J Bangladesh Agril Univ 19(1): 8–13, 2021 https://doi.org/10.5455/JBAU.24989

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

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

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ARTICLE INFO

Article history
Received: 09 Dec 2020
Accepted: 13 Jan 2021
Published: 30 Mar 2021

Keywords
Aphid, *Gossypium hirsutum*, jassid, temperature, humidity, rainfall

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OPEN ACCESS

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 arboretum, 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

Cite This Article
Shipa, A.S., Amin, M.R., Swapon, M.A.H., Akanda, A.M. 2021. Incidence of Sucking Insect Pests on Cotton Plants Based on the Weather Conditions. *Journal of Bangladesh Agricultural University*, 19(1): 8–13. https://doi.org/10.5455/JBAU.24989

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.

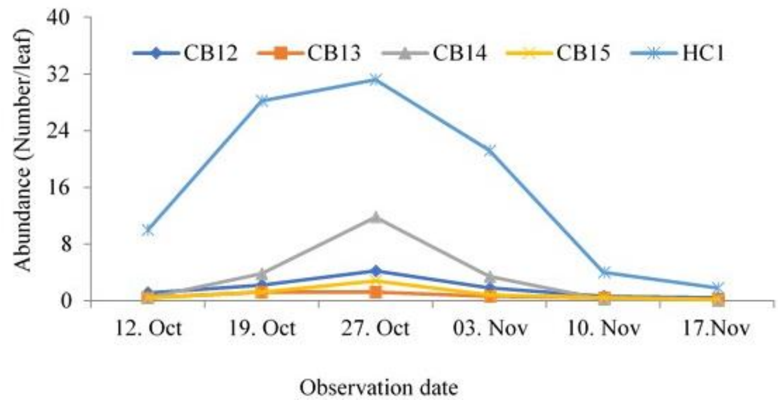

Figure 1. Abundance of aphid (number/leaf) on five varieties of cotton at Gazipur in Bangladesh from July 2018 to January 2019

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

Variety	Temperature (°C)			Relative Humidity (%)	Rainfall (mm)
	Maximum	Minimum	Average		
CB12	0.461 NS	0.410 NS	0.455 NS	-0.532 NS	-0.131 NS
CB13	0.261 NS	0.480 NS	0.420 NS	-0.268 NS	-0.271 NS
CB14	0.400 NS	0.251 NS	0.326 NS	-0.461 NS	-0.265 NS
CB15	0.436 NS	0.285 NS	0.366 NS	-0.453 NS	-0.170 NS
HC1	0.287 NS	0.549 NS	0.467 NS	-0.415 NS	-0.104 NS

NS = Non-significant at $p \geq 0.05$.

