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COMBINING ABILITY FOR YIELD AND YIELD CONTRIBUTING CHARACTERS OF WHITE JUTE (*CORCHORUS CAPSULARIS* L.)*

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Abstract

Crosses were made between three varieties and seven accessions of white jute (*Corchorus capsularis* L.) in all possible combinations to establish 10 × 10 full diallel set. Variances for general combining ability (GCA) and specific combining ability (SCA) were significant or highly significant for all the characters indicating additive and non-additive gene actions played predominant role for expression of these characters. The magnitudes of GCA variance were higher than the corresponding SCA variance confirmed the predominance of additive genetic variations for these traits. The variety CVL-1 and Acc. 1831 were good general combiners for plant height, technical height, base diameter, number of nodes, bark weight, fibre weight and stick weight. Crosses, var. CVL-1 × Acc. 1831, Accs. 3695 × 4087, Accs. 1831 × 1833, Accs.1831 × var.CC-45, Acc. 2146 × var. A-38 and Acc. 2146 × var.CC-45 revealed significant positive SCA effect for fibre weight. Significant reciprocal SCA effect was observed in crosses, Accs.1832 × 3695, Accs.1833 × 1831 and Acc. 4087 × var.CVL-1. Crosses, var. CVL-1 × Acc.1831, Accs. 3695 × 4087, Acc.1831 × var.CC-45, Acc.2146 × var.CC-45 and a reciprocal cross, Accs.1833 × 1831 were found to be good specific combiners for bark weight, fibre weight and stick weight.

Introduction

It is generally recognized that genetic make up of different quantitative characters is essential in order to execute successful breeding programs for the improvement of jute. Hence, gene action and combining ability help in proper understanding of inheritance of characters in the selection of suitable parents for hybridization program and for the formation of an appropriate selection scheme. In the combining ability of jute, some studies have been made by several authors (Paul and Eunus 1975, Srivastava *et al.* 1978, Ghosh *et al.* 1979, Ghosh Dastidar and Das 1982, Alam and Husain 1985, Kumar 1987, Sinhamahapatra and Ghosh Dastidar 1990, De and Ghosh Dastidar 1991, Pulve and Kumar 1991, Chaudhury and Sasmal 1992, Shah *et al.* 1994, Kumar and Palve 1995). Therefore, an attempt was made to obtain information on the nature of combining ability in white jute (*Corchorus capsularis* L.).

Materials and Methods

The materials consisted of seven Accessions *viz.* 3695, 1515, 1831 1832, 1833, 2146 and 4087 as well as three improved varieties, *viz.* CVL-1, A-38 and CC-45. All the parents were crossed in all possible combinations including reciprocals. Ten parents and their crosses (45 F_1s and 45 reciprocals) were grown in a randomized complete block design with three replications at the field of central station of Bangladesh Jute Research Institute in 2001. Seeds of each parent and F_1s were sown in one row of 3 m long. Space between rows was 30 cm and that between plants was 6 - 7 cm. From each replication 10 plants were selected at random and harvested 120 days after sowing. Standard intercultural practices were followed to raise a healthy and disease free crop.

Data on plant height, technical height, base diameter, number of nodes, number of branches, bark weight, fibre weight, stick weight, number of fruits, number of seeds per fruit, seed weight and 1000 seed weight on per plant basis were recorded. The combining ability analysis was done following Method-1, Model-1 of Griffing (1956).

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Results and Discussion

Analysis of variance for combining ability revealed that variance due to GCA and SCA was highly significant for all the characters (Table 1) indicating additive and non-additive gene actions which played predominant role for expression of these characters. The magnitudes of GCA variance were higher than the corresponding SCA variance for all the characters indicated preponderance of additive effects in controlling the expression of these traits. Additive variance is fixable, and therefore, selection for traits governed by such variance is very effective (Singh and Narayanan 1993). Reciprocal differences were also significant for base diameter, number of branches, bark weight, fibre weight, stick weight, number of fruits, seed weight and 1000 seed weight. Significant reciprocal variance indicated maternal effect of parents in their offsprings.

