Incidence of Sucking Insect Pests on Cotton Plants Based on the Weather Conditions

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Abstract
Seasonal abundance of the sucking insect pests particularly the aphid and jassid on the cotton Gossypium hirsutum varieties CB12, CB13, CB14, CB15 and HC1, which are being cultivated in different Cotton Research and Multiplication Farms of Bangladesh, were studied from July 2018 to January 2019 at Gazipur in Bangladesh. The study also investigated the impact of weather parameters on the incidence of the pests. Aphids showed their abundance from the second week of October to the third week of November and the population revealed fluctuation. Aphid population reached to the peak in the fourth week of October (31.2/leaf) on HC1 followed by CB14, CB12, CB15 and CB13 cotton varieties. The weather factors collectively predicted 79.5% to 84.6% contribution on the abundance of aphid, and the highest and lowest effects were found on the varieties HC1 and CB14, respectively. Jassids showed their abundance from the first week of November to the second week of January and reached to the peak (7.2 leaf⁻¹) in the fourth week of November on CB15 followed by CB12, CB13, HC1 and CB14 cotton varieties. The combination effect of the weather factors ranged from 57.4% to 71.0% abundances of jassid and the highest and lowest results were found on HC1 and CB15 varieties, respectively.

Introduction
Cotton, deliberated as the best fiber crop has four cultivated species namely Gossypium arboreum, G. herbaceum, G. hirsutum and G. berbadense. In Bangladesh, several varieties of G. hirsutum, developed by the cotton Development Board, are being cultivated covering an area of 13100 hectares (BBS, 2018). The yield of cotton in Bangladesh is very low (2.4 Mt/ha) due to some abiotic and biotic constraints like climatic conditions, unavailability of suitable variety and infestation of insects (Azad et al., 2011; BBS, 2018).

In Bangladesh, twelve species of insects with sucking and chewing mouthparts are causing damage to cotton. Among the sucking insects, aphid, Aphis gossypii Glover (Hemiptera:Aphididae) and jassid, Amrasca devastans Distant (Hemiptera: Cicadellidae) prevail in the cotton field of Bangladesh throughout the season and the pests cause severe damage (Tithi et al., 2010).

Aphids and jassids mostly ingest phloem sap from the lower surface of the leaves of the terminal buds, and also from the developing bolls of the cotton plants (Deguine et al., 2000; Sharma and Singh, 2011). Aphid and jassid are vectors of viral diseases and they secrete honeydew on their feeding sites, and their infestation causes similar injury in cotton plants (Amin et al., 2016). Sooty mold fungi grow on the infested plant parts, and the insects inject toxins along with their saliva into the plants, and cause hopper burn symptom (Raj, 2003). Consequently, the infestation of aphid and jassid affects cotton plants' morphological and phytochemical traits, deteriorates yield and quality of the lint, and creates lint processing problems (Hossain et al., 2012; Amin et al., 2016).

The amount and distribution of the weather parameters like temperature, humidity and rainfall affect the reproduction, growth, development, foraging and feeding behavior of phytophagous insects and interrupt their population dynamics (Amin et al., 2017; Amin et al., 2020a). Morphological and phytochemical traits among the varieties of a crop species vary greatly and the characteristics influence the infestation and population development of the herbivore insects (Amin et al., 2020b). Seasonal population dynamics of the herbivore insects on different crop varieties helps in selecting...
suitable variety and provides information for development of management schedule. Considering the above points, this research was done with the cotton varieties namely CB12, CB13, CB14, CB15 and HC1, which are being cultivated in different Cotton Research and Multiplication Farms of Bangladesh, to assess the seasonal incidence of aphid and jassid.

Materials and Methods

Study site and conditions
The study was conducted from July 2018 to January 2019 in the field and laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur (25°25′ N and 89°5′ E), Bangladesh. The location occupies subtropical climate having dry season (February to May), rainy season (June to September) and short winter (December and January). The annual mean maximum and minimum temperatures, relative humidity and rainfall were 36.0 and 12.7 °C, 65.8% and 2376 mm, respectively (Amin et al., 2018).

