Int.J.Curr.Microbiol.App.Sci (2021) *10*(09): 268-275

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 09 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1009.031

Heterosis in Pearl Millet for Yield and Yield Attributing Characters

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Keywords

Rice, wheat, maize, Pearl millet, bajra, cat tail, spiked or bulrush millet, cumbu

Article Info

Accepted:
15 August 2021
Available Online:
10 September 2021

A B S T R A C T

The experimental material comprised of thirty two crosses along with twelve parents (four lines and eight testers) and standard checks AHB 1200 Fe and AHB 1269. The experiment was laid out in Randomized Block Design with two replications. The observations were recorded on ten characters *viz*., days to 50 per cent flowering, days to maturity, plant height, number of effective tillers, earhead length, earhead head girth, downey mildew, 1000 grain weight, grain yield and fodder yield. The analysis of variance revealed that there were significant differences among the parents and crosses for all the characters studied. Considering the heterosis ICMA 00888 X AUBI 15236, ICMA 00888 X AUBI 15157, ICMA 06777 X AUBI 15051 and ICMA 00888 X AUBI 15026 appeared to be the more promising hybrids for breeding.

Introduction

Pearl millet or bajra (*Pennisetum glaucum* (L.) R. Br.) is the world's sixth and India's fourth most important cereal food crop after rice, wheat and maize. It is commonly known as pearl millet, cat tail, spiked or bulrush millet, cumbu and locally known as bajra or bajari in different parts of the world. It belongs to the family Poaceae (Gramineae), subfamily *Panicoideae* having chromosome number 2n=14, genus *Pennisetum* and species *glaucum* and also others. Pearl millet or bajra is a highly cross-pollinated crop with protogynous (pistil mature before stamens) flowering and wind-borne pollination

mechanism, which fulfils one of the essential biological requirements for a hybrid development programme.

Pearl millet has a balanced genetic load and suffers from significant inbreeding depression (Harinarayana, 1980). As a result, the varieties sought for development in pearl millet should be heterozygous to be heterotic and homozygous to be synchronous and evenly productive. As a result, breeding efforts are focused on creating hybrids, synthetic, and composite populations. The quantum leap in pearl millet productivity (from 303 kg to 850 kg/ha) was made possible primarily through the production of hybrids using the cytoplasmic genetic male sterility system. Burton (1958) was the first to discover the Tift 23A cytoplasmic male sterile line, which was developed in Tifton, Georgia, USA. This prepared the path for hybrid seed development in Pearl millet. The first Pearl millet hybrid, HB-1, was released in India in 1965 (Athwal, 1965), and several promising hybrids have since been created and released for general cultivation, including HB-1, HB-2, HB-3, HB-4, and HB-5. The use of other sources of male sterility was then thought necessary, and study in this area resulted in the identification of multiple alternative sources such as A1, A2, A3, A4, A5, and so on. The present study was, therefore, conducted to estimate nature and magnitude of heterosis for yield and its components.

Materials and Methods

The parental materials consisting of 4 male sterile lines used as female, 8 inbreds or tester used as male and 2 checks were used and obtained from National Agricultural Research Project (NARP), Aurangabad. The crosses were done in line x tester fashion during *Kharif* 2020. The following important parents are used in the crossing programme and cross produced for the studies in pearl millet.

Parents

Female (A line)

ICMA 98222

ICMA 91444

ICMA 06777

ICMA 00888

Male (R line)

AUBI 15615

AUBI 15003

AUBI 15026

AUBI 15051

AUBI 15157

AUBI 15236

AUBI 15039

AUBI 15308

Checks

AHB 1200 Fe

AHB 1269

The crossing programme for obtaining crossed or hybrid seed was undertaken during *Kharif* 2020 at the field of National Agricultural Research Project (NARP), Aurangabad. 4 male sterile lines (female) and 8 inbreds (male) were crossed in line x tester fashion (4 x 8 =32). These crossed seed obtained were utilized as F1 or hybrid seed in the present research or investigation. The experiment was laid out in a Randomized Block Design (RBD)

with 2 replications. The total number of treatments was 46, comprising of 32 F1's, 4 females and 8 male parents with 2 checks. The parent and hybrids were planted in a plot of 1 row of 4.0 m length having a row to row spacing 45 cm and 15 cm plant to plant.

