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Studies on Correlation of *Amrasca biguttula biguttula* (Ishida) Population with Physio-morphic Characters of Okra, *Abelmoschus esculentus* (L.) Monech

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Abstract.- The study was conducted on nine selected genotypes of okra to determine the role of physio-morphic plant characters with the population of jassid. Various physio-morphic plant characters were correlated with the population of jassids and their impact was determined by processing the data into multiple linear regression analysis. Hair density on the midrib, veins and lamina of the upper, middle and bottom leaves, showed a significant and negative correlation with the population of jassids on okra. Similarly, the hair-length on midrib of middle leaves, hair-length on the vein of middle leaves, plant-height and number of primary branches also showed a negative and significant correlation with the pest-population. Moisture contents in the middle leaves and leaf-area of the lower leaves showed a positive and significant correlation. Hair density on the midrib of upper leaves, showed 53.10% role in the population fluctuation of the pest, followed by the hair-density on the midrib of lower leaves and hair-density on the lamina of lower leaves, with 15.1 and 7.2 % role in the population fluctuations of the jassid. All these factors had a significant and negative impact on the population fluctuations of the pest.

Key Words: *Abelmoschus esculentus*, *Amrasca biguttula biguttula*, physio-morphic characters, jassid population, pest resistance.

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Monech is the most important traditional vegetable of Pakistan. It has relatively good nutritional value and is good complement in developing countries where there is often a great alimentary imbalance. Unfortunately, as with most local vegetables, this crop has so far received only very limited research attention in Pakistan. Increasing crop loss owing to pests is a major constraint in sustaining agricultural productivity and production. *A. biguttula biguttula* is among the most important sucking insects that attack on okra crop (Singh *et al*., 1993; Dhandapani *et al*., 2003). There is very little movement of the leafhopper nymphs between leaves (Mabbett *et al*., 1984) and they remain confined to plants where hatched**.** The ill effects created by chemical pesticides prompted us the need to identify alternate method to manage pests. Among environmental friendly methods for pest management, Host Plant Resistance (HPR) is one of the most cost-effective and environmental safe methods for pest control. Unfortunately, a little concentration has been paid to factors responsible for jassid resistance/ susceptibility on okra crop.

The degree of hair or trichomes, on the leaves occurs in large numbers and plays a vital role in the plant defense particularly among phytophagous insects. Identification of physical and morphological characteristics of resistance varieties may lead to introduction of resistance traits to preferred varieties. Uthamasamy (1985) found that the resistant varieties had more hairs than the susceptible ones. Mahal *et al*. (1993) found an inverse relationship between emergence of nymphs and density of trichomes on the mid-vein of leaves. Similarly Taylo and Bernardo (1995) concluded that emergence of *A. biguttula biguttula* was significantly and negatively correlated with the density of trichomes. The factors affecting the oviposition are important components in searching source of resistance to a particular insect pest. Singh (1988) reported that there was a positive correlation of moisture contents with the incidence of *A. biguttula biguttula*.

The preference of *A. biguttula biguttula* for oviposition varies among different varieties of okra. Keeping in view the above facts, the present project was undertaken to determine the correlation of

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various physio-morphic characteristics of okra genotypes having different degrees of resistance and susceptibility with the population of jassids.

MATERIALS AND METHODS

Nine genotypes of okra *viz.*, 3 genotypes showing susceptibility (Pusa sawani, Dera local and Okra-3), 3 with intermediate (Karam-5, Sabz pari and Clean spineless) and 3 with resistant (Makhmali, Punjab selection and Green wonder) responses against jassid, were sown on March 31, 2007 in the experimental area of the Post Graduate Agricultural Research Station (PARS), following RCBD, in triplicates. The seeds of okra genotypes were obtained from the Vegetable Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad and Agricultural Research Institute (ARI), Ratta Kulachi, Dera Ismail Khan. No plant protection measures were applied for the control of jassid population and the material was screened out under natural insect pressure. All the recommended agronomic practices were adopted during the experiment. The row to row distance was kept to be 75 cm and that of the plant to be 30 cm. The plot size was maintained at 15 m × 20 m during the study season. With the appearance of jassid-population, the data were recorded early in the morning twice a week. For the counts on jassid-population, plants of each genotype in each replication were selected at random and tagged. The leaves were observed in such a way that one leaf at upper part of the first plant, one leaf of the middle part of the second plant and one leaf of the bottom part from the third plant of each variety, of similar age, was taken in to account. So a total of 15 leaves were taken per treatment for recording the population data of jassids. The average population of nymphs and adults per leaf, for each genotype, was calculated by simple arithmetic means.

