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Research Note

Identification of best combiners for development of castor hybrids under irrigated conditions

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Abstract
Sixty hybrids developed from 6 lines and 10 testers in a line x tester mating design were evaluated under irrigated and intensive cultivation at Regional Research Station, Anand Agriculture University, Anand, Gujarat. Analysis of variance for combining ability depicted considerable variation among the lines and testers and also lines x testers for seed yield and yield attributing characters. The ratio of GCA and SCA variance was low and close to unity for all the characters studied, indicating the predominance of the non-additive gene action for all the characters studied. DPC-21 was the best general combiner for seed yield, early maturity, effective primary spike length, hundred seed weight and oil content. Among 10 testers, PMC-55, PMC-9 and PMC-18 were good combiners for seed yield. Five of the crosses JP-77-1 x PMC-4, M-619 x PMC-11, JP-77-1 x PMC-19, SKP-84 x PMC-9 and DPC-21 x PMC-11 were found to be superior combinations for seed yield responding better to irrigated and high intensive cropping conditions.

Keywords
Castor, Combining ability, GCA, Irrigated, Line x Tester and SCA.

Castor is an important non edible oil seed crop grown in India. India accounts for nearly 60% of the world's castor area and 65% of world castor production (Sarada *et al* 2015). Castor productivity in India is more than the world average and India ranks first among the major producing countries *viz*., China and Brazil (Sarada *et al.* 2015). Castor is cultivated under two contrasting environments i) irrigated intensive cultivation, largely with hybrids, with high productivity in Gujarat and Rajasthan and ii) rainfed cultivation, mostly with varieties and hybrids coupled with low input application in Telangana, Andhra Pradesh, Karnataka, Odisha and Tamil Nadu. Presently GCH-7 released from Sardarkrushinagar Agricultural University, SK Nagar, Gujarat is the ruling hybrid cultivated in Gujarat and Rajasthan. In order to further increase the productivity and sustain resistance to wilt disease and wider adaptability, there is a need to develop new potential hybrids for irrigated conditions. At IIOR, Hyderabad constant efforts are made to develop parental lines for development of hybrids suitable for irrigated and rainfed condition. Stable lines from advance generations of different crosses were identified (IIOR, 2014). These stable lines are being used as male parents to develop hybrids using well known pistillate lines. Combining ability analysis is useful to find the nature of gene action of quantitative traits and aids the plant breeders in selecting good combining parents for development of hybrids. The present study was taken up to identify the best general combiners and specific combiners among the newly developed monoecious lines

Six pistillate lines *viz*., M-619, SKP-84, DPC-21, DPC-25, JP-77-1 and Rb (13)-1854 were crossed with ten monoecious lines *viz*., PMC-4, PMC-7, PMC-9, PMC-11, PMC-13, PMC-18, PMC-19, PMC-27, PMC-32 and PMC-55. Sixty hybrids were produced in a line x tester mating design at ICAR-Indian Institute of Oilseeds Research, Hyderabad during Rabi 2015. Sixty hybrids were sown during September 2016 in two replications along with three checks at Regional Research Station, Anand Agriculture University, Anand, Gujarat. Each entry was sown in two rows with the spacing of 120x60 cm accommodating 20 plants. The crop was irrigated five times and recommended agronomic and plant protection measures were provided in time to ensure a healthy crop. The observations on five randomly selected plants were recorded for 12 characters *viz*., days to 50 % flowering of primary raceme, days to maturity of primary raceme, plant height up to primary raceme (cm), number of nodes up to primary raceme, effective length of primary raceme (cm), number of effective spikes per plant, number of capsules on primary raceme, seed yield per plant (g), 100-seed weight (g) and oil content (%).The data were subjected to combining ability analysis as suggested by Kempthorne (1957).

