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Heterosis for grain yield components in Pearl millet [*Pennisetum glaucum* (L) R.Br.]

PRIYANKA D. SOLANKI[1], M. S. PATEL[2] AND N. N. PRAJAPATI[3]

Centre for Crop Improvement,
S. D. Agricultural University, Sardarkrushinagar-385 506 (Gujarat)

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ABSTRACT

An experiment comprised of 70 genotypes consisting of 54 hybrids resulting from Line x Tester mating design involving 15 parental line and standard check (GHB-558) was conducted at Center for Crop Improvement, S.D.Agricultural University, Saradarkhushinagar (Gujarat) during *kharif*-2014 for studying the extent of hybrid vigour in F_1 for grain yield and its components. The hybrid ICMA-96333 X J-2454 show significant positive relative heterosis, heterobeltiosis and standard heterosis for harvest index and protein content and also showed significant positive standard heterosis for Zn content and hybrid JMSA-20072 x J-2512 showed significant positive standard heterosis for Fe content. The significant economic heterosis in desirable direction was observed in most of the high heterotic hybrid of a grain yield per plant number of effective tillers per plant and Zn content which indicating that the maximum contribution of this character towards yield heterosis.

Key words : Heterosis, heterobeltosis, standard heterosis, pearl millet

Pearl millet [*Pennisetum glaucum* (L) R.Br.] is a stable diet for the vast majority of poor farmers and also form an important fodder crop for livestock population in arid and semi-arid region of India. Heterosis breeding has been recognized as the most suitable breeding methodology for augmenting yield in pearlmillet. Selection of suitable parents and assessment of degree of heterosis in the resulting crosses forms an important step. In relation to the yield,quality traits have also important role for increasing value addition because pearl millet grain is richer source of starch (56.05-73.37) (Choudhary, 2005), fat (1.5-9.9%), protein (6.40-24.25%), iron (30.1–75.7 mg/kg) and zinc (24.5– 64.8 mg/kg) (Velu,2011) phosphorous (185.0-363.0 mg/100g) and total carotenoids (84-445 mg/100g) (Sharma, 2005). An extensive survey of pearl millet literature showed 40% average better parent heterosis for grain yield. Previous studies showed that, high amount of heterosis for grain yield and harvest index, high magnitude of heterosis for grain yield and standard heterosis for grain yield, effective tillers per plant, ear head leangth, ear head girth, test weight. Heterosis breeding was ideal for increasing yield in pearl millet. Therefore the present investigation was conducted to study the extent of hybrid vigour in F_1 for grain yield and its components.

MATERIALS AND METHODS

In present study fifty-four crosses were made during summer 2014 using the 6 male sterile line and 9 tester. The parents were obtained from Main Bajara Reserch Station, Junagadh Agricultural University, Jamnagar. Thus, present investigation carried out using 54 hybrids and 15 parents along with standard check GHB-558 formed with Rendomized Block Design (Kempthorne,1957) with three replication at Center for Crop Improvement, S.D. Agricultural University, Saradarkhushinagar (Gujarat) during *kharif*-2014. Each hybrid and parents represented two rows having 4 m length spaced at 45 cm between row and 15 cm apart from plant to plant within row. Uniformed and recommended cultural practices were followed to raise agronomically good managed crop. The observations were recorded on five randomly selected competitive plant from each replication for 12 traits, *viz.*, Days to

[1]Senior Research Fellow, [2&3] Assistant Research Scientist

flowering, Days to maturity, Plant height (cm), Effective tillers per plant, Ear head length(cm), Ear head girth(mm), Test weight(g), Grain yield per plant(g), Harvest index (%), Protein content(%), Fe content(mg/kg), and Zn content(mg/kg). The expression of heterosis 54 hybrids involving 6 lines and 9 testers was measured in term of relative heterosis in relation to mid parent, heterobeltiosis in relation to better parent and standad heterosis in comparison with GHB-558, the hybrid as the standard.

