.3 a	118.5±3.9 c
Branches per plant	15.8±1.3 ab	17.8±1.9 a	15.9±1.5 ab	15.0±1.3 b	14.9±1.2 b
Leaves per plant	73.7±6.1 ab	76.8±5.9 a	70.0±3.3 bc	66.2±4.2 cd	64.7±3.5 d
Sympodia per plant	10.2±1.0 a	9.5±1.5 ab	8.4±1.2 b	9.0±0.9 ab	9.3±1.5 ab
Bolls per plant	17.4±1.7 ab	18.7±2.4 a	16.6±2.0 ab	17.9±1.8 ab	15.9±2.6 b
Locules per boll	4.3±0.5 ab	4.4±0.5 a	4.0±0.0 b	4.0±0.0 b	4.3±0.6 ab
Uninfested boll length (cm)	4.9±0.1 a	4.8±0.2 ab	4.8±0.3 ab	4.8±0.4 ab	4.5±0.2 b
Infested boll length (cm)	4.8±0.2 a	4.6±0.2 a	4.6±0.3 a	4.7±0.2 a	4.2±0.3 b
Uninfested boll width (cm)	3.6±0.1 ac	3.7±0.2 a	3.5±0.1 bc	3.7±0.2 a	3.4±0.2 c
Infested boll width (cm)	3.4±0.2 a	3.4±0.2 a	3.3±0.2 ab	3.3±0.1 ab	3.2±0.1 b
Uninfested boll weight (g)	6.9±0.7 a	6.7±0.5 a	6.3±0.4 ab	6.8±0.5 a	6.0±0.9 b
Infested boll weight (g)	6.2±0.7 ab	6.3±0.5 a	5.6±0.5 bc	5.8±0.3 ab	5.2±0.7 c

Data expressed as mean±SD.

Means within a row followed by the same letter(s) are not significantly different (Tukey's HSD post hoc analysis, $p \leq 0.05$).

There were significant differences in the widths of the uninfested (Table 1, $F_{4,70} = 6.9$, $p < 0.001$) and infested bolls ($F_{4,70} = 3.9$, $p < 0.05$). The *t*-statistic revealed significant variations between uninfested and infested boll widths of the cultivars ($t_{14} = 3.5$, $p < 0.01$; $t_{14} = 3.5$, $p < 0.01$; $t_{14} = 4.0$, $p < 0.01$; $t_{14} = 10.1$, $p < 0.001$; $t_{14} = 4.4$, $p < 0.01$, for CB1, CB3, CB5, CB8, and CB12, respectively).

The weights of uninfested ($F_{4,70} = 5.5$, $p < 0.01$) and infested ($F_{4,70} = 10.7$, $p < 0.001$) bolls of the cultivars differed significantly (Table 1), and the *t*-statistic revealed significant differences between uninfested and infested boll weights of the cultivars ($t_{14} = 3.6$, $p < 0.01$; $t_{14} = 2.5$, $p < 0.05$; $t_{14} = 4.6$, $p < 0.001$; $t_{14} = 7.7$, $p < 0.001$; $t_{14} = 3.5$, $p < 0.01$, for CB1, CB3, CB5, CB8, and CB12 respectively). CB12 had the lowest uninfested and infested boll weights.

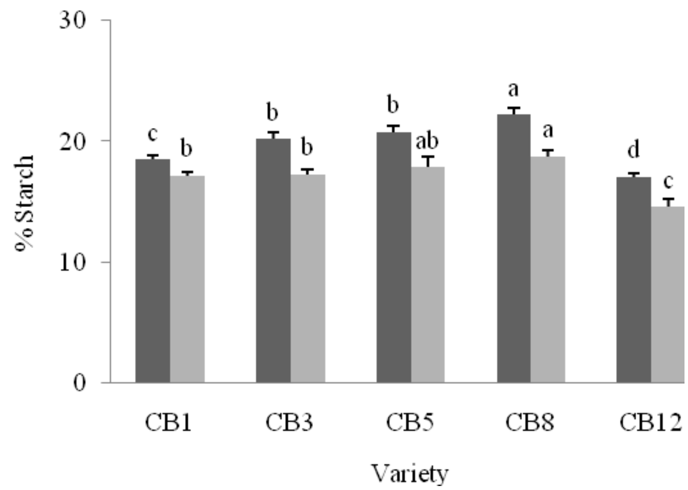

Figure 3. Starch content of twigs (■ uninfested and ■ infested) of five cotton varieties (mean±SD). Bars with common letter(s) for each parameter are not significantly different (Tukey's HSD post hoc analysis, $p \leq 0.05$).

