HETEROSIS FOR GRAIN YIELD AND ITS COMPONENT TRAITS IN SORGHUM [*Sorghum bicolor* (L.) MOENCH]

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ABSTRACT

The present investigation was carried out to study the magnitude of standard heterosis in 35 crosses (F_1s) of sorghum [Sorghum bicolor (L.) Moench] developed by crossing the five females with seven testers using Line X Tester mating design. Observations were recorded on six characters viz., days to 50 per cent flowering, days to maturity, plant height (cm), panicle length (cm), grain yield per plot (g) and test weight (g). The analysis of variance revealed significant differences among the genotypes viz., parents, crosses and parents vs. crosses for all the characters. The crosses 1005A x SR-2872, 1009A x SR-2872, 1005A x Pantchari, 296A x SR-2879 and ICSA-467A x SR-2879 showed high standard heterosis for grain yield per plot and other component traits. Thus, these crosses can be exploited by conventional breeding procedure.

KEY WORDS: Sorghum bicolor, standard heterosis, grain yield.

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is an important crop for dry land area, which provides staple food for the poor people of world. Sorghum is a multipurpose crop belongs to family *poaceae* having 2n=20 chromosomes. The grain is used as human food, whereas the fodder is utilized as cattle feed, which provides milk and meat for the nourishment of human being. Sorghum is also nutritionally superior to other fine cereals such as rice and wheat, hence it known as nutritious cereal.

Heterosis is expressed as per cent increase or decrease of hybrid performance over the parental value (Mutazing, 1945, Pal and Singh, 1946). Since the better parent may fall on either extreme, depending upon the traits, heterosis may results in any one of the two directions, positive or negative. The utilization of heterosis or hybrid vigour as a means of maximizing the yield of agricultural crops has become one of the most important techniques in plant breeding. Knowledge on the magnitude of heterosis for various characters is essential to decide better combinations to exploit them through heterosis breeding. The economic heterosis rather than mid parent heterosis and heterobeltiosis, reflects the actual superiority over the best existing cultivar to be replaced and appears to be more relevant and practical.

MATERIALS AND METHODS

Five lines *viz*., 296A, AKMS-14A, ICSA-467A, 1005A and 1009A; and seven testers *viz*., B-58586, CSV-20, Kekri local, Pantchari, SR-2872, SR-2879 and Nizer goti were employed and crosses were made in Line x Tester mating design during *Kharif* 2014. The thirty five crosses, twelve parents including a standard check (GJ-42) were grown in a randomized block design (RBD) with three replications in three diverse environments *viz*., Surat, Vyara and Waghai during *kharif* 2015. The observations were recorded on five random plants for each treatment in each replication for plant height (cm), panicle length (cm) and test weight (g). The observations for days to 50 % flowering, days to maturity and grain yield per plot (g) were recorded on the plot basis. The collected data were subjected to statistical analysis to understand the magnitude of heterosis. Computation of standard heterosis was carried out as per procedure suggested by Meredith and Bridge (1972).

RESULTS AND DISCUSSION

The analysis of variance revealed that the mean squares due to the genotypes, parents and hybrids were highly significant for all the characters (Table 1). This reflected presence of considerable amount of variability existed among genotypes, parents and hybrids. The mean squares due to environments for all the characters were also found highly significant indicating considerable influence of environment on the expression of various traits. The average performance of hybrids differed significantly than that of parents suggesting the presence of average heterosis, which was evident from the significance of parents vs. hybrids comparison for all the characters pooled over environments except days to 50 % flowering and days to maturity. Highly significant mean squares due to genotypes x environments and hybrids x environments were also observed for all the characters which emphasized that genotypes, parents and hybrids differently interacted to diverse environments. Similarly the mean squares due to parents x environments interactions were found to be significant to highly significant for all the characters except days to maturity.

The range of standard heterosis along with number of significant crosses for different characters is present in Table 2. In the present study, heterosis for grain yield per plot was found significantly positive 5 crosses (1005A x SR-2872 followed by 1009A x SR-2872, 1005A x Pantchari, 296A x SR-2879 and ICSA-467A x SR-2879) over standard check (Table 2 and 3). The range of heterosis for grain yield varied from 1.63 per cent (1005A x SR-2879) to 44.10 per cent (1005A x SR-2872) over standard check (Table 2.). Similar results for grain yield were reported by Udutha (2008), El-Dardeer *et al*. (2011), Tariq *et al.* (2012), Jain and Patel (2014) and Boratkar and Ninghot (2015). Thus, these crosses in future can be exploited easily for grain yield purpose by conventional breeding procedure. Heterosis for grain yield is being manifested as the cumulative effect of heterosis for component traits. The elaborative study of above crosses revealed the fact that most of the crosses exhibited positive and significant heterosis for grain yield and for most of the component characters.

Heterosis for days to 50 per cent flowering and days to maturity were significant and negative (desirable) in 13 and 10 crosses over standard check, respectively (Table 2). The range of heterosis for days to 50 per cent flowering varied from -1.05 per cent (296A x Nizer goti) to -17.96 per cent (AKMS-14A x B-58586) over standard check, whereas for days to maturity, it ranged from -0.31 per cent (296A x Nizer goti) to -11.90 per cent (AKMS-14A x B-58586) over standard check. Similar trend was also reported by Udutha (2008) and Kale (2012). This indicated that there was a possibility for breeding of sorghum for earliness.

