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EXPLOITATION OF HETEROSIS FOR YIELD AND GRAIN ZINC ENRICHMENT IN RICE (*Oryza Sativa* L.)

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ABSTRACT

Exploitation of heterosis is an effective strategy for enhancing grain yield and nutritional quality in rice. The present investigation was undertaken to estimate heterosis for yield, yield-attributing traits and grain zinc (Zn) concentration using a line × tester mating design involving five CMS lines, twelve testers and sixty F hybrids. The experimental material, along with the parents and standard checks, was evaluated for twelve quantitative traits including grain yield and grain Zn content. Analysis of variance revealed highly significant differences among parents, hybrids and line × tester interactions for most of the traits, indicating the presence of substantial genetic variability and the importance of both additive and non-additive gene effects in controlling these characters. Considerable heterosis over the better parent and standard checks was recorded for grain yield and its component traits. The cross CMS 69A × IET 27984 exhibited the highest heterobeltiosis for grain yield (149.62% over the better parent), while several hybrids including CMS 11A × IET 28713, CMS 11A × IET 27984, CMS 52A × IET 27984, CMS 59A × IET 28713, CMS 64A × CR Dhan 315, CMS 69A × CR Dhan 411, CMS 69A × IET 28713, and CMS 69A × IET 27984 expressed significant positive standard heterosis for grain zinc concentration, ranging from approximately 74 to 88% over the standard check. These hybrids also exhibited desirable performance for important yield-contributing traits such as filled grains per panicle, spikelet fertility, and effective bearing tillers. The results indicate the existence of substantial exploitable heterosis for simultaneous improvement of grain yield and zinc enrichment. The identified superior hybrids represent promising genetic resources for the development of high-yielding, zinc-biofortified rice hybrids and warrant further multi-location evaluation before commercial utilization.

Key words: L x T mating design, Rice, Standard heterosis, heterobeltiosis, Zinc content.

Rice (*Oryza sativa* L.) is the staple food for more than 65% of the Indian population and contributes significantly to national food and nutritional security. India is the world's second-largest producer and consumer of rice, cultivating the crop across diverse agro-climatic aregions. With the continuous increase in population, shrinking agricultural land, and changing climatic conditions, enhancing rice productivity while improving its nutritional quality has become a major breeding objective. Therefore, the development of rice hybrids with superior yield potential and enhanced nutritional value is essential for ensuring sustainable food and nutrition security (Bouis *et al*. 2010).

The success of hybrid rice breeding depends on identifying genetically diverse parental lines with high combining ability that can produce hybrids expressing significant heterosis for yield and its component traits. Although remarkable progress has been made in increasing rice production, nutritional deficiencies remain a serious public health concern.

In India, the integration of conventional hybrid breeding with biofortification has gained increasing importance in response to national initiatives aimed at reducing malnutrition and improving dietary quality. Identifying parental lines with superior combining ability and evaluating the magnitude of heterosis for yield-related traits and grain zinc content are therefore critical steps in developing commercially viable zinc-biofortified rice hybrids. Such hybrids have the potential to enhance farmers' productivity while simultaneously improving the nutritional status of millions of rice consumers.

Therefore, the present investigation was undertaken to estimate heterosis for grain yield and its component traits, evaluate grain zinc concentration among experimental hybrids, and identify promising cross combinations suitable for the development of high-yielding, zinc-biofortified hybrid rice adapted to Indian conditions.

MATERIAL AND METHODS

The experiment was conducted at Regional Agricultural Research Station (RARS), Polasa, Jagtial (PJTAU) during *Kharif,* 2024. The crossing was effected in the Line X Tester mating design of Kempthorne (1957) during *Rabi,* 2023-24 to develop 70 F_1 hybrids by crossing between five (5) cytoplasmic

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male sterile (CMS) lines to twelve (12) Zn rich tester by clipping method. The experimental material for evaluation consisting of 70 F_1 hybrids, 5 B-lines and 12 testers during *Kharif,* 2024 along with two standard checks CR dhan 411 (check used for Zinc) and US-312 (hybrid check used for yield) in a Randomized Complete Block Design (RCBD) with two replications. The list of parents and the hybrids obtained by crossing the parents are presented in **Table 1.**

Twenty-five day's old seedlings were transplanted in the main field with a spacing of 15 x15 cm. All the recommended agronomic practices from transplanting to harvesting were followed correctly to raise a healthy crop. Morphological data were recorded for twelve quantitative characters *viz.,* days to 50% flowering, plant height, the number of effective tillers per plant, panicle length, number of filled grains per panicle, chaffy grin per panicle, total grains per panicle, spikelet fertility %, 1000 grain weight, grain yield per plot, grain per yield ha. and Zn content. For most of the trait's data was recorded on five randomly selected plants in each plot. In every replication whereas the data for days to 50% flowering, EBT, Plant height, panicle length and grain yield per plant were collected on plot basis. Zn content was estimated using brown rice grain with di-acid method at chemistry lab, RARS, Jagtial. Heterosis was estimated from mean values obtained from each replication according to Fehr (1987) and t-test performed.

