Environment and Ecology 37 (4) : 1256—1264, October—December 2019
Website: environmentandecology.com ISSN 0970-0420

Impact of Trichomes on Population of Leafhopper *Amrasca biguttula biguttula* Ishida in Okra Genotypes

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Received 7 June 2019; Accepted 27 August 2019; Published on 3 October 2019

ABSTRACT

The resistance of okra genotypes against leafhopper, *Amrasca biguttula biguttula* Ishida was investigated under field condition following recording of leafhopper population, trichome density per cm^2 of leaf and trichome length on midrib, veins, leaf lamina of adaxial and abaxial surface of leaves. The results indicate that genotype AE 65 had more number of trichomes (102 Nos.) with less leafhopper population (2.28/plant) and genotypes, AE 26 (10.67) and Pusa Sawani (20.33) had less number of trichomes with maximum leafhopper population of 28.79 and 27.70/plant. Trichome density and length had negative influence on leafhopper population. Results from correlation and regression analysis, it is evident that increase in total trichome density by one unit/cm^2 leaf area and increase in trichome length, there was significant decline in leafhopper population. Hence, presence of trichomes proved foremost resistant factor against okra leafhopper by providing first line of defense.

Keywords *Amrasca biguttula biguttula,* Okra, Trichome, Density and length, Resistance.

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INTRODUCTION

In India, okra *Abelmoschus esculentus* L. (Moench), is cultivated in an area of 5.28 lakh ha with an annual productivity of 11.63 mt/ha (Indiastat 2016).Among various factors influencing okra production, okra leafhopper, *Amrasca biguttula biguttula* Ishida (Homoptera : Cicadellidae) infestation from early stage of croptill maturity is the most devasting problem (Dhandapani et al. 2003). According to Sharma and Singh (2002) okra was the most suitable host in terms of oviposition, nymphal survival and feeding of leafhopper. Both nymphs and adults of the leafhopper can cause damage right from early seedling stage till fruit maturity of the crop by sucking the cell sap thereby causing typical hopper burn (phytotoxemia) ; resulting in 40-50% yield reduction (Bindra and Mahal 1981). At present, management of this notorious sucking pest is controlled using chemical method. However, the hassles for clean and ecologically sound

environmental condition envisages, careful planning for rationalizing the insecticides interventions are need of the hour. With the environmental friendly pest management approach, Host Plant Resistance (HPR) is one of the promising cost-effective and safe methods. Development of suitable resistant/tolerant varieties is an ideal component at no additional cost, compatible with other methods of pest control and free from environmental pollution against buildup of pest population. Various biophysical and biochemical characters of plants play an important role by providing resistance against number of insect pests (Halder et al. 2006, Halder and Srinivasan 2011). Therefore, an attempt was made to identify the response of leafhopper to genotypes of okra and correlation of leafhopper population with trichomes in order to determine resistance/susceptibility.

The morphological feature of host plant significantly alters the behavior of the herbivores viz., host plant selection, feeding and oviposition thereby playing a vital role in host plant resistance against herbivore. Trichomes also known as hairs or pubescence that develop on plant structures such as leaves, stems and even fruits can be glandular or non-glandular, unicellular or multi cellular and often serve as physical barriers against insect attack and fungal infection (Lazniewska et al. 2012). Long and dense trichomes reportedly hinder normal feeding and oviposition by various insect pests. Glandular trichomes secrete adhesive or viscous fluids that neither entrap arthropods nor adversely affect the feeding, growth, survival and oviposition of several insect pests (Wheeler and Krimmel 2015). Non glandular, simple erect trichomes on plants are effective in trapping a multitude of herbivores and natural enemies thus having a direct impact on individual fitness and population evolution of affected insects (Peterson et al. 2016). Non glandular trichomes which can be either straight or hooked with variable densities and distributions on plant are variety dependent (Jimenez et al. 2012). There are early reports on trichomes as typical physical barriers against many agricultural pests. A classical example was impediment of *Heliconius charithonia* (L.) larvae by hooked trichomes in Neotropical passion fruits (Gilbert 1971). But there are very less literatures pertaining to study on trichome characters and its impact on insect pest population. In this regard, present study was conducted to understand the impact of trichome characters viz., length and density on leafhopper population.

