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Association of Chemical Components of Okra with its Resistance Against *Amrasca biguttula biguttula* (Ishida)

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Abstract.- The current study was conducted on nine selected genotypes of okra to determine the role of chemical components of plant on population of jassid. Crude protein, nitrogen, lignin, reducing sugar, phosphorus and copper showed positive correlation whereas neutral detergent fiber, acid detergent fiber, cellulose, silica, total ether, non reducing sugars, total sugars, calcium and magnesium had negative correlation with the population of jassid on okra. Crude protein showed the positive and significant impact (69%) on the jassid population fluctuation on okra which was followed by neutral detergent fibre with 21% contribution. When computed together, all the chemical components showed 99.7% role on jassid population fluctuation.

Key Words: Okra genotypes, jassid, chemical plant characters.

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Monech, is most important traditional vegetable of Pakistan and is susceptible to a large variety of pests that hamper its marketable fruit yield. *Amrasca biguttula biguttula* is one of the most important sucking insects that attack okra crop (Singh *et al*., 1993; Dhandapani *et al*., 2003). Okra received the maximum number of eggs of leaf hopper and is most suitable host in nymph survival and feeding (Bernardo and Taylo, 1990; Sharma and Singh, 2002). Among environmental friendly methods for pest management, host plant resistance is considered the most cost-effective and environmentally safe method for pest control. Unfortunately, little attention has been paid to factors responsible for resistance or susceptibility of okra crop to jassids. The factors affecting the oviposition are important components in searching source of resistance to a particular insect pest. *A. biguttula biguttula* preference for oviposition varies among different varieties of okra. Certain genotypes, inspite of being less hairy are resistant to jassids (Singh *et al.,* 1972), perhaps because of the presence of some biochemical compounds in the leaves of host plants (Uthamasamy *et al.,* 1971; Singh *et al.,* 1972). According to Barroga and Bernado (1993), the cause of death of jassids on the resistant varieties may largely be due to the nutrient deficiency, rather than the presence of toxic materials in the plants. Singh *et al.* (1972) concluded that the higher contents of mineral especially silicon, iron and magnesium in resistant strain increase the osmotic pressure of the cell sap thereby adversely affecting the feeding ability of jassids. Based on the facts mentioned above, the present project was initiated to relate chemical components of okra genotypes having different degrees of resistance and susceptibility, with the population of jassids.

