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PHENOTYPIC STABILITY AND ADAPTABILITY OF CASTOR HYBRIDS

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ABSTRACT

A set of 112 crosses of castor were studied under four artificially created environments to characterize stability for yield and its contributing components. Both linear and non-linear components of G x E interaction were found to be significant for all the traits (except days to flowering and days to maturity) revealing difficulty in prediction of performance of the characters studied in varied environments. The crosses SKP 25 x T 4, SKP 25 x EC 97700, SKP 93 x JI 77, VP 1 x Aruna and SKP 25 x RC 8 showed high seed yield/plant with unit regression coefficients and non-significant deviation from regression indicating stable performance of these crosses in varying environments. Number of effective branches/plant, number of capsules/plant and 100-seed weight were the major components of seed yield varied in compensatory fashion to impart homeostasis to seed yield/plant.

INTRODUCTION

The productivity of a population is the function of its adaptability, while the latter is a compromise of fitness (stability) and flexibility. Stability of a genotype depends on the ability to retain certain morphological and physiological characters steadily and allowing others to vary resulting in predictable G x E interactions for yield. A population that can adjust its genotypic and phenotypic state in response to environmental fluctuations in such a way to give high and stable yield is termed as "Well buffered". The study of individual yield components can lead to simplification in genetic explanation and determination of environmental affects (Grafius, 1956). Models for estimating G x E interactions have been proposed by several workers. Kabaria and Gopani (1971), Hirachand *et al.* (1982), Patel *et al.* (1984) and Henry and Daulay (1985) used Eberhart and Russell (1966) model to identify suitable hybrids of castor which may perform consistent in respective agroclimatic conditions. Therefore, the present study is aimed at analyzing the stability of yield of promising castor hybrids and identify the stable yield components.

MATERIAL AND METHODS

On hundred-twelve hybrids of castor (*Ricinus communis* L.) involving 4 pistillate lines and 28 inbred lines through line x tester mating design were grown in a randomized block design with three replications in four artificially created environments (E1 and E2 as sowing in the 1st fortnight of July as rainfed crop and supplementary irrigations, respectively; E3 and E4 as sowing in the 1st week of August and September, respectively as irrigated crop) during *kharif* 1990 at the College Instructional farm, G.A.U., Sardar Krushinagar. Each entry was planted in a single row plot of 7.2 m long keeping 90 x 60 cm spaicng. All the recommended package of practices were followed timely to raise a healthy crop. The data were collected on five randomly selected plants for 12 characters (Table 1). The stability analysis was done as per Eberhart and Russell (1966) and the stability parameters of individual hybrids were summarized according to Singh and Singh (1980).

RESULTS AND DISCUSSION

The pooled analysis of variance for stability (Table 1) indicated that differences among the hybrids and environments were significant suggesting the presence of genetic differences among the castor hybrids and varied response of environments, respectively for all the 12 characters. Significance of G x E

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Table 1. Pooled analysis of variance over four environments for stability 12 characters in castor

Source	d.f.	Mean squares											
		Days to flowering	Days to maturity	Plant height	Number of nodes upto main spike	Length of main spike (cm)	Number of capsules	Seed yield/ main spike (g)	Number of effective branches/ plant	Number of capsules/ plant	Seed yield/ plant (g)	100-seed weight (g)	Oil content (%)
Genotypes (G)	111	226.3*	193.3*	838.1*+	33.7*+	231.3*	1287.4*+	627.8*+	13.4*+	20285.2*+	9519.7*+	26.3*+	1.3*+
Environments (E)	3	851.4*	1012.5*	4240.8*+	126.3*+	1489.0*+	3507.5*+	7909.4*+	704.7*+	1487136.3*+	1258370.5*+	1998.4*+	37.2*+
G x E	333	2.3	7.5	135.8*	6.2*	54.2*	457.7*	164.8*	7.0*	3195.1*+	1510.6*+	2.3*+	0.9*
Environment + G x E	336	9.8	16.5*	172.4*+	7.2*	67.0*	484.9*	233.8*+	13.3*+	16444.6*+	12732.6*+	20.1*+	1.3*+
Environment (linear)	1	2553.6*	3035.1*	12694.1*+	378.8*+	4466.5*+	10524.5*+	23723.8*+	2113.9*+	446130.7*+	377105.2*+	5995.1*+	112.8*+
G x E (Linear)	111	3.4	11.2	173.4*+	5.1*	61.6*	445.4*	180.9*	7.9*	4947.9*+	2857.9*+	4.7*+	1.0*
Pooled deviation	224	1.7	5.6	115.9*	6.6*	50.0*	459.7*	155.4*	6.5*	2298.5*	829.5*	1.1*	0.9*
Pooled error	888	13.0	9.3	27.3	2.5	10.1	294.3	22.0	1.2	222.8	112.4	0.9	0.5