Cultivation of cotton plants
The study was conducted with cotton, Gossypium hirsutum L. (Malvales: Malvaceae) varieties namely CB12, CB13, CB14, CB15 and Hilly Cotton 1 (HC1). These varieties were developed by the Cotton Development Board of Bangladesh. The cotton seeds were sown in the experimental plots on 2 August 2018. Each variety of cotton was cultivated in three plots following randomized complete block design. Each plot measures an area of 3.0 m × 3.0 m and the spacing between block to block was 1.5 m and plot to plot was 1.0 m. Fertilizers were applied according to the doses of the Fertilizer Recommendation Guide of Bangladesh Agricultural Research Council (TSP 250, MoP = 175, gypsum = 175, zinc sulphate = 100, magnesium sulphate = 10 and borax = 10 kg/ ha) (FRG 2012). Intercultural operations were done on necessity based and the plants were grown without insecticide spray with a view to allowing insect infestation.

Abundance of aphid and jassid population
After emergence of seedlings, field inspection was done weekly to record the data of the abundance of aphid and jassid on the plants. Data collection was started from the first incidence of the pests and continued until the first harvest of seed cotton. To collect data of the seasonal occurrence, five plants for each variety were randomly selected, and the numbers of nymph and adult of aphid and jassid on the shoot (apical shoot) of the plants were recorded using a magnifying glass (FD 75, Ballon Brand, China).

Collection of weather data
The mean daily temperature, relative humidity and rainfall data were collected from the weather station of BSMRAU and calculated into standard meteorological week.

Data analysis
Pearson correlation between the abundance of the insects and meteorological parameters, and multiple regression model along with the abundance of the insects and meteorological factors were analyzed. All the analyses were performed using IBM SPSS 21.0.

Results

Abundance of aphid on the cotton varieties
Abundance of aphid on the tested cotton varieties was found from the second week of October to the third week of November and the results showed fluctuation (Figure 1). Aphid population reached to the peak (31.2/leaf) on HC1 followed by CB14, CB12, CB15 and CB13 in the fourth week of October and then declined rapidly.

Relationship between aphid population and weather parameters
Abundance of aphid on the tested cotton varieties revealed positive but insignificant correlations with maximum temperature, minimum temperature and average temperature (Table 1). Relative humidity and rainfall had non-significant negative correlation with the population of aphid on all the cotton varieties. Multiple linear regression models revealed that maximum temperature, minimum temperature, average temperature, rainfall and relative humidity contributed 6.8% to 21.3%, 0.1% to 24.4%, 0.1% to 11.7%, 0.2% to 3.8% and 40.7% to 59.3% abundances of aphid on the cotton varieties (Table 2). The weather factors collectively predicted 79.5% to 84.6% contribution on the abundance of aphid on the tested cotton varieties and the highest and lowest effects were found on HC1 and CB14, respectively.

Abundance of jassid on the cotton varieties
Jassid showed their occurrence on the tested cotton varieties from the first week of November to the second week of January (Figure 2). Jassid population increased rapidly and reached to the peak (7.2 leaf⁻¹) in the fourth week of November on CB15 followed by CB12, CB13, HC1 and CB14. After reaching the peak, the population of jassid declined rapidly.

Collection of weather data
The mean daily temperature, relative humidity and rainfall data were collected from the weather station of BSMRAU and calculated into standard meteorological week.

Data analysis
Pearson correlation between the abundance of the insects and meteorological parameters, and multiple regression model along with the abundance of the insects and meteorological factors were analyzed. All the analyses were performed using IBM SPSS 21.0.
Figure 1. Abundance of aphid (number/leaf) on five varieties of cotton at Gazipur in Bangladesh from July 2018 to January 2019

Table 1. Correlation coefficient (r) values between aphid population on five cotton varieties and weather parameters at Gazipur in Bangladesh

<table>
<thead>
<tr>
<th>Variety</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Average</td>
</tr>
<tr>
<td>CB12</td>
<td>0.461 NS</td>
<td>0.410 NS</td>
<td>0.455 NS</td>
</tr>
<tr>
<td>CB13</td>
<td>0.261 NS</td>
<td>0.480 NS</td>
<td>0.420 NS</td>
</tr>
<tr>
<td>CB14</td>
<td>0.400 NS</td>
<td>0.251 NS</td>
<td>0.326 NS</td>
</tr>
<tr>
<td>CB15</td>
<td>0.436 NS</td>
<td>0.285 NS</td>
<td>0.366 NS</td>
</tr>
<tr>
<td>HC1</td>
<td>0.287 NS</td>
<td>0.549 NS</td>
<td>0.467 NS</td>
</tr>
</tbody>
</table>

NS = Non-significant at p ≥ 0.05.

