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Line x Tester Analysis for Combining Ability in Sorghum

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ABSTRACT

Two-factor mating design using line x tester analysis was adopted involving four male-steriles as lines and six pollen-parents as testers. Both additive as well as non-additive gene effects were important for inheritance of grain yield. 2219 A and IS 370 were good combiners for yield. Better transgressive segregants are expected from the hybrids for one or another character.

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INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is grown on approximately 81 million hectares world wide. It ranks fourth in acreage of the cereal crops in the world, exceeded only by wheat, corn and rice. Grain of sorghum is used directly for human-diet in Asia and Africa while in the western hemisphere most of it is fed to livestock.

A significant milestone in sorghum breeding in India was witnessed by the release of the first successful commercial hybrid CSH-1. Since then, continued research to develop more and more male-steriles and to test their combining ability with Indian as well as exotic lines of sorghum has kept its pace ahead. In the present investigation, four promising male-steriles have been assessed for combining ability in crosses with six males following line x tester mating system.

MATERIALS AND METHODS

The study was conducted during the monsoon season of 1978 at Jowar Research Station of Gujarat Agricultural University at Surat. The experimental material consisted of 24 single-crosses using four seed-parents (Lines) and six pollen-parents (testers). The crosses were grown in five-row plots replicated four times in a randomized block design. Observations were recorded on randomly selected five competitive plants for grain yield, days to flower and plant height. Mean value for each character were used for computational purpose.

Combining ability analysis was carried out according to the two-factor mating design as suggested by Kempthorne (1975) and later on elaborated by Rao *et al.* (1968).

RESULTS AND DISCUSSION

The mean values of hybrids with respect to grain yield, days to flower and plant height appear in Table 1. *Inter se* comparison of lines revealed that 2219 A produced hybrids with relatively higher grain yield, however, they were neither early nor dwarf. On the other hand, crosses involving CK-60A as

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TABLE 1

Mean values.

Character	Line	Tester						
		IS 370	*JP 765*	*Sona 108*	*H.D. 1*	*No. 2*	*S-5*	*Mean*
Gain yield (Gm./plant)	CK 60A	30.92	24.19	31.15	23.91	20.86	25.60	27.77
	2219 A	39.84	50.00	42.96	26.39	50.00	31.71	40.15
	10446A	52.38	28.49	23.49	26.19	40.83	21.54	32.15
	534A	45.38	28.57	20.51	31.41	33.33	35.48	32.44
	Mean	42.13	32.81	29.53	26.98	38.36	28.58	33.13
Days to flower	CK 60A	69	73	80	74	66	74	73
	2219A	71	76	73	70	74	71	73
	10446A	66	76	75	56	73	76	70
	534A	50	53	73	55	73	75	63
	Mean	64	70	75	64	72	74	70
Plant height (cm.)	CK 60A	231	285	205	235	181	195	222
	2219A	228	252	225	230	257	222	236
	10446A	215	210	264	161	173	239	210
	534A	208	170	244	173	163	258	203
	Mean	221	229	235	200	194	119	218

S.E.m. Grain yield = 2.90 (gm.) S.Em. Days to flower = 1.375 (days) S.E.m. Plant height = 10.62 (cm.)

female parent were poor yielders coupled with prolonged maturity and tall plant habit. Inspection of genetic worth of testers showed that IS 370 gave out hybrids characterised by better yield and earliness. Recently released variety GJ-108 (Sona-108) did not prove having better nicking with females used in the present study since it produced poor yielding late and tall hybrids.

The analysis of variance for combining ability and the estimates of variances due to general (gca) and specific combining ability (sca) are presented in Table 2. The mean squares due to lines were greater as compared to those due to testers as well as lines x testers which suggested more genetic variability present among lines. Lower magnitude of mean squares due to line x tester for grain yield and days to flower indicated more uniformity among hybrids with respect to these traits. However, they greatly differed for plant height. The lines under study differed markedly from one another in respect of their gca effects for yield and yield components (Table 2). A

TABLE 2

Combining ability analysis of variance.

Source	d.f.	M. S. S.		
		Grain Yield	Days to Flower	Plant height
Repblication	3	29.77	4.31	655.73
Crosses	23	89.54.**	16.23**	1201.43**
Lines	3	158.84	29.83	1243.11
Testers	5	147.43	24.05	1159.96
Lines x Tester	15	56.39	10.89	1206.94
Error	69	33.86	7.50	451.33
σ^2_{gca}		4.83	3.22	0.27
σ^2_{sca}		5.65	9.01	187.82

