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Heterosis studies in Dual Purpose Sorghum [*Sorghum bicolor* (L.) Moench]

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ABSTRACT

Thirty hybrids of sorghum derived from 10 lines and 3 testers, their parents and checks were grown in randomized block design with three replications. Analysis of variance revealed highly significant differences among the genotypes viz., parents, crosses and parents *Vs* crosses for all the characters. SPV 1714 x HC 308 recorded highest significant relative heterosis and heterobeltiosis and SPV 1782 x HC 308 recorded the highest standard heterosis for grain yield. For stover yield SPV 1782 x HC 308 recorded highest relative heterosis and heterobeltiosis, while SPV 1754 x CSV 15 and SPV 1730 x HC 308 recorded the highest significant standard heterosis. Among the crosses SPV 1782 x HC 308 and SPV 1754 x HC 308 recorded significant standard heterosis for 9 and 8 characters respectively.

Key words : Dual purpose,Heterosis, Sorghum, *Sorghum bicolor*

Sorghum is a major cereal grown as dual purpose crop for food, feed and fodder adapted to the drought prone semi arid tropic regions of the world. The discovery of heterosis has been recognized as one of the major landmarks in the annals of plant breeding. Hence the present study was undertaken to generate the information on nature and magnitude of heterosis which would be helpful in identifying superior cross combinations of dual pur pose sorghum.

MATERIAL AND METHODS

The experimental material for the study consisted of thirty F_1 crosses derived through crossing 10 lines with 3 testers in line ´ tester mating design, their 13 parents and three checks. Forty six genotypes were sown in randomized block design replicated thrice at Agricultural College Farm, Bapatla during *rabi* 2006-07. Each entry was sown in 5 rows of 3 m length with a uniform inter and intra - row spacing of 45 X 15 cm. Recommended package of practices were adopted. Observations were recorded on each entry in each replication for seventeen characters viz, number of days to 50% flowering, days to maturity, plant height, number of green leaves per plant at harvest, number of dry leaves per plant at harvest, leaf length, leaf breadth, leaf length breadth ratio, leaf weight, stem weight, leaf stem ratio, green forage yield at 50% flowering, stover yield per plant, grain yield per plant, 1000 grain weight, leaf crude protein content and grain crude protein content. Mean values were used for computing relative heterosis, heterobeltiosis and standard heterosis over the check CSH 15 as per Liang *et al.* (1971) and significance of each estimate was tested using 't' test.

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed highly significant differences due to genotypes, parents and crosses for all characters indicating considerable amount of genetic variability in the material studied. The parents *vs* hybrids comparison was significant for all the characters which indicated the performance of parents was different to that of F_1 hybrids. The range of relative heterosis, heterobeltiosis and standard heterosis for different characters are presented in Table 2.

The degree of heterosis varied from cross to cross for all characters. Considerable heterosis in certain crosses and low in other crosses revealed that nature and gene action varied with genetic architecture of parents. The study revealed distribution of heterosis in both positive and negative directions for all the traits. Variable magnitude of three types of heterosis as exhibited by different cross combination for all the characters indicated sufficient divergence in parental material for these traits. Significant relative heterosis and heterobeltiosis for all the characters indicated the presence of non-additive gene action. Manifestation of relative heterosis in F_1 hybrids indicated the presence of dominance for the characters where as heterobeltiosis revealed considerable over dominance for all the characters under study. Negative heterosis observed in some of the crosses might be attributed to the considerable disharmony between gene combinations in the parents involved. Heterosis over the best check could be considered as the best criterion for the evaluation of hybrids even though it has no genetic base.

Table 1. Analysis of variance for line x tester mating design for different characters in sorghum

Source of variations	d.f	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	No. of green leaves plant at harvest^{-1}	No. of dry leaves plant at harvest^{-1}	Leaf length (cm)	Leaf breadth (cm)	Leaf length breadth ratio
		Mean sum of squares							
Replication	2	0.07	0.14	0.60	0.00	0.95	0.20	0.001	0.01
Genotypes	42	81.87**	85.73**	3223.50**	1.60**	0.58**	114.86**	2.05**	3.13**
Parents	12	51.95**	61.65**	2627.64**	1.01**	0.28**	82.07**	1.16**	3.17**
Parent Vs Crosses	1	1130.32**	1175.74**	8430.05**	22.76**	1.98**	1199.32**	14.76**	0.20**
Crosses	29	58.10**	58.10**	3290. 53**	1.22**	0.65**	91.04**	1.98**	3.21**
Error	58	1.52	1.52	1.24	0.01	0.00	1.03	0.03	0.00

Source of variations	d.f	Leaf weight (g)	Stem weight (g)	Leaf stem ratio	Green forage yield at 50 % flowering (kg)	Stover yield plant^{-1} (g)	Grain yield plant^{-1} (g)	1000 grain weight (g)	Leaf crude protein content (%)	Grain crude protein content (%)
		Mean sum of squares								
Replication	2	0.02	0.00	0.03	0.09	0.01	0.02	0.00	0.00	0.00
Genotypes	42	181.67**	0.00**	13025. 91**	131.75**	8278.54**	354.51**	26.75**	14.60**	18.06**
Parents	12	189.08**	0.00**	8620.45**	129.99**	1540.47**	455.67**	15.36**	10.15**	13.62**
Parent Vs Crosses	1	2124.06**	0.01**	248952.17**	1122.54**	154391.29**	6291.53**	255.12**	57.11**	36.65**
Crosses	29	111.63**	0.00**	6713.47**	98.32**	6028.34**	107.93**	23.59**	14.98**	19.26**
Error	58	1.03	1.02	0.00	0.96	1.03	1.03	0.01	0.00	0.00

