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RESEARCH PAPER

Evaluation of heterosis and inbreeding depression for seed yield and its components in castor (*Ricinus communis* L.)

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Abstract : Heterobeltiosis and standard heterosis was studied by using generation mean analysis involving six generations, namely P_1, P_2, F_1, F_2, BC_1 and BC_2 of five crosses of castor (*Ricinus communis* L.). The high magnitude of heterobeltiosis was observed in crosses JP 101 x SKI 215(86.51 %) and JP 96 x JI 368 (25.90 %) for seed yield per plant. Among the five crosses studied, JP 96 x JI 368 (52.20 %) exhibited the highest significantly positive standard heterosis over the check hybrid (GCH-6) for seed yield per plant followed by JP 101 x SKI 291 (21.24 %) and JP 101 x SKI 215 (9.00 %). Hybrids showing high positive heterosis for seed yield also depicted high to moderate heterotic effects for majority of its component traits in desirable direction. The magnitude of inbreeding depression varied from cross to cross indicating influence of genetic constitution of crosses. Either low or moderate amount of inbreeding depression in desired direction was found for most of the traits. Association of high heterosis with high inbreeding depression was observed for seed yield and some of its component traits. Most of the crosses in majority of the traits showed positive inbreeding depression indicated the presence of dominance gene effects. Suitable breeding strategies were suggested for the improvement of seed yield in castor.

Key Words : Heterosis, Inbreeding depression, Castor

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INTRODUCTION

Castor is a highly cross pollinated crop in which most of the cultivars have been developed through hybridization followed by selection. The exploitation of heterosis has been an important breeding tool in castor, which became feasible due to availability of 100% pistillate lines (Gopani *et al*., 1968). In Gujarat, real break through in castor production has come with the development and release of hybrids for commercial cultivation. Still there is potential to further increase in yield level of castor through genetic improvement. The selection of suitable parents is an important for the development of better hybrids. For this, it is always essential to evaluate available promising lines in their hybrid combinations for seed yield and yield attributing characters (Giriraj *et al*., 1973). Therefore, an experiment was laid out to identify the most promising heterotic cross combinations developed by generation mean analysis fashion.

MATERIAL AND METHODS

Six basic generations *viz*., P_1, P_2, F_1, F_2, BC_1 and BC_2 derived from five crosses namely JP 96 x JI 368, JP 96 x JI 372, JP 101 x SKI 215, JP 101 x SKI 291and JP 102 x JI 372 were produced (F_1 generated during *Kharif* 2008-09 and rest of the generations produced during *Kharif* 2009-10). These six basic generations of the five crosses alongwith standard check hybrid, GCH 6 was evaluated in Compact Family Block Design with three replications during *Kharif* 2010-11 at Oilseeds Research Station, Junagadh Agricultural University, Junagadh (Gujarat). Each replication was divided

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into five compact blocks each consists of single cross and blocks were consisted of seven plots comprised of six basic generations of each cross and standard check hybrid GCH-6. The single row plot was sown for both parents and its F_1; five rows for each F_2 generation, three rows for each backcross and single row of standard check hybrid (GCH-6). The crop was dibbled at 90 cm and 60 cm inter and intra row spacing, respectively, with 7.20 m of row length. All the recommended cultural and plant protection practices were followed to raise good crop. The data were recorded on individual plant basis in each replication on randomly selected five competitive plants in P_1, P_2, F_1 and standard check hybrid (GCH-6), 20 plants in each of backcross and 40 plants in F_2 generations for 12 characters (Table 1). The heterosis as percentage deviation from the better parent (heterobeltiosis) and the standard check, GCH-6 (standard heterosis) for each character were worked out as per the standard procedure given by Fonseca and Patterson (1968) and Meredith and Bridge (1972), respectively.

RESULTS AND DISCUSSION

The degree of heterosis varied from cross-to-cross for all the twelve characters studied (Table 1). For the purpose of estimation of heterosis over better parent, the parent having less number of days to flowering and days to maturity was considered as better parent. Hence, negative heterosis is useful for days to flowering and days to maturity. A perusal of Table 1 revealed that heterobeltiosis and standard heterosis was not exploited for days to flowering and days to maturity in all the five crosses as, respectively low, positive and mostly significant values for both these traits. However, significant and negative heterobeltiosis and standard heterosis were observed for most of the crosses for plant height and number of nodes up to main raceme. None of the hybrid was found significant and desired direction heterosis for length of main raceme, effective length of main raceme, number of effective branches per plant and number of capsules on main raceme. High magnitude of heterobeltiosis and standard heterosis were exhibited for 100-seed weight (24.48 and 13.50 % in JP 102 x JI 372), shelling out turn (4.63 and 2.46 % in JP 96 x JI 368), seed yield per plant (25.90 and 52.2 % in JP 96 x JI 368) as compared to rest of the crosses. Two crosses *viz*., JP 96 x JI 368 and JP 96 x JI 372 exhibited significant and positive standard heterosis for the oil content. In addition to the above crosses, the cross JP 101 x SKI 291 also expressed significant and positive heterobeltiosis for number of effective branches per plant (6.25 %), shelling out turn (10.31 %) and 100 seed weight (2.63 %). High magnitude of negative heterobeltiosis and standard heterosis were observed for plant height up to main raceme (-2.12 and -9.76 %) and number of nodes up to main raceme (-13.16 and -10.81 %) in JP 96 x JI 372.