* Significant against pooled error at P=0.05.
\+ Significant against pooled deviation at P=0.05.

Table 2. Estimates of stability parameters of selected crosses for different characters in castor

Genotypes	Plant height			Number of nodes upto main spike			Length of main spike			Number of capsules per main spike			Seed yield per main spike		
	Mean	bi	S² di	Mean	bi	S² di	Mean	bi	S² di	Mean	bi	S² di	Mean	bi	S² di
VP 1 x HO	51.58	1.95	357.07**	20.65	1.26	3.40**	36.18	0.75	12.56**	83.77	0.45	-64.08	59.23	1.26	-0.13
VP 1 x Aruna	54.77	0.06	-3.82	15.03	2.22	3.52**	37.90	0.33	0.62	85.12	2.33	148.79	46.72	1.09	45.61**
VP 1 x SH 41	41.08	-0.21	31.41**	15.17	2.14	3.75**	37.58	-0.33	39.65**	91.30	3.62	103.97	65.57	2.04	204.17**
TSP10R x 2-73-11	87.90	-1.70	-5.08	19.73	2.73	1.06	28.85	1.21	72.76**	53.88	-1.30	60.52	44.77	-0.28	7.11
TSP10R x Hazari 1	41.08	1.06	45.66*	13.93	0.67	6.91**	34.15	1.63	60.83**	61.68	-3.16	284.50*	39.45	-1.32	111.46**
TSP10R x HC 8	52.30	-0.58	73.71**	16.05	2.05	1.48	38.15	4.51**	141.15**	78.72	5.27	2.72	57.37	3.06*	21.53*
SKP 25 x T 4	43.48	0.43	59.68**	14.18	0.68	2.237*	21.42	0.15	75.75**	61.25	-1.20	167.25	41.45	-0.17	40.10**
SKP 25 x RC 8	61.17	1.74	0.15	14.23	-0.90	2.63*	27.08	0.30	-1.84	78.40	-0.27	339.51**	43.57	0.07	29.15**
SKP 25 x SA 2	61.35	1.04	146.80**	16.22	1.13	-0.25	21.88	-0.29*	10.96*	57.25	2.43	58.39	32.18	0.53	83.64**
SKP 25 x SKI 12	60.92	-1.07	527.66**	14.82	2.73	2.16*	20.80	-1.24	78.22**	85.58	6.25*	1732.12**	51.80	-0.21	574.50**
SKP 25 x EC 97700	54.98	-0.14	409.82**	15.12	3.85*	0.30	34.43	-0.79	7.15*	114.08	1.76	-32.15	76.33	2.69	-5.17
SKP 93 x 6-219-22	55.65	0.47	0.66	17.20	0.87	0.23	30.95	1.63	27.92**	73.07	-3.10	49.07	53.93	1.34	346.88**
SKP93 x J 1	47.98	1.62	102.98**	17.03	2.21	11.22**	35.08	2.24	66.63**	97.30	0.80	1934.01**	58.50	-1.44	175.08**
SKP 93 x Punjab 1	68.58	1.07**	-2.75	15.73	0.35	3.39**	34.18	0.77	71.34**	85.42	-2.72	-5.19	69.85	0.72	186.78**
SKP 93 x JI 77	63.77	2.98	27.34*	18.68	2.43	12.23**	23.90	1.32	-3.16	62.32	0.70	-23.69	44.00	0.58	-0.68
SKP 93 x Bhagya	53.52	1.62	20.13*	15.48	0.83	2.09*	20.82	-0.54	45.50**	45.77	2.08	-67.99	33.85	0.97	25.66**
SKP 93 x Aruna	75.,97	0.86	4.59	16.83	0.99	37.42**	24.28	-1.12	96.90**	66.15	-1.42	638.52**	34.65	-0.66	29.28**
Mean	53.52	-	-	15.56	-	-	29.71	-	-	71.61	-	-	47.47	-	-
S.Em.	6.21	1.01	-	1.48	1.40	-	4.08	1.12	-	12.38	2.21	-	7.20	0.86	-

Table 2. Contd......

