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Extent of heterosis for green fodder yield and its components traits in sorghum [*Sorghum bicolor* (L.) Moench]

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SUMMARY

Sorghum having ability to grow in poor soil, faster growth habit, high yielding, palatable, nutritious quality and uniform green forage yield through out the year. The experimental material comprised of three male sterile lines used as female parents, 16 genotypes used as male parents, one standard check variety and 48 F_1 hybrids in a line x tester fashion. All sixty eight entries were studied in randomized complete block design with three replications. The results revealed that the degree of heterosis varied from cross to cross for all the traits under study. The expression of heterosis in the positive direction was in maximum number of hybrids for green fodder yield, leaf length,number of nodes per plant, dry matter yield and crude protein yield. While, the magnitude of heterosis in the negative direction was observed for days to flowering, leaf width, leaf : stem ratio, stem thickness, dry matter content, HCN content and NDF content. The hybrid AKMS 14A x S 1049 revealed the highest and significant heterosis and heterobeltiosis for green fodder yield, dry matter content and dry matter yield. The hybrids 3660 A x PB 22, Indore 9 A x PB 22 and AKMS 14A x HC 171 and AKMS 14A x PB 78 were recorded to be the most significant heterotic hybrids over standard check GFSH 1. Hybrid AKMS 14 A x IS 2472 gave higher green fodder yield with low HCN content and NDF content as compared to check variety GFSH 1. On the basis of gca : sca ratio, preponderance of non-additive gene action for green fodder yield per plant suggesting heterosis breeding programme could be useful for developing superior genotype for green fodder yield.

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Key words : Heterosis, Green fodder yield, Genotypes, HCN content, Protein content

Sorghum is a often cross-pollinated crop. In order to make forage sorghum an enterprising and remunerative crop, there is a need to develop varieties / hybrids having early maturity, faster growth, and high forage yield compiled with high protein and low HCN content at flowering stage. For development of such forge hybrid, knowledge and information on genetic architecture is essential for formulation of efficient breeding strategies for genetic improvement of sorghum as a forage crop. The availability of cytoplasmic male sterile line (CMS) in this crop had made commercial exploitation of heterosis. The phenomenon of heterosis had provided the most important genetic tool for improving yield. Identification of specific parental combination, which is capable of producing the highest level of heterotic effects in F_1, is of greater value in hybrid seed production programme.

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MATERIALS AND METHODS

In present experiments, material comprised of three male sterile line as a female, sixteen genotype as a tester and it's 48 hybrids and one standard check evaluate in three different environment (different date of sowing) condition in RBD design with three replications. The experiment was conducted at Department of Plant Breeding and Genetic, Ananad Agricultural University, Anand. Each entry was accommodated in a 4.5 m long single row plot with spacing of 30 x 10 cm. Recommended package of practices were followed. Five plants were randomly selected and tagged to record data on green fodder yield and its related traits. For measuring qualitative traits random sample drawn from the total yield of a particular entry.

RESULTS AND DISCUSSION

Per cent heterosis over better parent (heterobeltosis) for green fodder yield revealed varying magnitude of expression in different environment (Table 1). The reletive heterobeltosis ranged from –72.93% (P_1 x P_{15}) to 6.04% (P_3 x P_4) in E_1. In E_2, -45.81% (P_1 x P_{15}) to 196.42% (

Table 1: Estimates of heterosis (H_1), heterobeltiosis (H_2) and standard heterosis (H_3) for green fodder yield per plant

