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Evaluation of Biophysical and Biochemical Parameters of Okra Genotypes for Resistance against jassid, *Amrasca biguttula biguttula* (Ishida)

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ABSTRACT: The study was conducted on twenty selected genotypes of okra to evaluate the role of biophysical and biochemical parameters imparting resistance or susceptibility to jassid [(*Amrasca biguttula biguttula)* (Ishida)] Leafhopper is a sucking insect pest which causes hopper burn symptom that can reduce productivity of the crop. The biophysical characters *viz*., trichome density on vein, leaf lamina and midrib of different okra genotypes are associated with infestation of leafhopper ranged as 7 to 15, 7.9 to 15.1 and 6.5 to 12.7, respectively. The highest phenol content (1.57 mg/gm) and lowest percentage of total soluble sugar content (2.36%) was recorded in the genotype, PDKV Pragati while, minimum phenol content (0.87 mg/gm) and highest total soluble sugar content was observed in the genotype, Korchi x Phule (5.21%). The biophysical characters of okra genotypes exhibited significant influence on infestation of leafhoppers. The plant characters *viz*., trichome density on vein (r = -0.97), leaf lamina (r = -0.93) and midrib (r = -0.98) were negatively correlated with resistance to leafhopper infestation. The biochemical constituent total soluble sugar (0.964) was positively correlated while phenol content (r = -0.83) showed negative correlation with leafhopper population. The okra genotypes, PDKV Pragati, Arka Anamika, Parbhani Kranti and Akola Bahar were found to be resistant, while Korchi x Phule and Vijayalaxmi were categorized as susceptible. Thus, the genotypes which are resistant can be used as a source for breeding of okra against *Amrasca biguttula biguttula.*

Keyword: Okra, *Amrasca biguttula biguttula*, Biophysical parameter, Biochemical parameters, correlation coefficient, correlation matrix.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) also known as lady's fingerplays important role in human diet and is a good source of vit-A, B and C and also rich in protein, minerals and iodine. Among many factors responsible for low production in okra, incidence of insect pests is one of the prime factors (Barman *et al.,* 2022). Okra is attacked by numerous insect pests amongst which the leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) is one of the major concern on this crop and cause severe damage (Singh and Joshi 2004). Leafhopper is a sucking insect pest both nymph and adults of jassid devitalize the plant by direct feeding on the phloem sap from lower surface of leaves and inject the toxic saliva into upward curling of leaves and cause typical symptoms known as "Hopper burn" which cause yellowing, browning, bronzing, upward cupping, withering and complete defoliation and has become one of the major limiting factors in economic productivity of the crop. (Barman *et al.,* 2022). Leafhopper alone had caused 59.79 per cent losses in okra fruit yield (Atwal and Singh, 1990). The losses in yield up to 35-40% was reported by (Sultana *et al.,* 2017). At present, Chemical tactics effectively controls insect pests, which leads to increase in cost of production. (Kavitha and Reddy, 2012). Excessive dependance on insecticides for management of this pests has resulted in control failures at field level. Other detrimental effect like pesticide contamination, resurgence of secondary pests, Insecticide resistance and various undesirable effects of the operators, consumers and natural enemies is still a lingering problem in the Indian subcontinent. Plants because of their sessile nature, always encounter diverse environmental challenges including attack by a large number of insect pests and pathogens, when grown in the natural environment. In general, plant-insect interaction is a complex process involving physical and chemical interaction and governed by plant, insect, plant–insect factors. A systematic evaluation of insect-plant interaction demonstrated the role of several classes of either preformed or induced secondary compounds such as phenolic compounds, cyanogenic glycosides, glucosinolates (Kumar *et al.,* 2017). Some physio-chemical characters that induce resistance against pests of okra have also been determined through correlation studies (Seth *et al.,* 2016). Therefore, alternative methods must be designed, and Host Plant resistance is an ideal prevention against insect damage, involved lower cost of production and are eco-friendly in nature. This study analyses the biophysical and biochemical traits of okra genotypes with differing degree of resistance or susceptibility against *Amrasca biguttula biguttula*. The study of correlation will help in identifying the traits which have strong association with yield and correlation matrix shows the level of significance among the traits.

