Combining Ability and Gene Action for Yield and Yield Component Characters of Newly Developed Castor (Ricinus Communis L.) Hybrid

Geeta Chaudhari*, Dr. B. N. Patel[1]
** B. A. College of Agriculture, Anand Agricultural University, Anand , Gujarat, INDIA*
[1] Unit Head & Associate Research Scientist Agricultural Research Station, A.A.U., Sansoli, Gujarat, INDIA

***Abstract*- Twelve castor (*Ricinus communis* L.) genotypes consisting four lines and eight testers were crossed in a line × tester mating design. The resulting 32 hybrids along with 12 parents and one standard check was included in crosses were grown in a randomized block design at the Agricultural Research Station, Anand Agricultural University, Sansoli-387130 Gujarat in kharif 2014. The estimates of gca effects indicated that, among females and males, VP 1 and SKP 84 and ANDCM 2, ANDCI 9 and ANDCI 10-4 were good general combiners for seed yield per plant. High sca effects were observed in the crosses JP 65 x JC 22, SKP 84 x ANDCM 2 and SKP 84 x SKI 215 for seed yield.**

Key words: Castor, combining ability, seed yield, hybrid, yield Components.

I. INTRODUCTION

Castor (*Ricinus communis* L., 2n = 2x = 20) is an industrially important non-edible oilseed crop widely cultivated in the arid and semi-arid regions of the world. Castor is a sexually polymorphic species with different sex forms *viz.*, monoecious, pistillate, hermaphrodite and pistillate with interspersed staminate flowers (ISF). The countries like India, Brazil, China, Russia, Thailand and Philippines are the principal castor growing countries.

Combining ability is a powerful tool to provide guideline to the plant breeder in selecting the elite parents and desirable cross combinations to be used in the formulation of systematic breeding programme and at the same time provides means of understanding the nature of gene action involved in the inheritance of various traits. General combining ability is due to additive and additive x additive gene action and is fixable in nature while specific combining ability is due to non-additive gene action which may be due to dominance or epistasis or both and is non-fixable. The presence of non-additive genetic variance is the primary justification for initiating the hybrid breeding programme (Cockerham, 1961).

II. MATERIALS AND METHODS

The experimental material comprising of four lines (VP1, SKP 84, GEETA, JP 65) and eight testers (ANDCM 2, ANDCI 8, ANDCI 9, ANDCI10-4, SKI 215, JC 20, JC 22, JI 96) were selected on the basis of the morphological differences. All these twelve parents were crossed to produce 32 F_1S hybrids according to the line × tester mating design developed by Kempthorne (1957). The resulting 32 hybrids along with 12 parents and one standard check was included in crosses were grown in a randomized block design replicated thrice at the Agricultural Research Station, Anand Agricultural University, Sansoli-387130, Gujarat in kharif 2014. Each entry was planted in a 6 meter long row with inter and intra row spacing of 120 × 60 cm.

The observations were recorded on five randomly selected plants for nine characters in each replication for each genotype and the average value per plant was computed except for days to 50 per cent flowering and days to 50 per cent maturity of primary spike. The observations of both these characters were recorded on population basis.

Data recorded were subjected to analysis of variance according to Panse and Sukhatme (1978) to determine significant differences among genotypes. They were computed according to the line × tester method. Significance test for general combining ability and specific combining ability effects were performed using t-test. Different ratios were used to rate the relative weight of additive versus non-additive type of gene actions.

III. RESULTS AND DISCUSSION

Analysis of variance for combining ability

The recorded data were subjected to analysis of variance and mean square due to various sources of variation to confirm the differences among castor genotypes (Table 1). Analysis of variance for combining ability revealed that mean squares due to females (lines) were highly significant for all the characters except for total number of branches per plant and 100 seed weight. Whereas for males (testers), it was highly significant for all the characters except for total number of branches per plant. The mean squares due to females x males interaction were highly significant for all the characters. A comparison of variances due to males (σ^2m) and females (σ^2f) indicated that the females showed higher magnitude of variability for the character seed yield per plant. The magnitudes of sca variances were higher than the gca variances for almost all the characters indicated the predominance of non-additive gene action in the inheritance of almost all the traits.

The presence of non-additive genetic variance is the primary justification for initiating the hybrid programme (Cockerham, 1961). The perusal of the data revealed lower σ^2 A/σ^2 D ratio for days to 50 per cent flowering and plant height up to primary spike suggested preponderance of non-additive gene action. Above one value of potence ratio and above one half value of predictibility ratio indicated preponderance of additive genetic variance for plant height up to primary spike, whereas, non–additive genetic variance was prime importance for the characters like length of primary spike, number of capsules on primary spike and seed yield per plant as their values of potence ratio was less than one and values of predictability ratio were below one half.

