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Assessment of Potential Standard Heterosis for Yield Components using by Line X Tester in Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] Hybrids

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ABSTRACT: Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important cereal in Asia and Africa, grown on about 26 million hectares, including 9.3 million hectares in India where Rajasthan leads in area and production. Despite its adaptation to harsh environments, productivity in hyper-arid regions remains low due to drought, poor soil fertility, and the emerging threat of blast disease (*Magnaporthe grisea*). Hybrid breeding using cytoplasmic male sterile (CMS) lines provides opportunities to enhance yields, but systematic evaluation of combining ability, heterosis, and stability is essential for sustainable improvement. The present study, conducted during Kharif 2022 at ARS, Bikaner, involved eight CMS lines and nine restorers crossed in a line × tester design to develop 72 F_1 hybrids. These, along with three checks (BHB-1202, BHB-1602, and HHB-299), were evaluated under three staggered sowing environments (early, timely, and late), each exposing the crop to moisture stress at critical growth stages. Trials were laid out in RBD with three replications, and heterosis was estimated against the best check, BHB-1602. Results revealed wide variability in standard heterosis (–75% to +77%) with strong environmental influence. While several hybrids performed well in individual environments, only a few maintained superiority across sowing dates. The highest heterosis for grain yield per plant was 22.38% (ICMA 04999 × BIB 51), with desirable negative heterosis for earliness (–8.64% for days to 50% flowering, –10.54% for maturity). Significant heterotic effects were also observed for plant height (22.61%), ear head weight (28.54%), ear head length (41.86%), ear head diameter (38.36%), straw yield (41.9%), and test weight (26.83%). Six hybrids—ICMA 13666 × BIB 9, ICMA 98222 × BIB 12, ICMA 04999 × BIB 61, ICMA 13666 × BIB 95, ICMA 04999 × BIB 122, and ICMA 88004 × BIB 122—consistently expressed significant positive heterosis for grain yield across environments. These results confirm the potential of heterosis breeding in pearl millet, with identified hybrids showing promise for yield stability and further multi-location testing.

Keywords: Heterosis breeding, pearl millet, multi-location testing.

INTRODUCTION

Pearl millet [Pennisetum glaucum (L.) R. Br.] is a major warm-season cereal grown on about 26 million hectares in Asia and Africa, serving as both a staple food and an important fodder source in arid and semi-arid regions. In India, it is cultivated on nearly 9.3 million hectares, with Rajasthan as the leading state, accounting for the largest area and production. Despite its adaptability to harsh conditions, productivity in hyper-arid zones such as western Rajasthan remains very low due to drought and poor soil fertility. As a cross-pollinated and highly heterozygous crop, pearl millet offers great potential for hybrid breeding through the exploitation of heterosis. The availability of cytoplasmic male sterile (CMS) lines has enabled the commercial development of hybrids, which now form the backbone of yield improvement programs. However, identifying superior parents and cross combinations requires systematic evaluation of combining ability and heterotic response across environments (Badhe *et al*. 2018). Exploiting hybrid vigor is regarded as one of the remarkable achievements in plant breeding for this crop. The cross-pollinated nature of pearl millet, combined with the availability of cytoplasmic male sterile lines, has enabled the commercial-scale utilization of hybrid vigor. To identify potential hybrid combinations, it is crucial to study the extent and direction of heterotic behavior under varied environmental conditions. The spread of virulent strains threatens high-yielding cultivars, further complicating breeding efforts. Therefore, genetic studies focusing on heterosis are essential for developing stable and high-yielding hybrids (Bhasker *et al*. 2017). The line × tester mating design provides a robust framework to assess parental performance and guide breeders in selecting elite combinations for sustainable pearl millet improvement.

MATERIAL AND METHODS

The present investigation was carried out to assess combining ability, standard heterosis, phenotypic stability, and blast disease resistance under different moisture regimes created by staggered sowing dates. The field experiments were conducted during Kharif 2022 at the Agricultural Research Station (ARS), Bikaner, while crossing work was completed during Summer 2022. The experimental material comprised eight CMS (female) lines and nine restorer (male) lines of pearl millet, crossed in a line × tester mating design to generate 72 F_1 hybrids at ARS, Bikaner. The parental material, sourced from ICRISAT, Patancheru and ARS, Bikaner. Three commercial hybrids—BHB-1202, BHB-1602 (SKRAU, Bikaner), and HHB-299 (HAU, Hisar)—were used as standard checks for heterosis estimation. Three experiments were conducted at ARS, Bikaner under different sowing dates to create environmental variability (E1: early sown on 1 July, E2: timely so sown on 15 July, and E3: late sown on 30 July). Each environment coincided with moisture stress at critical growth stages (tillering, flowering, and grain filling). The experimental material consisted of 72 hybrids and three checks, evaluated in a Randomized Block Design (RBD) with three replications under each environment. Each plot consisted of two rows of 4 m length with 60 cm × 15 cm spacing. Recommended agronomic practices were followed to raise a healthy crop. The method proposed by Panse and Sukhatme was used to perform analysis of variance for all characteristics. As indicated by Fonseca and Patterson (1968) and Meredith and Bridge (1972), heterobeltiosis and standard heterosis were calculated as a deviation of F1 value from the better-parent and standard parent, respectively.

RESULTS AND DISCUSSION

Standard heterosis is typically calculated as the percentage increase or decrease of the mean performance of hybrids compared to the best check (a known variety used for comparison) in the experiment. In this particular experiment, three standard checks were used for comparison. Among these checks, BHB1602 exhibited the highest grain yield per plant across different environments. Consequently, BHB 1602 was designated as the best check for estimating standard heterosis within individual environments as well as across all environments. The results of this estimation are presented in Tables 1 to 5 and they likely detail the percentage increase or decrease in mean performance of hybrids compared to BHB1602, both within specific environments and across all environments. These results provide insights into the level of hybrid vigor or inferiority relative to the best-performing check.

Across the evaluated crosses and environments (E1, E2, E3 and pooled), standard heterosis showed marked variability and strong environment dependence: many hybrids exhibited significant positive or negative heterosis in one or two sowing regimes but far fewer retained significance in pooled analysis. The magnitude of heterotic response was wide (roughly –75% to +77%), indicating both pronounced depression and substantial enhancement for different cross × environment combinations. Early-sown, timely-sown and late-sown conditions influenced expression differently, so several hybrids that performed well under a specific moisture/sowing regime failed to do so elsewhere; conversely, a limited set of crosses showed consistent advantage across environments and are therefore promising for further testing. Overall, heterotic effects were trait- and environment-specific, pooled performance narrowed the list of promising hybrids, and selection should prioritize crosses showing both sizeable heterosis and stability across environments (for example, crosses like ICMA-00444×BIB-12 and ICMA-98222×BIB-60 were notable for consistent effects in multiple environments). These stable, high-performing crosses merit advanced evaluation, multi-location trials and detailed combining-ability assessment before hybrid development.

Pearl millet, its protogynous flowering and cross-pollinated nature have enabled large-scale hybrid development using cytoplasmic-genetic male sterile lines, making heterosis a key tool in yield enhancement. The extent of heterosis depends on non-additive gene action and genetic diversity among parents, with positive heterosis being desirable for yield traits and negative heterosis useful for early flowering and maturity. In the present study, standard heterosis was estimated for grain yield per plant and related traits against the check BHB-1602, and the highest value recorded was 22.38% (ICMA 04999 × BIB 51) for grain yield per plant, while notable heterosis was also observed for plant height (22.61%), ear head weight per plot (28.54%), ear head length (41.86%), ear head diameter (38.36%), straw yield per plant (41.9%), and test weight (26.83%), along with desirable negative heterosis for earliness. Pooled analysis across environments revealed heterosis ranging from –57.44% (ICMA 88004 × BIB 61) to 22.38% (ICMA 04999 × BIB 51), with six hybrids—ICMA 13666 × BIB 9, ICMA 98222 × BIB 12, ICMA 04999 × BIB 61, ICMA 13666 × BIB 95, ICMA 04999 × BIB 122, and ICMA 88004 × BIB 122—exhibiting significant positive heterosis for grain yield per plant. Promising combinations such as ICMA 98222 × BIB 481–500, ICMA 88004 × BIB 501–510, and ICMA 93333 × BIB 551–560 expressed heterosis consistently for multiple yield components across environments, indicating their suitability for yield improvement. These results are in agreement with earlier reports by Vetriventhan *et al.* (2008), Chotaliya *et al*. (2009), Vagadiya *et al*. (2010), Jethva *et al.* (2012), Kapadia et al. (2016), Patel *et al.* (2016), Acharya *et al.* (2017), Bhasker *et al.* (2017), Kumar *et al*. (2017b), Badhe *et al*. (2018), and Chittora and Patel (2017), confirming the potential of heterosis breeding for yield enhancement in pearl millet.

Table 1: Estimates of standard heterosis for days to 50% flowering, days to maturity and plant height.