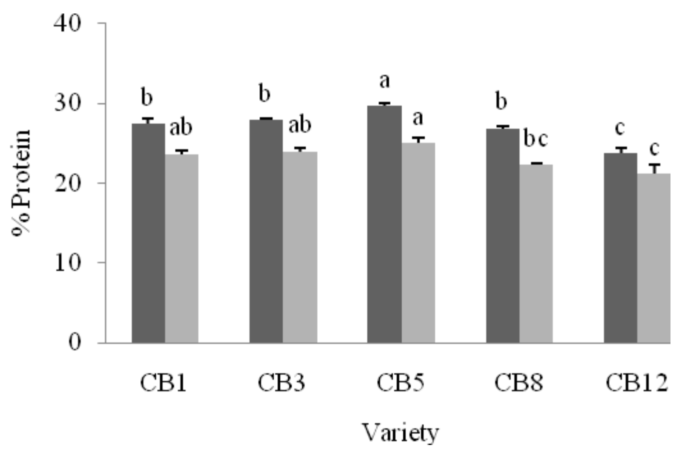

Figure 4. Protein content of twigs (uninfested ■ and infested ■) of five cotton cultivars (mean±SD). Bars with common letter(s) for each parameter are not significantly different (Tukey's HSD post hoc analysis, $p \leq 0.05$).

There were significant differences in seed cotton yield ($F_{4,10} = 48.1$, $p < 0.001$), GOT ($F_{4,20} = 6.2$, $p < 0.01$), seed index ($F_{4,20} = 14.2$, $p < 0.001$), germination percentage ($F_{4,20} = 49.4$, $p < 0.001$), lint index ($F_{4,20} = 5.1$, $p < 0.01$), and micronaire ($F_{4,10} = 559.8$, $p < 0.001$) of the varieties (Table 2). Among the tested cultivars, CB12 had the lowest yield and quality characteristics. CB1 and CB3 had statistically higher yield and lint index than those of other cultivars, while CB3 and CB8 had the highest GOT and micronaire, respectively. There were no significant differences in seed index or germination percentage among cultivars except for CB12.

Table 2. Yield and quality characteristics of five cotton cultivars exposed to aphid and jassid infestation

Characteristic	Cultivar				
	CB1	CB3	CB5	CB8	CB12
Yield (kg ha^{-1})	795.3±16.2 a	777.0±11.5 a	728.3±12.6 b	722.7±16.6 b	638.7±8.3 c
GOT (%)	35.4±1.5 ac	36.4±1.3 a	36.2±1.5 ab	33.6±1.5 bc	32.8±1.3 c
Seed index (g)	10.0±0.6 a	10.0±0.6 a	9.9±0.4 a	9.4±0.5 a	8.1±0.2 b
Germination (%)	86.4±4.4 a	83.2±4.2 a	80.6±2.1 a	82.2±2.6 a	59.0±3.5 b
Lint index (g)	6.1±0.3 a	6.0±0.3 a	5.7±0.4 ab	5.6±0.3 ab	5.3±0.3 b
Micronaire (Mic)	3.7±0.02 c	3.8±0.01 b	3.8±0.01 b	4.0±0.01 a	3.6±0.01 d

Data express as mean±SD.

Means within a row followed by same letter(s) are not significantly different (Tukey's HSD post hoc analysis, $p \leq 0.05$).

DISCUSSION

Sucking insects are serious pests of cotton during seedling, vegetative, flowering, and fruiting stages (Abro et al., 2004). This study found significant aphid and jassid infestations in the leaves and bolls of cotton. The evaluated cultivars differed in their morphological characteristics, biochemical content, seed cotton yield, germination percentage, and fiber quality.