In order to ascertain or study the heterosis, parents were also included in the same set and analysis of the data was done. In the form of modified line x tester design as suggested by Arunachalam (1974). Mean data were used for statistical analysis. The degree of heterosis in F1 over mid parent (Jinks, 1983) and better parent (Turner, 1953) was calculated for individual character and expressed in per cent.

Results and Discussion

Heterosis is expressed as percentage increase or decrease in F1 or hybrid. Relative or average heterosis i.e. heterosis over mid parent (MP), heterobeltiosis or better parent superiority over better parent (BP) and standard heterosis i.e. superiority over standard hybrid check were calculated for ten different characters under study and are presented in the Table 2. Among the characters under study, highest magnitude heterosis over the mid parent (135.3%), over better parent (122.22%) noted in case of no. of effective tillers/plant.

For days to 50 per cent flowering, in the present study the most heterotic hybrids in negative direction was ICMA 06777 x AUBI 15157 over mid parent. However the hybrid ICMA 06777 x AUBI 15157 exhibited the highest negative heterosis over better parent. Similar results were reported by earlier workers Pachade (2006).

The hybrids showing higher magnitude of heterosis over mid parent in desirable direction for days to maturity were ICMA 06777 x AUBI 15026 and ICMA 06777 x AUBI 15615. However the hybrids ICMA 06777 x AUBI 15026 and ICMA 06777 x AUBI 15236 exhibited the highest negative heterosis over better parent. Similar results were observed by Chavan and Nerkar (1994).

The hybrid ICMA 00888 x AUBI 15026 recorded the higher magnitude of heterosis in desired direction over the standard hybrid check AHB 1200 Fe and the hybrid ICMA 00888 x AUBI 15026 the higher magnitude of heterosis in desired direction over the standard hybrid check AHB 1269 Fe. The above results were in agreement with those of Patil *et al.,* (1994) which reported significant positive heterobeltiosis for plant height.

Effective tillers per plant is one of the important yield attributes and positive heterosis is desirable.

The hybrid, ICMA 06777 x AUBI 15051 displayed higher positive heterosis over both mid parent and better parent. Similar type of reports were reported by Davda *et al.,* (2008) and Jethva *et al.,* (2012).

For earhead length, hybrid ICMA 00888 x AUBI 15051 showed higher heterosis over both mid and better parent hybrid.

While, hybrid ICMA 00888 x AUBI 15051 was most heterotic over standard hybrid checks AHB 1200 Fe and AHB 1269 Fe respectively. The present result reported were in agreement with those of Sheoran *et al.,* (2000)

The responce of the hybrids for earhead girth, highest significant heterosis was exhibited by the cross ICMA 06777 x AUBI 15003 for mid, better parents and standard checks.

In previous studies Sheoran *et al.,* (2000) and Jethva *et al.,* (2012) reported positive heterosis for earhead girth.

Table.1 Analysis of the variance for different characters in L x T mating design in pearl millet.

Source	D.F.	Days to 50% flowering	Days to maturity	Plant height	No. of effective tillers/ Plant	Ear head length	Ear head girth	Downey Mildew	1000 grain weight	Grain yield /Plant	Fodder yield /plant
Replications	1	0.73	1.92	1.28	0.0028	4.28	0.14564	00	0.29	0.34	**3.08**
Treatments	43	8.88**	26.74**	370.55**	0.45**	27.75**	0.37**	00	14.22**	123.48**	**166.21****
Error	**43**	**1.44**	**2.33**	**91.90**	**0.23**	**14.52**	**0.20**	**00**	**7.77**	**64.24**	**89.05**

*, ** denote significant at 5% and 1 % levels, respectively.