Sr. No.	Crosses	Green fodder yield per plant								
		Heterosis (H_1)			Heterobeltiosis (H_2)			Standard heterosis (H_3)		
		E1	E2	E3	E1	E2	E3	E1	E2	E3
1.	P_1 x P_4	63.52 **	58.12 **	102.22**	38.72	12.21	45.21**	-49.66	45.81**	-20.18*
2.	P_1 x P_5	61.62 **	121.88 **	52.76 **	47.97*	65.90**	3.19	-46.31**	115.58**	-43.27**
3.	P_1 x P_6	16.01	12.85	35.37 *	6.26	-22.12	18.09	-53.65**	1.20	-35.09**
4.	P_1 x P_7	37.89 **	161.00 **	93.80 **	23.18	98.16*	32.98**	-43.18**	157.49**	-26.90**
5.	P_1 x P_8	65.88 **	-12.60	8.16	55.27**	-21.66	3.92	-35.39**	1.80	-38.01**
6.	P_1 x P_9	-27.27 **	-14.47	-10.42	-51.84*	-19.51	-39.08**	-46.13**	18.57	-7.02
7.	P_1 x P_{10}	1.34	13.70	28.71**	-23.24	-10.14	20.37*	-45.91**	16.77	-23.98**
8.	P_1 x P_{11}	58.36 **	-32.45 **	64.88**	36.77*	-35.17**	52.25**	-31.77**	-8.38	-1.17
9.	P_1 x P_{12}	25.36	22.78	-26.78*	13.69	-6.22	-28.72	-58.75**	21.86	-60.82**
10.	P_1 x P_{13}	124.01 **	-25.57 *	-5.94	117.27**	-26.24*	-17.60	-16.11**	-2.39	-39.77**
11.	P_1 x P_{14}	67.76 **	16.43	64.77**	57.21*	-6.91	54.26**	-42.95	20.96	-15.20
12.	P_1 x P_{15}	-60.73 **	-58.15**	45.18**	-73.35**	-58.29**	38.83**	-72.93**	-45.81*	-16.37*
13.	P_1 x P_{16}	30.38 *	60.62 **	40.31**	3.64	42.86**	38.14*	-36.24**	85.63**	-21.64**
14.	P_1 x P_{17}	36.20	173.45 **	53.26**	11.34	98.16**	50.00**	-59.60**	157.49**	-17.54
15.	P_1 x P_{18}	17.60	-24.60 *	45.15**	-9.09	-32.97**	20.28*	-39.60**	11.98	0.58
16.	P_1 x P_{19}	194.56 **	166.13 **	86.75**	143.53**	128.11**	64.89**	-11.63**	196.42**	-9.36
17.	P_2 x P_4	227.74 **	74.58 **	1.37	198.83**	42.07**	-29.52**	-8.28	23.36	-56.73**
18.	P_2 x P_5	105.88 **	63.96 **	27.54	104.08**	42.76**	-16.19	-37.36	23.96	-48.54**
19.	P_2 x P_6	-5.72	75.82 **	70.29**	-19.69	37.93	41.90**	-64.97**	19.76	-12.87
20.	P_2 x P_7	12.29	49.51 *	16.43	-6.50	32.76	-22.38	-56.87**	15.27	-52.34**
21.	P_2 x P_8	-2.85	-2.52	6.28	-15.59	-10.17	4.76	-64.88**	-7.48	-35.67**
22.	P_2 x P_9	-46.77 **	-42.46 **	-34.97**	-66.08**	-54.27**	-54.41**	-62.06**	-32.63	-30.41**
23.	P_2 x P_{10}	19.42	43.91 *	71.83**	-14.29	34.48	69.44**	-39.60**	16.77	7.02
24.	P_2 x P_{11}	80.46 **	56.43**	13.89	45.74**	26.27*	10.81	-27.29**	78.45**	-28.07**