Table 2. Multiple linear regression models along with coefficient of determination (R²) regarding the impact of weather parameters on the abundance of aphid on five varieties of cotton at Gazipur in Bangladesh

<table>
<thead>
<tr>
<th>Cotton Variety</th>
<th>Regression equation</th>
<th>R²</th>
<th>100 R²</th>
<th>Role of individual factor</th>
<th>F statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB12</td>
<td>Y = -13.020 + 0.487X₁</td>
<td>0.213</td>
<td>21.3</td>
<td>21.3</td>
<td>F₁, e = 1.08</td>
</tr>
<tr>
<td></td>
<td>Y = -11.755 + 0.365X₂ + 0.119X₃</td>
<td>0.225</td>
<td>22.5</td>
<td>1.2</td>
<td>F₂, e = 0.44</td>
</tr>
<tr>
<td></td>
<td>Y = -16.391 + 0.008X₄ + 5.821X₅ - 11.149 X₆</td>
<td>0.328</td>
<td>32.8</td>
<td>10.0</td>
<td>F₃, e = 0.33</td>
</tr>
<tr>
<td></td>
<td>Y = -10.038 + 0.111Xₑ + 0.441Xₓ₂ - 0.022Xₓ₃ - 0.364Xₓ₄</td>
<td>0.358</td>
<td>35.8</td>
<td>3.0</td>
<td>F₄, e = 0.37</td>
</tr>
<tr>
<td></td>
<td>Y = 692.017 + 1.620X₅ + 5.761X₆ + 1.874 X₇ + 5.454 X₈ + 3.530 X₉</td>
<td>0.825</td>
<td>82.5</td>
<td>53.8</td>
<td>F₅, e = 1.18</td>
</tr>
<tr>
<td>CB13</td>
<td>Y = -1.912 + 0.085X₁</td>
<td>0.068</td>
<td>6.8</td>
<td>6.8</td>
<td>F₁, e = 0.29</td>
</tr>
<tr>
<td></td>
<td>Y = -0.443 - 0.057X₂ + 0.138X₃</td>
<td>0.245</td>
<td>24.5</td>
<td>17.7</td>
<td>F₂, e = 0.49</td>
</tr>
<tr>
<td></td>
<td>Y = -0.477 - 0.016X₄ + 0.180X₅ - 0.082X₆</td>
<td>0.246</td>
<td>24.6</td>
<td>0.1</td>
<td>F₃, e = 0.22</td>
</tr>
<tr>
<td></td>
<td>Y = -0.372 - 0.068Xₑ + 0.151Xₓ₁ + 0.021Xₓ₂ - 0.051Xₓ₃</td>
<td>0.248</td>
<td>24.8</td>
<td>0.2</td>
<td>F₄, e = 0.22</td>
</tr>
<tr>
<td></td>
<td>Y = -331.927 + 2.025X₅ + 2.004X₆ + 0.017X₇ + 2.626X₈ - 1.466X₉</td>
<td>0.841</td>
<td>84.1</td>
<td>59.3</td>
<td>F₅, e = 1.32</td>
</tr>
<tr>
<td>CB14</td>
<td>Y = 37.858 + 1.360X₁</td>
<td>0.160</td>
<td>16.0</td>
<td>16.0</td>
<td>F₁, e = 0.76</td>
</tr>
<tr>
<td></td>
<td>Y = -39.798 + 1.548X₂ - 0.182X₃</td>
<td>0.163</td>
<td>16.3</td>
<td>0.3</td>
<td>F₂, e = 0.29</td>
</tr>
<tr>
<td></td>
<td>Y = 55.805 + 2.035X₄ + 19.510X₅ - 38.497 X₆</td>
<td>0.280</td>
<td>28.0</td>
<td>11.7</td>
<td>F₃, e = 0.26</td>
</tr>
<tr>
<td></td>
<td>Y = 33.868 + 0.678Xₑ + 0.931Xₓ₁ + 0.023Xₓ₂ + 1.258Xₓ₃</td>
<td>0.318</td>
<td>31.8</td>
<td>3.8</td>
<td>F₄, e = 0.31</td>
</tr>
<tr>
<td></td>
<td>Y = -3145.013 + 20.309X₅ + 18.32X₆ + 0.022X₇ + 24.640X₈ + 14.530X₉</td>
<td>0.725</td>
<td>79.5</td>
<td>47.7</td>
<td>F₅, e = 0.97</td>
</tr>
<tr>
<td>CB15</td>
<td>Y = 8.858 + 0.318X₁</td>
<td>0.190</td>
<td>19.0</td>
<td>19.0</td>
<td>F₁, e = 0.94</td>
</tr>
<tr>
<td></td>
<td>Y = -8.976 + 0.349X₂ - 0.030X₃</td>
<td>0.191</td>
<td>19.1</td>
<td>0.1</td>
<td>F₂, e = 0.36</td>
</tr>
<tr>
<td></td>
<td>Y = -11.335 + 3.221X₄ + 2.872X₅ - 5.673X₆</td>
<td>0.247</td>
<td>24.7</td>
<td>5.6</td>
<td>F₃, e = 0.22</td>
</tr>
<tr>
<td></td>
<td>Y = 8.057 + 0.217Xₑ + 0.145Xₓ₁ + 0.023Xₓ₂ - 0.195Xₓ₃</td>
<td>0.271</td>
<td>27.1</td>
<td>2.4</td>
<td>F₄, e = 0.25</td>
</tr>
<tr>
<td></td>
<td>Y = -709.181 + 4.639X₅ + 4.061X₆ + 0.020X₇ + 5.553X₈ - 3.263X₉</td>
<td>0.800</td>
<td>80.0</td>
<td>52.9</td>
<td>F₅, e = 1.00</td>
</tr>
<tr>
<td>HC1</td>
<td>Y = 66.160 + 2.720X₁</td>
<td>0.082</td>
<td>8.2</td>
<td>8.2</td>
<td>F₁, e = 0.36</td>
</tr>
<tr>
<td></td>
<td>Y = -16.076 - 2.139X₂ + 4.686X₃</td>
<td>0.326</td>
<td>32.6</td>
<td>24.4</td>
<td>F₂, e = 0.73</td>
</tr>
<tr>
<td></td>
<td>Y = -54.499 + 44.636X₄ + 51.965X₅ - 92.409X₆</td>
<td>0.413</td>
<td>41.3</td>
<td>8.7</td>
<td>F₃, e = 0.47</td>
</tr>
<tr>
<td></td>
<td>Y = -1.817 + 4.240Xₑ + 3.371Xₓ₁ + 0.020Xₓ₂ - 3.025Xₓ₃</td>
<td>0.439</td>
<td>43.9</td>
<td>2.6</td>
<td>F₄, e = 0.52</td>
</tr>
<tr>
<td></td>
<td>Y = -7991.154 + 46.181X₅ + 52.024X₆ + 0.017X₇ + 63.275X₈ - 37.981X₉</td>
<td>0.846</td>
<td>84.6</td>
<td>40.7</td>
<td>F₅, e = 1.18</td>
</tr>
</tbody>
</table>