MATERIALS AND METHODS

Twenty three okra genotypes viz., AE 4, AE 7, AE 12, AE 14, AE 15, AE 16, AE 19, AE 23, AE 24, AE 26, AE 27, AE 30, AE 35, AE 42, AE 64, AE 65, AE 66, No. 315, Co 1, Kashi Satha Bahar, Bhendi hybrid Co 4, Pusa Sawani and Arka Anaminka were obtained from Department of Vegetable Crops, Tamil Nadu Agricultural University, Coimbatore, Indian Institute of Horticultural Research, Bangalore and Indian Agricultural Research Institute, New Delhi. These genotypes were sown in Singanallur and Karamadai villages of Coimbatore district by adopting Randomized Block Design with two replications. The crop was raised without insecticide application throughout cropping period. Leaf samples from experimental plots were collected for estimation of trichome density and trichome length under laboratory condition.

Estimation of trichome density

Five plants from the experimental fields laid during 2018-2019 were selected at random in each genotype for enumeration of trichome density. The trichome density from different parts of leaf viz., leaf lamina, midrib and veins were enumerated under stereozoom microscope by selecting top three leaves from each okra genotype. Trichome density on different okra genotypes was estimated by adopting the method suggested by Maite et al. (1980). The third fully opened leaf was selected for sampling. Three replicates were maintained for each leaf sample collected at random which were cut into one square centimeter bits and boiled with 20 ml of water in test tubes for 15 min in hot water bath at 85^{o}C. The water was then poured out retaining the leaf bits alone which were again boiled after adding 20 ml of 96 % ethyl alcohol for 20 min at 80^{o}C.

Alcohol was again added and the boiling process was repeated to remove the chlorophyll completely from the leaves and leaf bits turned transparent. Then 90% lactic acid was added. The test tubes were stop-

pered and heated at 85°C until leaf segments were fully cleared (approximately 30-45 min). The test tubes were cooled and the leaf segments carefully mounted on clean slides using a drop of lactic acid to observe the trichome density. The number of trichomes per square centimeter area was counted under stereozoom microscope at 10 X magnification for each leaf sample. The trichome densities on adaxial surface, abaxial surface, midrib and veins of leaves were correlated with incidence of leafhopper.

Estimation of trichome length (μm)

Leaf sample preparation for trichome length estimation was done as the method adopted for trichome density estimation. The trichome length was measured using image analyzer, fitted to stereozoom microscope (STEMI 508) after making the fine cut from the plant tissue with surgical blade.

Leafhopper population (Nos. / plant)

In the field screening experiment, *A. biguttula biguttula* population was recorded at 15 days interval at peak leafhopper infestation period starting from 45 DAS to 90 DAS. Leafhopper population was assessed on top , middle and bottom leaves of each randomly selected five plants from each test entries, with two replications (Kavitha and Reddy 2012). The pooled mean leafhopper population was correlated with trichome density and length of trichomes on lamina of adaxial surface and abaxial surface of leaf, midrib and veins of leaf.

Correlation and regression

The observation on mean leafhopper population and trichome density and length were related to work out the correlation coefficient. The data were subjected to correlation and multiple linear regression analysis using SPSS ver.21.0 software. The multiple linear regression analysis was carried out to assess the degree and extent of influence of the trichomes on the population buildup of *A.biguttula biguttula* on okra genotypes screened.

Statistical analysis

The data on leafhopper population, mean trichome density and trichome length were analyzed by LSD at 5% probability using SPSS 21.0 software. Data were subjected to square root transformation and correlation and regression analyses were carried out using SPSS 21.0 software.

RESULTS AND DISCUSSION

Effect of trichome density on *A. biguttula biguttula*

Trichome density recorded from different areas in leaves of okra genotypes shows high significant differences among the genotypes screened. The trichome density was found to be maximum on the adaxial surface of AE 65 (27.30 nos./cm^2 leaf area), abaxial surface of AE 23 (45.00 nos./cm^2 leaf area), midrib and veins of AE 65 (19.30 and 15.63 nos./cm^2 leaf area). Minimum number of trichomes were documented in genotypes Pusa Sawani and AE 26 (0.00/cm^2 leaf area) on the adaxial surface, AE 64 (2.00/cm^2 leaf area) on the abaxial surface, AE 26 on the midrib (4.33 nos./cm^2 leaf area) and veins (134 nos./cm^2 leaf area). The total trichome density was maximum on the leaves of AE 65 (102 nos. / cm^2) and the minimum number (10.67/cm^2 leaf area) was recorded in case of AE 26 (Table 1).