25.	P_2 x P_{12}	70.88 **	-17.15	38.14**	67.64*	-25.86	27.62*	-48.55**	-35.63	-21.64**
26.	P_2 x P_{13}	90.45 **	72.13 **	-16.52	70.92**	42.53**	-23.20*	-34.00**	88.63**	-43.86**
27.	P_2 x P_{14}	61.29 **	165.45 **	92.51**	58.67*	151.72**	71.43**	-49.66**	118.57**	5.26
28.	P_2 x P_{15}	7.24	-11.23	-19.23	-30.18**	-25.75	-20.00	-29.08**	-4.19	-50.88**
29.	P_2 x P_{16}	31.49 *	129.30 **	77.23**	-1.45	113.02**	70.48**	-39.37**	115.58**	4.68
30.	P_2 x P_{17}	95.67 **	112.37 **	87.69**	71.28**	77.59**	74.29**	-47.43**	54.20**	7.02
31.	P_2 x P_{18}	46.02 **	-23.58 *	33.06**	6.73**	-41.94**	15.38	-29.08**	-2.99	-3.51
32.	P_2 x P_{19}	122.04 **	17.33	49.15**	96.79**	13.55	25.71	-39.60**	5.39	-22.81**
33.	P_3 x P_4	25.00	136.84 **	54.84**	-2.01	80.00**	5.26	-56.38**	88.63**	-29.82**
34.	P_3 x P_5	31.82	125.13 **	67.35**	10.55	81.71**	7.89	-50.78**	90.42**	-28.07**
35.	P_3 x P_6	13.71	28.93	51.09**	12.56	-5.14	21.93	-49.89**	-0.60	-18.71*
36.	P_3 x P_7	28.33	69.04 **	59.73**	26.09	38.86*	4.39	-41.83**	45.51*	-30.41**
37.	P_3 x P_8	14.39	46.97 **	21.30	10.65	45.71**	14.91	-50.74**	52.70**	-23.39**
38.	P_3 x P_9	-5.58	24.70 *	-17.87**	-34.00**	6.71	-41.00**	-26.17**	57.19**	-9.94
39.	P_3 x P_{10}	1.17	185.71 **	18.92	-17.46	145.71**	15.79	-41.83**	157.49**	-22.81**
40.	P_3 x P_{11}	65.88 **	-19.22	6.67	56.95**	-29.66*	5.26	-21.70**	-0.60	-29.82**
41.	P_3 x P_{12}	71.72 **	-0.17	4.43	42.81*	-17.43	-7.02	-36.42*	-13.47	-38.01**
42.	P_3 x P_{13}	131.43 **	83.84 **	33.05**	116.08**	64.71**	27.20*	-3.80**	117.97**	-7.02
43.	P_3 x P_{14}	34.98	-16.39	2.04	15.58	-27.14	-12.28	-48.55	-23.65	-41.52**
44.	P_3 x P_{15}	-18.84	-38.03 **	15.21	-41.63**	-43.85**	9.65	-40.72**	-27.54	-26.90**
45.	P_3 x P_{16}	22.36	-32.56 *	23.22*	5.45*	-33.71*	14.04	-35.12**	-30.54	-23.98**
46.	P_3 x P_{17}	121.85 **	-6.79	56.86**	68.34**	-27.43	40.35**	-25.06**	-23.95	-6.43
47.	P_3 x P_{18}	37.10 **	-16.52	18.29	14.48**	-32.08**	6.29	-23.94**	13.48	-11.11
48.	P_3 x P_{19}	210.82 **	-21.21	-1.08	138.19**	-25.71	-19.30	6.04	-22.15	-46.20**
	SE ±	10.89	16.54	8.20	12.57	19.10	9.47	12.57	19.10	9.47

