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Heterosis for yield and yield attributing traits in castor, *Ricinus communis* L.

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ABSTRACT

Heterosis, heterobeltiosis and standard heterosis for seed yield and its attributes were studied in 45 hybrids developed through diallel mating design (ten parents) without reciprocal in castor. The magnitude of heterosis over mid parent (MP) and better parent (BP) for seed yield ranged from 47.73 % to 131.77 % and 39.15 % to 123.9 %, respectively. None of the hybrids exhibited significant positive heterosis over standard check *i.e.*, GCH 5 for seed yield. The cross combination DCS 89 x PCS 124 (131.77 %) and JI 321 x PCS 124 (123.9 %) exhibited significant positive heterosis over mid parent and better parent, respectively. These superior cross combinations also exhibited significant and positive heterosis for raceme length, number of capsules on main raceme, number of branches per plant and test weight, which are yield attributes.

Key words : Heterosis, heterobeltiosis, castor

Castor (*Ricinus communis* L.) is an important non-edible oil seeds crop of Gujarat state. In Gujarat, the common practice of castor growing is an intercrop under rainfed and as sole crop under irrigated condition. Yield potentiality of castor has considerably increased through exploitation of hybrid vigour on commercial scale. In order to assess the extend of heterotic parents in F_1 hybrid , it essential to evaluate newly developed inbred lines in cross combination for seed yield and its components.

MATERIALS AND METHODS

The experimental material comprised of ten inbred lines of castor *viz.,* 48-1, SKI 321, SKI 314, JI 321, DCS 89, PCS 124, DCS 9, SKI 291, SKI 281 and SKI 215, 45 hybrids using half diallel mating design and GCH-5 as standard check were evaluated in Randomized Block Design with three replications during year 2007-08 and 2008-09 at Main Castor-Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar. Each entry was planted in a single row of 10 dibbles keeping 90 cm row to row and 60 cm plant to plant distances. Recommended package of practices were followed for raising the normal crop. Observations on five randomly selected competitive plants were recovered for 10 traits. (Table 1). However, days to flowering and days to maturity were recorded on plot basis. Each characters was analyzed separately using analysis of variance technique suggested by Panse and Sukhatme (1969) and heterosis was calculated in F_1 hybrids over mid parent, better parent and standard check GCH 5 .

RESULTS AND DISCUSSION

Analysis of variance was carried out to test the differences among parents and hybrids for ten characters. The results revealed that the mean squares due to genotypes were highly significant for seed yield per plant as well as all its components studied. Mean squares due to parents and hybrids (F_1's) exhibited highly significant differences. This indicates the presence of considerable amount of variability among the parents and hybrids for various

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Table 1 Analysis of variance and variance estimates for combining ability for seed yield and its components in castor.

Source of variation	d.f.	Days to 50 per cent flowering (Primary raceme)	Days to 80% maturity (Primary raceme)	Plant height (cm)	Number of nodes on main stem	Effective raceme length (cm)	Number of capsules on primary raceme	Number of branches per plant	Seed yield per plant (g)	100-seed weight (g)	Oil content (%)
Replications	2	0.947	2.77	1.72	0.01	12.30	89.88	0.02	150.02	0.09	0.10
Parents	9	47.76**	45.45**	572.80**	3.98**	120.26**	535.50**	3.55**	122.57	8.79**	1.95**
F_1's	44	38.98**	43.49**	401.91**	3.39**	182.74**	429.82**	2.495**	1053.2**	12.66**	3.88**
Parents vs F_1's	1	89.65**	30.87*	3731.2**	39.84**	177.03**	272.85*	0.685**	86618.1**	7.28**	3.64**
σ^2 gca	9	65.38**	102.73**	511.44**	7.13**	21.79**	735.58**	4.22**	622.43**	11.39**	1.68**
σ^2 sca	45	25.27**	75.14**	462.02**	5.90**	228.42**	928.36**	1.06**	1897.16**	9.21**	6.33**
Error	198	13.98	19.20	9.33	0.32	4.52	94.21	0.046	887.65	3.95	1.22
σ^2 gca/σ^2 sca		2.59	1.38	1.11	1.21	0.096	0.79	23.04	0.33	1.24	0.27

* = Significance at P = 0.05 level. ** = Significance at P = 0.01 level.