Characters	Range			Number of significant crosses		
	Relative heterosis	Hetero-beltiosis	Standard Heterosis	Relative heterosis	Hetero-beltiosis	Standard Heterosis
Days to 50% flowering	-25.06 to 7.14	-24.88 to 18.18	-17.49 to 10.93	26	20	15
Days to maturity	-17.05 to 5.38	-17.05 to 12.64	-12.28 to 5.96	26	18	20
Plant height	-30.12 to 36.38	-30.71 to 26.18	-26.59 to 37.94	22	21	22
No. of green leaves plant at harvest^{-1}	-16.54 to 44.93	-18.67 to 41.87	-16.92 to 20.37	27	22	18
No. of dry leaves plant at harvest^{-1}	-98.68 to 70.73	-98.189 to 90.22	-98.89 to 40.00	20	17	25
Leaf length	-10.57 to 42.86	-19.12 to 40.35	-12.70 to 26.98	25	16	26
Leaf breadth	-12.60 to 47.59	-14.29 to 26.30	-11.11 to 25.93	25	16	18
Length breadth ratio	-20.98 to 19.10	-28.2 to 14.76	-11.79 to 34.94	8	4	18
Leaf weight	-11.11 to 147.19	-13.16 to 83.33	-3.03 to 72.73	24	17	27
Stem weight	-1.25 to 192.98	-16.64 to 139.57	-22.62 to 50	30	28	23
Leaf stem ratio	-41.46 to 108.7	-45.83 to 71.43	-23.08 to 100	7	5	11
Green forage yield	-6.47 to 109.3	-18.37 to 72.57	-17.24 to 55.17	26	18	24
Stover yield	-0.42 to 193.58	-7.81 to 120.67	-16.9 to 86.62	29	29	24
Grain yield	-3.72 to 86.05	-10.47 to 58.81	1.67 to 35	29	28	28
1000 grain weight	-4.69 to 25.39	-12.31 to 17.38	-15.38 to 11.08	26	20	15
Leaf crude protein content	-27.92 to 185.48	-42.86 to 150.00	-42.86 to 87.43	20	13	10
Grain crude protein content	-33.38 to 149.67	-50.06 to 75.00	-55.58 to 66.5	15	9	10

In the present study the range of relative heterosis, heterobeltiosis and standard heterosis for grain yield varied from –3.72 (SPV 1730 x CSH 16) to 86.05 (SPV 1714 x HC 308), -10.47 (SPV 1730 x CSH 16) to 58.81 (SPV 1714 x HC 308) and –1.67 (SPH 1467 x HC 308) to 35.00 (SPV 1782 x HC 308) respectively. Heterosis for grain yield per plant was significant in 29, 28 and 28 crosses over mid parent, better parent and check respectively. SPV 1714 x HC 308 recorded highest relative heterosis and heterobeltiosis and SPV 1782 x HC 308 recorded highest standard heterosis. These results are in agreement with Hemlata Sharma and Vithal Sharma (2006), Iyanar and Gopalan (2006) and Umakanth *et al.*(2006).

Range of heterosis for stover yield varied from –0.42 (SPV 1730 x CSH 16) to 193.58 (SPV 1782 x HC 308) over mid parent, -7.81 (SPV 1730 x CSH 16) to 120.69 (SPV 1782 x HC 308) over better parent and –16.90 (SPV 1730 x CSH 16) to 86.62 (SPV 1754 x CSV 15) over standard check. Twenty nine hybrids recorded significant relative heterosis and heterobeltiosis, where as twenty four hybrids recorded significant standard heterosis. SPV 1782 HC 308 recorded highest relative heterosis and heterobeltiosis. SPV 1754 x CSV 15 and SPV 1730 x HC 308 recorded highest significant standard heterosis. Meenu Agarwal and Shrotria (2005) also reported all the three types of heterosis.

Heterosis for grain yield and stover yield is being manifested as the cumulative effect of heterosis for component traits. In the present study the hybrid which recorded positive and significant heterosis for grain yield and stover yield also showed heterosis for other component characters. SPV 1782 x HC 308 recorded significant standard heterosis in desirable direction for nine characters, SPV 1754x HC 308 for eight characters, SPV 1714 x HC 308 and SPV 1714 x CSH 16 for six characters each and SPV 1616 x CSH 16, SPV 1754 x CSV 15 and SPV 1714 x CSV 15 for five characters each. Thus the present study on heterosis has clearly indicated the heterotic response for yield and its components results only in selected cross combinations indicating the predominant role of non-fixable inter allelic interactions. These crosses hold promise for further evaluation and commercial exploitation of heterosis and in future can be exploited easily for dual purpose attributes by conventional breeding procedure.

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