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The Physio-Morphic Characters of Different Okra Germplasm and their Relationship with the Population Dynamics of Okra Leafhopper, *Amrasca biguttula biguttula* (Ishida)

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Abstract

The reactions of twenty five (25) accessions of okra were evaluated under field conditions against Leafhopper, *Amrasca biguttula biguttula.* The experiment was conducted at NBPGR, regional station Hyderabad. Among twenty five germplasm (25) screened against the okra leafhopper, IC344596 recorded significantly lowest leafhopper population which was followed by RJR-124, PSRJ12952, NIC 9402 and IC433667. PSRJ 13040 and RJR-193 recorded high population of leafhopper. RJR-124, PSRJ12952 and IC344596 recorded significantly highest number of trichomes of 57.00, 47.67 and 42.33 trichomes m^{-2}, respectively. RJR-193 and PSRJ 13040 recorded significantly less number of trichomes (10.33 m^{-2}). Correlation between okra leafhopper and the various yield and growth parameters of okra accessions revealed highly significant and negative correlation for yield, number of pods and significant positive correlation with plant height while non-significant correlation recorded with pod length.

Keywords: Accessions, *Amrasca biguttula biguttula*, Okra germplasm, Trichome density

Introduction

Okra (*Abelmoschus esculentus* L.), also known as okra, is a popular vegetable crop throughout the world. India is the world's largest producer of okra. From sowing to harvest, a variety of sucking pests have an impact on the production and quality of okra fruits. Sucking insect pests, particularly the leafhopper (*Amrasca biguttula biguttula*), attack the okra crop at all stages of development, causing massive losses. The leafhopper (*Amrasca biguttula biguttula*) is a pestiferous insect that feeds on cell sap and injects toxic saliva into leaves, causing yield loss (Singh *et al.,* 2008). The nymphs and adults suck plant sap primarily from the lower surface of the leaves, causing phytotoxic symptoms known as hopper burn, which results in complete desiccation and has become one of the limiting factors in economic productivity of the crop. Leafhopper alone had caused 59.79% losses in okra fruit yield (Atwal *et al.,* 1990).

Insecticides are mostly used by vegetable growers because they provide immediate relief to crops and appear to benefit farmers. For the same reason, chemical use is rapidly increasing, while indiscriminate insecticide use has resulted in insecticide resistance, pest resurgence, adverse effects on non-target organisms, environmental pollution, and an undesirable load of pesticide residues in saleable vegetables (Kumari *et al.,* 2002). The widespread and indiscriminate use of pesticides causes a slew of issues, including pesticide resistance, resurgence, and pollution (Arora and Singh, 2004). This has necessitated alternative environmentally friendly methods, and the use of resistant varieties is one of these (Ahmad and Sarwar, 2013; Sarwar, 2013).

Leaf pubescence, colour and shape, hair density, silica content, and plant anatomy have all been observed to be resistant to leafhoppers in cotton (Sadasivam and Thayumanavan, 2003). Because many of these are heritable, identifying them will be the most important step in developing resistant varieties. Furthermore, resistant

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genotypes must be identified on a continuous basis to meet the needs of breeders. This study compares 23 okra genotypes to leafhoppers in this context.

Today's era is an IPM era in which all control measures are likely to be integrated; whereas, insect resistant plants offer ideal protection against insect damage, have low production costs, and are environmentally friendly. Thus, there is a lot of scope for pest-resistant varieties to evolve in vegetable crops. Host plant resistance is a cost-effective, environmentally friendly method of controlling insect pests. Given the economic importance of the leafhopper, *A. biguttula biguttula*, on the okra crop, the current study was designed to investigate the reaction of different okra genotypes to the leafhopper and its incidence on different varieties in order to identify a variety that can be considered a resistant variety to these pests and also the morphological characters responsible for the resistance to the leafhopper in okra.

Materials and Methods

The experiment was carried out at NBPGR's regional station in Hyderabad. Twenty-five (25) okra germplasm samples were screened to determine the source of resistance to the okra leafhopper, *Amrasca biguttula biguttula*. During the study, Pusa Sawani and Parbhani Kranti were used as susceptible and resistant controls, respectively. All germplasm was raised in two rows of 6 m with a spacing of 60 cm × 30 cm, with three replications per treatment. Except for plant protection measures against leafhoppers, the crop was grown in accordance with the recommended package of practices. The response of okra germplasm against leafhopper infestation is recorded by counting the number of leafhoppers from randomly selected five (5) plants covering three leaves, one each from top, middle and bottom portion of the plant. Yield parameters were also recorded in every germplasm including susceptible and resistant check. The data were subjected to statistical analysis.

