Volume : 2 | Issue : 1 | January 2013 ISSN - 2250-1991

Research Paper Agriculture

Studies on the Heterotic Potential of Single and Three-way Cross Hybrids of Okra (Abelmoschus Esculentus (L.) Moench.)

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ABSTRACT

Fifteen hybrids of diallel origin and 60 three-way cross hybrids of triallel origin were compared for their heterotic potential. Eight single cross hybrids and 60 three-way cross hybrids showed significant positive relative heterosis for fruit yield per plant. Six single cross hybrids and 53 three-way cross hybrids exhibited significant positive better parent heterosis for fruit yield per plant. However, the magnitude of heterobeltiosis was higher with three way cross combinations. The three-way cross combinations which recorded higher better parent heterosis had the higher heterobeltiotic single cross combinations as grand parents.

Keywords: Okra, diallel, triallel, heterosis

Introduction

In autogamous crops like okra (Bhendi), recombination breeding has extensively been used to develop the variability reservoir for exploitation in breeding programmes. In a systematic breeding programme, it is essential to identify the elite parents for hybridization and superior crosses to expand the variability reservoir for selection of superior genotypes. So far, single cross hybrids have been produced and evaluated for their breeding potential. However, for a quantum jump in yield and other quantitative characters, it is better to resort to multiple crossing programme. The information on the heterotic potential of three-way cross hybrids is almost lacking in okra. Keeping this in view, the present investigation was undertaken to compare the heterotic potential of single and three way cross hybrids of okra.

Materials and Methods

Six genotypes of okra viz., Arka Anamika, Parbhani Kranti, Pusa Sawani, EC-112112, EC-305626 and IC-128076 were mated in full diallel fashion during July, 2003. During February, 2004, fifty per cent of the F1 hybrids of 15 direct crosses obtained through diallel mating design were sown in the field along with their parents. The balance 50 per cent of the crossed seeds was kept as reserve. All the parents and their hybrids were selfed. Apart from this, the 15 direct F1 hybrid plants were crossed with four unrelated parents, to effect as many as 60 three way cross hybrids. Three staggered sowings of parents and F1 hybrids were done with 10 days interval to synchronize flowering. The parents and their single as well as three way cross hybrids were sown in RBD with three replications, in two rows plot of size 4.5 m length, during July 2004. A row-to-row spacing of 60 cm and plant-to-plant spacing of 45 cm was adopted. Recommended agronomic practices and need based plant protection measures were adopted. Observations were recorded on five randomly selected competitive plants in each entry per replication for fruit yield per plant. The mean data were subjected to statistical analysis. Heterobeltiosis was worked out following standard methods (Eswaran,2008).

Results and Discussion

Development of hybrid is one of the most important genetic tool in achieving higher fruit yield in okra. Emphasis is given in the development of single cross okra hybrids. Of late, interest is developed to find out the scope of three way cross hybrids which provide broad genetic base to sustain the climatic fluctuations, especially under stress conditions.

The analysis of variance for diallel analysis revealed that the parents and their 15 direct hybrids differed among themselves for all the three traits of interest. The ANOVA for triallel analysis also revealed that the 60 crosses differed among themselves. The result indicated the presence of sufficient amount of genetic variability. Therefore, further analysis is appropriate (Eswaran,2008).

The mean data on fruit yield per plant is presented in Table 1. Fruit yield per plant was maximum with the parent AA. The single cross hybrids viz., AA ´ PK and PK ´ EC-112112 portrayed higher fruit yield per plant. When low yielding single cross hybrids of PK ´ PS, AA ´ IC-128076 and AA ´ EC-305626 were crossed with their low performing parents viz., IC-128076, EC-112112 and EC-305626, respectively, the resulting three-way cross hybrids exhibited higher fruit yield per plant (Table 2). The result indicated that no generalization can be done with regard to the performance of the three-way cross hybrids from that of the performance of their parents. It seemed that the genetic constitution of the three-way cross hybrids decide the performance of the three way cross hybrids rather than the phenotypic performance of their parents (F1 or lines). When low or highly performing F1 hybrids were crossed with low or high performing parent, the resulting three-way cross hybrids recorded higher performance with regard to the component characters of the fruit yield per plant. It is quite interesting to conceive that low performing F1 hybrids when crossed with low performing parent produced high yielding three-way cross hybrids. It amply indicated that the combination of genes decides the yielding potential rather than the phenotypic performance of the parents.

