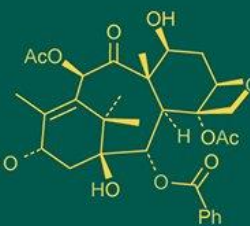
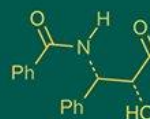
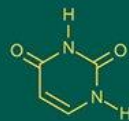
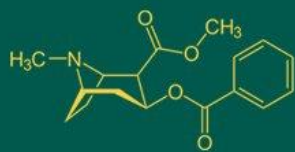


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(6): 1351-1356
www.biochemjournal.com
Received: 01-05-2026
Accepted: 02-06-2026

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Heterosis studies in CGMS based hybrids of pearl millet [*Pennisetum glaucum* (L.) R.]

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i6Sp.8831>

Abstract

The experimental material comprised of nine female lines, five male lines of pearl millet, their 45 hybrids developed by line $\times$ tester design and one standard check hybrid (GHB 1129). They were evaluated in randomized block design with three replications at Main Pearl Millet Research Station, J.A.U., Jamnagar during *kharif* 2024 for studies heterotic effects of hybrids over better parent and standard check. The analysis of experimental variance revealed highly significant differences among the genotypes for all the traits under studied. The heterobeltiosis for grain yield per plant was laid between -34.69% (ICMA₄ 18222 $\times$ J-2571) to 141.48% (ICMA₁ 17555 $\times$ J-2576). While the standard heterosis ranged from -41.36% (ICMA₄ 18222 $\times$ J-2571) and 58.64% (JMSA₄ 20215 $\times$ J-2604). Further exploitation of these crosses could lead to the development of desirable hybrids of pearl millet.

Keywords: Pearl millet, Line $\times$ tester analysis, Heterosis

Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a key member of the Poaceae (Gramineae) family and the *Pennisetum* genus. Commonly known as bajra, bajri, cattail millet, spiked millet, and bulrush millet, this crop is highly cross-pollinated and features protogynous flowering with wind-borne pollination. These traits facilitate hybrid development and the commercial benefits of heterosis. In India, pearl millet is a major staple food, ranking fourth in acreage after rice, wheat, and sorghum, and it is the sixth most important cereal globally (Acharya *et al.* 2017) ^[1]. Believed to have originated in tropical Western Africa around 4000 years ago, pearl millet is diploid, with a chromosome number of $2n=2x=14$. Exploitation of hybrid vigor is considered to be one of the outstanding achievements in this crop. Cross pollinated nature and availability of male sterile lines in crop had made of its feasible to exploit hybrid vigor on commercial scale. Therefore, to identify better heterotic response for grain yield and its components characters are of paramount importance (Patel *et al.* (2016) ^[20].

Materials and Methods

The experimental material comprised of nine CGMS (Female) lines viz., JMSA₁ 20208, JMSA₅ 20211, JMSA₄ 20215, JMSA₄ 20221, JMSA₄ 20223, ICMA₁ 17555, ICMA₄ 18222, ICMA₁ 93333, ICMA₁ 97111; five restorer (male) lines of pearl millet viz., J-2296, J-2480, J-2571, J-2576, J-2604 and their 45 F₁s hybrids developed by line $\times$ tester design and one standard check hybrid (GHB 1129) (Table 1). They were evaluated in randomized block design (RBD) with three replications at Main Pearl Millet Research Station, J.A.U., Jamnagar during *kharif* 2024. Row to row and plant to plant spacing was 60 cm $\times$ 15 cm. To produce a better crop, the region's recommended agronomic practices were followed. The observations were recorded on five randomly selected plants expect the plot basis from parents and crosses for 12 characters viz., days to 50% flowering, days to maturity, plant height, number of effective tillers per plant, earhead length, earhead diameter, dry earhead weight per plant, 1000-grain weight, dry fodder yield per plant, grain yield per plant, threshing index and harvest index. Mean data were used for statistical analysis. The variance analysis for each character was performed using the method described by Panse and Sukhatme (1995). Heterosis was estimated in term of two parameters, i.e. heterobeltiosis (heterosis over better parental value) as suggested by Fonseca and Patterson (1968) and standard heterosis (heterosis over standard check) as suggested by Meredith and Bridge (1972) ^[18, 10, 15].