MATERIAL AND METHODS

The present investigation was carried out at the experimental field of Centre for Organic Agriculture Research and Training, Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2022-23. This research Centre located in the subtropical region at 77”30’ to 77”35’E Longitude, 21”18’ to 21”30’ N latitude and 1297 feet above mean sea level. This place comes under semiarid tropical agro-climatic zone with annual rainfall 1250 mm with black cotton soil. The experiment was laid out in randomized block design (RBD) with 20 treatments and two replications with plot size of 4.5m x 1.2m. The treatments comprised of 20 okra genotypes namely, IC 42451, IC 42456, Akola-Bahar, EC 329386, Ankur – 40, Arka Abhay, EC 329384, Parbhani Kranti, Arka Anamika, PDKV Pragati, Varsha Uphar, Kokan Bhendi, Korchi, Phule Vimukta, EC 329395, Akola – 1, Korchi x Phule, Vijayalaxmi, Akola – 2 and Akola – 3. Sowing was done in the last week of July at a spacing 45 x 60 cm, and package of practices of okra were followed as per university recommendation. Weekly observations on leafhopper nymphs and adults were recorded on five selected plants from each replication till 63 days after emergence. Biophysical attributes, trichome density of leaf *viz*., leaf lamina, veins and midrib were enumerated under phase contrast microscope by randomly selected three leaves from each okra genotypes. Trichome density on different okra genotypes was estimated by adopting the method suggested by Maite *et al.* (1980). 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. The number of trichomes per square centimeter area was counted under phase contrast 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. In case of biochemical parameters, the uninvested healthy leaves were used for the sample from the plots of selected okra genotypes. The samples of healthy apical shoots were collected. The collected leaves were oven dried; each sample was analyzed for total soluble sugar, total phenol and data were correlated with insect pest infesting for their significance. The dried leaves were powdered separately in gridling mill, so as to pass through 60 mesh size sieves. The powered material was used for further estimation. The analysis was undertaken separately by using different methods *viz*., Total Phenol were determined by method of Bray and Thorpe (1954) and total soluble sugar as per Dubois *et al.* (1956). The collected data were subjected to statistical analysis using ANOVA, to know the significance of differences among treatments and LSD (Least Significance Difference) test was employed to compare different treatments for their efficacies against leafhopper. The correlation studies were undertaken to find out the correlation of the morphological as well as biochemical attributes with the leafhopper infestation. The coefficient was worked out by the equation $R = \sum xy / \sqrt{\sum x2 \ x \sum y2}$. The infestation was taken as dependent factor (x) and the morphological and biochemical attributes were taken as independent factor (y). To work out correlation coefficient morphological factors were taken as ‘y’ and leafhopper infestation as ‘x’. In biochemical factors, the different ingredients from the chemical composition of leaf were taken as ‘y’ and the infestation of leafhopper was taken as ‘x’. The correlation co-efficient among all possible character combinations were estimated employing formula given by Al- Jibouri *et al.* (1958) and was carried out to know the significant or non-significant effect of the morphological and biochemical traits on plant yield.

RESULT AND DISCUSSION

Observations on the presence of number of trichomes (microscopic hairs) per cm^2 on the vein, leaf lamina and midrib of different okra genotypes were recorded during 2022-23 (Table 1) and graphically illustrated in figures 1, 2 and 3.

Table 1: Biophysical parameters (trichome density) of different okra genotypes in relation to population of leafhopper.