Various physio-morphic plant characters were studied at the crop maturity when the plants were green. Leaves were collected, sealed in transparent white plastic bags and transported to the laboratory for analysis. The plant height measured from the ground level to the plant canopy with the help of an ordinary meter rod from randomly selected ten plants in each test entry. The branches arising from the basal node were counted from randomly selected ten plants in each test entry and their average, per plant, calculated. To determine area of the leaf lamina (cm^2), three full-grown leaves were taken randomly each from five randomly selected plants of each test entry. These leaves were taken, one each from the top, middle and lower part of each plant. For the determination of hair density on lamina, midrib and leaf vein, five plants were randomly selected in each test entry and one leaf each from the top, middle and lower parts of each selected plant was taken and then their hair-density noted under a stereoscopic microscope, which was converted in to cm^2 with a simple multiplication. Similarly for the determination of the thickness of the leaf lamina (µm), three full-grown leaves, one each from the top, middle and bottom parts were taken each from five randomly selected plants of each test entry. A cross-section of the leaves was cut with the help of fine razor and thickness of leaf-lamina determined from six different places of each leaf with the help of an ocular micrometer, under a carl zeiss binocular microscope. The length of the hair on the leaf-lamina, midrib and vein (µm) was also calculated. Three full-grown leaves were taken each from five randomly selected plants of each test entry and the length of hair on the leaf-lamina, midrib and veins determined under the microscope with the help an ocular micro-meter. For the determination of moisture percentage in the leaves, three samples, each of 10-grams of fresh leaves from the top, middle and bottom parts of different plants were taken from every plot. All the leaves, under experiment, were cleaned with a muslin cloth, weighed and kept into a drying oven run at 65°C for 72 hours. After drying, the leaves were weighed again and put back to in the oven at the same temperature, for another six hours. The leaves were taken out from the oven and kept in a desiccator for 10 minutes and weighed. After the weight of the dry material became constant, the moisture percentage was calculated according to the following formula:

$$\text{Moisture percentage} = \frac{\text{Wt. of fresh leaves - Wt. of dry leaves}}{\text{Wt. of fresh leaves}} \times 100$$

The data were analyzed for analysis of

variance to determine the significance of treatments. The means were compared by Duncan's Multiple Range Test at P = 0.05. The data on various physio-morphic plant characters were correlated with the jassid population data. Multivariate regression models, by steps, were developed between pest-population and various physio-morphic plant factors**.** Simple correlation was worked out, between the population and physio-morphic factors individually and cumulatively, by using a Multiple Linear Regression Equation of the Type 1, *viz*., = a + b1x1+ X b2x2 X b3x3 X b4x4……………….. where population of jassids was taken as the Response Variables (Y) and the X represent the physical factors in the equation. The data were analyzed on an IBM-PC Computer, using M. Stat (Steel *et al*., 1997) Package.

Table I.- **Means comparison of the data regarding per leaf population of jassid on selected genotypes of Okra at different dates of observation during 2007.**

Genotypes	Means
Dera local	4.73 a
Pusa swani	4.65 a
Okra-3	3.42 b
Sabz pari	2.86 c
Karam-5	2.80 cd
Clean spineless	2.76 d
Makhmali	1.54 e
Green wonder	1.26 f
Punjab selection	1.25 f

Means sharing similar letters are not significantly different by DMR.
Test at P = 0.05
LSD value= 0.09068