Results and Discussion

The analysis of variance showed highly significant differences among the genotypes for all the traits under studied. Thus, the results quantified the considerable amount of genetic diversity exist among genotypes for the different traits under study. The genotypic variance was further partitioned into different source of variances. It is cleared that the variance due to parents and crosses was significant for all the 12 characters under studied except day to maturity due to crosses. However, mean squares due to parents vs crosses were found significant for all the characters under studied except number of effective tillers per plant and earhead diameter, indicating the significant difference between the parents and crosses for these important traits. Further, partitioning of mean squares due to parents into lines, testers and lines vs testers revealed that the mean squares due to lines were significant for all the characters. Mean squares due to testers were found significant for all the characters under studied except for threshing index. The mean squares due to lines vs testers were significant for all characters except for plant height, dry earhead weight per plant, 1000-grain weight and dry fodder yield per plant, indicating the significant difference between male and female parents for these traits. Magnitude of variability was higher with lines for earhead length, earhead diameter, 1000-grain weight, threshing index and harvest index in comparison to testers. This indicated that the more contribution of lines in total variance for these characters, while the magnitude of variability was higher with testers for the rest of the traits under studied to the total variance (Table 2). Similar result observed by Moghariya *et al.* (2024)^[16] for days to 50% flowering, days to maturity, number of effective tillers per plant, earhead length, dry earhead weight per plant, 1000-grain weight, grain yield per plant, threshing index and harvest index.

A number of crosses depicted significant heterosis over better parent and standard check in favourable direction for grain yield per plant (36, 5), days to 50 per cent flowering (41, 0), days to maturity (35, 0), plant height (42, 15), number of effective tillers per plant (11, 3), earhead length (23, 38), earhead diameter (11, 8), dry earhead weight per plant (35, 19), 1000-grain weight (21, 15), dry fodder yield per plant (35, 20), threshing index (14, 1) and harvest index (10, 3), respectively (Table 3).

Performance of crosses in respect of heterosis over better parent and standard check (GHB 1129) revealed that the high magnitudes of heterobeltiosis in desirable direction was found for grain yield per plant, plant height, number of effective tillers per plant, earhead length, earhead diameter, dry earhead weight per plant, 1000-grain weight, dry fodder yield per plant, threshing index and harvest index. The moderate magnitude of heterosis over better parent was recorded for days to 50% flowering and days to maturity. Similar observations were also made by pethani *et al.* (2004), Patil *et al.* (2008), Jethva *et al.* (2012), Davda *et al.* (2012), Bachkar *et al.* (2014) and Patel *et al.* (2019)^[24, 22, 4, 21].

Earliness is desirable character in pearl millet and days to 50% flowering is component which effects on earliness. The range of heterobeltiosis for days to 50% flowering was -22.40% (ICMA1 17555 × J-2571) to 0.00% (JMSA4 20215 × J-2571). The standard heterosis ranged from -4.23% (JMSA1 20208 × J-2480) to 12.68% (ICMA1 17555 × J-2604) (Table 3). Similar results for heterobeltiosis and standard heterosis in negative desirable directions were

observed by Reshma Krishnan *et al.* (2019), Pareek *et al.* (2020) and Choudhary *et al.* (2023)^[25, 19].

The range of heterobeltiosis for days to maturity was -16.16% (ICMA4 18222 × J-2296) to 0.98% (JMSA4 20215 × J-2571). The range of standard heterosis for days to maturity was between -2.52% (JMSA1 20208 × J-2480) to 7.48% (ICMA1 17555 × J-2604). Similar findings were reported by, Davda *et al.* (2012), Bachkar *et al.* (2014), Singh *et al.* (2015) and Pawar *et al.* (2015)^[9, 4, 28, 23].

Plant height is regarded as a favourable character due to the important role of the stem in supplementing assimilates during grain development. The range of heterobeltiosis, for plant height was -0.55% (ICMA1 97111 × J-2604) to 68.11% (ICMA1 17555 × J-2480). The range of standard heterosis for plant height varied from -7.11% (JMSA1 20208 × J-2480) to 26.46% (JMSA4 20221 × J-2604). These results are agreed with the results obtained by Suryawanshi *et al.* (2021), Patel *et al.* (2019), Athoni *et al.* (2022) and Sharma *et al.* (2023)^[21, 3, 27, 30].