Table 1. List of Lines, Testers and their hybrids evaluated in the present study

S. No.	Entry	S. No.	Entry	S. No.	Entry
	Lines (CMS lines)	26	CMS 11A x CR dhan 311	54	CMS 64A x IET 28701
1	CMS 11B	27	CMS 11A x IET 28713	55	CMS 64A x CR dhan 310
2	CMS 52B	28	CMS 11A x IET 28694	56	CMS 64A x CR dhan 411
3	CMS 59B	29	CMS 11A x IET 27984	57	CMS 64A x DR dhan 48
4	CMS 64B	30	CMS52A x IET 28701	58	CMS 64A x CGZR 1
5	CMS 69B	31	CMS 52A x CR dhan 310	59	CMS 64A x CR dhan 315
	Testers	32	CMS 52A x CR dhan 411	60	CMS 64A x IET 28703
6	IET 28701	33	CMS 52A x DR dhan 48	61	CMS 64A x IET 28704
7	CR dhan 310	34	CMS 52A x CGZR 1	62	CMS 64A x CR dhan 311
8	CR dhan 411	35	CMS 52A x CR dhan 315	63	CMS 64A x IET 28713
9	DRR dhan 48	36	CMS 52A x IET 28703	64	CMS 64A x IET 28694
10	CGZR 1	37	CMS 52A x IET 28704	65	CMS 64A x IET 27984
11	CR dhan 315	38	CMS 52A x CR dhan 311	66	CMS 69A x IET 28701
12	IET 28703	39	CMS 52A x IET 28713	67	CMS 69A x CR dhan 310
13	IET 28704	40	CMS 52A x IET 28694	68	CMS 69A x CR dhan 411
14	CR dhan 311	41	CMS 52A x IET 27984	69	CMS 69A x DR dhan 48
15	IET 28713	42	CMS 59A x IET 28701	70	CMS 69A x CGZR 1
16	IET 28694	43	CMS 59A x CR dhan 310	71	CMS 69A x CR dhan 315
17	IET 27984	44	CMS 59A x CR dhan 411	72	CMS 69A x IET 28703

S. No.	Entry	S. No.	Entry	S. No.	Entry
	Hybrids	45	CMS 59A x DR dhan 48	73	CMS 69A x IET 28704
18	CMS11A x IET 28701	46	CMS 59A x CGZR 1	74	CMS 69A x CR dhan 311
19	CMS 11A x CR dhan 310	47	CMS 59A x CR dhan 315	75	CMS 69A x IET 28713
20	CMS 11A x CR dhan 411	48	CMS 59A x IET 28703	76	CMS 69A x IET 28694
21	CMS 11A x DR dhan 48	49	CMS 59A x IET 28704	77	CMS 69A x IET 27984
22	CMS 11A x CGZR 1	50	CMS 59A x CR dhan 311		**Checks**
23	CMS 11A x CR dhan 315	51	CMS 59A x IET 28713	78	CRdhan-411(Varietal check)
24	CMS 11A x IET 28703	52	CMS 59A x IET 28694		
25	CMS 11A x IET 28704	53	CMS 59A x IET 27984	79	US 312 (Hybrid check)

RESULTS AND DISCUSSION

Analysis of variance presented in **Table 2**, exhibited significant differences among different lines for various characters under study, days to 50% flowering, plant height, panicle length, 1000-grain weight, grain yield per plot, grain yield per ha. and days to 50% flowering, plant height, panicle length, the number of filled grains per panicle, spikelet fertility %, 1000-grain weight, grain yield per plot, grain yield per ha and grain Zn content for variances among testers. The variances among crosses were highly significant for all crosses except plant length and EBT. This showed that there is sufficient variability in the material included in the study and can be exploited. These findings confirm with the reports of Rudresha Naik *et al.* (2021), Karthikeyan *et al.* (2010), Saidaiah *et al.* (2011) who reported significant variability for different yield and yield contributing attributes in genotypes of rice. Similar observations have been reported by Gramaje *et al*. (2020), and Pradhan *et al*. (2022), who demonstrated that adequate genetic diversity among parental lines is essential for achieving higher heterosis in rice.

Heterosis is the F1's superiority, which shows increased or decreased performance over better parent value (heterobeltiosis) and standard heterosis (standard check variety). The results obtained from the experimental findings for yield, yield-related traits and grain Zinc content was computed over better parents (heterobeltiosis) and presented in **Table 3** and for standard heterosis over both checks (CR dhan 411 and US-312) is presented in **Table 4.**

The comparison of parents versus crosses was significant for most characters, indicating the superiority of hybrids over their parental lines and confirming the presence of heterosis. Significant mean squares for lines, testers, and line × tester interactions suggested that both additive and non-additive gene effects contributed to the inheritance of the traits. However, the significant line × tester interaction for grain yield and grain zinc content indicated the predominance of non-additive gene action, which favours the exploitation of heterosis through hybrid breeding.

Better Parent Heterosis

Substantial variability in better-parent heterosis was observed among the sixty hybrids for all the characters studied. Negative heterosis for days to 50% flowering, considered desirable for earliness, ranged up to "12.37%, with crosses such as CMS 64A × CGZR 1, CMS 52A × DR Dhan 48, CMS 11A × IET 28703, CMS 64A x CR dhan 315 and CMS 69A × CR Dhan 411 exhibiting significant earliness over their better parents. Similar findings have been reported by Kumar *et al.* (2017), and Thorat *et al*. (2017), who observed substantial negative heterosis for flowering time in diverse rice hybrids.

Positive heterosis for effective bearing tillers per plant and number of filled grains per panicle was observed in several hybrids, reflecting improved sink capacity. The cross CMS 69A × CR Dhan 315 exhibited the highest better-parent heterosis (58.43%) for effective tillers, while CMS 69A × CR Dhan 411 recorded exceptionally high heterosis (463.64%) for filled grains per panicle. Similar improvements were observed in CMS 52A × CR Dhan 310, CMS 11A × DR Dhan 48, and CMS 59A × CR Dhan 411, indicating the contribution of both increased grain number and sink size to enhanced productivity.

Grain yield exhibited wide variation in better-parent heterosis, ranging from highly negative values to a maximum of 149.62% in CMS 69A × IET 27984, followed by CMS 11A × IET 27984 (56.30%), CMS 69A × IET 28701 (46.75%), CMS 59A × CR Dhan 310 (46.52%), and CMS 11A × IET 28701 (46.08%). These hybrids also showed superiority for one or more component traits, suggesting that increased grain yield resulted from cumulative improvements in productive tillers, filled grains, and spikelet fertility. Similar associations between heterosis for yield and improvements in sink-related traits have been documented by Yuan (1987), Virmani (1994) and Gramaje *et al.* (2020), who reported that increased numbers of productive tillers, higher filled grain percentage, and improved spikelet fertility are the principal contributors to superior hybrid performance.

