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EVALUATION OF OKRA GENOTYPES FOR MORPHOLOGICAL CHARACTERISTICS, YIELD AND RESISTANCE TO YELLOW VEIN MOSAIC VIRUS

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Abstract

The experiment was conducted during the *kharif* season of 2020 and 2021 in the experimental field of RARS, Cumilla in a randomized complete block design with three replications. A total thirteen genotypes of okra were collected from different locations of the Cumilla region to evaluate morphological characteristics, yield and resistance to Okra Yellow Vein Mosaic Virus (OYVMV). The experimental results revealed that number of pods per plant was varied significantly among the okra germplasm and it was maximum in AE Cum-004 (32.82) whereas AE Cum-009 produced the maximum individual fruit weight (18.01 g) with the highest fruit yield (28.82 t/ha). Among the thirteen okra germplasm, AE Cum-004 was also found highly resistant (10.00 and 10.00%) to OYVMV whereas the high yielding genotype AE Cum-009 was found moderate resistant (12.41 and 14.00 %) to OYVMV in both years (2020 and 2021), respectively. Considering fruit yield and resistance to OYVMV, it is concluded that the genotypes AE Cum-009 and AE Cum-004 perform best and may be selected for further verification for their suitability as okra varieties.

Keywords: Okra, OYVMV, Resistant, Susceptibility, Tolerant, Yield.

Introduction

Okra (*Abelmoschus esculentus* L.) is a valuable vegetable crop cultivated in tropical and sub-tropical regions. Okra cultivation area is steadily increasing in Bangladesh, but production per hectare remains unchanged or is decreasing gradually (Anon., 2019). Bangladesh produced approximately 54,183 metric tons of okra from 11,606 hectares of land which is very low compared to that of other developed countries (Anon., 2019). Okra is a vital vegetable crop that offers a variety of nutritional benefits and health advantages. The production and marketing of the crop have been severely limited by several challenges including a lack of improved high-yielding okra yellow vein mosaic virus (OYVMV)-resistant varieties. Okra OYVMV belonging to the family Geminiviridae are the most devastating plant pathogen which causes huge crop losses. Symptoms of OYVMV, spread by whitefly (*Bemisia tabaci* Genn), include varying levels of

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chlorosis, yellowing of veins and veinlets, reduced leaf size, diminished fruit yield, and stunted growth (Venkataravanappa *et al*., 2012). Infected plants showed 24.9% reduction in plant height, 15.5% decrease in root length, and 32.1% in number of fruits per plant, whereas compared to healthy plants stem girth was reduced by 16.3% (Sheikh *et al*., 2013). If plants are infected within 20 days after germination, their growth is retarded; few leaves and fruits are formed and loss may be about 94%. The extent of damage declines with a delay in infection of the plants. BARI has developed two okra varieties, namely BARI Dherosh-1 and BARI Dherosh-2. These varieties were tolerant to OYVMV for a few years after release. But in recent times, it has been nearly susceptible to OYVMV. It is necessary to develop a new variety of okra for high-yielding as well as resistance to OYVMV. Therefore, the study was undertaken to evaluate the collected thirteen okra genotypes to select high yielding genotype (s) resistant to OYVMV.

Materials and Methods

This experiment was conducted in the experimental field of RARS, Bangladesh agricultural Research Institute (BARI), Cumilla during the *kharif* seasons of 2020 and 2021 to screen out the collected 13 okra genotypes including BARI Dheros-2. The seeds of thirteen genotypes, viz. AE Cum-001, AE Cum-002, AE Cum-003, AE Cum-004, AE Cum-005, AE Cum-006, AE Cum-007, AE Cum-008, AE Cum-009, AE Cum-010, AE Cum-011, AE Cum-012 and AE Cum-013 were collected from different locations of Cumilla and BARI Dheros-2 seeds were collected from the Olericulture Division of Horticulture Research Centre (HRC) of BARI. The experiment was executed in a randomized complete block design with three replications. The seeds were sown on 4 and 17 April 2020 and 2021, respectively. The unit plot size was 4.0 m × 1.2 m and the plants were spaced at 60 cm × 40 cm. Cowdung was applied @ 15 tons per hectare. Fertilizers were applied in the form of urea, TSP, and MoP @ 72-30-75 kg ha^{-1} of N-P-K. The entire amount of cow dung and TSP and two-thirds of MoP were applied at the time of final land preparation. The remaining MoP was applied after 30 days of seed sowing (DAS). Urea was top dressed in three equal installments at 30, 45, and 60 DAS. Other necessary intercultural operations such as irrigation, weeding, and plant protection measures were done properly as and when necessary. Data on yellow vein mosaic virus (OYVMV)-infected plants were recorded at 80 DAS. The number of plants showing OYVMV disease from 10 randomly plants was counted. The disease on each test entry was assessed according to the disease rating scale by Ali *et al.* (2005a,b) presented in the following Table 1. Based on the severity of OYVMV incidence, the germplasm accessions were grouped into different categories based on a 0-6 scale mentioned in Table 1. (Data on yield and yield attributes were recorded by harvesting fresh fruits from 7 plants in the plot at weekly intervals over a month and were sorted out into marketable and unmarketable fruits per hectare. In addition, the color of the flower, stem, and pod as well as the shape of