Genotypes	Trichome Density on Vein per cm^2	Trichome Density on Leaf Lamina /cm^2	Trichome Density on Midrib per cm^2	Mean leafhopper/ 3 leaves/ 5 plants
IC 42451	10.2	13.2	9	4(2.00)
IC 42456	9.5	12.1	8	4.23(2.06)
Akola- Bahar	12.9	14.9	11.5	3.31(1.82)
EC 329386	10.7	13.5	9.7	3.89(1.97)
Ankur- 40	11.7	14.2	10.6	3.61(1.90)
Arka abhay	11.1	13.9	9.9	3.78(1.94)
EC 329384	9.7	11.6	8	4.25(2.06)
Parbhani kranti	13.1	15	12	3.02(1.74)
Arka Anamika	14.2	15.1	12.1	2.92(1.71)
PDKV Pragati	15	15.5	12.7	2.52(1.59)
Varsha uphar	12	14.5	10.9	3.51(1.87)
Kokan bhendi	10.2	12.5	8.9	4.22(2.05)
Korchi	9.2	11	7	4.39(2.10)
Phule Vimukta	8.5	10	6.6	4.56(2.14)
EC 329395	8.8	10.2	6.7	4.54(2.13)
Akola – 1	8.1	8.9	6.6	4.59(2.14)
Korchi x Phule	7	7.9	6.5	4.81(2.19)
Vijayalaxmi	8	8.8	6.5	4.71(2.17)
Akola – 2	10.5	10.6	6.9	4.51(2.12)
Akola – 3	8.6	8.9	6.6	4.58(2.14)
Sem	0.22	0.06	0.06	0.02
CD 5%	0.65	0.18	0.17	0.08
C.V.	9.71	2.45	2.89	1.99

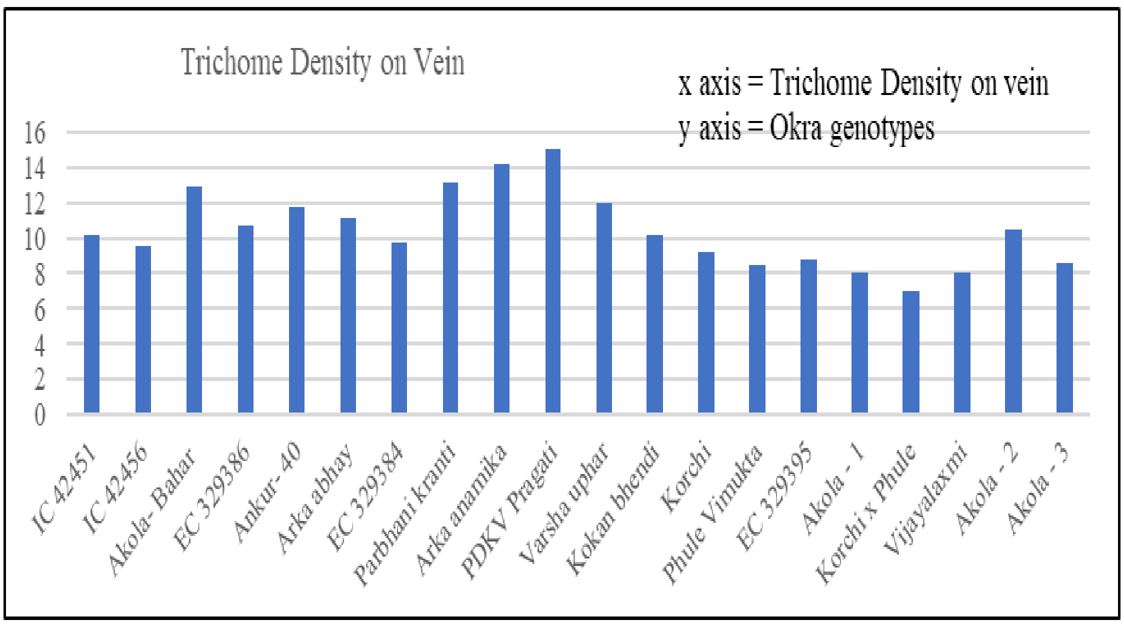

Fig. 1. Trichome density on vein of different genotypes of okra.