Y, aphid abundance leaf⁻¹; X₁, maximum temperature (°C); X₂, minimum temperature (°C); X₃, average temperature (°C); X₄, rainfall (mm); Xₑ, relative humidity (%).
Figure 2. Abundance of jassid (number/leaf) on five varieties of cotton at Gazipur in Bangladesh from July 2018 to January 2019

Table 3. Correlation coefficient (r) values between jassid abundance on five cotton varieties and weather parameters at Gazipur in Bangladesh

<table>
<thead>
<tr>
<th>Cotton variety</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Average</td>
<td>Minimum</td>
</tr>
<tr>
<td>CB12</td>
<td>0.718*</td>
<td>0.641*</td>
<td>0.596*</td>
</tr>
<tr>
<td>CB13</td>
<td>0.770*</td>
<td>0.708*</td>
<td>0.667*</td>
</tr>
<tr>
<td>CB14</td>
<td>0.700*</td>
<td>0.629*</td>
<td>0.584*</td>
</tr>
<tr>
<td>CB15</td>
<td>0.610*</td>
<td>0.521*</td>
<td>0.471*</td>
</tr>
<tr>
<td>HC1</td>
<td>0.810*</td>
<td>0.795*</td>
<td>0.775*</td>
</tr>
</tbody>
</table>

*Significant (p ≤ 0.05), NS: Non-significant (p ≥ 0.05).

