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RESEARCH ARTICLE

Heterobeltiosis and inbreeding depression for grain yield and its components in sorghum [*Sorghum bicolor* (L.) Moench]

■ MUKESH VYAS, LATA CHOUDHARY AND B.R.RANWAH

SUMMARY

Heterosis over better parent was maximum for grain yield per plant and also depends on plant height, length of panicle, number of whorls per panicle, number of primaries per panicle, 1000 grain weight, biological yield per plant and harvest index. Cross SPV 1329 x ICSV 272 had maximum heterobeltiosis in both thez environments (95.38% in E_1 and 94.74% in E_2). Crosses SU 248 x ICSV 298, SPV 1329 x ICSV 272 and SU 248 x ICSV 272 had maximum grain yield per plant along with higher biological yield per plant thus indicated suitability for dual purpose hybrids. These crosses had highest the heterobeltiotic effects for grain yield per plant, number of primaries per panicle, 100 grain weight, bilogical yield per plant and harvest index. Most of the high heterotic crosses showed high inbreeding depression for all most all the traits. Heterosis with inbreeding depression for grain yield may be an out come of the expression of heterosis for yield components studied depending in such a manner that such crossed can be exploited only through hybrid breeding instead of selecting for trangessive segregants.

Key Words : Sorghum, Heterosis, Heterobeltiosis, Inbredding depression, Grain yield, Yield components

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In the recent past, plant breeders have extensively explored and utilized heterosis in boosting up yield in a number of crops and exploitation of hybrid vigour is considered an out standing accomplishment of plant breeding. Sorghum is an often cross pollinated crop wherein grain yield is a complex character. It is a product of large number of components and their interactions. Therefore, the scope for exploitation of hybrid vigour will depend on the direction and magnitude of heterosis, biological feasibility and nature of gene action. Study of heterosis and inbreeding depression will have a direct effect. Therefore, there is a requirement to develop and identify high yielding hybrids hence, there is urgent need to evaluate the best hybrids with suitable performance over a wide range of environmental conditions. The present investigation aimed to estimate and to obtained information on the extent of heterosis and inbreeding depression in two succeeding years *i.e. Kharif*, 2000 and 2001 of sorghum for grain yield and components of yield with an over all objective to select superior crosses for exploitating heterosis over a wide range of environmental conditions.

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
MUKESH VYAS, Department of Plant Breeding and Genitics, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA
Email: vyas.mukesh66@gmail.com

Address of the Co-authors:
LATA CHAUDHARY, Department of Plant Breeding and Genitics, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA

R.B. RANWAH, A.I.C.P.R. on Sorghum, Department of Plant Breeding and Genitics, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, UDAIPUR (RAJASTHAN) INDIA

MATERIAL AND METHODS

A set of LxT design crosses were produced by crossing six diverse sorghum lines *viz.*, SPV 1330, SU 248, SPV 1329, SPV 1201, SU 556 and SU 562 with three drought tolerant testers. *viz.*, IRAT-204, ICSV-272 and ICSV 298. The nine parents and their 18 F_1s and F_2s were grown in Complete Randomized Block Design with three replications in two different

Table 1: Heterobeltiosis and inbreeding depression (ID) of best hybrids for grain yield and its components in sorghum under *Kharif*, 2000 (E_1) and *Kharif*, 2001 (E_2) environments