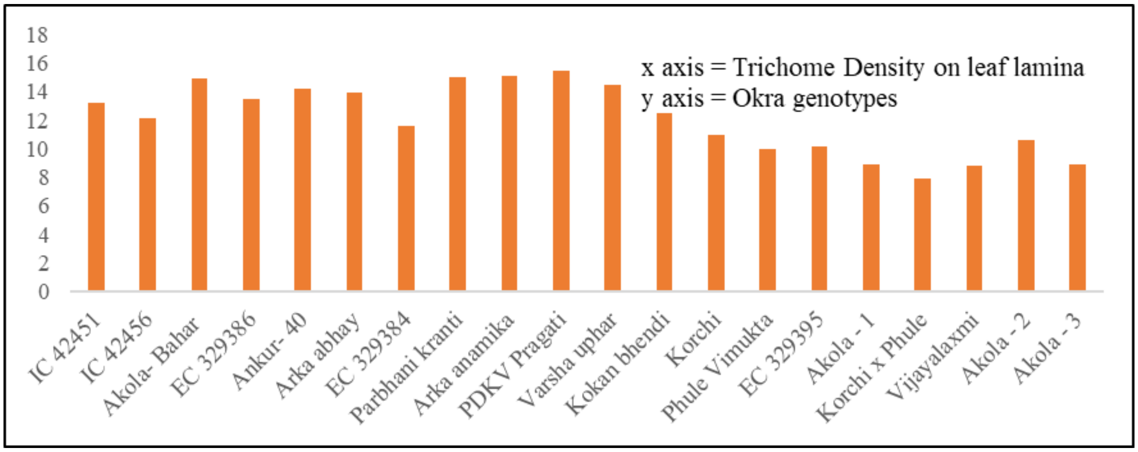

Fig. 2. Trichome density on leaf lamina of different genotypes of okra.

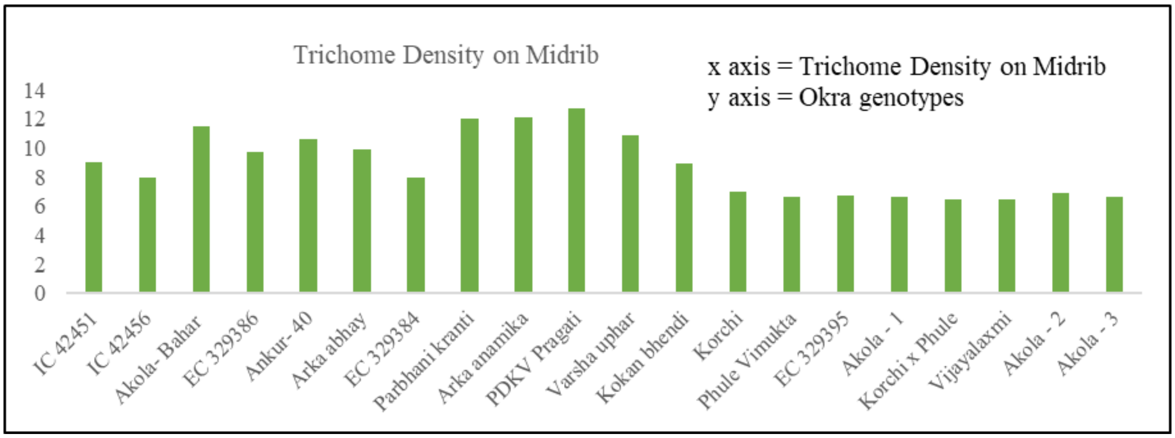

Fig. 3. Trichome density on midrib of different genotypes of okra.

On Vein. The data revealed that the trichome density on the vein ranged from 7 to 15 in different genotypes. The mean trichome density on vein was significantly less in Korchi x Phule genotypes (7 per $cm^{2)}$ and was at par with Vijayalaxmi (8 per cm^2) which had susceptible reaction against leafhopper. Whereas, the maximum trichome density (15 per cm^2) was recorded on genotypes PDKV Pragati which showed resistant reaction against leafhoppers.

