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Role of Different Morphological Characters of Okra Genotypes against Insect Pests Complex

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Abstract

The field experiment was conducted during summer 2021 and 2022 at Anand Agricultural University, Anand, Gujarat to evaluate the effects of different morphological characters of okra genotypes against insect pests infestation. The genotype, AOL 20-03 recorded the minimum population of jassid, whitefly, mite as well as fruit damage due to shoot and fruit borer, with the maximum trichome density on leaf and fruit with higher thickness of the fruit wall. Further, genotype AOL 16-01 recorded the maximum insect-pest infestation with the minimum trichome density on leaf with lesser thickness of the fruit wall.

Keywords : Okra, Jassids, Whitefly, Mites, Shoot and fruit borer, Fruit borer, Morphological characters

Okra, *Abelmoschus esculentus* (L.) Moench, which is one of the important vegetable crop of *Malvaceae* family, is known as *Bhindi* in India (Navneet *et al*., 2018).Green tender fruits of okra are consumed as a vegetable in different forms. These fruits are rich in vitamins, calcium, potassium and other mineral matters. The mature okra seed is a good source of oil and protein has been known to have superior nutritional quality, which is rich in unsaturated fatty acids such as linoleic acid which was essential for human nutrition. Its mature fruit and stems contain crude fiber, which is used in the paper industry (Kumar *et al*., 2013). In India, okra is one of the most important vegetable crops grown for its tender green fruits during the Summer and *kharif*. During the year 2020-21, India ranked first in production followed by Nigeria (Anonymous, 2022). Several pests and diseases causing considerable damage at different stages of growth in okra. Among the insect pests of okra, jassid, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius), mite, *Tetranychus cinnabarinus* (Boisd.) and shoot and fruit borer, *Earias insulana* (Boisd.), *Earias vittella* (Fab.) are the major pests (Nagar *et al*., 2017). Management of insect pests is a basic requirement for the higher and quality yield of field crops. Hence, one of the important strategy for the management of sucking pests is the use of resistant genotypes / cultivars. Resistance genotypes / cultivars act as a preventive measure with maximum insect pest control, ease of adoption and compatibility with other tactics of pest management. Resistance against pests is due to the presence of morphological characters in the plant parts which plays a pivotal role in invoking host plant resistance against insect pests. Therefore, the present investigation was carried out to screen the different okra genotypes/cultivars with their morphological basis of resistance to insect pests.

Material and Methods

The field experiment was conducted during Summer, 2021 and 2022 at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). The experiment was laid out in Randomized Block Design with ten genotypes/cultivars *viz*., AOL 15-30, AOL 16-01, AOL 18-06, AOL 19-10, AOL 20-03, GAO-5, GO-6, Kashi Kranti, Red One Long, Phule Prajatika replicated thrice. Each genotype was sown in 2.7 × 1.5 m plot size with the spacing of 45 × 15 cm. All recommended cultural practices were followed for raising the crop except the plant protection measures.

Observation of Sucking Pests

To record observations on the population of sucking pests *viz*., jassid, *A. biguttula biguttula* and whitefly, *B. tabaci* five plants were randomly selected from each plot. From each selected plants, one leaf each from top, middle and lower canopy was observed and number of individuals of sucking pests were counted at weekly interval starting from one week after germination till the termination of crop. In case of jassid, number of nymphs as well as adults were counted whereas, in case of whitefly only number of adults were counted from each leaf. Whereas, the observations of mite, *T. urticae* population was recorded per one cm^2 leaf area.

