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RESEARCH ARTICLE

Combining ability studies in *Kharif* sorghum [*Sorghum bicolor* (L.) Moench]

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SUMMARY

Combining ability effects and variances were estimated in F_1s and their parents. The analysis of variance for combining ability indicated that, mean sum of squares due to female x male interaction was highly significant for all the traits except days to maturity. In the present study contribution of females for variability was found to be higher than that of males for majority of the characters studied except number of leaves per plant, peduncle length and panicle length. The sca variance was higher than gca variance *i.e.* variance ratio was less than unity, indicating predominance of dominance variance. Dominance variance was more than additive variance for all the characters studied. The parents SB 7001, CS 3541 and DSV 6 among females and IS 3547 among males were good general combiners for grain yield and its components. These parents should be extensively used in the crossing programme to exploit maximum genetic variability and isolate transgressive segregants for grain yield and its components. Based on the sca effects and *per se* performance the hybrid CS 3541 x IS 8607 was found to be better than commercial hybrids CSH 16 and DSH 3 for grain yield and other traits. Hence, segregants of these in further generation may give promising genotypes. Thus these may be advanced to next generation.

Key Words **:** Combing ability, *Kharif*, Sorghum

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Genetic information especially about the nature of combining ability and type of gene action governing the inheritance of important traits are guidelines to breeder in selecting the parents for the development of hybrids, varieties and parental lines. Selection of parents based on combining ability play a vital role in developing superior genotypes for grain yield and its components.

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MATERIALS AND METHODS

Experimental material was supplied by All India Co-ordinated Sorghum Improvement Project, University of Agricultural Sciences, Dharwad. The base material for experimentation consisted of four resistant males *viz.,* IS 8607, IS 8185, IS 3547 and IS 27042 for downy mildew and eight females *viz.,* SB 7001, CS 3541, DSV 3, DSV 6, IMS 9B, DSV 2, SPV 1747, SPV 1600 and their 32 F_1 hybrids. Thirty-two F_1 hybrids were developed by hybridization between resistant x susceptible genotypes during 2005-06. The observations were recorded on five plants for grain yield and other component traits. To derive information on combining ability, line x tester

Table 1 : Mean sum of squares for combining ability in respect of 11 characters in sorghum

Sources	d.f.	Days to 50% flowering	Plant height	No. of leaves/ plant	Days to maturity	Peduncle length	Panicle length	Panicle breadth	Fodder yield/ plant	1000 seed weight	Sorghum downy mildew	Grain yield/ plant
Replication	1	1.56	200.22	0.29	1.00	48.30*	1.53	0.43	0.22	22.30	8.41	209.28
Females	7	34.03**	1073.06	3.40	19.8	271.84**	19.43	16.53	1.22	15.59	143.26	137.37
Males	3	56.41**	3331.53	20.93**	0.85	1094.54**	463.70**	13.47*	2.42	23.16	147.81	241.44
Females x Males	21	8.64**	1721.61**	2.01**	44.03	28.83**	17.24**	5.54**	203.60**	14.23**	126.26**	191.81**
Error	31	1.65	302.81	0.44	43.19	7.58	2.93	0.44	16.38	0.99	34.61	22.57
Contribution of females (%)		40.45	14.00	18.46	13.01	32.85	7.20	42.45	23.22	23.76	24.51	16.83
Contribution of males (%)		28.74	18.63	48.71	0.24	56.69	73.63	14.83	19.78	14.38	10.82	12.68
Contribution of female x male(%)		30.81	67.38	32.830	86.75	10.45	19.17	42.73	57.00	61.86	64.67	70.49
GCA		0.30	0.27	.063	0.28	4.70	1.30	0.09	1.65	0.44	0.1788	0.2232
SCA		3.49	709.40	0.78	0.41	10.62	7.15	2.55	138.60	6.62	45.82	84.62
GCA/SCA		0.088	0.00039	0.081	0.68	0.44	018	0.037	0.011	0.0060	0.0039	0.0026

* and ** indicates significance of values at p 0.05 and 0.01, respectively

Table 2 : General combining ability effects for parents in respect of 11 characters in sorghum

Parents	Days to 50% flowering	Plant height	No. of leaves/ plant	Days to maturity	Peduncle length	Panicle length	Panicle breadth	Fodder yield/ plant	1000 seed weight	Sorghum downy mildew	Grain yield/ plant
Females											
SB 7001	1.75**	9.77	1.16**	0.72	10.45**	2.37**	1.37**	0.47	1.38**	0.42	5.48**
CS 3541	1.63**	9.42	0.08	2.97	5.64**	1.80**	1.76**	6.07 **	1.07**	4.94*	1.41**
DSV 3	0.38	1.27	0.40	0.72	2.62**	0.01	0.01	3.45 *	1.37**	0.56	1.92
DSV 6	0.63	14.71*	1.14*	2.03	1.71	2.34**	0.33	2.58	1.26**	2.13	6.94**
IMS 9B	1.38**	13.12*	0.38	0.78	7.99**	0.50	2.23**	6.97 **	0.95	2.02	2.8
DSV 2	1.13*	3.18	0.10	0.59	4.00**	0.55	0.54*	0.62	0.68	1.68	3.12
SPV 1747	0.38	18.21**	0.09	1.03	1.96*	0.50	1.98**	11.81 **	2.26**	6.30**	2.36
SPV 1600	4.5**	4.82	0.06	1.16	1.87	1.37*	0.44	8.36 **	1.18**	7.05**	3.64*
S.E.	0.45	6.15	0.23	2.32	0.97	0.60	0.23	1.01	0.24	2.08	1.18
Males											
IS 8607	0.19	13.05**	0.07**	0.22	4.13**	2.40**	0.76**	4.85 **	0.37	3.91*	1.12
IS 8185	2.69**	11.51*	1.10**	0.09	8.30**	6.76**	1.07**	6.18 **	1.49**	0.68	2.25
IS 3547	0.94**	9.16*	1.02**	0.20	1.63*	1.42**	0.45**	3.13 **	1.29**	1.44	4.94**
IS 27042	1.56**	15.41**	0.96**	0.16	10.80**	5.78**	0.77**	7.89 **	0.57*	3.15*	3.81**
S.E.	0.32	4.35	0.16	1.64	0.68	0.42	0.16	1.43	0.35	1.47	1.67

