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COMBINING ABILITY ANALYSIS OF HARVEST INDEX AND ITS COMPONENTS IN SORGHUM

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ABSTRACT

Genetics of harvest index and its components was studied following diallel approach. Seven genotypes having three maintainer of cytoplasmic genetic male sterile lines, two improved varieties and one each improved local variety and restorer of CSH-10 were selected for crossing in half diallel fashion. Pooled combining ability analysis revealed that harvest index, grain yield and its related characters were governed by both additive and nonadditive gene action. Maintainer lines 296 B, M-9 B and 2077 B were identified as most desirable general combiners for harvest index. Improved varieties SPV 472, SPV 475 and Vidisha 60-1 were identified as desirable combiners for grain yield. The cross combination SPV 475 x M-9 B was superior for harvest index and grain yield on the basis of sca effects. Hybrids with high harvest index and productivity can be bred by using lines already improved for these traits.

Key words: Combining ability, gene action, harvest index.

Harvest index measures the physiological efficiency of the plants [1]. Breeders have recognized the importance of a favourable harvest index in terms of partitioning of photosynthate to economically important plant part. Harvest index in local and hybrids sorghum reported to be 29 and 50 per cent, respectively [2]. Thus, there is a greater need for genetic manipulations for increasing the harvest index. Productivity of sorghum can be improved by enhancing the biological yield without loosing the harvest index [3]. The present investigation is an attempt to obtain information on combining ability of harvest index, grain yield and related characters in sorghum.

MATERIALS AND METHODS

Seven sorghum cultivars belonging to different height and maturity groups representing a fairly wide range of genetic diversity were crossed in a half diallel fashion.

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Genotypes included three maintainers of cytoplasmic genetic male sterile lines (2077 B, M-9 B and 296 B), two improved varieties, SPV 472 and SPV 475 and one each restorer line (SB 1085) of hybrid CSH-10 and local variety (Vidisha 60-1). The resulting 21 F_1s and their seven parents were planted in randomized block design with two replications in two successive rainy seasons of 1985 and 1986 at Research Farm, Indore. Plot size comprised of single row, 3 m long spaced 45 cm apart with intrarow distance of 15 cm.

The data were recorded on five competitive random plants in each plot on days to 50 per cent flowering, plant height, dry matter, dry weight of stem and leaves per plant, 1000-grain weight, grain yield and harvest index (HI). The test of homogeneity showed homogeneous error variances in both the seasons. Pooled combining ability analysis was done following Model I and Method II of Griffing [4] and Singh [5].

RESULTS AND DISCUSSION

In pooled analysis of variance mean squares due to general combining ability were highly significant for harvest index and other related characters. Higher proportion of additive genetic variance as compared to nonadditive variance for harvest index and other related characters is a desirable feature. Preponderance of additive variance for harvest index [6, 7] and days to 50% flowering, dry weight of leaves and stem [7] were reported earlier also.

Table 1. Analysis of variances for combining ability in sorghum

Source	d.f.	Days to flowering	Plant height	Dry matter per plant	Dry weight of stem per plant	Dry weight of leaves per plant	1000-grain weight	Harvest index	Grain yield per plant
Gca	6	183.9**	9129.4**	0.020**	5422.4**	116.9**	104.0**	119.6**	0.0003**
Sca	21	10.5**	1961.7**	0.006**	2571.7**	40.7**	9.5**	9.9**	0.0005**
Environment (E)	1	50.1**	45319.3**	0.108**	26886.8**	1128.0**	142.6**	60.0**	0.0034**
Gca x E	6	5.4**	575.9*	0.033**	2284.0**	9.7	9.9**	12.6**	0.0005**
Sca x E	21	11.8**	261.1	0.0034**	686.9**	33.5**	47.5**	17.9**	0.0001**
Pooled error	54	2.25	233.2	0.001	161.7	7.8	1.3	2.6	0.0001

*,**Significant at 5 and 1%, respectively.

Significant and negative pooled effects of general combining ability (gca) for days to 50% flowering in SPV 472, 2077 B, SB 1085 and M-9 B indicated them as good general combining parents for this trait as they are transmitting genes for early flowering (Table 2). Significant and positive gca effects in Vidisha 60-1 for dry matter, stem and leaf weight per

Table 2. Estimates of gca effects in sorghum pooled over two years

Parent	Days to flowering	Plant height	Dry matter per plant	Dry weight of stem/plant	Dry weight of leaves per plant	1000-grain weight	Harvest index	Grain yield per plant
SPV 472	-2.51**	16.8**	0.0003	5.61	-0.55	2.84**	-0.20	0.0025**
SPV 475	0.55	-7.1*	-0.0115	-5.45	-0.76	-3.13**	0.11	0.0034**
2077 B	-0.81*	-10.6**	-0.0171**	-18.06**	0.13	-1.46**	2.25**	-0.0008
SB 1085	-1.98**	10.9**	-0.0115*	-3.02	-3.62**	-0.90**	-1.53**	-0.007**
M 9 B	-2.23**	-26.5**	-0.0312**	-22.52**	-1.59*	-1.21**	2.22**	-0.002*
Vidisha 60-1	6.71**	36.9**	0.0711**	41.16**	4.19**	3.44**	-3.92**	0.003**
296 B	0.27	-20.1**	0.0001	-9.65**	2.20**	0.47	1.22**	0.001
SE (g_i) ±	0.33	3.3	0.0055	2.77	0.61	0.25	0.35	0.001
SE ($g_i - g_j$) ±	0.50	5.1	0.0083	4.24	0.93	0.38	0.54	0.001

*,**P = 0.05 and 0.01, respectively.

plant and significant and negative gca effects for HI indicated that Vidisha 60-1 was good general combining parent for dry matter, stem and leaf weight per plant and poor combining parent for HI. The lines 296 B, M-9 B and 2077 B showed significant and positive gca effects for HI, therefore, identified as good general combining parent for HI. SPV 472 and Vidisha 60-1 for 1000-grain weight and grain yield and SPV 475 for grain yield showed positively significant gca effects, indicating their good general combining ability for these traits.