On leaf lamina. The mean of trichome density on leaf lamina was noted on different genotypes of okra on which, the minimum trichome density observed on Korchi x Phule (7.9 per cm^2) and was found at par with Vijayalaxmi (8.8 per cm^2), Akola-1 and Akola- 3 (8.9 per cm^2) which had susceptible reaction against leafhopper. Whereas, the maximum mean trichome density (15.5 per cm^2) was recorded on PDKV Pragati and genotypes Arka Anamika, Parbhani Kranti and Akola Bahar with 15.1 per cm^2, 15 per cm^2 and 14.9 per cm^2 trichome density per leaf, respectively and were found statistically at par with each other and shows resistant reaction against leafhopper. The next successive okra genotypes which showed moderate to high trichome were Varsha Uphar, Ankur- 40, Arka Abhay, EC 329386, IC 42451, Kokan Bhendi, IC 42456, EC 329384, Korchi, Akola- 2, EC329395 and Phule Vimukta which recorded 14.5, 14.2, 13.9, 13.5,13.2, 12.5, 12.1, 11.6, 11, 10.6 and 10 trichome density per cm^2 respectively in that order.

On midrib. The mean of trichome density on midrib was noted on different genotypes of okra and it has ranged from 6.5 to 12.7 per cm^2. Maximum mean trichome density (12.7 cm^2) was recorded on PDKV Pragati and genotypes Arka Anamika, Parbhani Kranti and Akola Bahar with 12.1 per cm^2, 12 per cm^2 and 11.5 per cm^2 trichome density per leaf was found statistically at par with each other which showed resistant reaction against leafhopper. The next successive okra genotypes which showed moderate to high trichome were Varsha Uphar, Ankur- 40, Arka Abhay, EC 329386, IC 42451, Kokan Bhendi, IC 42456, EC 329384, Korchi, Akola- 2 and EC329395 which recorded 10.9, 10.6, 9.9, 9.7, 9, 8.9, 8, 7, 6.9 and 6.7, trichome density per cm^2 respectively. The minimum trichome density was observed on Korchi x Phule and Vijayalaxmi (6.5 cm^2) and was found at par with Phule Vimukta and Akola- 1 (6.6) which had susceptible reaction against leafhopper. These results are in conformity and with close harmony with the findings of Hooda *et al.*, (1997), Halder *et al.*, (2016), Nagar *et al.*, (2017), and Kadu (2018) who reported that trichomes play an important role in imparting resistance to leafhopper i.e., higher the trichome density, lower is the leafhopper population.

Biochemical parameters also imparted resistance to *A. biguttula biguttula* on okra. The results on important biochemical constituents in leaves of twenty different okra genotypes influencing relative infestation of leafhopper are analyzed and summarized in Table 1.

Phenol. The total phenol content on dry weight basis in leaves of okra genotypes varied from 0.87 to 1.57 mg/gm (Table 2, Fig. 4). The highest phenol content of 1.57 mg/gm was recorded in the genotypes PDKV Pragati and was found statistically at par with Arka Anamika (1.54 mg/gm) and Parbhani Kranti (1.53 mg/gm). The remaining genotypes occupied intermediate positions for phenol content in okra leaves. However, the minimum phenol content was observed in the genotypes Korchi x Phule (0.87 mg/gm). The data in Table 2 showed that higher the total phenols in the genotypes, the lesser the leafhopper attack. This might be due to the fact that the phenols act as antifeedant to insect herbivores. The findings are in line with Raju and Reddy (1982) who reported a negative and significant correlation of nymphal population of leafhopper in cotton with total phenols. The reports of Tirumala (1984) stated that the total phenols in resistant cotton varieties were more as compared to tolerant or more susceptible varieties. The findings of Gunnaway (1994) also matched the present findings who reported that total phenols were in higher concentrations in less susceptible cotton varieties for sucking pests. Similarly, Hooda *et al.*, (1997) observed that the higher concentration of phenols in the leaves of resistant cultivars were associated with resistance to leafhopper. Similar results were reported by Acharya and Singh (2008), Rohini *et al.*, (2011), Vaishali *et al.* (2012), Mudgalkar *et al.* (2015), Deb *et al.* (2015), Abhang *et al.* (2018), Halder *et al.* (2016).