Table 4. Multiple linear regression models along with coefficients of determination (R²) regarding the impact of weather parameters on the abundance of jassid on five varieties of cotton at Gazipur in Bangladesh

<table>
<thead>
<tr>
<th>Cotton Variety</th>
<th>Regression equation</th>
<th>( R^2 )</th>
<th>100 ( R^2 )</th>
<th>Role of individual factor</th>
<th>F statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB12</td>
<td>( Y = -20.330+0.848X_1 )</td>
<td>0.515</td>
<td>51.5</td>
<td>F1,8 = 8.5 ( P &lt; 0.05 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -37.391+1.670X_1X_2 )</td>
<td>0.575</td>
<td>57.5</td>
<td>F2,7 = 4.7 ( P &lt; 0.05 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -41.705+5.226X_1X_2 )</td>
<td>0.593</td>
<td>59.3</td>
<td>F3,6 = 2.9 ( P = 0.1 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -43.318+5.383X_1X_2 )</td>
<td>0.594</td>
<td>59.4</td>
<td>F4,5 = 1.8 ( P = 0.3 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -41.676+1.810X_1X_2 )</td>
<td>0.652</td>
<td>65.2</td>
<td>F5,4 = 2.4 ( P = 0.2 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -17.166+0.710X_1 )</td>
<td>0.593</td>
<td>59.3</td>
<td>F6,3 = 11.7 ( P &lt; 0.01 )</td>
<td></td>
</tr>
<tr>
<td>CB13</td>
<td>( Y = -26.808+1.174X_1X_2 )</td>
<td>0.625</td>
<td>62.5</td>
<td>F7,2 = 5.8 ( P = 0.1 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -29.166+3.118X_1X_2 )</td>
<td>0.634</td>
<td>63.4</td>
<td>F8,1 = 3.5 ( P = 0.1 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -35.860+4.413X_1X_2 )</td>
<td>0.641</td>
<td>64.1</td>
<td>F9,0 = 2.2 ( P = 0.2 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -34.164+1.335X_1X_2 )</td>
<td>0.698</td>
<td>69.8</td>
<td>F10,9 = 2.9 ( P = 0.1 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -12.945+0.554X_1 )</td>
<td>0.491</td>
<td>49.1</td>
<td>F11,8 = 7.7 ( P &lt; 0.05 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -23.769+1.075X_1X_2 )</td>
<td>0.544</td>
<td>54.4</td>
<td>F12,7 = 4.2 ( P &lt; 0.06 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -24.610+1.768X_1X_2 )</td>
<td>0.546</td>
<td>54.6</td>
<td>F13,6 = 2.4 ( P = 0.2 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -28.233+2.469X_1X_2 )</td>
<td>0.549</td>
<td>54.9</td>
<td>F14,5 = 1.5 ( P = 0.3 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -29.58+1.199X_1X_2 )</td>
<td>0.600</td>
<td>60.0</td>
<td>F15,4 = 1.9 ( P = 0.3 )</td>
<td></td>
</tr>
<tr>
<td>CB14</td>
<td>( Y = -17.207+0.777X_1 )</td>
<td>0.372</td>
<td>37.2</td>
<td>F16,3 = 4.7 ( P &lt; 0.05 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -40.712+1.908X_1X_2 )</td>
<td>0.470</td>
<td>47.0</td>
<td>F17,2 = 3.1 ( P = 0.1 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -43.157+3.924X_1X_2 )</td>
<td>0.475</td>
<td>47.5</td>
<td>F18,1 = 1.8 ( P = 0.3 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -40.027+3.188X_1X_2 )</td>
<td>0.476</td>
<td>47.6</td>
<td>F19,0 = 1.1 ( P = 0.4 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -46.936+2.066X_1X_2 )</td>
<td>0.574</td>
<td>57.4</td>
<td>F20,9 = 1.7 ( P = 0.3 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -19.820+0.791X_1 )</td>
<td>0.657</td>
<td>65.7</td>
<td>F21,8 = 15.3 ( P &lt; 0.05 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -18.038+0.705X_1X_2 )</td>
<td>0.658</td>
<td>65.8</td>
<td>F22,7 = 6.7 ( P &lt; 0.05 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -19.62+2.013X_1X_2 )</td>
<td>0.661</td>
<td>66.1</td>
<td>F23,6 = 3.9 ( P = 0.1 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = -30.658+4.147X_1X_2 )</td>
<td>0.679</td>
<td>67.9</td>
<td>F24,5 = 2.6 ( P = 0.2 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( Y = 27.53+0.88X_1X_2 )</td>
<td>0.710</td>
<td>71.0</td>
<td>F25,4 = 3.1 ( P = 0.2 )</td>
<td></td>
</tr>
</tbody>
</table>