The pooled effect of specific combining ability (sca) presented in Table 3 revealed that four crosses for days to 50% flowering, seven crosses each for plant height and 1000-grain weight, six crosses each for dry matter and dry stem weight per plant and four crosses each for dry weight of leaves and HI exhibited significant sca effects in desirable direction. It was interesting to note that only one cross, viz., SPV 472 x 296 B, could be identified as most superior cross combination for dry matter, dry stem and leaves weight per plant, plant height and 1000-grain weight but it was a poor cross combination for HI. The majority of cross combinations involved either good x good or good x poor general combining ability parents. For grain yield, 10 crosses recorded significant positive sca effects but the values were statistically at par. Crosses, viz., SPV 475 x M-9 B, SB 1085 x 296 B, SPV 472 x SB 1085, and SB 1085 x Vidisha 60-1, have been identified as best specific crosses for HI and grain yield as they were showing significant sca effects for both the traits. On the basis of per se performance and sca effects, the cross SPV 475 x M-9 B proved to be most superior combination for HI and grain yield.

Table 3. Estimates of sca effects in sorghum pooled over two years

Cross	Days to flowering	Plant height	Dry matter per plant	Dry weight of stem per plant	Dry weight of leaves per plant	1000-grain weight	Harvest index	Grain yield per plant
SPV 472 x SPV 475	0.89	26.9**	0.038*	-6.8	3.37	1.23	0.81	-0.003
SPV 472 x 2077 B	1.25	23.2*	0.018	2.9	1.96	-0.68	-0.01	0.020**
SPV 472 x SB 1085	-0.08	11.2	0.006	-2.9	7.21**	-0.59	3.70**	0.020**
SPV 472 x M 9 B	3.42**	25.7*	0.023	15.0	3.93*	-3.15**	-0.84	0.008**
SPV 472 x Vidisha 60-1	-0.53	8.1	-0.090**	-29.8**	-8.60**	0.35	0.96	-0.003
SPV 472 x 296 B	0.67	53.6**	0.137**	67.9**	7.32**	2.28**	-4.84**	0.006
SPV 475 x 2077 B	-3.81**	17.6	0.031	24.3**	1.87	-2.81**	-4.14**	0.007**
SPV 475 x SB 1085	-3.64**	-9.7	0.007	12.4	1.08	0.79	-0.51	-0.005*
SPV 475 x M 9 B	-0.89	31.9**	0.026	-2.6	1.36	0.91	2.70*	0.023**
SPV 475 x Vidisha 60-1	2.16*	0.3	0.474**	25.5**	-1.97	2.36**	-4.50**	-0.010**
SPV 475 x 296 B	-0.39	-5.7	-0.293**	16.7*	-2.53	-2.62**	0.07	0.014**
2077 B x SB 1085	-0.78	36.6**	0.029	14.9	-0.85	1.50*	0.59	0.009**
2077 B x M 9 B	-0.28	-4.7	-0.030	-14.6	1.62	1.49	1.16	-0.008**
2077 B x Vidisha 60-1	1.03	16.8	0.066**	23.2**	2.90	2.08**	-1.98	0.001
2077 B x 296 B	-3.28**	-13.7	-0.015	-4.7	-3.55	-0.33	0.92	-0.011**
SB 1085 x M 9 B	0.64	5.7	-0.024	8.9	-7.00**	0.47	-3.28**	-0.013**
SB 1085 x Vidisha 60-1	1.44	-8.5	0.020	-25.8**	4.90**	0.95	2.77*	0.014**
SB 1085 x 296 B	1.14	38.0**	0.009	-16.2	-3.02	0.88	5.34**	0.019**
M 9 B x Vidisha 60-1	-2.56*	17.4	0.075**	10.2	-2.38	1.51*	-2.34*	0.004
M 9 B x 296 B	-1.61	-5.1	-0.026	-9.1	0.80	3.05**	1.93	0.004
Vidisha 60-1 x 296 B	2.94*	10.0	0.037*	61.9**	4.98**	-2.08**	-1.95	0.006*
SE S_{ij} ±	0.95	9.7	0.016	8.1	1.77	0.72	1.03	0.002
SE S_{ij}-S_{ik} ±	1.41	14.4	0.024	12.0	2.63	1.06	1.53	0.003
SE S_{ij}-S_{kl} ±	1.32	13.5	0.025	11.2	2.46	1.00	1.42	0.003

*,**P = 0.05 and 0.01, respectively.

The use of temperate germplasm enabled to increase HI of the derivatives of temperate x tropical crosses [3, 8]. This has been mainly due to reduction in vegetative growth and biological yield per se. It was, further, observed that increase in total biomass production by combining grain and fodder yield without affecting HI would help in developing dual purpose high yielding variety/hybrid. The present results signify the importance of

exploitation of both additive and nonadditive gene effects for attaining improvement in yield without affecting HI. The hybrid with high HI can be bred by using the lines having high gca effects for HI alongwith high grain and fodder yield.

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