The success of single cross or three way cross hybrids depends upon the magnitude of heterosis. In the present investigation, 15 single cross hybrids and 60 three-way cross hybrids were compared to assess the feasibility of multiple cross breeding in okra. The extent of heterosis for fruit yield per plant in single cross hybrids is presented in Table 3. The extent of heterosis over mid-parent and better parent was significant in 60 and 53 out of 60 three way cross hybrids, respectively, for fruit yield per plant (Table 4). The relative heterosis was highest with (PS ´ IC-128076) ´ EC-305626 followed by (EC-112112 ´ IC-128076) ´ PS and (PS ´ IC-128076) ´ PK. The three way cross combinations which recorded high mid-parent heterosis also witnessed significant positive mid-parent heterosis for the remaining two yield contributing traits.

The three-way cross combinations viz., (PS ´ IC-128076) ´ EC-305626; (EC-305626 ´ IC-128076) ´ PS and (EC-112112 ´ IC-128076) ´ PS portrayed higher better parent heterosis for fruit yield per plant. These three-way cross combinations also exhibited higher better parent heterosis for number of fruits per plant and fruit weight (Eswaran, 2008).

Comparison between single cross hybrids and three-way cross hybrids indicated that the following cross combinations viz., AA ´ PK, PK ´ EC-112112, PK ´ EC-305626; PS ´ EC-112112, PS ´ EC-305626 and EC-112112 ´ IC-128076 recorded higher better parent heterosis for fruit yield per plant. The three-way cross combinations which recorded higher fruit yield per plant involved the aforementioned crosses as grand parents. However, the magnitude of heterobeltiosis was higher with three-way cross combinations. Kide et al. (1985) reported that the performance of the three-way cross hybrids was on par with that of single cross hybrids in sorghum. The variation between the lowest and highest phenotypic expression was observed to the maximum in the three-way cross hybrids (Table 5). Such a result was earlier reported by Gridharan (1996) in maize. The identified cross combinations could well be utilized in heterosis as well as recombination breeding.

Table 1: Mean performance of parents and their hybrids for fruit yield per plant

Parents	AA	PK	PS	EC-112112	EC-305626	IC-128076
AA	**490.35**	685.31	563.27	358.39	377.04	391.12
PK	742.12	**441.82**	318.26	617.84	648.58	446.71
PS	429.29	298.84	**348.57**	438.61	499.23	328.73
EC-112112	394.73	672.61	443.23	**402.58**	360.75	511.03
EC-305626	403.13	682.83	369.23	343.63	**357.84**	319.74
IC-128076	385.99	449.48	318.91	458.24	373.54	**314.20**

Diagonal values indicate parental mean General mean = 444.05
CD at 1 per cent level = 31.41± 8.44

