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Screening of okra cultivars and genotypes for their resistance to fruit borers in middle Gujarat

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ABSTRACT: The study was conducted during summer and *kharif*, 2016 to know the infestation of fruit borers, *Earias vittella* (Fab.) and *Helicoverpa armigera* (Hübner) Hardwick in okra at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). Total ten genotypes and cultivars *viz.,* GO-2, GAO-5, GJO-3, Pusa Sawani, Parbhani Kranti, AOL-13-88, AOL-12-55, AOL-13-90, AOL-13-137 and AOL-13-136 were selected for screening. Among the ten okra genotypes/cultivars screened for their resistance to fruit borers, none of the okra genotypes/cultivars found highly resistant. The cultivars GAO-5 and GJO-3 were found resistant. Whereas, AOL-12-55 and AOL-13-88 as moderately resistant, while AOL-13-137, AOL-13-90, GO-2 and AOL-13-136 were categorized as moderately susceptible during summer. The same trend was followed during *kharif* except AOL-13-137, it was found moderately resistant. The correlation between fruit damage and morphological characters showed that plant height, fruit wall thickness and trichome density on fruits were observed significantly negatively correlated. Maximum fruit yield of okra was harvested from the cultivars GAO-5 and GJO-3 during both seasons.

Keywords: Okra, cultivars, genotypes, fruit borers and resistance

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is an annual vegetable belonging to Malvaceae family; it is also known by different names *viz.,* ladies finger, bhindi, bamia, okro or gumbo in different parts of the world. Okra is valued for its tender green fruits. It is cooked in a variety of ways and used as an ingredient in a wide variety of dishes. Young tender leaves are used as a leafy vegetable in some parts of the world. The ripe seeds are roasted, ground and used as substitute for coffee in Turkey (Mehta, 1959). It also contains 16-22 per cent edible oil. The roots and stem are used for clearing the cane juice from which gur or brown sugar is prepared (Chauhan, 1972). Its medicinal value has also been reported in curing ulcers and relief from haemorrhoids (Adams, 1975). The total area and production under okra in the world is reported to be 1.25 million ha and 22.28 million tonnes, respectively (Anonymous, 2015). It is mainly grown in India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Saudi Arabia, Mexico and Cameroon. India rank first in area and production followed by Nigeria. In India, it is grown in an area of 0.51 million ha with an annual production of 5.85 million tonnes. West Bengal is the leading producer followed by Bihar (Anonymous, 2015). One of the important limiting factors in the cultivation of okra is insect pests. As high as 72 species of insects have been recorded on okra (Sharma and Jat, 2009) of fruit borers like *Earias* spp. and *Helicoverpa armigera* (Hübner) Hardwick causes significant damage to crop to the tune of 91.60 per cent (Pareek and Bhargave, 2003) . Varietal resistance is a vital tool of integrated pest management in crops such as okra, because the fruits are picked at short intervals, therefore, the spray of insecticides becomes not only uneconomical but hazardous also (Sardana and Dutta, 1989). Host plant resistance is an important approach in pest management which offers many advantages. It is highly effective based on cost benefit analysis and play an important role in sustaining productivity. It suppresses the pest population with least disturbance to crop ecosystem and also reduces need for harmful pesticides that pollute the environment. It is a very effective strategy to manage both direct damage produced by insects and indirect damage produced by insect-transmitted plant pathogens and is generally compatible with other methods of pest management (Jayaraj and Uthamasamy, 1990; Dhaliwal and Arora, 2003)

MATERIALS AND METHODS

Per cent fruit infestation and yield

Different ten genotypes/cultivars of okra (Table 1) were sown in a Randomized Complete Block Design

(RCBD) with three replications by following 60x30cm spacing and gross and net plot area of 4.8×2.1 m and 3.6×1.5 m, respectively at Main Vegetable Research Station, Anand Agricultural University, Anand during summer and *kharif*, 2016.

