Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(1): 565-568

Received: 24-11-2017
Accepted: 25-12-2017

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Screening of okra genotypes against white fly [*Bemisia tabaci* (Gennadius)] and YVM Virus

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Abstract
The present investigation was carried out during *rabi* season (March - June) 2017 at the central research farm of SHUATS, Allahabad. The ten okra genotypes viz. HRB-55, H14-A, JPM-20-16-32, IIVR-10, IC-14-934, IC-45862, JC-034-1124-A, VRO-6, 317-10-1, 326-10-1 were raised in randomized block design with three replications to know their response on incidence of *Bemisia tabaci* and resistance against YVMV. Among these ten genotypes IIVR-10 showed the lowest mean population of white fly (01.98) and the highest mean population (07.52) was recorded in genotype 317-10-1. It is observed that the population of *Bemisia tabaci* reached the peak level on 21st standard week (9 week after sowing). The genotype IIVR-10 (03.33 %) and VRO-6 (check) (06.66 %) were highly resistant recorded against YVMV Fallowed by HRB-55 (20%) moderate resistant.

Keywords: Okra, *Bemisia tabaci*, YVMV, Resistance, Genotype

1. Introduction
Okra *Abelmoschus esculentus* L. (Moench), belongs to family Malvaceae, is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. Cultivated okra is polyploid in nature (Joshi and Harda, 1956) [8]. The somatic (2n) chromosome number in the genus *Abelmoschus* ranges from 72 to 144. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malayasia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. India ranks first in the world with 6.34 million tons (72% of the total world production) of okra produced from over 0.51 million hectare land (NHB 2014-15). In U.P. area, production and productivity of okra is 14.18 thousand hac, 181.66 thousand tones, 12.2 metric tons per hectare respectively (NHB 2014-15).

It has good nutritional value. Per 100 g of edible portion of okra contain calories 35.0, Moisture 89.6 gm., Carbohydrates 6.4 gm., Protein 1.9 gm., Fat 0.2 gm., Fibre 1.2 gm., Minerals 0.7 gm., Phosphorus 56.0 mg., Sodium 6.9 mg., Sulphur 30.0 mg., Calcium 66.0 mg., Iron 1.5 mg., Potassium 103 mg., Magnesium 53 mg., Copper 0.19 mg., Riboflavin 0.01 mg., Thiamine 0.07 mg., Nictonic acid 0.06 mg., Vitamin C 13.10 mg., Oxalic acid 8.0 mg. (Gopalan *et al*., 2007) [7].

Okra is attacked by a number of insect pests and diseases. There are about 13 major insect and non-insect pest species, which attack this crop at various stages of growth (Dhamdhere *et al*., 1984)[4]. Unfortunately, okra is the worst sufferer of shoot and fruit borer (*Earias vittella* Fab.), which is the main bottleneck for cultivation of this crop. Under different agro-climatic conditions, the losses may vary from 10.10 to 50.00 per cent (Kashyap and Verma, 1983) [9].

Among the various biotic diseases yellow vein mosaic virus is a more serious disease and caused substantial yield losses (80-90%) in okra crops (Sastry and Singh, 1974) [14]. This YVMV disease to okra spread in the humid and heavy rainfall areas and transmitted by a vector whitefly (*Bemisia tabaci* Gen.) belonging to genus *begomovirus* and family of geminivireadea. (Chakraborty *et al*., 1999) [3].

The whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) is a worldwide pest, causing yield loss and economic injury in many crop species (Gerling and Mayer, 1996; Oliveira *et al*., 2001) [5, 12]. It causes damage to the crop through direct plant feeding, producing physiological disorders; *B. tabaci* transmitted viruses and by honeydew production with associated black mould development, resulting in reduced photosynthesis and a decreasing commercial value of the crop (Oliveira *et al*., 2001) [12].