Total soluble sugar. The total sugar content in different okra genotypes revealed that the quantities of sugar varied from 2.36 to 5.52% (Table 2, Fig. 5). The genotypes Korchi × Phule (5.52%) recorded significantly highest total sugar and found statistically at par with Vijayalaxmi which recorded total sugar content of 5.21%. However, the lowest total sugar content was observed in PDKV Pragati (2.36%) followed by Arka Anamika (2.47%), Parbhani Kranti (2.66%) and Akola Bahar (2.73%). In general, it was observed that resistant genotypes recorded lesser amount of total sugar as compared to susceptible genotypes.

Table 2: Biochemical parameters in different okra genotypes and its correlation with leafhopper.

Genotypes	Phenol Content (mg/gm)	TSS (%)	C.M. leafhopper/ 3 leaves/ 5 plants
IC 42451	1.41	3.95	4(2.00)
IC 42456	1.38	4.12	4.23(2.06)
Akola- Bahar	1.52	2.73	3.31(1.82)
EC 329386	1.42	3.30	3.89(1.97)
Ankur- 40	1.47	3.09	3.61(1.90)
Arka abhay	1.44	3.70	3.78(1.94)
EC 329384	1.35	4.32	4.25(2.06)
Parbhani kranti	1.53	2.66	3.02(1.74)
Arka Anamika	1.54	2.47	2.92(1.71)
PDKV Pragati	1.57	2.36	2.52(1.59)
Varsha uphar	1.48	2.84	3.51(1.87)
Kokan bhendi	1.40	4.01	4.22(2.05)
Korchi	1.33	4.56	4.39(2.10)
Phule Vimukta	1.16	4.85	4.56(2.14)
EC 329395	1.22	4.70	4.54(2.13)
Akola – 1	0.94	5.01	4.59(2.14)
Korchi x Phule	0.87	5.52	4.81(2.19)
Vijayalaxmi- 3	0.94	5.21	4.71(2.17)
Akola – 2	1.28	4.62	4.51(2.12)
Akola – 3	0.99	4.92	4.58(2.14)
Sem	0.03	0.18	0.02
CD 5%	0.09	0.52	0.08
C.V.	3.12	6.29	1.99

