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IDENTIFICATION OF HETEROTIC CROSSES FOR YIELD COMPONENTS AND RESISTANCE TO YELLOW VEIN MOSAIC VIRUS IN OKRA

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Abstract

Fifty six hybrids obtained from eight parents (ArkaAbhay, ArkaAnamika, DBh-30, DBh-37, DBh-39, DBh-43, DBh-47 and DBh-55), which are crossed in full diallele fashion along with eight parents and four popular hybrids were evaluated for estimating heterosis for yield and yield related traits viz., days to 50 per cent flowering, plant height, number of branches, inter-nodal length, fruit length, fruit diameter, number of fruits per plant, average fruit weight, fruit yield per plant and fruit yield per hectare during rabiseason of 2011-2012. The results revealed that the standard heterosis for fruit yield per plant was maximum in the hybrid ArkaAnamika x DBh-43, with a value of 96.97 per cent. This hybrid recorded high standard heterosis for number of fruits per plant, average fruit weight and fruit yield per hectare.

Key words : Heterosis, heterobeltiosis, standard heterosis, okra.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench], one of the important vegetable crops of India, belongs to family Malvaceae and the genus *Abelmoschus*. It is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. It is native of tropical Africa. It is called lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhendi in India. It is often cross pollinated crop and thus heterosis can be exploited in it. Heterosis breeding based on the identification of the parents and their cross- combinations is capable of producing the highest level of transgressive segregates (Falconer, 1960). It is one of the tools in overcoming yield barrier and increasing productivity. It also identifies the cross combinations which are promising in conventional breeding programme. Heterosis adaptability, biotic and abiotic resistance, general vigour and quality leads to increase in yield, reproductive ability. The initial selection of parents to be involved in any effective hybridization programme depends upon the nature and magnitude of heterobeltiosis (heterosis over better parent) and economic heterosis (heterosis over check) present in genetic stocks. The magnitude of heterosis provides a guide for the choice of desirable parents for developing superior F_1 hybrids, so as to exploit hybrid vigour. It also helps in choosing suitable crosses to be used for commercial exploitation as well as in component breeding programme.

Materials and Methods

Eight parents *viz*., ArkaAnamika, ArkaAbhay, DBh-30, DBh-37, DBh-39, DBh-43, DBh-47 and DBh-55 selected and were crossed in diallel fashion to analyse the combining ability and heterosis for yield and yield component traits. Fifty six hybrids obtained from full diallel crossing programme, eight parents along with four popular hybrids (Syngenta 152, Mahyco No. 10, Mahyco No. 55, and Mahyco No. 64) were evaluated in three replications of Randomized Block Design during rabi season of 2011-2012. Row-to-row and plant-to-plant distances were maintained at 60 cm and 30 cm, respectively. The crop protection and other cultural practices were carried out as required to raise a good crop.

Observations were recorded on five competitive plants excluding border plants in each replication for days to 50 per cent flowering, plant height, number of branches,

Table 1 : Analysis of variance (mean sum of square) for Fruit yield and its component traits in okra.

Character	d.f.	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Inter nodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (T/ha)
Replicates	2	1.943	7.06	0.021	0.11	0.46	63.021	0.328	0.161	63.453	0.715
Treatments	63	9.680**	527.220**	0.735**	1.037**	1.406**	134.053**	15.497**	3.603**	4030.338**	10.314**
Parents	7	3.310**	383.501**	1.048**	0.911**	2.486**	190.476**	23.708**	2.381**	4714.736**	14.480**
Hybrids	55	9.787**	529.491**	0.696**	0.927**	1.281**	128.820**	14.018**	3.678**	3773.176**	8.951**
Parent vs. Hybrids	1	48.382**	1408.352**	0.715*	7.955**	0.679	26.86	39.360**	8.048**	13383.510**	56.146**
F_1's	27	11.247**	606.506**	0.619**	0.902**	1.116**	154.630**	14.827**	4.802**	4475.661**	10.902**
Reciprocals	27	8.354**	471.788**	0.750**	0.863**	1.494**	107.231**	13.321**	2.224**	3122.593**	7.280**
F_1 Vs Reciprocals	1	9.054**	8.061	1.339**	3.343**	0.005	14.881	11.006**	12.595	2371.810**	1.414
Error	126	0.959	35.549	0.148	0.089	0.177	40.799	1.566	1.050	89.282	0.958
Total	191	3.846	197.425	0.34	0.402	0.585	71.79	6.148	1.883	1388.941	4.042

* - Significant at 5%   ** - Significant at 1%.

inter-nodal length, fruit length, fruit diameter, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare. Heterobeltiosis was computed as deviation of mean performance of F_1 from that of better parent (BP). The estimates of economic heterosiswere computed as deviation of mean performance of F_1 from that of the commercial hybrids (Syngenta 152, Mahyco No. 10, Mahyco No. 55, and Mahyco No. 64). Magnitude of heterosis and average heterosiswas computed according to Turner (1953) and Hayes *et al.* (1956).