Table 2: Mean values of three-way cross hybrids

S. No.	Three-way cross hybrids	Fruit yield per plant (g)
	AA x PK x PS	543.73
	AA x PK x EC- 112112	528.23
	AaxPKxEC-305626	501.97
	AA x PK x IC-128076	739.90
	AA x PS x PK	559.87
	AaxPSxEC-112112	747.47
	AaxPSxEC-305626	696.37
	AaxPSxIC-128076	446.60
	AA x EC-112112xPK	624.27
	AA x EC-112112 x PS	756.36
	AA x EC-112112 x EC-305626	648.67
	AA x EC-112112 x IC-128076	668.43
	AaxEC-305626 x PK	587.27
	AaxEC-305626xPS	615.70
	AA x EC-305626 x EC-112112	555.87
	AA x EC-305626 x IC-128076	873.66**
	AA x IC-128076 x PK	555.76
	AA x IC-128076 x PS	674.07**
	AA x IC-128076 x EC-112112	919.93**
	AA x IC-128076 x EC-305626	745.93
	PK x PS x AA	595.43
	PK x PS x EC-112112	601.33
	PK x PS x EC-305626	622.40
S. No.	Three-way cross hybrids	Fruit yield per plant (g)
	PK x PS x IC-128076	921.10**
	PK x EC-112112 x AA	777.83**
	PKxEC-112112xPS	757.66
	PK x EC-112112 x EC-305626	822.40**
	PK x EC-112112 x EC-305626	700.87
	PK x EC-305626 x AA	654.56
	PKxEC-305626xPS	692.60
	PK x EC-305626 x EC-112112	496.83
	PK x EC-305626 x IC-128076	645.06
	PK x IC-128076 x AA	775.37**
	PKxIC-128076xPS	538.53
	PK x IC-128026 x EC-112112	625.23
	PK x IC-128076 x EC-305626	621.50
	PS x EC-112112xAA	705.63
	PS x EC-112112 x PK	593.87
	PS xEC-112112 x EC-305626	714.43
	PS x EC-112112 x IC-128076	743.80
	PS x EC-305626 x AA	835.60**
	PSxEC-305626 xPK	624.36
	PS x EC-305626 x EC-112112	657.10
	PS x EC-305626 x IC-128076	727.30
	PS x IC-128076 x AA	797.23**
	PS x IC-128076 x PK	854.83**
S. No.	Three-way cross hybrids	Fruit yield per plant (g)
	PS x IC-128076 x EC-112112	719.70
	PS x IC-128076 x EC-305626	848.80**
	EC-112112 x EC-305626 x AA	793.73**
	EC-112112 x EC-305626 x PK	722.83
	EC-112112 x EC-305626 x PS	740.86
	EC-112112 x EC-305626 x IC-128076	768.50**
	EC-112112 x IC-128076 x AA	828.33**
	EC-112112 x IC-128076 x PK	810.53**
	EC-112112 x IC-128076 x PS	851.33**
	EC-112112 x IC-128076 x EC-305626	797.16**
	EC-305626 x IC-128076 x AA	723.63
	EC-305626 x IC-128076 x PK	534.30
	EC-305626 x IC-128076 x PS	783.13**
	EC-305626 x IC-128076 x EC-112112	704.10
	Grand mean	695.33
	S.E	26.43
	CD at 1 per cent	69.27

** Significant at 1per cent level

Table 3: Estimates of heterosis of diallel hybrids for fruit yield per plant

Sl. No.	Cross combinations	Relative heterosis (di)	Hetero-beltiosis (dii)	Standard heterosis (diii)
		Direct	Direct	Direct
1	AA x PK	47.03**	39.76**	55.11**
2	AA x PS	34.28**	14.87	27.49**
3	AA x EC-112112	-19.73**	-26.91**	-18.88**
4	AA x EC-305626	-11.10**	-23.11**	-14.66**
5	AA x IC-128076	-2.77	-20.24**	-11.48**
6	PK x PS	19.47**	-27.97**	-27.97**
7	PK x EC-112112	46.34**	39.84**	39.84**
8	PK x EC-305626	62.21**	46.80**	46.80**
9	PK x IC-128076	18.17**	1.11	1.11

10	PS x EC-112112	16.78**	8.95**	-0.73
11	PS x EC-305626	41.34**	39.51**	12.99
12	PS x IC-128076	-0.80	-5.69*	-25.60*
13	EC-112112 x EC-305626	-5.12**	-10.39**	18.35**
14	EC-112112 x IC-128076	42.59**	26.94**	15.66**
15	EC-305626 x IC-128076	-4.85	-10.65	-27.63**

