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Varietal screening of okra against whitefly, *Bemisia tabaci* (Gennadius)

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Abstract
Investigations on varietal screening of whitefly, *Bemisia tabaci* (Gennadius) infesting okra was carried out under field condition during the *kharif*, 2018 at Instructional Farm, Junagadh Agricultural University, Junagadh, Gujarat, India. Different ten varieties/genotypes *viz*., GO-2, GJO-3, GAO-5, Pusa Sawani, VRO-6, Kashi Kranti, HRB-55, HRB-108-2, JOL-11-12 and JOL-09-05 of okra were grown in a Randomized Block Design. Result revealed that the lowest whitefly incidence was recorded in HRB-108-2 (1.65whitefly /leaf) and JOL-11-12 (1.94) genotypes of okra and was categorized as resistant (R). While, the highest whitefly population was recorded in Pusa Sawani (5.09) variety and it was categorized as susceptible (S).

Keywords: *Bemisia tabaci* (Gennadius), okra, whitefly

Introduction
Among the vegetable crops grown in India, okra (*Abelmoschus esculentus* L. Moench), is also known as 'lady's finger' or 'bhendi' which is an important crop grown throughout the year. Besides India, it is grown in many tropical and subtropical parts of the world. Okra is the member of the family Malvaceae and is said to be native of Africa, possibly Ethiopia (Singh and Bhagchandani, 1967) [12]. Okra is one of the most economically important vegetable crop. It is widely cultivated as a summer season crop in North India and as a *kharif* and summer season crop in Maharashtra, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. In India, okra is cultivated in 52.84 lakh ha with a production of 61.46 lakh tonne. While in Gujarat, total area under okra was 0.74 lakh ha with aproduction of 8.59 lakh tonne (Anonymous, 2017) [1].

Okra is one of the drought tolerant vegetable species of the world and can tolerate poor soils with heavy clay and intermittent moisture. It grows well in the areas where day temperatures remain between 25 to 40 °C and that of night over 22 °C. It is quite popular in India because of easy cultivation, dependable yield and adaptability to varying climatic conditions.

Its medicinal value has also been reported in curing ulcers and relief from haemorrhoids. Okra is very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery (Thakur and Arora, 1986) [14]. Naturopathic medicines include okra for intestinal and irritable bowel dysfunction due to its mucilaginous properties. Okra mucilage is used for glace paper production and also a confectionary use. It has medicinal application as a plasma replacement or blood volume expander (Kumar *et al*., 2001) [5]. Okra is also known for harnessing a superior fibre, which helps with digestion, stabilizes blood sugar and helps to control the rate at which sugar is absorbed. Okra plants are also used for treating diseases like stones in kidney, leucorrhoea, backache and goitre in human beings.

Like other crops, okra is also ravaged by various insect pests. Shrinivas and Rajendran (2003) [11] recorded 72 species of insects infesting the okra.

The whitefly, *Bemisia tabaci* (Gennadius) the milky white minute flies; nymphs and adults causes damage to okra by sucking the cell sap from plants and plant parts of okra. The damage is caused by desapping the plants and deposits the droplets of honeydew on leaves, which provide a suitable condition for sooty mold development; as a result it inhibits the foliar photosynthesis and reduces commercial value of the crop (Oliveira *et al.*, 2001) [6]. Yellow vein clearing mosaic virus is a member of Geminivirus group which is semi persistently transmitted by whitefly. This virus is also transmitted through grafting, but not mechanically or through seeds. YVMV is one of the most destructive diseases of the crop and causes considerable reduction in yield which could be as 92 to 94% (Sastry and Singh, 1974) [10]. The virus seems to attack okra plants in any stage of plant growth, spreads quickly in the field and adversely affects the growth and yield (Hossain, 1998 and Sarma *et al.*, 1995) [3, 9]. Besides quantity, fruit quality is also adversely affected due to this disease. dversely affected due to this disease.

Materials and Methods

The experiment was laid out at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. To study the susceptibility of different ten varieties/genotypes *viz*., GO-2, GJO-3, GAO-5, Pusa Sawani, VRO-6, Kashi Kranti, HRB-55, HRB-108-2, JOL-11-12 and JOL-09-05 of okra, an experiment was carried out during *kharif* 2018. Two lines of each varieties /genotypes were grown in a Randomized Block Design with the spacing of 60cm x 30cm with three replications and plot size was 1.2m x 4.0m. All other agronomical practices were followed as per the scientific recommendations and varieties /genotypes under the experiment were kept free from the insecticides throughout the season. From the lines of each varieties /genotypes, five plants were randomly selected and tagged. The observations on whitefly population was recorded from three leaves from upper, middle and lower portion of each plant early in the morning at weekly interval. The data thus obtained were analyzed for assessing the least susceptible genotype against the whitefly on okra.