Table 1. Trichome density and leafhopper *Amrasca biguttula biguttula* population on okra genotypes. * Each value is the mean of three replications. S * -Susceptible check. Figures in parentheses are square root transformed values. In a column, means sharing similar letter(s) are not significantly different by LSD at p=0.05.

Sl. No.	Okra genotype	Mean leafhopper population (No./plant)	Trichome density / cm^2 area of leaf* Adaxial surface	Abaxial surface	Midrib	Veins	Total number of trichomes/cm^2 area of leaf
1	AE4	5.95	6.00 (2.65)^h	13.30 (3.78)n	16.00 (4.12)^l	13.00 (3.75)^0	48.30
2	AE7	8.24	3.00 (2.00)^f	3.33 (2.08)^c	9.00 (3.16)^e	4.67 (2.38)^e	20.00

Table 1. Continued.

Sl. No.	Okra genotype	Mean leafhopper population (No. / plant)	Trichome density / cm² area of leaf: Adaxial surface	Abaxial surface	Midrib	Veins	Total number of trichomes /cm² area of leaf
3	AE12	11.97	6.67 (2.77)^{i}	11.00 (3.46)^{l}	9.67 (3.27)^{f}	12.00 (3.61)^{n}	3934
4	AE14	10.29	1.67 (1.63)^{d}	3.0 (2.00)^{b}	7.33 (2.89)^{d}	8.62 (3.10)^{i}	20.62
5	AE15	25.83	5.60 (2.57)^{g}	19.67 (4.55)^{p}	15.30 (4.04)^{k}	7.60 (2.93)^{i}	48.17
6	AE16	9.01	6.00 (2.65)^{h}	30.67 (5.63)^{a}	5.60 (2.57)^{h}	15.33 (4.04)^{p}	57.60
7	AE19	15.24	26.00 (5.20)^{0}	6.00 (2.65)^{fg}	16.00 (4.12)^{l}	9.30 (3.21)^{k}	57.30
8	AE23	3.40	23.67 (4.97)^{n}	45.00 (6.78)^{u}	18.66 (4.43)^{n}	11.00 (3.46)^{m}	98.33
9	AE24	15.56	2.33 (1.82)^{c}	10.67 (3.42)^{l}	12.67 (3.70)^{ij}	6.00 (2.65)^{g}	31.67
10	AE26	28.79	0.00 (1.00)^{a}	5.00 (2.45)^{c}	4.33 (2.31)^{a}	1.34 (1.53)^{a}	10.67
11	AE27	4.11	13.00 (3.74)^{l}	10.02 (3.32)^{k}	11.00 (3.46)^{g}	2.67 (1.92)^{b}	36.69
12	AE30	7.80	1.00 (1.41)^{b}	12.00 (3.61)^{m}	12.00 (3.61)^{h}	6.33 (2.71)^{h}	31.33
13	AE35	12.08	1.60 (1.61)^{d}	7.33 (2.89)^{h}	6.30 (2.70)^{e}	5.60 (2.57)^{f}	20.83
14	AE42	18.59	1.30 (1.52)^{c}	5.67 (2.58)^{f}	6.00 (2.65)^{c}	5.67 (2.58)^{f}	18.64
15	AE64	25.23	1.33 (1.53)^{c}	2.00 (1.73)^{a}	18.60 (4.43)^{n}	3.60 (2.14)^{c}	25.53
16	AE65	2.28	27.30 (5.32)^{p}	39.67 (6.38)^{i}	19.30 (4.51)^{n}	15.63 (4.08)^{p}	101.90
17	AE66	20.18	1.60 (1.61)^{d}	6.33 (2.71)^{g}	7.30 (2.88)^{d}	2.63 (1.91)^{b}	17.86
18	No.315	4.36	17.00 (4.24)^{m}	24.67 (5.07)^{r}	17.63 (4.32)^{m}	20.00 (4.58)^{q}	79.30
19	Co l	11.94	9.33 (3.21)^{j}	19.00 (4.47)^{o}	15.30 (4.04)^{k}	10.00 (3.32)^{l}	53.63
20	Kashi Satha Bahar	14.40	10.30 (3.36)^{k}	22.67 (4.87)^{q}	17.66 (4.32)^{m}	4.60 (2.37)^{e}	55.23
21	Bhendi Hybrid Co 4	9.28	2.33 (1.82)^{c}	8.33 (3.05)^{i}	16.63 (4.20)^{l}	10.00 (3.32)^{l}	37.29
22	Pusa Sawani (S*)	27.79	0.00 (1.00)^{a}	4.00 (2.24)^{d}	12.30 (3.65)^{hi}	4.00 (2.24)^{d}	20.30
23	Arka Anamika	9.00	5.63 (2.57)^{g}	9.33 (3.21)^{j}	13.00 (3.74)^{j}	6.67 (2.77)^{i}	34.63
	SEd	–	0.026	0.037	0.036	0.026	
	CD (p=0.05)	–	0.052	0.074	0.074	0.052	– .