Crosses	Environment	Grain yield per plant			Days to 50% flowering		Days to maturity		Plant height		Number of leaves plant		Flag leaf area		Length of panicle		Weight of panicle		Number of whorls per panicle		Number of primaries panicle		1000 Grain weight		Biological yield per plant		Harvest indes	
		BP	ID	Per se	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID	BP	ID
L_3xT_2	E_1	95.38*	5.14*	127.49		-7.85*		-1.88*	10.22*	3.79*	14.29*	-15.63*	0.28	-1.11*	3.95	-0.07	10.76*	2.97*	8.82*	5.41	9.63*	3.41*	5.33*	2.76*	82.66*	3.57*	3.90*	1.62*
	E_2	94.74*	9.18*	126.40	-0.55	2.78	-6.55 *	-8.56*	11.91*	4.18*		-14.29*	0.80*	0.92*	8.86*	3.26*	9.20*	5.21*			9.84*	5.19*	1.24	-1.18	80.70*	10.05*	4.90*	-0.94*
L_2xT_2	E_1	88.19*	29.98*	123.12		4.42*		-11.19*	1.53*	7.91*	11.11	-16.67		-2.24*	6.90*	3.31		2.57*	40.00*	2.86	8.00*	-9.26	8.83*	-3.61*	44.73*	27.18*	5.71*	3.85*
	E_2	85.32*	13.84*	115.83	-5.75 *	-3.66	-2.56*	-10.15*	2.97*	12.57*	3.03	5.88		-0.30*	2.09	6.08*	2.54*	2.71*	9.38	-2.86	12.03*	4.52*	10.43*	-2.79	48.79*	19.60*	7.68*	-7.16*
L_2xT_3	E_1	54.46*	3.86*	128.84	-1.71	-5.23*		-3.55*		13.00*	15.38	0.00		-13.86*	6.93*	6.61*		2.14*	33.33*	11.11*	30.28*	5.95*	9.78*	-2.44	46.79*	3.49*	5.22*	0.38
	E_2	49.16	1.83	126.45		-5.26*		-5.04*	4.25*	15.62*		9.68		-13.63*	11.14*	5.75*	7.68*	3.02*	20.00	11.11*	27.59*	4.32*	9.09*	4.11*	38.64*	1.15*	7.59*	0.70
L_1xT_2	E_1	18.30*	0.78*	100.16		0.54		-2.57*	7.53*	-0.85*		-16.13*		-1.16*	0.96	1.45	0.24	5.91*		3.12		-2.84*	3.13*	-1.33	1.04	-0.34*	2.56*	1.53
	E_2	37.87	15.36	115.45				1-43	10.38*	1.97*	12.50*	2.78		-0.37*	8.07*	7.27*		4.21*		5.88		-5.14*	2.76*	2.77	38.33*	16.71*		-1.63
L_4xT_1	E_1	11.91*	10.34*	117.41	-5.71*	-9.70*		-6.32*		20.68*	6.67	-9.38		-1.34*		8.99*		-3.93*	18.75*	10.53*	13.11*	4.83*	3.71	-1.44		0.62*	2.75*	-1.71
	E_2	9.46	3.10	112.50	-5.33*	-9.38*		-4.89*		20.27*		-14.29*		3.05*		3.57*		1.86	25.00*	12.50*	15.14	3.76*		1.20*	3.44*	6.42*	5.29*	-4.06*
L_4xT_2	E_1	4.18*	3.83*	110.26	-2.72*	2.23		-4.80*		7.41*	6.67	-9.38		-0.56	5.08	5.14 *		1.04	11.76*	7.89	9.39	1.01	1.09	-4.72		2.35*	4.73*	1.47
	E_2	6.36	4.70	109.95	-5.17*	-16.97	-0.74	-6.69*	1.45*	5.76*		-19.23*		4.64	5.77*	3.92		1.04	14.29*	5.00	13.04*	5.29*	3.23*	0.56		0.64*	10.03*	4.08*
L_4xT_3	E_1	2.48*	11.10*	107.86	-0.55	-1.65		-0.37		5.23*	10.71	-9.68		-2.04*	3.01	-0.42		-2.00*	8.82	8.11	6.35*	4.48*		-3.71	1.03	11.87*	1.74*	-0.87
	E_2	2.08*	10.66*	108.08	-2.30	-10.59		-1.84	0.45*	6.31*	20.69*	2.86	1.62*	8.99*	3.86	-0.61		-0.24	27.59	-2.70	8.38*	3.09*	1.95*	-0.35	1.05*	12.19*	1.91*	-1.75*

* indicate significance of value at P=0.05 L_1 = SPV 1330, L_2 = SU 248, L_3 = SPV 1329, L_4 = SPV 1201, T_1 = IRAT 204, T_2 = ICSV 272 T_3 and = ICSV 298

environments *i.e. Kharif*, 2000 and 2001 at Instructional Research Farm. Rajasthan College of Agriculture, Udaipur (Rajasthan). Each parents and F_1 progency were represented by a single row, while F_2 by 4 rows plots of 3 meter length with recommended distances of 45 cm spacing between rows and 15 cm between plants. All the agronomical package of practices was followed to raise the healthy crop.

Observation were recorded on 10 randomly selected plants in P_1, P_2 and F_1 and 20 plants in F_2 generations in both the environment on thirteen quantitative characters *viz.*, days to 50 per cent flowering, days to maturity, plant height, number of leaves per plant, flag leaf area, length of panicle, weight of panicle, number of whorls per panicle, number of primary branches per panicle, grain yield per plant, 1000 grain weight, biological yield per plant and harvest index. Magnitude of heterosis over better parent according Fonesca and Patterson (1968) and Shall (1914) and inbreeding depression (Matzinger *et al.*,1962) form F_1 to F_2 for all the eighteen crosses in both the environment were calculated.