\( Y \), jassid abundance leaf; \( X_1 \), maximum temperature (°C); \( X_1X_2 \), minimum temperature (°C); \( X_2 \), average temperature (°C); \( X_3 \), relative humidity (%); \( X_4 \), rainfall (mm).
**Relationship between jassid population and weather parameters**

Abundance of jassid on the tested cotton varieties revealed significant positive correlations with maximum temperature, minimum temperature and average temperature (Table 3). Relative humidity showed non-significant negative correlation but rainfall depicted non-significant positive correlation with the population of jassid on all the cotton varieties. Multiple linear regression models revealed that maximum temperature, minimum temperature, average temperature, relative humidity and rainfall contributed 37.2% to 65.7%, 0.1% to 9.8%, 0.2% to 1.8% 0.1% to 1.8% and 3.1% to 9.8% abundances of jassid on the cotton varieties (Table 4). The weather factors collectively predicted 57.4% to 71.0% abundances of jassid, and the highest and lowest effects were found on HC1 and CB15 varieties, respectively. Among the parameters, maximum temperature had the highest effect on jassid abundance.

**Discussion**

The present study showed that the sucking insect pests aphid and jassid started to build up their population after the termination of rainy season when the cotton plants were established with proper canopy area. The insects prevailed on all the tested cotton varieties until the harvest of seed cotton, and their population showed fluctuation. Abundance of the sucking insects revealed variation among the cotton varieties at different observation days of the season. Our findings showed agreement with Shivanna et al. (2011) who found the abundance of aphid on cotton throughout the season except July, August and September when the rainfall was very high. The heavy rainfall creates the habitat unfavorable and washed away the tiny aphid from the plants. Amjad et al. (2009) observed the population of sucking insects on five cotton cultivars and found significant variations in the abundance of the insects with time of the season. Amin et al. (2017) found that jassid population on cotton plants increased in the second week of November and then declined.

The aphid and jassid substantially inflict young and tender plants as well as plant parts. They cause significant damage during early stage of the plants by sucking cell sap. The fluctuation of the ambient weather conditions affects the growth and vigor of plants and interrupts the feeding and reproduction of herbivore insects. Bishnoi et al. (1996) reported that the jassid population decreased with decrease in air temperature. Sitaramaraju et al. (2010), and Kumar and Sharma (2012) reported negative influence of relative humidity on the population of leafhopper. However, Parsad et al. (2008) found positive correlation between jassid population and relative humidity.

In the current study, jassid population was negatively correlated with relative humidity. This negative correlation may be due to the responses of the cotton varieties to weather conditions. The present findings are partially in accordance with Arif et al. (2006), who reported a negative and non-significant correlation between the relative humidity and jassid population on okra.

The present study showed that the weather factors predicted 79.5% to 84.6% contribution on the abundance of aphid and 57.4% to 71.0% contribution on jassid abundance on the cotton varieties. The results are related with the findings of Mahmood et al. (1990) in Pakistan who showed that the weather parameters together were responsible for 73.0% population fluctuation of aphid on okra plants. Amin et al. (2017) reported that the weather parameters together contributed 8.8% to 43.2% abundance of jassid on cotton plants. The physiomorphic variations of the tested cotton varieties and their responses to weather parameters result in the variation of the abundance of the insects. Sharma and Singh (2012) noted 50.0 to 96.0% population fluctuation of jassid on five varieties of potato in Uttar Pradesh, India.

The population dynamics of a pest regarding meteorological factors is a perquisite for developing integrated pest management strategy against herbivore insects. The present study demonstrated fluctuation of the abundance of aphid and jassid on five cotton varieties and the weather parameters predicted significant contribution on the population of jassid. The effects of the meteorological factors on the abundance of aphid were insignificant.

**Conclusion**

The abundances of the sucking insects were found according to the characteristics of the tested cotton varieties, and the weather factors affected the population of the insects. Aphid and jassid depicted low levels of abundance on CB13 and HC1 varieties, respectively.

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**Conflict of Interests**

The authors declare that there is no conflict of interests regarding the publication of this paper.
References