The minimum and maximum values of heterobeltiosis for number of effective tillers per plant were -55.89% (JMSA4 20223 × J-2571 and JMSA4 20223 × J-2576) and 66.67% (ICMA1 97111 × J-2576), respectively. The range of standard heterosis for number of effective tillers per plant lied between -44.46% (JMSA1 20208 × J-2576, JMSA4 20223 × J-2571 and JMSA4 20223 × J-2576) to 14.81% (JMSA5 20211 × J-2296). Similar heterobeltiosis and standard heterosis estimates for number of productive tillers in positive directions were obtained by some previous researchers, viz., 29Sumathi and Revathi (2017), 5Badhe *et al.* (2018) and Choudhary *et al.* (2023)

Heterobeltiosis values for earhead length were between -21.51% (ICMA1 17555 × J-2480) to 32.69% (JMSA4 20215 × J-2571). The quantum of variation for standard heterosis ranged 4.26% (JMSA1 20208 × J-2576) to 66.33% (JMSA4 20215 × J-2571). Significant results were obtained by some previous workers viz. Bachkar *et al.* (2014), Bhasker *et al.* (2017) and Sumathi and Revathi (2017)^[4, 2, 29].

The heterosis over better parent for earhead diameter laid between -32.00% (JMSA4 20223 × J-2296) to 37.31% (JMSA4 20223 × J-2480). The estimates of standard heterosis ranged between -18.18% (JMSA5 20211 × J-2576) and 44.16% (JMSA4 20215 × J-2571) for earhead diameter. The results were the same as reported by Salagarkar and Wali (2016), Pallavi *et al.* (2020), Chittora and Patel (2017) and Choudhary *et al.* (2023)^[26, 17, 8].

The estimated heterosis over better parent varied from -15.46% (JMSA4 20221 × J-2296) to 133.70% (JMSA4 20223 × J-2480) for dry earhead weight per plant. Magnitude of standard heterosis varied from -25.40% (ICMA4 18222 × J-2576) to 47.37% (JMSA4 20215 × J-2604). The significant results were reported by Aswini *et al.* (2021), Choudhary *et al.* (2023) and Kapildev *et al.* (2023)^[2, 13].

Considering heterosis over better parent, the variation for 1000-grain weight was from -28.99% (JMSA5 20211 × J-2576) to 57.55% (JMSA5 20211 × J-2296). Estimations of standard heterosis for 1000-grain weight ranged from -17.49% (JMSA5 20211 × J-2576) to 48.66% (ICMA1 17555 × J-2576). Positive estimation of heterosis in this trait was also reported by Sharma *et al.* (2023), Choudhary *et al.* (2023) and Moghariya *et al.* (2024)^[27, 16].

For dry fodder yield per plant, the estimates of heterobeltiosis ranged from -13.35% (JMSA4 20215 × J-2296) to 127.21% (JMSA1 20208 × J-2576). The range of heterosis over

standard check for dry fodder yield per plant expressed from -19.86% (JMSA1 20208 × J-2296) to 80.82% (JMSA4 20221 × J-2604). Significant positive results for heterobeltiosis and standard heterosis were reported by Athoni *et al.* (2022), Choudhary *et al.* (2023), Moghariya *et al.* (2024) and Bhatiya *et al.* (2025)^[3, 16, 7].

Range of heterosis over better parent for grain yield per plant was -34.69% (ICMA4 18222 × J-2571) to 141.48% (ICMA1 17555 × J-2576). The minimum and the maximum values of heterosis over standard check were -41.36% (ICMA4 18222 × J-2571) and 58.64% (JMSA4 20215 × J-2604). The highest positive and significant standard heterosis showed by the cross JMSA4 20215 × J-2604 (58.64%) followed by JMSA4 20215 × J-2576 (29.83%) and JMSA4 20215 × J-2571 (26.10%) for this trait. These results are in conformation to the findings of, Athoni *et al.* (2022), Choudhary *et al.* (2023), Kapildev *et al.* (2023), Sharma *et al.* (2023), Moghariya *et al.* (2024) and Bhatiya *et al.* (2025)^[3, 13, 27, 16, 7].

The values of heterobeltiosis for threshing index ranged from -55.14% (ICMA4 18222 × J-2571) to 56.65% (ICMA1 97111 × J-2576). The range of standard heterosis for threshing index varied between -50.23% (ICMA4 18222 × J-2571) to 17.78% (JMSA1 20208 × J-2480). The significant results in a positive direction for threshing index were reported by Athoni *et al.* (2022) and Choudhary *et al.* (2023) and Sharma *et al.* (2023)^[3, 27].