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

Cotton Variety	Regression equation	R^2	100 R^2	Role of individual factor	F statistic	
CB12	$Y = -13.020 + 0.487X_1$	0.213	21.3	21.3	$F_{1,4}$= 1.08	P = 0.36
	$Y = -11.755 + 0.365X_1 + 0.119X_2$	0.225	22.5	1.2	$F_{2,3}$= 0.44	P = 0.68
	$Y = -16.391 + 6.008X_1 + 5.821X_2 - 11.149X_3$	0.328	32.8	10.0	$F_{3,2}$= 0.33	P = 0.81
	$Y = -10.038 + 0.112X_1 + 0.441X_2 - 0.022X_3 - 0.364X_4$	0.358	35.8	3.0	$F_{3,2}$ = 0.37	P = 0.79
	$Y = -962.017 + 61.120X_1 + 5.761X_2 + 1.874X_3 + 4.540X4 - 4.530X_5$	0.825	82.5	53.8	$F_{4,1}$ = 1.18	P = 0.59
CB13	$Y = -1.912 + 0.085X_1$	0.068	6.8	6.8	$F_{1,4}$= 0.29	P = 0.62
	$Y = -0.443 - 0.057X_1 + 0.138X_2$	0.245	24.5	17.7	$F_{2,3}$= 0.49	P = 0.66
	$Y = -0.477 - 0.016X_1 + 0.180X_2 - 0.082X_3$	0.246	24.6	0.1	$F_{3,2}$= 0.22	P = 0.88
	$Y = -0.372 - 0.068X_1 + 0.151X_2 + 0.021X_3 - 0.051X_4$	0.248	24.8	0.2	$F_{3,2}$ = 0.22	P = 0.87
	$Y = -331.927 + 2.025X_1 + 2.004X_2 + 0.017X_3 + 2.626X_4 - 1.466X_5$	0.841	84.1	59.3	$F_{4,1}$ = 1.32	P = 0.57
CB14	$Y = -37.858 + 1.360X_1$	0.160	16.0	16.0	$F_{1,4}$= 0.76	P = 0.43
	$Y = -39.798 + 1.548X_1 - 0.182X_2$	0.163	16.3	0.3	$F_{2,3}$= 0.29	P = 0.77
	$Y = -55.805 + 21.035X_1 + 19.510X_2 - 38.497X_3$	0.280	28.0	11.7	$F_{3,2}$= 0.26	P = 0.85
	$Y = -33.868 + 0.678X_1 + 0.931X_2 + 0.023X_3 - 1.258X_4$	0.318	31.8	3.8	$F_{3,2}$ = 0.31	P = 0.82
	$Y = -3145.013 + 20.309X_1 + 18.32X_2 + 0.022X_3 + 24.640X4 - 14.530X_5$	0.795	79.5	47.7	$F_{4,1}$ = 0.97	P = 0.63
CB15	$Y = -8.658 + 0.318X_1$	0.190	19.0	19.0	$F_{1,4}$= 0.94	P = 0.39
	$Y = -8.976 + 0.349X_1 - 0.030X_2$	0.191	19.1	0.1	$F_{2,3}$= 0.36	P = 0.73
	$Y = -11.335 + 3.221X_1 + 2.872X_2 - 5.673X_3$	0.247	24.7	5.6	$F_{3,2}$= 0.22	P = 0.88
	$Y = -8.057 + 0.217X_1 + 0.143X_2 + 0.023X_3 - 0.195X_4$	0.271	27.1	2.4	$F_{3,2}$ = 0.25	P = 0.86
	$Y = -709.181 + 4.639X_1 + 4.061X_2 + 0.020X_3 + 5.553X4 - 3.263X_5$	0.800	80.0	52.9	$F_{4,1}$ = 1.00	P = 0.63
HC1	$Y = -66.160 + 2.720X_1$	0.082	8.2	8.2	$F_{1,4}$= 0.36	P = 0.58
	$Y = -16.076 - 2.139X_1 + 4.686X_2$	0.326	32.6	24.4	$F_{2,3}$= 0.73	P = 0.55
	$Y = -54.499 + 44.636X_1 + 51.965X_2 - 92.409X_3$	0.413	41.3	8.7	$F_{3,2}$= 0.47	P = 0.73
	$Y = -1.817 - 4.240X_1 + 3.371X_2 + 0.020X_3 - 3.025X_4$	0.439	43.9	2.6	$F_{3,2}$ = 0.52	P = 0.71
	$Y = -7991.154 + 46.181X_1 + 52.024X_2 + 0.0175X_3 + 63.275X4 - 37.981X_5$	0.846	84.6	40.7	$F_{4,1}$ = 1.18	P = 0.95

Y, aphid abundance leaf^{-1}; X_1, maximum temperature (°C); X_2, minimum temperature (°C); X_3, average temperature (°C); X_4, rainfall (mm); X_5, relative humidity (%).