Crosses/hybrids	Days to 50% flowering				Days to maturity				Plant height			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 00444XBIB9	3.56*	4.85**	-6.27	0.98	2.04	3.25	-8.82	-0.98	-6.28	-14.49	-6.28	-10.04
ICMA 04999XBIB9	0.86	-0.33	-2.62	-0.63	1.18	-5.3	-2.6	-2.25	-1.1	4.43	-1.1	1.77
ICMA 07222XBIB9	10.04**	-2.05	-6.59	0.69	4.3	-8.15	-9.35	-4.32	-9.73	-13.47	-9.73	-10.69
ICMA 07555XBIB9	3.43	1.4	-3.93	0.45	1.93	-2.45	-4.82	-1.72	-19.44	-16.85	-19.44	-15.83
ICMA 13666XBIB9	-1.12	-3.78*	5.29	-0.07	-1.95	-11.01	10.85	-1.01	-4.77	13.02	-4.77	2.82
ICMA 15222XBIB9	-2.1	-5.5**	-6.47	-4.64	-2.79	-13.86	-9.16	-8.62	-7.36	-1.99	-7.36	-3.79
ICMA 88004XBIB9	3.81*	18.65**	-4.47	6.45	2.26	26.05**	-5.76	7.91	1.7	3.42	1.7	2.2
ICMA 98222XBIB9	0.26	4.85**	-4.33	0.45	-0.78	3.25	-5.52	-0.89	-19.44	-7.39	-19.44	-10.82
ICMA 00444XBIB12	-5.01**	-7.23**	-6.99	-6.4	-0.78	-16.71	-10.03	-9.2	-15.99	1.05	-15.99	-5.15
ICMA 04999XBIB12	3.97*	15.2**	-2.28	5.97	2.39	20.35*	-2.03	7.18	-11.03	-3.34	-11.03	-5.77
ICMA 07222XBIB12	3.69*	15.2**	-6.03	4.72	2.15	20.35*	-8.41	5.08	-8.44	9.84	-8.44	2.11
ICMA 07555XBIB12	5.59**	6.57**	-2.5	3.44	3.21	6.1	-2.41	2.43	-24.19*	-5.7	-24.19*	-11.56
ICMA 13666XBIB12	10.72**	11.75**	-2.09	7.14	6.29	14.65	-1.71	6.64	-15.78	-8.74	-15.78	-10.27
ICMA 15222XBIB12	7.31**	3.12	4.81	5.08	5.25	0.4	10.03	5.09	-6.93	-0.3	-6.93	-2.74
ICMA 88004XBIB12	4.8**	3.12	1.25	3.12	3.11	0.4	3.98	2.45	-8.44	7.81	-8.44	1.03
ICMA 98222XBIB12	-0.41	11.75**	4.6	5.39	-1.34	14.65	9.66	7.66	4.94	-4.01	4.94	-0.62
ICMA 00444XBIB18	3.43	8.3**	0.99	4.38	1.93	8.95	3.53	4.86	-12.32	-0.97	-12.32	-4.96
ICMA 04999XBIB18	11.26**	53.51**	-4.45	21.21**	3.33	23.2*	-5.72	7.31	-5.42	9.84	-5.42	3.15
ICMA 07222XBIB18	2.81	8.3**	-3.39	2.82	1.4	8.95	-3.91	2.32	-13.83	0.04	-13.83	-4.94
ICMA 07555XBIB18	4.29*	13.47**	-3.09	5.23	2.66	17.5	-3.4	5.85	-7.79	-1.31	-7.79	-3.58
ICMA 13666XBIB18	0.17	4.85**	-5.9	-0.06	-0.85	3.25	-8.17	-1.76	-8.87	-6.04	-8.87	-6.46
ICMA 15222XBIB18	0.45	-0.33	-4.93	-1.48	-0.61	-5.3	-6.53	-4.11	-3.69	-20.57	-3.69	-12.37
ICMA 88004XBIB18	4.09*	8.3**	9.38	7.19	2.49	8.95	17.8*	9.57	-46.84**	-49.02**	-46.84**	-54.58**
ICMA 98222XBIB18	7.14**	-7.23**	-5.47	-1.77	5.1	-16.71	-7.46	-6.4	0.41	-20.9	0.41	-11.13
ICMA 00444XBIB19	-2.57	-7.23**	-5.9	-5.22	-3.19	-16.71	-8.17	-9.43	0.19	-22.59	0.19	-12.1
ICMA 04999XBIB19	-2.59	-2.05	-4.86	-3.1	-3.2	-8.15	-6.42	-5.93	-9.09	-11.45	-9.09	-9.39
ICMA 07222XBIB19	3.72*	11.75**	8.11	7.88	2.18	14.65	15.63	10.74	-60.02**	-10.77	-60.02**	-26.6*

Crosses/hybrids	Days to 50% flowering				Days to maturity				Plant height			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 07555XBIB19	3.36	13.47**	13.68	10.07	1.87	17.5	25.1**	14.62	-7.58	-2.33	-7.58	-4.04
ICMA 13666XBIB19	1.51	8.3**	-3.12	2.46	0.29	8.95	-3.46	2.09	-11.89	-0.64	-11.89	-4.63
ICMA 15222XBIB19	4.55*	8.3**	0.83	4.72	2.89	8.95	3.26	5.1	-9.09	5.11	-9.09	-0.62
ICMA 88004XBIB19	4.1*	8.3**	-6.2	2.4	2.5	8.95	-8.7	1.17	-10.6	9.16	-10.6	1
ICMA 98222XBIB19	9.71**	13.47**	8.5	10.65	7.29	17.5	16.31	13.67	-4.34	1.05	-4.34	-1.13
ICMA 00444XBIB55	-1.06	6.57**	-7.45	-0.36	-1.9	6.1	-10.82	-1.97	5.37	4.09	5.37	3.82
ICMA 04999XBIB55	11.87**	6.57**	-4.35	5.02	9.14	6.1	-5.54	3.44	-2.62	9.5	-2.62	3.94
ICMA 07222XBIB55	7.63**	11.75**	44.75**	20.5**	5.52	14.65	27.58**	15.66	-1.75	4.09	-1.75	1.37
ICMA 07555XBIB55	11.84**	6.57**	-7.02	4.19	12.54	6.1	-10.09	3.15	1.05	22.67	1.05	12.18
ICMA 13666XBIB55	13.51**	13.47**	11.61	12.91*	8	17.5	9.53	11.76	-24.84*	0.38	-24.84*	-8.56
ICMA 15222XBIB55	0.37	3.12	-6.74	-0.85	-0.68	0.4	-9.6	-3.14	-7.36	-1.65	-7.36	-3.61
ICMA 88004XBIB55	2.19	3.12	-4.24	0.54	0.87	0.4	-5.36	-1.27	-7.15	-6.38	-7.15	-6.04
ICMA 98222XBIB55	9.32**	11.75**	5.6	9.03	6.96	14.65	11.37	11.01	-14.05	-9.42	-14.05	-10.03
ICMA 00444XBIB60	5.96**	10.02**	-2.79	4.69	4.09	11.8	-2.9	4.53	1.92	-0.3	1.92	0.31
ICMA 04999XBIB60	2.68	3.12	-1.69	1.49	1.29	0.4	-1.02	0.25	6.01	20.64	6.01	12.82
ICMA 07222XBIB60	-0.47	-2.05	-4.38	-2.23	-1.4	-8.15	-5.6	-5.06	-0.89	-5.7	-0.89	-3.52
ICMA 07555XBIB60	5.4**	4.85**	-5.95	1.71	3.61	3.25	-8.27	-0.28	5.37	15.92	5.37	10.09
ICMA 13666XBIB60	-4.62*	-2.05	-5.88	-4.11	-4.94	-8.15	-8.16	-7.07	3.21	10.17	3.21	6.3
ICMA 15222XBIB60	-1.96	-5.5**	-10.11	-5.71	-2.67	-13.86	-15.34	-10.54	-15.34	-19.22	-15.34	-15.67
ICMA 88004XBIB60	5.63**	11.75**	-7.69	3.67	3.81	14.65	-11.23	2.78	-0.03	18.28	-0.03	9.48
ICMA 98222XBIB60	-8.41**	-5.5**	-12.15	-8.54	-8.17	-13.86	-18.82*	-13.5	-20.74	-27.32*	-20.74	-21.82
ICMA 00444XBIB61	-6.01**	1.4	-6.08	-3.44	-6.13	-2.45	-8.48	-5.61	-17.72	-29.35*	-17.72	-21.85
ICMA 04999XBIB61	-6.76**	3.68*	-0.31	-1.12	-4.03	2.2	-0.18	-0.66	-1.72	-3.98	-1.72	-3.23
ICMA 07222XBIB61	-7.27**	-0.74	1.73	-2.21	-4.33	-0.44	0.99	-1.3	-18.93	-11.13	-18.93	-13.91
ICMA 07555XBIB61	-6.01**	-0.74	-2.61	-3.12	-3.59	-0.44	-1.5	-1.84	-13.58	-3.38	-13.58	-6.92
ICMA 13666XBIB61	2.78	1.47	-2.57	0.68	1.66	0.88	-1.47	0.4	-17.78	-2.78	-17.78	-7.98
ICMA 15222XBIB61	-3.04	-0.74	-4.51	-2.69	-1.81	-0.44	-2.58	-1.58	-15.3	-4.97	-15.3	-8.57