Results and Discussion

The variance due to treatments was found highly significant for all the characters studied. The parents and hybrids exhibited highly significant variation for all the characters studied. It indicates significant difference among parents and hybrids. Parents Vs hybrids exhibited significant variation for days to 50% flowering, plant height, number of branches days, inter-nodal length, number of fruits, fruit weight, average fruit yield per plant and yield per hectare and non-significant variation for fruit length and fruit diameter. Variance due to F_1's and reciprocal was found significant for all characters studied. Variance due to F_1's v/s reciprocal interaction was highly significant for days to 50% flowering, number of branches per plant, inter-nodal length, number of fruits, average fruit yield per plant and non-significant for plant height, fruit length, fruit diameter, fruit weight and fruit yield per hectare (table 1).

The range of heterosis for the trait fruit yield per plant was -20.78 to 96.46 per cent over mid parent, -35.22 to 89.13 per cent over better parent and -29.82 to 78.25 per cent over commercial hybrid, -9.15 to 6.08 per cent and -3.37 to 6.08 per cent for days to 50 per cent flowering, -5.56 to 4.63, -7.48 to 4.26 and 1.49 to 12.69 for days to 50 per cent flowering, -29.69 to 56.46, -40.37 to 35.77 and -15.56 to 85.02 for plant height, -30.00 to 73.33, -36.36 to 62.50 and -33.33 to 44.44 for number of branches per plant, -15.69 to 44.56, -27.12 to 37.21 and 27.72 to 103.96 for inter-nodal length, -5.24 to 11.50, -11.00 to 6.97 and -6.94 to 12.75 for fruit length, -8.10 to 10.28, -11.67 to 9.43 and -7.27 to -7.27 for fruit diameter, -14.67 to 56.36, -30.43 to 48.28 and -23.81 to 47.62 for average fruit weight and -12.41 to 96.96, -24.42 to 89.10 and -15.6 to 86.68 for fruit yield per hectare, respectively (table 2).

The standard heterosisfor days to 50% flowering over Mahyco 64 ranged from 2.47 per cent (ArkaAnamika x DBh-55) to 16.67 per cent (DBh-43 x DBh-39) and none of hybrids exhibited significant negative heterosis. The negative average heterosis (-2.87%) also substantiated

Table 2 : Estimation of heterosis range over mid parent, better parent and standard checks for 10 characters in 56 okra hybrids.

Characters	MP	BP	Mahyco No. 10	Mahyco No. 55	Mahyco No. 64	Syngenta
Days to 50% flowering	-5.56 to 4.63	-7.48 to 4.26	-2.16 to 8.63	-1.45 to 9.42	1.49 to 12.69	0 to 11.03
Plant height (cm)	-29.69 to 56.46	-40.37 to 35.77	-15.56 to 85.02	-0.53 to 117.95	22.58 to 168.59	55.91 to 241.61
Number of branches	-30.00 to 73.33	-36.36 to 62.50	-33.33 to 44.44	-33.33 to 44.44	-33.33 to 44.44	0 to 116.67
Internodal length (cm)	-15.69 to 44.56	-27.12 to 37.21	-9.15 to 45.07	-8.51 to 46.10	-7.86 to 47.14	27.72 to 103.96
Fruit length (cm)	-5.24 to 11.50	-11.00 to 6.97	-6.94 to 12.75	5.32 to 27.59	3.74 to 25.69	-1.89 to 18.87
Fruit diameter (cm)	-8.10 to 10.28	-11.665 to 9.432	-7.27 to 7.27	-1.92 to 13.46	2.00 to 18.00	-3.77 to 11.32
Number of fruits	-14.67 to 56.36	-30.43 to 48.28	-23.81 to 47.62	-23.81 to 47.62	-11.11 to 72.22	-11.11 to 72.22
Average fruit weight (g)	-7.44 to 18.70	-12.50 to 16.67	-1.79 to 30.36	3.77 to 37.74	7.84 to 43.14	3.77 to 37.74
Fruit yield per plant (g)	-20.78 to 96.46	-35.22 to 89.13	-27.50 to 84.13	-22.44 to 96.99	-28.74 to 80.99	-29.82 to 78.25
Fruit yield per hectare (T)	-12.41 to 96.46	-24.42 to 89.10	-14.59 to 88.91	-10.95 to 96.97	-15.6 to 86.68	-12.72 to 93.05

Table 3 : Range and mean performance of parents and hybrids and average heterosis for different characters in okra.