The range of heterobeltiosis for harvest index laid between -58.08% (ICMA4 18222 × J-2571) to 58.07% (JMSA1 20208 × J-2480). The range of heterosis over standard check for harvest index varied between -48.58% (ICMA4 18222 × J-2571) to 16.31% (ICMA1 17555 × J-2296). The significant results in a positive direction for harvest index were reported by Pareek *et al.* (2020), Galani *et al.* (2022), Moghariya *et al.* (2024) and Bhatiya *et al.* (2025)^[19, 11, 16, 7].

The superior cross JMSA4 20215 × J-2604 was also exhibited significant standard heterosis in desired direction for the characters, viz., plant height, earhead length, dry earhead weight per plant and dry fodder yield per plant suggesting the greater role of these traits towards the grain yield. This cross had also registered significant heterobeltiosis in desirable direction for days to 50 per cent flowering, plant height, number of effective tillers per plant, earhead length, dry earhead weight per plant, 1000-grain weight, dry fodder yield per plant, threshing index and harvest index (Table 4).

The second highest heterotic cross JMSA4 20215 × J-2576 was recorded significant and positive heterosis over standard check for plant height, earhead length, dry earhead weight per

plant, 1000-grain weight and dry fodder yield per plant. This cross had also exhibited significant heterobeltiosis in desired direction for plant height, number of effective tillers per plant, earhead length, dry earhead weight per plant, 1000-grain weight, dry fodder yield per plant, threshing index and harvest index (Table 4).

The second highest heterotic cross JMSA4 20215 × J-2576 was recorded significant and positive heterosis over standard check for plant height, earhead length, dry earhead weight per plant, 1000-grain weight and dry fodder yield per plant. This cross had also exhibited significant heterobeltiosis in desired direction for plant height, number of effective tillers per plant, earhead length, dry earhead weight per plant, 1000-grain weight, dry fodder yield per plant, threshing index and harvest index (Table 4).

On the other hand, the fourth highest heterotic cross ICMA4 18222 × J-2296 had significant standard heterosis in desirable for earhead length, earhead diameter, dry earhead weight per plant and harvest index. The fourth highest heterotic cross, ICMA4 18222 × J-2296 was also recorded significant heterosis over better parent in desirable direction for days to 50 per cent flowering, days to maturity, plant height, earhead length, dry earhead weight per plant and dry fodder yield per plant (Table 4).

Similarly, the fifth highest heterotic cross ICMA1 17555 × J-2604 was manifested significant standard heterosis in desirable direction to plant height, earhead length, dry earhead weight per plant and dry fodder yield per plant. The same cross ICMA1 17555 × J-2604 had also noticed significant and positive heterobeltiosis for days to 50% flowering, days to maturity, plant height, dry earhead weight per plant, dry fodder yield per plant, threshing index and harvest index (Table 4).

It is interesting to note that the high heterotic crosses for grain yield did not show high heterosis for all the yield component traits (Table 4). But it was fact from present investigation that the significant and positive heterosis for grain yield was associated with significantly desirable heterosis for two or more yield attributing traits. Similar cumulative heterotic effect of two or more yield components on grain yield of pearl millet was also reported earlier by Jethva *et al.* (2012), Bachkar *et al.* (2014), Patel *et al.* (2016), Acharya *et al.* (2017), Ladumor *et al.* (2018), Chovatiya *et al.* (2019), Reshma Krishnan *et al.* (2019), Patel *et al.* (2019), Athoni *et al.* (2022), Choudhary *et al.* (2023) and Moghariya *et al.* (2024)^[12, 4, 20, 1, 14, 25, 21, 3, 16].

Table 1: List of parents used in line × tester mating design

Sr. No.	Genotypes	Pedigree	Source
Line (Female) parents			
1	JMSB 20208	(([78-7088/3/SER3 AD/B282(3/4)EB × PBLN/S95-359]-7-4-B-B-2-B-B × HHVDBC HS-10-1-2-1-1-1-4-1-1)-12-3-4 × Early thick compact B-lines bulk (1827-1831/S11))-5((HHVDBC HS-246-1-2-1-2 × ICMB 99555)-2-2-2-1 × {(MC 94 S1-34-1-B × HHVBC)-16-2-1-1-1-1-B-B-5 × (MC 94 S1-34-1-B × HHVBC)-10-4-1-2-1-B-B-1-30-2-4-2-6-2-4)-3-4-5-B-2	PMRS, JAU, Jamnagar
	JMSA ₁ 20208	ICMA ₁ 95333 BC to JMSB 20208	
2	JMSB 20211	(7005 × 7001-7011)-2-6-1	PMRS, JAU, Jamnagar
	JMSA ₅ 20211	ICMA ₅ 12111 BC to JMSB 20211	
3	JMSB 20215	[(ICMB 96555 × IP 10437)-3-4-1-2-3 × (ICMB 96555 × LaGrap C2 S1-32-1)-10 × IP 14758-2-1]-1-2-1-5-2-2 × Early D2 / Med group × long panicle (Bxzong) lines (1330-41)-2-1-4	PMRS, JAU, Jamnagar
	JMSA ₄ 20215	JMSA ₄ 20143 BC to JMSB 20215	
4	JMSB 20221	(SRC II C3 S1-19-3-2 × HHVBC)-3-5-1-1-2-B	PMRS, JAU, Jamnagar
	JMSA ₄ 20221	A ₄ source BC to JMSB 20221	