Crosses/hybrids	Days to 50% flowering				Days to maturity				Plant height			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 88004XBIB61	4.6*	5.15**	0.29	3.46	2.74	3.08	0.17	2.04	7.27	8.35	7.27	8.04
ICMA 98222XBIB61	2.87	6.62**	1.73	3.83	1.71	3.96	0.99	2.26	6.69	12.72	6.69	10.75
ICMA 00444XBIB95	-1.05	8.82**	0.24	2.8	-0.63	5.29	0.14	1.65	3.25	7.16	3.25	5.87
ICMA 04999XBIB95	2.5	2.21	0.03	1.64	1.49	1.32	0.02	0.97	3.06	0.4	3.06	1.32
ICMA 07222XBIB95	4.29*	5.88**	2.59	4.32	2.56	3.52	1.48	2.55	19.31	24.06	19.31	22.61
ICMA 07555XBIB95	-3.34	2.94	-5.09	-1.68	-1.99	1.76	-2.91	-0.99	0.57	-0.2	0.57	0.07
ICMA 13666XBIB95	-0.6	4.41**	-2.29	0.63	-0.36	2.64	-1.31	0.37	9.18	6.36	9.18	7.38
ICMA 15222XBIB95	7.23**	8.82**	1.02	5.88	4.31	5.29	0.58	3.47	2.68	0.6	2.68	1.32
ICMA 88004XBIB95	3.93*	5.15**	-4.55	1.75	2.35	3.08	-2.61	1.03	3.63	0.8	3.63	1.78
ICMA 98222XBIB95	7.21**	7.35**	3.47	6.11	4.3	4.41	1.99	3.6	-6.88	-7.75	-6.88	-7.52
ICMA 00444XBIB122	0.2	5.15**	-5.87	0.06	0.12	3.08	-3.36	0.04	-1.72	-5.57	-1.72	-4.29
ICMA 04999XBIB122	-1.66	4.41**	-7.18	-1.24	-0.99	2.64	-4.11	-0.73	2.49	-9.34	2.49	-5.34
ICMA 07222XBIB122	5.86**	5.88**	-0.58	3.89	3.5	3.52	-0.33	2.29	-3.06	-1.79	-3.06	-2.24
ICMA 07555XBIB122	-4.61*	4.41**	-2.26	-0.73	-2.75	2.64	-1.3	-0.43	-1.34	-8.15	-1.34	-5.87
ICMA 13666XBIB122	-0.35	6.62**	-4.06	0.95	-0.21	3.96	-2.32	0.56	-6.5	-8.95	-6.5	-8.18
ICMA 15222XBIB122	-5.38**	3.68*	0.64	-0.36	-3.21	2.2	0.37	-0.21	-8.8	-17.5	-8.8	-14.64
ICMA 88004XBIB122	1.68	4.41**	-1.58	1.63	1	2.64	-0.9	0.96	-4.59	2.39	-4.59	0
ICMA 98222XBIB122	4.62*	10.29**	-4.65	3.75	2.76	6.17	-2.66	2.21	-3.82	-1.79	-3.82	-2.51
BHB-1202	-5.54**	-0.74	-2.63	-2.96	-3.3	-0.44	-1.51	-1.75	-16.44	-19.68	-16.44	-18.72
HHB-299	6.75**	6.62**	5.47	6.31	4.75	3.96	3.13	3.97	-20.27	-22.07	-20.27	-21.63
Total				5				-				4

*and ** represent significant at 5% &1% level of significance, respectively

Table 2: Estimates of standard heterosis for total numbers of tillers per plant, number of effective tillers per plant and flag leaf area.

Crosses/hybrids	Total numbers of tillers per plant				Number of effective tillers per plant				Flag leaf area			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 00444XBIB9	18.39**	-27.18**	-19.37**	-11.75	-5.55	-27.21**	-19.27**	-16.98	-2.55	-2.23	3.43	-0.57
ICMA 04999XBIB9	25.8**	-30.64**	-21.7**	-11.71	9.31	-30.68**	-22.8**	-13.8	-2.07	-2.53	2.89	-0.67
ICMA 07222XBIB9	3.57	-12.08	-24.33**	-10.59	9.31	-12.15	-23.36**	-7.63	0.13	-0.11	5.91	1.86
ICMA 07555XBIB9	-11.24	-28.32**	-28.42**	-23.31**	0.97	-28.36**	-27.9**	-17.54	-13.37	-10.99	-7.24	-10.65
ICMA 13666XBIB9	18.39**	-5.17	-11.42**	0.18	6.77	-5.2	-11.94*	-2.82	2.43	4.42	9.25	5.23
ICMA 15222XBIB9	-7.54	-31.28**	-28.16**	-23.48**	-1.2	-31.32**	-27.62**	-19.26*	-14.81	-12.9	-8.42	-12.17
ICMA 88004XBIB9	-14.94*	-27.29**	-22.96**	-22.54**	-5.91	-27.33**	-22.98**	-18.25*	-11.65	-10.18	-4.98	-9.07
ICMA 98222XBIB9	-18.65**	-23.74**	-15.91**	-20.24**	-14.24	-23.78**	-16.16**	-18.07	-27.65**	-29.22**	-26.63**	-27.86**
ICMA 00444XBIB12	-3.83	-28.1**	-26**	-20.4**	10.39	-28.11**	-27.53**	-13.91	-7.34	-16.22	-14.24*	-12.48
ICMA 04999XBIB12	3.57	-20.34*	-18.63**	-12.85	-8.81	-20.41**	-18.76**	-15.7	-10.31	-8.77	-5.84	-8.39
ICMA 07222XBIB12	-3.83	-27.85**	-29.83**	-21.27**	-4.1	-27.89**	-30.46**	-19.98*	-15.77*	-12.5	-8.32	-12.34
ICMA 07555XBIB12	18.39**	-27.11**	-27.09**	-13.68	20.18	-27.15**	-28.13**	-10.2	-11.65	-10.69	-8.42	-10.32
ICMA 13666XBIB12	29.5**	-17.27*	-23.88**	-5.16	32.13**	-17.28*	-24.02**	-1.26	3.87	5.63	10.43	6.51
ICMA 15222XBIB12	10.98	-20.99**	-23.04**	-12.08	6.05	-21.05**	-23.2**	-11.81	-1.02	-3.03	1.92	-0.77
ICMA 88004XBIB12	-14.94*	-34.32**	-39.84**	-30.01**	-10.26	-34.38**	-39.11**	-26.98**	-23.72**	-20.45	-21.25**	-21.85*
ICMA 98222XBIB12	14.69*	-2.52	-10.63**	0.49	17.64	-2.54	-11.26	2.25	-22.57**	-20.66	-18.88**	-20.77*
ICMA 00444XBIB18	-7.54	-20.13*	-13.47**	-14.71*	-5.55	-20.2**	-14.69*	-13.24	-26.21**	-23.37*	-22.43**	-24.08**
ICMA 04999XBIB18	-18.65**	-27.01**	-34.89**	-26.55**	-14.97	-27.08**	-34.72**	-24.91**	-20.08*	-18.54	-14.67*	-17.87*
ICMA 07222XBIB18	-14.94*	-29.83**	-47.74**	-30.01**	-10.26	-29.9**	-47.75**	-27.99**	-16.63*	-27.7*	-25.45**	-23.1**
ICMA 07555XBIB18	-29.76**	-33.32**	-43.64**	-34.9**	-27.65*	-33.36**	-44.18**	-34.46**	-24.96**	-25.89*	-23.08**	-24.68**
ICMA 13666XBIB18	-0.13	-19.97*	-23.85**	-15.11*	4.96	-20.01**	-23.26**	-11.87	-26.59**	-24.99*	-25.45**	-25.7**
ICMA 15222XBIB18	3.57	-14.14	-14.67**	-9.05	4.23	-14.22	-14.89*	-7.69	-21.8**	-24.58*	-21.57**	-22.66**
ICMA 88004XBIB18	-26.05**	-56.32**	-47.67**	-45.19**	-20.4	-56.37**	-47.68**	-40.71**	-26.98**	-35.46**	-33.53**	-31.87**
ICMA 98222XBIB18	14.69*	-26.54**	-28.27**	-14.82*	5.68	-26.62**	-27.32**	-15.06	-34.83**	-38.48**	-35.58**	-36.29**
ICMA 00444XBIB19	-14.94*	-16.93*	-6.59**	-13.71*	-5.91	-16.97*	-6.59	-9.89	-18.55*	-19.95	-16.72*	-18.45*
ICMA 04999XBIB19	-7.54	-23.85**	-22.8**	-18.77**	-4.46	-23.9**	-23.02**	-16.56	-5.62	-1.62	2.89	-1.62
ICMA 07222XBIB19	-33.46**	-29.91**	-27.67**	-30.39**	-13.16	-29.95**	-27.61**	-23.14*	-12.9	-12.9	-8.1	-11.4