Grain zinc concentration also exhibited considerable heterosis. Positive better-parent heterosis was observed in several hybrids, with the highest value of 17.45% recorded in CMS 69A × CR Dhan 411, followed by CMS 59A × CR Dhan 411 (12.95%), CMS 52A × CR Dhan 411 (12.51%), CMS 69A × IET 27984 (11.80%), and CMS 11A × IET 27984 (10.67%). These hybrids are particularly valuable because they combine high productivity with enhanced nutritional quality, making them promising candidates for biofortified hybrid rice development.

Standard Heterosis

Standard heterosis over the commercial checks (CR Dhan 411 and US 312) also varied considerably among the hybrids. Significant negative standard heterosis for days to 50% flowering was observed in most crosses, indicating the possibility of developing early-maturing hybrids without compromising productivity.

Among the hybrids, CMS 59A × CR Dhan 411 exhibited 50.00% standard heterosis for grain yield over CR Dhan 411 and 122.45% over US 312. Likewise, CMS 11A × CR Dhan 411, CMS 69A × IET 27984, CMS 59A × IET 28713, and CMS 69A × IET 28701 showed substantial positive standard heterosis for grain yield, indicating their superiority over the existing commercial hybrids. Similar levels of standard heterosis have been reported by Singh *et al*. (2018), Hasan *et al*. (2015), and Pradhan *et al*. (2022), highlighting the importance of selecting genetically diverse parental combinations to maximize hybrid performance.

For grain zinc concentration, the highest standard heterosis over US 312 was observed in CMS 59A × IET 28713 (88.28%), followed closely by CMS 69A × IET 27984 (87.06%), CMS 11A × IET 28713 (85.20%), CMS 69A × CR Dhan 411 (85.02%), CMS 11A × IET 27984 (85.16%), and CMS 52A × IET 27984 (88.06%). These hybrids demonstrated simultaneous improvement in grain yield and zinc concentration, highlighting their potential for developing nutritionally enriched hybrid rice varieties. Similar conclusions have been reported by Swamy *et al*. (2016), Pradhan *et al*. (2020), and Anandan *et al.* (2022), who demonstrated that grain zinc concentration can be improved without significant yield penalties when suitable parental combinations are utilized.

The significant heterosis observed for grain yield and its associated traits demonstrates the effectiveness of exploiting non-additive gene action in hybrid rice breeding. The identification of hybrids exhibiting concurrent superiority for grain yield and grain zinc concentration is particularly important in the context of nutritional security. Hybrids such as CMS 69A × IET 27984, CMS 69A × CR Dhan 411, CMS 59A × CR Dhan 411, and CMS 11A × IET 27984 combined high grain yield with enhanced zinc content, suggesting that improvement in micronutrient density need not compromise productivity. These hybrids therefore represent valuable genetic materials for the development of biofortified hybrid rice suitable for cultivation and future breeding programmes.

Overall, the present investigation demonstrated ample scope for exploiting heterosis to improve both grain yield and grain zinc concentration. The identified superior hybrids warrant further multi-location evaluation for stability, combining ability, and commercial exploitation.

Table 2. Analysis of variance for different traits of rice.

	DF	Days to 50% flowering	effective bearing tillers/plant	plant hight (cm)	panicle length (cm)	1000 grain weight (gr)	No of grains filled/ panicle	Chaff grains	Total Grains	Spikelet fertility %	Yield (kg/plot)	Yield (kg/ha)	Zn (ppm)
Replications	1	37.408 *	108.680 *	56.307	51.877 *	6.302	83.333	57.408	270	4.022	0.006 *	2123398.000 *	0.43
Parents	16	100.73529	2.4936	221.70968	12.32836	8.22283	435.67279	265.84191	434.04779	238.102	0.03417	11719057.9	46.53209
Lines	4	80.404 *	8.401	283.345 *	19.983 *	29.884 *	1652.654	114.804	2038.846	132.137	0.134 *	46082540.00 *	11.846
Testers	11	211.627 *	2.772	357.244 *	8.054	22.260 *	4238.061 *	758.317	3635.306 *	912.581 *	0.110 *	37639950.00 *	333.482 *
Lines x Testers	44	12.931 *	3.897	56.897 *	4.441	9.340 *	1527.309 *	414.304 *	1165.050 *	449.527 *	0.033 *	11460080.00 *	9.615 *
Parents vs Crosses	1	8.1722	5.9702	434.9385	58.54378	0.44135	1535.7972	7735.86632	16115.98291	4895.86992	0.0563	19306075.29	161.55599
Crosses	59	54.551 *	3.993	128.246 *	6.168	13.141 *	2041.201*	458.137 *	1684.847 *	514.341 *	0.054 *	18688360.00 *	70.148 *
Error	76	0.781	4.885	17.646	5.113	1.746	150.028	82.561	195.085	64.036	0.001	50838.2	0.364

Table 3. Percentage heterosis of F_1 crosses over better parent for various characters in rice.