S. no.	Characters	Parents		Hybrids		Average heterosis (%)
		Range	Mean	Range	Mean	
1	Days to 50% flowering	59-62	61	55-63	60	-2.87
2	Plant height (cm)	48.3-73.7	61.2	44-96.3	68.3	13.74
3	Number of branches per plant	2.0-4.0	3	2.0-4.0	3	9.66
4	Inter nodal length (cm)	4.3-5.9	4.9	4.3-6.9	5.4	15.48
5	Fruit length (cm)	13.8-16.4	14.7	13.8-16.8	14.9	1.26
6	Fruit diameter (cm)	1.7-2.0	1.8	1.7-2.0	1.8	0.45
7	Number of fruits per plant	9.0-16	13	10.0-21.0	14	12.3
8	Average fruit weight (g)	10 to 12	11.13	10 to 16	11.88	2.79
9	Fruit yield per plant (g)	89.59-194.66	147.99	96.81-285.10	169.95	19.6
10	Fruit yield per hectare (T/ha)	4.96-10.82	8.19	5.38-15.84	9.63	21.09

the fact that the hybrids in general were early in flowering. Swamy Rao (1997), Shukla and Gautam (1990), Bendale *et al*. (2003), Dahake *et al*. (2006), Amutha *et al*. (2007) and Weerasekara *et al*. (2008) also reported heterosis for earliness in okra hybrids.In case of plant height, 38 hybrids exhibited significant standard heterosis and an average heterosis of 13.74 per cent was observed for this character over the parents inferring that hybrids were taller than their parents. The predominance of tallness over dwarfness, indicated tallness as a dominant character as reported by Singh *et al.* (1975), Vijay and Manohar (1986),Wankhade *et al.* (1997), Dhankar *et al.* (1996), Dhankar and Dhankar (2002), Dahake *et al.* (2006), Amutha *et al*. (2007), Sriram *et al*. (2007) and Weerasekara *et al*. (2008). Four hybrids showed highly significant heterosis and an average heterosis was 9.66 per cent for number of branches per plant indicating that hybrids had more branches than their respective parents. 5 hybrids over mid-parent, 8 over better parent had expressed negative heterosis for intermodal length. Negative heterosis is desirable for the character inter-nodal length. But, only few crosses recorded negative heterosis over mid parent, better parent and none of the hybrids exploited negative heterosis over standard checks. The average heterosis for the character was 15.48 per cent which indicates that hybrids had longer inter-nodal length than the parents.

Eight hybrids over mid-parent, two over better parent, 9 over commercial check for fruit length. The positive average heterosis (1.26) also substantiated the fact that the hybrids in general had longer fruits. Shukla and Gautam (1990), Bendale *et al*. (2003), Dahake *et al*. (2006) and Weerasekara *et al.* (2008) also observed similar results. The positive average heterosis also substantiated the fact that the hybrids had more diameter. These results are in conformity with earlier findings of More and Patil(1997) and Dahake *et al*. (2006).The number of fruits per plant of the parents and hybrids ranged from 9 to 16 and 11 to 21, respectively. In case of number of fruits per plant, 23 hybrids exhibited significant positive heterosis over mid-parent, 9 over better parent, 11over superior check. The positive average heterosis (12.30%) also substantiated the fact that the hybrids in general had higher fruit number. Poshiya and Shukla (1986), Dhankar and Dhankar (2002),

Table 4 : Performance of top 10 hybrids for yield and yield related components in okra.