characters. The mean squares due to parents vs. hybrids were significant for all the traits , which revealed that the performance of parents was different to that of F_1 hybrids as well as presence of overall heterosis for all the characters studied . The crosses exhibiting heterosis in negative direction are of immense value for earliness. The hybrid JI 321 x PCS 124 exhibited maximum significant and negative mid parent heterosis (-16.25 %) heterobeltiosis (-15.50 %) and standard heterosis (-14.07 %) for days to 50% flowering. For early maturity the cross SKI 314 x SKI 215(-6.79 %), JI 321 x PCS 124(-8.89 %) and JI 321 x DCS 9 (-6.24 %) depicted significant relative heterosis, heterobeltiosis and standard heterosis in desired direction, respectively. The hybrid 48-1 x SKI 291 exhibited significant and desirable relative heterosis (-39.06 %) and heterobeltiosis (34.91 %), respectively for the plant height and for the number of nodes up to primary raceme SKI 321 x SKI 215 having high heterotic value in desire direction for mid parent heterosis (-21.01 %) and the cross PCS 124 x SKI 291 having high heterotic value in desire direction for heterobeltiosis (-17.20 %) and standard heterosis (-21.36 %) over check hybrid, GCH 5, respectively. The cross PCS 124 x SKI 291 showed significant and positive mid parent heterosis (38.59 %) and cross PCS 124 x DCS 9 expressed significant and positive heterobeltiosis (32.73 %) while none of the hybrids showed significant and positive standard heterosis over check hybrid GCH 5 for the character effective raceme length. The maximum relative heterosis was recorded in SKI 314 x PCS 124 (93.67), maximum heterobeltiosis was recorded in JI 321 x DCS 9 (47.58) and none of the hybrids showed standard heterosis for the characters number of capsules on primary raceme. The number of branches per plant the heterosis over mid-parental was recorded by the cross SKI 321 x JI 321 (53.04 %), the heterobeltiosis for this character was registered by the cross SKI 321 x JI 321 (46.67 %). The maximum relative heterosis (13.61 %) and heterobeltiosis (7.80 %) was registered in cross 48-1 x SKI 314, while none of the hybrid showed positive significant over registered standard check GCH 5 for the character test weight in castor. The oil content trait observed in cross combination SKI 321 x SKI 291 recorded maximum and positive heterotic effect over mid-

Table 2 Promising crosses for seed yield /plant with heterosis over mid parent (MP), better parent (BP) and standard check GCH 5 (SC) in castor

Sr. No.	Characters studied	Heterosis over	Range of heterosis		Best heterotic hybrid	No. of hybrids in desirable direction
1	Days to 50 per cent flowering	MP	-16 25	13 59	JI 321 x PCS 124	24
		BP	-15.50	24.80	JI 321 x PCS 124	17
		SC	-20.34	4.07	SKI 321 x DCS 9	37
2	Days to 80% maturity	MP	-6.79	5.33	SKI 314 x SKI 215	14
		BP	-8.89	9.93	JI 321 x PCS 124	05
		SC	-6.24	6.48	JI 321 x DCS 9	03
3	Plant height	MP	-39.06	39.68	48-1 x SKI 291	35
		BP	-34.91	85.47	48-1 x SKI 291	22
		SC	-37.11	32.29	SKI 314 x PCS 124	37
4	Number of nodes on main stem	MP	-21.01	5.03	SKI 321 x SKI 215	29
		BP	-17.20	33.91	PCS 124 x SKI 291	11
		SC	-21.36	-1.46	PCS 124 x SKI 291	38
5	Effective raceme length	MP	-24.08	38.59	PCS 124 x SKI 291	19
		BP	-28.07	32.73	PCS 124 x DCS 9	16
		SC	-35.76	1.10	SKI 314 x SKI 215	01
6	Number of capsules on primary raceme	MP	-33.54	93.67	SKI 314 x PCS 124	10
		BP	-46.21	47.58	JI 321 x DCS 9	05
		SC	-49.49	-0.13	DCS 89 x PCS 124	00
7	Number of branches per plant	MP	-31.58	53.04	SKI 321 x JI 321	18
		BP	-43.48	46.67	SKI 321 x JI 321	09
		SC	-56.79	-19.75	PCS 124 x SKI 215	00
8	100-seed weight	MP	-15.65	13.61	48-1 x SKI 314	20
		BP	-17.19	7.80	48-1 x SKI 314	13
		SC	-21.42	4.09	SKI 314 x SKI 281	00
9	Oil content	MP	-5.73	6.48	SKI 321 x SKI 291	22
		BP	-5.91	5.51	SKI 321 x SKI 291	16
		SC	-7.48	1.98	DCS 89 x DCS 9	02
10	Seed yield per plant	MP	47.73	131.77	DCS 89 x PCS 124	45
		BP	39.15	123.9	JI 321 x PCS 124	45
		SC	-39.36	-7.09	SKI 291 x SKI 281	00

Table 3 Relative heterosis, heterobeltiosis and standard heterosis of superior crosses for seed yield and other components in castor