Crosses	Days to 50% flowering	effective bearing tillers/ plant	plant height (cm)	panicle length (cm)	1000 grain weight (gr)	No of filled grains / panicle	Chaff grains/ panicle	Total Grains/ panicle	Spikelet fertility %	Yield (kg/plot)	Yield (kg/ha)	Zn (ppm)
CMS11A x IET 28701	-3.61 *	6.93	-1.34	-3.47	-12.04	71.98 *	62.07	73.08 *	-0.89	46.08 *	46.08 *	-27.84 *
CMS 11A x CR dhan 310	-6.45 *	-29.17	-9.25 *	-3.68	0.45	28.13	262.07 *	86.81 *	-31.11 *	-39.22 *	-39.22 *	-20.78 *
CMS 11A x CR dhan 411	-9.22 *	-12	16.13 *	7.9	0.46	105.48 *	51.72	104.76 *	-0.33	25.63 *	25.63 *	10.63 *
CMS 11A x DR dhan 48	-7.88 *	-9.71	10.65 *	6.26	-14.35 *	44.67 *	286.21 *	97.01 *	-25.56 *	-7.41	-7.41	-21.20 *
CMS 11A x CGZR 1	-3.01	-2.78	-11.13 *	-14.24	-13.18 *	-61.35 *	206.90 *	-20.94	-51.65 *	-37.83 *	-37.83 *	-40.90 *
CMS 11A x CR dhan 315	-0.61	3	-7.64	2.02	-6.94	29.13	0	21.82	4.21	-59.62 *	-59.62 *	-15.32 *
CMS 11A x IET 28703	-9.73 *	-6.28	1.9	-2	-6.35	-39.19 *	282.76 *	17.54	-49.13 *	-48.81 *	-48.80 *	-12.15 *
CMS 11A x IET 28704	-5.43 *	6.5	-2	-4.92	-7.97	-28.57 *	117.24 *	1.05	-28.94 *	-29.59 *	-29.59 *	-27.64 *
CMS 11A x CR dhan 311	-1.15	-26.03	0.44	-2.56	-21.76 *	0.53	124.14 *	25.74	-19.85 *	-7.96	-7.96	-39.22 *
CMS 11A x IET 28713	-8.76 *	4.5	-1.36	10.97	-7.2	10.84	55.17	26.52	-11.85	-26.19 *	-26.19 *	6.82 *
CMS 11A x IET 28694	-0.54	-8	-14.22 *	4.87	-7.81	-7.64	150.00 *	21.02	-22.76 *	-25.46 *	-25.46 *	-50.99 *
CMS 11A x IET 27984	-4.30 *	-7	5.42	3.85	-8.07	-7.19	55.17	9.43	-15.58	56.30 *	56.30 *	10.67 *
CMS52A x IET 28701	-9.79 *	-32.67	13.27 *	-2.26	-6.24	-18.68	203.85 *	9.62	-25.99 *	-1.39	-1.4	-51.72 *
CMS 52A x CR dhan 310	-4.30 *	-10	-10.06 *	7.54	-8.91	56.25 *	317.39 *	105.56 *	-23.73 *	-66.87 *	-66.87 *	-30.14 *
CMS 52A x CR dhan 411	-4.85 *	0	15.74 *	20.37 *	-8.91	54.11 *	195.65 *	74.40 *	-11.58	-40.71 *	-40.72 *	12.51 *
CMS 52A x DR dhan 48	-10.34 *	-3.4	5.98	13.99	-0.67	-5.33	-43.48	-7.19	2.78	-44.20 *	-44.20 *	-26.84 *
CMS 52A x CGZR 1	-2.41	-21.76	-4.32	-9.15	-46.23 *	-66.26 *	421.43 *	5.24	-69.72 *	-65.13 *	-65.13 *	-53.64 *
CMS 52A x CR dhan 315	-0.6	33.86	3.67	18.95 *	-10.02	45.67 *	7.89	37.58 *	0.55	-79.69 *	-79.69 *	-16.29 *
CMS 52A x IET 28703	-3.24 *	-16.59	10.89 *	22.65 *	4.9	25.68	34.78	26.32	-1.38	-36.44 *	-36.44 *	-46.58 *
CMS 52A x IET 28704	-1.09	-3.7	0.2	-5.46	-0.42	-46.15 *	178.26 *	-15.18	-35.90 *	-55.45 *	-55.45 *	-31.78 *

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Crosses	Days to 50% flowering	effective bearing tillers/ plant	plant height (cm)	panicle length (cm)	1000 grain weight (gr)	No of filled grains / panicle	Chaff grains/ panicle	Total Grains/ panicle	Spikelet fertility %	Yield (kg/plot)	Yield (kg/ha)	Zn (ppm)
CMS 52A x CR dhan 311	2.3	-16.44	7.86 *	-8.06	-2	-31.38 *	117.39	-11.39	-22.87 *	-49.43 *	-49.43 *	-32.86 *
CMS 52A x IET 28713	-4.12 *	-17	2.54	18.63	3.39	12.05	82.61	25.97	-11	-53.44 *	-53.44 *	4.57
CMS 52A x IET 28694	-0.54	31.58	-14.40 *	7.11	-16.92 *	-20.83	0	-17.61	-3.81	-57.28 *	-57.28 *	-51.59 *
CMS 52A x IET 27984	-2.15	- 6.63	4.24	15.96	10.19	8.63	56.52	17.61	-7.71	-39.84 *	-39.84 *	12.40 *
CMS 59A x IET 28701	6.70 *	38.61	0.97	-0.52	-8.54	-26.92 *	-37.23 *	-12.33	-20.73 *	-23.37 *	-23.37 *	-48.16 *
CMS 59A x CR dhan 310	-3.76 *	-21.25	-2.56	8.77	7.48	48.44 *	-30.85	15.98	-16.08	46.52 *	46.52 *	-35.07 *
CMS 59A x CR dhan 411	-6.31 *	13.78	5.33	15.91	-5.68	123.97 *	-56.38 *	67.58 *	2.1	-10.67	-10.67	12.95 *
CMS 59A x DR dhan 48	-5.42 *	-17.48	9.15 *	7.27	-8.65	91.33 *	-32.98	59.82 *	-8.11	-4.83	-4.83	-44.04 *
CMS 59A x CGZR 1	-6.08 *	-15.28	-3.53	-13.05	7.11	-0.61	-38.30 *	0.46	-14.12	-60.10 *	-60.10 *	-48.41 *
CMS 59A x CR dhan 315	-8.29 *	9.5	-3.47	4.72	1.02	-67.72 *	40.43 *	-21	-68.92 *	-41.41 *	-41.41 *	-16.08 *
CMS 59A x IET 28703	-3.78 *	4.04	-0.3	0	-4.54	27.03	-68.09 *	-0.46	-0.21	-54.96 *	-54.96 *	-38.79 *
CMS 59A x IET 28704	-0.54	21.69	-2.15	-2.37	-10.69	-48.90 *	-36.17 *	-29.68 *	-34.85 *	-67.46 *	-67.46 *	-25.92 *
CMS 59A x CR dhan 311	-1.66	-3.2	3.82	-9.16	0.96	-37.77 *	28.72	8.68	-47.10 *	-50.55 *	-50.55 *	-14.53 *
CMS 59A x IET 28713	-1.55	-10.5	-3.31	7.27	-5.51	76.51 *	-86.17 *	40.18 *	4.1	3.69	3.69	8.60 *
CMS 59A x IET 28694	-0.54	12.11	-2.93	12.38	-4.99	-11.11	-19.15	-6.39	-23.56 *	-56.69 *	-56.69 *	-37.95 *
CMS 59A x IET 27984	-0.54	18.88	5.53	-1.35	2.34	-9.35	-62.77 *	-26.03 *	-10.39	-32.01 *	-32.01 *	-1.99
CMS 64A x IET 28701	1.03	- 7.92	0.79	-6.25	2.2	-32.97 *	14.63	2.88	-35.28 *	-36.92 *	-36.92 *	-56.86 *
CMS 64A x CR dhan 310	-0.54	- 8.75	-4.69	-10	7.71	25	-20.73	17.8	-20.86 *	1.94	1.94	-44.65 *
CMS 64A x CR dhan 411	-10.19 *	-5.1	12.03 *	-4.03	-6.91	36.99 *	-37.8	31.41 *	-8.27	-40.69 *	-40.69 *	5.44 *
CMS 64A x DR dhan 48	-2.46	1.46	7.55	1.21	-15.26 *	10.67	-51.22 *	8.38	-9.84	-42.64 *	-42.64 *	-24.49 *
CMS 64A x CGZR 1	-12.37 *	-	-0.35	-14.24	-11.09	-11.66	19.51	26.7	-30.52 *	-49.03 *	-49.03 *	-44.96 *

