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Combining ability studies for shoot fly resistance and yield parameters in sorghum

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The parents and crosses differed significantly for most of the characters indicating considerable amount of genetic variability in the materials studied. The lines MS 104B and SPSFR 94010B and the testers SFCR 125 and SFCR 151 were found as best general combiners. Amongst the crosses MS 104A x SFCR 151, SPSFR 94010A x SFCR 125 and PMS 7A x ICSV 700 were identified as best considering sca effects for shoot fly resistance traits and grain yield.

Key words: Combining ability, Shoot fly, Resistance, Sorghum.

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth most important cereal crop after rice, maize, wheat and barley. Productivity of sorghum is highly variable from county to country. Several constraints affect grain productivity, one of the major factors causing these low sorghum grain yields is insect pest damage. The annual loss of sorghum production due to shoot fly (*Atherigona soccata* Rond.) in India is estimated at nearly US$ 200 million (ICRISAT, 1992). The choice of suitable parents for evolving better varieties or hybrids is important in plant breeding. Parents for hybrid breeding can be selected based on either *per se* performance or general combining ability or both. The combining ability studies were carried out by using 78 hybrids generated by crossing 6 lines with 13 testers.

MATERIALS AND METHODS

The parental lines for present study were obtained through the courtesy of Senior Sorghum Breeder, Sorghum Research Station, Marathawada Agricultural University, Parbhani and International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad, India. These genotypes were selected on the basis of genetic variation observed for shoot fly resistance and yield contributing traits. Total 78 crosses were developed by crossing 6 lines with 13 testers in a line x tester mating design were planted along with parents. The material was tested in late *kharif*, 2005 in randomized block design with two replications. Each genotype was planted in a single row plot (4m) with 45 cm x 15 cm crop geometry.

Border rows (6) with susceptible genotype (PVK 801) were sown around experimental plot 20 days before sowing of main experiment. To attain uniform shoot fly pressure under field condition the inter lard fish meal technique was followed for screening. Ten days after seedling emergence polythene bags containing moistened fish meal were kept in test entries at uniform interval covering the entire area to attract the emerging shoot flies from infester rows (PVK 801). The protection measures were avoided until the shoot fly infestation period is over. Observations were recorded on Glossiness score (1-5), 1 for high glossiness and 5 for non-glossy genotypes, per cent oviposition (14 and 21 DAE), per cent dead hearts (21 and 28 DAE), trichome density (nos./ microscopic field (10x) on upper and lower leaf surfaces) and grain yield/plant (g).

The analysis was carried out for line x tester mating design as suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

The results of analysis of variances for line x tester (Table 1) indicated that the differences due to genotypes, crosses, parents, lines, testers and line x testers were significant for most of the characters studied indicating presence of genetic variability for all the characters except for lines for oviposition I (%), oviposition II (%), dead heart I (%) and dead heart II(%) and grain yield per plant (g).

The ratio of 6^2gca/6^2sca less than unity indicated

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Table 1. ANOVA of combining ability for various characters

Source of	D.F.	Glossiness	Seedling vigor	Oviposition I (%)	Oviposition II (%)	Dead Hearts I (%)	Dead Hearts II (%)	Trichomes density (Nos./microscopic field)		Grain yield/plant (g)	Fodder Yield/plant (g)
								Upper	Lower		
Replication	1	0.06	0.06	38.58	15.55	25.55	1.37	61.1	23.36	24.32	319.36
Genotypes	96	0.99**	1.07**	119.77**	48.42**	63.01**	48.19**	3681.06**	607.02**	286.40**	3232.31**
Crosses	77	0.73**	1.12**	53.33**	32.24**	40.77**	37.53**	3118.84**	508.60**	276.59**	2729.15**
Parents	18	1.99**	0.77**	380.03**	116.67**	149.68**	95.81**	6146.63**	1058.46**	217.73**	4022.17**
Parents Vs Crosses	1	2.97**	2.02**	551.02**	65.63*	216.22**	12.69	2591.31**	59.22**	2277.66**	27758.03**
Lines	5	0.60**	4.49**	77.38	18.63	45.57	31.59	7201.64**	1007.96**	380.51	8901.32**
Testers	12	2.78**	0.96	86.63*	45.47**	68.92**	63.29**	9801.19**	1514.56**	543.61**	8074.94**
Line x Testers	60	0.33**	0.87**	45.06**	30.72**	34.74**	32.87**	1442.14**	265.79**	214.52**	1145.64**
Error	96	0.25	0.24	16.04	11.61	14.72	11.24	56.46	7.22	21.33	279.22
Genetic components											
6^2gca (f)		0.01	0.16	2.33	0.26	1.2	0.76	274.88	38.49	13.91	331.61
6^2sca (m)		0.21	0.06	5.65	2.79	4.55	4.3	812.22	125.6	43.72	649.62
6^2gca (avg.)		0.15	0.26	6.75	2.11	4.52	3.76	889.15	131.99	46.64	864.07
6^2sca		0.03	0.31	14.11	9.37	10.2	10.57	693.8	129.23	97.79	433.07
6^2gca/6^2sca		5.02	0.84	0.48	0.23	0.44	0.36	1.28	1.02	0.48	2.00