For plant height, the range of standard heterosis was observed from -29.51 (ICSA-467A x CSV-20 to 46.24 (296A x Kekri local). Total twenty three crosses exhibited highly significant and two crosses were significant positive heterotic effects for plant height (Table 2). Such results were also reported by Jain and Patel (2014), which indicated that hybrids were tall compared to standard check. Six crosses found highly significant negative and one was significant negative heterotic effect for plant height, it was also noted in study carried out by Tariq et al. (2012), suggested that seven crosses were found significantly dwarf compared to standard check.

The hybrids recorded standard heterosis for panicle length ranged from 0.40 per cent (1009A x CSV-20) to 68.11 per cent (296A x B-58586) (Table 2). Twenty nine F_1's exhibited positive and significant to highly significant heterosis for this trait. The most significant positive heterotic crosses in order were 296A x B-58586, AKMS-14A x SR-2872 and 296A x Nizer goti (Table 3). A positive heterosis for panicle length was also reported by Desai *et al*. (2006), Kshirsagar (2007), Udutha (2008) and Kale (2012).

The estimates of standard heterosis in hybrids for test weight varied from 0.09 per cent (1009A x B-58586) to 18.24 per cent (AKMS-14A x Nizer goti) (Table 2). Total twelve crosses exhibited highly significant and one was significant positive heterosis over the standard check. The most three heterotic hybrids in order were AKMS-14A x Nizer goti, AKMS-14A x SR-2879 and 1009A x Pantchari. Similar result also reported by Kulkarni et al. (2007) and Jain and Patel (2014).

CONCLUSION

Based on results and discussion, it can be concluded that heterotic response for yield and its components resulted only in selected cross combinations (1005A x SR-2872 followed by 1009A x SR-2872, 1005A x Pantchari, 296A x SR-2879 and ICSA-467A x SR-2879) indicating the predominant role of non-fixable interalielic interactions. These crosses hold promise for further evaluation and commercial exploitation of heterosis for grain yield purpose attributes by conventional breeding procedure.

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Table 1: Mean squares for different characters in grain sorghum (pooled over locations).

Source of variation	d.f.	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	Panicle Length (cm)	Grain Yield per Plot (g)	Test Weight (g)
Environments	2	557.816 **	448.915 **	17012.500 **	142.546 **	178501.400 **	0.413 **
Replication x Environments	4	1.610	16.571	107.387	3.052	814.535	0.001
Genotypes	46	277.633 **	253.460 **	24121.150 **	117.047 **	290536.300 **	0.878 **
Parents	11	125.434 **	87.120 **	26859.100 **	109.806 **	82215.350 **	0.759 **
Females (F)	4	58.856 **	34.644	5801.225 **	30.290 **	24603.800 **	0.378 **
Males (M)	6	128.497 **	91.735 **	10660.950 **	127.494 **	132223.700 **	1.027 **
Females vs Males (F vs M)	1	373.371 **	269.334 **	208279.400 **	321.738 **	12611.67	0.677 **
Hybrids	34	334.948 **	314.571 **	21038.170 **	89.852 **	337656.000 **	0.503 **
Parents vs. hybrids (P vs H)	1	3.116	5.395	98824.750 **	1121.334 **	979998.300 **	14.916 **
Genotypes x Environments	92	17.671 **	22.567 **	1149.694 **	13.294 **	11125.000 **	0.032 **
Parents x Environments	22	15.313 *	15.762	756.388 **	10.672 **	6816.895 *	0.026 **
Females x Environments	8	18.872 *	20.578	479.885	8.234	7916.292 *	0.030 **
Males x Environments	12	14.450	13.743	358.779	11.088 **	4256.782	0.022 *
(F vs M) x Environments	2	6.257	8.608	4248.058 **	17.928 *	17779.980 *	0.03
Hybrids x Environments	68	18.659 **	25.005 **	1258.758 **	13.571 **	12551.280 **	0.035 **
(P vs H) x Environments	2	9.984	14.537	1767.910 **	32.705 **	10020.73	0.031
Error	276	9.561	14.666	347.353	4.308	3800.966	0.012

, ** = significant at 5 per cent and 1 per cent levels of significance, respectively.

Table 2: The range and number of crosses showing significant desirable heterosis in grain sorghum (Pooled over locations).

Characters	Standard Heterosis		Number of Significant Crosses
	Minimum	Maximum	
Days to 50 % Flowering	-1.05	-17.16	13
Days to Maturity	-0.31	-11.90	10
Plant Height (cm)	-29.51	46.24	25 Tallness 7 Dwarfness
Panicle Length (cm)	0.40	68.11	29
Grain Yield per Plot (g)	1.63	44.10	5
Test Weight (g)	0.09	18.24	13

Table 3: Crosses having positive heterosis for six characters in grain sorghum (Pooled over locations).

Characters	Best Crosses
Days to 50 % Flowering	AKMS-14A x B-58586, AKMS-14A x CSV-20, ICSA-467A x B-58586
Days to Maturity	AKMS-14A x B-58586, ICSA-467A x B-58586, AKMS-14A x CSV-20
Plant Height (cm)	296A x Kekri local, 296A x B-58586, ICSA-467A x Kekri local (Tallness) ICSA-467A x CSV-20, ICSA-467A x B-58586, AKMS-14A x Pantchari (Dwarfness)
Panicle Length (cm)	296A x B-58586, AKMS-14A x SR-2872, 296A x Nizer goti
Grain Yield per Plot (g)	1005A x SR-2872, 1009A x SR-2872, 1005A x Pantchari, 296A x SR-2879 and ICSA-467 x SR-2879
Test Weight (g)	AKMS-14A x Nizer goti, AKMS-14A x SR-2879, 1009A x Pantchari

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