Among five crosses studied, JP 96 x JI 368 exhibited the highest standard heterosis (52.20 %) followed by JP 101 x SKI 291 (21.24 %) and JP 101 x JI 215 (9.00 %) for seed yield per plant. These crosses also displayed significant and positive heterobeltiosis for seed yield per plant except JP 101 x SKI 291. The highest positive and significant standard heterosis for seed yield per plant in JP 96 x JI 368 was accompanied by high standard heterosis in desired direction for days to flowering of main raceme, shelling out turn, 100-seed weight and oil content. Mehta *et al.* (1991), Golakia *et al*. (2004) and Patel and Pathak (2006) have reported similar findings that supported the present investigation. Several research workers have been reported heterosis in desired direction for various characters in castor like plant height and number of nodes up to main raceme (Mehta *et al.*, 1991; Patel and Pathak, 2006), shelling out turn (Saiyed *et al.*, 1997), 100-seed weight (Dangaria *et al.*, 1987; Pathak *et al.*, 1988; Dobariya *et al*., 1989; Golakia *et al*., 2004 and Patel and Pathak 2006), and oil content (Pathak *et al*., 1986; Dobariya *et al*., 1989; Joshi *et al.*, 2002; and Patel and Pathak, 2006).

In the present study either low or moderate amount of inbreeding depression (ID) in desired direction was found in most of the traits. The characters which manifested low heterosis in F_1 also showed low inbreeding depression in F_2. The four crosses namely JP 96 x JI 372, JP 101 x SKI 215, JP 101 x SKI 291 and JP 102 x JI 372 exhibited significant and positive inbreeding depression for days to flowering of main raceme thereby suggesting that F_2s flowered earlier than their respective F_1s. Similarly, in all the five crosses, F_2s was also matured earlier than their respective F_1s. The cross JP 96 x JI 368 also expressed significant and positive inbreeding depression for length of main raceme, effective length of main raceme, number of capsules on main raceme, shelling out turn and 100-seed weight. While, JP 101 x SKI 291 and JP 101 x SKI 215 also expressed significant and positive inbreeding depression for 100-seed weight and oil content.

Only one cross combination (JP 96 x JI 372) exhibited non-significant inbreeding depression for seed yield per plant. Similarly, JP 101 x SKI 291 and JP 96 x JI 368 had non-significant inbreeding depression with significant heterosis over standard check for shelling out turn and oil content, respectively. High inbreeding depression in F_2 population for seed yield ranged from -0.35 % (JP-96 x JI 372) to 57.91 % (JP 96 x JI 368) which might be due to wide base of genetic materials. All the crosses in most of the traits showed positive inbreeding depression indicated the presence of dominance effects for most of the traits. The magnitude of inbreeding depression in the present investigation varied from cross to cross indicating influence of genetic constitution of crosses. Association of high heterosis with high inbreeding depression for seed yield and

Table 1 : Heterosis over better parent (BP), heterosis over standard hybrid (SH) and inbreeding depression (ID) for seed yield and its component traits of five crosses in castor