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MATERIALS AND METHODS

Nine local genotypes of okra *viz.*, 3 genotypes (Pusa sawani, Dera local and Okra-3) showing susceptibility to jassids, three intermediate varieties (Karam-5, Sabz pari and Clean spineless) and three resistant varieties (Makhmali, Punjab selection and Green wonder) against jassid were sown on 31st March, 2007 in the experimental area of the Post Graduate Agricultural Research Station (PARS), following Completely Randomized Block Design with three replications. No plant protection measures were applied for the control of jassid. 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 plants 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, 15 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 into 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 chemical components of plant were studied at the crop maturity when the plants were green. Green fresh leaves (500 g) of each selected variety of okra were taken from the top (leaves of 5 to 7 days age) and middle+bottom (full-grown leaves) parts of the plants from each plot, washed with distilled water and dried under-shade, followed by drying at 100±5ºC in an oven for 12 hours. The dried material was cut into pieces, ground and passed through a sieve of 1.0 mm mesh. The samples were stored in dry polythene bags for chemical analyses. Crude protein and nitrogen percentage were determined by Kjeldahl method (Winkleman *et al*., 1986), while potassium was determined by a flame photometer, Model Jenway PFP-7 according to Page *et al*. (1982). Phosphorous concentration in plant samples was estimated using vanadate-molybdate UV-visible spectrophotometer **(**Chapmann and Pratt, 1961). Cupper, zinc, manganese, magnesium, iron and calcium in okra leaves were determined by the method described by AOAC (1990). The data were analyzed by ANOVA to determine the significant differences among treatments. Then means were compared by Duncan's Multiple Range Test at P = 0.05. The data on various biochemical plant factors were correlated with the jassid population data. Multivariate regression models, by steps, were developed between pest-population and various biochemical plant factors**.** The data were transformed into square roots before proceeding with the analysis. Simple correlation was worked out, between the population and chemical 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 chemical factors in the equation. The data were analyzed using M. Stat Package (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Table I showed means of population of jassid per leaf on selected genotypes of okra at different dates of observation during 2007. Various chemical plant characters, such as, crude-protein, nitrogen, neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, hemi-cellulose, silica, lignin, ash, total ether, reducing sugars, potassium, calcium, phosphorus, magnesium, copper, zinc, manganese and iron were correlated with the population fluctuations of jassid on okra. The correlation coefficient values between jassid-population per leaf and chemical plant characters in okra leaves are given in Table II. The effect of crude protein, nitrogen, reducing sugars, lignin, phosphorous and copper in the leaves of okra plants was positively correlated with correlation coefficient values of 0.831**, 0.833**, 0.406*, 0.572**, 0.511** and 0.578**, respectively; whereas those of the NDF, ADF, cellulose, silica, total either, non-reducing sugar, total sugars, calcium, and magnesium were seen to have a negative effect on the jassids populations per leaf on okra with correlation coefficient values of 0.488**, 0.487**, 0.479**, 0.833**, 0.512**, 0.931**, 0.923**, 0.863**, and 0.831**, respectively. There was no significant correlation among Hemi-cellulose, ash contents, potassium, zinc, manganese and iron, and jassids population on okra. In the present study, crude-proteins and nitrogen showed a positive and significant correlation with the population of jassid in okra. In other words, it showed that higher contents of protein and nitrogen resulted in a higher population of jassids on okra, and vice versa. The present findings are in conformity with those of Uthamasamy (1980) who reported that an inadequate concentration of amino acids played an important role in the poor multiplication of *A. devastans*. Similar observation regarding the minerals were also observed by the same scientist, whereas in the present studies various minerals, showed different responses towards the population fluctuations of the pest. Conclusively, the difference

Table I.- Means of jassid population per leaf 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

Similar letters are not significantly different by DMR Test at P = 0.05

Table II. Correlation coefficient values between jassid population, per leaf and the bio-chemical plant factors, of various selected genotypes, of okra, (*Abelmoschus esculentus* L.)

Chemical plant factors	Jassid population period
Crude protein (%)	0.831 **
Nitrogen (%)	0.833 **
Neutral detergent fiber (%)	-0.448 **
Acid detergent fiber (%)	-0.487 **
Cellulose (%)	-0.479 **
Hemi-cellulose (%)	0.012 ns
Silica (%)	-0.833 **
Lignin (%)	0.572 **
Ash (%)	0.218 ns
Total Ether (%)	-0.512 **
Reducing sugars (%)	0.406 *
Non reducing sugars (%)	-0.931 **
Total sugars (%)	-0.923 **
Potassium (ppm)	-0.187 ns
Calcium (ppm)	-0.863 **
Phosphorus (ppm)	0.511 **
Magnesium (ppm)	-0.831 **
Copper (ppm)	0.578 **
Zinc (ppm)	0.023 ns
Manganese (ppm)	-0.080 ns
Iron	-0.331 ns

Where:
* = Significant at $P \leq 0.05$
** = Significant at $P \leq 0.01$
ns = Non- Significant

in organic acid contents was related to the difference in the pest feeding preferences. Similar observations were also recorded in the present study. The present findings are not in corresponding with those of Singh (1988a), who reported that the affects of protein was less significant on the incidence of *A. biguttula biguttula* on okra. Furthermore, Singh and Agarwal (1988b) reported that highly susceptible genotypes contained significantly higher amount of proteins, as compared to the resistant genotypes. These findings are in conformity with the present results in which proteins showed a positive and significant correlation with the jassid-population; on okra. Similar findings were also observed by Singh and Taneja (1989), who reported a positive correlation between the protein contents and survival as well as oviposition of jassids. The present findings are also in agreement with those of Balasubramanian and Gopalan (1981), who reported lesser amounts of reducing sugar in the susceptible variety as compared to that in the resistant ones. The result of Singh and Agarwal (1988b) showed the negative correlation among the incidence of *A. biguttula biguttula* and the amount of total sugars and non-reducing sugars, in the leaves of resistance genotypes. The present findings are partially in conformity where reducing sugars, showed a positive and significant correlation, while non-reducing sugar exerted a significant and negative correlation with the jassid-population. In the present findings silica had a negative and significant effect on the jassid population and is in conformity with those of Singh (1988a), who negatively correlated the incidence of *A. biguttula biguttula* with silica in the leaves of resistant genotypes.