Data on leafhopper population and trichome density were correlated and the results showed (Table 2) significant negative relationship with values of r=-0.513, -0.503, -0.260, -0.597, -0.575 respectively, on adaxial surface , abaxial surface, midrib , veins and total trichome density in the okra entries screened.

Significant differences in leaf hopper population among genotypes indicated that their responses and resistance susceptibility to leafthopper varied. From the results of correlation analysis, it is apparent that an increase in trichome density by 1 unit/cm² leaf area in adaxial surface results in 0.33 % decrease of

Table 2. Correlation Matrix between trichome density and lea hopper (*Amrasca biguttula biguttula* population on okra genotypes. *Significant at 5% probability. Multiple linear regression equation : $Y = 18.60-0.049x_1-0.284^{**}x_2 +0.261x_3-0.086x_4-0.739^{*}x_5$.

Population (Nos./leaf)	Correlation	Trichome density / cm² area of leaf: Adaxial surface	Abaxial surface	Midrib	Veins	Total number of trichomes
	r	-0.513*	-0.503*	-0.260	-0.597*	-0.597*
	Y=a+bx	17.68-0.33X	16.65-0.47X	17.85-0.38X	21.03-0.98X	20.53-0.17X
Amrasca biguttula biguttula Ishida	Significance (p=0.05*)	0.018	0.015	0.293	0.002	0.006
	Non-Significant	–	–	–	–	–

A. biguttula biguttula population while , an increase in trichome density by 1 unit / cm² leaf area in abaxial surface results in 0.47 % decrease in *A. biguttula biguttula* population. Similarly , 0.38% decrease in leafhopper population was recorded for increase in trichome density by 1 unit / cm² in midrib region, whereas an increase in trichome density by 1 unit / cm² leaf area on vein region resulted in decrease of *A. biguttula biguttula* population by 0.98%. From the present investigation, it is evident that an increase in total trichome density by 1 unit / cm² leaf area resulted in decrease of *A. biguttula biguttula* population by 0.17%. Coefficient of determination from multiple regression analysis was significantly high (R^2 = 0.412), which infers that these trichome densities i.e. ,on adaxial surface, abaxial surface, midrib, veins and total trichome density on leaves have direct impact on activity of *A. biguttula biguttula* with 41.20% in okra genotypes screened. Therefore, it was evident that the trichome density plays a significant role in population reduction of *A. biguttula biguttula* in okra genotypes chosen.

Effect of trichome length on leafhopper

The present investigation on trichome length of okra genotypes revealed highly significant difference. The maximum trichome length was recorded in AE 65 (72.51µm) on the adaxial surface, AE 23 (78.94 µm) on the abaxial surface, AE 65 and AE 23 (84.07 and 82.00 µm) on the midrib and AE 65 on veins (69.42 µm). The least length of trichomes was recorded in genotype AE 26, 13.28 µm on the adaxial surface, 16.07 µm on the abaxial surface, 22.73 µm on the

Table 3. Trichome length and leafhopper *Amrasca biguttula biguttula* population on okra genotypes. * Each value is the mean of three replications. S* - Susceptible check. Figures in parentheses are square root transformed values. In a column, means sharing similar letter (s) are not significantly different by LSD at p = 0.05.

