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Preliminary screening of okra genotypes for leafhopper resistance *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae)

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Abstract
The study was conducted for preliminary screening of 23 okra genotypes for relative susceptibility/resistance against leafhopper, *Amrasca biguttula biguttula* (Ishida) during 2018. The genotypes were raised in Completely Randomized Design layout and each genotype was replicated thrice. From this screening result, each genotype was categorized under moderately resistant, susceptible and highly susceptible grades. No genotype showed complete immune to leafhopper incidence. Leafhopper population was maximum in genotypes AE 26, Pusa Sawani, AE 64 and AE 15 with leafhopper population of 16.83, 16.42, 15.17 and 14.00/plant. The damage grade index was maximum in AE 26 (3.50) and Pusa sawani (3.35). Hence, it is evident from the present result that, AE 26 and Pusa Sawani was highly susceptible while, AE 65 and AE 23 are moderately resistance which can be used for further studies.

Keywords: Okra, genotypes, leafhopper, screening, resistance, grade index

Introduction
Okra jassid, *Amrasca biguttula biguttula* (Homoptera: Cicadellidae) has become a serious pest of agronomic crops, vegetables and ornamental plants. It is the most destructive amongst sucking insect pests attacking the 'okra' crop (Meena *et al.*, 2010) [10]. Okra is the most suitable host for survival and feeding to its nymph (Sharma and Singh, 2002) [20]. The damage caused by *Amrasca. Biguttula biguttula* starts from young seedling to the mature crop resulting in 50% yield loss (Bindra and Mahal, 1981) [3]. Excessive feeding damage the phloem tubes and causes disease, hopper burn (phytotoxemia) the main symptom of jassid attack (Javed, 2016) [6]. Damage leaves develop brown and curl at the edges, stunted growth and unable to produce flowers and fruits and fall off leaves.

Development and cultivation of resistant varieties to pests provides a suitable and desirable means of pest management. The success of such programme depends upon the extent of variability in the genotypes. Further, in crops like okra, frequent pickings, high operational cost and residual effect of insecticides are the limiting factors for the management of insect-pests through chemicals. Therefore, the most effective and economical management of okra pests is the use of resistant varieties. The present study focuses on preliminary screening of 23

Materials and Methods
Pot culture screening
Studies were carried out during 2017 - 2018 to screen okra genotypes against leafhopper, *A. biguttula biguttula* based on per leaf population density count. 23 genotypes of okra were sown in earthen pots in Insectary, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

Seeds of test entries were collected from Department of Vegetable Crops, TNAU, Coimbatore, Indian Institute of Horticulture Research, Bangalore and Indian Agricultural Research Institute, New Delhi. Seeds of collected genotypes were sown in earthen pots and a single plant represents a replicate and each entry was replicated three times. Recommended pot mixture was used in each pot to raise the plants. Experiment was conducted using Completely Randomized Design (CRD) with three replications. After 30 days of sowing, 10 leafhoppers per plant were released and observation on number of leafhoppers per plant was recorded at 15 days interval. Leafhopper population was counted on top, middle and bottom leaf of each replication. No pesticides were sprayed.

3.3.1.1. Method of assessment

The leafhopper population was recorded on each genotype with each replication from 45 DAS to 90 DAS. In each plant, leafhopper nymphs were observed from top, middle and bottom leaves categorized into respective grades as given in following table and means were worked out for overall grading. Based on per leaf population density of leafhopper and damage grades all genotypes were categorized as Resistant, moderately resistant, susceptible and highly susceptible (Kavitha and Reddy, 2012) [8].

Based on hopper burn symptoms, each genotype was rated by adopting 1-4 Grade scale of Indian Central Cotton Committee (ICCC) as given below (Murugesan and Kavitha, 2010) [11]:

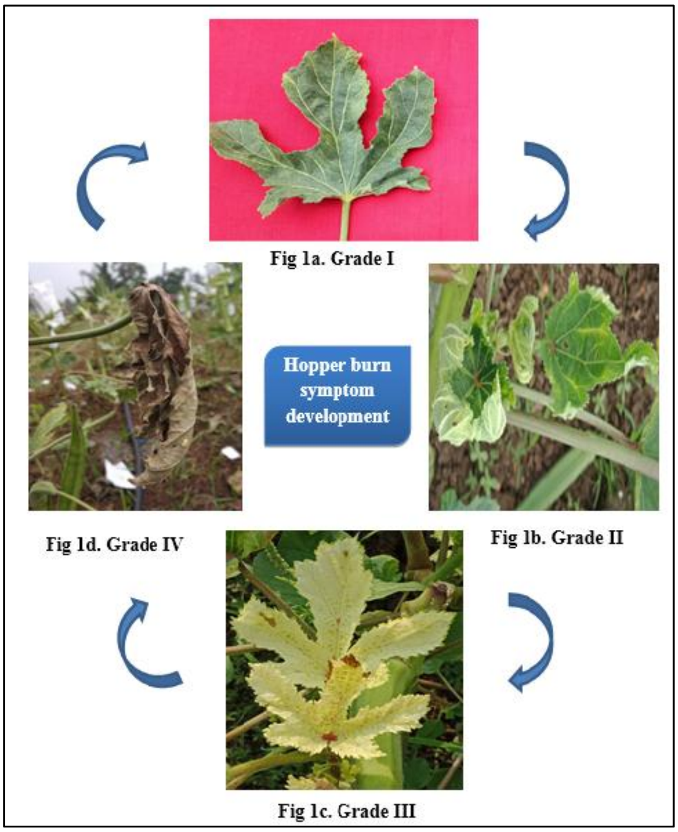

Fig 1: Visual estimation scale

Grade scale	Symptoms
I	Entire foliage free from crinkling/curling with no yellowing, bronzing, browning and drying of leaves (Fig 1a)
II	Crinkling, curling of few leaves mostly in lower portion of plant, little yellowing of leaves (Fig 1b)
III	Crinkling, curling and yellowing of leaves almost all over the plant, plant growth noticeably hampered (Fig 1c)
IV	Extreme crinkling, curling, yellowing, bronzing and drying of leaves and progressive defoliation, plant growth remarkably stunted (Fig 1d)

Hopper burn index/ Leafhopper resistance index

Hopperburn index or leafhopper resistance index were calculated using the following formula (Nageswararao 1973, Srinivasan and Rakha, 2019) [13, 24]

$$LHRI=\frac{(G_1\times P_1)+(G_2\times P_2)+(G_3\times P_3)+(G_4\times P_4)}{P_1+P_2+P_3+P_4}$$

Where, G - Leafhopper Injury Grade, P - The plant population under the grade for each category

Where, G is the leafhopper injury grade and Pi is the total number of plants in Gi.

After indexing, the genotypes were categorized as resistant or susceptible, as given below:

Table 1: The genotypes were categorized as resistant or susceptible, as given below

Grade index	Resistance categorization
0.1 – 1.0	Resistant
1.1 – 2.0	Moderately resistant
2.1 – 3.0	Susceptible
3.1 – 4.0	Highly susceptible

Statistical analysis

The data were subjected to statistical analysis by analysis of variance (ANOVA) and least significant difference (LSD) at 0.05 probability to separate the means with significant differences. Statistical analysis was done using SPSS software 21.0.

Results and Discussion

Varietal screening against leafhopper was evaluated to identify resistant genotypes. The results showed that leafhopper population build up started from 45 DAS where crop stage was more preferable for leafhopper. The population of leafhopper augmented with the crop age and high leafhopper infestation was recorded from 45 to 90 DAS. There was significant difference in leafhopper population in each genotype with significant damage grade index.

Table 1 showed that among screened genotypes none of them were completely immune to leafhopper infestation. Leafhopper population was maximum in AE 26 (16.83/plant), Pusa Sawani (16.42/plant), AE 64 (15.17/plant) and AE 15 (14.00/plant) with highest mean damage grade index of 3.50, 3.35, 3.20 and 3.40. These genotypes were categorized under highly susceptible with damage grade index ranging between 3.01-4.00. Comparatively least number of leafhopper was recorded in genotypes AE 42 (12.67/plant), No. 315 (12.17/plant), AE 16 (12.00/plant), AE 19 (11.67/plant), AE 12 (11.25/plant), AE 35 and Co 1 (11.08/plant), AE 24 (10.92/plant), Bhendi Hybrid Co 4 (10.17/plant), AE 4 (9.83/plant), AE 66 (9.42/plant), Kashi Satha Bahar (9.15/plant), Arka Anamika (8.50/plant) and AE 7 (8.50/plant) with mean damage grade index of 2.90, 2.70, 2.15, 2.80, 2.80, 2.80, 2.70, 2.95, 2.60, 2.05, 3.00, 2.85, 2.65 and 2.85, respectively. AE 14 (7.75/plant with mean damage grade index of 2.50) and AE 30 (7.42/plant with mean damage grade index of 2.30) were found to be statistically on par. The mean damage grade index range between 2.1 and 3.0 and so these genotypes were categorized as susceptible genotypes against leafhopper. Minimum leafhopper population was recorded on AE 65 (4.50/plant) with mean damage grade index of 1.40 followed by AE 23 (5.00/plant) and AE 27 (5.08/plant) with mean damage grade index of 1.50 and 1.75, respectively.