Observation of Lepidopteran Pests

Observations on per cent fruit damage due to lepidopteran pests *viz*., *E.vittella* and *H.armigera* were recorded during each picking by counting number of healthy and damaged fruits and per cent fruit damage was calculated by using formula:

$$\text{Fruit damage(\%)} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

To know the role of different morphological characters in imparting resistance to insect pests infestation, five samples of okra leaves and fruits were randomly plucked from each plot of genotypes per replication at 45 days after germination. Morphological characters *viz*., leaf thickness, leaf area, trichome density on leaf, trichome density on fruit, length and girth of fruit and thickness of fruit wall were recorded. Leaf thickness (mm), girth of fruit (mm) and thickness of fruit wall (mm) were recorded by Dial Vernier calliper whereas, leaf area (cm^2) was measured by digital leaf area meter. Trichome density on leaf and fruit (0.25 cm^2 area) were recorded under stereomicroscope. Length of fruit (cm) was measured by using standard scale. The data obtained were correlated with insect pests incidence to know the role of above morphological characters in imparting resistance against insect pests.

Results and Discussion

The experimental results obtained on morphological characteristics of okra genotypes and their correlation with insect pests infestation are presented and discussed here in under. The yearly (Summer, 2021 and 2022) data of incidence of sucking pests and their correlation with morphological characters are presented in Table 1 and 2, respectively while the infestation of fruit borers were correlated with morphological characters and correlation co-efficient values (r) are presented in Table 3 and 4, respectively. While the average data of the two years (Summer, 2021 and 2022) on incidence of sucking pests and infestation of fruit borers were correlated with morphological characters are depicted in Fig. 1 and 2 and correlation co-efficient values (r) are presented in Table 5 and 6, respectively.

Jassid, *A. biguttulabiguttula*

In Summer, 2021 data presented in Table 1 showed that among the various morphological characters of okra leaf, trichome density showed highly significant negative association (r= -0.882**) with the jassid population in okra. Leaf thickness and leaf area exhibited a non-significant negative and positive association, respectively with the population of jassids.

Study of the various morphological characters of okra leaf showed that trichome density highly significant negative association (r= -0.931**) with the incidence of jassid in okra during Summer 2022, (Table 2). While, the leaf thickness and leaf area exhibited a non-significant negative and positive association, respectively with the population of jassids.

The data (Summer, 2021 and 2022) of the various morphological characters of okra leaf and their correlation with sucking pests presented in Table 3,

TABLE 1

Population of sucking pests and morphological characters of leaf of different okra genotypes/ cultivars (Summer, 2021)

Genotypes/ Cultivars	No. of sucking pests/ leaf		No. of mites/ cm^2 leaf area	Morphological characters		
	Jassid	Whitefly		Trichome density (No. of trihomes / 0.25 cm^2 leaf area)	Leaf thickness (mm)	Leaf area (cm^2)
AOL 15-30	2.41	0.77	2.51	5.73	0.26	106.37
AOL 16-01	3.10	0.98	3.19	4.67	0.45	77.95
AOL 18-06	1.64	0.40	1.78	10.60	0.16	81.00
AOL 19-10	2.27	0.72	2.38	5.93	0.34	64.39
AOL 20-03	1.46	0.25	1.45	11.07	0.55	83.51
GAO 5	3.01	0.91	3.11	5.27	0.19	88.91
GO 6	1.90	0.54	1.94	7.33	0.27	110.30
Kashi Kranti	2.19	0.66	2.30	7.20	0.25	86.08
Red One Long	1.74	0.43	1.83	7.93	0.43	61.72
Phule Prajatika	1.82	0.50	1.88	7.53	0.19	80.54
Correlation co-efficient (r)						
	Jassid			-0.882 **	-0.100	0.096
	Whitefly			-0.935 **	-0.184	0.126
	Mite			-0.882 **	-0.140	0.081

Note : ** Significant at 0.01 % level

TABLE 2

Population of sucking pests and morphological characters of leaf of different okra genotypes/ cultivars (Summer, 2022)