Crosses/hybrids	Total numbers of tillers per plant				Number of effective tillers per plant				Flag leaf area			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 07555XBIB19	-14.94*	-27.05**	-23.7**	-22.62**	-2.29	-27.08**	-24.18**	-17.2	-25.73**	-24.18*	-21.68**	-23.94**
ICMA 13666XBIB19	-3.83	-30.07**	-38.7**	-24.53**	16.19	-30.11**	-38.84**	-15.81	-18.55*	-20.25	-16.18*	-18.38*
ICMA 15222XBIB19	-3.83	-19.43*	-12.96**	-13.18	11.48	-19.48*	-14.55*	-6.75	-7.63	-16.12	-13.17	-12.21
ICMA 88004XBIB19	-3.83	-29.57**	-34.56**	-23.25**	2.42	-29.64**	-34.4**	-19.36*	-2.74	-2.33	2.57	-0.94
ICMA 98222XBIB19	22.09**	-20.42*	-14.45**	-6.36	15.83	-20.48**	-15.36**	-5.75	0.61	2.2	5.91	2.8
ICMA 00444XBIB55	-18.65**	-37.57**	-26.18**	-29.08**	-5.91	-37.62**	-27.15**	-22.99*	1.57	3.72	9.03	4.62
ICMA 04999XBIB55	7.28	-27.15**	-24.15**	-16.23*	5.32	-27.21**	-24.33**	-14.51	2.62	1.6	5.91	3.31
ICMA 07222XBIB55	-14.94*	-29.77**	-19.11**	-22.68**	-11.34	-29.83**	-19.42**	-20.04*	7.41	9.76	15.39*	10.69
ICMA 07555XBIB55	-14.94*	-3.07	-1.66	-6.21	-2.29	-3.1	-2.28	-2.56	-3.03	-0.41	5.8	0.61
ICMA 13666XBIB55	-29.76**	-30.57**	-23.25**	-28.47**	-16.78	-30.6**	-23.13**	-23.37*	0.8	3.41	8.93	4.22
ICMA 15222XBIB55	29.5**	-19.92*	-25.14**	-6.68	18.37	-19.96**	-23.93**	-7.16	-4.56	-4.24	0.2	-2.96
ICMA 88004XBIB55	-0.13	-13.36	-14.37**	-9.71	1.34	-13.42	-15.48**	-8.65	-12.8	-14.31	-10.79	-12.68
ICMA 98222XBIB55	10.98	-26.99**	-29.78**	-16.5*	55.58**	-27.04**	-31.14**	1.85	-5.42	-1.72	2.46	-1.72
ICMA 00444XBIB60	-0.13	-28.06**	-28**	-19.81**	11.84	-28.08**	-27.86**	-13.47	2.62	1.6	6.88	3.61
ICMA 04999XBIB60	-7.54	-34.03**	-38.48**	-27.35**	5.68	-34.07**	-39.73**	-21.25*	1.57	0.79	6.02	2.7
ICMA 07222XBIB60	-11.24	-30.88**	-23.19**	-23.12**	-2.29	-30.88**	-23**	-18.15	-1.5	-0.72	2.57	0.04
ICMA 07555XBIB60	-18.65**	-30.9**	-18.24**	-24.05**	-4.82	-30.93**	-19.08**	-17.94	-5.14	-6.46	-0.13	-4.01
ICMA 13666XBIB60	7.28	-28.12**	-26.95**	-17.38*	4.96	-28.15**	-27.54**	-15.91	-5.9	-3.74	-1.63	-3.84
ICMA 15222XBIB60	10.98	1.55	-10.68**	1.21	-7.6	1.5	-11.07	-5.51	-2.74	-2.33	2.14	-1.08
ICMA 88004XBIB60	-0.13	-19.9*	-23.09**	-14.88*	12.57	-19.94**	-23.45**	-9.13	-18.55*	-19.85	-15.64*	-18.07*
ICMA 98222XBIB60	7.28	-15.72*	-15.5**	-8.88	6.05	-15.78*	-14.4*	-7.42	0.99	0.79	6.34	2.6
ICMA 00444XBIB61	-7.54	-22.76**	-23.97**	-18.58**	-4.82	-22.76**	-23.61**	-16.48	7.41	9.46	14.31*	10.26
ICMA 04999XBIB61	0	-15.87*	-19.37**	-12.09	1.09	-15.84*	-19.39**	-10.72	-13.51	-11.18	-7	-10.69
ICMA 07222XBIB61	-14.81*	-19.01*	-22.08**	-18.56**	-8.33	-19.01*	-23.13**	-16.33	9.2	9.26	13.9*	10.69
ICMA 07555XBIB61	-29.63**	-30.28**	-23.41**	-28.34**	-21.38	-30.28**	-23.53**	-25.05**	-1.15	-0.7	3.13	0.34
ICMA 13666XBIB61	-11.11	-18.94*	-24.86**	-18.14**	-4.71	-18.93*	-24.01**	-15.24	-6.9	-5.74	0	-4.35
ICMA 15222XBIB61	-11.11	-30.34**	-31.27**	-24.91**	0.76	-30.36**	-30.97**	-19.2*	2.87	3.52	7.54	4.55

Crosses/hybrids	Total numbers of tillers per plant				Number of effective tillers per plant				Flag leaf area			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 88004XBIB61	-33.33**	-53.61**	-51.64**	-47.13**	-24.64*	-53.61**	-50.92**	-42.27**	-16.48*	-26.99*	-23.06**	-22.06*
ICMA 98222XBIB61	3.7	-21.35**	-21**	-13.87*	6.16	-21.38**	-21.95**	-11.51	-24.14**	-23.56*	-22.31**	-23.37**
ICMA 00444XBIB95	-18.52**	-44.51**	-47.65**	-37.64**	-8.33	-44.48**	-47.63**	-32.24**	-16.67*	-14.6	-11.21	-14.27
ICMA 04999XBIB95	-14.81*	-26.8**	-23.66**	-22.46**	-10.51	-26.81**	-23.19**	-19.81*	-26.34**	-24.27*	-22.74**	-24.52**
ICMA 07222XBIB95	-11.11	-27.34**	-14.17**	-19.19**	-3.62	-27.31**	-14.13*	-14.81	-26.44**	-25.18*	-24.14**	-25.3**
ICMA 07555XBIB95	-11.11	-26.81**	-16.53**	-19.56**	-6.88	-26.84**	-15.94**	-16.37	-2.97	-0.81	3.23	-0.3
ICMA 13666XBIB95	-22.22**	-2.51	-9.47**	-10.1	1.09	-2.52	-10.87	-3.66	-3.35	-0.4	3.23	-0.3
ICMA 15222XBIB95	-7.41	-41.14**	-31.99**	-28.86**	-4.35	-41.13**	-31.24**	-24.82**	-21.65**	-21.05	-17.89**	-20.27*
ICMA 88004XBIB95	-14.81*	-37.33**	-37.87**	-30.83**	-7.97	-37.35**	-39.01**	-27.14**	-19.25*	-17.52	-15.52*	-17.5*
ICMA 98222XBIB95	-14.81*	-30.2**	-24.48**	-24.2**	-5.43	-30.22**	-26.97**	-20.24*	-32.09**	-31.72**	-30.17**	-31.37**
ICMA 00444XBIB122	-7.41	-27.58**	-22.95**	-20.45**	-3.26	-27.57**	-22.91**	-17.34	-21.55**	-19.74	-19.29**	-20.24*
ICMA 04999XBIB122	-11.11	-12.9	-12.1**	-12.17	13.04	-12.89	-14.19*	-3.83	-20.88**	-22.96*	-21.88**	-21.89*
ICMA 07222XBIB122	-3.7	-27.13**	-20.1**	-18.43**	-9.42	-27.13**	-19.41**	-18.41*	-5.65	-4.93	-0.22	-3.71
ICMA 07555XBIB122	-18.52**	-37.54**	-30.34**	-30.09**	-19.57	-37.53**	-31.36**	-29.18**	-22.51**	-20.95	-21.98**	-21.82*
ICMA 13666XBIB122	-22.22**	-40.26**	-42.5**	-35.51**	-18.48	-40.26**	-42.79**	-33.07**	-8.24	-8.16	-4.09	-6.91
ICMA 15222XBIB122	-7.41	-27.14**	-26.39**	-21.13**	-7.97	-27.15**	-26.79**	-20.06*	2.87	4.93	7.97	5.16
ICMA 88004XBIB122	11.11	-20.17*	-23.77**	-11.86	6.88	-20.16**	-22.69**	-11.05	-0.67	0.5	6.03	1.82
ICMA 98222XBIB122	-7.41	-14.3	-10.94**	-11.41	-7.97	-14.31	-10.91	-11	-0.86	0.4	0.75	0.07
BHB-1202	-11.11	-34.63**	-38.56**	-28.7**	-34.78**	-34.63**	-39.19**	-36.03**	-2.2	-0.81	1.4	-0.61
HHB-299	-18.52**	-26.46**	-22.08**	-23**	-15.22	-26.44**	-23.21**	-21.4*	-4.41	-1.81	2.69	-1.32
Total				**2**				**1**				**5**

*and ** represent significant at 5% &1% level of significance, respectively

Table 3: Estimates of standard heterosis for total no. of ear head per plant, ear head weight per plot & ear head length.

Crosses/hybrids	Total no. of ear head per plot				Ear head weight per plot				Ear head length			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 00444XBIB9	-10**	-27.21**	-19.32*	-18.62**	-14.33	9.31	-8.73	-5.63	-6.39	6.24	6.81	1.36
ICMA 04999XBIB9	6.88**	-30.68**	-22.85**	-14.7*	-16.72	10.88	3.33	-3.86	7.96	40.82**	44.5**	28.76*
ICMA 07222XBIB9	6.88**	-12.15	-23.41**	-8.53	-5.07	-0.01	13.13	0.21	-0.47	16.69	18.19	10.27
ICMA 07555XBIB9	-1.45	-28.37**	-27.95**	-18.44**	-26*	-8.34	-26.32**	-20.41	-13.86	17.4	18.97	5.37
ICMA 13666XBIB9	4.35*	-5.2	-12	-3.72	5.91	26.37**	39.76**	19.26	26.74*	45.14**	49.2**	38.96**
ICMA 15222XBIB9	-3.62	-31.33**	-27.67**	-20.16**	-10.31	12.61	9.36	0.98	5.17	29.9*	32.59*	20.8
ICMA 88004XBIB9	-11.96**	-27.33**	-23.04**	-20.47**	-14.31	1.9	5.59	-5.12	-12.36	2.31	2.53	-3.48
ICMA 98222XBIB9	-16.67**	-23.78**	-16.22*	-18.97**	-15.98	-1.43	16.64*	-4.77	7.42	0.7	0.77	3.4
ICMA 00444XBIB12	7.97**	-28.11**	-27.59**	-14.81*	-15.48	18.56*	3.58	-0.75	1.93	7.14	7.79	5.25
ICMA 04999XBIB12	-11.23**	-20.41*	-18.82*	-16.6**	-6.55	9.31	21.77**	4.22	13.09	35.33**	38.51**	27.36*
ICMA 07222XBIB12	-6.52**	-27.89**	-30.51**	-20.88**	4.47	16.92*	44.28**	16.46	12.52	43.67**	47.61**	32.37*
ICMA 07555XBIB12	17.75**	-27.15**	-28.19**	-11.1	-0.48	23.84**	24.18**	12.27	9.09	24.06	26.23	18.71
ICMA 13666XBIB12	12.83**	-17.28*	-24.08**	-8.31	-3.87	1.25	-1.7	-1.8	-9.88	16.01	17.45	6.09
ICMA 15222XBIB12	3.62	-21.06*	-23.26**	-12.71*	-11.13	18.64*	45.99**	9.88	0.75	42.44**	46.26**	26.89*
ICMA 88004XBIB12	-12.68**	-34.38**	-39.17**	-27.88**	-24.95*	-20.18*	-3.26	-19.06	29.92*	30.29*	33.02*	30.93*
ICMA 98222XBIB12	15.22**	-2.54	-11.31	1.35	11.13	19.24*	46.79**	20.89*	21.55	37.18**	40.53**	31.91*
ICMA 00444XBIB18	-7.97**	-20.2*	-14.74*	-14.14*	-13.16	1.12	-0.69	-6.08	12.63	44.91**	48.95**	33.18*
ICMA 04999XBIB18	-17.39**	-27.08**	-34.78**	-25.81**	-24.09*	-13.88	-10.99	-18.19	17.15	29.56*	32.22*	25.37
ICMA 07222XBIB18	-12.68**	-29.9**	-47.8**	-28.89**	-29.17**	-20.84*	-35.37**	-27.75**	3.14	12.82	13.98	9.29
ICMA 07555XBIB18	-30.07**	-33.37**	-44.23**	-35.36**	-44.15**	-48.77**	-54.46**	-47.7**	-7.21	15.93	17.37	7.1
ICMA 13666XBIB18	2.54	-20.01*	-23.31**	-12.77*	-2.06	9.46	14.88	5.03	-3.1	-4.65	-5.06	-4.15
ICMA 15222XBIB18	1.81	-14.22	-14.94*	-8.59	5.22	34.42**	-35.62**	6.36	-20.58	-6.05	-6.58	-12
ICMA 88004XBIB18	-22.83**	-56.37**	-47.74**	-41.61**	-48.17**	-66.25**	-45.42**	-53.4**	-40.03**	-26.9*	-29.32*	-32.84*
ICMA 98222XBIB18	3.26	-26.62**	-27.37**	-15.96*	-10.3	24.79**	15.01	6.02	10.53	11.89	12.97	11.66
ICMA 00444XBIB19	-8.33**	-16.97*	-6.64	-10.79	-9.15	-10.8	38.75**	-0.05	0.77	16.7	18.2	10.77
ICMA 04999XBIB19	-6.88**	-23.9**	-23.07**	-17.46**	3.43	15.8	24.43**	11.61	-2.3	25.83*	28.16*	15.27
ICMA 07222XBIB19	-15.58**	-29.95**	-27.66**	-24.04**	-54.06**	-15.6	-53.96**	-41.73**	-34.29*	-10.79	-11.76	-20.45