Sr. No	Crosses	Mean seed yield	Hete rosis	Days to 50 per cent flowering	Days to 80% maturity	Plant height	Number of nodes on main stem	Effective raceme length	Number of capsules on primary raceme	Number of branches per plant	Seed yield per plant	100-seed weight	Oil content
1	SKI 291 x	171.6	MP	1.49	-0.47	-7.01**	-12.55**	20.93**	-32.56**	12.82**	117.77**	0.89*	5.75**
	SKI 281		BP	4.07**	2.15	-8.67**	26.34**	14.29**	-40.06**	-2.22	99.53**	-0.17	5.50**
			SC	-13.22**	-1.20	8.19**	-15.05**	-4.54	-36.63**	-27.16**	-7.09	-3.21**	-0.14
2	PCS 124 x	168.3	MP	-2.29*	-1.88	-25.63**	-13.73**	38.59**	36.35**	-0.28	120.33**	6.04**	1.01*
	SKI 291		BP	8.33**	2.40	-7.43**	-17.20**	28.58**	8.51	-1.67	96.16**	3.46 **	0.08
			SC	-9.66**	-0.96	-28.55**	-21.36**	-4.81*	-10.41	-27.16**	-8.88*	-1.15*	-3.71**
3	SKI 281 x	168.2	MP	-4.76**	1.08	-1.76	-8.32**	16.30**	-4.37	20.39**	123.03**	1.31**	-4.02**
	SKI 215		BP	1.74**	2.28	6.13*	2.91*	15.6**	-21.26*	-0.54	113.3**	-0.27	-6.15**
			SC	-10.68**	0.40	16.87**	-7.28**	-1.79	-17.10	-24.69**	-8.93*	-3.33**	-7.48**
4	PCS 124 x	167.7	MP	-7.81**	-0.54	-10.06**	-6.22**	33.79**	62.8**	6.04*	129.99**	3.75**	1.07**
	SKI 215		BP	-6.66**	-0.88	-19.81**	0.00	16.74**	39.72**	4.89	112.7**	0.51	-0.15
			SC	-7.29**	-0.48	-10.84**	-9.71**	-0.83	-4.76	-19.75**	-9.20*	-2.57**	-1.56**
5	DCS 89 x	166.0	MP	-11.32**	-2.40	-2.68	0.76	16.54**	55.9**	14.29**	131.77**	3.30**	4.22**
	PCS 124		BP	-10.81**	-6.57**	8.25**	5.70**	-2.25	25.27	9.09**	118.5**	2.11**	2.78**
			SC	-10.51**	-3.28	-10.48**	-3.88	-8.53**	-0.13	-25.93**	-10.07*	-4.09**	-0.42

*=Significance at P = 0.05 levels.
**=Significance at P = 0.01 levels.

Table 4 Best heterotic crosses and their performance for some related parameters for seed yield

Sr. No	Best crosses	Mean yield per plant (g)	Heterobeltiosis	sca effect	Significant heterobeltiosis for other traits in desire direction
1.	JI 321 x PCS 124	154.5	123.9**	24.089**	DF, PH,NN, RL, NC, NB, TW
2.	PCS 124 x SKI 281	158.8	121.8**	20.875**	PH,RL, TW, OC,
3.	DCS 89 x PCS 124	166.0	118.5**	33.659**	DF,NB, TW, OC
4.	SKI 281 x SKI 215	168.2	113.3**	35.536**	NN, RL,
5.	PCS 124 x SKI 215	167.7	112.7**	32.136**	DF, RL, NC,
6.	PCS 124 x DCS 9	151.3	104.1**	26.042**	DF, PH, RL, NB, OC
7.	SKI 321 x DCS 89	153.9	99.91**	35.884**	NN, NC, NB, OC
8.	SKI 291 x SKI 281	171.6	99.53**	34.381**	NN, RL, OC, WI
9.	SKI 321 x JI 321	151.5	96.75**	35.447**	DF, DM, PH, NN, NB, TW, OC
10.	PCS 124 x SKI 291	168.3	96.16**	28.247**	PH, NN, RL, TW
11.	SKI 314 x SKI 281	156.0	95.00**	31.011**	PH, NB, TW
12.	DCS 89 x SKI 215	151.6	92.30**	24.453**	PH, OC

* = Significance at P = 0.05 levels.

** = Significance at P = 0.01 levels

DF = Days to flowering; PH = Plant height; NC = Number of capsules on main raceme
DM = Days to maturity; RL = Raceme length; NN = Number of nodes on main raceme
TW = Test weight; OC = Oil content; NB = Number of branches per plant
WI = Wilt incidence

parent(6.48 %) and better parent (5.51 %), while cross DCS 89 x DCS 9 (1.98 %) recorded maximum and positive heterotic effect over standard check GCH 5. The best five crosses for yield (SKI 291 x SKI 281,PCS 124 x SKI 291, SKI 281 x SKI 215, PCS 124 x SKI 215 and DCS 89 x PCS 124) observed based on *per se* performance , heterosis over mid parent and better parent indicated that most superior hybrids were accompanied by significant and positive heterosis over MP, BP and Standard check for yield attributing like effective length of raceme, number of capsule on primary raceme, number of branches per plant and test weight advocating that the high heterosis for seed yield resulted through contribution of its components traits. (Table 2). On the whole, consideration of relative heterosis, heterobeltiosis and standard heterosis observed for seed yield and other associate characters suggested the presence of large genetic diversity among the inbred lines and also the unidirectional distribution of allelic constitution contributing towards desirable heterosis in the parental material. Low magnitude of desirable heterosis and heterobeltiosis was observed for some of the characters *viz.*, oil content and test weight indicating the narrow genetic base among the inbred lines and also the ambidirectional distribution of allelic constitution contributing towards undesirable heterosis or may be due to mutual cancellation of effect of dominant alleles present in the parental material. Similar finding were also reported in castor by Chakrabarty (1997) and Lavanya (2003).

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