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Reaction of okra cultivars against okra leafhopper, *Amrasca biguttula* (Ishida)

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Abstract
The study was carried out to screen okra cultivars against okra leafhoppers, *Amrasca biguttula* (Ishida) during *Karif* 2018 at AHRS, Bhavikere, UAHS, and Shivamogga Karnataka. Fourteen okra genotypes *viz*., Arka Anamika, Pusa A-4, Phule utkharsh, Kasha kranti, Kashi satdhari, Avishkar, Ankur-40, Apsara, Amar tulsi, Usha, Megha, Supreme, Vnr-999 and Dhenu were raised in randomized block design with three replications to know their resistance against *A. biguttula.* Among these fourteen cultivars Arka Anamika and pusa A-4 recorded as highly resistant with lowest leafhopper population. Cultivars Phule utkharsh, Kashi kranti, Kashi satdhari, Avishkar, Apsara, Ankur-40 were found resistant, whereas Usha, Megha and Amar tulsi were identified as susceptible cultivars. In contrast to this, Dhenu, Vnr-999 and Supreme were recorded as highly susceptible cultivars with higher leadfhopper population.

Keywords: *Amrasca biguttula*, okra cultivars, screening, resistant, okra, susceptible

Introduction

Okra *Abelmoschus esculentus* (L.) Moench commonly known as *Bhendi* or lady's finger belongs to the family Malvaceae is a popular vegetable crop. Okra fruits have got nutritional and medicinal values. Okra finds its origin in South Africa. It is grown in many tropical and subtropical parts of the world. The okra tender fruits are used as vegetables or in culinary preparations it is used as sliced and dried pieces. The fruits of okra contain carbohydrate (6.4%), protein (1.9%), fat (0.2%), fibre (1.2%), minerals (0.7%) and moisture (89.6%). It has good nutritional value, particularly the high content of vitamin C (30 mg /100 g), calcium (90 mg /100 g), iron (1.5 mg / 100 g) and other minerals like magnesium and potassium, vitamin A and B, fats and carbohydrates (Aykroud, 1963) [3].

In India, it is an important vegetable crop grown throughtout the year. India stands first in area and production, occupying an area over 0.51 m hectares with an annual production of 6.21 m.MT. In Karnataka, it is grown in an area of 11.14 thousand hectares with an annual production of 96.27 thousand metric tonnes (Anon, 2018) [2].

The okra crop is attacked by a number of insect pests right from germination. As many as 72 species of insects have been recorded on okra (Srinivas Rao and Rajendran, 2003) [10]. Among these Aphid, *A. gossypii*, jassid, *A. biguttula*, whitefly, *B. tabaci and* spider mite, *Tetranychus cinnabarinus* are most important sucking pests of okra (Dangi and Ameta, 2005) [5], (Meena and Kanwat, 2005) [7]. Leafhopper was important pest in the early stage of the crop which desap the plants, make them weak and reduce the yield. Failure to control them in the initial stages was reported to cause yield loss to the tune of 54.04 per cent (Chaudhary and Dadeech, 1989) [4].

In order to prevent the infestation of the pests and to produce a quality crop, it is essential to manage the pest population at appropriate time with suitable control measures. The management stratergies like resistant varieties of crops in insect pest management at no additional cost plays an important role in integrated pest management (IPM). An insect resistant plant offer ideal prevention against insect damage, involving minimum cost of production and are eco-friendly. Keeping this in view, the present studies were undertaken to screen the suspetibility or resistance of okra cultivars/ genotypes against *A. biguttula* during *Kharif*, 2018.

Materials and Methods

The field experiment was laid out in Randomized Block Design (RBD) with three replications at AHRS, Bhavikere, UAHS, and Shivamogga. Fourteen cultivars were sown in individual plots measuring 2 rows of 6 meter length with a spacing of 60 cm x 30 cm in plot size of 1.8 m^2. All cultivation practices were followed as per the package of practices except the plant protection measures against sucking pest of okra.

Observations were made at weekly intervals throughout the crop growth on number of leafhoppers on five randomly selected plants. From each plant three leaves from top, middle and bottom canopy leaves were considered. The data was subjected to square root ($\sqrt{x} + 0.5$) transformation and then statistically analyzed using the ANOVA.