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Crosses	Days to 50% flowering	effective bearing tillers/ plant	plant height (cm)	panicle length (cm)	1000 grain weight (gr)	No of filled grains / panicle	Chaff grains/ panicle	Total Grains/ panicle	Spikelet fertility %	Yield (kg/plot)	Yield (kg/ha)	Zn (ppm)
CMS 64A x CR dhan 315	-11.83 *	41.25	-17.86 *	6.05	-8.44	-46.46 *	-7.32	-24.61	-42.17 *	-49.75 *	-49.75 *	-0.4
CMS 64A x IET 28703	-6.99 *	3.14	-1.95	14.83	0.68	26.35	-76.83 *	7.85	4.43	27.57 *	27.57 *	-39.02 *
CMS 64A x IET 28704	-1.61	-24.34	-5.94	-6.01	-6.5	-29.67 *	9.76	14.14	-37.10 *	-41.29 *	-41.29 *	-22.68 *
CMS 64A x CR dhan 311	-0.54	- 9.13	-10.08 *	-8.61	-4.55	-26.06 *	6.1	11.88	-32.99 *	-29.04 *	-29.04 *	-7.77 *
CMS 64A x IET 28713	-3.61 *	23	-9.38 *	11.69	3.18	-6.02	-54.88 *	1.05	-11.94	-72.10 *	-72.10 *	3.8
CMS 64A x IET 28694	9.14 *	18.95	-21.16 *	3.23	-18.66 *	40.28 *	-41.46 *	30.89 *	-1.75	-44.40 *	-44.40 *	-47.83 *
CMS 64A x IET 27984	0.54	6.63	-4.75	-2.12	-8.07	-71.22 *	-14.63	-42.41 *	-58.27 *	0.31	0.31	7.52 *
CMS 69A x IET 28701	-4.64 *	21.78	7.12	-0.69	12.93	23.08	57.69	27.40 *	-3.3	46.75 *	46.75 *	-47.75 *
CMS 69A x CR dhan 310	-4.30 *	-11.25	2.73	-5.96	-4.54	-25.78	325.00 *	25	-40.71 *	-8.75	-8.75	-19.77 *
CMS 69A x CR dhan 411	-9.22 *	1.53	20.86 *	5.82	11.11	-8.9	463.64 *	52.98 *	-40.89 *	-9.94	-9.94	17.45 *
CMS 69A x DR dhan 48	-7.88 *	17.96	1.96	2.92	5.25	33.33 *	150	49.70 *	-10.29	-0.75	-0.75	-40.63 *
CMS 69A x CGZR 1	1.2	4.63	6.46	-5.25	-11.72 *	-19.02	171.43 *	9.42	-24.60 *	0.73	0.73	-44.73 *
CMS 69A x CR dhan 315	-1.83	58.43 *	-7.24	-2.02	14.00 *	7.87	176.32 *	46.06 *	-31.24 *	-31.91	-31.91	0.82
CMS 69A x IET 28703	-9.19 *	-16.59	10.54 *	13.63	5.67	-8.78	56.52	0	-8.84	27.57 *	27.57 *	-45.18 *
CMS 69A x IET 28704	-8.70 *	0.53	3.05	-6.56	18.87 *	-61.54 *	115	-40.84 *	-37.20 *	-53.09 *	-53.09 *	-55.23 *
CMS 69A x CR dhan 311	4.60 *	3.2	-8.74 *	-2.93	19.38 *	-65.96 *	235.00 *	-35.15 *	-48.58 *	-32.34 *	-32.34 *	-57.70 *
CMS 69A x IET 28713	-4.64 *	11.5	-0.14	7.45	5.72	-21.08	60	-9.94	-12.03	33.48 *	33.48 *	0.76
CMS 69A x IET 28694	-0.54	12.11	-11.68 *	-0.43	-0.22	-7.64	150.00 *	20.45	-24.73 *	5.77	5.77	-50.77 *
CMS 69A x IET 27984	-3.76 *	13.78	1.69	14.62	-0.21	51.08 *	90	56.60 *	-3.7	149.62 *	149.62 *	11.80 *

Table 4. Percentage heterosis of F_1 crosses over standard checks for various characters in rice.