* Significant at 5 per cent level

** Significant at 1 per cent levelTable 4: Heterosis in three way cross hybrids for fruit yield per plant

Three way cross hybrids	Fruit yield per plant	
	Relative heterosis (di)%	Hetero-beltiosis (dii) %
AA x PK x PS	27.36**	10.89
AA x PK x EC- 112112	18.73**	7.73
AA x PK x EC-305626	16.74**	2.37
AA x PK x IC-128076	78.09**	50.89**
AA x PS x PK	31.14**	14.18
AA x PS x EC-112112	80.62**	52.44**
AA x PS x EC-305626	74.56**	42.01**
AA x PS x IC-128076	16.19*	-8.92*
AA x EC-112112xPK	40.31**	27.31**
AA x EC-112112 x PS	82.77**	54.25**
AA x EC-112112 x EC-305626	55.58**	32.29**
AA x EC-112112 x IC-128076	66.12**	36.32**
AA x EC-305626 x PK	36.57**	19.76**
AA x EC-305626 x PS	54.34**	25.56**
AA x EC-305626 x EC-112112	33.33**	13.36
AA x EC-305626 x IC-128076	125.48**	78.16**
AA x IC-128076 x PK	33.77**	13.34*
AA x IC-128076 x PS	75.37**	37.47**
AA x IC-128076 x EC-112112	128.62**	87.61**
AA x IC-128076 x EC-305626	92.52**	52.12**
PK x PS x AA	39.47**	21.43**
PK x PS x EC-112112	51.22**	36.10**
PK x PS x EC-305626	62.62**	40.82**
PK x PS x IC-128076	150.17**	108.48**
PK x EC-112112 x AA	74.83**	58.63**
PK x EC-112112 x PS	90.53**	71.49**
PK x EC-112112 x EC-305626	105.22**	86.14**
PK x EC-112112 x EC-305626	81.48**	58.63**
PK x EC-305626 x AA	52.22**	33.49**
PK x EC-305626 x PS	80.96**	56.76**
PK x EC-305626 x EC-112112	23.98**	12.45
PK x EC-305626 x IC-128076	73.74**	46.00**
PK x IC-128076 x AA	86.63**	58.13**
PK x IC-128076 x PS	46.26**	21.89**
PK x IC-128026 x EC-112112	61.89**	41.51**
PK x IC-128076 x EC-305626	67.39**	40.67**
PS x EC-112112 x AA	70.51**	43.90**
PS x EC-112112 x PK	49.34**	34.41**
PS x EC-112112 x EC-305626	93.27**	77.46**
PS x EC-112112 x IC-128076	109.45**	84.76**
PS x EC-305626 x AA	109.47**	70.41**
PS x EC-305626 x PK	63.13**	41.32**
PS x EC-305626 x EC-112112	77.76**	63.22**
PS x EC-305626 x IC-128076	113.79**	103.26**
PS x IC-128076 x AA	107.41**	62.58**
PS x IC-128076 x PK	132.17**	93.58**
PS x IC-128076 x EC-112112	102.67**	78.77**
PS x IC-128076 x EC-305626	149.50**	137.20**
EC-112112 x EC-305626 x AA	90.38**	61.87**
EC-112112 x EC-305626 x PK	80.37**	63.60**
EC-112112 x EC-305626 x PS	100.42**	84.03**
EC-112112 x EC-305626 x IC-128076	114.54**	90.89**
EC-112112 x IC-128076 x AA	105.86**	68.93**
EC-112112 x IC-128076 x PK	109.87**	83.45**
EC-112112 x IC-128076 x PS	139.73**	111.47**
EC-112112 x IC-128076 x EC-305626	122.54**	98.01**
EC-305626 x IC-128076 x AA	86.76**	47.57**
EC-305626 x IC-128076 x PK	43.90**	20.93**
EC-305626 x IC-128076 x PS	130.20**	118.85**
EC-305626 x IC-128076 x EC-112112	96.56**	74.90**

* significant at 5% level
** significant at 1% level

Table 5: Comparison of parents, single cross and three ways cross hybrids for lowest, average and highest values

Characters	Lowest values			Average values			Highest values		
	Parents	Single cross hybrids	Three way cross hybrids	Parents	Single cross hybrids	Three way cross hybrids	Parents	Single cross hybrids	Three way cross hybrids
Fruit yield per plant	314.20	298.84	528.34	392.56	444.05	695.33	490.35	742.12	921.10

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