the leaf were recorded. Yield and yield attributes data were analyzed using Statistix10 software and the means were separated by LSD test at 5% level of significance.

Table 1: Disease rating scale of Okra Yellow Vein Mosaic Virus (OYVMV) disease

Rating scale	Type	Severity Range (%)
0	Immune	0
1	Highly resistant	1-10
2	Moderate resistant	11-25
3	Tolerant	26-50
4	Moderate susceptible	51-60
5	Susceptible	61-70
6	Highly susceptible	71-100

Source: Ali *et al*. (2005a,b)

Results and Discussion

Morphological characteristics

Morphological characteristics in terms of the color of the flower, stem, pod, and leaf shape of different germplasms of okra were recorded and shown in Table 2. There were no differences in flower color and shape of leaf among okra genotypes. The flower color and leaf shape were light yellow and palmate shape, respectively. Based on their stem and pod color, germplasms were grouped into 3. There was light green, dark green, and reddish green were similar to the results reported by Alam and Hossain (2008). Among thirteen genotypes, seven (AE Cum-001, AE Cum-002, AE Cum-003, AE Cum-006, AE Cum-010, AE Cum-012 and AE Cum-013) were grouped into light green, four (AE Cum-005, AE Cum-007, AE Cum-008, AE Cum-009) were grouped into dark green, whereas the rest 2 germplasm (AE Cum-004, AE Cum-011) were categorized into reddish green (Table 2). The leaves arrangement was alternate and single leaf in one section. The tip of the leaf was acute and its' rim was serrated. Similar results reported by (Lamont, 1999; Rashwan, 2011).

Yield attributes

In case of okra, main yield attributing characters are Plant height, fruit length, fruit breadth, number of fruits per plant and individual fruit weight. Yield contributing characters of okra germplasm varied significantly (Table 3).

Table 2: Morphological characteristics of various okra germplasm

Treatment	Flower color	Stem color	Pod color	Leaf shape
AE Cum-001	Light yellow	Light green	Light green	Palmate
AE Cum-002	Light yellow	Light green	Light green	Palmate
AE Cum-003	Light yellow	Light green	Light green	Palmate
AE Cum-004	Light yellow	Reddish green	Reddish green	Palmate
AE Cum-005	Light yellow	Dark green	Dark green	Palmate
AE Cum-006	Light yellow	Light green	Light green	Palmate
AE Cum-007	Light yellow	Dark green	Dark green	Palmate
AE Cum-008	Light yellow	Dark green	Dark green	Palmate
AE Cum-009	Light yellow	Dark green	Dark green	Palmate
AE Cum-010	Light yellow	Light green	Light green	Palmate
AE Cum-011	Light yellow	Reddish green	Reddish green	Palmate
AE Cum-012	Light yellow	Light green	Light green	Palmate
AE Cum-013	Light yellow	Light green	Light green	Palmate
BARI Dheros-2	Light yellow	Light green	Light green	Palmate

Plant height

The plant height is usually a good index of plant vigor which may contribute towards higher productivity (Pandey *et al*., 2017). The mean values of plant height of different genotypes showed significant variations, ranging from 100.68 to 174.67 cm. Maximum plant height was observed in AE Cum-002 (174.67 cm) followed by BARI Dherosh-2 (170.54 cm) and AE Cum-006 (166.56) whereas minimum in AE Cum-006 (100.68). The increase in plant height might be due to longer intermodal length. Similar observations were also reported by Saifullah *et al.* (2009) and Pandey *et al.* (2017).