The different okra cultivars were categorized into Highly Resistant (HR), Resistant (R), Susceptible (S) and Highly Susceptible (HS) to leafhoppers based on the level of infestation (Siddhapara *et al*., 2018) [9]. Mean value of individual varieties ($\bar{x}i$) was compared with the mean value of all varieties ($\bar{x}$) and standard deviation (Sd) following the modified scale (Table 1). The retransformed data was used for computation of $\bar{x}$, $\bar{x}i$ and Sd for the each parameter.

Table 1: The scale used for categorizing resistance for different varieties of okra

S. No.	Category of resistance	Scale for resistance
1.	Highly resistant (HR)	$\bar{x}i < \bar{x} - Sd$
2.	Resistant (R)	$\bar{x}i > (\bar{x} - Sd) < \bar{x}$
3.	Susceptible (S)	$\bar{x}i > \bar{x} < (\bar{x} + Sd)$
4.	Highly susceptible (HS)	$\bar{x}i > (\bar{x} + Sd) < (\bar{x} + 2Sd)$

Results and Discussions

Incidence of leafhoppers on all the okra cultivars started from three WAS and peak incidence was noticed during 8th WAS. The leafhopper population ranged from 24.43 leafhoppers/ 3 leaves (Dhenu) to 10.30 leafhoppers/3 leaves (Arka Anamika). There was a gradual decline in leafhopper population at 8 WAS in all the okra lines. The number of mean leafhopper population of all the ten observations reveals that variety Arka Anamika recorded least number of leafhoppers of 5.14 / 3 leaves followed by Pusa A-4 (6.30 leafhoppers / 3 leaves) while, highest leafhopper count was recorded in Dhenu (15.48 leafhoppers / 3 leaves) fallowed by VNR-999 (14.08 leafhoppers / 3 leaves).

The mean number of leafhoppers ranged from 5.14 to 15.48 / three leaves in different okra cultivars (table 2). The maximum leafhopper population was observerd on variety Dhenu (15.48 / three leaves) followed by VNR-999 (14.08 / three leaves) and Supreme (13.72 / three leaves), the lowest number of leafhopper was observed on variety Arka Anamika (5.14 / three leaves) (table 2).

The other cultivars like Kashi Kranti, Kashi Satdhari, Avishkar, Apsara, Usha, Megha and Supreme recorded 8.30, 8.69, 9.22, 9.91, 11.92, 12.60 and 13.72 leafhoppers per three leaves, respectively.

Table 2: Screening of different cultivars of okra against okra leafhopper, *Amrasca biguttula*

