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Short Note

Identification of heterotic combinations and breeding for higher fruit yield and earliness in okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract

A field experiment was conducted during *kharif* 2005 to spot out the heterotic combinations for higher fruit yield and earliness in okra amongst eighteen cross-combinations developed in line x tester mating design after crossing six diverse lines with three well adapted varieties as testers. The analysis of variance for node at which first flower appears, days to 50% flowering, days to first picking and fruit yield per plant indicated significant differences among genotypes (hybrids and parents), which showed the genetic diversity among the genotypes evaluated. The maximum standard heterosis (Parbhani Kranti as standard check) for fruit yield was observed in the crosses, IC-90269 x P-8 (98.2%), IC-90269 x Parbhani Kranti (87.34%) and EC-169468 x Parbhani Kranti (69.25%). These crosses also displayed significant negative standard heterosis for days to 50% flowering and days to first picking. Non-additive gene action in the inheritance of fruit yield per plant and additive gene action for earliness (node at which first flower appears, days to 50% flowering and days to first picking) was observed.

Key words: Okra, *Abelmoschus esculentus*, heterosis, gene action.

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable crop of tropical and subtropical parts of the world. The immature unripe fruits are used in a variety of ways and are rich source of vitamins (A, B, C) and minerals (Fe, Ca, P) besides having many medicinal properties. It is largely exported to Middle East countries and accounts for about 70 per cent of the foreign exchange earnings from the export of fresh vegetables (Dhankhar and Mishra, 2001). The early maturing hybrids are of great importance in okra to fetch high prices prevailing in the market early in the season.

Eighteen F_1s along with 9 parents (six lines viz., VRO-4, EC-169464, EC-169468, IC-90269, IC-31850 and IC-32398 used as female parent and three testers viz., P-8, Parbhani Kranti and Arka Anamika as male parent) were evaluated in experimental farm of the Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, H.P. during *Kharif*, 2005 in randomized block design with three replications. Each experimental plot consisted of two rows of 1.5 m length. The plants were spaced at 60 cm row to row and 15 cm plant to plant. The Experimental Farm is located at an elevation of 1290.8 m above mean sea level, $32^0 6'$ N latitude and $76^0 3'$ E longitude, representing mid hill zone of Himachal Pradesh. The soil of the zone is podzolic type with pH ranging from 5-5.6. The data were recorded on 10 competitive plants selected at random on some fruit characteristics viz., node at which first flower appears, days to 50% flowering, days to first picking and fruit yield per plant. For computation of standard heterosis, Parbhani Kranti (tester) was taken as standard check.

Table 1. Analysis of variance for design of experiment

Source of variation	Mean square due to		
Trait			
	Replication	Treatment	Error
df	2	26	52
Node at which first flower appears	3.468*	0.777*	0.224
Days to 50% flowering	3.351	16.320*	2.587
Days to first picking	2.175	52.195*	7.757
Yield per plant	502.011	2077.636*	204.856

*Significant at 5% level of significance

In okra, node at which first flower appears, days to 50% flowering and days to first picking are considered as good indices of earliness. The analysis of variance for these parameters along with fruit yield per plant indicated significant differences among genotypes (hybrids and

parents), which showed the diversity among the genotypes evaluated.

Heterosis study for node at which first flower appears revealed that none of the cross combination could exhibit significant negative heterosis either over better parent or over the standard check. This may happen either due to the internal cancellation of both positive and negative effects or when the dominance is not of unidirectional nature (Mather and Jinks, 1982). However, IC-169498 x Arka Anamika, VRO-4 x Parbhani Kranti and IC-32398 x Arka Anamika, over better parent and VRO-4 x Parbhani Kranti over standard check exhibited non -significant negative heterosis.

Early flowering is another trait, which accounts for early fruit yield. For days to 50% flowering, the heterosis ranged from –9.64 (IC-32398 x P-8) to 3.57% (EC-169468 x Arka Anamika) and –11.40 (EC-169468 x Parbhani Kranti) to 1.25% (VRO-4 x P–8) over better parent and the standard check (Parbhani Kranti), respectively. Three crosses over better parent and 11 over the standard check took less number of days to 50% flowering. From heterosis estimates and *per se* performance, it was observed that the crosses, EC-169468 x Parbhani Kranti, IC-32398 x P-8 and IC-31850 x Parbhani Kranti were amongst the top ranking cross combinations for earliness.