RESULTS

Table I shows per leaf population of jassid on selected genotypes of okra during 2007. The data regarding various physio-morphic plant characters were subjected to correlation coefficient values and multiple linear regression models to determine the impact of these factors on the population fluctuations of jassids on the okra crop (Table II). In the present study, hair-density and length of hair on the midrib veins and lamina of upper, middle and bottom leaves, leaf area, moisture percentage and thickness of the leaf lamina on upper, middle and bottom leaves, plant-height and number of primary branches, showed a significant differences among genotypes. In the present studies, the hair-density on midrib, veins and lamina of the upper, middle and bottom leaves, showed a significant negative correlation with the population of jassids on okra. Similarly, the hair-length on the midrib of middle-leaves and on the veins of middle leaves, plant-height and number of primary branches also showed a negative and significant correlation with the pest population. The moisture contents in the middle leaves and leaf area in lower leaves, however, showed a positive and significant correlation. Hair-density on the midrib of upper leaves, showed maximum role in the population fluctuations of the pest, followed by the hair-density on the midrib of lower leaves and hair-density on the lamina of lower leaves. All these factors had significantly negative impact on the pest population. Furthermore all the physio-morphic plant characters contributed 96.2% in the population fluctuations of the pest, when computed together. Keeping in view the above results, it was evident that hair-density was found to be the most important factor which played an important role in imparting resistance to the jassids in okra and the length of hair on midrib, vein and lamina showed a non-significant correlation with the jassid-population, except the length of hair on midrib and vein of middle leaves, which had a negative and significant correlation with it.

In the present study, thickness of the leaf lamina did not show a significant correlation with the jassid-population and considered it not to be an important plant factor, while the number of primary branches showed a significant difference among genotypes. The percent role of various physio-morphic plant characters, individually and in the form of multiple linear regression equations, on the population fluctuations of jassid on okra crop was determined. The results are presented in Table III. It is evident from the results that the hair density on the midrib of upper leaves was found to have a maximum role in population fluctuations of the pest and appeared to be the most important physio-morphic plant character. The second most important physio-morphic plant character was found to be the hair-density on the midrib of lower leaves. The

Table II.- The correlation between jassid population, per leaf and the physical plant characters of various selected genotypes, of Okra, (*Abelmoschus esculentus* L.)

Physical plant characters		Per leaf jassid population (Correlation)	Covariance	Standard Error
Hair density on midrib (cm)	Upper leaves	-0.729 **	-0.24	0.355
	Middle leaves	-0.427 *	-0.11	0.358
	Lower leaves	-0.750 **	-0.22	0.316
Hair density on vein (cm)	Upper leaves	-0.663 **	-0.22	0.402
	Middle leaves	-0.545 **	-0.10	0.244
	Lower leaves	-0.582 **	-0.16	0.361
Hair density on lamina (cm^2)	Upper leaves	-0.614 **	-0.43	0.889
	Middle leaves	-0.519 **	-0.23	0.617
	Lower leaves	-0.504 **	-0.24	0.647
Length of hair on midrib (µm)	Upper leaves	-0.300 ns	-0.04	0.227
	Middle leaves	-0.649 **	-0.12	0.222
	Lower leaves	-0.131 ns	-0.02	0.263
Length of hair on Vein (µm)	Upper leaves	-0.311 ns	-0.05	0.243
	Middle leaves	-0.440 *	-0.07	0.222
	Lower leaves	-0.168 ns	-0.04	0.379
Length of hair on Lamina (µm)	Upper leaves	-0.134 ns	-0.02	0.24
	Middle leaves	0.169 ns	0.03	0.274
	Lower leaves	-0.212 ns	-0.04	2.282
Moisture contents (%)	Upper leaves	0.187 ns	0.00	0.026
	Middle leaves	0.649 **	0.02	0.042
	Lower leaves	0.278 ns	0.01	0.056
Thickness of lamina (µm)	Upper leaves	0.259 ns	0.02	0.128
	Middle leaves	0.290 ns	0.02	0.115
	Lower leaves	0.187 ns	0.01	0.088
Leaves area (cm^2)	Upper leaves	0.265 ns	0.04	0.248
	Middle leaves	-0.292 ns	-0.09	0.463
	Lower leaves	0.553 **	0.22	0.523
Plant height (cm)		-0.483**	-0.12	0.335
Number of primary branches		-0.474**	-0.01	0.041

*Significant at $P \leq 0.05$; **Significant at $P \leq 0.01$; ns, Non- Significant.

response of this character was negative and significant. The hair-density on the lower leaves of lamina appeared to be the third important physio-morphic plant character and had a negative significant impact. Furthermore the R^2 value was calculated to be 0.962, when all the factors were computed together.