The analysis of variance for combining ability indicated that the mean sum of squares due to lines were found to be highly significant for all the eleven traits studied (Table 1). In case of testers, number of node number up to primary raceme and oil content was non-significant. The Similar result was observed in mean sum of squares of line x tester also. Male parents having 15 to 17 nodes till the base of the primary raceme were selected for hybridization. The hybrids also had 15 to 17 nodes which led to approximately similar days to 50% flowering in them. The ratio of GCA and SCA variance was low and close to unity for all the characters studied. This suggest the predominance of the non-additive gene action for all the characters. Kavani *et al* (2016) analysed combining ability for all the characters in castor but with different lines and testers and reported the predominance of non-additive gene action except for oil content. Chandra Mohan *et al* (2006) and Madariya *et al* (2008) reported non-additive gene effects for seed yield and yield components.

The estimates of general combining ability for lines and testers are given in the table 2. Among six lines DPC-21 was found to be best general combiner for seed yield, early maturity, effective primary spike length, hundred seed weight and oil content. Among 10 testers, PMC-55, PMC-9 and PMC-18 were good combiners for seed yield. PMC-4 and PMC-11 were good combiners for early flowering but not for early maturity. PMC-13 and PMC-27 were good combiners for early maturity. PMC-11 is a good combiner for number of effective spikes per plant. For capsule number per primary spike PMC-19 is the best combiner. PMC-13, PMC-11 and PMC-9 were found to be good combiners for hundred seed weight while PMC-18 and PMC-32 were good combiners for oil content. A perusal of GCA effects of 10 newly developed male lines for 10 traits revealed that none of the parents was found good general combiner simultaneously for all the traits studied. The *per se* performance was considered as the first and foremost important criterion for the selection of superior crosses. Best five hybrids showing high SCA effect for 8 characters are given in table 3. The SCA effects showed that no single cross showed maximum SCA effects for all the characters. The crosses JP-77-1 x PMC-4, M-619-PMC-11, JP-77-1 x PMC-19, SKP-84-PMC-9 and DPC-21 x PMC-11 were found to be superior combinations for seed yield responding to irrigated and high intensive cropping conditions. The cross between M-619 x PMC-17 showed maximum SCA effect for number of capsules per primary spike and number of effective spikes per plant. The hybrid DPC-21 x PMC-11 showed high SCA effect for seed yield along with early maturity while the hybrid DPC-21 x PMC-4 showed high SCA effect for early maturity and oil content. From the present study it is concluded that the parental lines DPC-21 is a potential pistillate line which can be utilized for commercial production of hybrids. Among male lines, four lines *viz*., PMC-9, PMC-18, PMC-19 and PMC-55 can be utilized for development of hybrids and for further breeding programmes with recurrent selection. The cross DPC-21 x PMC-11 can be utilized in recombination breeding in order to evolve high yielding genotypes suitable for irrigated conditions.

References

Annual report on castor.2014-15. ICAR-Indian Institute of Oilseeds Research, Hyderabad, India. Pp 29.

Chandra Mohan, Y., Vishnuvardhan Reddy, A., and Nageshwar Rao 2006. Inheritance of bloom nature in castor, *Ricinus communis* L. *J. Oilseeds Res*., **23**(2):184-186.

Kavani R. H., Vachhani J. H., Madariya R. B., Jadeja S. R. and Dobariya K. L. 2016. Combining ability for seed yield and its components in castor (*Ricinus communis* L.). *J. Oilseeds Res*., **33(1)**:22-25.

Kempthorne, O. 1957. An introduction to Genetic Statistics. John Wiley & Sons, New York, 545 pp.

Madariya, R. B., Vaddoria, M. A., Mehta, D. R. and Kavani, R. H. 2008. Combining ability analysis over environment for seed yield and its components in castor (*Ricinus communis* L.). *Crop Improv*., **35(2)**:163-166.