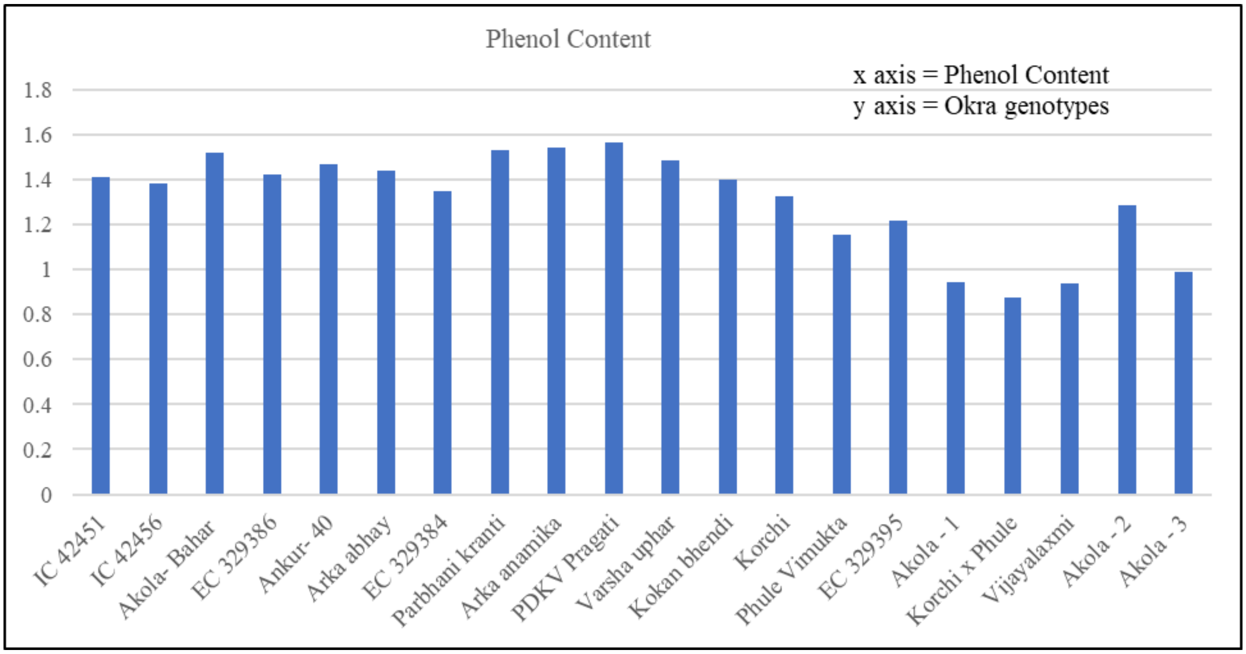

Fig. 4. Biochemical parameter (Phenol content) of different genotypes of okra.

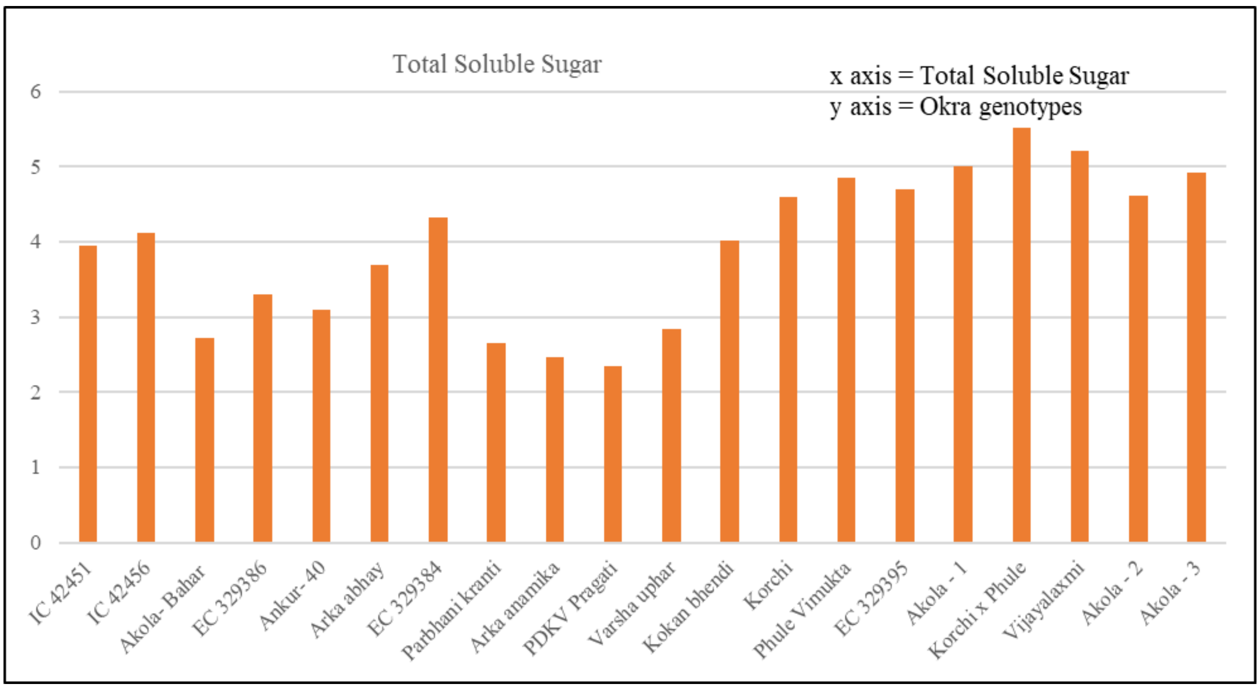

Fig. 5. Biochemical parameter (total soluble sugar) of different genotypes of okra.