Categorization of varieties /genotypes

In order to differentiate the whitefly infestation on different ten varieties/genotypes, an attempt was made to splinter the varieties /genotypes in different categories. Patel *et al.* (2002) [7] categorized castor varieties against semi looper in to four groups *viz.*, highly resistant, resistant, susceptible and highly susceptible which was modified to fit into okra varieties for screening against whitefly. Different okra genotypes/cultivars were grouped in to six categories of resistance to whitefly *viz.*, highly resistant, resistant, moderately resistance, moderately susceptible, susceptible and highly susceptible based on no. of whitefly/three leaves. For the purpose, mean value of individual genotype ($\overline{X}_i$) was compared with mean value of all genotypes ($\overline{X}$) and standard deviation (SD). The retransformed data were used for computation of $\overline{X}$, $\overline{X}_i$ and SD in case of this parameter (Table 1).

Table 1: The scale used for categorizing different varieties /genotypes

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

The susceptibility of different varieties /genotypes of okra to *B. tabaci* were evaluated based on number of whitefly/leaf.

The data on different periods [Table 2 and Figure 1] revealed the order of various varieties /genotypes based on lower number of whitefly /leaf is given in bracket was: HRB-108-2 (1.65) < JOL-11-12 (1.94) < VRO-6 (2.34) < Kashi Kranti(2.53) < GAO-5 (2.90) < GJO-3 (3.17) < GO-2 (3.47) < JOL-9-5 (3.72) < HRB-55 (4.13) < Pusa Sawani (5.09)

Table 2: Infestation of whitefly in varieties /genotypes of okra and their yield

Varieties /Genotypes	No. of whitefly /leaf	Fruit yield (kg /ha)
Pusa Sawani	2.23*f* (5.09)	4695*g*
Kashi Kranti	1.58*bc* (2.53)	8307*bc*
GAO-5	1.70*cd* (2.90)	7612*cd*
HRB-108-2	1.28*a* (1.65)	10668*a*
JOL-9-5	1.92*de* (3.72)	5529*fg*
JOL-11-12	1.38*ab* (1.94)	9557*ab*
HRB-55	2.02*ef* (4.13)	5112*fg*
GO-2	1.85*de* (3.47)	6154*ef*
VRO-6	1.52*abc* (2.34)	9001*b*
GJO-3	1.77*cde* (3.17)	6848*de*
Mean	1.73 (3.09)	7348
ANOVA		
S. Em.	0.08	424.17
C.D. at 5%	0.26	1260.21
C.V. %	8.92	10

Notes:

1. Figures in parentheses are retransformed values; those outside are √x transformed value.
   Treatment mean with letter(s) in common are not significant at 5% level of significance within a column.

The incidence of whitefly on okra was differed significantly among various varieties /genotypes. Variety HRB-108-2 (1.65 whitefly /leaf) recorded significantly lower infestation than rest of the varieties /genotypes which was found at par with JOL-11-12 (1.94) and VRO-6 (2.34). Further, VRO-6 (2.34) found at par with Kashi Kranti (2.53). On other side, Kashi Kranti (2.53) was found at par with GAO-5 (2.90) and GJO-3 (3.17). While, GJO-3 (3.17) was found at par with GO-2 (3.47) and JOL-9-5 (3.72). Again, JOL-9-5(3.72) was found at par with okra variety HRB-55 (4.13). HRB-55 (4.13) and Pusa Sawani (5.09) were found with at par with each other. Pusa Sawani (5.09) recorded significantly higher infestation than any other varieties /genotypes. Patel *et al.* 2003 [8] reported that Pusa Sawani was more susceptible to whitefly as compared to Gujarat Okra Hybrid-1. Dabhi *et al.* (2012) [2] recorded least population of whitefly on the genotypes VRO-5 and VRO-6. Solanki (2005) [13] noted that GO-2 were the most susceptible to whitefly under field conditions. Kabade (2009) [4] reported that HRB-108-2 genotype showed significantly lower population of whitefly.