Significant differences in infestation levels of leaves and bolls among cultivars indicated that their responses and resistance/susceptibility to these pests varied. Ahmed et al. (2005) observed different levels of *Amrasca devastans* infestation among 18 cotton varieties and reported that two varieties (CRIS-467 and CRIS-134) were resistant, whereas two (CRIS-82 and MNH-536) were susceptible. The present study showed that CB1 and CB3 sustained lower infestation levels in comparison to the other cultivars, whereas CB12 was subjected to the highest level of infestation. We observed the abundance of aphids and jassids from the vegetative stage to harvest. Infested leaves and bolls turned pale and rusty red, turned downwards, dried up, and fell to the ground. Infested bolls scarred and became rusty brown. The observed infestation levels suggest that CB12 is susceptible compared to the other four cultivars tested. Our cotton cultivars differed in the number of trichomes, morphological characteristics, and biochemical content, which might have affected the feeding, oviposition, and population buildup of the pests, thus resulting in a variation of infestation levels. CB3 and CB1 had the highest number of trichomes and intermediate starch and protein content, and these cultivars sustained significantly lower levels of infestation. The number of trichomes was lowest on the midribs of CB12, the cultivar which tended to have the highest levels of infestation. Our results are similar to those of Khan et al. (2000), who observed lower levels of *Aphis gossypii* infestation in varieties of ash gourd, *Benincasa hispida*, with higher trichome densities. High densities of trichomes on plant surfaces create a physical barrier to insect foraging, feeding, ingestion, digestion, mating and oviposition, thus protecting against infestation (Jayaraj and Uthamasamy, 1990). Aphid and jassid infestations reduced starch and protein content in the tested cultivars. This finding reflects the results of Wei et al. (2010) who noted reductions in soluble sugar content in various host plants due to infestations of the sucking insect, *Lygus lucorum.* In barley, Lorenz and Collins (1989) observed reductions in protein content and deterioration of starch properties when rose-grain aphid (*Metopolophium dirhodum*) infested the plants. Aphids take up amino acids from phloem tissue to fulfill their nitrogen requirements and deplete protein content (Douglas, 2003). Ojmelukwe et al. (1999) observed depletion of protein, starch and soluble sugar content in pulse beetle (*Callosobruchus maculatus*) infested cowpea seeds. Woolly apple aphid (*Eriosoma lanigerum*) infestation reduced soluble sugar, protein, and amino acid content in fuji apple twigs (Zhou et al., 2013). Our evaluated cultivars differed in plant height (118.5 to 131.9cm), number of branches (14.9 to 17.8), and number of bolls per plant (15.9 to 18.7). This was similar to those studied by Khan (2011) who observed differences in plant height (88.7 to 127.8cm), number of branches (10.0 to 16.0), and number of bolls per plant (13.0 to 76.8) among nine cotton varieties exposed to sucking insect infestations. Our studied varieties also differed in numbers of leaves and sympodial branches per plant, locules per boll, boll size, and weight.

We observed differences in seed cotton yield (638.7-795.3 kg ha^{-1}), GOT (32.8-36.4%), seed index (8.1-10.0g), germination percentage (59.0-86.4%), lint index (5.3-6.1g) and micronaire (3.6-3.8 Mic) among the cultivars. These are consistent with the results of Azad et al. (2011) who cultivated CB9, CB10, and SR05 cotton varieties without insecticide application and found variations in yield (618-792 ka ha^{-1}), GOT (36.2-37.3%), seed index (7.8-8.3g) and germination percentage (81.3-82.3%). A study of CB3 and CB9 by Hossain et al. (2012) showed lint indexes of 5.9 and 6.0g per 100 seeds and micronaires of 3.96 and 3.93, respectively.

The aphid and jassid infestations of leaves and bolls affected the aforementioned traits of the cultivars. Due to sustaining the highest level of infestation, CB12 had the lowest performance in all these aspects. In contrast, CB1 and CB3 had the lowest levels of infestation, and produced higher number of branches and bolls, as well as larger and heavier bolls, resulting in higher yields and lint indices.

This study demonstrated clear differences in performance among the five cotton cultivars and assessed their resistances to aphid and jassid infestation.

Variations in yield and quality characteristics among cultivars were found due to differences in trichome density, morphological features, and biochemical content, which influenced infestation levels. Ali et al. (1999) stated that variations in trichome density on cotton leaves and gossypol glands resulted in significant differences in resistance against cotton insect pests. In this study, the resistance and susceptibility of the cultivars tested were not regulated by any single mechanism, but instead by a combination of several complementary physical, biochemical, and environmental factors.

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