Genotypes/ Cultivars	No. of sucking pests/ leaf		No. of mites/ cm^2 leaf area	Morphological characters		
	Jassid	Whitefly		Trichome density (No. of trihomes / 0.25 cm^2 leaf area)	Leaf thickness (mm)	Leaf area (cm^2)
AOL 15-30	2.49	0.87	2.93	6.87	0.23	113.26
AOL 16-01	2.91	1.15	3.43	5.60	0.43	82.22
AOL 18-06	1.69	0.47	2.17	11.87	0.13	84.91
AOL 19-10	2.42	0.81	2.88	7.07	0.32	67.73
AOL 20-03	1.41	0.33	1.59	12.27	0.53	85.61
GAO 5	2.86	1.07	3.35	6.47	0.15	90.71
GO 6	2.01	0.62	2.38	8.47	0.24	106.60
Kashi Kranti	2.33	0.73	2.79	8.27	0.23	86.28
Red One Long	1.82	0.51	2.24	9.07	0.41	66.97
Phule Prajatika	1.88	0.57	2.31	8.67	0.15	87.52
Correlation co-efficient (r)						
	Jassid			-0.931 **	-0.177	0.124
	Whitefly			-0.922 **	-0.146	0.138
	Mite			-0.923 **	-0.250	0.094

Note : ** Significant at 0.01 % level

TABLE 3

Population of sucking pests and morphological characters of leaf of different okra genotypes/ cultivars (Summer, 2021 and 2022)

Genotypes/ Cultivars	No. of sucking pests/ leaf		No. of mites/ cm²leaf area	Morphological characters		
	Jassid	Whitefly		Trichome density (No. of trihomes / 0.25 cm² leaf area)	Leaf thickness (mm)	Leaf area (cm²)
AOL 15-30	2.45	0.82	2.72	6.30	0.25	109.81
AOL 16-01	3.01	1.06	3.31	5.13	0.44	80.09
AOL 18-06	1.66	0.43	1.97	11.23	0.14	82.96
AOL 19-10	2.35	0.76	2.62	6.50	0.33	66.06
AOL 20-03	1.44	0.29	1.52	11.67	0.54	84.56
GAO 5	2.94	0.99	3.23	5.87	0.17	89.81
GO 6	1.95	0.58	2.16	7.90	0.25	108.45
Kashi Kranti	2.26	0.70	2.54	7.73	0.24	86.18
Red One Long	1.78	0.47	2.03	8.50	0.42	64.35
Phule Prajatika	1.85	0.54	2.09	8.10	0.17	84.03
Correlation co-efficient (r)						
	Jassid			-0.910 **	-0.139	0.112
	Whitefly			-0.929 **	-0.164	0.133
	Mite			-0.907 **	-0.196	0.088

Note : Data on population of insect pests and morphological characters are mean value of two years; ** Significant at 0.01 % level

TABLE 4

Fruit damage due to fruit borers and morphological characters of fruit of different okra genotypes/ cultivars (Summer, 2021)

Genotypes/ Cultivars	Fruit damage (%)		Morphological characters of fruits			
	E. vittella	*H. armigera*	Trichome density (No. of trihomes / 0.25 cm² leaf area)	Length of fruit (cm)	Girth of fruit (cm)	Thickness of fruit wall(mm)
AOL 15-30	6.64	9.85	81.53	9.62	1.53	1.34
AOL 16-01	9.05	13.42	46.13	10.23	1.38	1.21
AOL 18-06	5.57	7.87	97.80	9.83	1.45	1.38
AOL 19-10	6.22	9.17	100.40	9.83	1.29	1.36
AOL 20-03	3.22	5.10	89.87	11.94	1.22	1.42
GAO 5	7.23	10.66	67.27	10.71	1.34	1.27
GO 6	4.83	6.98	105.07	10.99	1.32	1.41
Kashi Kranti	6.83	10.18	70.33	9.14	1.33	1.27
Red One Long	4.40	6.62	106.67	10.29	1.31	1.42
PhulePrajatika	5.23	7.43	109.53	10.07	1.27	1.39
Correlation co-efficient (r)						
Fruit damage (%), *E. vittella*			-0.798 **	-0.531	0.487	-0.947 **
Fruit damage (%), *H. armigera*			-0.834 **	-0.503	0.465	-0.962 **

Note : ** Significant at 0.01 % level

indicated that the trichome density had highly significant negative association (r= -0.910**) with the jassid population in okra. Whereas, leaf thickness and leaf area exhibited a non-significant negative and positive association, respectively with the population of jassids.