Sl. No.	Varities	Number of leafhoppers / three leaves											Scale
		3 WAS	4 WAS	5 WAS	6 WAS	7 WAS	8 WAS	9 WAS	10 WAS	11 WAS	12 WAS	Mean	
1	Avishkar	2.16 (1.47)^{ef}	4.60 (2.14)^{fg}	7.83 (2.78)^{ef}	10.80 (3.38)^{de}	11.86 (3.44)^{efg}	16.43 (4.05)^{efg}	12.70 (3.98)^{ef}	11.36 (3.37)^{ghi}	7.90 (2.81)^{ef}	6.60 (2.56)^{ef}	9.22	R
2	Apsara	2.40 (1.54)^{de}	5.13 (2.26)^{ef}	8.20 (2.86)^{ef}	11.26 (3.42)^{de}	12.40 (3.52)^{ef}	17.86 (4.22)^{def}	13.40 (4.11)^{de}	12.90 (3.58)^{efg}	8.40 (2.89)^{e}	7.13 (2.67)^{e}	9.91	R
3	Dhenu	3.67 (1.91)^{a}	8.20 (2.85)^{a}	11.40 (3.37)^{a}	15.93 (4.05)^{a}	20.33 (4.50)^{a}	24.43 (4.93)^{a}	22.60 (4.72)^{a}	18.46 (4.29)^{a}	17.50 (4.41)^{a}	12.26 (3.50)^{a}	15.48	HS
4	Usha	2.86 (1.69)^{cd}	6.06 (2.46)^{cd}	9.46 (3.07)^{cd}	13.45 (3.72)^{bc}	14.86 (3.85)^{cd}	19.60 (4.42)^{bcd}	17.40 (4.21)^{cde}	14.80 (3.84)^{cde}	11.80 (3.43)^{cd}	8.90 (3.00)^{cd}	11.92	S
5	Megha	3.10 (1.76)^{bc}	6.60 (2.56)^{bc}	9.73 (3.11)^{bcd}	14.03 (3.82)^{abc}	15.40 (3.92)^{c}	20.83 (4.56)^{bc}	18.50 (4.24)^{cd}	16.06 (4.00)^{bcd}	12.30 (3.51)^{c}	9.46 (3.07)^{b}	12.60	S
6	Ankur-40	1.93 (1.38)^{f}	3.93 (1.97)^{gh}	7.40 (2.71)^{fg}	10.26 (3.28)^{ef}	11.06 (3.32)^{efg}	16.60 (3.99)^{fgh}	15.90 (3.83)^{fg}	13.80 (3.71)^{ef}	7.33 (2.70)^{efg}	6.16 (2.48)^{fg}	9.44	R
7	Pusa A-4	0.60 (0.75)^{i}	2.50 (1.57)^{jk}	5.40 (2.32)^{i}	8.16 (2.94)^{g}	9.13 (3.02)^{hi}	12.86 (3.72)^{i}	8.40 (5.86)^{i}	6.96 (2.62)^{j}	5.40 (2.31)^{i}	3.60 (1.89)^{j}	6.30	HR
8	Supreme	3.30 (1.81)^{abc}	7.20 (2.68)^{ab}	10.53 (3.24)^{abc}	14.53 (3.78)^{bc}	16.80 (4.11)^{bc}	22.30 (4.71)^{ab}	19.80 (4.45)^{bc}	17.96 (4.23)^{ab}	14.20 (3.77)^{b}	10.53 (3.24)^{b}	13.72	HS
9	Amar Tulsi	2.50 (1.58)^{de}	5.63 (2.37)^{de}	8.66 (2.90)^{de}	12.73 (3.63)^{cd}	12.93 (3.59)^{de}	18.80 (4.33)^{cde}	15.80 (4.14)^{de}	14.20 (3.73)^{de}	10.40 (3.21)^{d}	8.40 (2.89)^{d}	11.01	S
10	Kashi Sathadhari	1.40 (1.18)^{g}	4.46 (2.11)^{fg}	6.46 (2.53)^{gh}	9.20 (3.11)^{fg}	11.20 (3.34)^{efg}	15.96 (3.99)^{fgh}	13.70 (3.64)^{g}	11.9 (3.45)^{fgh}	6.63 (2.57)^{fgh}	5.90 (2.42)^{gh}	8.69	R
11	VNR-999	3.50 (1.87)^{ab}	7.60 (2.75)^{ab}	10.86 (3.29)^{ab}	15.56 (3.98)^{ab}	18.86 (4.33)^{ab}	22.40 (4.72)^{ab}	18.60 (4.50)^{ab}	16.66 (4.08)^{abc}	15.13 (3.88)^{b}	11.63 (3.41)^{a}	14.08	HS
12	Phule Utkharsh	0.93 (0.96)^{h}	2.93 (1.71)^{ij}	5.80 (2.40)^{hi}	8.26 (2.96)^{g}	10.20 (3.18)^{gh}	13.60 (3.68)^{hi}	11.70 (3.36)^{h}	9.90 (3.14)^{i}	5.96 (2.44)^{hi}	4.40 (2.09)^{i}	7.37	R
13	Kashi Kranti	1.30 (1.13)^{g}	3.56 (1.43)^{hi}	6.17 (2.48)^{hi}	9.67 (3.18)^{efg}	10.73 (3.72)^{fgh}	14.60 (3.81)^{ghi}	13.80 (3.57)^{gh}	10.93 (3.03)^{hi}	6.80 (2.48)^{ghi}	5.40 (2.32)^{h}	8.30	R
14	Arka Anamika	0.40 (0.61)^{i}	2.06 (1.43)^{k}	4.16 (2.04)^{j}	6.20 (2.58)^{h}	8.40 (2.86)^{i}	10.30 (3.31)^{j}	7.40 (2.72)^{i}	6.10 (2.46)^{j}	4.20 (2.04)^{j}	2.13 (1.45)^{k}	5.14	HR
	S.Em ±	0.12	0.27	0.39	0.64	0.73	0.91	0.71	0.66	0.50	0.38	-	-
	CD (p=0.05)	0.37	0.83	1.20	1.94	2.22	2.77	2.17	2.00	1.54	1.16	-	-
	CV %	10.00	9.45	8.59	9.69	9.64	9.0	8.05	8.11	9.21	9.06	-	-