Fruit damage due to *H. armigera* and *E. vitella* was recorded at each picking by counting the healthy and damaged fruits from net plot area on number as well as weight basis and per cent fruit damage was worked out by using the following formula. The observations on yield of okra fruits were recorded picking wise from each net plot area till to end of the crop. The plot was kept free from spraying of any insecticides. The periodical data on fruit damage recorded at each picking was subjected to analysis of variance (ANOVA) after transforming them to arcsine transformation. The data on yield was analyzed without any transformations. The data on per cent fruit damage due to *H. armigera* and *E. vitella* were analyzed periodically as well as pooled over periods.

Morphological characters of okra

Various morphological characters *viz.,* plant height, trichomes per square mili meter on fruits, thickness of fruit wall, length of fruit, width of fruit and number of fruits per plant were recorded at peak activity of the pests to know the factors responsible in imparting resistance/ susceptibility to fruit borers. The height of fifteen randomly selected plants from each genotype/cultivar was measured in centimetre from ground surface to tip of the top most leaf. Total number fruits in each plant were counted from fifteen randomly selected plants. Length of fifteen fruits from each genotype/ cultivar was measured in centimetre by using ordinary standard scale. Width and thickness of fruit wall was measured from fifteen randomly collected fruits in each genotype/ cultivar by using digital VernierCalipers and trichome density on fruit (0.5 cm^2) was counted under stereomicroscope under 10 X magnitude from fifteen randomly collected fruits in each genotype/ cultivar (Aziz *et al*, 2012), Later the genotype/cultivars data on various morphological characters were correlated (r) with the data on fruit damage to know the role of above morphological characters in imparting resistance against pests.

Categorization of genotypes/cultivars

The okra genotypes/ cultivars were grouped into six categories of resistance to fruit borers*viz.,* highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible based on per cent fruit damage. For the purpose, mean value of individual genotype ($\bar{X}_i$) was compared with mean value of all genotypes ($\bar{X}$) and standard deviation (SD) following the modified scale adopted by (Patel *et al*, 2002). The retransformed data were used for computation of $\bar{X}$, $\bar{X}_i$ and SD in case of this parameter (Table 1).

Table - 1 Categorisation of resistance atributes.

Category of resistance	Scale for resistance
Highly resistant	$\bar{X}_i < (\bar{X} - 2SD)$
Resistant	$\bar{X}_i > (\bar{X} - 2SD) < (\bar{X} - SD)$
Moderately Resistant	$\bar{X}_i > (\bar{X} - SD) < \bar{X}$
Moderately susceptible	$\bar{X}_i > \bar{X} < (\bar{X} + SD)$
Susceptible	$\bar{X}_i > (\bar{X} + SD) < (\bar{X} + 2SD)$
Highly susceptible	$\bar{X}_i > (\bar{X} + 2SD)$

RESULTS AND DISCUSSION

Evaluation of genotypes/cultivars for their resistance

Summer, 2016

The data on per cent fruit damage (number basis) on different cultivars recorded during summer, 2016 (Table 1) showed significant difference among the genotypes/ cultivars. Among different ten genotypes/cultivars, significantly the lowest (8.30%) fruit damage was noticed on the cultivar GAO-5 followed by GJO-3 (9.11%). The genotypes AOL-12-55 and AOL-13-88 registered relatively less (10.55 and 11.14%, respectively) fruit damage. However, the genotypes/cultivars AOL-13-137,AOL-13-90 and GO-2 recorded significantly higher fruit damage with the range of 12.85 to 12.93% and were found at par with each other. Among the evaluated genotypes/cultivars, maximum fruit damage was noticed in AOL-13-136, PusaSawani and ParbhaniKranti with 15.41, 17.29 and 17.68%, respectively. Looking to the data (Table 1) on per cent fruit damage on weight basis due to fruit borers in okra, significantly low weight losses in the cultivar GAO-5 by registering 8.19 per cent. However, cultivar GJO-3 stood next and found at par with the aforesaid cultivar by recording 8.99 per cent loss in fruit weight. The genotypes/ cultivars AOL-12-55 (10.45%) and AOL-13-88 (11.03%) observed to be relatively lower in weight loss when compared to PusaSawani and ParbhaniKranti with 17.20 and 17.59 per cent loss in fruit weight, respectively.