Trichome Estimation

Trichome density were recorded for determining their role in oviposition preferences of okra Leafhopper. The trichome density was taken from a 1 mm^2 round disc from the distal part of the lower side of the top fully opened leaf of the plant. Three discs from each of five (5) plants (standardized stage) of every genotype were examined. The total number of trichomes were counted under a stereomicroscope at ×40.

Scanning Electron Microscopy (SEM)

Fresh leaf pieces (10 × 10 mm^2) were immersed in a fixation solution of 2-5% glutaraldehyde in 0-1 M phosphate buffer for 24 hours at 4 °C and post fixed in 2% aqueous osmium tetroxide for 4 hours for Scanning Electron Microscopy (SEM). Samples were washed with the buffer for 15-30 minutes before being dehydrated with the following ethanol concentrations: 25 and 50% for 5 minutes, 70, 80, 95, and twice 99% for 10 minutes, and dried to critical point drying with a CPD unit. The processed samples were taped to the aluminium stubs with double-sided carbon conductivity tape, and a thin layer of gold coat was applied to the samples using an automated sputter coater (Model- JEOL JFC-1600) for 3 minutes before being scanned with a scanning electron microscope at ×75, ×150, and ×200 magnification.

Results and Discussion

Leafhopper Incidence

Significant differences were observed among the okra germplasm in leafhopper incidence. Among twenty five (25) germplasm, screened against the okra leafhopper, IC344596 recorded significantly lowest leafhopper population (8.76 3 $leaves^{-1}$) which was followed by RJR-124 (9.06 3$leaves^{-1}$), PSRJ12952 (10.40 3$leaves^{-1}$), NIC 9402 (10.76 3$leaves^{-1}$), IC433667 (11.76 3$leaves^{-1}$), IC433438 (12.63 3$leaves^{-1}$), IC433597 (15.90 3$leaves^{-1}$), and IC141020 (18.70 3$leaves^{-1}$). PSRJ 13040 and RJR-193 sustained high population of 48.30 and 44.13 leafhoppers per three leaves, respectively as compared to other germplasm (Table 1).

Influence of Trichome Density on Leafhopper Incidence

RJR-124, PSRJ12952 and IC344596 recorded significantly highest number of trichomes of 57.00, 47.67 and 42.33 trichomes m^{-2}, respectively (Table 2). RJR-193 and PSRJ 13040 recorded significantly less number of trichomes (10.33 m^{-2}).

The correlation study between trichome density and Leafhopper population revealed that there was a negative and significant relationship between trichome density and leafhopper population during *summer* 2015 ($r = -0.62^*$) and *summer* 2015 ($r = -0.63^*$). However, numerically less Leafhopper populations were recorded on germplasm that possessed more numbers trichomes (RJR-124, PSRJ12952 and IC344596). While, those germplasm possessed less number of trichomes (RJR-193 and PSRJ 13040) recorded numerically higher Leafhopper population (Table 3).

Yield and Growth Parameters of Okra Accessions Screened against Leafhopper

RJR 279 recorded the significantly maximum height (92.67 cm) which was followed by RJR 405 (82.67 cm). IC433667 recorded minimum height (40.00 cm) compared to other germplasm. Significantly highest pod length was recorded in PSRJ12932 (15.53 cm). RJR 124 (14.90 cm) and RJR 670 (13.40 cm) were the next best accessions (Table 2).

IC344596, IC141020 and IC433597 recorded significantly highest number of pods of 40.33, 36.00 and 34.00 respectively. PSRJ13040 recorded significantly less number of pods (6 $plant^{-1}$ $year^{-1}$) followed by RJR 193 (7 $plant^{-1}$ $year^{-1}$). Significantly highest yield was recorded in PSRJ12932 (9,853 Kg ha^{-1}). The next best accession was RJR 193 (9,583 Kg ha^{-1}) followed by IC344596 (9,016 Kg ha^{-1}). Lowest yield was recorded from PSRJ13040 (2,540 Kg ha^{-1}) and RJR 193 (2,620 Kg ha^{-1}).

Correlation between okra leafhopper, *Amrasca biguttula biguttula* and the various yield and growth parameters of okra accessions revealed an highly significant and negative correlation for yield ($r = -0.86^{**}$) and number of pods ($r = -0.78^{**}$). There is a significant and positive correlation with plant height ($r = 0.64^*$) and pod length ($r = 0.43^*$).