Crosses	Days to 50% flowering		Effective bearing tillers/plant		Plant height(cm)		Panicle length(cm)		1000 grain weight(gr)		No of filled grains / Panicle	
	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312
CMS11A x IET 28701	-9.22 *	-6.97 *	8	44	16.56 *	-4.05	2.96	6.53	13.1	-2.81	43.58 *	112.93 *
CMS 11A x CR dhan 310	-15.53 *	-13.43 *	-15	13.33	16.34 *	-4.23	1.67	5.19	31.85 *	13.3	-24.77 *	11.56
CMS 11A x CR dhan 411	-9.22 *	-6.97 *	-12	17.33	10.16 *	-9.31 *	-3.89	-0.56	29.17 *	11	37.61 *	104.08 *
CMS 11A x DR dhan 48	-9.22 *	-6.97 *	-7	24	11.26 *	-8.41 *	-5.74	-2.47	10.12	-5.37	-0.46	47.62 *
CMS 11A x CGZR 1	-21.84 *	-19.90 *	5	40	-2.24	-19.52 *	-6.3	-3.05	23.51 *	6.14	-71.10 *	-57.14 *
CMS 11A x CR dhan 315	-20.87 *	-18.91 *	3	37.33	1.75	-16.24 *	-6.3	-3.05	19.64 *	2.81	-24.77 *	11.56
CMS 11A x IET 28703	-18.93 *	-16.92 *	4.5	39.33	11.48 *	-8.23 *	-9.44	-6.3	22.92 *	5.63	-58.72 *	-38.78 *
CMS 11A x IET 28704	-15.53 *	-13.43 *	6.5	42	7.21	-11.74 *	-3.33	0.02	30.65 *	12.28	-40.37 *	-11.56
CMS 11A x CR dhan 311	-16.50 *	-14.43 *	-19	8	23.66 *	1.8	-1.48	1.94	0.6	-13.55	-13.3	28.57
CMS 11A x IET 28713	-14.08 *	-11.94 *	4.5	39.33	18.91 *	-2.11	-0.74	2.7	30.36 *	12.02	-15.6	25.17
CMS 11A x IET 28694	-10.19 *	-7.96 *	-8	22.67	8.74	-10.48 *	-4.63	-1.32	26.49 *	8.7	-38.99 *	-9.52
CMS 11A x IET 27984	-13.59 *	-11.44 *	-7	24	12.68 *	-7.24	0	3.47	28.87 *	10.74	-40.83 *	-12.24
CMS52A x IET 28701	-15.05 *	-12.94 *	-32	-9.33	33.83 *	10.17 *	4.26	7.88	25.30 *	7.67	-32.11 *	0.68
CMS 52A x CR dhan 310	-13.59 *	-11.44 *	8	44	15.30 *	-5.08	13.52	17.46	21.73 *	4.6	-8.26	36.05 *
CMS 52A x CR dhan 411	-4.85 *	-2.49	-2	30.67	10.87 *	-8.73 *	7.22	10.94	21.73 *	4.6	3.21	53.06 *
CMS 52A x DR dhan 48	-11.65 *	-9.45 *	-0.5	32.67	6.56	-12.28 *	1.11	4.62	32.74 *	14.07	-34.86 *	-3.4
CMS 52A x CGZR 1	-21.36 *	-19.40 *	-15.5	12.67	5.25	-13.36 *	-0.74	2.7	-23.51 *	-34.27 *	-74.77 *	-62.59 *
CMS 52A x CR dhan 315	-19.90 *	-17.91 *	26.5	68.67 *	14.21 *	-5.98	9.26	13.05	20.24 *	3.32	-15.14	25.85
CMS 52A x IET 28703	-13.11 *	-10.95 *	-7	24	21.31 *	-0.13	13.33	17.26	40.18 *	20.46 *	-14.68	26.53
CMS 52A x IET 28704	-11.65 *	-9.45 *		21.33	9.62 *	-9.76 *	-3.89	-0.56	41.37 *	21.48 *	-55.05 *	-33.33 *
CMS 52A x CR dhan 311	-13.59 *	-11.44 *	-8.5	22	32.79 *	9.31 *	-7.04	-3.81	30.95 *	12.53	-40.83 *	-12.24
CMS 52A x IET 28713	-9.71 *	-7.46 *	-17	10.67	23.61 *	1.75	6.11	9.79	45.24 *	24.81 *	-14.68	26.53
CMS 52A x IET 28694	-10.19 *	-7.96 *	25	66.67 *	8.52	-10.66 *	-2.59	0.79	13.99	-2.05	-47.71 *	-22.45
CMS 52A x IET 27984	-11.65 *	-9.45 *	-8.5	22	11.42 *	-8.28 *	11.67	15.54	54.46 *	32.74 *	-30.73 *	2.72
CMS 59A x IET 28701	0.49	2.99 *	40	86.67 *	19.29 *	-1.8	6.11	9.79	11.61	-4.09	-38.99 *	-9.52
CMS 59A x CR dhan 310	-13.11 *	-10.95 *	-5.5	26	24.92 *	2.83	14.81	18.80 *	41.07 *	21.23 *	-12.84	29.25
CMS 59A x CR dhan 411	-6.31 *	-3.98 *	11.5	48.67	14.54 *	-5.71	9.26	13.05	13.69	-2.3	50.00 *	122.45 *
CMS 59A x DR dhan 48	-6.80 *	-4.48 *	-15	13.33	18.69 *	-2.29	1.11	4.62	6.85	-8.18	31.65 *	95.24 *
CMS 59A x CGZR 1	-17.48 *	-15.42 *	-8.5	22	6.12	-12.64 *	-5	-1.71	52.38 *	30.95 *	-25.69 *	10.2
CMS 59A x CR dhan 315	-19.42 *	-17.41 *	-2	30.67	6.34	-12.46 *	-1.3	2.13	18.15 *	1.53	-81.19 *	-72.11 *

Contd..