***Kharif,* 2016**

Table 2: Screening of different genotypes/ cultivars of okra against fruit borers during summer and *kharif*, 2016 (Pooled over periods)

Genotypes/ cultivars	Fruit damage (%)			
	Summer		*Kharif*	
	Number basis	Weight basis	Number basis	Weight basis
GO-2	21.07d (12.93)	21.00d (12.84)	21.81c (13.80)	21.73c (13.71)
GAO-5	16.75a (8.30)	16.62a (8.19)	18.08a (9.63)	17.90a (9.45)
GJO-3	17.56ab (9.11)	17.45ab (8.99)	18.31a (9.86)	18.21a (9.76)
PusaSawani	24.57e (17.29)	24.51ef (17.20)	25.79e (18.93)	25.74e (18.85)
ParbhaniKranti	24.86e (17.68)	24.80f (17.59)	26.52e (19.94)	26.48e (19.88)
AOL-13-88	19.50cd (11.14)	19.39cd (11.03)	19.98b (11.67)	19.89b (11.57)
AOL-12-55	18.95bc (10.55)	18.86bc (10.45)	19.51b (11.15)	19.41b (11.04)
AOL-13-90	21.06d (12.91)	20.97d (12.81)	21.74c (13.72)	21.67c (13.64)
AOL-13-137	21.01d (12.85)	20.90d (12.73)	19.87b (11.55)	19.76b (11.43)
AOL-13-136	23.11e (15.41)	23.04e (15.32)	23.28d (15.62)	23.20d (15.52)
S.Em. ± **T**	0.53	0.53	0.38	0.39
P	0.41	0.41	0.42	0.43
T x P	1.30	1.31	1.33	1.35
C. V. (%)	10.77	10.91	10.71	10.90

Note: 1. Figures in parentheses are retransformed values; those outside are arcsine transformed values

2. Treatment means with the letter(s) in common are not significant by DNMRT at 5 % level of significance

Table 3 : Categorization of different genotypes/ cultivars of okra for susceptibility to fruit borers during summer, 2016

Category of resistance	Scale	Genotypes/ cultivars	
Per cent fruit damage :	$\overline{X}$ = 12.82	SD = 3.21	
Highly Resistant (HR)	$\overline{X_i}$ < 6.40	--	
Resistant (R)	$\overline{X_i}$ > 6.40 < 9.61	GAO-5	16.75 (8.30)*
		GJO-3	17.56 (9.11)
Moderately Resistant (MR)	$\overline{X_i}$ > 9.61 < 12.82	AOL-12-55	18.95 (10.55)
		AOL-13-88	19.50 (11.14)
Moderately Susceptible (MS)	$\overline{X_i}$ > 12.82 < 16.03	AOL-13-137	21.01 (12.85)
		AOL-13-90	21.06 (12.91)
		GO-2	21.07 (12.93)
		AOL-13-136	23.11 (15.41)
Susceptible (S)	$\overline{X_i}$ > 16.03< 19.23	PusaSawani	24.57 (17.29)
		ParbhaniKranti	24.86 (17.68)
Highly Susceptible (HS)	$\overline{X_i}$ > 19.23	--	

Note: $\overline{X}$=Mean value of all varieties

$\overline{X_i}$ = Mean value of individual variety, SD = Standard Deviation

* Figure in the parenthesis are retransformed values

The data on pooled over periods are presented in (Table 1) and interpreted here under. The order of genotypes for their resistance to fruit borers based on per cent fruit damage (number basis) are given in brackets after each genotypes was GAO-5 (9.63) < GJO-3 (9.86) < AOL-12-55 (11.15) < AOL-13-137 (11.55) < AOL-13-88 (11.67) < AOL-13-90 (13.72) < GO-2 (13.80) < AOL-13-136 (15.62) <PusaSawani (18.93) <ParbhaniKranti (19.94). There was a significant difference among the genotypes/ cultivars. However, cultivars GAO-5 and GJO-3 did not differ from each other as they were at par with each other. The genotypes AOL-12-55, AOL-13-137 and AOL-13-