RESULTS AND DISCUSSION

The analysis of variance for yield and its components traits in RBD revealed that the parents and their hybrids involved in the present study differed significantly for all the characters. Mean values of grain yield and yield component characters of parents (line and tester) and their hybrid is presented in Table 1. The ranged of mid parent heterosis, heterobeltiosis and standard heterosis as well as, number of hybrids showed significant heterosis in desirable direction in present in Table 2.

The extent of heterosis for days to flowering had range varied from -16.45 to 95.21 percent when all the three types were considered. The highest significant negative relative heterosis and heterobeltiosis was observed in cross JMSA-20072 X J-2512, Similar results were reported by Kushwah and Singh (1992), Kulkarni *et al.* (1993), Karale *et al.* (1997), Katti *et al.* (1997) and Yadav (2006). For days to maturity 16, 25, and 1 hybrids showing relative heterosis, heterobeltiosis, and standard heterosis respectively. The hybrid ICMA-842 X J-2496 showed highest significant relative heterosis, heterobeltiosis as well as standard heterosis for earliness over standard check GHB 558. Similar results were reported by Kushwah and Singh (1992) and Manga and Dubey (2004).

The extent of heterosis for plant height had range varied from -21.51 to 87.06 percent when all three types were considered. With respect to dwarfness the hybrid JMSA-9904 X J-2454, ICMA-96333 X J-2538 AND JMSA-9904 X J-2454 showed highest relative heterosis, heterobeltiosis and standard heterosis, respectively. These findings were in agreement with the reports of Kushwah and Singh (1992), Chavan and Nerkar (1994), Yadav (1999), Sheoran *et al.* (2000) and Yadav *et al.* (2006).

Number of effective tillers per plant is an important component of grain yield, for effective tiller per plant range of heterosis varied from -60.71 to 100.00 percent when all the three types were considered. For number of effective tillers per plant 22, 15, and 39 hybrids showing relative heterosis, heterobeltiosis, and standard heterosis respectively. Hybrid ICMA-96333 X J-2479, JMSA-20072 X J-2496 and JMSA-20042 X J-2510 showed relative heterosis, heterobeltiosis and standard heterosis, respectively, Similar results in all the three type of heterosis were also reported by Kushwah and Singh (1992), Patil *et al.* (1994), Balakrishnan and Das (1996), Karale *et al.* (1997), Manga and Dubey (2004) and Arulselvi *et al.* (2006).

For ear head length out of the 54 crosses, 44 crosses recorded significant positive relative heterosis in desirable direction, and the croas ICMA-08111 X J-2454 showed highest relative heterosis, 28 crosses manifested significant positive heterobeltiosis and the hybrid ICMA-08111 X J-2454 showed highest heterobeltiosis, 14 hybrids showed standard heterosis in positive direction and the cross JMSA-20042 X J-2510 showed desirable standard heterosis Same observation recorded for all three type of heterosis by Kushwah and Singh (1992), Kulkarni *et al.* (1993), Balakrishna and Das (1996), Karale *et al.* (1997), Katti *et al.* (1997), Ramamoorthi and Govindarasu (2000) and Manga and Dubey (2004). For ear head girth, out of 54 hybrids, 35 hybrids depicted significant positive heterosis over mid parent and 22 hybrids showed significant positive heterosis in desirable direction over better parent. The cross JMSA-20042 X J-2454 showed highest significant positive relative heterosis and heterobeltiosis, Azhaguvel *et al.* (1998) Sheoran *et al.* (2000) also supported these results., where as none of the hybrid showed positive economic heterosis, similar results were also reported by Kushwah and Singh (1992), Kulkarni *et al.* (1993), Patil *et al.* (1994), Balakrishna and Das (1996), Karale *et al.* (1997) and Katti *et al.* (1997).

The trait, test weight showed a range of -32.71 to 26.17 with 28 crossed exceeded the value of standard check (GHB-558). The cross JMSA-20042 X J-2507 registered highest relative heterosis, heterobeltiosis and standard heterosis. These findings were in agreement with the reports of Kushwah and Singh (1992), Kulkarni *et al.* (1993), Patil *et al.* (1994), Karale *et al.* (1997), Manga and Dubey (2004) and Arulselvi *et al.* (2006).