Categorization of okra varieties for susceptibility

The data (Table 3) revealed that none of the varieties/ genotypes was observed highly resistant (HR) to whitefly. The HRB-108-2 (1.65 whitefly/leaf) and JOL-11-12 (1.94 whitefly/leaf) were observed resistant (R) against whitefly population ranged from 0.99 to 2.04 whitefly /leaf. VRO-6 (2.34), Kashi Kranti (2.53), GAO-5 (2.90) categorized into group of moderately resistant (MR) as the infestation was recorded in the range of 2.04 to 3.09 whitefly /leaf. In case of varieties /genotype GJO-3 (3.17), GO-2 (3.47), JOL-9-5 (3.72), HRB-55 (4.13), the infestation was recorded in the range of 3.09 to 4.14 whitefly /leaf and so were categorized into moderately susceptible (MS) group. Under susceptible (S) category *i.e.*, range from 4.14 to 5.19 only one variety, Pusa Sawani (5.09) was observed. None of the varieties /genotypes was observed to have higher no. of whitefly count which comes under highly susceptible (HS) category. While spanning the information on this aspect from the published reports, Solanki (2005) [13] noted that Pusa Sawani and GO-2 were the most susceptible to whitefly under field conditions. Kabade (2009) [4] reported that HRB-108-2 genotype showed significantly lower population of whitefly. Navneet and Tayde (2018) investigated different okra varieties and revealed that VRO-6 (6.66%) was recorded more resistant against YVMV than HRB-55 (20%).

The data [Table 2 and Figure 1] was noted on yield from the different varieties /genotypes of okra. The chronological order of various varieties /genotypes recorded the highest yield, based on yield (kg/ha) given in bracket was HRB-108-2 (10668) < JOL-11-12 (9557) < VRO-6 (9001) < Kashi Kranti (8307) < GAO-5 (7612) < GJO-3 (6848) < GO-2 (6154) < JOL-9-5 (5529) < HRB-55 (5112) < Pusa Sawani (4695). Among the different varieties /genotypes, HRB-108-2 was found the best variety and recorded significantly higher (10668 kg /ha) yield than rest of the varieties/ genotypes. However, it was found at par with JOL-11-12 (9557). On other side, JOL-11-12 (9557) found at par with VRO-6 (9001) and Kashi Kranti (8307). Further, Kashi Kranti (8307) was found at par with GAO-5 (7612) and GJO-3 (6848). While, GJO-3 (6848) was found at par with GO-2 (6154), JOL-9-5 (5529) and HRB-55 (5112). While, Pusa Sawani (4695.43) recorded lowest yield.

Table 7: Categorization of okra varieties /genotypes for their susceptibility to whitefly, *B. tabaci*

Category of resistant	Scale	Varieties /genotypes $\overline{X_i}$	
1	2	3	
Based on three leaves [upper, middle & lower] (whitefly/leaf): $\overline{X}$ = 3.09 and SD =1.05			
Highly resistant	$\overline{X_i}$ < (0.99)	-	
Resistant	$\overline{X_i}$ > (0.99) < (2.04)	HRB-108-2 JOL-11-12	(1.65) (1.94)
Moderately resistant	$\overline{X_i}$ > (2.04) < (3.09)	VRO-6 Kashi Kranti GAO-5	(2.34) (2.53) (2.90)
Moderately susceptible	$\overline{X_i}$ > (3.09) < (4.14)	GJO-3 GO-2 JOL-9-5 HRB-55	(3.17) (3.47) (3.72) (4.13)
Susceptible	$\overline{X_i}$ > (4.14) < (5.19)	Pusa Sawani	(5.09)
Highly susceptible	$\overline{X_i}$ > (5.19)	-	

Note: Figures in parentheses are whitefly /leaf on okra

Where, $\overline{X_i}$ = Mean value of individual genotype, $\overline{X}$ = Mean value of infestation of all genotypes, SD= Standard deviation

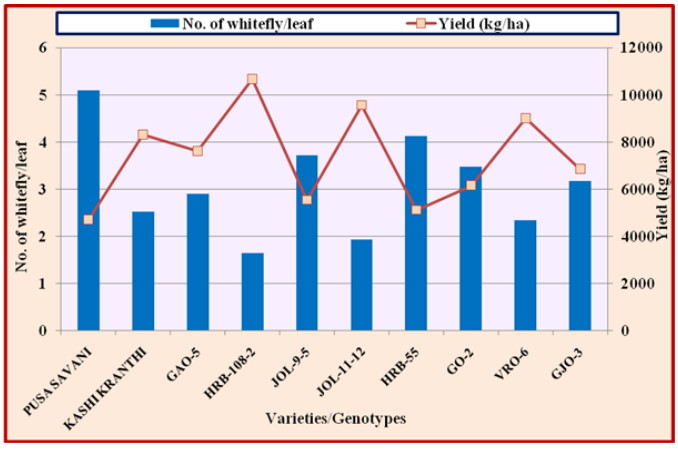

Fig 1: Bhalu *et al*., Infestation of whitefly, *Bemisia tabaci* in different varieties/genotypes of okra and their yield

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