The role of various chemical plant characters which showed a significant correlation with the population of jassid on okra was determined through a Linear Multiple Regression Analysis and through the coefficient of determination (R^2) values. It is evident from the results (Table III) that crude-protein percentage in the leaves of okra showed maximum contribution towards the population fluctuations of the pest followed by that of NDF. The contribution of all the other factors, when assessed individually ranged from 0.00 to 2.20% towards the population fluctuations of the pest. Therefore, these results showed that the crude proteins and NDF were the most important factors affecting on jassid population fluctuations and both of them showed significant impact with positive and negative response, respectively. The 100 R^2 value

Table III.- Multivariate linear regression models, along-with the co-efficient of determination (R^2) between the jassid population per leaf and various biochemical plant characters.

Regression equation	R^2	100 R^2	Role of individual factor (%)
** $Y = -4.617223 + {**}1.6136\ X1$	0.690	69.0	69.0
$Y = -7.158002 - 2.1543\ X_1 + 0.10192\ X_2$	0.695	69.5	0.5
** $Y = -2.222774 + 0.24622\ X_1 + 3.7415\ X_2 - {**}\ 0.69241\ X_3$	0.905	90.5	21
** $Y = -2.720323 - 0.59358\ X_1 + 5.9475\ X_2 - {**}\ 0.60484\ X_3 - 0.98112\ X_4$	0.908	90.8	0.3
** $Y = -1.161635 + 1.2704\ X_1 + 1.1165\ X_2 - {**}\ 0.80680\ X_3 - {*}\ 0.37295\ X_4 + {*}\ 0.40787\ X_5$	0.929	92.9	2.1
** $Y = -2.142919 - 2.8837\ X_1 + 0.11636\ X_2 - {**}\ 0.87092\ X_3 - 0.16902\ X_4 + 0.24158\ X_5 - {*}0.18271\ X_6$	0.946	94.6	1.7
** $Y = 0.345755 - 1.8238\ X_1 + 7.8634\ X_2 - {**}\ 0.80860\ X_3 - 0.12904\ X_4 + 0.15393\ X_5 - {**}\ 0.20820\ X_6 - 0.53264\ X_7$	0.952	95.2	0.6
** $Y = 2.709061 - 2.3839\ X_1 + 9.0913\ X_2 - {**}\ 0.95347\ X_3 - 0.12264\ X_4 + 0.15301\ X_5 - {**}\ 0.32294\ X_6 - {**}0.75558\ X_7 - {**}\ 0.28509\ X_8$	0.974	97.4	2.2
** $Y = 3.068239 - 0.76758\ X_1 + 4.3484\ X_2 - {**}\ 0.88880\ X_3 - 0.96920\ X_4 + 0.13407\ X_5 - {**}\ 0.33594\ X_6 - {**}\ 0.74229\ X_7 - {**}\ 0.21439\ X_8 + 0.90213\ X_9$	0.978	97.8	0.4
** $Y = 2.788685 - 1.3365\ X_1 + 5.0507\ X_2 - {**}\ 0.38220\ X_3 - {**}\ 0.19542\ X_4 - 0.91989\ X_5 - {**}\ 0.11180\ X_6 - 0.19573\ X_7 - {**}0.24508\ X_8 + {**}\ 0.69078\ X_9 - {**}\ 0.53040\ X_{10}$	0.996	99.6	1.8
** $Y = 2.5651127 - 1.3735\ X_1 + 5.3248\ X_2 - {**}\ 0.37247\ X_3 - {**}\ 0.24516\ X_4 - 0.65043\ X_5 - 0.90381\ X_6 - 0.13384\ X_7 - {**}\ 0.23104\ X_8 + 0.20196\ X_9 - 1.5175\ X_{10} + 1.0560\ X_{11}$	0.996	99.6	0.00
** $Y = 3.633526 - 1.3652\ X_1 + 5.3534\ X_2 - {**}\ 0.38011\ X_3 - {*}\ 0.21268\ X_4 - 0.73248\ X_5 - 0.49069\ X_6 + 0.13305\ X_7 - {**}\ 0.22255\ X_8 - 0.46989\ X_9 - 0.23534\ X_{10} + 1.9485\ X_{11} - 0.98669\ X_{12}$	0.997	99.7	0.1
** $Y = 3.755335 - 1.3297\ X_1 + 5.1981\ X_2 - {**}\ 0.36956\ X_3 - 0.20084\ X_4 - 0.78163\ X_5 - 0.41097 + 0.23573\ X_7 - {**}\ 0.21482\ X_8 - 0.41667\ X_9 - 2.2851\ X_{10} + 1.8696\ X_{11} - 0.98667\ X_1 - 0.15299\ X_{13}$	0.997	99.7	0.0
** $Y = 3.683934 - 1.10342\ X_1 + 4.3397\ X_2 - {**}\ 0.34922\ X_3 - 0.18447\ X_4 - 0.10101\ X_5 - 0.39628\ X_6 - 0.30109\ X_7 - {**}\ 0.21227\ X_8 - 0.4044\ X_9 - 2.3629\ X_{10} + 1.9565\ X_{11} - 1.0178\ X_{12} - 0.79486\ X_{13} + 0.2525\ X_{14}$	0.997	99.7	0.0
** $Y = 3.848864 - 0.80258\ X_1 + 3.7440\ X_2 - {**}\ 0.34735\ X_3 - 0.17683\ X_4 - 0.10790\ X_5 - 0.38438\ X_6 - 0.62840\ X_7 - {**}\ 0.23958\ X_8 - 0.45338\ X_9 - 2.1240\ X_{10} + 1.7362X_{11} - 1.0258\ X_{12} - 0.16576\ X_{13} + 0.38188\ X_{14} + 0.21047\ X_{15}$	0.997	99.7	0.0