For grain yield per plant, the mid parent heterosis ranged from -32.88 to 105.75 percent, heterobeltiosis

Table 1 Mean value of grain yield and its component characters of pearl millet.

Charecters	Mean value			
	Line	Tester	Hybrids	C.D.%
Days to flowering	48.83	47.89	48.20	4.93
Days to maturity	78.60	77.53	77.60	4.67
Plant height (cm)	114.28	131.56	91.44	25.75
No. of effective tiller/ plant	2.05	1.88	2.00	0.40
Ear head length (cm)	18.53	19.29	20.85	2.32
Ear head girth (mm)	21.4	21.86	23.63	2.44
Test weight (g)	9.82	9.23	10.45	1.00
Grain yield/plant (g)	22.22	19.91	25.59	3.08
Harvest index (%)	29.47	27.08	31.09	3.02
Protein content (%)	8.92	8.04	8.87	0.74
Fe content (mg/kg)	70.17	32.07	50.11	2.35
Zn content (mg/kg)	41.73	11.90	21.32	1.64

ranged from -43.23 to 101.39 whereas, economic heterosis varied from -62.50 to 14.77 percent with 4 crosses yielded more than the standard check GHB-558. Out of 54 crosses, 39, 34 and 4 hybrids registered high significant positive heterosis over MP, BP and SC respectively for grain yield per plant. The crosses JMSA-20072 X J-2512, JMSA-20072 X J-2510 and JMSA-20072 X J-2479 showed high significant positive relative heterosis as well as heterobeltiosis. The highest standard heterosis for grain yield per plant recorded by the JMSA-20072 X J-2512 (14.77%), followed by ICMA-96333 X J-2454 (6.82%) and JMSA-20072 X J-2510 (5.97%) over the check GHB-558. Similar type of results for all heterosis also finding by Kushwah and Singh (1992), Penthani and Dave (1992), Kulkarni *et al.* (1993), Nijhawan and Yadav (1993), Izge *et al.* (2007) and Vaghasiya *et al.* (2009).

Harvest index is also important component for grain yield, for harvest index 38, 19 and 6 hybrid showed relative heterosis, heterobeltiosis, and standard heterosis respectively. The hybrid ICMA-9633 X J-2496 showed highest relative heterosis and heterobeltiosis, the results were supported by Deore *et al.* (1997) and JMSA-20072 X J-2454 hybrid showed highest significant positive standard heterosis, Nijhawan and Yadav (1993), Deore *et al.* (1997) and Manga and Dubey (2004) were supported this results.

For protein content, the perusal of estimate of relative heterosis indicated the 29 hybrids showed significant positive heterosis, 17 crosses showed significant positive heterobeltiosis and 9 crosses showed significant positive standard heterosis, where hybrid JMSA-20042 X J-2479 showed highest relative heterosis as well as heterobeltiosis and ICMA-96333 X J-2454 showed standard heterosis. The results were supported by Sukhchin and Phul (1990). In case of Fe content, hybrid ICMA-842 X J-2556 showed highest relative heterosis, heterobeltiosis and standard heterosis. For Zn content, 18, 8 and 52 hybrids showed relative heterosis, heterobeltiosis, and standard heterosis respectively, whereas hybrid ICMA-842 X J-2556 showed highest relative heterosis as well as heterobeltiosis and ICMA-08111 X J-2556 hybrid showed standard heterosis.