Fig.1 Ear head with matured pollen grains.

Table.2 Five top ranking cross combinations resulting in Heterosis.

1. Days to 50 % flowering.

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 00888 X AUBI 15308	10.20 **	9.09 **	6.93 **	**13.68 ** **
2	ICMA 98222 X AUBI 15051	8.63 **	7.00 **	5.94 *	**12.63 ** **
3	ICMA 06777 X AUBI 15615	7.94 **	7.37 **	0.99	**7.37 ** **
4	ICMA 91444 X AUBI 15157	3.96	2.94	3.96	**10.53 ** **
5	**ICMA 98222 X AUBI 15615**	**3.66**	**2.06**	**-1.98**	**4.21**

2. Days to maturity

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB- 1200 Fe	AHB 1269
1	ICMA 91444 X AUBI 15236	10.18 **	10.18 **	6.98 **	**4.55 ***
2	ICMA 00888 X AUBI 15236	9.20 **	8.24 **	6.98 **	**4.55 ***
3	ICMA 98222 X AUBI 15003	8.67 **	5.62 **	9.30 **	**6.82 ** **
4	ICMA 98222 X AUBI 15051	8.31 **	4.42 *	9.88 **	**7.39 ** **
5	**ICMA 98222 X AUBI 15308**	**8.06 ** **	**7.74 ** **	**5.23 ** **	**2.84**

3. Plant height

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 91444 X AUBI 15039	16.13 **	14.40 *	13.09 *	**21.21 ** **
2	ICMA 06777 X AUBI 15003	14.29 **	11.14 *	12.39 *	**20.46 ** **
3	ICMA 98222 X AUBI 15003	13.44 **	8.33	13.76 *	**21.93 ** **
4	ICMA 00888 X AUBI 15236	10.64 *	0.27	13.76 *	**21.93 ** **
5	**ICMA 91444 X AUBI 15615**	**9**	**7.97**	**5.55**	**13.13 ***

4. No. of Effective tillers per plant

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 06777 X AUBI 15051	135.3 **	122.22 **	81.82 **	**42.86 ** **
2	ICMA 91444 X AUBI 15051	92.00 **	84.62 **	45.45 **	**14.29 ***
3	ICMA 91444 X AUBI 15236	84.62 **	84.62 **	45.45 **	**14.29 ***
4	ICMA 06777 X AUBI 15236	81.13 **	77.78 **	45.45 **	**14.29 ***
5	**ICMA 00888 X AUBI 15236**	**79.66 ** **	**60.61 ** **	**60.61 ** **	**26.19***

5. Ear head length

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 00888 X AUBI 15051	80.82 **	67.15 **	18.92 **	**52.20 ** **
2	ICMA 91444 X AUBI 15236	55.63 **	37.94 **	17.42 **	**50.28 ** **
3	ICMA 00888 X AUBI 15615	48.48 **	34.82 **	-0.22	**27.71 ** **
4	ICMA 00888 X AUBI 15026	43.34 **	27.65 **	-1.29	**26.33 ** **
5	**ICMA 00888 X AUBI 15003**	**43.12 ** **	**28.17 ** **	**-2.15**	**25.23 ** **

6. Ear head girth

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 06777 X AUBI 15003	34.20 **	29.15 **	51.31 **	**25.30 ** **
2	ICMA 06777 X AUBI 15026	20.30 **	19.94 **	30.72 **	**8.25**
3	ICMA 00888 X AUBI 15026	15.23 **	10.11	31.70 **	**9.07**
4	ICMA 06777 X AUBI 15157	14.48 **	-21.85 **	2.29	**-15.29 ** **
5	**ICMA 98222 X AUBI 15236**	**13.73 ***	**5.9**	**14.38 ***	**5.28**

