RUSSEL, R.S. and BARBAR, D.A. (1960). **Annual Review of Plant Physiol. 11:** 127.

SAMMI REDDY, K., SRIRAMA MURTHY, V.M.M. and SHANTARAM, M.V. (1992). Nitrogen, phosphorus and sulphur nutrition of groundnut (*Arachis hypogaea* L.) grown in alfisols. **J. Oilseeds Res. 9(2):** 189-195.

SINGH, R.P., DAS, S.K., BHASKARA RAO, U.M. and NARAYANA REDDY (1990) Towards sustainable dry land agricultural practices. CRIDA, Hyderabad. p.106.

STANFORD, S. and ENGLISH, L. (1949). Use of flame photometer in rapid soil test for K and Ca. **Agron. J. 4:** 446-447.

VENKATESWAR RAO, K. (1985). Influence of organic manures on nutrient availability, uptake and crop yield. M.Sc. (Ag.) Thesis. Tamil Nadu Agric. Univ., Coimbatore.

WALKLEY, A. and BLACK, I.A. (1934). An examination of the Degtiareff method for determining soil organic matter and proposed modification of the Chromic acid titration method. **Soil Sci. 37:** 29-34.

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HETEROSIS FOR YIELD AND ITS COMPONENTS OVER ENVIRONMENTS IN CASTOR (*Ricinus communis* L.)**

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ABSTRACT

Investigation with 19 parents (4 cent per cent pistillate lines and 15 inbreds) and their 60 hybrids of castor produced through L x T was taken up over four environments (two seasons and two locations) to determine the extent of heterosis for seed yield and seven related traits and to identify the best heterotic crosses for commercial cultivation. The relative heterosis, heterobeltiosis and standard heterosis for seed yield per plant over environments ranged from 1.23 to 148.76, -9.29 to 118.93 and -23.94 to 84.75 per cent respectively. The hybrids LRES 17 x RC 1226, 240 X USSR 2 and JP 65 X JH 120 exhibited maximum seed yield (183.2 g, 162.7 g and 158.7 g per plant respectively) with maximum heterosis. The heterosis for seed yield appeared to be due to high manifestation of heterosis for length of primary raceme, racemes per plant, capsules per plant and 100 seed weight. Selection of crosses on the basis of per se performance with considerable per cent of heterosis would be more desirable.

KEY WORDS : Castor, *Ricinus communis*, Heterosis, Environment

Castor being a cross pollinated crop endowed with the pistillate mechanism, has lent itself amenable for crop improvement through heterosis breeding. This had led to the evolution of quite a few commercial castor hybrids that are popular among the farmers. The degree of expression of exploitable heterosis for seed yield and homogeneity as well as stability of resulting F1 hybrids are factors contributing to the evaluation of commercial hybrids in castor. Hence the present study was undertaken to study the extent of heterosis for yield and related traits and to identify the best heterotic cross for commercial exploitation. Singh and Narayanan (1995) opined that in order to obtain accurate results the crosses have to be evaluated over multilocation for two or three years. Hence, the study was taken up under two locations and two seasons.

MATERIALS AND METHODS

The materials consisted of four cent percent pistillate lines and 15 inbreds of castor and their 60 hybrids produced in line x tester mating design. The parents and their hybrids were evaluated in RBD with three replications at two locations, viz., Oilseeds Research Station, Tindivanam (11.°46 N,

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Table 1. Range of heterosis, heterobeltiosis and standard heterosis over four environments for yield and related traits in castor

Traits	Heterosis	Heterobeltiosis	Standard heterosis
Seed yield per plant (g)	1.23 to 148.76	-9.29 to 118.93	-23.94 to 84.75
Days to 50% flowering	-23.84 to 26.37	-14.41 to 42.02	2:28 to 63.49
Plant height upto PR (cm)	-45.98 to 22.71	-64.82 to -4.32	-75.21 to -25.96
No.of nodes upto PR	-21.94 to 23.07	-33.53 to 19.32	-39.55 to -10.23
Length of PR	-43.93 to 94.22	-56.37 to 87.28	-57.85 to -3.43
Racemes per plant	-0.29 to 146.58	-12.55 to 141.65	18.39 to 62.72
Capsules per plant	-4.41 to 92.89	-13.71 to 90.54	-30.27 to 54.59
100 seed weight (g)	-25.37 to 24.06	-25.63 to 25.47	-31.39 to 5.31

PR - Primary raceme

79.46" NE, 45.6m MSL, temperature range from 24.1°C to 31.7°C, annual rainfall of 1228.6 mm, sandy loam soil with 7.4 pH) and Sugarcane Research Station, Cuddalore (12.56" N, 79.50"E, 4.60 m MSL, temperature range from 23.61°C to 32.80°C, annual rainfall of 1196.6 mm, sandy clay loam soil with 6.8 pH.) in two seasons *viz.*, Summer 1993 and *Kharif* 1993. Each entry was raised in two rows, accommodating 10 plants in each row. A spacing of 90 cm between rows and 45 cm between plants was adopted. Data were recorded on 10 randomly selected plants for eight quantitative traits (Table 1). The heterosis over mid parent, over better parent (heterobeltiosis) and over the best parent (standard heterosis) was calculated and expressed in per cent.