*, ** - Significant at 5 % and 1 % level, respectively

Table 2. Estimates of general combining ability effects of the parents.

Sr.No.	Parents	Glossiness	Oviposition I (%)	Oviposition II (%)	Dead heart I (%)	Dead heart II (%)	Trichome density (Nos./microscopic field) Upper surface	Trichome density (Nos./microscopic field) Lower surface	Grain Yield/ plant (g
	Lines								
1.	PMS 7B	0.18	2.24**	-0.42	-0.45	1.13	12.68**	3.68**	-0.91
2.	PMS 8B	0.18	0.23	-1.05	-0.38	-1.39*	-10.68**	-5.43**	-1.28
3.	PMS 28B	-0.19*	0.88	1.02	1.63*	1.28	-21.02**	-8.52**	-0.92
4.	MS 104B	0.02	-0.34	0.86	0.1	0.09	15.86**	4.96**	7.12**
5.	SPSFR 94010B	-0.09	-2.99**	-0.67	-2.08**	-0.01	15.93**	7.09**	-4.37**
6.	SPSFR 94012B	-0.09	-0.02	0.27	1.19	-1.11	-12.77**	-1.79**	0.35
	Testers								
7.	KR 192	0.34*	0.97	0.49	0.72	1.26	-19.95**	-8.04**	5.83**
8.	KR 196	0.72**	3.94**	2.93**	2.36*	2.06*	-30.06**	-10.40**	7.95**
9.	KR 199	0.51**	3.67**	2.59*	3.37**	3.30**	-16.00**	-7.82**	1.97
10.	CS 3541	0.42**	0.31	-0.21	2.09	2.39*	-15.61**	-3.65**	-5.49**
11.	MR 750	0.30*	1.71	2.50*	1.15	0.78	-19.70**	-9.35**	4.89**
12.	C 43	0.30*	1.67	0.08	0.13	-0.04	-33.36**	-11.43**	3.74**
13.	SFCR 125	-0.99**	-5.88**	-3.93**	-5.25**	-4.60**	25.83**	4.89**	9.26**
14.	SFCR 151	-0.33*	-3.36**	-1.65	0.04	-0.6	12.05**	2.56**	-0.81
15.	ICSV 700	-0.24	-0.71	0.74	-2.22*	-2.27*	10.50**	2.36**	-10.13*
16.	ICSV 705	-0.41**	-0.03	-1.97*	-0.93	-0.76	11.72**	3.62**	-6.18**
17.	ICSV 708	-0.04	-0.08	-0.45	0.52	1.17	52.11**	23.31**	-5.06**
18.	ICSV 91011	-0.12	-1.28	-0.88	-3.24**	-3.35**	-23.92**	-6.40**	4.22**
19.	PS 30710	-0.45**	-0.93	-0.25	1.26	0.66	46.39**	20.36**	-10.20*
	S.E. (gi) ± (Lines)	0.1	0.8	0.67	0.74	0.67	1.44	0.53	0.85
	S.E. (gi) ± (Testers)	0.14	1.18	0.99	1.09	0.98	2.13	0.78	1.25

* - Significant at 5 % and 1 % level, respectively

Table 3. Promising crosses; selected on the basis of SCA effects and per se performance for different characters