The mean damage grade index was higher in AE 26 (3.50), AE 15 (3.40) and Pusa Sawani (3.35). This specifies the higher susceptibility of genotypes towards leafhopper, *A. biguttula biguttula.* Lesser level of mean damage grade index was recorded in genotypes, AE 65 (1.40), AE 23 (1.50) and AE 27 (1.75) which ranges between 1.10-2.00 grading scale which indicates moderate resistance of genotypes towards leafhopper.

Development and cultivation of resistant varieties to pests provides a suitable and desirable means of pest management. The success of such programme depends upon the extent of variability in the genotypes. The results of showed that no variety presented 100% resistance against leafhopper but significantly different level of resistance in each genotype. In the present study, AE 26, AE 15 and Pusa Sawani harbored the highest leafhopper nymphal population with high mean damage grading index. While, AE 65 showed comparatively less leafhopper population with pooled mean damage grading index of 1.18 (Moderately resistant). Gonde *et al.* (2012) [4] has reported Pusa Sawani as highly susceptible to leafhopper which is in conformity with our present findings. Iqbal *et al.* (2008) [5] also screened varieties of okra for relative susceptibility/ resistance against *A. biguttula biguttula* and found Pusa Sawani as susceptible genotype which is in conformity with present finding where Pusa Sawani was categorized as susceptible genotype with damage grade index ranging between 3.01-400. Ali *et al.* (2016) [1] also evaluated relative plant resistance of nine cultivars of eggplant (*Solanum melongena* L.) against leafhopper (*Amrasca biguttula biguttula*) and reported that all the cultivars were significantly different and the infestation increased and reached its peak when the crop was 12-week old afterwards it decreased gradually. The most preferred variety for leafhopper was Bemissal (3.36 leafhoppers/ leaf) whereas the least preferred variety was Rubi (1.42 leafhoppers/ leaf). The present study is also in line with Ashraf *et al.* (2017) [2] who also reported that maximum leafhopper population was recorded in Pusa Sawani (6.256 ± 1.978 per leaf) genotype.

Sharma *et al*. (2001) [19] reported that variety Arka Anamika and Parbhani Kranti showed moderate resistance against aphids, jassids and whitefly.

By adopting ICCC grades and based on resistance index Murugesan and Kavitha, (2010) [11] categorized 26 cotton accessions against leafhopper as Highly resistant (KC2, SVPR 2), Resistant (TKH 1128), Intermediate (MCU 5, MCU 10, NISD 2, TKH 1143, TKH 1175), Susceptible (TKH 1789, TKH 1173, TKH 1174, TKH 1178, TKH 1179, TKH 1185, TKH 1186, TKH 1209, TKH 1225, TKH 1233) and Highly susceptible (ICMF 20, LRA 5166, TKH 1133, TKH 1172, TKH 1176, TKH 1182, TKH 1197 and TKH 1198). This finding is parallel to the present study wherein, leafhopper population and damage grade index were used to categorize different genotypes under susceptibility and resistance. Sandhi *et al.* (2017) [18] also screened 15 okra genotypes based on leafhopper population and jassid injury index and categorized Pusa Sawani as highly susceptible with 24.11 nymphs/leaf/plant and 3.30 jassid injury index. This finding is in concordance with present finding where, Pusa Sawani is categorized as highly susceptible with 27.79 leafhoppers/plant with damage grade index of 3.15.

In the present study, the genotype Arka Anamika appeared susceptible to leafhopper while Pusa Sawani was highly susceptible. Similar results were recorded by Kumar and Singh (2002) [9] who observed comparatively low population of leafhopper on Arka Anamika while the highest on Pusa Sawani. Whereas, in contradiction Rehman *et al.* (2015) [16] reported that Arka Anamika (1.59/leaf) was the most susceptible variety to leaf hopper while Pusa Sawani (1.32/leaf) was comparatively resistant to leaf hopper. Kadu *et al.* (2018) [7] have also reported Arka Anamika as leafhopper resistant whereas, it was susceptible in present findings. According to Tripathy *et al*. (2008) [22] also Arka Anamika was resistant against leafhopper and recorded mean population of 5.02 leafhoppers/3 leaves. Similar contradictory results have been quoted by Saif *et al*. (2012) [17], Srivastava and Parasnath, (2011) [23], Patel *et al.* (2012) [15], Nataraja *et al.* (2013) [14], Javed *et al*. (2016) [6], Sultana *et al*. (2017) [21] and Nagar *et al*. (2017) [12]. Thus, plant resistance may vary in different genotypes due to any other biotic or abiotic factors.