7. 1000 Seed grain weight

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 00888 X AUBI 15039	52.17 **	33.00 **	29.24 **	**21.89 ** **
2	ICMA 91444 X AUBI 15308	48.37 **	35.39 **	45.95 **	**37.64 ** **
3	ICMA 06777 X AUBI 15308	47.94 **	37.27 **	42.66 **	**34.55 ** **
4	ICMA 00888 X AUBI 15026	47.70 **	44.00 **	47.30 **	**38.92 ** **
5	**ICMA 06777 X AUBI 15039**	**44.81 ** **	**23.05 ** **	**27.88 ** **	**20.60 ** **

8. Grain yield per plant

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 06777 X AUBI 15039	70.09 **	44.09 **	70.76 **	**52.35 ** **
2	ICMA 00888 X AUBI 15039	64.62 **	44.62 **	57.19 **	**40.24 ** **
3	ICMA 98222 X AUBI 15003	52.10 **	48.56 **	74.57 **	**55.75 ** **
4	ICMA 06777 X AUBI 15026	51.85 **	49.43 **	77.10 **	**58.01 ** **
5	**ICMA 98222 X AUBI 15026**	**48.55 ** **	**46.79 ** **	**68.44 ** **	**50.28 ** **

9. Fodder yield per plant

Sr. No.	Hybrids	M.P. (%)	B.P. (%)	AHB-1200 Fe	AHB 1269
1	ICMA 00888 X AUBI 15236	86.54 **	66.78 **	72.30 **	**71.01 ** **
2	ICMA 98222 X AUBI 15308	40.45 **	36.42 **	47.77 **	**46.67 ** **
3	ICMA 98222 X AUBI 15236	37.93 **	20.80 *	30.85 **	**29.88 ** **
4	ICMA 00888 X AUBI 15308	37.26 **	36.46 **	40.97 **	**39.92 ** **
5	**ICMA 06777 X AUBI 15236**	**37.26 ** **	**14.92 * **	**38.72 ** **	**37.69* **

Fig.2 Hybridization techniques in Pearl millet

The highest relative heterosis and heterobeltiosis was exhibited by the cross ICMA 00888 x AUBI 15039, for 1000 grain weight. Standard heterosis over both the checks AHB 1200 Fe and AHB 1269 Fe was exhibited by same ICMA 00888 x AUBI 15026. Previously Sheoran *et al.,* (2000), Vagadiya *et al.,* (2010), Jethva *et al.,* (2012) observed heterosis for 1000 grain weight.

The highest heterosis for grain yield per plant was displayed by ICMA 06777 x AUBI 15039, over the mid parent and ICMA 06777 x AUBI 15026 over the better parent. Whereas, hybrid ICMA 06777 x AUBI 15026 showed highly significant heterosis over the standard check AHB 1200 Fe and AHB 1269 Fe. Vagadiya *et al.,* (2010) and Jethva *et al.,* (2012) reported similar findings earlier in their studies.

Relative heterosis for fodder yield per plant was observed in case of ICMA 00888 x AUBI 15236. The highly heterotic hybrids over better parents were ICMA 00888 x AUBI 15236. Whereas, some hybrids showed significantly positive standard heterosis for this trait. The results on similar line were also observed by Vagadiya *et al.,* (2010).

Acknowledgement

Author thank to Dr. A. B. Bagade, Assistant Professor (Breeding), National Agricultural

Research Project, Paithan Road, Aurangabad for his inspiring guidance, keen interest, his activeness and sharpness. I take this opportunity to express my deep and sincere feeling of gratitude to him for suggesting research topic, valuable guidance, constant inspiration, constructive criticism, talented versatile advice and untiring efforts in preparation of the manuscript of this dissertation.

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How to cite this article:

Madane, A. A., A. B. Bagade, A. L. Suradkar and Pawar, S. B. 2021. Heterosis in Pearl Millet for Yield and Yield Attributing Characters. *Int.J.Curr.Microbiol.App.Sci.* 10(09): 268-275.
doi: https://doi.org/10.20546/ijcmas.2021.1009.031