Crosses/hybrids	Total no. of ear head per plot				Ear head weight per plot				Ear head length			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 07555XBIB19	-4.71*	-27.08**	-24.24**	-18.1**	-38.67**	-3.33	-45.42**	-28.71**	15.94	52.73**	57.47**	39.41**
ICMA 13666XBIB19	13.77**	-30.11**	-38.9**	-16.71**	-28.22*	-23.14**	-14.01	-23.74*	19.87	54.15**	59.02**	41.86**
ICMA 15222XBIB19	9.06**	-19.48*	-14.6	-7.65	-32.23**	-5.03	-3.46	-17.74	33.21*	35.21**	38.38**	35.32**
ICMA 88004XBIB19	0	-29.64**	-34.46**	-20.26**	-15.38	3.33	4.58	-5.38	9.59	31.62*	34.47*	23.65
ICMA 98222XBIB19	13.41**	-20.48*	-15.42*	-6.65	3.22	8.54	26.69**	9.64	2.7	47.01**	51.25**	30.54*
ICMA 00444XBIB55	-8.33**	-37.62**	-27.21**	-23.89**	-14.4	-43.53**	-40.89**	-29.05**	8.67	47.2**	51.44**	33.04*
ICMA 04999XBIB55	2.9	-27.21**	-24.39**	-15.41*	-10.39	11.38	23.43**	3.38	25.95	35.37**	38.55**	32.52*
ICMA 07222XBIB55	-13.77**	-29.83**	-19.47**	-20.94**	-16.4	7.83	-13.26	-8.01	14.48	41.46**	45.19**	31.76*
ICMA 07555XBIB55	-4.71*	-3.1	-2.33	-3.46	-55.56**	23.21**	21.92**	-14.77	12.91	38.71**	42.19**	29.41*
ICMA 13666XBIB55	-19.2**	-30.6**	-23.18**	-24.27**	-33.08**	-37.85**	-15.01	-30.98**	-14.89	40.59**	44.24**	19.49
ICMA 15222XBIB55	15.94**	-19.96*	-23.98**	-8.06	2.16	-9.29	23.93**	2.87	30.74*	45.68**	49.79**	40.9**
ICMA 88004XBIB55	-1.09	-13.42	-15.54*	-9.55	-16.43	0.02	16.64*	-4.51	21.18	29.69*	32.36*	27.06*
ICMA 98222XBIB55	7.97**	-27.04**	-31.19**	-15.51*	1.26	12.48	-42.65**	-3.97	-10.38	16.36	17.84	6.11
ICMA 00444XBIB60	9.42**	-28.08**	-27.92**	-14.37*	-24.49*	-22.07**	-14.26	-21.66*	13.3	38.67**	42.15**	29.54*
ICMA 04999XBIB60	3.26	-34.08**	-39.78**	-22.15**	-28.13*	-12.44	-45.17**	-26.54*	9.58	22.74	24.79	18.07
ICMA 07222XBIB60	-4.71*	-30.89**	-23.05**	-19.05**	-16.31	-12.82	-27.07**	-17.36	25.16	31.91*	34.78*	30.04*
ICMA 07555XBIB60	-7.25**	-30.93**	-19.14*	-18.84**	-35.3**	-50.63**	-55.47**	-44.26**	4.91	17.76	19.36	13.09
ICMA 13666XBIB60	2.54	-28.16**	-27.6**	-16.81**	-4.27	25.58**	22.15**	10.59	29.15*	46.58**	50.77**	40.83**
ICMA 15222XBIB60	8.33**	1.5	-11.12	0.28	7.43	18.87*	18.4*	13.3	9.63	27.66*	30.15*	21.18
ICMA 88004XBIB60	10.14**	-19.94*	-23.51**	-10.03	-5.86	12.63	-16.02	-1.98	-8.54	8.71	9.5	2.05
ICMA 98222XBIB60	3.62	-15.78	-14.45	-8.32	20.85	0.18	-18.28*	6.37	14.39	23.69	25.83	20.59
ICMA 00444XBIB61	-7.25**	-22.76**	-23.67**	-17.38**	-1.55	12.48	10.86	5.44	-2.39	6.27	6.84	2.98
ICMA 04999XBIB61	1.09	-15.84	-19.39**	-10.72	1.67	28.43**	44.47**	18.84	9.25	31.96*	34.83*	23.72
ICMA 07222XBIB61	-8.33**	-19.01*	-23.13**	-16.33**	-26.92*	-16.06	-8.29	-19.7	10.45	26.96*	29.39*	21.07
ICMA 07555XBIB61	-21.38**	-30.28**	-23.53**	-25.05**	-47.55**	-55.51**	-46.23**	-49.83**	7.96	36.89**	40.21**	26.3*
ICMA 13666XBIB61	-4.71*	-18.93*	-24.01**	-15.24*	-28.44*	-21.43**	-8.79	-22.24*	6.23	35.27**	38.44**	24.59
ICMA 15222XBIB61	0.76	-30.36**	-30.97**	-19.2**	-32.59**	-59.94**	-56.03**	-46.06**	4.35	37.1**	40.43**	24.98

Crosses/hybrids	Total no. of ear head per plot				Ear head weight per plot				Ear head length			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 88004XBIB61	-24.64**	-53.61**	-50.92**	-42.27**	-37.97**	-61.34**	-68.84**	-51.66**	-2.06	27.39*	29.85*	16.34
ICMA 98222XBIB61	6.16**	-21.38*	-21.95**	-11.51	-16.03	0.19	1.26	-7.36	13.81	40.28**	43.9**	30.75*
ICMA 00444XBIB95	-8.33**	-44.48**	-47.63**	-32.24**	-28.32*	-22.28**	-43.47**	-29.43**	4.6	23.8	25.94	16.75
ICMA 04999XBIB95	-10.51**	-26.81**	-23.19**	-19.81**	-24.23*	-27.93**	-20.35*	-24.63*	-4.99	12.27	13.37	5.7
ICMA 07222XBIB95	-3.62	-27.31**	-14.13	-14.81*	-26.81*	-18.6*	-14.07	-21.62*	3.97	34.28**	37.36**	23.07
ICMA 07555XBIB95	-6.88**	-26.84**	-15.94*	-16.37**	-24.26*	6.47	-24.87**	-14.55	8.38	46.41**	50.58**	32.43*
ICMA 13666XBIB95	1.09	-2.52	-10.87	-3.66	12.13	30.47**	26.13**	20.82*	17.56	33.36**	36.36**	27.91*
ICMA 15222XBIB95	-4.35*	-41.13**	-31.24**	-24.82**	-3.49	25.24**	29.65**	12.37	0.48	18.65	20.33	11.88
ICMA 88004XBIB95	-7.97**	-37.35**	-39.01**	-27.14**	-35.76**	-37.93**	-50.5**	-39.42**	3.46	31.42*	34.24*	21.07
ICMA 98222XBIB95	-5.43**	-30.22**	-26.97**	-20.24**	-24.79*	-5.82	-36.43**	-21.06*	9.18	40.78**	44.45**	29.22*
ICMA 00444XBIB122	-3.26	-27.57**	-22.91**	-17.34**	4.94	4.59	0	3.83	12.4	15.75	17.17	14.82
ICMA 04999XBIB122	13.04**	-12.89	-14.19	-3.83	16.54	52.1**	19.6*	28.54**	2.97	27.91*	30.42*	18.68
ICMA 07222XBIB122	-9.42**	-27.13**	-19.41**	-18.41**	-24.47*	-5.02	-5.78	-14.49	-7.62	17.14	18.68	7.7
ICMA 07555XBIB122	-19.57**	-37.53**	-31.36**	-29.18**	-47.59**	-45.41**	-41.46**	-45.66**	12.17	34.61**	37.72**	26.54*
ICMA 13666XBIB122	-18.48**	-40.26**	-42.79**	-33.07**	-35.15**	-15.46	1.76	-21.43*	11.31	22.01	23.99	18.3
ICMA 15222XBIB122	-7.97**	-27.15**	-26.79**	-20.06**	-4.69	14.53	17.34*	5.89	5.94	25.65*	27.95*	18.44
ICMA 88004XBIB122	6.88**	-20.16*	-22.69**	-11.05	7.26	28.57**	46.48**	21.97*	-4.42	26.54*	28.93*	14.87
ICMA 98222XBIB122	-7.97**	-14.31	-10.91	-11	3.88	14.15	29.4**	12.3	-3.13	7.34	7.99	3.35
BHB-1202	-34.78**	-34.63**	-39.19**	-36.03**	-56.22**	-43.69**	-28.64**	-46.67**	-9.51	0.17	0.18	-3.69
HHB-299	-15.22**	-26.44**	-22.75**	-21.26**	-23.65*	-20.09*	-10.3	-19.83	-15.81	-5.52	-6.01	-9.77
Total				**2**				**4**				**4**

*and ** represent significant at 5% &1% level of significance, respectively

Table 4: Estimates of standard heterosis for ear head diameter, grain yield per plant & grain yield per plot.