Genotypes	Number of effective branches per plant			Number of capsules per plant			Seed yield per plant			100-seed weight			Oil content		
	Mean	bi	S² di	Mean	bi	S² di	Mean	bi	S² di	Mean	bi	S² di	Mean	bi	S² di
VP 1 x HO	6.63	0.77	5.95**	450.13	1.09	7025.37**	307.45	1.61**	3812.26**	26.93	1.34**	2.40**	49.60	0.73	0.56*
VP 1 x Aruna	8.98	2.58**	26.69**	345.88	1.17	659.00**	198.23	1.04	3.53	20.55	0.69	3.85**	49.68	1.06	0.16
VP 1 x SH 41	4.75	0.67	4.36**	310.48	1.19	1846.81**	234.33	1.28	519.42**	26.99	0.99	0.01	51.30	2.23	0.06
TSP10R x 2-73-11	4.50	0.80	-0.16	257.42	1.32	451.19**	183.08	1.13*	-9.96**	25.13	0.22	0.10	48.02	0.70	2.46**
TSP10R x Hazari 1	4.13	0.74	2.21**	244.02	0.83	321.04*	155.02	0.72	7.18	23.85	0.42	0.99**	49.37	0.02	0.64*
TSP10R x HC 8	3.67	0.75	0.48	190.52	0.75	1194.12**	145.28	0.93	6.83	26.79	1.96**	1.76**	49.55	1.77	0.03
SKP 25 x T 4	4.63	0.79	0.60	326.17	1.27	963.92**	236.78	0.97	-11.02	26.19	1.29**	2.10**	49.40	0.35	0.60*
SKP 25 x RC 8	5.08	0.84	-0.14	305.98	1.09	414.39*	186.62	1.06	28.61	21.58	1.04	0.13	49.73	0.31	0.95**
SKP 25 x SA 2	8.20	0.45	15.23**	248.98	0.99	632.19**	149.80	0.86	-7.69	21.07	0.94	1.47**	48.94	1.15	0.82**
SKP 25 x SKI 12	6.92	0.57	0.07	288.12	1.11	309.88**	198.73	1.13	2.07	24.60	1.21	1.00*	49.40	0.05	0.51*
SKP 25 x EC 97700	7.52	0.91	9.86**	286.85	1.35	15.07	208.55	1.05	32.85	25.45	1.23	0.66**	49.28	1.19	0.23
SKP 93 x 6-219-22	6.68	1.01	1.94**	379.10	1.36	426.67**	297.28	1.59**	150.76**	27.90	1.26	0.22	49.75	1.14	1.60**
SKP93 x J 1	5.58	0.97	2.45**	494.00	1.92**	12.64.25**	326.77	1.79**	2736.35**	23.95	0.76	0.48	49.63	1.22	0.33
SKP 93 x Punjab 1	8.03	1.69	0.49	244.93	0.79	41.35	215.03	1.15	62.53*	30.91	1.67**	-0.30	50.88	0.75	0.35
SKP 93 x JI 77	4.87	0.48	2.25**	278.03	0.81	835.31**	206.18	0.97	140.97	26.70	1.10	-0.29	49.74	1.09	0.20
SKP 93 x Bhagya	6.03	0.31	8.42**	236.23	0.79	1014.84**	178.73	0.90	27.27	27.95	1.23	0.21	50.72	0.67	-0.07
SKP 93 x Aruna	4.17	0.39	1.00*	291.05	0.89	487.15**	169.45	0.85	65.45	20.90	0.93	0.15	49.81	-0.15	-0.16
Mean	6.48	-	-	273.03	-	-	188.19	-	-	25.03	-	-	49.67	-	-
S.Em.	1.48	0.59	-	27.68	0.24	-	16.63	0.16	-	0.61	0.14	-	0.55	0.94	-

* Significant at P=0.05; ** Significant at P=0.01.

interactions for all the traits except days to flowering and days to maturity indicated that the hybrids interacted with artificially created environments. Mean squares due to environments (linear) was significant for all the 12 traits indicating real differences in the hybrids for regression over environmental means. The variance due to G x E (linear) and non-linear component (pooled deviation) were significant for all the characters except days to flowering and days to maturity. G x E (linear) is attributable to regression and hence predictable, while non-linear component is attributable to deviation from regression and hence unpredictable. Similar findings were reported by Kabaria and Gopani (1971), Hirachand *et al.* (1982), Patel *et al.* (1984) and Henry and Dauley (1985).