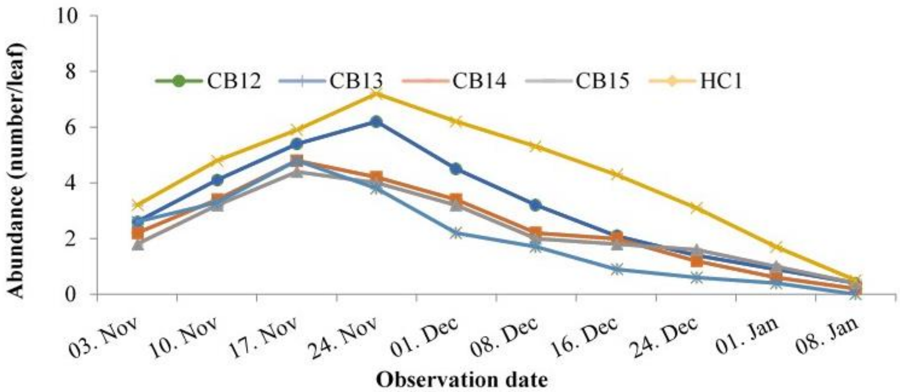

Figure 2. Abundance of jassid (number/leaf) on five varieties of cotton at Gazipur in Bangladesh from July 2018 to January 2019

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

Cotton variety	Temperature (^{o}C)			Relative Humidity (%)	Rainfall (mm)
	Maximum	Minimum	Average		
CB12	0.718*	0.596^{NS}	0.641*	-0.013^{NS}	0.167^{NS}
CB13	0.770*	0.667*	0.708*	-0.118^{NS}	0.217^{NS}
CB14	0.700*	0.584^{NS}	0.629^{NS}	-0.093^{NS}	0.203^{NS}
CB15	0.610^{NS}	0.471^{NS}	0.521^{NS}	-0.029^{NS}	0.063^{NS}
HC1	0.810*	0.775*	0.795*	-0.244^{NS}	0.311^{NS}

*Significant ($p \le 0.05$), ^{NS}Non-significant ($p \ge 0.05$).

Table 4. Multiple linear regression models along with coefficients of determination (R^2) regarding the impact of weather parameters on the abundance of jassid on five varieties of cotton at Gazipur in Bangladesh