The general expectation of the pearl millet farmer is mainly focused on level of superiority of newly released hybrids than the local standard hybrids, which is grown widely. So there is a compulsion need for the breeder to evaluate the newly developed hybrids with such standard hybrids for yield or any other desirable characters. With this point of views the hybrids generated in the present investigation were evaluated and selected on their standard heterosis values. The hybrid *viz.*,JMSA-20072 X J-2512, ICMA-96333 X

Table 2 Range of heterosis, number of crosses showing desirable heterotic performance and best heterotic combination for yield and its components in Pearl millet

Character	Range of heterosis			No. of significant hybrids on the basis of			Best heterotic combination over					
							MP		BP		SC	
	MP	BP	SC	MP	BP	SC	Cross	Value	Cross	Value	Cross	Value
Days to flowering	-13.90 to 13.93	-16.45 to 13.98	-0.73 to 95.21	21	26	0	JMSA-20072× J-2512	-13.90	JMSA-20072× J-2512	-16.45	JMSA-20042× J-2496	-0.73
							JMSA-20042× J-2496	-13.68	JMSA-20042× J-2496	-16.33	-	-
							JMSA-20072× J-2496	-12.41	JMSA-20042× J-2507	-14.29	-	-
Days to maturity	-15.14 to 6.16	-16.03 to 4.60	-7.53 to 13.94	16	25	1	ICMA-842× J-2496	-15.14	ICMA-842× J-2496	-16.03	ICMA-842× J-2496	-7.53
							ICMA-08111× J-2496	-8.86	ICMA-08111× J-2496	-8.86	-	-
							JMSA-9904× J-2372	-4.44	JMSA-9904× J-2372	-5.44	-	-
Plant height	-11.80 to 47.06	-21.51 to 44.23	-21.09 to 87.06	5	16	20	JMSA-9904× J-2454	-11.80	ICMA-96333× J-2538	-21.51	JMSA-9904× J-2454	-21.09
							ICMA-96333× J-2538	-11.26	ICMA-842× J-2538	-16.93	JMSA-20042× J-2496	-17.29
							JMSA-9904× J-2496	-8.31	JMSA-20042× J-2538	-14.14	JMSA-9904× J-2496	-14.85
No. of effective tillers/plant	-48.84 to 71.43	-60.71 to 100.00	-38.89 to 78.95	22	15	39	JMSA-9904× J-2479	71.43	JMSA-20072× J-2496	100.00	JMSA-20042× J-2510	78.95
							JMSA-9904× J-2372	56.25	JMSA-9904× J-2507	66.67	JMSA-9904× J-2479	44.44
							ICMA-08111× J-2454	52.94	ICMA-96333× J-2479	60.00	ICMA-842× J-2454	38.89
Ear head length	-13.08 to 50.15	-22.32 to 44.09	-19.91 to 88.68	44	28	14	ICMA-08111× J-2454	50.15	ICMA-08111× J-2454	44.09	JMSA-20042× J-2510	88.68
							JMSA-9904× J-2507	45.64	JMSA-9904× J-2512	41.03	JMSA-20072× J-2538	27.60
							JMSA-9904× J-2512	44.26	JMSA-9904× J-2507	39.66	JMSA-9904× J-2507	16.74
Ear head girth	-18.72 to 53.81	-18.74 to 51.30	-30.82 to -4.11	35	22	0	JMSA-20042× J-2454	53.81	JMSA-20042× J-2454	51.30	-	-
							JMSA-20042× J-2496	53.78	JMSA-20042× J-2496	49.82	-	-
							JMSA-20042× J-2507	51.43	JMSA-20042× J-2507	45.64	-	-
Test weight	-28.95 to 46.93	-34.18 to 43.26	-32.71 to 26.17	47	41	28	JMSA-20042× J-2507	46.93	JMSA-20042× J-2507	43.26	JMSA-20042× J-2507	26.17
							JMSA-20042× J-2454	38.20	JMSA-20042× J-2538	33.21	ICMA-08111× J2556	17.76
							JMSA-20042× J-2538	34.69	JMSA-20042× J-2454	26.90	ICMA-08111× J-2507	16.82
Grain yield/ plant	-32.88 to 105.75	-43.23 to 101.39	-62.50 to 14.77	39	34	4	JMSA-20072× J-2512	105.75	JMSA-20072× J-2512	101.39	JMSA-20072× J-2512	14.77
							JMSA-20072× J-2510	102.17	JMSA-20072× J-2510	94.11	ICMA-96333× J-2510	6.82
							JMSA-20072× J-2479	86.91	JMSA-20072× J-2479	81.56	JMSA-20072× J-2510	5.97
Harvest index	-37.71 to 136.81	-40.81 to 69.39	-41.49 to 37.37	38	19	6	ICMA-96333× J-2496	136.81	ICMA-96333× J-2496	69.36	JMSA-20072× J-2454	37.37
							ICMA-96333× J-2512	111.18	ICMA-96333× J-2512	42.29	JMSA-20042× J-2454	10.57
							ICMA-96333× J-2372	73.78	ICMA-08111× J-2507	32.19	ICMA-96333× J-2512	8.76
Protein content	-26.34 to 44.44	-30.11 to 32.33	-29.47 to 17.89	29	17	9	JMSA-20042× J-2479	44.44	JMSA-20042× J-2479	32.23	ICMA-96333× J-2454	17.89
							ICMA-96333× J-2454	36.91	JMSA-20042× J-2454	27.90	JMSA-9904× J-2512	12.63
							JMSA-20042× J-2454	29.58	ICMA-96333× J-2454	24.13	JMSA-20072× J-2454	11.58
Fe content	-72.26 to 348.8	-83.85 to 242.73	-69.00 to 105.06	23	11	9	ICMA-842× J2556	348.80	ICMA-842× J2556	242.73	ICMA-842× J2556	105.06
							ICMA-842× J-2510	186.43	ICMA-842× J-2510	159.09	ICMA-842× J-2512	67.54
							JMSA-9904× J-2510	138.54	JMSA-9904× J-2510	122.33	ICMA-842× J-2510	54.97
Zn content	-84.37 to 484.81	-90.45 to 425.00	-25.37 to 1049.25	18	8	52	ICMA-842× J-2556	484.81	ICMA-842× J-2556	425.00	ICMA-08111× J2556	1049.25
							ICMA-842× J-2454	212.33	ICMA-842× J-2454	159.09	ICMA-08111× J-2479	541.79
							JMSA-9904× J-2496	124.44	JMSA-9904× J-2538	69.35	ICMA-842× J-2454	467.16