For seed yield/plant, out of 112 hybrids, 11 hybrids had neither regression coefficients nor deviations from regression significant (Table 2). Out of these 11 hybrids, SKP 25 x T 4, SKP 215 x EC 97700, SKP 93 x JI 77, VP 1 x Aruna and SKP 25 x RC 8 had regression coefficients equal to unity and non-significant S^2di associated with high seed yield over grand mean and could be considered as stable hybrids and widely adapted hybrids. This also suggested that the performance of these crosses may be predicted over environments with adequate precision. Of these five stable hybrids, VP 1 x Aruna was stable for plant height, length of main spike, number of capsules/main spike and oil content; SKP 25 x T 4 for number of effective branches/plant and number of capsules/plant; SKP 25 x RC 8 for plant height, length of main spike, number of effective branches/plant, number of capsules/plant and 100-seed weight; SKP 25 x EC 97700 for number of capsules/main spike and seed yield/main spike and SKP 93 x JI 77 for length of main spike, number of capsules/main spike, seed yield/main spike, number of capsules/plant, 100-seed weight and oil content.

Two hyrbids *viz.*, TSP 10 R x 2-73-11 and SKP 25 x SKI 12 had average seed yield/plant, regression coefficients greater than unity and non-significant deviation from regression suggesting that these hybrids were below average stability and these could be performed better in superior/favourable environmental conditions. On the other hand, hybrids *viz.*, TSP 10R x Hazari 1, TSP 10R x HC 8, SKP 25 x SA 2, SKP 93 x Aruna and SKP 93 x Bhagya were exhibited below average seed yield/plant, bi values less than unity and non-significant deviation from regression showed its above average stability and performed better under poor/unfavourable environmental conditions. The highest oil content was registered in cross VP 1 x SH 41 which was also stable for oil content and number of capsules/main spike. The cross SKP 93 x Punjab 1 was better responsive to favourable environments with high 100-seed weight which was also stable for plant height, number of effective branches/plant, number of capsules/plant and oil content.

Hybrids SKP 93 x J 1, SKP 93 x 6-219-22 and VP 1 x HO with highest magnitude of heterosis for seed yield/plant over better parent as well as standard hybrid (GCH 4) were unstable under varying environments for seed yield in castor. However, the cross SKP 93 x J 1 was stable for 100-seed weight and oil content, SKP 93 x 6-219-22 was stable for plant height, number of nodes upto main spike, number of capsules/main spike and 100-seed weight. Whereas VP 1 x HO was stable only for number of capsules/main spike and seed yield/main spike.

It is evident that no generalization can be made with regard to the stability of crosses as none of the crosses exhibited uniform stability and response pattern for all the characters. These two parameters appeared to be specific for individual traits of a given cross.

This may be explained on the basis of compensation among the developmental pattern of different characters. Such examples of component compensation in imparting homeostasis for complex traits have been reported earlier (Grafius, 1956 and Bradshaw, 1965).

Critical examination of the stability of cross SKP 25 x T 4 for seed yield revealed interesting informaiton with regard to the role of component traits in imparting stability of yield. This cross exhibited high plasticity (predictable G x E interaction) for number of effective branches/plant and number of capsules/plant. The crosses lacking stability for seed yield were characterized by unpredictable G x E interactions. Bradshaw (1965) suggested that minimum fitness can be obtained by adjustment in the plastic component traits. In a homeostatically buffered population, expression of component traits can shift in compensating manner in changing environment in order to perform for the final traits; otherwise high unpredictable G x E interaction would be results. In the present study also, number of effective branches/plant, number of capsules/plant and 100-seed weight varied in compensating manner in different crosses to conform homeostasis for seed yield in castor.

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