Sr. No	Character	Promising Crosses	SCA effects	Mean Performance
1.	Glossiness	MS 104A x SFCR 151	-0.98**	2.00
		PMS 7A x KR 199	-0.97**	3.00
		PMS 7A x ICSV 700	-0.97**	2.25
		SPSFR 94012A x ICSV 91011	-0.82**	2.25
2.	Oviposition I (%)	MS 104A x SFCR 151	-24.91**	0.00
		SPSFR 94010A x SFCR 125	-8.63**	7.14
		SPSFR 94010A x KR 199	-6.26**	15.56
3.	Oviposition II (%)	MS 104A x SFCR 151	-12.26**	17.86
		SPSFR 94010A x C 43	-5.66**	27.78
		PMS 7A x CS 3541	-5.32**	28.21
		SPSFR 94010A x SFCR 125	-5.14**	22.62
4.	Dead hearts I (%)	SPSFR 94010A x SFCR 125	-18.90**	0.00
		MS 104A x SFCR 151	-7.51**	10.71
		PMS 7A x ICSV 700	-7.11**	8.01
5.	Dead hearts II (%)	MS 104A x SFCR 151	-11.30**	14.29
		PMS 7A x ICSV 700	-9.28**	16.03
		PMS 7A x CS 3541	-7.64**	24.87
		SPSFR 94010A x SFCR 125	-6.25**	15.48
6.	Trichome Density (No./Micro. Field) Upper leaf surface	SPSFR 94012A x ICSV 91011	64.07**	68.67
		MS 104A x SFCR 151	63.31**	132.50
		MS 104A x ICSV 705	45.47**	114.33
7.	Trichome Density (No./Micro. Field) Lower leaf surface	MS 104A x PS 30710	27.45**	66.16
		SPSFR 94012A x ICSV 91011	26.28**	31.67
		MS 104A x ICSV 705	45.47**	46.00
8.	Grain Yield/plant (g)	MS 104A x SFCR 151	25.53**	77.00
		SPSFR 94010A x SFCR 125	18.95**	69.00
		PMS 7A x ICSV 700	17.05**	51.17

*, ** - Significant at 5 % and 1 % level, respectively

the presence of non additive gene action for most of the characters except for glossiness, trichome density (upper). The results are in conformity with Nimbalkar and Bapat(1987), Elbadawi *et al*.(1997) and Jayanthi *et al*.(1999).

The estimates of gca effects in Table 2 showed that the lines MS 104A was found as best general combiner not only for grain yield but it also exhibited significantly positive gca effects for trichome density and gca effects in desirable direction for other shoot fly resistance parameters. This parent was involved in two out of top seven crosses The parental line SPSFR 94010A also showed good gca performance for shoot fly resistance traits and also involved in two crosses out of top seven crosses selected on the basis of shoot fly resistance parameters.

Among the testers SFCR 125 revealed good general combining ability for dead heart (%), oviposition (%), glossiness and grain yield per plant. The other testers, ICSV 700,ICSV 705 and PS 30710 showed good gca for the shoot fly resistance traits but recorded negative gca effects for grain yield per plant. However, the tester SFCR 151 expressed good general combining ability for shoot fly resistant traits and positive but marginal gca effect for grain yield, the testers SFCR 125, SFCR 151, ICSV 700 and ICSV 705 were involved in top ranking hybrids.

If *per se* performance of the parents is seen alongwith the gca effects, the parental lines showing high means were having good gca in majority of characters studied. Hence, it can be concluded that gca effects of the lines and testers were concomitant with their *per se* performance. The close relationship between *per se* performance of the parents and their gca effects has been reported by Dalvi *et al*, (1990) and Jayanthi *et al*,(1999).

It is revealed from the Table 3 that amongst 78 crosses, the hybrid MS 104A x SFCR 151 exhibited significant sca effects for shoot fly resistance traits and grain yield per plant. Similarly the hybrids SPSFR 94010A x SFCR 125 and PMS 7A x ICSV 700 showed significant sca effects for most of the characters studied.

The parental combination in above crosses was either high x high gca, low x high gca or high x low gca. Therefore, it appeared that for getting good cross combination at least one of the parent should have good gca. Similar kind of results were reported by Borikar and Chopde (1981) and Marawar (1995).

It is concluded that the lines MS 104B and SPSFR 94010B and the testers SFCR 125 and SFCR 151 were found as best general combiners. Amongst the crosses MS 104A x SFCR 151, SPSFR 94010A x SFCR 125 and PMS 7A x ICSV 700 were identified as best considering sca effects for shoot fly resistance traits and grain yield.

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