Table 2. Estimation of heterosis for node at which first flower appears, days to 50% flowering, days to first picking and fruit yield per plant over better parent (BP) and standard check, Parbhani Kranti (SC)

Trait	Node at which first flower appears		Days to 50% flowering		Days to first picking		Fruit yield per plant	
	% Increase over		% Increase over		% Increase over		% Increase over	
Cross	BP	SC	BP	SC	BP	SC	BP	SC
VRO-4 x P-8	23.51*	13.40	2.56	1.25	9.21*	4.69	14.83	19.61
VRO-4 x Arka Anamika	23.91*	20.84*	1.25	0.69	3.76	5.59	-16.76	6.04
VRO-4 x Parbhani Kranti	-1.53	-3.97	-1.51	-1.52	0.42	0.43	-4.14	9.75
EC-169464 x P-8	17.02	7.44	3.21	0.46	2.04	-3.07	-19.11*	3.05
EC-169464 x Arka Anamika	19.39*	28.29*	-0.17	-2.83	3.74	-1.46	19.48*	52.22*
EC-169464 x Parbhani Kranti	33.25*	33.25*	1.98	-0.74	2.39	-2.74	12.40	43.19*
EC-169468 x P-8	19.73*	9.93	0.64	-7.07*	5.04	-1.46	6. 55	22.00
EC-169468 x Arka Anamika	-2.75	14.14	3.57	-4.36*	11.09*	4.22	-5. 51	7.98
EC-169468 x Parbhani Kranti	25.81*	25.81*	-4.05	-11.40*	2.42	-3.92	47.82*	69.25*
IC-32398 x P-8	23.51*	13.40	-9.64*	-10.84*	-8.80*	-12.68*	19.10*	49.71*
IC-32398 x Arka Anamika	-1.43	19.85*	-7.12*	-8.35*	-14.66*	-14.67*	23.52*	55.26*
IC-32398 x Parbhani Kranti	14.14	14.14	-4.22	-5.48*	-3.69	-3.69	3.75	30.41*
IC-90269 x P-8	33.24*	22.33*	-3.77	-5.01*	-2.68	-6.72*	47.85*	98.20*
IC-90269 x Arka Anamika	27.21*	35.73*	-2.13	-2.68	-8.56*	-6.96*	8.36	45.26*
IC-90269 x Parbhani Kranti	26.55*	26.55*	-4.62*	-4.63*	-11.30*	-11.30*	39.75*	87.34*
IC-31850 x P-8	8.91	0.00	1.07	-5.50*	3.09	-1.18	54.37*	48.39*
IC-31850 x Arka Anamika	12.24	36.48*	1.81	-4.81*	-9.83*	-9.84*	35.95*	29.34*
IC-31850 x Parbhani Kranti	18.36	18.36	-2.94	-9.26*	-11.70*	-11.97*	29.62*	29.62*
SE±	0.38	0.38	1.31	1.31	2.27	2.27	11.69	11.69

Early maturing strains can also be identified by the parameter, days to first picking. The range of heterosis for the trait varied from 14.66 (IC-32398 x Arka Anamika) to 11.09% (EC-169468 x Arka Anamika), over better parent and standard check, respectively. Six crosses over better parent and seven over the standard check showed significant negative heterosis. The crosses, IC-32398 x Arka Anamika, IC-32398 x P-8 and IC-31850 x Parbhani Kranti were among the top scoring crosses which took least days to first picking. In literature, earliness in okra has been reported by the researchers like Partap *et al.* (1981), Ahmed *et al.*(1999) and Rewale *et al.* (2003).

In addition to early maturity, higher yield is the another prime objective especially in vegetable improvement programme and unless a new hybrid has a potential equal to or exceeding that of high yielding well adapted cultivar or hybrid, it will not find much favour among the vegetable growers. The magnitude of heterosis for this trait ranged from –19.11 (EC169464 x P-8) to 54.37% (IC-31850 x P-8) over better parent and