J-2454, JMSA-20072 X J-2510 and JMSA-20042 X J-2556 showed high per se performance with high significant relative heterosis, heterobeltiosis and standard heterosis for grain yield per plant respectively. The hybrid ICMA-96333x J-2454 show significant relative heterosis, heterobeltiosis and economic heterosis for harvest index and protein content and also showed significant positive standard heterosis for Zn content and hybrid JMSA-20072 x J-2512 showed significant positive standard heterosis for Fe content. The significant economic heterosis in desirable direction was observed in most of the high heterotic hybrid of a grain yield per plant, number of effective tillers per plant and Zn content which indicating that the maximum contribution of this character towards yield heterosis.

REFERENCES

Arulselvi, S., Mohansundaram, K. and Maharvizul, P. 2006. Heterosis for grain yield components and grain quality characterism pearl millet. *International Sorghum and Millets Newsletter.* **47** (1): 36-38.

Azhaguvel, P., Jayaraman, N. and Nirmala, V. S. 1998. Studies on heterosis in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Annals of Agricultural Research*, **19** (4): 501-502.

Balakrishnan, A. and Das, L. D. V. 1996. Heterosis and combining ability in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Madras Agricultural Journal*, **83** (3) : 196-198.

Chavan, A. A. and Nerkar, Y. S. 1994. Heterosis and combining ability studies for grain yield and its components in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Journal of Maharashtra Agricultural University*, **19** (1): 58-61.

Deore, G. N., Pawar, B. B. and Salunke, C. B. 1997. Heterosis for physiological traits and grain yield in pearl millet [*Pennisetum americanum* (L.) Leeke]. *Annals of Plant Physiology*, **11** (1): 20-25.