General combining ability

Variation in general combining ability (gca) effects was estimated among females and males for yield and its traits to identify the best parent for subsequent hybrid development programme (Table 2). However, an overall appraisal of general combining ability effects revealed that VP 1, SKP 84, ANDCM 2, ANDCI 9 and ANDCI 10-4 among females and males was found to be a better and consistent general combiner for majority of the traits. Among females VP 1 (16.39) and SKP 84 (8.92) were good general combiners as indicated by significant and positive gca effects for seed yield per plant. Seed yield per plant, being the ultimate objective is very important to castor breeders. Among the males ANDCM 2 (25.54), ANDCI 9 (21.76) and ANDCI 10-4 (20.24) were good general combiners as indicated by significant and positive gca effects for seed yield per plant.

For contributing characters in female parent JP 65 (3.86), VP 1 (1.49) and SKP 84 (0.96) and male parent ANDCI 9 (10.24), ANDCI 8 (5.94), ANDCM 2 (2.07) and SKI 215 (0.67) exhibited significant positive estimates of gca effects and thus possessed favorable genes for length of primary spike. The perusal of results revealed that only female parent VP 1 (10.94) exhibited significant and positive gca effect in number of capsule on primary spike. Among male parents, inbreds ANDCM 2 (17.52), ANDCI 9 (7.72) and ANDCI 10-4 (3.82) had significantly and positive estimates of gca effect in number of capsule on primary spike. Identification of such superior combiners helps the breeders in selecting appropriate parents to be used in the breeding programmes to develop superior hybrids.

Specific combining ability

Specific combining ability effect estimates revealed a wide range of variation for all the characters (Table 3). The results of seed yield per plant revealed that 12 crosses exhibited significant positive sca effects. Out of them, positive significant sca effect for seed yield per plant was exhibited by five promising specific crosses viz., JP 65 x JC 22 (32.09), SKP 84 x ANDCM 2 (28.75), SKP 84 x SKI 215 (27.66), Geeta x ANDCI 8 (23.77) and VP 1 x ANDCI 9 (22.77) indicated the preponderance of non-additive gene action. Of these five combinations, in addition to seed yield per plant, the cross combinations JP 65 x JC 22, SKP 84 x ANDCM 2, SKP 84 x SKI 215 and Geeta x ANDCI 8 registered high and positive sca effects for length of primary spike.

From this study it is observed that parental lines VP 1, SKP 84, ANDCM 2 ANDCI 9 and ANDCI 10-4 were good general combiners. The best three hybrids for seed yield per plant *viz.*, JP 65 x JC 22 (poor x poor), SKP 84 x ANDCM 2 (good x good) and SKP 84 x SKI 215 (good x poor) had significant positive sca effects. This could be exploited beneficially in future castor breeding programme by adopting appropriate breeding technique in order to evolve high yielding hybrid varieties.

REFERENCES

[1]. ***Cockerham, C. C. (1961).** Implication of genetic variances in a hybrid breeding programme.*Crop Sci*., 8: 720-722.

[2]. ***Kempthorne, O. (1957).** An introduction to genetic statistics. John Willey and Sons Inc., New York.

[3]. **Panse, V. G. and Sukhatme, P. V. (1978).** Statistical Methods for Agricultural Workers, I.C.A.R., New Delhi.

***original not seen**

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

Source	df	Days to 50 % flowering	Days to 50 % maturity	Plant height up to primary spike	Length of primary spike	Number of capsules on primary spike	Number of effective branches per plant	100 seed weight	Seed yield per plant	Oil content
Replication	2	5.91	16.42	16.41	5.31	2.43	0.003	0.14	42.62	0.70
Hybrids	31	50.68**	54.43**	202.15**	383.64**	842.06**	2.69**	5.47**	3177.99**	9.95**
Females	3	237.39**	177.25**	399.51**	451.64**	1511.45**	1.41**	3.43	5865.10**	11.11**
Males	7	44.36**	58.85**	562.70**	509.67**	1015.28**	2.14**	5.37**	5343.51**	5.84**
Females x Males	21	26.11**	35.41**	53.78**	331.91**	688.69**	3.05**	5.79**	2072.27**	11.15**
Error	62	7.86	5.25	9.47	5.44	15.86	0.15	1.40	134.98	1.48
ESTIMATES										
$\sigma^2 f$	3	8.76	5.91	14.41	4.99	34.27	-0.07	-0.10	158.09	0.01
$\sigma^2 m$	7	1.47	1.96	42.41	14.81	27.20	-0.08	-0.04	272.63	-0.44