close look of the estimates of variances due to gca and sca led to conclude that both the major components of grain yield viz., days to flower and plant height were governed by high magnitude of non-additive gene action. The findings are akin to the reports of Chavada and Drolsom (1970), Goud (1971), Chandra *et al.* (1973), Campbell *et al.* (1975), Subba Rao (1975) and Subba Rao *et al.* (1976a). However, they are at variance from Vishnuswarup and Chaugale (1962), Shankergowda *et al.* (1972), Baghel *et al.* (1975), Subba Rao *et al.* (1976b), Chavan and Nerkar (1978), Dangi and Patoda (1978) and Srivastava *et al.* (1979). Grain yield, on other hand, was found to be controlled by both additive and non-additive genetic variances, however, latter was slightly more pronounced, which is similar to Liang and Walter (1968), Nagur and Murty (1970), Goud *et al* (1973 a and b) and Vasudeva Rao and Goud (1977). With previously selected material non-additive effects are more pronounced than other effects in determining the yield differences. However, preponderance of additive gene action for grain yield has been reported by Beil and Atkins (1967), Balakotaih *et al.* (1974) and Laosuwan and Atkins (1977). This can happen since the nature of gene action is known to vary with the genetic architecture of the parental material involved in the study.

The male-steriles revealed very interesting picture with regard to gca effects (Table 3) for all the characters examined. 534 A gave poor yielding hybrids with dwarf stature and early blooming. Whereas 2219-A could yield

TABLE 3

General combining ability effects.

	Grain yield	Days to flower	Plant height
Lines			
1. CK 60 A	-5.36**	3.00**	4.33
2. 2219 A	7.02**	2.83**	17.99**
3. 10446 A	-0.98	0.66	-7.34
4. 534 A	-0.68	-6.51**	-15.01**
S.E. $(g_i)\pm$	1.18	0.55	4.33
S.E. $(g_i^1-g_i^2)\pm$	1.67	0.79	6.13
Testers			
1. IS 370	9.00**	-5.67**	2.83
2. JP 765	-0.30	-0.17	11.15
3. Sona 108	-3.60*	5.58**	16.83**
4. H.D. 1	-6.15**	-5.92**	-17.92**
5. No. 2	5.63**	1.83*	-24.17**
6. S.5	-4.55**	4.33**	10.83
S.E. $(g_j)\pm$	1.45	0.68	5.31
S.E. $(s_{ij}^1-s_{ij}^2)$	±2.05	0.96	7.51

high yielding hybrids but tall and late in maturity. Among testers used, IS 370 was found good general combiner for grain yield as well as early blooming as its effects were highly significant in positive and negative direction res-

pectively. In the case of grain yield gca effect in positive direction is desirable whereas for days to flower negative effects are considered useful in breeding of high yielding and early maturing cultivars. The male parents JP 765, Sona-108 and S-5 were having gca effects in undesirable direction.

As seen from sca effects of crosses (Table 4), no generalised conclusion could be drawn in this regard. The hybrids produced do not seem acceptable in all aspects i.e. some are good yielder but late in maturity and/or tall in plant habit. Taking these things into consideration, they are likely to

TABLE 4

Specific combining ability effects.

Character	Line	Tester					
		IS 370	*JP 765*	*Sona 108*	*H.D. 1*	*No. 2*	*S. 5*
Grain yield (gm/plant)	CK 60A	-5.85	-3.28	6.98*	2.29	-2.54	2.38
	2219A	-9.31**	10.15**	6.41*	-7.61*	4.22	-3.89
	10446A	11.23**	-3.38	-5.06	0.19	-4.45	-6.06
	534A	3.93	-3.58	-8.34*	5.11	-4.75	7.58*
Days to flower	CK 60A	16.19**	0.13	-0.75	1.82	-2.12	-0.75
	2219A	1.04	0.92	-1.27	0.86	-0.08	-1.46
	10446A	0.33	1.46	-0.23	-2.10	0.21	0.33
	534A	-1.89	-2.51	1.05	-0.57	1.99	1.86
Plant height (cm.)	CK 60A	6.17	51.42**	-33.83**	30.92*	-16.83	-37.83*
	2219A	-10.49	4.76	-27.49*	12.26	45.51**	-24.49*
	10446A	1.84	-11.91	36.84**	-3.14	-13.16	17.84*
	534A	2.51	-44.24**	24.51*	-11.74	-15.94	44.51**

S.E. (s_{ij}) Grain Yield ± 2.91

S.E. (s_{ij}) Days to flower ± 1.36

S.E. (s_{ij}) Plant height ± 10.62

S.E. ($s^1_{ij} - s^2_{ij}$) Grain yield ± 4.11

S.E. ($s^1_{ij} - s^2_{ij}$) Days to flower ± 1.94

S.E. ($s^1_{ij} - s^2_{ij}$) Plant height ± 15.02

throw better segregants in further segregating generations for one or more characters. As such, predominance of non-additive gene action for grain yield and other two variables included in the study suggested to go for reciprocal recurrent selection for improving the yield potential of sorghum. In the methodology to be followed, the desirable segregants for earliness and dwarfness will constitute as one population and those for higher yield will serve as another population. Alternate crossing and selection within a population will upgrade the genotypic worth of the segregants which could be utilized in combining higher yield potential coupled with earliness and dwarfness.

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