Sarada, C., Alivelu, K., Sambasiva Rao. V., Sudhakar Babu, S. N. and Varaprasad, K.S. (2015). Oilseeds statistics a compendium. ICAR-Indian Institute of Oilseeds Research, Hyderabad India. Pp172

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Table 1. Analysis of variance for combining ability of eleven characters; DF=Degrees of freedom, SY=seed yield per plot (g), DOF=Days for 50% flowering of primary spike, DOM=Days for maturity, PN=Number of nodes till primary spike, PH=Plant height (cm) upto primary spike, EPSL=Effective primary spike length, CN/PS=Capsule number per primary spike length, ES/P=Effective number of spikes per plant, TW=100-seed test weight (g), OC=Oil content (%)

Source	DF	Mean sum of squares									
		SY	DOF	DOM	PN	PH	EPSL	CN/PS	ES/P	TW	OC
Replication	1	639.8ns	4.4*	0.2ns	30**	185.5ns	17.4ns	137.3ns	1.7ns	3.5ns	0.4ns
Cross	59	6732**	17.6**	36**	14.4ns	312.8*	79.3**	418.6**	5.5**	27.4**	1.8ns
Line (c)	5	8454.2**	23.8**	30.7**	49.5**	1125.9**	120.3**	2424**	4.6**	98.9**	8.6**
Tester(c)	9	8261.9**	21.4**	20.8**	10.2ns	245.2*	109.9**	253.8**	5.3**	82.8**	2.1ns
LXT (c)	45	6228.7**	16.2*	39.6**	11.3ns	236*	68.6**	228.8**	5.6**	8.4ns	1ns
Error	59	1426.7	0.9	2.5	10.1	62.7	15.2	28.6	0.7	0.9	0.5
Mean		251.8	58.61	132.84	16.55	92.63	74.26	93.62	9.12	34.25	49.37
CV(%)		15	1.66	1.2	19.29	8.55	5.26	5.71	9.42	2.84	1.49
σ^2GCA		706.54	0.00	0.03	-0.07	0.06	1.56	0.22	3.85	0.00	0.02
σ^2SCA		633767.63	0.21	7.66	18.55	0.59	86.62	26.72	100.12	2.47	0.24
σ^2GCA/ σ^2SCA		0.001	0.005	0.004	-0.004	0.105	0.018	0.008	0.038	-0.001	0.069

*,**,significant at 5% and 1% level of probability respectively; ns, non-significant

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Table 2. General combining ability of lines and testers; SY=seed yield per plot (g), DOF=Days for 50% flowering of primary spike, DOM=Days for maturity, PN=Number of nodes till primary spike, PH=Plant height (cm) upto primary spike, EPSL=Effective primary spike length, CN/PS=Capsule number per primary spike length, ES/P=Effective number of spikes per plant, TW=100-seed test weight (g), OC=Oil content (%)

	SY	DOF	DOM	PN	PH	EPSL	CN/PS	ES/P	TW	OC
LINES										
M-619	-15.95ns	1.29**	0.61ns	1.47*	8.99**	-0.94 ns	-18.4**	-0.64**	-2.31**	-0.19 ns
SKP-84	-0.12ns	-0.1ns	-0.5 ns	2.19**	-3.2 ns	-1.63 ns	14.39**	-0.33 ns	0.54*	0.16 ns
Rb (13)-1854	-27.67**	-0.2ns	1.51**	0.32 ns	-1.64 ns	-2.24*	-4.77**	0.23 ns	0.74**	-0.44**
JP-77-1	12.38ns	-1.9**	-0.5 ns	-1.2 ns	-12.3**	-1.41 ns	5.51**	0.75**	-2.77**	-0.66**
DPC-21	30.65**	0.04ns	-1.9**	-1.27 ns	5.46**	2.86**	1.32 ns	0.1 ns	3.25**	1.21**
DPC25	0.72ns	0.79**	0.86	-1.51	2.67 ns	3.37**	2.01 ns	-0.1 ns	0.54*	-0.08 ns
TESTERS										
PMC-4	-36.88**	-1.5**	2.66**	0.6 ns	4.1 ns	-2.54*	-0.27 ns	-0.54*	-3.83**	-0.17 ns
PMC-7	18.92ns	-0.2ns	0.49 ns	-1.2 ns	0.79 ns	-1.46 ns	-1.12 ns	-0.43 ns	-2.91**	0.38 ns
PMC-9	22.92*	-0.2ns	0.24 ns	-0.27 ns	-3.93 ns	-2.91**	2.08 ns	-0.57*	1.55**	-0.38 ns
PMC-11	-7.22ns	-0.9**	-0.3 ns	0.15 ns	2.25 ns	7.34**	0.28 ns	-0.81**	1.72**	0.25 ns
PMC-13	8.93ns	-0.2ns	-2.4**	-0.45 ns	1.7 ns	1.46 ns	-2.26 ns	-0.54*	5.5**	-0.38 ns
PMC-18	22.57*	3.22**	0.49 ns	2.2	-5.76	-2.78**	-2.77 ns	0.66**	-0.63*	0.59*
PMC-19	-24.23*	0.22ns	0.08 ns	-0.67 ns	0.27 ns	0.67 ns	11.69**	0.29 ns	-1.1**	0.11 ns
PMC-27	3.38ns	-0.3ns	-1.3**	-0.17 ns	-8.23**	-0.01 ns	-5.72**	0.84**	0.93**	-0.45*
PMC-32	-40.94**	0.98**	0.49ns	0.27 ns	3.12 ns	0.89 ns	-1.47 ns	1.01**	-0.36 ns	0.55*
PMC-55	32.55**	-1.2**	-0.5ns	-0.47 ns	5.69	-0.65 ns	-0.42 ns	0.09 ns	-0.87**	-0.49*