Crosses/hybrids	Ear head diameter				Grain yield per plant				Grain yield per plot			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 00444XBIB9	-18.13	-20.63*	-21.52	-19.98	-9.54	7.46	-12.08	-4.48	-9.5	7.48	-12.25	-4.55
ICMA 04999XBIB9	-3.74	-21.15*	-22.06*	-15.01	-12.41	1.76	-2.63	-5.64	-12.38	1.79	-2.8	-5.72
ICMA 07222XBIB9	-9.92	-7.82	-8.21	-8.72	-3.56	1.2	15.11	2.02	-3.53	1.23	14.94	1.95
ICMA 07555XBIB9	-14.73	-1.07	-1.2	-6.15	-18.96*	-12.91	-27.69**	-18.84	-18.93*	-12.89	-27.85*	-18.86*
ICMA 13666XBIB9	-13.81	-12.32	-12.89	-13.05	6.83	24.65*	41.85**	20.23*	6.86	24.67**	41.69**	20.08*
ICMA 15222XBIB9	-11.43	-9.9	-10.37	-10.61	-8.02	8.58	8.47	0.99	-7.99	8.61	8.3	0.89
ICMA 88004XBIB9	-1.2	-3.41	-3.63	-2.66	-15.07	4.37	0.78	-5.26	-15.04	4.39	0.61	-5.37
ICMA 98222XBIB9	2.26	-3.54	-3.76	-1.47	-14.21	-2.1	9.95	-5.03	-14.18	-2.08	9.78	-5.13
ICMA 00444XBIB12	-10.4	5.81	5.95	-0.13	-11.19	4.02	2.11	-3.32	-11.16	4.04	1.94	-3.41
ICMA 04999XBIB12	-1.91	-8.43	-8.84	-6.15	-6.37	8.2	20.14*	4.12	-6.34	8.22	19.97	4.01
ICMA 07222XBIB12	11.64	-6.01	-6.32	0.41	3.85	14.48	41.48**	15.43	3.88	14.5	41.31**	15.31
ICMA 07555XBIB12	-0.12	-7	-7.36	-4.57	4.53	20.15	19*	12.78	4.56	20.17*	18.83	12.69
ICMA 13666XBIB12	8.25	12.77	13.19	11.23	1.18	2.31	-0.26	1.24	1.21	2.33	-0.42	1.23
ICMA 15222XBIB12	-8.16	-13.45	-14.06	-11.69	-4.75	19.97	37.56**	12.48	-4.72	20*	37.39**	12.31
ICMA 88004XBIB12	-6.92	0.31	0.24	-2.38	-25.51**	-1.19	-4.45	-12.97	-25.48**	-1.16	-4.62	-13.11
ICMA 98222XBIB12	-7.38	-7.69	-8.08	-7.7	12.23	27.2*	34.91**	22.03*	12.26	27.22**	34.74**	21.92*
ICMA 00444XBIB18	3.56	1.57	1.55	2.29	-9.28	6.59	-1.65	-2.41	-9.25	6.61	-1.82	-2.49
ICMA 04999XBIB18	8.36	29.65**	30.73**	22.13*	-18.99*	-7.6	-14.46	-14.26	-18.96*	-7.58	-14.62	-14.32
ICMA 07222XBIB18	-1.15	-0.64	-0.75	-0.86	-26.51**	-21.07*	-38.93**	-27.39**	-26.48**	-21.05*	-39.09**	-27.39**
ICMA 07555XBIB18	0.38	-9.29	-9.74	-5.86	-41.08**	-44.67**	-53.91**	-45.02**	-41.05**	-44.64**	-54.07**	-44.99**
ICMA 13666XBIB18	-0.98	-19.38*	-20.22	-12.85	-2.7	8.23	-1.82	1.09	-2.67	8.26	-1.98	1.04
ICMA 15222XBIB18	1.55	-11.55	-12.08	-6.88	6.18	22*	-10.41	7.83	6.21	22.02*	-10.58	7.8
ICMA 88004XBIB18	0.77	-15.48	-16.17	-9.7	-45.76**	-62.43**	-57.88**	-53.86**	-45.73**	-62.41**	-58.05**	-53.79**
ICMA 98222XBIB18	-6.46	-21.45*	-22.38*	-16.21	-6.44	1.77	2.29	-1.86	-6.41	1.79	2.12	-1.92
ICMA 00444XBIB19	-8.72	-16.95*	-17.7	-14.15	-5.87	-8.53	18.57	-1.49	-5.84	-8.51	18.4	-1.55
ICMA 04999XBIB19	5.28	-8.34	-8.75	-3.44	4.53	14.19	25.26**	12.17	4.56	14.21	25.1*	12.08
ICMA 07222XBIB19	0.34	4.98	5.1	3.31	-49.54**	-14.63	-66.41**	-41.66**	-49.5**	-14.61	-66.57**	-41.75**

Crosses/hybrids	Ear head diameter				Grain yield per plant				Grain yield per plot			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 07555XBIB19	3.51	3.38	3.43	3.45	-40.79**	-5.18	-48.56**	-30.73**	-40.76**	-5.16	-48.72**	-30.84**
ICMA 13666XBIB19	10.74	25.02**	25.92*	20.03	-27.05**	-24.39*	-26.2**	-25.99**	-27.02**	-24.37**	-26.37*	-26.02**
ICMA 15222XBIB19	19.05	27.92**	28.93**	24.96*	-26.48**	-9.75	-7.35	-16.86	-26.45**	-9.73	-7.52	-16.96
ICMA 88004XBIB19	2.93	9.1	9.37	6.91	-7.52	2.28	9.37	-0.66	-7.49	2.3	9.2	-0.74
ICMA 98222XBIB19	-12.8	-6.31	-6.64	-8.8	4.1	15.97	25.16**	12.53	4.13	15.99	24.99*	12.44
ICMA 00444XBIB55	5.84	6.2	6.36	6.11	-13.06	-45.1**	-47.89**	-31.1**	-13.03	-45.07**	-48.05**	-30.94**
ICMA 04999XBIB55	12.69	6.67	6.85	8.95	-7.2	7.25	16.67	2.69	-7.17	7.27	16.5	2.58
ICMA 07222XBIB55	49.49**	31.29**	32.44**	38.36**	-18.67*	-8.87	-13.98	-14.43	-18.64*	-8.84	-14.15	-14.49
ICMA 07555XBIB55	-4.6	-8.39	-8.8	-7.12	-48.13**	20.49	14.57	-12.05	-48.1**	20.51*	14.41	-12.41
ICMA 13666XBIB55	-30.01**	-29.72**	-30.96**	-30.21**	-29.28**	-23.63*	-21.81*	-25.82**	-29.25**	-23.61*	-21.98	-25.86**
ICMA 15222XBIB55	5.34	-3.28	-3.49	-0.17	1.62	-5.82	20.11*	3.14	1.65	-5.79	19.94	3.11
ICMA 88004XBIB55	3.21	-2.41	-2.59	-0.4	-11.23	3.13	0.98	-3.87	-11.2	3.16	0.81	-3.96
ICMA 98222XBIB55	12.95	19.52*	20.21	17.31	6.15	18.27	-11.75	6.3	6.18	18.29*	-11.91	6.28
ICMA 00444XBIB60	-0.2	-22.23**	-23.19*	-14.4	-25.61**	-20.03	-19.75*	-22.52*	-25.76**	-20.01*	-19.92	-22.64*
ICMA 04999XBIB60	9.61	7.54	7.75	8.37	-24.82**	-25.41*	-45.38**	-29.43**	-24.97**	-25.39**	-45.54**	-29.49**
ICMA 07222XBIB60	10.85	2.82	2.85	5.79	-22.16*	-9.25	-29.15**	-19.41*	-22.31**	-9.23	-29.32*	-19.53*
ICMA 07555XBIB60	-4.67	-14.79	-15.45	-11.26	-41.51**	-48.23**	-56.5**	-46.94**	-41.66**	-48.21**	-56.66**	-46.99**
ICMA 13666XBIB60	-12.84	-16.22	-16.94	-15.19	0	14.22	17.75	8.5	-0.15	14.25	17.58	8.32
ICMA 15222XBIB60	-0.63	-11.2	-11.72	-7.46	5.14	19.46	13.81	11.72	4.99	19.49*	13.64	11.56
ICMA 88004XBIB60	9.43	-20.98*	-21.88*	-10.04	-4.46	10.38	-19.98*	-2.91	-4.61	10.4	-20.15	-3.02
ICMA 98222XBIB60	11.52	1.57	1.55	5.23	8.67	4.07	-17.15	1.61	8.52	4.1	-17.32	1.58
ICMA 00444XBIB61	8.62	-19.81*	-20.67	-9.59	0.4	14.28	9.19	6.86	0.24	14.31	9.03	6.7
ICMA 04999XBIB61	-7.11	1.6	1.66	-1.59	10.9	30.13**	34.84**	22.38*	10.9	30.13**	34.84**	22.27*
ICMA 07222XBIB61	-8.93	-15.62	-16.23	-13.34	-21.58*	-12.47	-11.64	-16.44	-21.58**	-12.47	-11.64	-16.49
ICMA 07555XBIB61	-4.4	9.95	10.34	4.78	-45.83**	-53.64**	-47.03**	-48.66**	-45.83**	-53.64**	-47.03**	-48.63**
ICMA 13666XBIB61	12.91	30.29**	31.47**	24.25*	-27.88**	-23.4*	-12.57	-23.12*	-27.88**	-23.4*	-12.57	-23.16*
ICMA 15222XBIB61	-0.47	6.45	6.7	3.98	-27.05**	-56.33**	-58.59**	-43.47**	-27.05**	-56.33**	-58.59**	-43.32**

