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Heterosis for yield and yield related components using diverse restorer lines in pearl millet [*Pennisetum glaucum* (L.) R. Br.]

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Abstract: Experiment comprised of five male sterile lines and nine testers of pearl millet and their 45 hybrids was conducted at Regional Agricultural Research Station, Vijayapur during *kharif* 2015, for studying the extent of hybrid vigour in F_1 for grain yield and its components. For plant height, the cross combination ICMA 88004 x A5RLT 107, showed significant heterosis over mid parent and three checks used in the experiment. The hybrid ICMA 88004 x A5RLT 122, showed highest significant positive heterosis over the three checks for panicle length. Hybrid ICMA 00888 x A5RLT 106, showed highest significant mid parent and standard heterosis over the three checks for no. of productive tillers. The hybrid, ICMA 94555 x A5RLT 106 showed highest significant mid parent, better parent and standard heterosis over check GHB-558 towards positive direction for panicle girth (cm). The hybrid ICMA 81A x A5RLT 107, showed highest significant mid parent, better parent and standard heterosis over check GHB-558 for grain yield per hectare (kg/ha). While ICMA 81A x A5RLT 107, showed highest significant positive heterosis over the three checks used in the experiment for 1000 seed weight (gm).

Key Words: Better parent, Heterosis, Mid parent, Standard heterosis

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a C4 species with very good photosynthetic efficiency and dry matter production. It is an important course grain cereal and forage crop of the arid and semi-arid tropics of the Indian subcontinent and several African regions. It is having a great potential as a warm season crop in the temperate zone. Heterosis breeding has been recognized as the most suitable breeding methodology for augmenting yield in pearl millet. Selection of suitable parents and assessment of degree of heterosis in the resulting crosses forms an important step. The quantum jump in the productivity of pearl millet (from 303 to 1106 kg/ha) was possible mainly through development of hybrids by the utilization of cytoplasmic genetic male sterility system. Pearl millet hybrids grown widely in India are all based on A1 CMS source. Though alternative sources of CMS were available and found to be highly stable, their utility is restricted due to non-availability of suitable restorer. Considering the importance of the crop and the above indicated facts, the present investigation was conducted to study the extent of hybrid vigour in F_1 for grain yield and its components using restorer based on A5 cytoplam.

Material and methods

In the present study involving five male sterile lines and nine male parents (testers) of pearl millet were chosen. The materials were obtained from ICRISAT, Patancheru, India. Five male sterile lines (Tifton 23A) used are ICMA 00888, ICMA 96666, ICMA 88004, ICMA 81A and ICMA 94555 while, nine male parents (testers) are A5 RLT-103, A5 RLT-104, A5 RLT-105, A5 RLT- 106, A5 RLT-107, A5 RLT- 114, A5 RLT-119, A5 RLT-121 and A5 RLT- 122. The parental lines (14), F_1 hybrids (45) generated and the standard checks (GHB-558 (National check), Kaveri boss 65 and 86M52 (Private checks)) were evaluated in RCBD trial during *Kharif,* 2015 to get the information about heterosis of the lines for yield and yield components. Each hybrid was accommodated in two row with a row spacing of 45 cm and plant to plant spacing of 15 cm. Uniform and recommended cultural practices were followed to raise agronomical good managed crop. The observations were recorded on five randomly selected plants from each replication for 8 traits *viz.,* days to 50 percent flowering, plant height (cm), total number of tillers, ear length (cm), ear girth (cm), fodder yield per hectare (kg/ha), 1000 grains weight (g) and grain yield per hectare (kg/ha). The expression of heterosis in 45 hybrids involving five lines and nine testers were measured in terms of relative heterosis in relation to mid parents, heterobeltiosis in relation to better parent and standard heterosis in comparison with GHB-558, Kaveri boss 65 and 86M52

Results and discussion

The analysis of variance for yield and its components traits in RCBD revealed that the hybrids involved in the present study differed significantly for all the characters except for productive tillers, while parents showed highly significant variation for panicle length, plant height, days to 50% flowering and test weight (Table1). The range of mid parent heterosis, heterobeltiosis and standard heterosis, as well as, number of hybrids showing significant heterosis in desirable direction is presented in Table 2.