σ^2 fm	21	6.08**	10.05**	14.77**	108.82**	224.22**	0.97	1.47	645.76**	3.22**
σ^2 gca (Av.)		6.38	4.59	23.74**	8.26**	31.91**	-0.071	-0.08	196.22**	-0.15
σ^2sca		6.08**	10.05**	14.77**	108.82**	224.22**	0.97	1.47	645.76**	3.22**
Potence ratio		-	-	4.52	0.214	0.401	-	-	0.86	-
Predictability ratio		-	-	0.76	0.31	0.22	-	-	0.37	-
σ^2A		12.76	9.18	47.48	16.52	63.82	-0.14	-0.16	392.44	-0.3
σ^2D		6.08**	10.05**	14.77**	108.82**	224.22**	0.97	1.47	645.76**	3.22**
$[\sigma^2 D / \sigma^2 A]^{0.5}$		0.69	1.05	0.55	2.57	1.87	2.63	3.03	1.28	3.27

*, ** significant at 0.05 and 0.01 levels of probability, respectively

Table 2: Estimates of general combining ability (gca) effects of parents for yield and its components

Parents	Days to 50 % flowerin g	Days to 50 % maturity of primary spike	Plant height up to primary spike	Length of primary spike	Number of capsules on primary spike	Number of effective branches per plant	100 seed weight	Seed yield per plant	Oil content
Females									
VP 1	-4.63**	-3.00**	-2.09**	1.49**	10.94**	0.25**	-0.12	16.39**	-0.84*
SKP 84	1.56**	-1.46*	-1.81**	0.96*	-5.20**	0.12	-0.16	8.92**	-0.21
Geeta	2.23**	1.52	6.11**	-6.22**	-6.46**	-0.30**	-0.28	-18.33**	0.74*
JP-65	0.85	2.95**	-2.22**	3.86**	0.72	-0.08	0.56*	-6.99**	0.32
S.E. (gi)	0.57	0.66	0.63	0.48	0.81	0.08	0.24	2.37	0.25
CD at 5 %	1.11	1.29	1.23	0.94	1.58	0.15	0.47	4.64	0.49
S.E. (gi – gj)	1.14	0.94	1.25	0.95	1.62	0.16	0.48	4.74	0.497
CD at 5 %	2.23	1.84	2.45	1.86	3.17	0.31	0.94	9.30	0.97
Males									
ANDCM 2	2.76**	0.25	5.24**	2.07**	17.52**	0.25*	0.86**	25.54**	-0.34
ANDCI 8	-1.21	0.10	1.87	5.94**	-4.89**	-0.12	-0.91**	-9.04**	0.72*
ANDCI 9	-1.22	-3.82**	5.09**	10.24**	7.72**	-0.64**	0.24	21.76**	-0.99**
ANDCI 10-4	-1.71*	-2.88**	3.06**	-0.68*	3.82**	-0.48**	0.57	20.24**	-0.56
SKI 215	1.80*	2.10**	5.54**	0.67*	-3.04**	0.01	0.52	-0.23	0.56
JC 20	1.99*	1.45**	-11.58**	-1.08	-2.68*	0.45**	-0.14	-3.87	-0.34
JC 22	1.63*	2.10**	-9.88**	-9.92**	-8.90**	-0.19	-0.90**	-25.52**	-0.07
JI 96	1.49	0.70	0.89	-7.24**	-9.95**	-0.54**	-0.24	-28.88**	8.02**
S.E. (gj)	0.81	0.66	0.89	0.67	1.15	0.11	0.34	3.35	0.35
CD at 5 %	1.58	1.29	1.74	1.31	2.25	0.21	0.66	6.56	0.68
S.E. (gi – gj)	0.81	0.66	0.89	0.67	1.15	0.11	0.34	3.35	0.35
CD at 5 %	1.58	1.29	1.74	1.31	2.25	0.21	0.66	6.56	0.68

*, ** significant at 0.05 and 0.01 levels of probability, respectively

Table 3: Estimates of specific combining ability (sca) effects of hybrids for yield and its components

Sr. no.	Hybrids	Days to 50 % flowering	Days to 50 % maturity of primary spike	Plant height up to primary spike	Length of primary spike	Number of capsules on primary spike	Number of effective branches per plant	100-seed weight	Seed yield per plant	Oil content
1	VP 1 x ANDCM 2	-1.06	-1.09	-1.44	9.65**	22.57**	0.97**	1.26	22.76**	-2.66**
2	VP 1 x ANDCI 8	1.17	0.06	3.94*	1.34	-7.49**	0.07	0.03	-19.94**	-0.07
3	VP 1 x ANDCI 9	-2.75	1.27	0.64	0.38	8.13**	-0.11	-2.72**	22.77**	-0.97
4	VP 1 x ANDCI 10-4	-0.47	1.38	1.38	-0.59	8.32**	1.30**	0.90	15.10*	-0.70
5	VP 1 x SKI 215	1.71	-0.42	1.67	-7.50**	-14.76**	-1.90**	-0.18	-17.88**	3.22**
6	VP 1 x JC 20	1.97	1.46	0.34	6.96**	0.43	1.04**	1.96**	22.42**	-0.85
7	VP 1 x JC 22	-0.52	-1.39	-2.46	-5.47**	-6.29**	-0.77**	-1.95**	-27.96**	1.01
8	VP 1 x JI 96	0.02	-1.28	-4.08*	-4.77**	-10.90**	-0.61**	0.69	-17.27*	1.03