Crosses/ checks	Days to 50 % flowering	Plant height (cm)	Number of branches per plant	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (T/ha)
ArkaAnamika'DBh-43	56.67	94.87	2.67	5.53	16.23	1.93	20.67	16.00	285.10	15.84
DBh-37 × ArkaAbhay	56.67	96.33	2.33	6.47	15.33	1.90	19.67	13.00	248.03	13.78
ArkaAnamika × DBh-47	57.67	66.87	2.33	5.80	16.80	1.87	14.67	16.00	255.29	13.55
DBh-43 × ArkaAnamika	59.67	64.67	4.33	5.60	15.83	1.90	18.67	12.00	232.88	12.94
ArkaAnamika × DBh-37	57.00	90.27	3.33	6.13	15.17	1.90	17.00	13.00	224.93	12.50
Arka Abhay × Arka Anamika	57.67	51.77	3.67	6.13	15.57	1.73	19.67	12.00	235.31	12.17
DBh-39 × ArkaAnamika	59.33	88.00	3.33	5.73	16.03	1.97	15.33	14.00	207.80	11.54
ArkaAnamika × DBh-39	57.33	63.20	3.00	5.97	14.90	1.80	16.33	13.00	205.15	11.40
DBh-55 × ArkaAnamika	59.67	57.67	3.00	4.50	15.67	1.80	16.00	13.00	202.47	11.22
DBh-43 × ArkaAbhay	60.67	68.00	4.00	5.43	16.13	1.87	15.67	12.00	187.23	11.15
Mahycono.10	58.67	52.07	3.00	4.73	14.90	1.83	14.00	11.00	154.84	8.38
Mahycono.55	59.33	44.20	3.00	4.70	13.17	1.73	14.00	10.00	144.73	8.04
Mahycono.64	54.00	35.87	3.00	4.67	13.37	1.67	12.00	13.00	157.52	8.48
Syngenta519	56.67	28.20	2.00	3.37	14.13	1.77	12.00	13.00	159.95	8.20

Mamta Rani *et al.* (2002), Rewale *et al.* (2003), Bendale *et al.* (2004) and Weerasekara *et al*. (2008) also observed heterosis for increased number of fruits per plant in okra. The positive average heterosisfor fruit weight (2.79) also substantiated the fact that the hybrids in general had higher fruit weight. Similar results were obtained by Mamata rani *et al.* (2002), Bendale *et al.* (2004) and Amutha *et al*. (2007). ArkaAnamika x DBh-30 recorded high standard heterosis for number of fruits per plant, average fruit weight, fruit yield per plant and fruit yield per hectare.

In case of fruit yield per plant, maximum significant positive heterosis was observed in the cross DBh-55 x DBh-47 over mid-parent (96.46%), better parent (89.13%) and ArkaAnamika x DBh-43 over commercial checks Mahyco 10 (84.13%), Mahyco 55 (96.99%), Mahyco 64 (80.99%) and Syngenta 519 (78.25%). Among 56 crosses, 31 crosses over mid-parent, 14 over better parent and over the commercial checks Mahyco 10 (28 crosses), Mahyco 55 (35 crosses), Mahyco 64 (23 crosses) and Syngenta 519 (20 crosses) exhibited positive and significant heterosis for fruit yield per plant. The hybrid ArkaAnamika x DBh-43 had the highest standard heterosis over popular checks Mahyco 10 (84.13%), Mahyco 55 (96.99%), Mahyco 64 (80.99%) and Syngenta 519 (78.25%) as compared to other crosses. This hybrid is worth for commercial exploitation after large scale evaluation over different environments. The average heterosis for the character was 19.60 per cent which showed that hybrids had higher fruit yield per plant than parents (table 3). Similar conclusions have been drawn by Vijay and Manohar (1986), Shukla and Gautam (1990), Rewale *et al*. (2003), Bendale *et al*. (2004) and Weerasekara *et al*. (2008).

Among 56 hybrids, ArkaAnamika x DBh-43 (15.84), DBh-37 x ArkaAbhay (13.78), ArkaAnamika x DBh-47 (13.55), DBh-43 x ArkaAnamika (12.94), ArkaAnamika x DBh-37 (12.50), ArkaAbhay x ArkaAnamika (12.17), DBh-39 x ArkaAnamika (11.54), ArkaAnamika x DBh-39 (11.40), DBh-55 x ArkaAnamika (11.22) and DBh-43 x ArkaAbhay (11.15) recorded higher fruit yield per hectare (t/ha) and were superior to commercial checks Mahyco 10 (8.38), Mahyco 55 (8.04), Mahyco 64 (8.48) and Syngenta 519 (8.20) (table 4). Evaluation of these superior hybrids in multi-location trails in larger plots would be essential for reliable conclusion towards their commercial exploitation.

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