RESULTS AND DISCUSSION

Range of significant heterosis in per cent for respective traits pooled over environments is presented in table 1. The degree of heterosis varied from cross to cross for all the traits studied in individual as well as pooled over environments. The seed yield per plant, number of racemes and number of capsules per plant were found to be the most heterotic traits. Dangaria *et al* (1987) also recorded high heterosis for these traits.

Table 2. Number of significant heterotic, hybrids over mid parent (H1), better parent (H2) and best parent (H3) in individual and pooled over environment for yield and related traits in castor

Traits	E1			E2			E3			E4			Pooled		
	H1	H2	H3	H1	H2	H3	H1	H2	H3	H1	H2	H3	H1	H2	H3
Seed yield per plant (g)	52	44	33	57	51	38	52	45	20	57	54	40	57	50	38
Days to 50% flowering*	35	16	-	27	11	1	26	11	1	26	9	-	26	10	1
Plant height upto PR* (cm)	29	44	60	59	60	60	40	56	60	43	59	60	52	60	60
No.of nodes upto PR*	32	40	60	20	29	60	19	32	60	23	36	60	21	30	60
Length of PR (cm)	26	21	-	21	15	-	45	29	-	35	25	-	33	27	-
Racemes per plant	46	39	22	50	39	26	59	57	50	57	57	47	59	53	41
Capsules per plant	53	43	31	50	31	9	50	37	13	52	43	20	55	40	16
100 seed weight (g)	37	23	1	37	24	11	38	27	8	38	28	9	37	22	6

E1 - Summer season at Tindivanam
E2 - Summer season at Cudalore
E3 - *Kharif* season at Tindivanam
E4 - *Kharif* season at Cudalore
PR - Primary raceme
* - Negative significant hybrids

In pooled analysis over four environments, out of 60 crosses, positive significant heterosis, heterobeltiosis and standard heterosis for seed yield were recorded in 57, 50 and 38 crosses, respectively (Table 1). This suggested that most of the inbred lines had different genetic system of co-adapted genes which interacted and manifested heterosis for this complex trait.

Among the three parameters used to determine hybrid vigour, heterobeltiosis appears to be more reliable tool than relative heterosis and standard heterosis (Haycees *et al.*, 1955). In respect of yield components, 53 crosses were heterotic for racemes per plant, 40 for capsules per plant, 27 for length of primary raceme and 22 for 100 seed weight.

All the hybrids that have shown high degree of heterosis for seed yield, also exhibited substantial relative heterosis, heterobeltiosis and standard heterosis for racemes per plant, capsules per plant and heterosis and heterobeltiosis for length of primary raceme and 100 seed weight (Table 3). The magnitude of heterosis was higher in hybrids involving JP 65 as female parent and JH 120, RC 1226 and USSR 2 as male parents.

Castor is generally grown in marginal lands in drought prone areas. For this reason, early maturing (short) duration genotypes, which can escape drought and give good yield even with less precipitation, are better suited. Apart from days to 50% flowering, the plant height and (Swarnalatha *et al.*, 1984 ; Patel *et al.*, 1984) and Pathak and Dangaria, 1987). All the 60 crosses expressed negative heterosis for plant height, 30 for nodes up to primary raceme and 10 for days to 50% flowering. It suggested that there is a possibility of developing short duration and dwarf hybrids.

High heterosis is obtained with parents of diverse origin in the presence of adequate favorable environments and in the absence of mutual cancellation of components of heterosis. Generally parents with high order of expression of the characters when combined produced hybrids with high expression (Gilbert, 1958). This was not true in the present study, where the *per se* performance of the parents and the percentage heterosis of resultant hybrids were considered with best 10 hybrids mentioned (Table 3). Among the parents, LRES 17, and RC 913 recorded the highest seed yield but the yield increase in terms of heterosis

Table 3. Heterobeltiosis for yield and other traits on best ten hybrids pooled over environments in castor.