Table 1. Leafhopper (*Amrasca biguttula biguttula*) infestation in okra genotypes (Preliminary screening)

S. No	Okra Genotype	Leafhopper No./plant				Mean leafhopper (No./plant)	Mean damage grade index	Resistance category
		45 DAS	60 DAS	75 DAS	90 DAS			
1	AE4	3.33 (1.83)	7.67 (2.77)	12.33 (3.51)	16.00 (4.00)	9.83	2.05	S
2	AE7	3.67 (1.91)	6.33 (2.52)	10.67 (3.27)	13.33 (3.65)	8.50	2.85	S
3	AE12	4.33 (2.08)	8.00 (2.83)	14.33 (3.79)	18.33 (4.28)	11.25	2.80	S
4	AE14	3.00 (1.73)	5.67 (2.38)	8.33 (2.89)	14.00 (3.74)	7.75	2.50	S
5	AE15	5.33 (2.31)	8.67 (2.94)	16.67 (4.08)	25.33 (5.03)	14.00	3.40	HS
6	AE16	6.00 (2.45)	9.33 (3.06)	13.00 (3.61)	19.67 (4.43)	12.00	2.15	S
7	AE19	4.33 (2.08)	7.67 (2.77)	14.33 (3.79)	20.33 (4.51)	11.67	2.80	S
8	AE23	1.67 (1.29)	3.33 (1.83)	6.67 (2.58)	8.33 (2.89)	5.00	1.50	MR
9	AE24	4.67 (2.16)	7.33 (2.71)	12.67 (3.56)	19.00 (4.36)	10.92	2.95	S
10	AE26	7.00 (2.65)	12.33 (3.51)	19.33 (4.40)	28.67 (5.35)	16.83	3.50	HS
11	AE27	2.33 (1.53)	4.00 (2.00)	6.33 (2.52)	7.67 (2.77)	5.08	1.75	MR

12	AE30	3.00 (1.73)	6.33 (2.52)	8.00 (2.83)	12.33 (3.51)	7.42	2.30	S
13	AE35	4.33 (2.08)	7.67 (2.77)	13.33 (3.65)	19.00 (4.36)	11.08	2.80	S
14	AE42	5.00 (2.24)	9.67 (3.11)	14.67 (3.83)	21.33 (4.62)	12.67	2.90	S
15	AE64	6.33 (2.52)	10.00 (3.16)	17.33 (4.16)	27.00 (5.20)	15.17	3.20	HS
16	AE65	2.00 (1.41)	3.67 (1.91)	5.00 (2.24)	7.33 (2.71)	4.50	1.40	MR
17	AE66	3.67 (1.91)	6.67 (2.58)	9.33 (3.06)	18.00 (4.24)	9.42	3.00	S
18	No.315	3.00 (1.73)	8.67 (2.94)	14.33 (3.79)	22.67 (4.76)	12.17	2.20	MR
19	Co 1	4.33 (2.08)	7.33 (2.71)	12.00 (3.46)	20.67 (4.55)	11.08	2.70	S
20	Kashi Satha Bahar	3.33 (1.83)	6.00 (2.45)	9.67 (3.11)	15.00 (3.87)	9.15	2.85	S
21	Bhendi hybrid Co 4	4.00 (2.00)	7.00 (2.65)	11.33 (3.37)	18.33 (4.28)	10.17	2.60	S
22	Pusa Sawani (S*)	6.33 (2.52)	13.00 (3.61)	18.33 (4.28)	28.00 (5.29)	16.42	3.35	HS
23	Arka Anamika	3.00 (1.73)	5.67 (2.38)	9.00 (3.00)	16.33 (4.04)	8.50	2.65	S
	SEd	0.02	0.03	0.04	0.05	-	-	-
	CD (P=0.05)	0.04	0.07	0.07	0.11	-	-	-

DAS – Days after sowing; S*- Susceptible check
Figures in the parentheses are $\sqrt{X+1}$ transformed values
R- Resistant; MR- Moderately Resistant; S- Susceptible; HS- Highly Susceptible

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