*,**, significant at 5% and 1% level of probability respectively; ns,non significant

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Table 3. Top five specific combiners with high specific combining ability effects and mean of the respective cross for yield and its components

Characters/ Cross	Mean	SCA effect
Seed yield/plant (g)		
JP-77-1xPMC-4	325.19	97.93**
M-619xPMC-11	307.31	78.73**
JP-77-1xPMC-19	315.35	75.44**
SKP-84xPMC-19	296.07	68.66*
DPC-21xPMC-11	279.43	62.57*
Days to 50% flowering of primary spike		
SKP-84xPMC-7	52	-6.36**
DPC-25xPMC-11	53.5	-5.04**
M-619xPMC-19	55.5	-4.63**
Rb (13)-1854xPMC-4	52.5	-4.63**
M-619xPMC-11	54.5	-4.54**
Days to Maturity of primary spike		
JP-77-1xPMC-9	122	-10.54**
JP-77-1xPMC-11	125	-7.04**
JP-77-1xPMC-7	126.5	-6.29**
DPC-21xPMC-11	128.5	-5.59**
DPC-21xPMC-4	131.5	-5.51**
Plant Height (cm) upto primary spike		
DPC-21xPMC-55	84.1	12.73**
M-619xPMC-4	82.9	12.13**
JP-77-1xPMC-32	84.7	10.96**
Rb (13)-1854x PMC-18	81.1	6.76*
M-619xPMC-18	77.1	6.56*

Characters/ Cross	Mean	SCA effect
No.of capsules/ primary spike		
Rb (13)-1854xPMC-7	112.6	18.78**
M-619xPMC-55	91.8	17.04**
M-619xPMC-19	102.9	16.03**
DPC25xPMC-18	108.8	15.94**
DPC-21xPMC-19	112.8	12.26**
No. of effective spikes/plant		
DPC-21xPMC-27	13.9	3.7**
SKP-84xPMC-32	13.1	3.29**
M-619xPMC-27	12.1	2.78**
DPC25xPMC-4	11.2	2.72**
M-619xPMC-19	11.2	2.43**
100-seed weight (g)		
M-619xPMC-4	33.05	4.94**
SKP-84xPMC-9	39.19	2.85**
DPC-21xPMC-13	43.01	2.53**
M-619xPMC-18	33.75	2.44**
DPC-21xPMC-27	38.18	2.26**
Oil content (g)		
M-619xPMC-55	50.35	1.65**
DPC-21xPMC-4	50.22	1.46**

*,**, significant at 5% and 1% level of probability respectively