Sl. No.	Okra genotype	Mean leafhopper population (Nos./plant)	Trichome length (µm) / cm² area of leafS: Adaxial surface	Abaxial surface	Midrib	Veins
1	AE4	5.95	52.32 (7.30)^{m}	60.95 (7.87)^{q}	66.24 (8.20)^{n}	54.02 (7.42)^{0}
2	AE7	8.24	49.60 (7.11)^{l}	53.00 (7.35)^{0}	62.03 (7.94)^{m}	56.19 (7.56)^{p}
3	AE12	11.97	26.88 (5.28)^{gh}	35.02 (6.00)^{j}	40.47 (6.44)^{h}	38.39 (6.28)^{k}
4	AE14	10.29	28.21 (5.40)^{h}	47.55 (6.97)^{l}	50.90 (7.20)^{j}	41.42 (6.51)^{l}
5	AE15	25.83	16.33 (4.16)^{bc}	19.28 (4.50)^{c}	27.41 (5.33)^{bc}	22.00 (4.80)^{c}
6	AE16	9.01	37.62 (6.21)^{i}	51.03 (7.21)^{mn}	57.75 (7.66)^{l}	45.07 (6.79)^{m}
7	AE19	15.24	23.70 (4.97)^{f}	28.38 (5.42)^{g}	34.99 (6.00)^{f}	31.24 (5.68)^{h}
8	AE23	3.40	57.02 (7.62)^{n}	78.94 (8.94)^{s}	82.00 (9.11)^{q}	62.51 (7.97)^{r}

Table 3. Continued.

Sl. No.	Okra genotype	Mean leafhopper population (Nos. /plant)	Trichome length (µm) / cm² area of leaf			
			Adaxial surface	Abaxial surface	Midrib	Veins
9	AE24	15.56	22.84 (4.88)^{cf}	26.90 (5.28)^{f}	32.38 (5.78)^{c}	29.65 (5.54)^{g}
10	AE26	28.79	13.28 (3.78)^{a}	16.07 (4.12)^{a}	22.73 (4.87)^{a}	17.50 (4.30)^{a}
11	AE27	4.11	50.87 (7.20)^{lm}	62.41 (7.96)^{q}	73.04 (8.60)^{p}	57.28 (7.63)^{p}
12	AE30	7.80	46.69 (6.91)^{k}	53.18 (7.36)^{0}	64.73 (8.11)^{n}	60.12 (7.82)^{q}
13	AE35	12.08	24.30 (5.03)^{f}	32.65 (5.80)^{i}	38.70 (6.30)^{gh}	36.47 (6.12)^{j}
14	AE42	18.59	21.53 (4.75)^{e}	24.17 (5.02)^{e}	30.66 (5.63)^{d}	27.08 (5.30)^{f}
15	AE64	25.23	17.19 (4.26)^{c}	22.07 (4.80)^{d}	28.00 (5.39)^{bc}	23.56 (4.96)^{d}
16	AE65	2.28	72.51 (8.57)^{0}	70.66 (8.46)^{r}	84.07 (9.22)^{q}	69.42 (8.39)^{s}
17	AE66	20.18	19.07 (4.48)^{d}	23.62 (4.96)^{c}	28.95 (5.47)^{c}	25.21 (5.12)^{e}
18	No.315	4.36	49.55 (7.11)^{l}	56.17 (7.56)^{p}	69.59 (8.40)^{0}	63.94 (8.06)^{r}
19	Co l	11.94	26.30 (5.22)^{g}	38.05 (6.25)^{k}	42.33 (6.58)^{i}	40.72 (6.46)^{l}
20	Kashi Satha Bahar	14.40	22.90 (4.89)^{ef}	30.72 (5.63)^{h}	37.01 (6.17)^{g}	33.18 (5.85)^{i}
21	Bhendi Hybrid Co 4	9.28	37.32 (6.19)^{i}	49.46 (7.10)^{m}	54.22 (7.43)^{k}	43.95 (6.70)^{m}
22	Pusa Sawani (S*)	27.79	15.29 (4.04)^{b}	17.06 (4.25)^{b}	27.00 (5.29)^{b}	20.19 (4.60)^{b}
23	Arka Anamika	9.00	40.15 (6.41)^{j}	52.39 (7.31)^{no}	58.55 (7.72)^{l}	47.62 (6.97)^{n}
	SEd		0.07	0.06	0.08	0.06
	CD (p=0.05)		0.14	0.13	0.17	0.13