*, Significant at $P \leq 0.05$; **, Significant at $P \leq 0.01$.
Y, per leaves jassid population; X_1, crude protein (%); X_2, nitrogen (%); X_3, NDF (neutral detergent fiber) (%); X_4, ADF (acid detergent fiber) (%); X_5, cellulose (%); X_6, ether (%); X_7, silica (%); X_8, lignin (%); X_9, reducing sugar (%); X_{10}, non reducing sugar; X_{11}, total sugar; X_{12}, calcium; X_{13}, magnesium (ppm); X_{14}, phosphorous (ppm); X_{15}, copper (ppm).

was obtained to be 99.70, when the effect of all the factors were computed together. Reducing Sugars, Magnesium, Phosphorus and Copper showed zero percent impact on the fluctuations of jassid-population. The results (Table IV) regarding fruit yield of various selected genotypes of okra revealed highly significant differences among the genotypes. The means were compared by a DMR test (P=0.05). The genotype Punjab selection achieved the highest fruit yield, while the genotype Dera local has the lowest fruit yield. Correlation coefficient between the population of jassid per leaf and yield per plot was calculated to be 0.914, which was negative and highly significant.

Table IV.- Mean of yield of selected genotypes of okra, (*Abelmoschus esculentus* l.)

Genotypes	Yields
Green wonder	41.25 b
Punjab selection	43.49 a
Makhmali	40.93 c
Clean spineless	35.25 f
Sabz pari	38.39 d
Karam-5	36.49 e
Okra -3	31.97 g
Dera local	23.75 i
Pusa swani	31.03 h
LSD at 5%	0.9208

Similar letters are not significantly different by DMT Test.
r-value between population of jassid per leaf and yield per plot = -0.914**
** = Significant at ≤ 0.05

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