GCA effect: Parents with high GCA effects for different traits may be extensively used in hybridization program as a donor parents for the improvement of these traits. The estimates of GCA effect of the parents along with their mean values are presented in Table 2. The GCA effects revealed that the best general combiners were the parents of varieties CVL-1 and A-38, Accs. 1831 and 4087 for plant height; vars. CVL-1, A-38 and CC-45, Accs. 1831 and 4087 for technical height; vars. CVL-1 and A-38, Accs. 1831 and 4087 for base diameter; vars. CVL-1 and CC-45, Accs. 1831, 2146 and 4087 for number of nodes; Accs. 1832 and 1833 for number of branches; vars. CVL-1 and A-38 and Acc. 1831 for bark weight, fibre weight and stick weight; Accs. 1832 and 2146 for number of fruits; Acc. 2146 for number of seeds per fruit; var. CVL-1 and Acc. 2146 for seed weight and var. A-38 and Acc. 2146 for 1000 seed weight. Parents with good GCA for a particular trait associated with large adaptability indicated additive type of gene action.

SCA effect: The desirable specific parental combinations for yield and its components are presented in Table 3. Significant positive SCA effect was observed in crosses, Accs. 3695 × 1832, Accs. 1832 × 1833, Acc. 1832 × var. A-38 and Accs. 1833 × 4087 for plant height, crosses, Accs. 1515 × 1833, Acc. 1515 × var. A-38, Accs. 1831 × 1833, Accs. 1832 × 1833, Accs. 1833 × 2146 and Accs. 1833 × 4087 for technical height, crosses, var. CVL-1 × Acc. 1832, Accs. 3695 × 4087, Acc. 1515 × var. CC-45, Acc. 1831 × var. CC-45, Accs. 1833 × 4087 and Acc. 2146 × var. A-38 for base diameter, crosses, Accs. 3695 × 1833, Accs. 1515 × 1833, Accs. 1831 × 1833 and Accs. 1832 × 1833 for number of nodes,crosses, Accs. 1832 × 1833 and Accs. 1833 × 2146 for number of branches, crosses, var. CVL-1 × Acc. 1831, Accs. 3695 × 1833, Accs. 3695 × 4087, Accs. 1515 × 4087, Acc. 1831 × var. CC-45 and Acc. 2146 × var. CC-45 for bark weight, crosses, var. CVL-1 × Acc. 1831, Accs. 3695 × 4087, Accs. 1831 × 1833, Acc. 1831 × var. CC-45, Acc. 2146 × var. A-38 and Acc. 2146 × var. CC-45 for fibre weight, crosses, var. CVL-1 × Acc. 1831, Accs. 3695 × 1832, Accs. 3695 × 1833, Accs. 3695 × 4087, Accs. 1515 × 4087, Acc. 1831 × var. CC-45 and Acc. 2146 × var. CC-45 for stick weight, crosses, Acc. 1515 × var. CC-45, Accs. 1831 × 2146, Accs. 1832 × 1833 and Accs. 1832 × 2146 for number of fruits, crosses, var. CVL-1 × Acc.1515, Accs. 3695 x× 1831 and Accs. 1833 × 4087 for number of seeds per fruit,crosses, Accs. 1515 × 1831, Accs. 1832 × 2146 and Acc. 4087 × var. CC-45 for seed weight, crosses, Acc. 3695 × var. CC-45, Accs. 1515 × 1833 and Accs. 1832 × 1833 for 1000 seed weight.

Reciprocal effect: Significant positive reciprocal SCA effect was observed in cross, Accs. 2146 × 3695 for plant height, crosses, Accs. 2146 × 3695 and var. CC-45 × Acc. 1833 for technical height, crosses, Accs. 1831 × 1515, Accs. 1833 × 1831, Accs. 4087 × var. CVL-1 and var. CC-45 × Acc. 1515 for base diameter, crosses, Accs. 2146 × 3695 and var. CC-45 × Acc. 1833 for number of nodes, cross, Accs. 1833 × 1831 for bark weigt, crosses, Accs. 1832 × 3695, Accs. 1833 × 1831 and Acc. 4087 × var. CVL-1 for fibre weight, crosses, Acc. 3695 × var. CVL-1 and Accs. 1833 × 1831 for stick weight, crosses, Accs. 2146 × 1831, Accs. 2146 × 1832 and var.

Table 1. Analysis of variance for combining ability in *Corchorus capsularis* for 12 morphological characters.

Source	D. F.	Mean square for different characters											
		Plant height (m)	Technical height (m)	Base diameter (mm)	No. of nodes/ plant	No. of branches/ plant	Bark wt./plant (g)	Fibre wt./plant (g)	Stick wt./plant (g)	No. of fruits/ plant	No. of seeds/ fruit	Seed wt./plant (g)	1000 seed wt. (g)
GCA	9	0.66**	0.99**	26.67**	297.12**	7.69**	743.28**	205.73**	929.45**	1973.70**	6.95**	8.92**	0.18**
SCA	45	0.12**	0.15**	6.89**	48.54**	3.19**	217.94**	46.14**	286.74**	618.96**	5.34**	2.04**	0.04**
Reciprocal	45	0.02	0.04	3.60**	18.24	2.83*	129.91*	26.93*	154.65*	446.67*	3.09	2.48**	0.38**
Error	198	0.03	0.03	2.23	15.90	1.91	86.33	17.72	103.67	288.19	2.49	1.36	0.02

*,**, significant at 5 and 1% levels, respectively.