Crosses	Days to 50% flowering		Effective bearing tillers/plant		Plant height(cm)		Panicle length(cm)		1000 grain weight(gr)		No of filled grains / Panicle	
	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312
CMS 59A x IET 28703	-13.59 *	-11.44 *	16	54.67	9.07	-10.21 *	-5.74	-2.47	25.30 *	7.67	-13.76	27.89
CMS 59A x IET 28704	-11.17 *	-8.96 *	15	53.33	7.05	-11.88 *	-0.74	2.7	26.79 *	8.95	-57.34 *	-36.73 *
CMS 59A x CR dhan 311	-13.59 *	-11.44 *	6	41.33	27.81 *	5.22	-8.15	-4.96	25.60 *	7.93	-46.33 *	-20.41
CMS 59A x IET 28713	-7.28 *	-4.98 *	-10.5	19.33	16.56 *	-4.05	1.11	4.62	32.74 *	14.07	34.40 *	99.32 *
CMS 59A x IET 28694	-10.19 *	-7.96 *	6.5	42	23.06 *	1.3	5.93	9.6	30.36 *	12.02	-41.28 *	-12.93
CMS 59A x IET 27984	-10.19 *	-7.96 *	16.5	55.33	14.75 *	-5.53	-5	-1.71	43.45 *	23.27 *	-42.20 *	-14.29
CMS 64A x IET 28701	-4.85 *	-2.49	-7	24	19.07 *	-1.98	0	3.47	24.70 *	7.16	-44.04 *	-17.01
CMS 64A x CR dhan 310	-10.19 *	-7.96 *	9.5	46	22.19 *	0.58	-5	-1.71	41.37 *	21.48 *	-26.61 *	8.84
CMS 64A x CR dhan 411	-10.19 *	-7.96 *	-7	24	6.89	-12.01 *	-11.85	-8.79	12.2	-3.58	-8.26	36.05 *
CMS 64A x DR dhan 48	-3.88 *	-1.49	4.5	39.33	8.14	-10.98 *	-7.04	-3.81	-7.44	-20.46 *	-23.85 *	12.93
CMS 64A x CGZR 1	-20.87 *	-18.91 *	-2	30.67	9.62 *	-9.76 *	-6.3	-3.05	26.49 *	8.7	-33.94 *	-2.04
CMS 64A x CR dhan 315	-20.39 *	-18.41 *	13	50.67	-9.51 *	-25.51 *	-2.59	0.79	6.55	-8.44	-68.81 *	-53.74 *
CMS 64A x IET 28703	-16.02 *	-13.93 *	15	53.33	7.27	-11.70 *	6.11	9.79	32.14 *	13.55	-14.22	27.21
CMS 64A x IET 28704	-11.17 *	-8.96 *	-28.5	-4.67	2.9	-15.29 *	-4.44	-1.13	32.74 *	14.07	-41.28 *	-12.93
CMS 64A x CR dhan 311	-10.19 *	-7.96 *	-0.5	32.67	10.71 *	-8.86 *	-7.59	-4.39	18.75 *	2.05	-36.24 *	-5.44
CMS 64A x IET 28713	-9.22 *	-6.97 *	23	64.00 *	9.23	-10.08 *	2.59	6.15	44.94 *	24.55 *	-28.44 *	6.12
CMS 64A x IET 28694	-1.46	1	13	50.67	-0.05	-17.72 *	-5.19	-1.9	11.61	-4.09	-7.34	37.41 *
CMS 64A x IET 27984	-9.22 *	-6.97 *	4.5	39.33	1.8	-16.19 *	-5.74	-2.47	28.87 *	10.74	-81.65 *	-72.79 *
CMS 69A x IET 28701	-10.19 *	-7.96 *	23	64.00 *	26.56 *	4.18	5.93	9.6	37.80 *	18.41 *	2.75	52.38 *
CMS 69A x CR dhan 310	-13.59 *	-11.44 *	6.5	42	31.69 *	8.41 *	-0.74	2.7	25.30 *	7.67	-56.42 *	-35.37 *
CMS 69A x CR dhan 411	-9.22 *	-6.97 *	-0.5	32.67	16.17 *	-4.36	-5.74	-2.47	33.93 *	15.09 *	-38.99 *	-9.52
CMS 69A x DR dhan 48	-9.22 *	-6.97 *	21.5	62.00 *	2.51	-15.61 *	-8.7	-5.54	25.30 *	7.67	-8.26	36.05 *
CMS 69A x CGZR 1	-18.45 *	-16.42 *	13	50.67	17.10 *	-3.6	3.52	7.11	25.60 *	7.93	-39.45 *	-10.2
CMS 69A x CR dhan 315	-21.84 *	-19.90 *	31.5	75.33 *	2.19	-15.88 *	-10	-6.88	35.71 *	16.62 *	-37.16 *	-6.8
CMS 69A x IET 28703	-18.45 *	-16.42 *	-7	24	20.93 *	-0.45	5	8.64	38.69 *	19.18 *	-38.07 *	-8.16
CMS 69A x IET 28704	-18.45 *	-16.42 *	-5	26.67	12.73 *	-7.2	-5	-1.71	68.75 *	45.01 *	-67.89 *	-52.38 *
CMS 69A x CR dhan 311	-11.65 *	-9.45 *	13	50.67	12.35 *	-7.51	-1.85	1.55	48.51 *	27.62 *	-70.64 *	-56.46 *
CMS 69A x IET 28713	-10.19 *	-7.96 *	11.5	48.67	20.38 *	-0.9	-3.89	-0.56	48.51 *	27.62 *	-39.91 *	-10.88
CMS 69A x IET 28694	-10.19 *	-7.96 *	6.5	42	11.97 *	-7.83 *	-9.44	-6.3	36.90 *	17.65 *	-38.99 *	-9.52
CMS 69A x IET 27984	-13.11 *	-10.95 *	11.5	48.67	8.69	-10.53 *	10.37	14.2	39.88 *	20.20 *	-3.67	42.86 *

Table 4 (cont..). Percentage heterosis of F_1 crosses over standard checks for various characters in rice.