Table 1: Screening of okra germplasm against leafhopper under field conditions

Okra Accessions	Leafhopper population per 3 leaves										
	Standard weeks										
	14	15	16	17	18	19	20	21	22	23	Mean
T_1 - IC141020	9.00	13.66	26.33	31.00	26.66	27.33	21.33	16.33	11.00	4.33	18.70
T_2 - IC433597	4.33	8.33	16.66	25.00	29.00	22.00	23.00	17.33	10.66	2.66	15.90
T_3 - EC305672	11.66	10.00	39.00	41.00	49.00	46.66	54.00	47.66	23.00	6.00	33.00
T_4 - 433438	3.66	6.33	12.66	24.00	19.00	11.00	19.00	20.00	7.66	3.00	12.63
T_5 - IC433667	4.00	6.66	12.66	23.00	15.66	9.66	17.66	12.33	12.00	4.00	11.76
T_6 - EC305619	7.66	9.66	41.00	40.33	36.66	42.00	59.00	41.33	21.33	5.33	30.43
T_7 - EC305736	11.00	10.00	34.66	44.33	28.00	33.00	36.00	32.00	17.66	9.33	25.60
T_8 - NIC9402	5.33	4.66	9.33	19.00	18.00	13.00	17.00	12.00	7.00	2.33	10.76
T_9 - IC344596	3.66	4.66	10.00	14.00	16.00	11.33	12.66	8.66	5.00	1.66	8.76
T_{10} - NSJ- 401	10.00	10.33	32.33	45.00	44.00	47.00	47.00	41.33	16.33	3.33	29.66
T_{11} - PSRJ 13040	11.66	18.00	55.66	54.66	70.00	57.66	73.33	60.33	57.00	18.66	48.30
T_{12} - PSRJ12952	4.33	6.00	13.00	16.00	16.00	14.33	15.00	9.66	7.00	2.66	10.40
T_{13} - RJR 265	10.00	7.33	46.00	49.00	44.00	47.00	53.33	49.66	40.66	12.00	35.90
T_{14} - RJR-193	12.33	15.00	52.00	54.00	62.00	52.66	71.00	53.66	54.33	14.33	44.13
T_{15} - RJR-124	4.00	4.66	11.33	14.00	12.33	15.33	12.00	9.66	5.33	2.00	9.06
T_{16} - RJR-479	9.66	12.33	51.66	41.00	50.00	40.00	57.00	35.33	26.33	16.00	33.93
T_{17} - RJR 279	8.33	8.66	43.66	47.00	41.00	46.66	56.00	34.33	35.00	10.66	33.13
T_{18} - RJR-405	7.00	5.33	30.33	50.00	34.00	46.33	50.66	40.33	45.00	10.66	31.96
T_{19} - RJR-587	7.33	4.00	31.66	44.00	42.00	53.66	57.00	42.33	27.00	13.33	32.23
T_{20} - RJR 670	7.33	5.66	40.66	39.00	42.00	46.00	60.00	40.66	23.00	8.66	31.30
T_{21} - RJR110	11.00	9.66	51.00	51.00	41.33	48.33	38.00	28.33	13.66	10.33	30.26
T_{22} - RJR 45	8.33	8.33	46.33	49.00	51.00	48.66	40.00	39.00	16.66	10.33	31.76
T_{23} - IC 90402	7.00	7.33	12.33	39.00	17.33	44.33	41.00	35.00	21.33	6.33	23.10
T_{24} - Pusa Sawani	10.00	14.66	40.66	55.00	56.00	55.00	70.00	56.66	45.00	16.66	41.96
T_{25} - Parbhani Kranti	6.66	9.33	32.66	44.66	52.00	50.33	46.00	42.66	32.66	9.66	32.66
Mean	8.13	8.82	31.74	38.16	36.52	37.17	41.88	33.06	23.26	8.17	-
Factors	S.Em±	C.D at 5%									
Standard weeks (A)	0.23	0.64									
Accessions (B)	0.36	1.01									
Factor (A × B)	1.15	3.20									

The current findings are consistent with those of Ali *et al.* (2012) and Ullah *et al.* (2012), who found a significant negative relationship between brinjal physio-morphic characters and leafhopper population. In genotypes with the highest trichome density, hopper mobility on leaf surfaces may be hampered. Our findings are consistent with those of Khan *et al.* (2000), who found lower levels of *Aphis gossypii* infestation in ash gourd varieties with the highest trichome density.