9	SKP 84 x ANDCM 2	-2.24	-1.22	3.58*	16.33**	28.68**	1.31**	0.99	28.75**	-2.66**
10	SKP 84 x ANDCI 8	0.19	2.52	3.57*	11.35**	1.21	0.34	0.22	0.70	0.87
11	SKP 84 x ANDCI 9	1.52	0.84	-2.11	-14.27**	-17.00**	-0.81**	-0.27	-54.35**	2.81**
12	SKP 84 x ANDCI 10-4	3.15	1.50	0.56	-3.12*	-16.17**	-1.12**	0.54	-11.83	-0.24
13	SKP 84 x SKI 215	-1.04	7.27**	2.09	12.22**	17.25**	0.80**	0.59	27.66**	-0.80
14	SKP 84 x JC 20	-4.05*	-3.27*	-3.46	-12.02**	-4.61*	-0.46*	-0.94	6.89	1.29
15	SKP 84 x JC 22	1.55	-4.85**	-3.62*	-3.78**	-10.01**	0.16	0.58	-6.71	-2.15**
16	SKP 84 x JI 96	0.93	-2.79*	-0.61	-6.72**	0.64	-0.22	-1.72*	8.88	0.90
17	Geeta x ANDCM 2	-1.88	1.68	-4.47*	-6.73**	-24.90**	-1.24**	-1.12	-5.81	2.02**
18	Geeta x ANDCI 8	2.99	-4.99**	1.25	2.66*	8.47**	0.37	0.70	23.77**	1.31
19	Geeta x ANDCI 9	5.19**	-1.36	4.13*	10.36**	-2.69	0.91**	1.25	16.22*	-1.79*
20	Geeta x ANDCI 10-4	-3.22*	-3.52**	0.54	0.39	-2.92	-0.61**	-1.12	-11.11	0.87
21	Geeta x SKI 215	0.66	-1.60	-7.42**	-5.16**	3.07	0.46*	-1.18	-23.52**	-0.57
22	Geeta x JC 20	0.61	2.30	2.16	-5.40**	6.59**	-0.26	-0.82	-20.23**	-0.95
23	Geeta x JC 22	-1.85	6.13**	5.02**	2.19	9.81**	-0.60*	1.84**	2.58	0.26
24	Geeta x JI 96	-2.42	1.35	-1.20	1.69	2.56	0.97**	0.44	18.09**	-1.15
25	JP 65 x ANDCM 2	5.18**	0.63	2.32	-19.25**	-26.34**	-1.05**	-1.13	-45.71**	3.30**
26	JP 65 x ANDCI 8	-4.35**	2.40	-8.76**	-15.35**	-2.19	-0.79**	-0.95	-4.53	-2.12**
27	JP 65 x ANDCI 9	-3.96*	-0.76	-2.67	3.54**	11.57**	0.01	1.74*	15.36*	-0.04
28	JP 65 x ANDCI 10-4	0.54	0.64	-2.47	3.31*	10.76**	0.43	-0.33	7.84	0.07
29	JP 65 x SKI 215	-1.18	-5.25**	3.66*	0.43	-5.56*	0.64**	0.77	13.73*	-1.85**
30	JP 65 x JC 20	1.47	-0.50	0.96	10.46**	-2.41	-0.32	-0.21	-9.09	0.51
31	JP 65 x JC 22	0.82	0.11	1.07	7.07**	6.48**	1.21**	-0.48	32.09**	0.89
32	JP 65 x JI 96	1.48	2.72*	5.89**	9.80**	7.69**	-0.14	0.59	-9.70	-0.77
	Range Min.	-4.35	-5.25	-8.76	-19.25	-26.34	-1.90	-2.72	-54.35	-2.66
	Range Max.	5.19	7.27	5.89	16.33	28.68	1.31	1.96	32.09	3.30
	S. E.(Sij)	1.62	1.32	1.78	1.35	2.30	0.23	0.68	6.71	0.70
	CD at 5 %	3.17	2.58	3.48	2.64	4.50	0.45	1.33	13.15	1.37
	CD at 1 %	4.17	3.14	4.59	3.48	5.93	0.59	1.75	17.31	1.81

*, ** significant at 0.05 and 0.01 levels of probability, respectively.