Table 4:Categorization of different genotypes/ cultivars of okra for susceptibility to fruit borers during *kharif*, 2016

Category of resistance	Scale	Genotypes/ cultivars	
Per cent fruit damage :	$\overline{X}$ = 13.59	SD = 3.60	
Highly Resistant (HR)	$\overline{X_i}$ < 6.39	--	
Resistant (R)	$\overline{X_i}$ > 6.39 < 9.99	GAO-5	18.08 (9.63)
		GJO-3	18.31 (9.86)
Moderately Resistant (MR)	$\overline{X_i}$ > 9.99 < 13.59	AOL-12-55	19.51 (11.15)
		AOL-13-137	19.87 (11.55)
		AOL-13-88	19.98 (11.67)
Moderately Susceptible (MS)	$\overline{X_i}$ > 13.59 < 17.19	AOL-13-90	21.74 (13.72)
		GO-2	21.81 (13.80)
		AOL-13-136	23.28 (15.62)
Susceptible (S)	$\overline{X_i}$ > 17.19< 20.78	PusaSawani	25.79 (18.93)
		ParbhaniKranti	26.52 (19.94)
Highly Susceptible (HS)	$\overline{X_i}$ > 20.78	--	

Note: $\overline{x}$=Mean value of all varieties

$\overline{X_i}$ = Mean value of individual variety, SD = Standard Deviation

Table 5 : Fruit yield of different genotypes /cultivars of okra during summer and *kharif*, 2016

Genotypes/ cultivars	Yield (q/ha)		Genotypes/ cultivars	Yield (q/ha)	
	Summer	*Kharif*		Summer	*Kharif*
GO-2	41.65cd	83.20cd	AOL-12-55	46.49bc	91.42bc
GAO-5	59.51a	118.30a	AOL-13-90	37.17cd	70.54cde
GJO-3	54.39ab	112.26ab	AOL-13-137	39.15cd	85.94c
PusaSawani	34.82d	61.33ef	AOL-13-136	24.10e	49.44f
ParbhaniKranti	35.65cd	63.18def	S. Em.±	3.47	6.80
AOL-13-88	41.74cd	87.56c	C.V. (%)	14.51	14.32

Table 6 : Correlation co-efficient between morphological characters and fruit damage

Morphological character	Summer	*Kharif*
Plant height (cm)	-0.682*	-0.664*
Number of fruits per plant	0.585	0.624
Length of fruit (cm)	0.231	0.234
Width of fruit (mm)	-0.573	-0.584
Fruit wall thickness (mm)	-0.850**	-0.879**
Trichome density on fruit (0.5 cm^2)	-0.812**	-0.804**

Significant at 0.05% level of significance; **Significant at 0.01% level of significance.

88 were at par on one side and AOL-13-90 and GO-2 on other side of chronological order. Genotype AOL-13-136 recorded significantly maximum per cent fruit damage but less than check varieties *i.e.*PusaSawani and ParbhaniKranti. More or less similar trend was noticed for the weight losses due to fruit borers (Table 1).

Categorization of genotypes/cultivars for resistance

Summer, 2016

The cultivars GAO-5 and GJO-3 were found resistant by recording more than 6.40 per cent but less than 9.61 per cent fruit damage. Genotypes AOL-1255 and AOL-13-88 were found moderately resistant by recording per cent fruit damage between 9.61 and 12.82. Genotypes/ cultivars AOL-13-137, AOL-13-90, GO2 and AOL-13-136 recorded per cent fruit damage less than 16.03 but more than 12.82 and were found moderately susceptible. Whereas, the cultivars PusaSawani and ParbhaniKranti recorded more than 16.03 but less than 19.23 per cent fruit damage categorized as susceptible (Table 3)

Kharif, 2016

Cultivars GAO-5 and GJO-3 were found resistant by recording the fruit damage between 6.39 and 9.99, whereas AOL-12-55, AOL-13-137 and AOL-13-88 were moderately resistant with per cent fruit damage between 9.99 and 13.59, respectively. The genotypes/ cultivars, AOL-13-90, GO-2 and AOL-13-136 showed fruit damage of 13.59 to 17.19 per cent and hence they categorized as moderately susceptible, while PusaSawani and ParbhaniKranti had more than 17.19 per cent but less than 20.78 per cent fruit damage were found susceptible (Table 3).