Izge, A. U., Kadamas, A. M. and Gungula, D. T. 2007. Heterosis and inheritance of quantitative characters in a diallel cross of pearl millet. *Journal of Agronomy*, **6** (2): 278-285.

Karale, M. U., Ugale, S. D., Suryavanshi, Y. B. and Patil, B. D. 1997. Heterosis in line x tester crosses in pearl millet [*Pennisetum glaucum* (L.) R. BR.]. *Indian Journal of Agricultural Research*, **31** (1): 39-42.

Katti, M. V., Navale, P. A., Gandhi, S. D. and Vankatakrishnakishore. 1997. Heterosis for head volume in pearl millet [*Pennisetum glaucum* (L.) R. BR]. *Journal of Maharashtra Agricultural University*, **22** (3): 352-354.

Kempthorne, O. 1957. An introduction to Genetic Statistics. John Willey & Sons. Inc., New York. : 545.

Kulkarni, V. M., Aryana, K. J., Navale, P. A. and Harinarayana, G. 1993. Studies on heterosis in pearl millet [*Pennisetum typhoides* Burn (S. & H.)]. *Journal of Maharashtra Agricultural University*, **18** : 219-222.

Kushwah, V. S. and Singh, M. 1992. Heterosis in diallel crosses of pearl millet [*Pennisetum typhoides* Burn (S. & H.)]. I. Nature and magnitude, *Indian Journal of Genetics*, **52** (2): 107-110.

Manga, V. K. and Dubey, L. K. 2004. Identification of suitable inbreds based on combining ability in pearl millet [*Pennisetum glaucum* (L.) R. BR]. *Indian Journal of Agricultural Science.* **74** (2): 98–101.

Nijhawan, D. C. and Yadav, R. 1993. Heterosis and combining ability for some physiological traits and components of grain yield in pearl millet [*Pennisetum glaucum* (L.) R. BR]. *Crop Improvement*, **20** (2): 184-189.

Patil, P. A., Mehetre, S. S. and Mahajan, C. R. 1994. Heterosis in pearl millet [*Pennisetum americanum* (L.) Leeke]. *Annals of Agricultural Research*, **15** (1): 50-53.

Pethani, K. V. and Dave, H. R. 1992. Heterosis for grain yield in pearl millet [*Pennisetum typhoides* (B.) S. H.], *Indian Journal of Genetics*, **52** (1): 45-49.

Ramamoorthy, N. and Govindasaru R. (2000). Heterosis for grain yield and its components in pearl millet [*Pennisetum glaucum* (L.) R. Br.] *Madras Agricultural Journal*, **87** (1-3): 159-161.

Sharma, Sudhir 2005. Ph.D. Thesis, CCS Hariyana Agricultural University, Hissar

Sheoran, R. K., Govila, O. P. and Balzor Singh 2000. Genetic architecture of yield and yield contributing traits in pearl millet [*Pennisetum glaucum* (L.) R. BR]. *Annals of Agricultural Research*, **21** (3): 443-445.

Sukhchain and Phul, P.S. 1990. Gene effects for some quality traits in pearl millet. *Crop Improvement*, **17** (1): 70-72.

Vaghasiya, V. D. 2009. Heterosis studies studies in B x R crosses for selecton of superior females for A line development in pearl millet. *Agricultural Sciences and Digestion*, **29** (2): 84-88.

Velu, G., Rai, K.N., Murlidharan, V., Longvah, T. and Crossa, J. 2011. Gene effects and heterosis for grain iron and Zink density in pearl millet [*Pennisetum glaucum* (L.) R. BR]. *Euphytica*, **180** : 251-259.

Yadav, O. P. 1999. Heterosis and combining ability in relation to cytoplasmic diversity in Millet [*Pennisetum glaucum* (L.) R. BR]. *Indian Journal of Genetics*, **59** (4): 445-450.

Yadav, O. P. 2006. Heterosis in crosses between landraces and elite exotic populations of pearl millet [*Pennisetum glaucum* (L.) R. Br.] in arid zone environments, *Indian Journal of Genetics*, **66** (4): 308-311.