2. Materials and Methods

The experiment was conducted during the *Rabi* season 2016-2017 in Central research field of SHUATS, Allahabad which is situated at 25.27° North latitude 80.50° East longitude and at an altitude of 98 mt. above sea level. The climate is typically semi-arid and subtropical. The maximum temperature reaches up to 49 ^{0}C in summer and drops down to 1.5^0 C in winter. The site selected was uniform, cultivable with typical sandy loam soil having good drainage.

The experiments were conducted with ten okra genotypes viz. HRB-55, H14-A, JPM-20-16-32, IIVR-10, IC-14-934, IC-45862, JC-034-1124-A, VRO-6, 317-10-1 and 326-10-1 in three replications. Size of plots was 1×2 m^2 and sown with the spacing of 45×30 cm. The crop was raised following all standard agronomical practices and no any chemical pesticides were used. The observations were recorded at weekly intervals throughout the cropping season. To record the observations three leaves each from top, middle and lower part per plant were considered for whitefly, (*Bemisia tabaci*). The observation was recorded till the crop harvested. To assess the incidence of white fly, per plant was counted and recorded at weekly intervals on randomly selected five plants per plot. The population dynamics were determined by correlating weather parameters.

The coefficient of correlation was worked out by equation (Sharma *et al*., 2010) [15].

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}}$$

Where:

r= Simple correlation coefficient

X= Independent variable (meteorological parameter)

Y= Dependent variable

N= Number of observation

The observations on yellow vein mosaic were recorded on the interval of 15 days.

The percent disease incidence (PDI) was calculated by the following formula

(Tiwari *et al.*, 2012)[16]

$$PDI = \frac{\text{Number of diseased plant}}{\text{Total number plant observed}} 100$$

Table 1: Scale for classifying disease reaction of Okra to yellow vein mosaic virus (Ali *et al*., 2005) [2]

Severity Grade	Rating Scale	Severity Range (%)
0	Immune	0%
1	Highly resistant	1-10 %
2	Moderate resistant	11-25 %
3	Tolerant	26-50 %
4	Moderate Susceptibility	51-60 %
5	Susceptibility	61-70 %
6	High Susceptibility	71-100%

3. Results And Discussion

3.1 Seasonal abundance of White fly (*B. tabaci*) on different okra cultivars

The incidence of *B. tabaci* commenced from 3rd week of april (16th SMW) on cultivars HRB-55, IC-140934, IC-45862, 317-10-1 and 326-10-1 (on tables). The *B. tabaci* population reached the peak infestation level at 21st SMW, HRB-55(121.33/3leaves), JPM-20-16-32 (14.13/3leaves), IIVR-10 (7.2/3leaves), IC-140934 (17.06/3leaves), IC-45862 (15.66/3leaves), JC-034-1124-A (09.80/3leaves), VRO-6 (check) (10.13/3 leaves), 317-10-1 (19.33/3leaves) and 326-10-1 (14.66/3leaves), 22nd SMW H14-A (18.73/3leaves) recorded. Similarly, Gonde *et al.* (2013) [6] also reported the 02.52 average mean population of *B. tabacci* and Nagar *et al*. (2017) [11] has reported that white fly population reach the peak level of 12.40 per 3 leaves in variety IIVR-10.