The current study can be compared to Iqbal *et al.* (2011), who found that hair density on the midrib, veins, and lamina of leaves had a significant and negative correlation with leafhopper population. The current findings are also consistent with those of Nagar *et al.* (2017), who discovered that okra leaf hairiness had a significant negative impact on leafhopper infestation (r = -0.966).

Ahmed *et al.* (2005) tested different cotton varieties for jassid resistance in Faisalabad, Pakistan, and discovered that the 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 gossypol glands on the lamina of the middle leaf were all negatively and significantly correlated with the jassid nymph population, whereas all other morphological traits were not.

Table 2: Morphological and yield attributes of okra germplasm

Okra germplasm	Plant height (cm)	Trichome density mm^{-2}	No. of pods $plant^{-1}$ $year^{-1}$	Pod length (cm)	Yield (Kg ha^{-1})
IC141020	60	39.33	36	3.87	8386
IC433597	56	31.33	34	3.80	8296
EC305672	57	33.67	14.67	12.47	7453
IC432428	42	34.67	38	4.10	8606
IC433667	40	40.00	37	3.90	8443
EC305619	51	32.00	14	12.00	7106
EC305736	54	26.33	12	12.87	6740
NIC9402	29.33	28.67	38	4.20	8893
IC344596	60	42.33	40.33	4.40	9016
NSJ401	72.67	40.33	32	3.70	8100
PSRJ13040	59	13.00	6	9.53	2540
PSRJ12932	37.33	47.67	19	15.53	9853
RJR 265	79.67	29.00	10.33	11.20	3306
RJR 193	82.67	10.33	7	10.40	2620
RJR 124	72.00	57.00	17	14.90	9583
RJR 479	81.33	35.33	9	11.80	3123
RJR 279	92.67	28.00	10.67	12.03	4330
RJR 405	84.00	24.00	8.67	12.60	3426
RJR 587	71.33	24.00	11.67	12.30	3700
RJR 670	70.00	20.00	10.33	13.40	3783
RJR 110	59.33	41.33	27	3.50	4610
RJR 45	71.33	42.67	12	13.50	5733
IC90402	38.33	40.00	25.67	3.83	6083
Pusa Sawani	56.67	36.00	12.33	12.20	4600
Parbhani Kranti	77.33	37.67	15.33	12.37	7623
S.Em.±	1.15	1.25	1.21	0.62	8.12
C.D. at 5%	3.27	3.55	3.45	1.88	25.32

Table 3: Relationship of okra leaf hopper population with morphological and yield parameters

Parameters	Correlation values
Trichome density mm^{-2}	-0.63^{**}
Plant height (cm)	0.64^{**}
No of pods	-0.78^{**}
Pod length (cm)	0.43^{*}
Yield (Kg ha^{-1})	-0.86^{**}

* Significant at 5% level; ** Significant at 1% level

Correlation co-efficients between *A. biguttula biguttula* populations and various physio-morphic characteristics of okra were found to be highly significant. The findings can also be compared to those of Naqvi *et al.* (2008), who found a negative correlation between trichome density and leafhopper population on brinjal crops. Ali *et al.* (2012) also found that hair density on the lamina and leaf area played a 78.2% and 5.9% role in jassid population fluctuation in brinjal, respectively. Ullah *et al.* (2012) also reported that correlation coefficients between *A. biguttula biguttula* population and physio-morphic characters of okra were highly significant, strong, and negative for hair density on lamina (r = -0.831).

The current findings were consistent with Halder *et al.* (2016), who reported that okra genotype SB-6 had a relatively abaxial number of trichomes on leaf lamina (10.11), midrib (7.17), and vein (8.05) and was more susceptible to jassids (17.57 jassids $leaf^{-1}$) than tolerant genotype VROB-181 (5.43 jassids $leaf^{-1}$), which had 11.85, 9.17, and 9.95. Murugesan and Kavitha, 2010), discovered a significant negative correlation between trichome density on the ventral surface of leaves and leafhopper damage and oviposition on cotton. These findings were consistent with the current findings, which revealed a negative relationship between trichome density and leafhopper population.

Conclusion

Based on the outcome of the present study entitled "The physio-morphic characters of different okra germplasm and their relationship with the population dynamics of okra leafhopper, *Amrasca biguttula biguttula* (Ishida)", it was evident that, the cultivated accessions *viz.,* RJR-124 and PSRJ-12952 with good yield possessed high trichome density were found to be promising lines against the leafhopper, *Amrasca biguttula biguttula* (Ishida). These genotypes are identified as a source of resistance against leafhopper and could be used in breeding programme and development of IPM strategies.

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