Table 3: Categorization of different cultivars of okra for their susceptibility to leafhopper, *Amrasca biguttula bigutulla*

Category of resistance	Scale	Cultivars ($\bar{x}_i$)
Highly resistant (HR)	$\bar{x}I < 7.18$	Arka anamika (5.4) Pusa A-4 (6.30)
Resistant (R)	$\bar{x}I > 7.18 < 10.23$	Phule utkharsh (7.37) Kashi kranti (8.30) Kashi satdhari (8.69) Avishkar (9.22) Apsara (9.91) Ankur-40 (9.44)
Susceptible (S)	$\bar{x}I > 10.23 < 13.28$	Usha (11.92) Megha (12.60) Amar tulsi (11.01)
Highly susceptible (HS)	$\bar{x}I > 13.28 < 16.33$	Dhenu (15.48) Vnr-999 (14.08) Supreme (13.72)
$\bar{x} = 10.23$ and Sd = 3.05		
Mean number of Leafhopper per individual cultivar ($\bar{x}_i$) Mean number of all cultivars ($\bar{x}$) Standard deviation (Sd)		

Based on the mean number of leafhoppers, okra cultivars were categorized as Highly Resistant (below 7.18 leafhopper population / three leaves), Resistant (7.18 to 10.23/ three leaves), Susceptible (10.23 to 13.28 / three leaves) and Highly Susceptible (13.28 to 16.33 / three leaves) by using the scale of resistance (table 3). According to this scale, the varieties Arka Anamika and Pusa A-4 were categorised as highly resistant. The varieties, Phule utkharsh (7.37), Kashi kranti (8.30), Kashi satdhari (8.69), Avishkar (9.22), Apsara (9.91), and Ankur-40 (9.44) were categorised as resistant cultivars. The varieties, Usha (11.92), Megha (12.60) and Amar tulsi (11.01) were categorised as susceptible whereas, the cultivars Dhenu (15.48), Vnr-999 (14.08) and Supreme (13.72) were categorised as highly susceptible (table 3).

Based on the mean leafhoppers population, the ascending order of susceptibility of okra varieties against leafhopper was Arka Anamika < Pusa A-4 < Phule utkharsh < Kashi kranti < Kashi satdhari < Avishkar < Ankur-40 < Apsara < Amar tulsi < Usha < Megha < Supreme < Vnr-999 < Dhenu.

In general, it was observed that the incidence of leafhopper increased with the age of the crop. Generally, during vegetative phase the leafhopper population was comparatively less in all the bhendi cultivars than near maturing crop (60th day). This may be due to the presence of thinner veins during early stage crop, which further developed into thicker vein and thereby favored more number of hoppers on leaves. Similarly, as the age of the plant increases, increase in the size of leaf lamina, decrease in the hair density might favours the buildup of the population of leafhoppers as reported by Anitha and Nandihalli (2008) [1]. The present findings were in conformity with the findings of Raghumoorthi and Kumar (2000) [8]. Kumar and Singh (2002) [6] also reported that, variety Arka Anamika harbored lesser population of leafhopper and minimum leaf injury which on again support the present findings.

The leafhopper population observed on variety Arka Anamika (5.14 / 3 leaves) followed by Pusa A-4 (6.30 leafhoppers / 3 leaves) corroborate with findings of Anitha and Nandihalli (2008) [1] who reported that leafhopper population was recorded less on variety Arka Anamika (6.34 leafhoppers / 3 leaves) followed by Bhendi No. 10 (8.52 leafhoppers /3 leaves). The present results are in line with the support from the findings of Anitha and Nandihalli (2008) [1] who reported that variety Arka Anamika was least preferred by leafhoppers.

Conclusion

On the basis of leafhopper incidence, cultivars Arka Anamika and Pusa A-4 were categorized as highly resistance to *A. biguttula* with lowest leafhopper population. Cultivars *viz*., Phule utkharsh, Kashi kranti, Kashi satdhari, Avishkar, Apsara, Ankur-40 were found resistant, whereas Usha, Megha and Amar tulsi were categorized as susceptible to *A. biguttula.* In contrast to this, Dhenu, Vnr-999 and Supreme were recorded as highly susceptible cultivars with highest leadfhopper population.

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