3.2 Co-efficient between okra pest *B. tabaci* and weather parameters

The statistically analyzed data (Tables no. 2) revealed that the white fly incidence on HRB-55 genotype and positively non-significant correlation with maximum temperature (r = 0.17), minimum temperature (r = 0.47), evening RH (r = 0.24), rainfall (r = 0.37), wind velocity (r = 0.28) and sunshine (r = 0.08) and a negative correlation with morning RH (r = -0.58). Genotype H14-A rainfall (r = 0.59) is positively significant maximum temperature (r= 0.29), minimum temperature (r = 0.44), evening relative humidity (r= 0.21), wind velocity (r = 0.33) and sunshine (r= 0.03) are positively not significant, whereas morning RH (r = -0.58) shows a negative correlation. Genotype JPM-20-16-32 maximum temperature (r= 0.51) is positively correlation, minimum temperature (r = 0.31), evening relative humidity (r= 0.12), rainfall (r = 0.48) wind velocity (r = 0.36) and sunshine (r= 0.04) are positively not significant, whereas morning RH (r = -0.51) shows a negative correlation. IIVR 10 maximum temperature (r= 0.13), minimum temperature (r = 0.37), evening relative humidity (r= 0.15), rainfall (r = 0.18) wind velocity (r = 0.33) and sunshine (r= 0.29) are positively not significant, whereas morning RH (r = -0.61) shows a negative correlation. Genotype IC-140934 maximum temperature (r = 0.52) is positively significant, minimum temperature (r = 0.26), evening relative humidity (r = 0.12), rainfall (r = 0.25) wind velocity (r = 0.28) and sunshine (r = 0.18) shows a positively non-significant correlation and morning relative humidity (r = -0.52) is a negative correlation. Genotype IC-45862 maximum temperature (r= 0.44), minimum temperature (r = 0.36), evening relative humidity (r= 0.14), rainfall (r = 0.44), wind velocity (r = 0.36) and sunshine (r= 0.08) are positively not significant, whereas morning RH (r = -0.61) shows a negative correlation. Genotype JC-034-1124-A maximum temperature (r= 0.16), minimum temperature (r = 0.44), evening relative humidity (r= 0.27), rainfall (r = 0.31) wind velocity (r = 0.25) and sunshine (r= 0.13) are positively not significant, whereas morning RH (r = -0.60) shows negative correlation Genotype VRO-6 (check), maximum temperature (r= 0.41), minimum temperature (r = 0.34), evening relative humidity (r= 0.16), rainfall (r = 0.40) wind velocity (r = 0.33) and sunshine (r= 0.11) are positively not significant, whereas morning RH (r = -0.53) shows negative correlation. Genotype 317-10-1 maximum and minimum temperature (r = 0.33, r = 0.42) evening relative humidity (r = 0.17), rainfall (r = 0.39), wind velocity (r= 0.35) and sunshine (r= 0.08) are positively non-significant, and morning relative humidity (r= -0.65) shows negative correlation. Genotype 326-10-1 maximum and minimum temperature (r = 0.38, r = 0.37) evening relative humidity (r = 0.12) rainfall (r = 0.41), wind velocity (r= 0.37) and sunshine (r= 0.12) are positively non-significant, and morning relative humidity (r= -0.62) shows negative correlation.

Table 2: Seasonal abundance of White fly (*B. tabaci*) on different okra cultivars

Standered week	week after sowing	HRB 55	H14-A	JPM-20-16-32	IIVR 10	IC-140934	IC-45862	JC-034-1124-A	VRO-6	317-10-1	326-10-1	Mean
14	2	00	00	00	00	00	00	00	00	00	00	00
15	3	00	00	00	00	00	00	00	00	00	00	00
16	4	00.46	00	00	00	02.46	00.80	00	00	01.54	0.66	00.59
17	5	02.40	01.40	00.86	01.00	04.93	02.20	00	00	03.70	02.40	01.88
18	6	06.53	07.60	03.93	01.66	08.20	07.86	04.06	02.86	07.06	05.33	05.50
19	7	09.66	08.26	06.06	02.26	12.80	09.33	06.00	04.20	09.73	06.93	07.52
20	8	10.66	12.13	11.93	04.00	14.00	13.00	08.20	07.80	15.66	11.70	10.90
21	9	12.33	13.93	14.13	07.20	17.06	15.66	09.80	10.13	19.33	14.66	13.42
22	10	12.33	18.73	13.00	03.33	12.53	15.00	08.13	07.86	16.46	12.47	11.98
23	11	11.86	09.73	05.53	04.00	05.93	8.26	08.46	04.80	13.06	09.13	08.07
24	12	08.26	08.00	10.06	02.33	01.86	05.00	05.66	02.13	07.20	04.13	04.56
25	13	03.53	03.06	00.70	00	00.66	02.00	01.73	0.40	03.60	01.20	01.68
26	14	00.33	00	00	00	00	00.00	00.20	00	00.45	00.20	00.11
Mean		06.02	06.37	04.40	01.98	06.18	06.08	04.02	03.09	07.52	05.29	