Crosses	Seed yield per plant (g)	Days to 50% flowering@	Plant height upto primary raceme@ (cm)	No.of nodes upto primary raceme@	Length of primary raceme (cm)	Racemes per plant	Capsules per plant	100 seed weight (g)
JP 65 X JH 120	126.66 (158.7)	-1.81	-8.82	-19.08	87.28	87.71	81.98	-11.49
240 X USSR 2	118.93 (162.7)	15.22	-38.39	-7.13*	21.53	31.95	65.07	12.15
JP 65 X Salam local	98.86 (151.3)	10.78	-4.32	-8.37	41.01	31.98	90.54	0.29ns
JP 65 X RCG 43	97.73 (147.4)	5.38	-20.62	1.12ns	45.29	54.82	68.35	18.41
LRES 17 X RC 1226	95.65 (183.2)	8.87	-55.09	-16.04	-3.46ns	100.49	54.58	10.39
JP 65 X USSR 2	86.56 (132.7)	18.06	-22.20	3.94ns	45.64	36.62	68.88	20.66
240 X JI 1	84.98 (139.9)	3.87ns	-56.46	-12.85	41.08	-3.19ns	44.78	17.53
2JP 65 X SH 63	83.13 (152.2)	2.73ns	-22.73	-7.99	71.80	48.92	63.28	5.42
JP 65 X 60-16-11	79.15 (125.5)	26.67	-36.97	-4.46ns	29.45	44.86	48.98	20.60
240 X SH 63	77.84 (147.8)	32.24	-8.22	19.32	53.38	80.56	65.31	5.42
SE	1.93 (112.9)	0.70	2.33	0.50	1.14	0.12	4.63	0.29

Values in parenthesis are mean yield per plant in g.

All significant at 1% except NS and *, which are nonsignificant and significant at 5% level, respectively

@ Negative heterosis is preferable.

was not reflected in the resulting hybrid, whereas the hybrid resulting from LRES 17 as one of the parents with other parents (i.e., LRES (7xRC (226) recording less yield exhibited substantial increase in yield with high percentage of heterosis. Such situation could be attributable to high inter-allelic interaction canceling the individual effects of each other.

The investigation reveals that the magnitude and nature of heterosis for yield and its components in the crosses were high over environments in the 10 hybrids. These hybrids may be utilized for commercial explotation of heterosis.

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REFERENCE

DANGARIA, G.J., DOBARIA, K.L., FATTEH, U.G. and PATEL, V.J. (1987). Heterosis and combining ability analysis in Castor. **J. Oilseeds Res., 4:** 46-53.

Gilber, N.E.G. (1958). Diallel crosses in plant breeding. **Heredity, 12:** 477-498.

HAYES, H.K., IMMER, F.R., and SMITH, D.C. (1955). **"Methods of plant breeding"**. McGraw Hill Book Co., New York.

PATEL, I.D., DANGARIA, C.J., FATHEH, U.G., and PATIL, V.J. (1984). Combining ability for earliness and its related traits in castor. **Indian J. Agric. Sci., 54:** 625-629.

PATHAK, H.C. and C.J. DANGARIA. (1987). Combining ability for yield and its components in castor. **Indian J. Agric. Sci., 57(1):** 13-16.

SINGH, P. and NARAYANAN, S.S. (1995). *Biometrical Techniques in Plant Breeding.* Kalyani Publishers, New Delhi.

SWARNALATHA, M.V.R. PRASAD and B.S. RANA. (1984). Inheritance of yield and its components in castor. **Indian J. Genet. Pl. Breed., 44(3)** : 538-543.

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SEED HARDENING TO AUGMENT THE PRODUCTIVITY OF COTTON cv.LRA 5166 (*Gossypium hirsutum* L.)

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ABSTRACT

Field experiments conducted in summer and winter 1996 seasons to assess the productivity of hardened seeds highlighted significant benefits of seed hardening with prosopis (*Prosopis juliflora*) (0.5% solution) and pungam leaf extract (*Pungamea pinnata*) (1.0%) registering increase in field emergence (9%), dry matter production (26.1 % on 30 DAS), plant height at harvest (23.2%) over control. The plants from hardened seeds came to flowering one week earlier than those from nonhardened seeds. The number of sympodia plant^{-1}, number of boll plant^{-1}, boll weight, seed weight boll^{-1}, number of seeds boll^{-1} were significantly higher in plants from seeds given seed hardening treatment with 1.0% pungam leaf extract striking an increase of 7.9, 35.2, 29.0 and 18.0% respectively over control in two seasons trials. The seed cotton yield and seed yield were higher by 31.7 and 35.7% respectively in the summer crop and 43.6 and 48.0 % respectively in the winter crop in the same treatment over control. In the resultant seeds better quality vested with the seeds from botanical hardening.

Cotton is an important fibre crop grown in India in about 76 lakh hectares, out of which 52 lakh hectares are under rainfed condition. The national average yield is 268 to 302 kg ha^{-1} as against the global average of 595 kg ha^{-1}. The low productivity in cotton is attributed to several reasons of which, use of poor quality seed for sowing forms the major one. Even good quality seeds may perform poor under adverse ecological conditions like moisture stress, high temperature. The present study, was made to explore the feasibility of using easily available botanicals for getting desired hardening effect to withstand drought during the early phase of germinaiton and seedling growth.