This might be due to the fact that high total sugar content act as phago-deterrent to sucking pests. The results are in accordance with the studies of Balasubramanian and Gopalan (1981) and Singh (1988) who reported that the incidence of *A. biguttula biguttula* was negatively correlated with the amount of total sugars in the leaves of resistant cotton and okra genotypes. Present findings are also in conformity with the results of Hooda *et al.*, (1997) who reported that the higher concentration of sugar in the leaves of resistant cultivars were associated with resistance to leafhopper.

Correlation coefficient of biophysical and bio chemical parameters with leafhopper

The values of simple correlation coefficient (r) of different biophysical and biochemical plant characters in relation to infestation of leafhopper are presented in Table 3. There is a significant correlation of all the biophysical and biochemical parameters with leafhopper infestation among which TSS (0.964) showed positive correlation with leafhopper population whereas, the trichome density on vein (r = -0.97), trichome density on leaf lamina (r = - 0.93), trichome density on midrib (r = -0.98) and phenol content (r = - 0.83) showed negative correlation which imparts susceptible and resistant reaction against leafhopper, respectively. There was a negative correlation of trichome density with the leafhopper indicating more the number of trichomes on the vein, leaf lamina and midrib, less is the attack of pests which is in conformity with Anitha and Nandihalli (2008) and Ashfaq *et al.*, (2010) who reported negative correlation of trichome density with the leafhopper population. Phenol content showed negative significant correlation with the jassid incidence as earlier reported by Haldar *et al.*, (2016) as well. The TSS had positive correlation with leafhopper, Similar observation was reported by Pisda *et al.*, (2022) that the leafhopper population had positive correlation with total sugar.

Table 3. Correlation coefficient of different parameters of okra genotypes in relation to infestation of leafhopper.

Parameters	Correlation Coefficient
Trichome density on vein	-0.97
Trichome density on leaf lamina	-0.93
Trichome density on midrib	-0.98
Phenol content	-0.83
Total soluble Sugar	0.965

Correlation matrix for biophysical and biochemical attributes of different okra genotypes in relation to infestation of *A. biguttula biguttula.*

To determine the inter-relationship between plant morphological and biochemical character and leafhopper resistance, the values of simple correlation matrix (r) of different biophysical and biochemical plant characters in relation to infestation of leafhopper are presented in Table 4. The data showed highly significant correlation of all the biophysical and biochemical parameters with the leafhopper infestation. Among all the biophysical and biochemical traits i.e., variables are dependent on each other and showed highly significant reaction among them. The data revealed that as the trichome density on vein increases, the trichome density on different variables like trichome density on leaf lamina (r= 0.930**), trichome density on midrib (r= 0.953**) and phenol content (r= 0.870**) also increases that means it showed direct positive correlation with each other. Whereas, the trichome density on vein increases with decrease in the total soluble sugar (r= -0.961 **) revealing that, it had negative correlation between them. Phenol content showed highly negative correlation with total soluble sugar (r= -0.902 **) means as the phenol content in okra genotypes increases the total soluble sugar gets decreased, they are dependent on each other but showed negative significance among them.

Table 4: Correlation matrix of different variables of okra genotypes.

	Trichome Density on Vein	Trichome Density on Leaf Lamina	Trichome Density on Midrib	Phenol Content	TSS
Trichome Density on Vein					
Trichome Density on Leaf Lamina	0.930**				
Trichome Density on Midrib	0.953**	0.956**			
Phenol Content	0.870**	0.959**	0.851**		
TSS	-0.961**	-0.975**	-0.981**	-0.902**	

r = 0.444 at 5%, r = 0.567 at 1%, ** = level of significance

CONCLUSION

Biological factor (trichome density), high trichome density were strongly associated with resistance. Biochemical factors *viz.*, high phenol and low total soluble sugar were the contributing characters for imparting resistance against leafhoppers.

FUTURE SCOPE

The genotypes found resistance to leafhoppers in the present investigations can be used for future breeding programs to develop varieties which are resistant to leafhopper.

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