Correlation between morphological characters and fruit damage

The correlation (Table 5) between fruit damage and morphological characters were interpreted here. Plant height, fruit wall thickness and trichome density on fruit were significant negatively correlated with fruit damage. It indicated that an increase in plant height, fruit wall thickness and number of trichomes, the fruit damage significantly decreases or vice versa, whereas, width of fruits was found non-significant negative correlation with fruit damage. However, number of fruits per plant and length of fruit were found non-significant positive correlation with fruit damage.

Yield

So far okra fruit yield is concerned (Table 5), during summer there was significant difference among the genotypes/cultivars. However, cultivars GAO-5 (59.51 q/ha) and GJO-3 (54.39 q/ha) did not differ significantly from each other. The genotype AOL-12-55 was at par with GJO-3 by yielding 46.49 quintal per hectare. Whereas, remaining genotypes/ cultivars found at par with each other with the range of 41.74 to 34.82 quintal per hectare except the genotype AOL-13-136 (24.10 q/ ha) which yielded significantly the lowest compared to other genotypes/cultivars. The data on okra fruit yield recorded from different genotypes/cultivars during *kharif,* 2016(Table 5) indicated that maximum (118.30 q/ha) marketable fruit yield was registered in GAO-5 followed by GJO-3 (112.26 q/ha) and AOL-12-55 (91.42 q/ha). While, minimum (49.44 q/ha) yield was harvested from AOL-13-136 followed by PusaSawani (61.33 q/ha) and ParbhaniKranti (63.18 q/ha).

The various research workers (Mandal *et al,* 2006; Papal and Bharpoda, 2009; Sharma and Jat, 2009; Akhter *et al*, 2014; Aykroyd, 1963; Afzal *et al,* 2015; Narayanan *et al*, 2016) recorded the higher fruit damage in ParbhaniKranti and PusaSawani. Thus, the present results are in close agreement with the findings drawn by above research workers. The results regarding other genotypes/cultivars in present findings could not be supported as the local genotypes have been evaluated under present investigation which was not evaluated by any workers elsewhere. Parmar *et al*, 2017 had reported variety Gujarat Okra-2 as less susceptible. Papal and Bharpoda, 2009 mentioned that cultivar GO-2 categorized into susceptible based on per cent fruit damage. However, according to Raghunath 2011, cultivar Gujarat okra-2 exhibited as highly resistant. In present investigation the cultivar Gujarat Okra-2 exhibited as moderately susceptible against fruit borers. Thus, the above finding is more or less corroborating with present findings. High trichome density might be imparting the physical barrier for the borers rendering their non-preference over the low trichomes genotypes/ cultivars. Earlier, Sharma and singh, 2010 reported a significant negative correlation between trichome density and borer incidence in okra from Rajasthan. Similar observations were also documented by Halder *et al,* 2006 who observed significant ($P<0.05$) negative correlation between trichome density on pods and pod borer damage in mungbean. According to Halder *et al,* 2015 highly susceptible genotype, SB 8 had relatively lower number of trichomes (24) as compared to tolerant genotype SB 6 which had 51.8 trichomes/cm^2. In black gram, relationship between pod width and pod wall thickness was negative and significant as per the results of Halder, 2004. Raghunath, 2011 and Halder *et al*, 2015 showed the negative and significant correlations between plant height and borer incidence, these findings are in agreement with present study.

CONCLUSION

From the present investigation, it can be concluded that the cultivar GAO-5 and GJO-3 is comparatively resistant whereas, ParbhaniKranti and PusaSawani is found susceptible against okra fruit borers. The present finding suggests that inclusion of GAO-5 or GJO-3 in IPM programs to reduce the pest load and pesticide application.

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