Whitefly, *B. tabaci*

Data presented in Table 1 (Summer, 2021) showed that among the various morphological characters of okra leaf, trichome density showed highly significant negative association (r= -0.935**) with the whitefly population in okra. Whereas, leaf thickness and leaf area exhibited a non-significant negative and positive association, respectively with the population of whitefly. Study of the various morphological characters of okra leafindicated that trichome density had highly significant and negative association (r= -0.922**) with the incidence of whitefly in okra during Summer 2022, (Table 2). While, the leaf thickness and leaf area exhibited a non-significant negative and positive association, respectively with the population of whitefly.

The data on correlation studies presented in Table 3 (Summer, 2021 and 2022) indicated that the trichome density had a highly significant and negative correlation (r= -0.929**)with whitefly population in okra. However, leaf thickness showed non-significant negative correlation whereas, leaf area showed non-significant positive correlation with the incidence of whitefly.

Mite, *T. urticae*

In Summer, 2021 data presented in Table 1 showed that among the various morphological characters of okra leaf, trichome density showed highly significant negative association (r= -0.882**) with the mite population in okra. Whereas, leaf thickness and leaf area exhibited a non-significant negative and positive association, respectively with the population of mite.

Study of the various morphological characters of okra leaf indicated that trichome density had highly significant negative association (r= -0.923**) with the incidence of mite in okra during Summer 2022, (Table 2). While, the leaf thickness and leaf area exhibited a