Table 2. Mean performance and general combining ability effects of the parents for 12 morphological characters of *Corchorus capsularis*.

Parents Varieties/ Acc. No.	Plant height (m)	Technical height (m)	Base diameter (mm)	No. of nodes/ plant	No. of branches/ plant	Bark wt./plant (g)	Fibre wt./plant (g)	Stick wt./plant (g)	No. of fruits/ plant	No. of seeds/ fruit	Seed wt./plant (g)	1000 seed wt. (g)
CVL - 1	3.93	3.20	26.37	67.67	4.73	61.01	34.67	69.33	69.67	34.07	5.80	3.47
	0.23**	0.19**	1.42**	3.78**	−0.54	6.53**	4.05**	7.63**	−1.01	0.39	0.86**	−0.03
3695	3.12	2.13	18.85	47.73	2.93	29.29	12.67	34.00	32.20	29.67	1.21	2.83
	−0.04	−0.03	−0.11	0.12	−0.80**	0.76	0.37	−0.21	−16.21**	−0.21	−0.92**	−0.19**
1515	2.83	1.63	14.45	27.07	2.87	26.99	13.67	30.67	28.67	31.67	1.24	3.02
	−0.17**	−0.36**	−1.69**	−7.10**	−0.71*	−7.89**	−5.39**	−8.65**	7.03	0.50	−0.51*	−0.05
1831	3.65	2.99	25.69	57.38	2.80	66.29	26.00	75.33	16.57	28.07	0.25	2.92
	0.14**	0.18**	1.45**	2.57**	0.14	8.50**	3.96**	9.98**	0.97	0.53	0.27	−0.02
1832	2.38	1.66	18.07	35.18	5.00	18.38	9.14	20.89	79.00	32.20	2.60	3.13
	−0.32**	−0.34**	−1.54**	−5.55**	1.08**	−10.60**	−4.79**	−12.27**	10.45**	−0.06	0.09	0.00
1833	1.22	0.35	9.81	10.20	2.53	2.46	0.97	2.80	31.60	33.27	0.64	3.13
	−0.21**	−0.17**	−1.62**	−2.55**	0.88**	−3.22	−1.10	−3.35	−8.59*	−0.39	−0.23	0.02
2146	3.48	2.64	19.67	52.07	3.13	34.61	15.33	39.33	91.53	32.13	3.68	3.43
	0.05	0.04	-0.20	3.11**	0.42	0.91	−0.47	1.17	18.31**	1.03**	1.29**	0.12**
4087	3.97	3.45	25.43	53.47	4.33	46.93	21.33	53.33	35.80	27.87	2.31	2.98
	0.18**	0.27**	0.70*	3.31**	−0.46	−0.33	1.29	0.78	−1.78	−0.38	−0.06	−0.05
A - 38	3.43	2.76	22.63	44.50	4.27	54.27	26.33	61.67	54.00	27.33	2.25	3.73
	0.09*	0.11**	0.82*	0.19	−0.47	5.72**	2.27*	4.68*	−2.30	−0.86*	−0.25	0.15**
CC-45	3.22	2.62	20.89	57.90	3.27	39.60	17.00	45.00	24.33	28.67	0.77	3.32
	0.04	0.11**	0.31	2.10*	−0.26	−0.39	−0.20	0.24	−6.87	−0.54	−0.54*	0.05
S.E. (gi) ±	0.04	0.04	0.32	0.84	0.29	1.97	0.89	2.16	3.60	0.33	0.25	0.03
S.E. (gi -gj)±	0.05	0.55	0.47	1.26	0.44	2.94	1.33	3.22	5.37	0.50	0.37	0.04
C.D. 0.05%	0.07	0.07	0.62	1.66	0.57	3.86	1.75	4.28	7.06	0.66	0.48	0.06
C.D. 0.01%	0.09	0.09	0.82	2.18	0.75	5.08	2.30	5.57	9.29	0.86	0.64	0.08

*,**, significant at 5 and 1% levels, respectively. Upper and lower values indicate mean and GCA effects, respectively.