Fruit length

The results indicated a notable difference in fruit length among the various Okra genotypes (Table 3). Fruit length of ranged from 11.00 to 15.60 cm where the longest fruit was observed in AE Cum-007 (15.60 cm) followed by AE Cum-005 (15.52 cm), AE Cum-004 (15.40 cm), AE Cum-003 (15.34 cm), and the shortest in AE Cum-013 (11.00 cm).This outcome might be due to environmental factors and varietal traits . Pandey *et al*. (2017) and Rahman *et al*. (2012) also found similar results in the varietal evaluation of okra. In the experiment by Dash *et al*. (2013) pod length varied significantly among the varieties. Saha *et al*. (2016) also highlighted a notable impact of variety on fruit length, suggesting genetic diversity and environmental factor among the evaluated okra varieties.

Fruit breadth

Significant differences in fruit breadth were observed among all the genotypes (Table 3). Fruit breath ranged from 1.63 to 2.38 cm where the widest fruit was found from AE Cum-012 (2.38 cm) followed by AE Cum-009 (2.08 cm) and BARI Dherosh-2 (2.08 cm). The variation in fruit size may result from genetic variations among the okra genotypes and their reactions to the current environmental factors. This is further corroborated by the earlier study conducted by Saha *et al*. (2016) which highlighted a notable impact of variety on fruit size, suggesting genetic diversity among the evaluated okra varieties. A similar result was reported in okra by Dash *et al.* (2013) and Sarker (2014).

Number of fruits per plant

The number of fruits per plant is one of the most important yield contributing character of okra. The data shows that the quantity of fruits per plant directly impacts on the yield, meaning that a higher number of fruits per plant results in higher yield per plant. The number of fruits per plant was also statistically varied among the okra germplasms (Table 3). Maximum fruits per plant were produced by AE Cum-004 (32.82) followed by AE Cum-005 (32.67) and AE Cum-009 (32.00) and minimum fruits per plant by AE Cum-003 (10.80). Variations in the number of fruits per plant might be due to the greater plant height, a larger number of branches per plant may get more space for fruit development. Similar reports are also quoted by Singh *et al*. (2018) and Pandey *et al*. (2017). Rahman *et al*. (2012) also reported significant differences among the okra varieties for the number of pods per plant and this variation might be due to their genetic makeup of the variety and environmental effects.

Individual fruit weight

Individual fruit weight was maximum in AE Cum-009 (18.01 g) followed by AE Cum-004 (16.95 g), AE Cum-002 (16.32) and the lowest in AE Cum-012 (12.58 g). Pandey *et al*. (2017) and Singh *et al*. (2018) also found similar results. Saha *et al.* (2016) corroborates this finding that crop yield is influenced by various factors such as individual fruit weight. Rahman *et al*. (2012) also highlighted notable variations in different okra varieties and suggesting that genetic differences and environmental factors may impact pod weight per plant.

Fruit Yield

The mean values of green fruit yield per hectare exhibited significant variations among the genotypes with the range of 7.97 to 28.82 t/ha (Table 3). AE Cum-009 produced the maximum yield (28.82 t/ha) followed by AE Cum-004 (27.81 t/ha) and the lowest yield by AE Cum-003 (7.97 t/ha). The genotypes showed superior performance for pod yield due to their higher ranking for the number of pods per plant, weight of pods per plant, pod length, plant height, and less infection of

yellow vein mosaic virus, which caused greater assimilation of photosynthates. Masarapu *et al.* (2014) also found that a single OYVMV infection could lead to yield reductions ranging from 20 to 30%. Variation in yield among different okra cultivars was reported by other workers (Amjad *et al*., 2001; Halim *et al*., 2009; Saifullah and Rabbani, 2009).

Table 3. Fruit yield and yield attributes of okra germplasm (pooled of 2020 and 2021)

Treatment	Plant height (cm)	Pod length (cm)	Pod breadth (cm)	No. of pods/ plant	Individual pod wt. (g)	Fruit yield (t/ha)
AE Cum-001	148.56	13.60	1.91	23.06	14.80	17.06
AE Cum-002	174.67	14.50	1.83	31.40	16.32	25.62
AE Cum-003	117.23	13.05	1.72	10.80	14.75	7.97
AE Cum-004	138.89	15.40	1.76	32.82	16.95	27.81
AE Cum-005	166.56	15.52	1.94	32.67	15.51	25.34
AE Cum-006	100.68	12.06	1.85	29.23	14.67	21.44
AE Cum-007	152.34	15.60	1.91	29.80	14.72	21.93
AE Cum-008	123.79	13.61	1.94	26.00	16.08	20.90
AE Cum-009	147.45	13.40	2.08	32.00	18.01	28.82
AE Cum-010	134.67	13.07	1.98	29.65	15.43	22.42
AE Cum-011	128.73	15.34	1.83	21.00	15.12	16.20
AE Cum-012	138.81	11.05	2.38	19.46	12.58	12.24
AE Cum-013	109.27	11.00	1.63	21.98	15.31	16.83
BARI Dherosh -2	170.54	13.05	2.08	30.33	16.00	24.26
LSD ($_{0.05}$)	2.74	3.62	1. 22	4. 78	2.89	4.78
CV(%)	6.56	8.45	7.21	10.12	8.43	10.12