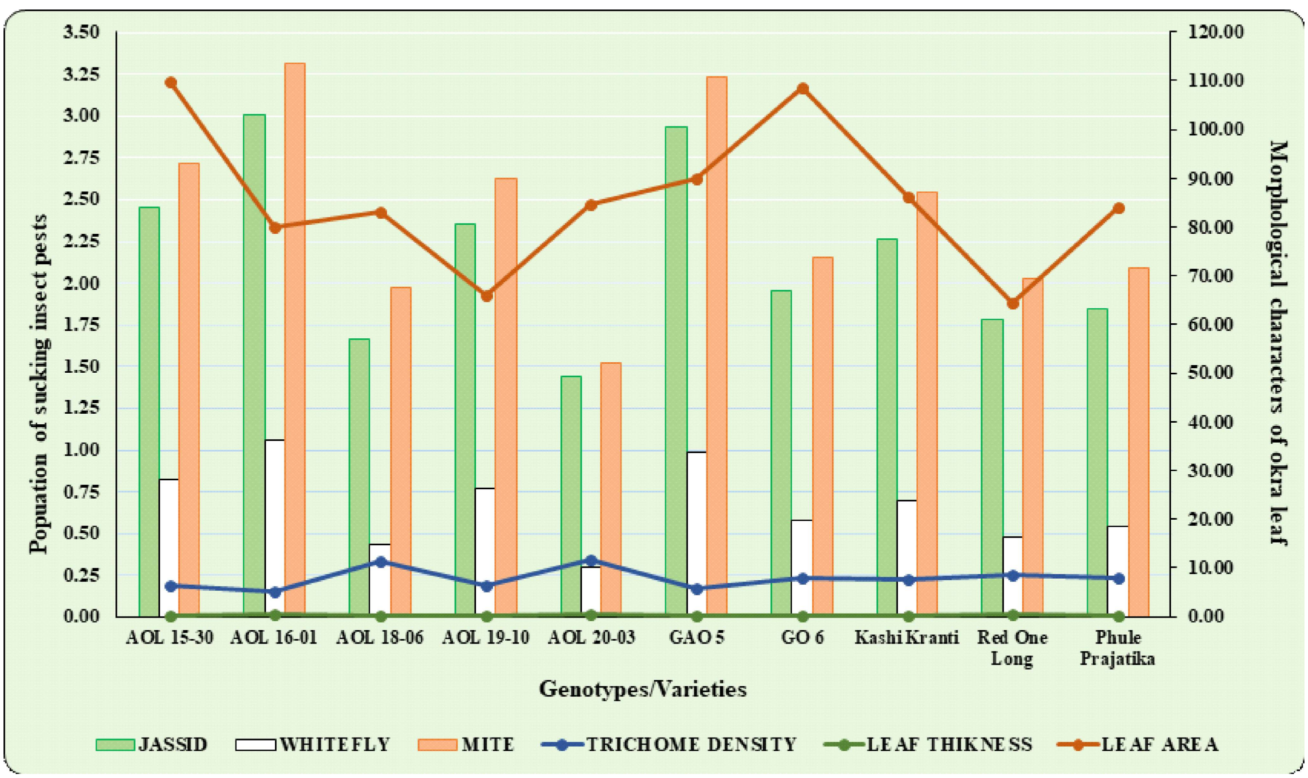

Fig. 1: Morphological characters of okra leaf and incidence of sucking insect-pests on different okra genotypes/varieties