RESULTS AND DISCUSSION

Performance of F_1 hybrids, as compared with the better parent mean (heterobeltiosis) and inbreeding depression from F_1 to F_2 for thirteen characters in two different environments *i.e. Kharif*, 2000 (E_1) and *Kharif*, 2001 (E_2) are presented in Table 1 Heterobeltiosis for grain yield per plant over better parent was in range of 95.38 per cent (L_3 x T_2) to 2.48 per cent (L_4 x T_3) in E_1 whereas in E_2 it ranged from 99.33 per cent (L_5 x T_1) to 2.98 per cent (L_4 x T_3). For grain yield per plant, all crosses had positive significant heterobeltiosis except L_1 x T_1 L_2 x T_1 and L_3 x T_3 in E_1. Inbreeding depression was significant in 15 crosses in E_1 where as in E_2 it was significant for 14 crosses except L_3 x L_1 L_6 x T_1 in E_1 and crosses L_1 x T_3 L_6 x T_1 and L_6 x T_3 in E_2. Depression effect of inbreeding was lowest in cross L_1 x T_2 (0.78%) in E_1 and in E_2 for L_2 x T_3 (1.883%). Inbreeding depression in negative direction was observed in L_6 x T_3 (-3.24%) in E_1 only.

Grain yield according to *per se* data of cross L_2 xT_3 was maximum in both the environment (E_1 = 128.84 g) and E_2 = 126.45 g) among all the crosses. It was followed by L_3 x T_2 (127.49 g and L_2 x T_2 (123.12 g) in E_1. L_3 x T_2 (126.40 g) L_1 x T_2 (115.45 g). L_2 x T_2 (115.83 g) in E_2. Among the F_1s six crosses *viz.*, L_2 x T_3, L_3 x T_2, L_2 x T_2, L_4 x T_1, L_4 x T_2 and L_4 x T_3 had significantly higher grain yield than parent SPV 1201 in both the environments. Grain yield of L_1 x T_2 was also higher than SPV 1201 in E_2. Such best heterobeltiotic crosses selected on the basis of grain yield per plant in both the environments revealed that for grain yield per plant depended upon one or more components like plant height, length of panicle, number of whorls per panicle, number of primaries per panicle, 1000 grain weight, biological yield per plant and harvest index. Similar findings were reported Chan and Chen (1994); Ghorade *et al.* (1997) and Reddy and Joshi (1993) who also suggested that no separate gene system exist for yield. It is the end product of mulplicative interaction between its contributing characters resulting in the expression of heterosis.

A persual of data (Table 1) indicated that most of the high heterotic crosses had high inbreeding depression for all the characters. Therefore, in general, the mean expression of F_2 was lower than that of F_1 but in some cases, comparable or even higher expression of F_2 were also found. However, there were crosses *viz.*, L_1 x T_3, L_2 x T_2, L_3 x T_2, L_4 x T_1, L_5 x T_1, L_6 x T_1, L_4 x T_3, L_5 x T_3, L_6 x T_2, L_6 x T_3, L_1 x T_1, L_3 x T_1, L_5 x T_2, L_3 x T_3, L_1 x T_2 and L_4 x T_2 having negative heterosis in E_1 or E_2 for characters *viz.*, biological yield per plant, 1000 grain weight, plant height, number of primaries per panicle, flat leaf area, number of leaves per plant, days to 50 per cent flowering and days to maturity. Among three crosses characters frequency of such crosses was higher for harvest index particularly in E_2 followed by biological yield per plant, 1000 grain weight and plant height.

Maximum heterobeltiosis was obtained in E_3 x T_2 (SPV 1329 x ICSV 272) in both the environment (98.83% in E_1 and 94.74% in F_2). This was followed by E_5 x T_1 L_2 x T_1 and L_2 x T_3 in both the environments *i.e.* 93.04, 88.19 and 54.46 per cent in E_1. 99.99, 85.32 and 46.16 per cent in E_2, respectively.

Among different crosses three crosses *viz.*, L_2 x T_3 (SU248 x ICSV 298), L_3 x T_2 (SPV 1329 x ICSV 272) and L_2 x T_2 (SU 248 x ICSV 272) had maximum grain yield per plant and also gave higher biological yield per plant thus, indicated suitability for dual purpose hybrids.

Relationship between heterotic response and inbreeding depression (*i.e.* crossing showing high heterotic response also showed high inbreeding depression) suggest the importance of non-additive genes in sorghum. High express F_2 and F_1 generation revealed the presence of such enhanced vigour for seed yield in F_2 can be attributed to epistatic gene actions. For grain yield per plant all the crosses with high heterotic had high inbreeding depression. These crosses can also had high inbreeding depression for component characters. Therefore, these crosses can be exploited only through hybrid breeding instead of selecting for transgrassive segregants of after incorporating male sterlity system.

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