Cotton Variety	Regression equation	R^2	100 R^2	Role of individual factor	F statistic	
CB12	$Y = -20.330+0.848X_1$	0.515	51.5	51.5	$F_{1,8}$= 8.5	$P < 0.05$
	$Y = -37.391+ 1.670X_1 -0.383X_2$	0.575	57.5	6.0	$F_{2,7}$= 4.7	$P < 0.05$
	$Y = -41.705+5.226X_1 +2.900X_2 -6.726X_3$	0.593	59.3	1.8	$F_{3,6}$= 2.9	$P = 0.1$
	$Y =-43.318+5.538X_1 +3.164X_2 -7.286X_3 -0.011X_4$	0.594	59.4	0.1	$F_{4,5}$ =1.8	$P = 0.3$
	$Y =-41.676+1.810X_1 -0.340X_2 + 7.566X_3 + X_4 -0.703X_5$	0.652	65.2	5.8	$F_{4,5}$= 2.4	$P = 0.2$
CB13	$Y = -17.166+0.710X_1$	0.593	59.3	59.3	$F_{1,8}$=11.7	$P < 0.01$
	$Y =-26.808- 1.174X_1 -0.217X_2$	0.625	62.5	3.2	$F_{2,7}$= 5.8	$P = 0.1$
	$Y = -29.166+3.118X_1 +1.578X_2 -3.677X_3$	0.634	63.4	0.9	$F_{3,6}$= 3.5	$P = 0.1$
	$Y =-35.860+4.413X_1 + 2.671X_2 -6.00X_3 +0.045X_4$	0.641	64.1	0.7	$F_{4,5}$ =2.2	$P = 0.2$
	$Y=-34.164+1.335X_1 0.215X_2 +6.718X_3 +0.035X_4 -0.55X_5$	0.698	69.8	5.7	$F_{4,5}$= 2.9	$P = 0.1$
CB14	$Y =-12.945+0.554X_1$	0.491	49.1	49.1	$F_{1,8}$= 7.7	$P < 0.05$
	$Y =-23.769+1.075X_1 –0.243X_2$	0.544	54.4	5.3	$F_{2,7}$= 4.2	$P = 0.06$
	$Y =-24.610+1.768X_1 +0.397X_2 -1.312X_3$	0.546	54.6	0.2	$F_{3,6}$= 2.4	$P = 0.2$
	$Y =-28.233+2.469X_1 +0.989X_2 -2.569X_3 -0.025X_4$	0.549	54.9	0.3	$F_{4,5}$ =1.5	$P = 0.3$
	$Y=-29.58+1.199X_1 -0.244X_2 +12.284X_3 -0.408X_4 -0.03X_5$	0.600	60.0	5.1	$F_{4,5}$= 1.9	$P = 0.3$
CB15	$Y =-17.207+ 0.777X_1$	0.372	37.2	37.2	$F_{1,8}$= 4.7	$P < 0.05$
	$Y =-40.712+1.908X_1 –0.528X_2$	0.470	47.0	9.8	$F_{2,7}$= 3.1	$P = 0.1$
	$Y =-43.157+3.924X_1 +1.333X_2 -3.813X_3$	0.475	47.5	0.5	$F_{3,6}$= 1.8	$P = 0.3$
	$Y =-40.027+3.318X_1 + 0.822X_2 -2.727X_3 -0.021X_4$	0.476	47.6	0.1	$F_{4,5}$ =1.1	$P = 0.4$
	$Y=-46.936+2.096X_1 -0.48X_2 +22.76X_3 +0.008X_4 -0.887X_5$	0.574	57.4	9.8	$F_{4,5}$= 1.7	$P = 0.3$
HC1	$Y =-19.820+0.791X_1$	0.657	65.7	65.7	$F_{1,8}$=15.3	$P < 0.05$
	$Y =-18.038+0.705X_1 +0.040X_2$	0.658	65.8	0.1	$F_{2,7}$= 6.7	$P < 0.05$
	$Y = -19.62+2.013X_1 +1.247X_2 -2.473X_3$	0.661	66.1	0.3	$F_{3,6}$= 3.9	$P = 0.1$
	$Y =-30.658+4.147X_1 +3.049X_2 -6.302X_3 +0.075X_4$	0.679	67.9	1.8	$F_{4,5}$ =2.6	$P = 0.2$
	$Y=27.53+0.88X_1 +0.016X_2 +0.196X_3 + 0.058X_4 -0.466X_5$	0.710	71.0	3.1	$F_{4,5}$= 3.1	$P = 0.2$

Y, jassid abundance leaf^{-1}; X_1, maximum temperature (^{0}C); X_2, minimum temperature (^{0}C); X_3, average temperature (^{0}C); X_4, relative humidity (%); X_5, 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.

Acknowledgement

Authors are grateful to the Ministry of Science and Technology (MOST), Government of the People's Republic of Bangladesh for funding the study.

Conflict of Interests

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

References

Amin, M.R., Afrin, R., Alam, M.Z., Hossain, M.M. and Kwon, Y.J. 2017. Effect of leaf trichomes and meteorological parameters on population dynamics of aphid and jassid in cotton. *Bangladesh Journal of Agricultural Research*, 42: 13-25. https://doi.org/10.3329/bjar.v42i1.31969

Amin, M.R., Afrin, R., Suh, S.J. and Kwon, Y.J. 2016. Infestation of sucking insect pests on five cotton cultivars and their impacts on varietal agronomic traits, biochemical contents, yield and quality. *SAARC Journal of Agriculture*, 14: 11-23. https://doi.org/10.3329/sja.v14i1.29572

Amin, M.R., Khisa, S., Rahman, H. and Jannat, R. 2018. Seasonal abundance of the fruit fly in a mango based agroforestry. *Bangladesh Journal of Entomology*, 28: 43-51.