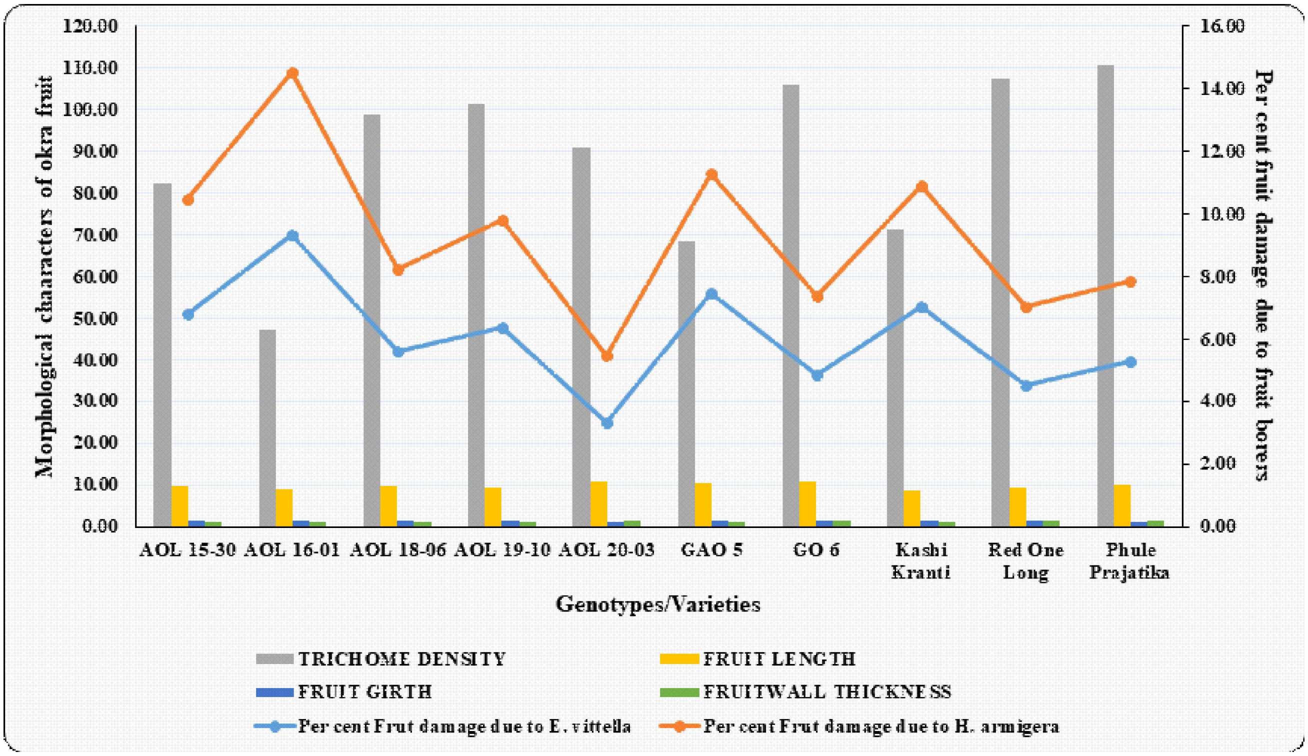

Fig. 2: Morphological characters of okra fruit and per cent fruit damage due to fruit borers on different okra genotypes/varieties

non-significant negative and positive association, respectively with the incidence of mite.

Correlation co-efficient value presented in Table 3 (Summer, 2021 and 2022) showed that mite population expressed highly significant and negative correlation (r= -0.907**) with trichome density, non-significant negative correlation with leaf thickness as well as positive relationship with leaf area.

Fruit damage due to *E. vittella*

Data presented in Table 4 (Summer, 2021) showed that among the various morphological characters of okra fruit studied for resistance, trichome density and thickness of fruit wall showed highly significant (r= -0.798** and -0.947**, respectively) negative correlation with fruit damage due to *E. vittella*. Whereas, rest of the characters *viz*., length and girth of fruit exhibited a non-significant negative and positive correlation, respectively with the fruit damage by *E. vittella*.

In Summer, 2022 data presented in Table 5 indicated that among the various morphological characters of okra studied for resistance, trichome density and thickness of fruit wall showed highly significant negative correlation (r= -0.822** and -0.941**, respectively) with fruit damage due to *E. vittella*. However, rest of the characters *viz*., length and girth of fruit exhibited a non-significant negative and positive correlation, respectively with the fruit damage by *E. vittella*.

Among the different morphological characters of okra fruit studied for resistance, trichome density and thickness of fruit wall showed highly significant (r= -0.810** and -0.979**, respectively) negative correlation with fruit damage due to *E. vittella* (Table 6). While, the rest of the characters *viz*., length and girth of fruit exhibited a non-significant negative and positive correlation, respectively with the fruit damage by *E. vittella*.

Fruit Damage due to *H. armigera*

In Summer, 2021 data presented in Table 4 indicated that among the various morphological characters of okra studied for resistance, trichome density and

TABLE 5

Fruit damage due to fruit borers and morphological characters of fruit of different okra genotypes/ cultivars (Summer, 2022)

Genotypes/ Cultivars	Fruit damage (%)		Morphological characters of fruits			
	E. vittella	H. armigera	Trichome density (No. of trihomes / 0.25 cm² leaf area)	Length of fruit (cm)	Girth of fruit (cm)	Thickness of fruit wall(mm)
AOL 15-30	6.93	11.16	83.40	9.93	1.51	1.12
AOL 16-01	9.59	15.71	48.07	8.01	1.36	1.05
AOL 18-06	5.69	8.65	99.80	9.45	1.43	1.15
AOL 19-10	6.56	10.42	102.40	8.53	1.27	1.14
AOL 20-03	3.43	5.88	91.87	9.57	1.20	1.31
GAO 5	7.74	11.96	69.20	9.75	1.32	1.09
GO 6	4.88	7.74	106.80	10.77	1.30	1.22
Kashi Kranti	7.25	11.61	72.20	8.35	1.31	1.10
Red One Long	4.61	7.43	108.40	8.23	1.29	1.28
Phule Prajatika	5.31	8.23	111.53	9.78	1.25	1.16
Correlation co-efficient (r)						
Fruit damage (%), *E. vittella*			-0.822 **	-0.411	0.464	-0.941 **
Fruit damage (%), *H. armigera*			-0.850 **	-0.446	0.442	-0.912 **