3.05(EC169464 x P-8) to 98.20% (IC-90269 x P-8) over standard check, respectively. Exactly one half of the cross combinations over better parent and two-third over the standard check produced significantly higher fruit yield. The mean performance of the parents and crosses for this trait ranged from 90.33 g (P-8) to 130.84 g (IC-90269) and 100.57 g (EC-169464 x P-8) to 193.44 g (IC-90269 x P-8), indicating the presence of sufficient genetic variability among the genotypes used in the present study. The most heterotic crosses were IC-90269 x P-8 (98.20%), IC-90269 x Parbhani Kranti (87.34%) and EC-169468 x Parbhani Kranti (69.25%) producing per plant fruit yield of 193.44 g, 182.84 g and 165.19 g in comparison to 97.6 g of Parbhani Kranti, a widely accepted variety of the region. Hybrid vigour for yield per plant has also been reported by Chaudhary *et al.*, (1991), Dhankhar and Dhankhar (2001) and Bhalekar *et al.* (2004). In general, the cross combinations exhibiting the maximum standard heterosis for these traits involve one parent a land variety (Parbhani Kranti), this will be of great utility in producing early maturing and high yielding hybrids/strains.

Table 3. Estimates of genetic components of variance and proportional contribution of lines, testers and their interactions

Component	Node at which first flower appears	Days to 50% flowering	Days to first picking	Fruit yield per plant
σ^2 GCA (lines)	0.01	3.85	11.33	272.55
σ^2 GCA (testers)	0.06	-0.04	-0.89	-46.62
σ^2 GCA (average)	0.045	1.25	3.18	59.769
σ^2 SCA	0.08	1.47	6.22	428.8
σ^2 A	0.09	2.52	6.36	119.54
σ^2 D	0.08	1.47	6.22	428.8
σ^2 A/σ^2 D	1.12	1.71	1.02	0.27
Proportional contribution of lines (%)	26.89	74.22	68.62	54.91
Proportional contribution of testers (%)	29.77	3.88	2.39	3.62
Proportional contribution of line x tester interaction (%)	43.32	21.90	28.99	41.47

Hybrid vigour for yield and its component traits in okra have been reported from various quarters but it has not been exploited so commercially yet. Lack of the availability of stable genetic mechanism (excepting hand emasculation and pollination) for hybrid seed production and susceptibility to various biotic stresses are the major bottlenecks in the popularization of hybrids among the farmers. Unless the hybrids possess resistance to major biotic stresses and hybrid seed becomes available at cheaper rates, these will be of little practical use to the growers.

Gene action

The estimates of specific combining ability variances (σ^2 SCA) were higher in magnitude as compared to general combining ability variances (σ^2 GCA average) for all the traits studied (Table 3). The lines showed higher magnitude of general combining ability variances (σ^2 GCA) than testers for all the traits except node at which first flower appears for which testers contributed more than the lines.

The dominant components of variance (σ^2D) were higher than additive components of variance (σ^2 A) for yield per plant which reflected the predominant role of non-additive gene action in the inheritance of these trait. This suggested that heterosis breeding programme may be taken up for the effective improvement of fruit yield in okra. Alternatively, selection of the promising high yielding plants/plant progenies in the later filial generations may be undertaken for bringing substantial improvement.

The additive gene action was observed for earliness (node at which first flower appears, days to 50% flowering and days to first picking), as reflected from their higher magnitude of additive components of genetic variances. Further, the ratios of additive to dominant components of variances were more than unity for all the traits, except fruit yield per plant, which confirmed the predominant role of additive gene action in the inheritance of these traits. Depending upon the nature of gene action, the early maturing strains in okra can be developed by employing simple selection procedures.

The proportional per cent contribution of lines ranged from 26.89 (node at which first flower appears) to 74.22% (days to 50% flowering) and the contribution of lines for yield per plant was 54.91%. The proportional per cent contribution of testers ranged from 2.39 (days to first picking) to 29.77% (node at which first flower appears), while the contribution of testers for yield per plant was 3.62% only. Similarly, the proportional per cent contribution of line x tester interactions ranged from 21.90 (days to 50% flowering) to 43.32% (node at which first flower appears) and the

contribution of line x tester interactions for fruit yield per plant was 41.47 per cent.

The contribution of the interactions between lines x testers was found to be higher than the individual contribution of lines and testers for node at which first flower appears. For the traits, days to 50% flowering, days to first picking and yield per plant, the proportional per cent contribution of lines was higher than the individual contribution of testers and lines x testes interactions. However, the per cent contribution of testers was higher than the lines for node at which first flower appears and fruits per plant.

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