For days to 50 % flowering nine hybrids recorded significant negative heterosis over mid parent, while 16 hybrids recorded significant negative heterosis over better parent. Majority of the hybrids recorded significant negative heterosis for this character over the checks Kaveri boss 65 and 86M52, while six hybrids recorded significant negative heterosis over check

Table 1. Analysis of variance (Mean sum of squares) in respect of 8 different characters in pearl millet

Source	df	DFL	Plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Productive tillers/plant	Fodder yield (kg/ha)	Grain yield (kg/ha)	TSW (g)
Parents	13	3.108 **	656.992**	7.533 **	0.030	0.145	750689.68	273632.39	10.93 **
Parents Vs. Crosses	1	4.038 *	4349.063**	30.965 **	0.327 **	3.198 **	943236.95	805142.81	12.93 **
Crosses/Hybrids	44	9.113 **	210.594**	9.269 **	0.061 **	0.178	2354731.68**	743548.15**	5.858 **
Line	4	2.900 **	904.630**	3.956 *	0.031	0.169	626428.94	91273.53	12.34 **
Tester	8	3.500 **	142.006**	10.250 **	0.031	0.131	788751.64	140884.71	11.38 **
Line × Tester	1	0.805	140.986**	0.101	0.017	0.157	943236.95	2065049.23**	1.72 *

Note: *Significance at 5% probability, **Significance at 1% probability, DFL: days to 50% flowering, TSW: 1000 seed weight

Table 2. Number of crosses showing significant level of heterosis with respective direction and their ranges for 8 different characters in pearl millet

Character	Relative heterosis			Heterobeltiosis			Standard heterosis over 86 M 52		
	Positive (No's)	Negative (No's)	Range (%)	Positive (No's)	Negative (No's)	Range (%)	Positive (No's)	Negative (No's)	Range (%)
DFL	11	9	-4.96 to 8.96	10	16	-8.22 to 8.45	1	40	-11.33 to 2.67
PH	32	3	-10.16 to 31.49	17	4	-11.94 to 12.13	24	4	-9.42 to 15.11
PL	4	15	-23.68 to 15.62	1	22	-28.08 to 12.24	6	3	-16.72 to 20.97
PG	1	9	-16.17 to 15.85	1	10	-19.54 to 13.1	0	30	-21.35 to -11.24
NPT	1	7	-39.68 to 39.62	0	12	-40.62 to -31.25	1	0	42.31
DFH	6	4	-30.34 to 39.24	1	4	-34.04 to 37.50	0	6	-35.42 to -25.00
GYH	2	7	-50.67 to 53.81	1	16	-56.61 to 39.8	0	31	-62.75 to -22.66
TSW	13	23	-44.83 to 45.26	5	30	-46.67 to 39.68	15	9	-26.24 to 29.79

Character	Standard heterosis over Kaveri boss 65			Standard heterosis over GHB-558		
	Positive (No's)	Negative (No's)	Range (%)	Positive (No's)	Negative (No's)	Range (%)
DFL	4	34	-9.52 to 4.76	12	6	-4.32 to 10.79
PH	33	1	-5.39 to 20.23	44	0	6.82 to 32.66
PL	7	3	-16.46 to 21.34	16	2	-12.46 to 27.16
PG	0	17	-19.54 to -11.49	1	0	21.79
NPT	1	0	60.87	2	0	51.22 to 80.49
DFH	3	5	-32.61 to 26.09	4	3	-31.11 to 28.89
GYH	0	22	-59.51 to -22.87	10	1	-38.43 to 84.14
TSW	6	25	-34.18 to 15.82	18	4	-23.53 to 34.56

Note: DFL: days to 50% flowering, PH: plant height (cm), NPT: no of productive tillers per plant, PL: panicle length (cm), PG: panicle girth (cm), DFH: fodder yield per hectare (kg), GYH: grain yield per hectare (kg), TSW: 1000-seed weight (g).

GHB-558. The hybrid ICMA 94555 x A5RLT 105 showed highest significant mid parent and better parent heterosis towards negative direction. While the hybrid ICMA 88004 x A5RLT 107 showed highest significant heterosis towards negative direction over the three checks used in the experiment.These results are in agreement with earlier findings (Vetriventhan *et al.,* 2008, Chotoliya *et al.,* 2009 and Davda *et al.,* 2012) . For plant height, 32 hybrids exhibited significant positive heterosis over mid-parent and 17 hybrids exhibited significant positive heterosis over better parent. 44 hybrids exhibited significant positive heterosis over standard check, GHB-558. 24 hybrids exhibited significant positive heterosis over standard checks 86M52 and 33 hybrids exhibited significant positive heterosis over standard checks Kaveri boss 65. The hybrid ICMA 88004 x A5RLT 107 showed highest significant positive mid parent heterosis and ICMA 94555 x A5RLT 114 showed highest significant positive better parent heterosis. While, ICMA 88004 x A5RLT 107 showed highest significant positive heterosis over the three checks. Many researchers have also reported marked heterosis for plant height (Davda *et al.,* 2012 and Kathale *et al.,* 2013).For productive tillers, only one hybrid exhibited positive heterosis over mid-parent and none of the hybrid exhibited significant positive heterosis over better parent. Two hybrids exhibited significant positive heterosis over standard check, GHB-558. While one hybrid exhibited significant positive heterosis over standard checks 86M52 and Kaveri boss 65. Hybrid ICMA 00888 x A5RLT 106 showed highest significant mid parent and standard heterosis over the three checks used in the experiment. These results are in agreement with earlier findings (Jethva *et al.,* 2012 and Kathale *et al.,* 2013).