DISCUSSION

The present findings cannot be compared with those of Uthamasamy (1980), who studied ovipositional preference of *Amrasca devastans*, due to hairiness on the leaf-lamina and midrib of different varieties of okra. The present findings are in conformity with those of Mahal *et al*. (1993), Taylo and Bernardo (1995), while partially coincided with the finding of the Lokesh and Singh (2005), who reported that the impact of trichomes-density on the main and lateral veins, in relation to oviposition was negative and significant. Similarly, Singh (1988), found a significant and negative correlation between the incidence of jassids and the hair-length on the lower leave surface, but in the present study hair-length on the midrib of middle leaves and on veins of middle leaves showed a negative and significant correlation which coincides with the results of Singh (1988), who did not mention the specific site of observation. According to Lal *et al*. (1997) the relationship between length of hair and the size of nymphal population, their damage and susceptibility indices, was adverse and significant but of a low magnitude. Similar findings were also, in partially observed in the present study

Table III.- Multivariate linear regression models, along-with coefficients of determination (R^2), between the jassid population per leaf, and various morpho-physical plant factors.

Regression Equation	R^2	100 R^2	Role of individual factor (%)
** Y= 3.377788 – **0.28118 X1	0.531	53.1	53.1
** Y= 3.481406 – **0.26095 X_1 – 0.57002 X_2	0.541	54.1	1.0
** Y= 3.161815 – **0.17526 X_1 + 0.49235 X_2 – ** 0.22405 X_3	0.692	69.2	15.1
** Y= 3.108114 – 0.11522 X_1 + 0.67186 X_2 – **0.23502 X_3 – 0.63075 X_4	0.695	69.5	0.3
** Y= 3.379206 – 0.17075 X_1 + 0.11308 X_2 – **0.23670 X_3 – 0.13488 X_4 – 0.15834 X_5	0.727	72.7	3.2
** Y= 3.255277 – 0.73664 X_1 + 0.16598 X_2 – **0.23156 X_3 – 0.13046 X_4 – 0.13507 X_5 – 0.11293 X_6	0.762	76.2	3.5
** Y= 2.2807345 – 0.44499 X_1 + 0.10463 X_2 – **0.43205 X_3 – 0.23421 X_4 + 0.92689 X_5 – **0.17475 X_6 + *0.15018 X_7	0.821	82.1	5.9
** Y= 2.682599 – 0.16164 X_1 + 0.11958 X_2 – **0.45353 X_3 – 0.26049 X_4 + 0.99732 X_5 – *0.18372 X_6 + *0.14782 X_7 + 0.17316 X_8	0.822	82.2	0.1
** Y= 3.123034 + 0.14976 X_1 + 0.26679 X_2 – **0.39346 X_3 – 0.21410 X_4 + 0.11723 X_5 – **0.38963 X_6 + 0.62421 X_7 – 0.24424 X_8 – ** 0.30581 X_9	0.894	89.4	7.2
** Y= 3.761712 – 0.24832 X_1 – 0.78562 X_2 – **0.34465 X_3 – 0.14670 X_4 + 0.13156 X_5 – **0.38881 X_6 + 0.56051 X_7 – 0.56051 X_8 + **26971 X_9 – 0.16768 X_{10}	0.907	90.7	1.3
** Y= 3.871019 – 0.15595 X_1 + 0.30412 X_2 – **0.36060 X_3 – 0.18354 X_4 + 0.11685 X_5 – **0.37556 X_6 + 0.37853 X_7 – 0.76454 X_8 + ** 0.22310 X_9 – 0.29797 X_{10} – *0.17180 X_{11}	0.93	93.0	2.3
** Y= 10.196991 – 0.42577 X_1 + 0.11684 X_2 – **0.35447 X_3 – 0.15781 X_4 + 0.17511 X_5 – **0.38495 X_6 –0.35153 X_7 – 0.32679 X_8 + * 0.25007 X_9 – 0.96900 X_{10} – *0.18217 X_{11} – 0.65419 X_{12}	0.93	93.0	0.0
** Y= 13.460778 + 0.13710 X_1 – 0.75813 X_2 – **0.25061 X_3 – *0.26995 X_4 – 0.10107 X_5 – 0.16720 X_6 – 0.88977 X_7 – 0.10827 X_8 + **0.28927 X_9 + 0.29336 X_{10} – **0.18483 X_{11} – 1.2506 X_{12} + **0.17125 X_{13}	0.959	95.9	2.9
** Y= 7.121338 + 0.81640 X_1 – 0.53233 X_2 – 0.17370 X_3 – **0.29094 X_4 – 0.40131 X_5 – 0.16644 X_6 – 0.96239 X_7 – 0.19026 X_8 + ** 0.27530 X_9 + 0.30760 X_{10} – **0.19447 X_{11} – 0.61245 X_{12} + **0.16549 X_{13} + 0.11836 X_{14}	0.96	96.0	0.1
** Y= 3.129615 + 0.47179 X_1 – 0.14122 X_2 – 0.17495 X_3 – *0.27776 X_4 – 0.64529 X_5 – 0.15919 X_6 – 0.85040 X_7 – 0.69237 X_8 + *0.23892 X_9 + 0.49555 X_{10} – *0.20740 X_{11} – 0.13512 X_{12} + 0.13861 X_{13} + 0.18147 X_{14} – 0.45275 X_{15}	0.962	96.2	0.2