Crosses/hybrids	Ear head diameter				Grain yield per plant				Grain yield per plot			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 88004XBIB61	0.69	-6.97	-7.24	-4.23	-42.01**	-67.38**	-74.94**	-57.44**	-42.01**	-67.38**	-74.94**	-57.29**
ICMA 98222XBIB61	6.92	2.47	2.56	4.14	-9.71	-2.6	-0.42	-5.37	-9.71	-2.6	-0.42	-5.41
ICMA 00444XBIB95	11.63	10.26	10.66	10.89	-27.55**	-40.59**	-47.43**	-36.12**	-27.55**	-40.59**	-47.43**	-36.04**
ICMA 04999XBIB95	7.13	0.65	0.67	3.05	-20.65*	-27.7**	-26.34**	-24.2*	-20.65*	-27.7**	-26.34*	-24.16**
ICMA 07222XBIB95	3.86	13.8	14.34	10.3	-23.38**	-20.14	-16.08	-20.74*	-23.38**	-20.14*	-16.08	-20.77*
ICMA 07555XBIB95	3.02	14.63	15.2	10.52	-19.82*	-6.21	-29.47**	-17.41	-19.82*	-6.21	-29.47*	-17.43
ICMA 13666XBIB95	-5.81	-15.19	-15.78	-11.91	13.85	27.04*	22.7*	20.1*	13.85	27.04**	22.7*	20.04*
ICMA 15222XBIB95	13.93	8.91	9.26	10.87	2.73	19.99	31.49**	14.6	2.73	19.99*	31.49**	14.48
ICMA 88004XBIB95	4.24	9.91	10.3	7.94	-24.17**	-44.18**	-52.14**	-36.77**	-24.17**	-44.18**	-52.14**	-36.65**
ICMA 98222XBIB95	5.89	10.77	11.2	9.1	-19.17*	-14.78	-37.2**	-21.6*	-19.17*	-14.78	-37.2**	-21.58*
ICMA 00444XBIB122	20.07	22.46**	23.34*	21.85*	4.1	-0.6	-3.6	0.9	4.1	-0.6	-3.6	0.93
ICMA 04999XBIB122	11.72	18.95*	19.69	16.51	10.97	36.1**	13.7	19.84*	10.97	36.1**	13.7	19.75*
ICMA 07222XBIB122	10.41	20.73*	21.54	17.17	-21.87*	-13.09	-12.7	-17.01	-21.87**	-13.09	-12.7	-17.05
ICMA 07555XBIB122	6.1	5.45	5.67	5.76	-42.63**	-41.58**	-48.36**	-43.51**	-42.63**	-41.58**	-48.36**	-43.5**
ICMA 13666XBIB122	3.22	-3.07	-3.19	-0.79	-30.2**	-13.32	-0.41	-18.24	-30.2**	-13.32	-0.41	-18.35*
ICMA 15222XBIB122	-8.48	-2.34	-2.43	-4.63	-5.72	11.2	11.39	3.53	-5.72	11.2	11.39	3.44
ICMA 88004XBIB122	18.79	27.48**	28.55*	24.6*	7.27	25.77*	37.71**	19.9*	7.27	25.77**	37.71**	19.78*
ICMA 98222XBIB122	8.93	6.45	6.7	7.44	1.83	13.79	19.69*	9.61	1.83	13.79	19.69	9.53
BHB-1202	-3.91	8.18	8.5	3.82	-51.22**	-39**	-31.58**	-42.98**	-51.22**	-39**	-31.58**	-43.06**
HHB-299	-24.96*	-8.7	-9.04	-14.8	-23.49**	-20	-21.35*	-21.88*	-23.49**	-20*	-21.35	-21.89*
Total				**4**				**5**				**5**

*and ** represent significant at 5% &1% level of significance, respectively

Table 5: Estimates of standard heterosis for dry stover yield per plant, test weight & harvest index.

Crosses/hybrids	Dry stover yield per plant				Test weight				Harvest index			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 00444XBIB9	-15.35	16.19	30.64**	6.18	-10.25	-10.62	-4.59*	-8.56	6.93	-7.57	-32.81**	-9.9
ICMA 04999XBIB9	2.19	21.9	-22.47*	2.63	-15.45*	-15.99	-16.51**	-15.97*	-14.27	-16.58	25.36**	-3.21
ICMA 07222XBIB9	-16.05	10.69	25.71*	2.87	-37.29**	-38.51**	-40.06**	-38.58**	14.93	-8.62	-8.57	-0.13
ICMA 07555XBIB9	10.25	19.91	0.51	11.04	-15.45*	-15.99	-16.51**	-15.97*	-26.48**	-27.43**	-28.15**	-27.31**
ICMA 13666XBIB9	1.37	30.98*	48.84**	22.62*	-28.21**	-29.14**	-30.26**	-29.18**	5.42	-4.91	-4.84	-1.17
ICMA 15222XBIB9	19.32*	17.23	26.13*	20.3	4.34	4.42	4.84*	4.53	-22.92**	-7.44	-14.13	-15.01
ICMA 88004XBIB9	15.48	34.19**	-6.58	16.23	-18.31*	-18.94*	-19.59**	-18.93**	-26.45**	-22.3*	7.7	-14.83
ICMA 98222XBIB9	9.67	17.27	27.68**	16.55	3.53	3.58	3.96	3.68	-21.77**	-16.58	-14.02	-17.68*
ICMA 00444XBIB12	0.65	31.01*	46.85**	21.84*	12.2	12.53	13.32**	12.67	-11.74	-20.68	-30.58**	-20.42*
ICMA 04999XBIB12	-14.03	8.76	41.61**	6.98	-7.39	-7.68	-7.81**	-7.62	8.97	-0.56	-15.3	-1.53
ICMA 07222XBIB12	7.72	25.83*	64.58**	27.5**	2.1	2.11	2.42	2.21	-3.58	-9.1	-14.17	-8.63
ICMA 07555XBIB12	16.74	51.32**	15.75	27.81**	-7.9	-8.2	-8.36**	-8.15	-10.45	-20.7	2.65	-10.03
ICMA 13666XBIB12	25.69**	28.85*	44.3**	31.26**	-24.13**	-24.94*	-25.86**	-24.95**	-19.5*	-20.67	-30.99**	-23.34**
ICMA 15222XBIB12	-5.32	32.76*	35.72**	17.14	-27.9**	-28.83**	-29.93**	-28.86**	0.64	-9.71	1.2	-2.73
ICMA 88004XBIB12	-0.98	15.28	-20.58	-0.44	-0.76	-0.84	-0.66	-0.75	-24.74**	-14.34	20.09*	-7.79
ICMA 98222XBIB12	9.11	41.86**	45.19**	28.62**	22.41**	23.05*	24.32**	23.23**	2.87	-10.42	-7.22	-4.68
ICMA 00444XBIB18	8.41	6.73	-6.47	4.24	5.77	5.9	6.38**	6.01	-16.31*	-0.17	4.99	-4.44
ICMA 04999XBIB18	-13.12	16.37	16.7	3.79	-24.13**	-24.94*	-25.86**	-24.95**	-6.69	-20.66	-26.81**	-17.47*
ICMA 07222XBIB18	-2.49	-7.89	-47.42**	-15.2	-10.86	-11.26	-11.56**	-11.22	-24.6**	-14.32	15.93*	-8.98
ICMA 07555XBIB18	-2.07	1.25	-40.56**	-10.36	-26.78**	-27.67**	-28.72**	-27.7**	-39.8**	-45.38**	-22.54**	-36.54**
ICMA 13666XBIB18	1.04	17.15	-24.26*	0.15	2.71	2.74	3.08	2.84	-3.67	-7.67	29.4**	4.85
ICMA 15222XBIB18	0.34	24.05	28.54**	14.97	-8.21	-8.52	-8.69**	-8.47	5.85	-1.72	-30.41**	-7.57
ICMA 88004XBIB18	-33.18**	-37.83**	-63.1**	-41.99**	-21.78**	-22.51*	-23.33**	-22.52**	-18.71*	-39.47**	13.9	-16.05
ICMA 98222XBIB18	-10.3	27.94*	16.89	8.84	2.2	2.21	2.53	2.31	4.35	-20.53	-12.62	-9.21
ICMA 00444XBIB19	12.44	-2.42	12.59	7.62	-14.53	-15.04	-15.52**	-15.02*	-16.27*	-6.29	5.14	-6.46
ICMA 04999XBIB19	-0.03	24.1	52.69**	20.71*	3.83	3.9	4.29*	4	4.59	-8.06	-18.09*	-6.5
ICMA 07222XBIB19	-16.27	-9.54	-44.72**	-21*	-5.55	-5.78	-5.83**	-5.72	-39.66**	-5.63	-39.25**	-27.93**