Amin, M.R., Sharmin, M.A., Miah, M.R.U., Akanda, A.M., Suh, S.J., Kwon, Y.J. and Kwon O. 2020b. Aphid population abundance and pestiferous effect on various bean plant species. *Entomological Research*, 50: 257-266. https://doi.org/10.1111/1748-5967.12432

Amin, M.R., Islam, M.A., Suh, S.J., Kwon, O. and Lee, K.Y. 2020a. Relationship between abiotic factors and the incidence of sucking pests on rose plants. *Entomological Research*, 50: 475-482. https://doi.org/10.1111/1748-5967.12463

Amjad, M., Bashir, M.H. and Afzal, M. 2009. Comparative resistance of some cotton cultivars against sucking insect pests. *Pakistan Journal of Life and Social Sciences,* 7: 144-147.

Arif, M.J., Gogi, M.D., Mirza, M., Zia, K. and Hafeez, F. 2006. Impact of plant spacing and abiotic factors on population dynamics of sucking insect pests of cotton. *Pakistan Journal of Biological Sciences*, 9: 1364-1369. https://doi.org/10.3923/pjbs.2006.1364.1369

Azad, H.M.S., Amin, M.R., Tithi, D.A. and Hossain, S.M.A. 2011. Performances of three cotton varieties cultivated under economic threshold level based insecticide sprayed and non-sprayed conditions. *Our Nature*, 9: 21-25. https://doi.org/10.3126/on.v9i1.5728

BBS. 2018. Yearbook of Agricultural Statistics. Statistics and Informatics Division, Ministry of Planning, Bangladesh Secretariat, Dhaka. P.73.

Bishnoi, O.P., Singh, M., Rao, V.U.M., Ram, N. and Sharma, P.D. 1996. Population dynamics of cotton pests in relation to weather parameters. *Indian Journal of Entomology*, 58: 103-107.

Deguine, J.P., Goze, E. and Leclant, F. 2000. The consequences of late outbreaks of the aphid *Aphis gossypii* in cotton growing in central Africa: towards a possible method for the prevention of cotton stickiness. *International Journal of Pest Management*, 46: 85–89. https://doi.org/10.1080/096708700227426

FRG. 2012. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council, Farm Gate, Dhaka.

Hossain, S.M.A., Baque, M.A., Amin, M.R. and Chun, I.J. 2012. Field evaluation of imidacloprid as an insecticidal seed treatment of cotton cultivar with particular references to sucking pest, predator and yield. *Our Nature*. 10: 44-52. https://doi.org/10.3126/on.v10i1.7750

Kumar, V. and Sharma, A. 2012. Incidence of sucking insect pests of transgenic Bt cotton in relation to abiotic factors. *International Journal of Plant Science*, 7: 240-243.

Mahmood, T., Khokhar, K.M., Banaras, M.and Ashraf, M. 1990. Effect of environmental factors on the density of leaf hopper, *Amrasca devastans* (Distant) on okra. *International Journal of Pest Management*, 36: 282-284. https://doi.org/10.1080/09670879009371488

Raj, B.T. 2003. Studies on potato pests in western Gangetic plains. *Journal of Experimental Zoology*, 6: 397-401.

Sharma, V. and Singh, B.P. 2011. Effect of pest infestation on processing attributes of potato in early crop season. *Potato Journal*, 38: 113-120.

Sharma, V. and Singh, B.P. 2012. Effect of varieties, seasons and weather on population buildup of leaf hopper (*Amrasca devastans* Distant) on potato crop. *Potato Journal*, 39: 23-30.

Shivanna, B.K., Gangadhara, B., Basavaraja, M.K., Nagaraja, R., Kalleswara, C. and Karegowda, C. 2011. Impact of abiotic factors on population dynamics of sucking pests in transgenic cotton ecosystem. *International Journal of Natural Sciences*, 2: 72-74.

Sitaramaraju, S., Prasad, N.V.V.S.D. and Krishnaiah, P.V. 2010. Seasonal incidence of insect pests on Bt cotton in relation to weather parameters. *Annals of Plant Protection Science*, 18: 49-52.

Tithi, D.A., Amin, M.R., Hossain, S.M.A. and Azad, H.M.S. 2010. Consequence of *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae) morphometrics reared on different cotton varieties. *Our Nature*, 8: 118-121. https://doi.org/10.3126/on.v8i1.4318