Cross	Heterosis (%) over		ID (%)	Heterosis (%) over		ID (%)
	BP	SH		BP	SH	
	Days to flowering of main raceme			Days to maturity of main raceme		
C_1	4.38**±1.08	7.25**±1.09	1.01±1.19	-0.18±1.10	9.25**±1.38	3.00*±1.25
C_2	4.48**±1.17	16.50**±0.98	6.54**±1.05	-6.48**±0.75	2.58*±1.20	3.56**±1.10
C_3	15.32**±0.41	17.62**±0.49	9.99**±0.82	4.49**±1.00	12.55**±1.11	11.75**±1.06
C_4	-2.97**±0.35	10.25**±0.41	10.64**±0.76	8.62**±0.79	3.65**±1.08	2.17*±1.01
C_5	-7.17**±0.83	6.88**±0.73	2.65**±0.99	1.32*±0.66	8.32**±1.03	6.89**±0.90
	Plant height up to main raceme (cm)			Number of nodes up to main raceme		
C_1	8.51**±1.26	-0.49**±1.42	-28.86**±3.13	(-)	(-)	(-)
C_2	-2.12*±0.91	-9.76**±1.13	-28.51**±5.61	-13.16**±0.74	-10.81**±0.45	-6.69**±0.42
C_3	65.38**±2.94	4.88±2.50	-26.53**±4.26	15.19**±0.94	-18.02**±0.86	-22.94**±0.87
C_4	21.26**±3.21	-24.88**±1.70	-115.50**±3.91	10.47**±0.75	-4.95**±0.63	-27.73**±0.69
C_5	12.12**±4.73	-27.88**±4.04	-116.98**±4.91	-28.09**±0.96	-42.34**±0.49	-101.76**±0.48
	Length of main raceme (cm)			Effective length of main raceme (cm)		
C_1	-3.30±3.17	-21.43**±1.69	12.5**±1.72	-3.30±3.17	-21.43**±1.69	13.14**±1.71
C_2	-20.69**±3.06	-48.66**±1.55	-52.28**±1.68	-21.38**±3.07	-49.11**±1.56	-51.10**±1.63
C_3	-2.56±2.16	-32.14**± 2.15	2.38±2.04	-2.56±2.16	-32.14**± 2.15	3.62±2.03
C_4	-23.33**±3.11	-48.66**±1.96	-28.15**±1.85	-24.67**±3.12	-49.55**±1.97	-29.65**±1.86
C_5	-27.59**±1.93	-53.13**±1.72	-53.21**±1.50	-27.59**±1.93	-53.13**±1.72	-52.50**±1.50
	Number of effective branches per plant			Number of capsules on main raceme		
C_1	(-)	(-)	(-)	8.05±4.75	-25.69**±4.07	24.00**±2.69
C_2	(-)	(-)	(-)	-3.80±3.50	-48.99**±4.02	-16.17**±2.46
C_3	-27.40**±0.43	-41.11**±0.43	-4.01**±0.25	-20.60**±4.47	-35.40**±4.72	4.38±3.67
C_4	6.25**±0.54	-24.45**±0.60	15.99**±0.49	-20.82**±4.22	-52.95**±4.58	-32.53**±3.53
C_5	(-)	(-)	(-)	-25.71**±5.71	-58.85**±4.31	-56.77**±2.89
	100-seed weight (g)			Oil content (%)		
C_1	2.38**±0.15	12.45**±0.17	13.39**±0.45	-7.35**±0.05	3.66**±0.03	-0.10±0.32
C_2	-2.03**±0.17	7.55**±0.15	6.34**±0.35	-0.08±0.08	10.95**±0.04	4.54**±0.14
C_3	-0.11**±0.12	-21.62**±0.13	4.85**±0.22	-4.08**±0.10	-8.49**±0.07	1.89**±0.36
C_4	2.63**±0.13	-16.88**±0.13	12.30**±0.25	-3.68**±0.08	-0.73**±0.06	1.10**±0.31
C_5	24.48**±0.11	13.50**±0.13	23.67**±0.63	-8.86**±0.07	-2.53**±0.07	-3.16**±0.28
	Shelling out turn (%)			Seed yield per plant (g)		
C_1	4.63**±0.26	2.46**±0.18	7.82**±0.49	25.90**±7.81	52.20**±5.58	57.91**±6.72
C_2	-7.34**±0.18	-9.27**±0.18	-4.60**±0.31	-50.14**±5.23	-37.14**± 4.55	-0.35±6.73
C_3	7.48**±0.17	-4.44**±0.20	7.17**±0.44	86.51**±5.64	9.00**±3.25	41.60**±4.43
C_4	10.31**±0.19	-3.06**±0.18	3.42±4.14	-21.59±6.90	21.24**±9.47	49.72**±9.93
C_5	-3.52**±0.18	-10.84**±0.18	2.40**±0.38	14.00±12.56	1.59±12.61	32.92*±12.94

*, ** = Significant at 5% and 1% levels, respectively.

(-) dropped from estimation of heterosis & ID due to non-significant difference among generation means.

C_1= JP 96 x JI 368; C_2=JP 96 x JI 372; C_3=JP 101 x SKI 215; C_4= JP 101 x SKI 291; C_5=JP 102 x JI 372.

some of its component traits in castor was observed by Kabaria and Gopani (1971), Pathak *et al*. (1988), Patel (1996) and Golakia *et al.* (2004) suggesting importance of non-additive gene effects.

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