Table 3: Co-efficient between okra pest *B. tabaci* and weather parameters

Genotypes	Temperature C°		Humidity%		Rainfall (mm)	Wind Velocity (km/hrs)	Sunshine (hrs/day)
	max.	min.	Morning	Evening			
HRB-55	0.177	0.477	-0.66	0.244	0.373	0.286	0.084
H14-A	0.297	0.452	-0.588	0.222	0.599	0.331	-0.05
JPM-20-16-32	0.523	0.312	-0.513	0.126	0.482	0.36	0.039
IIVR-10	0.225	0.342	-0.596	0.122	0.183	0.322	0.283
IC-140934	0.593	0.223	-0.597	-0.019	0.312	0.438	0.21
IC-45862	0.434	0.37	-0.618	0.134	0.458	0.36	0.081
JC-034-1124-A	0.161	0.448	-0.598	0.273	0.32	0.257	0.133
VRO-6	0.41	0.342	-0.534	0.17	0.399	0.334	0.113
317-10-1	0.336	0.425	-0.646	0.178	0.396	0.355	0.088
326-10-1	0.385	0.373	-0.624	0.124	0.412	0.373	0.122

3.3 Screening of okra genotypes against yellow vein mosaic virus

The disease is characterized by a homogenous knotted, yellow veins and yellowish or creamy color of green leaf, stunted plant growth and bear very few deformed small fruits. (Ali *et al.*, 2012) [1].

During the observation, it was noted that affected okra plants were showing a number of typical symptoms with varying intensity. Based on disease scale, the data presented in (Table no.4) of the screening of 10 different genotypes of okra against YVMV under field condition revealed that out of 10 genotypes tested, the genotypes IIVR-10 and VRO-6 were highly resistant to Yellow vein mosaic virus incidence. The genotype IIVR-10 (3.33 %) and VRO-6 (check) (6.66 %) were highly resistant recorded and fallowed by HRB-55 (20%) moderate resistant recorded, H14-A (26.66 %), JPM-20-16-32 (30 %), 317-10-1 (36.67) tolerant and fallowed by 326-10-1 (46.67 %) recorded. JC-034-1124-A (53.33 %) moderately susceptibile. IC-140934 (73.33 %) and IC-45862 (76.67%) high susceptibile recorded. Prashanth *et al.* (2008) [13] reported the similar result and similar results were also reported by Vijaya *et al.* (2013) [17]. Kumar *et al.* (2017) [10] has reported the okra variety IIVR-10 as moderate resistance and VRO-6 as resistance.

Table 4: Performance of different genotypes of Okra against Yellow vein mosaic virus

Sr.no	Genotypes	Severity Grade	Disease (%)	Reaction of genotypes
T1	HRB-55 (HISAR UNNAT)	2	20	Moderate Resistance
T2	H14-A	3	26.67	Tolerant
T3	JPM-20-16-32	3	30	Tolerant
T4	IIVR-10(KASHI SATDHARI)	1	3.33	Highly Resistance
T5	IC-140934	6	73.33	Highly Susceptibility
T6	IC-45862	6	76.67	Highly Susceptibility
T7	JC-034-1124-A	4	53.33	Moderate Susceptibility
T8	VRO-6 (KASHI PRAGATI) (check)	1	6.667	Highly Resistance
T9	317-10-1	3	36.67	Tolerant
T10	326-10-1	3	46.67	Tolerant

3. Conclusion

It can be concluded from the results of trial that the resistance is different in each variety. The population of insect pests and incidence of YVMV can be reduced with the cultivation of resistant varieties. The abiotic factors such as temperature and relative humidity can influence the incidence of disease pests. In Allahabad region the genotype IIVR-10 and VRO-6 are highly resistant against YVMV.

4. Acknowledgement

We are grateful thanks to Dean of Director of Research who allotting field for this research work at central field of Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P.

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