* and ** indicates significance of values at p 0.05 and 0.01, respectively

Table 3 : Specific combining ability effects and *per se* performance of selected hybrids in respect of 11 characters in sorghum

Hybrids	Days to 50% flowering		Plant height		No. of leaves/ plant		Days to maturity		Peduncle length		Panicle length		Panicle breadth		Fodder yield/ plant		1000 seed weight		Sorghum downy mildew		Grain yield/ plant	
	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance	sca	*Per se* performance
SB 7001 x IS 3547	4.31**	77.50	2.95	294.30	1.01*	13.75	7.03	116.50	3.54	27.20	1.16	22.55	0.53	12.85	0.14	30.45	0.39	30.45	1.50	15.49	4.43	51.56
CS 3541 x IS 8607	2.14*	74.00	29.71*	279.65	0.41	9.35	1.28	124.00	3.91	56.50	3.81	21.95	0.12	8.10	11.62**	27.90	0.19	27.90	2.67	19.64	20.19**	59.41
DSV 3 x IS 27042	0.31	75.00	42.20**	331.30	0.68	12.60	1.91	125.00	2.34	32.30	0.21	16.75	0.12	9.60	23.85**	29.18	0.15	29.18	1.96	16.25	2.81	28.16
DSV 6 x IS 8185	0.19	67.50	5.45	251.65	0.17	8.50	5.09	115.50	0.83	50.25	0.66	32.10	2.61**	13.85	5.24	27.26	0.09	27.26	7.87	12.94	0.26	41.12
DSV 6 x IS 3547	0.56	73.50	16.68	283.55	0.39	10.05	0.78	120.00	0.12	39.60	0.40	25.70	1.12**	9.20	4.01	31.30	1.36	31.30	12.02**	30.72	6.77*	55.34
IMS 9B x IS 3547	1.31	71.50	41.54**	310.00	0.21	10.99	0.47	122.50	6.37**	55.55	0.64	24.90	1.27**	7.45	11.95**	27.64	0.09	27.64	18.58**	7.69	0.16	38.99
IMS 9B x IS 27042	1.81	75.50	5.14	279.85	0.59	10.55	4.59	117.00	4.67*	35.35	1.25	18.30	2.21**	9.70	0.58	26.59	0.42	26.59	10.90*	13.13	10.67**	40.75
DSV 2 x IS 8607	1.31	77.00	38.96**	301.50	1.46**	11.05	2.09	125.00	0.45	43.40	3.59**	15.80	0.87	11.15	18.92**	25.19	1.15	25.19	3.75	33.27	4.05	30.64
DSV 2 x IS 8185	1.06	71.00	7.56	271.65	1.59**	10.95	7.72	115.50	0.68	46.45	4.20**	32.75	1.56**	10.55	1.70	26.65	1.43*	26.65	9.68*	12.16	8.69*	40.02
SPV 1747 x IS 3547	1.94*	76.00	9.46	309.25	0.91	12.40	0.28	121.50	1.33	37.90	1.69	25.95	2.52**	15.45	8.85 **	18.88	7.54**	18.88	5.97	16.52	2.48	36.8
S.E.	0.91		12.30		0.47		4.64		1.94		1.21		0.47		2.86		0.70		4.69		3.35	

* and ** indicates significance of values at p 0.05 and 0.01, respectively

analysis developed by Kempthorne (1957) were followed.

RESULTS AND DISCUSSION

The results of combining ability ANOVA revealed that, mean sum of squares due to female x male interaction were highly significant for all the traits except days to maturity. In the present study, contribution of females for variability was found to be higher than that of males for majority of the characters studied except number of leaves per plant, peduncle length and panicle length. The sca variance was higher than the gca variance *i.e.* variance ratio was less than unity, indicating predominance of dominance variance. Dominance variance was more than additive variance for all the characters studied (Table 1). The parents SB 7001, CS 3541 and DSV 6 among females and IS 3547 among males were the good general combiners for grain yield and its components. Whereas, CS 3541 and SPV 1600 among females and IS 27042 among males were good general combiners for downy mildew resistance, which is an additional trait investigated along with grain yield and its component traits in present experiment. These good general combiners were identified based on their combining ability effects in desirable direction (Table 2).

Based on the sca effects and *per se* performance the hybrid CS 3541 x IS 8607 was found to be better than commercial hybrids CSH 16 and DSH 3 for grain yield and other traits (Table 3). Besides, CS 3541, SB 7001 and DSV 6 were the good general combiners and they are already been under use as good restorers in the production of commercial hybrids. Hence, segregants of these in further generation may give promising genotypes. Thus these may be advanced to next generation. Parents, DSV 6 and SB 7001 were the best general combiners for grain yield and its component traits. Hence these parents may be used in development of commercial hybrids for grain yield. Parents CS 3541, SPV 1600 and IS 3547 may be utilized in the development of downy mildew resistant hybrids as these were good general combiners for resistant to downy mildew. Therefore, these parental lines can be utilized in developing superior hybrids. This is in accordance with the results repurted by Armugam *et al.* (1995), Dangi and Paroda (1982) and Gururaj *et al.* (1994).

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