midrib and 17.50 µm on veins, respectively (Table 3). The present findings are in close agreement with the findings of Ali et al. (2012) who reported that length of hair on leaf lamina, midrib and veins of brinjal had highly significant and negative correlation with leafhopper population. The lengthy trichomes may impede leafhopper from oviposition as leafhopper lays eggs in leaf tissues and also trichomes with maximum length may length may obstruct leafhopper from stylet penetration as stylets are shorter.

The correlation studies (Table 4) between tri-

Table 4. Correlation Matrix between trichome length and leafhopper (*Amrasca biguttula biguttula*) population on okra. **Significant at 1% probability, * Significant at 5% probability. Multiple linear regression equation : $Y=32.082-0.342x_1-0.720x_2+0.563x_3-0679x_4$.

Population (Nos./plant)	Correlation	Trichome length / cm² area of leaf			
		Adaxial surface	Abaxial surface	Midrib	Veins
Amrasca biguttula biguttula Ishida	r	-0.880**	-0.927**	-0.914**	-0.939**
	Y= a + bx	27.73-0.43X	29.86-0.40X	31.71-0.38X	32.92-0.48X
	Significance (p=0.05*)	0.00	0.00	0.01	0.00
	Non-Significant	–	–	–	–

chome length and *A. biguttula biguttula* population revealed that the trichome length (µm) on adaxial surface, abaxial surface, midrib and veins showed significant negative relationship (r = -0.880, -0.927, -0.914 and -0.939 respectively) in okra entries screened . Iqbal et al. (2011) also earlier proved that there was significant negative correlation between length of trichomes and leafhopper population.

Correlation analysis showed that an increase in trichome length by 1 µm in adaxial surface resulted in decrease of *A. biguttula biguttula* population by 0.43%, whereas an increase in trichome length by 1 µm in abaxial surface resulted in decrease of *A. biguttula biguttula* numbers by 0.40% . Similarly, an increase in trichome length by 1 µm in midrib resulted in decrease of *A. biguttula biguttula* population by 0.38%, whereas an increase in trichome length by 1 m on vein resulted in decrese of *A. biguttula biguttula* population by 0.48%. Multiple linear regression analysis (Table 4) revealed that the coefficient of determination was highly significantly (R^2= 0.940). which implies that trichome length i.e., on adaxial surface, abaxial surface, midrib and veins contributed directly towards the density of *A. biguttula biguttula* in okra genotypes screened to an extent of 94.00%. This is in line with findings of Singh and Singh (2005) who observed less number of eggs laid per leaf in the resistant genotypes than in susceptible ones, thereby indicating ovipositional antixenosis and found a negative and significant correlation between leafhopper oviposition and trichome density and trichome length on main vein and lateral veins.

Trichome morphology and density vary among plant species and also vary among populations and within individual plants (Kang et al. 2010). Laichattiwar et al. (2018) conducted a field experiment to study different genotypes of brinjal to find out role of physio-morphic characters of plant on population of sucking pests. They found that hair density and length of hairs had negative relationship.

Khan (2011) studied sucking pest population on nine cotton varieties and found significant variations in their abundance. This study showed that the leaf trichomes of the varieties had significant negative correlation with aphid and non-significant negative correlation with jassid and the varieties exerted significantly higher abundance of jassid compared to aphid.

According to Doele (2008) brinjal cultivars with smooth textured leaves were preferred more by leafhoppers compared to cultivars with leathery or leathery with spine textures. Uthamasamy (1985) also reported the influence of hairiness on resistance of okra to leaf hopper. The present results are also in consonance with findings of Nagar et al. (2017) who reported that hairiness on okra leaves had significant negative impact on leafhopper infestation (r=-0.966).