For panicle length (cm), four hybrids exhibited positive heterosis over mid-parent and just one hybrid exhibited positive heterosis over better parent. Sixteen hybrids exhibited significant positive heterosis over standard check, GHB-558 which indicates that heterosis for this trait commercially can be exploited. Six and seven hybrids exhibited significant positive heterosis over standard checks, 86M52 and Kaveri boss 65, respectively. The hybrid ICMA 00888 x A5RLT 119 showed highest significant mid parent and better parent heterosis towards positive direction. While the hybrid ICMA 88004 x A5RLT 122 showed highest significant positive heterosis over the three checks. Many researchers have also reported marked heterosis for panicle length (Lakshmana, 2008, Jethva *et al.,* 2012 and Kathale *et al.,* 2013).

For panicle girth (cm), one hybrid showed significant positive heterosis over mid-parent and better parent. One hybrid exhibited significant positive heterosis over standard check, GHB-558. While none of the hybrid exhibited significant positive heterosis over standard checks, 86M52 and Kaveri boss 65. The hybrid, ICMA 94555 x A5RLT 106 showed highest significant mid parent, better parent and standard heterosis over check GHB-558 towards positive direction. Many earlier researchers have also obtained the similar results (Jethva *et al.,* 2012 and Kathale *et al.,* 2013). Fodder yield per hectare (kg) hybrids showed significant heterosis in both positive and negative direction over relative heterosis and heterobeltiosis. Six hybrids recorded significant positive heterosis over mid-parent and one hybrid recorded significant positive heterosis over better parent. Four and three hybrids exhibited significant positive heterosis over standard checks GHB-558 and Kaveri boss 65 respectively. While none of the hybrid exhibited significant positive heterosis over standard checks 86M52. The hybrid ICMA 81A x A5RLT 121 showed highest significant mid parent and better parent heterosis towards positive direction. The hybrid ICMA 81A x A5RLT 119 showed highest significant positive heterosis over the check GHB-558 and Kaveri boss 65. Many researchers have also reported marked heterosis for fodder yield per hectare (Vagadiya *et al.,* 2010 and Jethva *et al.,* 2012).

For grain two hybrids recorded significant positive heterosis over mid-parent and one hybrid recorded significant positive heterosis over better parent. Ten hybrids exhibited significant positive heterosis over standard check, GHB-558. While none of the hybrid exhibited significant positive heterosis over standard checks, 86M52 and Kaveri boss 65. The hybrid ICMA 81A x A5RLT 107, showed highest significant mid parent, better parent and standard heterosis over check GHB-558. Many researchers have also reported similar findings (Blummel and Rai, 2003, Manga and Dubey, 2004, Davda *et al.,* 2012; Jethva *et al.,* 2012 and Kathale *et al.,* 2013). For 1000-seed weight (g) the test weight of a genotype serves as an indicator of the end product *i.e.,* grain yield as it is an important character contributing to yield. Thirteen and five hybrids showed positive significant heterosis over both mid-parent and better parent respectively. 18 hybrids recorded significant positive heterosis over standard check GHB-558. While fifteen and six hybrids recorded significant positive heterosis over standard check 86M52 and Kaveri boss 65 respectively. The hybrid ICMA 88004 x A5RLT 119 showed highest significant mid parent and better parent heterosis towards positive direction.

While the hybrid, ICMA 81A x A5RLT 107 showed highest significant positive heterosis over the three checks used in the experiment. These observations are in agreement with the reports of earlier workers (Pethani *et al.,* 2004, Vagadiya *et al.,* 2010; Jethva *et al.,* 2012 and Kathale *et al.,* 2013). Hence, the hybrid, ICMA 81A x A5RLT 107 can be used for future line of work as it had showed highest significant mid parent, better parent and standard heterosis over check GHB-558.

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