* and ** indicates significance of values at P=0.05 and 0.01, respectively

Table 2 : Hybrids with significant heterosis (H_1), heterobeltiosis (H_2) and standard heterosis (H_3) in the desired direction for different traits in sorghum

Sr. No.	Characters	Heterosis (H_1)			Heterobeltiosis (H_2)			Standard heterosis (H_3)		
		E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
1.	Days to 50% flowering	18	16	29	10	7	9	34	2	11
2.	Plant height	46	48	44	25	18	24	1	5	18
3.	Number of tillers per plant	2	3	8	2	2	2	1	2	1
4.	Number of leaves per plant	5	28	26	2	11	5	1	9	0
5.	Leaf length	33	21	11	19	13	4	10	4	17
6.	Leaf width	7	17	12	3	4	3	0	4	13
7.	Leaf stem ratio	14	4	4	8	0	3	24	0	9
8.	Number of nodes per plant	20	48	46	14	30	31	0	0	1
9.	Green fodder yield per plant	25	23	27	21	18	18	0	18	0
10.	Stem thickness	35	27	47	5	7	5	19	10	36
11.	Dry matter content	1	2	5	1	1	2	4	14	1
12.	Dry matter yield per plant	23	20	25	14	12	10	0	19	1
13.	Crude protein content	8	25	17	2	10	10	8	39	32
14.	Crude protein yield per plant	21	26	29	17	18	18	0	27	1
15.	HCN content	19	6	11	11	1	1	18	4	0
16.	NDF content	2	16	16	0	11	7	0	0	0

E_1: 15th, June,2005, E_2: 1st,August,2005, E_3: 15th, September'2005

P_1 x P_{19}) and –60.82 (P_2 x P_{10}) to 7.02% (P_2 x P_{17}). Data Showed wide range of variability in heterosis among the hybrids.

In E_1 *i.e.* 15th June 2005, P_3 x P_{19} showed positive heterosis over best check which indicates hybrid suitable for this seasons. In E_2 *i.e.* 1st August 2005, the crosses P_1x P_5, P_1x P_7, P_1 x P_{19}, P_2 x P_{14}, P_2 x P_{16} and P_3 x P_{13} were shows significant positive heterosis over best check (GFSH-1) and in E_3 *i.e.* 15th September 2005, the crosses P_2 x P_{10}, P_2 x P_{17} and P_2 x P_{14} showed positive heterosis over check varieties which indicate concern hybrid fit for concern environment.

The expression of heterosis in the positive direction was maximum in number of hybrids for green fodder yield, plant height, number of tillers per plant, number of leaves per plant, leaf length, number of nodes per plant, dry matter yield per plant and crude protein yield per plant. The finding is in close agreement with the Parmar (1991), Mistry and Patil (1994), Patel *et al.* (1995) and Rajguru *et al.* (2005). The magnitude of heterosis in negative direction was maximum for days to 50% flowering, leaf width, leaf: stem ratio, stem thickness, dry matter content, crude protein content, HCN and NDF content. This kind of environmental influence was earlier reported by Patel(1990), Parmar (1991), Patel(1991) and Parmar (1997) (Table 2).

Overall plant height, number of nodes per plant, green fodder yield per plant, crude protein yield per plant showed superiority in all three environments. It is interesting to note that very few number of crosses showed hereobeltiosis for days to 50% flowering, leaf: stem ratio, stem thickness and crude protein content but it was high for standard heterosis. For green fodder yield per plant, total 21, 18, and 18 hybrids displayed significant heterosis over better parents in E_1 and E_2 and E_3 environments, respectively. While for standard heterosis 0, 18 and 0 hybrids registered significant heterosis in E_1 and E_2 and E_3 environments, respectively. Among this Indore 9A x PB 22, AKMS 14A x IS 2472, AKMS 14A x PB 78, 3660A x PB-45 were recorded to be the most significant heterotic hybrids both over better parents in E_1 and E_2 and E_3 environments, respectively and over a check hybrid(GFSH-1) in E_2 environments.

Among all three environments, E_2 (1st Aug) was found suitable for cultivation of sorghum. Among all the hybrids, P_3 x P_{19}, P_1 x P_{19} and (P_2 xP_{10} and P_2 xP_{17}) were recorded to be the most significant heterotic hybrids over standard check (GFSH-1) in E_1, E_2, E_3, respectively. P_2 x P_{14} gave higher green fodder yield with low HCN and NDF content as compared to standard check GFSH-1.

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