High trichome density might impede the mobility of hoppers on leaf surfaces in genotypes with maximum trichome density. High densities of trichomes on plant surfaces create a physical barrier to insect foraging, feeding, ingestion, digestion, mating and oviposition, thus protecting against infestation (Jataraj and Uthamasamy 1990). Our results are similar to results of Khan et al. (2000) who reported that lower levels of *Aphis gossypii* infestation in ash gourd varieties with maximum trichome density. The present study can be compared with Iqbal et al. (2011) who reported that hair density on midrib, veins and lamina of leaves showed a significant and negative correlation with population of leafhoppers. Ullah et al. (2012) also reported that correlation coefficients between population of *A. biguttula biguttula* and physio-morphic characters of okra resulted in highly significant, strong and negative correlation for hair density on lamina (r=-0.831), while non-significant, weak and negative correlation for hair density on midrib (r=-0.045, non-significant at $p<0.01$).

Ahmed et al. (2005) evaluated different varieties of cotton for resistance to jassid in Faisalabad, Pakistan and reported that density of trichomes on vein and lamina of adaxial leaves, the length of hair on midrib and vein of adaxial leaves, midrib of middle leaves and midrib and vein of bottom leaves, gossypol glands on midrib, vein and lamina of adaxial, middle and bottom leaves and thickness of leaf lamina on midrib and bottom leaves played a significant and negative role towards resistance for jassid adult population. The length of hair on midrib, vein of middle leaves,

gossypol glands on lamina of middle leaf was negatively and significantly correlated with jassid nymph population, while all the other morphological traits showed non-significant correlation to jassid population. Correlation co-efficients between population of *A. biguttula biguttula* and different physio-morphic characters of okra found to be highly significant.

In this study, Pusa Sawani harbored higher leafhopper population with less abaxial trichome density which is akin to the findings of Dhankhar and Mishra (2001) and Thakur et al. (2003) who reported that abaxial hair density on mid veins of Pusa Sawani leaves harbored higher jassid population.

The results can also be compared with Naqvi et al. (2008) who reported that trichome density had negative correlation with leafhopper population on brinjal crop. Ali et al. (2012) also reported that hair density on the lamina and the leaf area showed 78.2% and 5.9% role, respectively in the population fluctuation of jassid in brinjal.

The present results were in congruity with Halder et al. (2016) who also reported that okra genotype SB-6 had relatively abaxial number of trichomes on leaf lamina (10.11), midrib (7.17) and vein (8.05) has showed high susceptibility to jassids (17.57 jassids /leaf) as compared to tolerant genotype VROB-181 (5.43 jassids /leaf) which had 11.85, 9.17 and 9.95 trichomes/cm^2, respectively. Similar observations were also documented by Murugesan and Kavitha (2010) who observed significant ($p<0.05$) negative correlation between trichome density on ventral surface of leaves and damage and oviposition by leafhopper on cotton. These findings were concordance with the present findings, where in negative correlation existed between trichome density and leafhopper population recorded.

Leafhopper population on the screened genotypes differed significantly and maximum leafhopper population was recorded in genotypes with least number of trichomes and less trichome length. The differences in abundance of leafhopper on the tested genotypes may be due to the presence of leaf trichomes. Thus, the presence of trichomes proved significant obstacles in foraging, feeding, ingestion, digestion, mating and oviposition of leafhopper, thus prevented their abundance.

Trichome morphology

In terms of trichome morphology, unicellular and multi cellular base with straight and branched trichomes were recorded in okra genotypes. Trichomes recorded were also non glandular and each trichome was situated at unequal distances and different sizes. No glandular trichomes were observed in any okra genotypes used for screening.

CONCLUSION

The findings of present study showed that okra's morphological traits such as trichome density and length had significant negative effect against leafhopper, *A. biguttula biguttula.* Thus, morphological resistance was evident in genotypes AE 65 which can be used as resistance factor in breeding program. Understanding the morphological parameters of a plant is essential to develop an integrated pest management strategy for crop varieties.

The present experiment demonstrated significant differences in the abundance of leafhopper among the 23 okra genotypes tested. The lower population abundance of leafhopper on AE 65 may be due to higher number of trichomes and lengthy trichomes.

ACKNOWLEDGEMENT

The authors thankfully acknowledge the Professor and Head, Department of Agricultural Entomology for providing necessary facilities and permissions sto conduct the experiments. Authors are grateful to Professor and Head, Department of Vegetable Crops, TNAU, Coimbatore for providing okra genotypes for screening and further laboratory studies.

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