Table 3. Desirable combinations with significant specific combining ability effects including reciprocals for various components of yield.

Plant height	Technical height	Base diameter	No. of nodes/ plant	No. of branches/ plant	Bark weight/ plant	Fibre weight/ plant	Stick weight/ plant	No. of fruits/ plant	No. of seeds/ fruit	Seed weight/ plant	1000 seed weight
P2 × P5*	P3 × P6*	P1 × P5 *	P2 × P6 *	P5 × P6**	P1 × P4 **	P1× P4*	P1 × P4**	P3 × P10**	P1 x P3**	P3 × P4*	P2 × P10**
P5 × P6**	P3 × P9*	P2 × P8*	P3 × P6**	P6 × P7**	P2 × P6*	P2 × P8**	P2 × P5*	P4 × P7**	P2 x P4**	P5 × P7**	P3 × P6*
P5 × P9*	P4 × P6*	P3 × P10*	P4 × P6**		P2 × P8*	P4 × P6**	P2 × P6*	P5 × P6*	P6 x P8**	P8 × P10*	P5 × P6*
P6 × P8**	P5 × P6**	P4 × P10*	P5 × P6**		P3 × P8*	P4 × P10*	P2 × P8**	P5 × P7**		(P7 × P5)*	
(P7 × P2)**	P6 × P7*	P6 × P8*	(P7 × P2)*		P4 × P10 **	P7 × P9 *	P3 × P8*	(P7 × P4)**		(P7 × P6)*	
	P6 × P8*	P7 × P9*	(P10 × P6)**		P7 × P10**	P7 × P10**	P4 × P10**	(P7 × P5)*		(P9 × P8)*	
	(P7 × P2)*	(P4 × P3)*			(P6 × P4)**	(P5 × P2)*	P7 × P10 **	(P9 × P3)*		(P10 × P1)**	
	(P10 × P6)*	(P6 × P4)**				(P6 × P4)**	(P2 × P1)*				
		(P8 × P1)*				(P8 × P1)*	(P6 × P4)**				
		(P10 × P3)**									

The combinations in parentheses are reciprocal effects. P1- var CVL-1, P2 - Acc.3695, P3- Acc.1515, P4- Acc.1831, P5- Acc.1832, P6- Acc.1833, P7- Acc. 2146, P8- Acc.4087, P9- var. A-38, PI0- var.CC-45.

A-38 × Acc. 1515 for number of fruits, crosses, Accs. 2146 × 1832, Accs. 2146 × 1833, var. A-38 × Acc. 4087 and vars. CC-45 × CVL-1 for seed weight. None of the crosses showed significant positive reciprocal effect for number of branches, number of seeds per fruit and 1000-seed weight.

In this study, results showed that GCA effects of parents were not related to the SCA effects of their crosses which had highest significant positive magnitude. The high SCA effects of these crosses may be due to complementary type of gene effects. Moll and Stuber (1974) reported that any sort of combination among the parents might produce hybrid vigour over parents, which might be due to favourable dominant, overdominant or epistatic gene action. Considering the combined effect of GCA and SCA it was found that var. CVL-1 and Acc. 1831 were found to be the best general combiner for fibre yield and yield attributes (Plant height, technical height, base diameter, number of nodes, bark weight and stick weight). Crosses, var. CVL-1 × Acc. 1831, Accs. 3695 × 4087, Acc. 1831 × var. CC-45, Acc. 2146 × var. CC-45 and Accs. 1833 × 1831 were good specific combiner for bark weight, fibre weight and stick weight. Again good specific combiner in the crosses, var. CVL-1 × Acc. 1515 and Accs. 3695 × 1831 for number of seeds per fruit, var. CVL-1 × Acc. 1832 and Accs. 1831 × 1515 for base diameter, Acc. 3695 × var. CVL-1 for stick weight, Acc. 4087 × var. CVL-1 for base diameter and fibre weight, vars. CC-45 × CVL-1 and Accs. 1515 × 1831 for seed weight, Accs. 1831 × 1833 for technical height, number of nodes and fibre weight, Accs. 1831 × 2146 and Accs. 2146 × 1831 for number of fruits, Acc. 1831 × var. CC-45 and Accs. 1833 × 1831 for base diameter, bark weight, fibre weight and stick weight. So, among all crosses, var. CVL-1 × Acc. 1831, Acc. 1831 × var. CC-45 and Accs,. 1833 × 1831 deserve attention as far as the future selection program to bring improvement of these traits is concerned. The combinations showing good SCA for fibre yield may be exploited for heterosis.

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