Note: ** Significant at 0.01 % level

TABLE 6

Fruit damage due to fruit borers and morphological characters of fruit of different okra genotypes/ cultivars (Summer, 2021 and 2022)

Genotypes/Cultivars	Fruit damage (%)		Morphological characters of fruits			
	E. vittella	H. armigera	Trichome density(No. of trihomes /0.25 cm² leaf area)	Length of fruit (cm)	Girth of fruit (cm)	Thickness of fruit wall(mm)
AOL 15-30	6.78	10.49	82.47	9.77	1.52	1.23
AOL 16-01	9.32	14.55	47.10	9.12	1.37	1.13
AOL 18-06	5.63	8.25	98.80	9.64	1.44	1.27
AOL 19-10	6.39	9.79	101.40	9.18	1.28	1.25
AOL 20-03	3.32	5.48	90.87	10.75	1.21	1.37
GAO 5	7.49	11.30	68.23	10.23	1.33	1.18
GO 6	4.85	7.36	105.93	10.88	1.31	1.31
Kashi Kranti	7.04	10.89	71.27	8.74	1.32	1.19
Red One Long	4.50	7.02	107.53	9.26	1.30	1.35
Phule Prajatika	5.27	7.83	110.53	9.93	1.26	1.27
Correlation co-efficient (r)						
Fruit damage (%), *E. vittella*			-0.810 **	-0.544	0.475	-0.979 **
Fruit damage (%), *H. armigera*			-0.843 **	-0.549	0.453	-0.970 **

Note : Data on per cent fruit damage and morphological characters are mean value of two years ; ** Significant at 0.01 % level thickness of fruit wall showed highly significant negative correlation (r= -0.834** and -0.962**, respectively) with fruit damage due to *H. armigera*. However, rest of the characters *viz*., length and girth of fruit exhibited a non-significant negative and positive correlation, respectively with the fruit damage by *H. armigera*. Data presented in Table 5 (Summer, 2022) showed that among the various morphological characters of okra fruit studied for resistance, trichome density and thickness of fruit wall showed highly significant (r= -0.850** and -0.912**, respectively) negative correlation with fruit damage due to *H. armigera*. Whereas, rest of the characters *viz*., length and girth of fruit exhibited a non-significant negative and positive correlation, respectively with the fruit damage by *H. armigera*.

The data on correlation co-efficient presented in Table 6 revealed that the highly significant negative association between fruit damage due to *H. armigera* and trichome density r= -0.843** and thickness of fruit wall r=-0.970**. However, non-significant negative with fruit length and positive association with girth of fruit are recorded with fruit damage by *H. armigera*.

According to Dabhi (2008) reported that hair density on midrib had significant negative correlation while leaf area had positive correlation with the population of leafhopper and whitefly in okra. Same conclusion also drawn by earlier researchers *viz*., Halder *et al*. (2016); Nagar *et al*. (2017); Sandhi *et al*. (2017); Chatterjee *et al*. (2019) and Kumar and Padhi (2022). Gautam *et al*. (2013) concluded that fruit length and diameter had non-significant association with fruit infestation due to *E. vittella*. Halder *et al*. (2015), Muthukumaran and Ganesan (2017), Anitha and Karthika (2018) also observed that susceptible genotype had lower number of trichomes with more damage due to *E. vittella* in okra. However, thickness of fruit wall and trichome density on fruits showed significant negative correlation with fruit borer infestation in okra. Thus, the conclusions drawn by Subbireddy *et al*. (2018) are in agreement with present study.

Overall, it can be concluded that morphological characters *viz*., trichome density on leaf and fruit as well as thickness of fruit wall were responsible for imparting resistance in okra genotype / cultivars against incidence of jassid, whitefly, mite as well as fruit damage due to *E. vittella* and *H. armigera* in okra. Fruit length had non-significant negative association whereas, girth of the fruit had non-significant positive association with fruit damage by *E. vittella* and *H. armigera.*

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