5	JMSB 20223	{(MC 94 S1-81-1-B × HHVBC)-4-4-1 × (MC 94 S1-81-1-B × HHVBC)-4-2-4-10-3-1-B-B-B × ICMB 02777}-3-3-B-2	PMRS, JAU, Jamnagar
	JMSA ₄ 20223	A ₄ source BC to JMSB 20223	
6	ICMB 17555	{(EEDBC S1-425-2-1-2-3-B-2-2-1 × NC D2 BC7F4-22-2-4-1-3-3-1-B) × (HHVDBC Dwarf HS-155-1-1-1-2-2-3 × HHVDBC Medium HS-15-1-1-1-2-2-4)}-3-1-4-1-1	ICRISAT, Patancheru
	ICMA ₁ 17555	A ₁ source BC to ICMB 17555	
7	ICMB 18222	[{{843B × (843B × 700651)-11-1-2-B} × 1163B} × (ICMB 89111 x ICMB 88005)]-5-2-2	ICRISAT, Patancheru
	ICMA ₄ 18222	A ₄ source BC to ICMB 18222	
8	ICMB 93333	(843B × ICMP5 900-9-3-8-2)-21-8-4	ICRISAT, Patancheru
	ICMA ₁ 93333	88006A Cyto Source (A ₁) BC to ICMB 93333	
9	ICMB 97111	HTBC-48-B-1-1-1-1	ICRISAT, Patancheru
	ICMA ₁ 97111	863A Cyto Source (A ₁) BC to ICMB 97111	
Tester (Male) parents			
1	J-2296	Source GP 532	PMRS, JAU, Jamnagar
2	J-2480	AS-14 (B-Senegal-2-5 × 700651)-2-1-4 (IPC-655)	
3	J-2571	(MC 94 C2-S1-3-2-2-2-1-3-B-B × ICMR 312 S1-3-2-3-2-1-1-B-B)-B-34-4-1	
4	J-2576	(EERC-HS-5)-B-5-3-3-1-B-B	
5	J-2604	Hope PT-1-154 kh 14= ICMB 93333	
Standard check hybrid			
1	GHB 1129	ICMA ₁ 99222 × J-2565	PMRS, JAU, Jamnagar

Table 2: Analysis of variance for experimental design of different characters in pearl millet

Source	d. f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of effective tillers/plant	Earhead length	Days to maturity
Replications	2	4.92	6.11	96.90	0.04	1.05	0.08
Genotypes	58	40.80**	42.70**	1573.89**	0.42**	20.60**	0.39**
Parents:	13	79.00**	88.97**	650.92**	0.74**	21.85**	0.71**
Lines	8	60.12**	67.40**	472.25**	0.55**	25.41**	0.73**
Testers	4	70.57**	82.23**	1169.14**	1.10**	15.86**	0.67**
L. vs T.	1	263.72**	288.59**	7.35	0.74**	17.30**	0.76**
P. vs H.	1	858.46**	840.95**	59480.05**	0.01	261.58**	0.14
Hybrids	44	10.93**	10.89	530.54**	0.33**	14.75**	0.30**
Error	116	1.93	7.44	69.81	0.02	1.49	0.07

Table 2 Cont...