Crosses/hybrids	Dry stover yield per plant				Test weight				Harvest index			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 07555XBIB19	-27.07**	1.49	-22.78*	-16.68	-13.41	-13.89	-14.31**	-13.86	-18.73*	-6.6	-33.46**	-18.99*
ICMA 13666XBIB19	4.07	2.21	8.04	4.43	0.57	0.53	0.77	0.62	-29.88**	-26.06*	-31.79**	-29.15**
ICMA 15222XBIB19	0.75	31.17*	17.02	14.67	-18.41*	-19.04*	-19.7**	-19.03**	-27**	-31.27**	-20.95**	-26.65**
ICMA 88004XBIB19	9.53	38.26**	34.69**	25.06*	1.38	1.37	1.65	1.47	-15.56*	-26.11*	-18.92*	-20.16*
ICMA 98222XBIB19	19*	47.59**	16.8	27.82**	3.12	3.16	3.52	3.26	-12.52	-21.52*	6.98	-9.76
ICMA 00444XBIB55	24.02**	-7.44	-4.14	6.86	4.34	4.42	4.84*	4.53	-29.9**	-40.7**	-45.69**	-38.31**
ICMA 04999XBIB55	5.04	35.8**	44.16**	24.64*	22.51**	23.15*	24.43**	23.34**	-11.63	-21.11*	-19.2*	-17.13
ICMA 07222XBIB55	16.02	59.87**	21.84*	31.79**	2.2	2.21	2.53	2.31	-29.9**	-43.1**	-29.51**	-34.29**
ICMA 07555XBIB55	-15.97	35.36**	29.48**	11.9	-23.11**	-23.88*	-24.76**	-23.9**	-38.21**	-11.07	-11.65	-21.01*
ICMA 13666XBIB55	7.88	39.92**	13	19.61	-1.47	-1.57	-1.43	-1.49	-34.44**	-45.51**	-30.91**	-37.16**
ICMA 15222XBIB55	-2.06	8.97	41.9**	12.26	12.71	13.05	13.87**	13.19	3.79	-13.62	-15.49	-7.91
ICMA 88004XBIB55	3.58	23.19	-26.85*	2.58	7.92	8.11	8.69**	8.23	-14.27	-16.35	37.77**	0.58
ICMA 98222XBIB55	-9.12	12.42	-26.86*	-6.39	11.89	12.21	12.99**	12.35	16.85*	5.16	20.44*	13.93
ICMA 00444XBIB60	0.57	-20.77	-9.98	-8.99	11.79	12.1	12.88**	12.24	-26.19**	0.96	-11	-12.38
ICMA 04999XBIB60	-23.04**	0.79	-59.43**	-24.11*	-3.72	-3.89	-3.85	-3.82	-2.47	-26.03*	34.29**	0.48
ICMA 07222XBIB60	-15.97	-7.02	-31.39**	-16.8	11.49	11.79	12.55**	11.93	-7.52	-2.42	3.1	-2.6
ICMA 07555XBIB60	7.73	-33.61**	-8.61	-9.78	-25.15**	-25.99**	-26.96**	-26.01**	-45.86**	-21.94*	-52.44**	-39.66**
ICMA 13666XBIB60	-7.57	35.45**	1.71	8.77	25.87**	26.63**	28.06**	26.83**	8.04	-15.75	15.58	2.17
ICMA 15222XBIB60	6.39	13.74	22.53*	12.73	-2.7	-2.84	-2.75	-2.76	-1.32	4.98	-7.26	-0.95
ICMA 88004XBIB60	4.26	31.2*	-22.51*	6.55	-0.35	-0.42	-0.22	-0.33	-8.52	-15.95	3.1	-7.58
ICMA 98222XBIB60	2.84	62.74**	-32.09**	13.93	1.69	1.69	1.98	1.78	5.51	-36.16**	21.77**	-3.85
ICMA 00444XBIB61	21.81*	44.69**	30.38**	31.39**	-5.25	-5.47	-5.5**	-5.4	-17.74*	-21.11*	-16.38*	-18.48*
ICMA 04999XBIB61	11.1	43.91**	42.92**	29.59**	2.14	2.21	2.31	2.22	-0.19	-9.58	-5.65	-5.02
ICMA 07222XBIB61	-8.53	24.31	-26.74*	-2.22	-8.88	-9.15	-9.57**	-9.19	-14.27	-29.59**	20.6**	-9.07
ICMA 07555XBIB61	-15.83	-48.73**	-24.06*	-28.6**	1.73	1.79	1.87	1.8	-35.64**	-9.58	-30.25**	-25.13**
ICMA 13666XBIB61	-1.85	-1.17	-15.88	-5.05	1.33	1.37	1.43	1.37	-26.52**	-22.49*	3.93	-16.04
ICMA 15222XBIB61	-10.91	-25.31*	-29.69**	-20.2	4.49	4.63	4.84*	4.65	-18.12*	-41.53**	-41.11**	-32.98**

Crosses/hybrids	Dry stover yield per plant				Test weight				Harvest index			
	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled	E_1	E_2	E_3	Pooled
ICMA 88004XBIB61	-21.09*	-43.24**	-60.04**	-37.83**	1.84	1.89	1.98	1.9	-26.52**	-42.53**	-37.29**	-35.2**
ICMA 98222XBIB61	-5.91	7.33	-2.48	-0.74	0.51	0.53	0.55	0.53	-4.04	-9.25	2.11	-3.98
ICMA 00444XBIB95	-1.41	-5	-54.33**	-15.48	-0.51	-0.53	-0.55	-0.53	-26.52**	-37.46**	15.1	-17.81*
ICMA 04999XBIB95	11.48	1.53	-31.07**	-2.14	2.55	2.63	2.75	2.64	-28.82**	-28.79**	6.85	-18.15*
ICMA 07222XBIB95	-15.85	-6.13	17.21	-4.62	12.24	12.63	13.21**	12.68	-8.95	-14.92	-28.4**	-16.8
ICMA 07555XBIB95	9.11	-6.5	-9.89	-0.63	-5.71	-5.89	-6.16**	-5.92	-26.52**	0.31	-21.74**	-15.93
ICMA 13666XBIB95	6.83	52.04**	49.44**	32.01**	4.49	4.63	4.84*	4.65	6.57	-16.45	-17.89*	-8.6
ICMA 15222XBIB95	14.69	58.51**	13.33	28.7**	3.47	3.58	3.74	3.59	-10.42	-24.3*	16.02*	-7.25
ICMA 88004XBIB95	-1.35	-9.76	-43.62**	-14.4	-7.35	-7.58	-7.92**	-7.61	-23.14**	-38.14**	-15.11	-25.86**
ICMA 98222XBIB95	33.59**	21.74	-21.79*	16.22	1.84	1.89	1.98	1.9	-39.5**	-30**	-19.71*	-30.34**
ICMA 00444XBIB122	21.13*	36.81**	38.1**	30.4**	6.12	6.31	6.6**	6.34	-14.06	-27.34*	-30.2**	-23.42**
ICMA 04999XBIB122	5.1	24.77	6.99	12	13.47	13.89	14.53**	13.95	5.58	9.09	6.28	6.99
ICMA 07222XBIB122	15.85	-3.53	-26.88*	-0.9	-9.8	-10.1	-10.56**	-10.14	-32.56**	-9.91	19.39*	-9.3
ICMA 07555XBIB122	18.88*	-18.24	-38.43**	-7.23	-12.45	-12.84	-13.43**	-12.89	-51.74**	-28.54**	-16.14*	-33.18**
ICMA 13666XBIB122	-23.73**	19.08	-7.82	-5.84	6.53	6.73	7.04**	6.76	-8.48	-27.21*	8.04	-9.94
ICMA 15222XBIB122	12.1	63.39**	4.56	27.05**	-5.51	-5.68	-5.94**	-5.71	-15.89*	-31.94**	6.53	-14.67
ICMA 88004XBIB122	-6.99	66.14**	19.86	23.48*	-20.61**	-21.26*	-22.23**	-21.35**	15.33	-24.3*	14.89	1.68
ICMA 98222XBIB122	23.78**	77.82**	25.59*	41.9**	-0.92	-0.95	-0.99	-0.95	-17.73*	-36.01**	-4.7	-20.07*
BHB-1202	-32.04**	8.08	-3.58	-11.98	1.02	1.05	1.1	1.06	-28.22**	-43.57**	-29.05**	-33.71**
HHB-299	-7.31	11.18	-0.22	0.47	3.27	3.37	3.52	3.38	-17.46*	-28.04**	-21.17**	-22.18*
Total				**5**				**3**				**4**

*and ** represent significant at 5% &1% level of significance, respectively

CONCLUSIONS

The crosses *viz.*, ICMA 13666 x BIB 9, ICMA 98222 x BIB 12, ICMA 04999 x BIB 61, ICMA 13666 x BIB 95, ICMA 04999 x BIB 122 and ICMA 88004 x BIB 122 showed high and significant standard heterosis for grain yield and its attributing characters over the environments. These crosses were considered promising for their use in yield improvement because of having high heterotic effect for yield as well as some other component characters. The highest and desirable standard heterosis was recorded for the maximum values of standard heterosis were 22.38 (ICMA 04999 X BIB 51) for grain yield per plant and related traits were -8.64 (ICMA 98222 X BIB 60) for days to 50% flowering, -10.54 (ICMA 88004 X BIB 60) for days to maturity, 22.61 (ICMA 07222 X BIB 95) for plant height, 1.21 (ICMA 15222 X BIB 60) for total tillers per plant, 2.25 (ICMA 98222 X BIB 12) for effective tillers per plant, 10.69 (ICMA 07222 X BIB 55) for flag leaf area, 1.35 (ICMA 98222X BIB 12) for number of ear head per plot, 28.54 (ICMA 04999 X BIB 122) for ear head weight per plot, 41.86 (ICMA 13666 X BIB 19) for ear head length, 38.36 (ICMA 07222 X BIB 55) for ear head diameter, 22.27 (ICMA 04999 X BIB 61) for grain yield per plot, 41.9 (ICMA 98222 X BIB 122) for dry stover yield per plant, 26.83 (ICMA 13666 X BIB 60) for test weight and 6.99 (ICMA 04999 X BIB 122) for harvest index. This suggested potentiality of heterosis breeding in pearl millet.

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