Okra Yellow Vein Mosaic Virus (OYVMV) disease

Mean percentages of OYVMV infestation were higher in 2021 than that of 2020 but their rating scale of severity was similar in both years (2020 and 2021) (Table 4). Based on the disease rating scale of OYVMV shown in Table 1, AE Cum-004 was found highly resistant in both years (2020 and 2021), and only 10.00 % plant infected by OYVMV was found on this genotype. AE Cum-005 (12.67 and 16.44% in 2020 and 2021, respectively), AE Cum-009 (12.41 and 14.00% in 2020 and 2021, respectively) and BARI Dherosh -2 (16.34% and 25.00% in 2020 and 2021, respectively) were categorized into moderate resistant against OYVMV. AE Cum-002 (27.41% in 2020 and 33.89% in 2021) and AE Cum-010 (39.23% in 2020 and 43.33% in 2021) showed tolerant to OYVMV infection. AE Cum-001 (52.62 and 56.78%) and AE Cum-011 (57.19 and 60.00%) were

found moderate susceptible whereas AE Cum-006 (62.32 and 67.63% in 2020 and 2021, respectively), AE Cum-007 (65.22 and 67.95% in 2020 and 2021, respectively) and AE Cum-012 (55.11 and 66.67% in 2020 and 2021, respectively) were found susceptible and the others genotypes AE Cum-003 (100 and 100% in 2020 and 2021, respectively), AE Cum-008 (77.23 and 79.63% in 2020 and 2021, respectively) and AE Cum-013 (72.23 and 100% in 2020 and 2021, respectively) were highly susceptible. In the case of hybrid plant, OYVMV disease incidence ranged between 19.26 and 69.13% whereas, on parent plants, it ranged from 19.95 to 51.16% reported by Chaudhary *et al*. (1992). A study revealed that the infection rate of OYVMV disease could reach 100% when field yield loss falls between 50 and 94% (Ali *et al*., 2012). Batra and Singh (2000) screened eight okra varieties against OYVMV, Okra No.6, LORM-1, VRO-3, and P-7 were found free from disease whereas VRO-4 showed a mild reaction. Ali *et al*. (2005b) reported Safal, Subz Pari and Surkh Bhindi varieties against OYVMV in a field trial (3.36-24.40%). Benchasri (2011) and Venkataravanappa *et al*. (2013) also reported similar results.

Table 4. Okra Yellow Vein Mosaic Virus (OYVMV) disease reaction of 13 okra germplasm during the *kharif* seasons of 2020 and 2021

Treatment	2020		2021	
	OYVMV infestation % (80 DAS)	Rating scale of severity	OYVMV infestation % (80 DAS)	Rating scale of severity
AE Cum-001	52.62	MS	56.78	MS
AE Cum-002	27.41	T	33.89	T
AE Cum-003	100	HS	100	HS
AE Cum-004	10.00	HR	10.00	HR
AE Cum-005	12.67	MR	16.44	MR
AE Cum-006	62.32	S	67.63	S
AE Cum-007	65.22	S	67.95	S
AE Cum-008	77.23	HS	79.63	HS
AE Cum-009	12.41	MS	14.00	MS
AE Cum-010	39.23	T	43.33	T
AE Cum-011	57.19	MS	60.00	MS
AE Cum-012	55.11	S	66.67	S
AE Cum-013	72.23	HS	100.00	HS
BARI Dherosh -2	16.34	MR	25.00	MR

S = Susceptible, MS = Moderate susceptible, HS = Highly susceptible, T = Tolerant, MR= Moderate resistant, R = Resistant; DAS = Days after sowing

Conclusion

Among all the genotypes, AE Cum-002, AE Cum-004, AE Cum-005, and AE Cum-009 exhibited higher yield than the average yield of BARI Dherosh -2. Among them, the genotypes AE Cum-009 performed best for its yield whereas the genotypes AE Cum-004 showed highly resistance to OYVMV. Considering the mean performance of the thirteen okra germplasm against OYVMV reactionand yield attributes, it might be concluded that the genotypes AE Cum-004 and AE Cum-009 were best performer and could be selected for further verification.

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