	d. f.	Dry earhead weight/plant (g)	1000-grain weight (g)	Dry fodder yield/plant (g)	Grain yield/plant (g)	Threshing index (%)	Harvest index (%)
Replications	2	9.05	0.06	1.76	1.79	12.84	5.71
Genotypes	58	135.81**	8.71**	111.26**	83.11**	340.40**	141.02**
Parents:	13	63.82**	10.53**	67.54**	33.84**	346.13**	182.98**
Lines	8	62.85**	12.34**	64.23**	30.87**	476.35**	237.05**
Testers	4	81.29**	9.39**	87.91**	41.11**	70.10	57.76**
L. vs T.	1	1.70	0.57	12.55	28.56**	408.48**	251.24**
P. vs H.	1	4021.45**	93.62**	2485.89**	2539.55**	3775.45**	928.71**
Hybrids	44	68.77**	6.24**	70.21**	41.84**	260.64**	110.72**
Error	116	7.14	0.38	3.83	2.81	34.09	9.73

*, ** Significant at 5% and 1% levels, respectively

Table 3: Range of heterobeltiosis (H1) and standard heterosis (H2) as well as number of crosses with specific heterotic effects for various traits in pearl millet

Sr. No.	Characters	Range of heterosis (%)						Number of crosses with significant heterosis			
		Heterobeltiosis (H1)			Standard heterosis(H2)			H1		H2	
		to (%)			to (%)			+Ve	-Ve	+Ve	-Ve
1	Days to 50% Flowering	-22.40	to	0.00	-4.23	to	12.68	0	10	0	3
2	Days to maturity	-16.16	to	0.98	-2.52	to	7.48	0	10	0	2
3	Plant height (cm)	-0.55	to	68.11	-7.11	to	26.46	42	9	4	9
4	Number of effective tillers/plant	-55.89	to	66.67	-44.46	to	14.81	11	16	2	15
5	Earhead length (cm)	-21.51	to	32.59	4.26	to	66.33	23	11	3	6
6	Earhead diameter (cm)	-32.00	to	37.31	-18.18	to	44.16	11	4	3	13
7	Dry earhead weight/plant (g)	-15.46	to	133.70	-25.40	to	47.37	35	9	0	14
8	1000-grain weight (g)	-28.99	to	57.55	-17.49	to	48.66	21	23	3	18
9	Dry fodder yield/plant (g)	-13.35	to	127.21	-19.86	to	80.82	35	2	2	7
10	Grain yield/plant (g)	-34.69	to	141.48	-41.36	to	58.64	36	4	0	3
11	Threshing index (%)	-55.14	to	56.65	-50.23	to	17.78	14	8	3	12
12	Harvest index (%)	-58.08	to	58.07	-48.58	to	16.31	10	13	8	2

Table 4: Comparative study of five most heterotic crosses for grain yield per plant and their heterotic effect for component characters in pearl millet

Heterotic crosses	Grain yield/plant (g)	Per cent heterosis for grain yield/plant over		sca effect for grain yield/plant	Significant and desirable heterosis for component traits over	
		Better parent	Standard check (GHB 1129)		Better parent	Standard check (GHB 1129)
JMSA ₄ 20215 × J-2604	31.20	114.68**	58.64**	4.84**	1,3,4,5,7,8,9,10,11	3,5,7,9
JMSA ₄ 20215 × J-2576	25.53	75.69**	29.83**	1.28	3,4,5,7,8,10,11	3,5,7,8,9
JMSA ₄ 20215 × J-2571	24.80	40.43**	26.10**	0.29	3,4,5,6,7,8,9	3,5,6,7,8,9
ICMA ₄ 18222 × J-2296	24.27	52.30**	23.39**	6.16**	1,2,3,5,7,9	5,6,7,11
ICMA ₁ 17555 × J-2604	22.87	93.79**	16.27**	1.07	1,2,3,7,9,10,11	3,5,7,9

Where, *, ** Significant at 5% and 1% levels, respectively
 1= Days to 50% flowering; 2= Days to maturity; 3= Plant height (cm); 4= Number of effective tillers / plants; 5= Earhead length (cm); 6= Earhead diameter (cm); 7= Dry earhead weight/plant (g); 8= 1000-grain weight (g); 9= Dry fodder yield/plant (g); 10= Threshing index (%) and 11= Harvest index (%)

Conclusion

From ongoing discussion, it could be concluded that the best two promising crosses viz., JMSA₄ 20215 × J-2604 and ICMA₄ 18222 × J-2296 exhibited high per se performance, significant and positive heterobeltiosis as well as standard heterosis in desired direction for grain yield per plant and some components traits. Therefore, these two best crosses could be further evaluated over years and locations to exploit for commercial cultivation through heterosis breeding or utilized in future breeding programme to obtain desirable transgressive segregants and to identify high yielding superior inbreds.

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