Where *, Significant at $P \leq 0.05$; **, Significant at $P \leq 0.01$.
Y = per leaves jassid population

X_1= Hair density on midrib of upper leaves (cm)
X_2 = Hair density on midrib of middle leaves (cm)
X_3 = Hair density on midrib of lower leaves (cm)
X_4 = Hair density on vein of upper leaves (cm)
X_5 = Hair density on vein of middle leaves (cm)
X_6 = Hair density on vein of lower leaves (cm)
X_7 = Lamina hair density on upper leaves (cm^2)
X_8 = Lamina hair density on middle leaves (cm^2)
X_9 = Lamina hair density on lower leaves (cm^2)
X_{10}=Hair length on midrib of middle leaves (µm)
X_{11}=Hair length on vein of middle leaves (µm)
X_{12}= Middle leaves moisture contents (%)
X_{13}= Lower leaves area (cm^2)
X_{14}= Plant height (cm)
X_{15} = Number of primary branches

that the length of hair had a negative correlation with the population of jassids at a low magnitude.

The present findings are not in conformity with those of Sikka *et al.* (1966) who reported that the length of hair was the most important factor followed by the hair-density on the cotton leaves, not on okra. In the present study the trichome density was found to be the most important character, which showed a significant and negative correlation with the pest-population whereas the length of hair generally was not so important. The present findings can, partially be compared with those of Uthamasamy (1985), who came to the conclusion that the number and length of hair rather than their density influenced the pest resistance, but also found that the resistant varieties had more hairs than the susceptible ones. Similarly, Taylo and Bernardo (1995), who also reported a negative and significant correlation between the jassid-population and density and length of trichomes.

The present findings can be, partially, compared with those of Taylo and Bernardo (1995), who found that the leaf thickness and number of primary branches did not differ significantly in resistant and susceptible okra varieties. In the present study the moisture contents in the middle leaves showed a positive and significant correlation, while in the upper and lower leaves showed a non-significant correlation and can be, partially, compared with the finding of Singh (1988), who reported that there was a positive correlation of moisture contents with the incidence of *A. biguttula biguttula*. From these results, it was concluded that resistance/susceptibility is governed by a combination of various factors rather than only from a single factor.

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