Crosses	Chaff grains		Total Grains		Spikelet fertility %		Yield (kg/plot)		Yield (kg/ha)		Zn (ppm)	
	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312
CMS11A x IET 28701	213.33	135	53.85 *	115.57 *	-7.24	-1.68	41.57 *	2.71	41.57 *	2.71	-31.37 *	7.67
CMS 11A x CR dhan 310	600.00 *	425.00 *	14.96	61.08 *	-34.52 *	-30.60 *	-45.95 *	-60.78 *	-45.95 *	-60.78 *	-28.06 *	12.87 *
CMS 11A x CR dhan 411	193.33	120	47.01 *	105.99 *	-7.16	-1.6	54.57 *	12.14	54.57 *	12.14	11.08 *	74.27 *
CMS 11A x DR dhan 48	646.67 *	460.00 *	40.60 *	97.01 *	-28.99 *	-24.73 *	10.94	-19.51 *	10.94	-19.51 *	-10.30 *	40.72 *
CMS 11A x CGZR 1	493.33 *	345.00 *	-35.47 *	-9.58	-55.79 *	-53.14 *	-34.23 *	-52.29 *	-34.23 *	-52.29 *	-46.06 *	-15.38 *
CMS 11A x CR dhan 315	153.33	90	-14.1	20.36	-13.13	-7.93	-64.09 *	-73.95 *	-64.09 *	-73.95 *	-3.66	51.15 *
CMS 11A x IET 28703	640.00 *	455.00 *	-14.1	20.36	-52.82 *	-50.00 *	-28.31 *	-47.99 *	-28.31 *	-47.99 *	-12.75 *	36.88 *
CMS 11A x IET 28704	320.00 *	215.00 *	-17.52	15.57	-27.75 *	-23.42 *	-4.76	-30.91 *	-4.76	-30.91 *	-31.69 *	7.17
CMS 11A x CR dhan 311	333.33 *	225.00 *	8.55	52.10 *	-20.36 *	-15.59	-18.15	-40.62 *	-18.15	-40.62 *	-45.15 *	-13.94 *
CMS 11A x IET 28713	200	125	-2.14	37.13 *	-13.45	-8.27	5.53	-23.44 *	5.53	-23.44 *	18.05 *	85.20 *
CMS 11A x IET 28694	433.33 *	300.00 *	-8.97	27.54	-32.11 *	-28.05 *	-11.84	-36.04 *	-11.84	-36.04 *	-49.35 *	-20.54 *
CMS 11A x IET 27984	200	125	-25.64 *	4.19	-20.96 *	-16.23	39.00 *	0.84	39.00 *	0.84	18.03 *	85.16 *
CMS52A x IET 28701	426.67 *	295.00 *	-2.56	36.53 *	-30.72 *	-26.58 *	45.56 *	5.6	45.56 *	5.6	-54.08 *	-27.96 *
CMS 52A x CR dhan 310	540.00 *	380.00 *	26.50 *	77.25 *	-27.50 *	-23.16 *	-51.09 *	-64.52 *	-51.09 *	-64.52 *	-36.55 *	-0.47
CMS 52A x CR dhan 411	353.33 *	240.00 *	25.21 *	75.45 *	-17.64 *	-12.71	-12.48	-36.51 *	-12.48	-36.51 *	12.98 *	77.24 *
CMS 52A x DR dhan 48	-13.33	-35	-33.76 *	-7.19	-1.95	3.92	-17.63	-40.24 *	-17.63	-40.24 *	-16.72 *	30.65 *
CMS 52A x CGZR 1	873.33 *	630.00 *	-14.1	20.36	-72.31 *	-70.66 *	-48.52 *	-62.65 *	-48.52 *	-62.65 *	-57.69 *	-33.62 *
CMS 52A x CR dhan 315	173.33	105	-2.99	35.93 *	-13.44	-8.25	-70.01 *	-78.24 *	-70.01 *	-78.24 *	-4.75	49.43 *
CMS 52A x IET 28703	106.67	55	-7.69	29.34	-8.54	-3.06	-6.18	-31.93 *	-6.18	-31.93 *	-46.95 *	-16.77 *
CMS 52A x IET 28704	326.67 *	220.00 *	-30.77 *	-2.99	-34.83 *	-30.93 *	-34.23 *	-52.29 *	-34.23 *	-52.29 *	-35.60 *	1.04
CMS 52A x CR dhan 311	233.33 *	150	-23.50 *	7.19	-23.36 *	-18.77 *	-25.35 *	-45.85 *	-25.35 *	-45.85 *	-39.41 *	-4.95
CMS 52A x IET 28713	180	110	-2.56	36.53 *	-12.61	-7.38	-31.27 *	-50.14 *	-31.27 *	-50.14 *	15.56 *	81.29 *
CMS 52A x IET 28694	113.33	60	-38.03 *	-13.17	-15.45	-10.39	-36.94 *	-54.25 *	-36.94 *	-54.25 *	-49.97 *	-21.51 *
CMS 52A x IET 27984	140	80	-20.09	11.98	-13.59	-8.42	-11.2	-35.57 *	-11.2	-35.57 *	19.88 *	88.06 *
CMS 59A x IET 28701	293.33 *	195.00 *	-17.95	14.97	-25.80 *	-21.36 *	-25.74 *	-46.13 *	-25.74 *	-46.12 *	-50.70 *	-22.65 *
CMS 59A x CR dhan 310	333.33 *	225.00 *	8.55	52.10 *	-20.24 *	-15.46	16.34	-15.59 *	16.34	-15.59 *	-41.03 *	-7.49
CMS 59A x CR dhan 411	173.33	105	56.84 *	119.76 *	-4.89	0.8	9.91	-20.26 *	9.91	-20.26 *	13.41 *	77.92 *

Contd..

Crosses	Chaff grains		Total Grains		Spikelet fertility %		Yield (kg/plot)		Yield (kg/ha)		Zn (ppm)	
	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312
CMS 59A x DR dhan 48	320.00 *	215.00 *	49.57 *	109.58 *	-12.34	-7.09	14.03	-17.27 *	14.03	-17.27 *	-36.30 *	-0.07
CMS 59A x CGZR 1	286.67 *	190.00 *	-5.98	31.74	-21.47 *	-16.76	-57.79 *	-69.37 *	-57.79 *	-69.37 *	-52.91 *	-26.13 *
CMS 59A x CR dhan 315	780.00 *	560.00 *	-26.07 *	3.59	-74.11 *	-72.56 *	-56.11 *	-68.16 *	-56.11 *	-68.16 *	-4.52	49.78 *
CMS 59A x IET 28703	100	50	-6.84	30.54	-7.45	-1.9	-36.94 *	-54.25 *	-36.94 *	-54.25 *	-39.20 *	-4.62
CMS 59A x IET 28704	300.00 *	200.00 *	-34.19 *	-7.78	-33.76 *	-29.79 *	-55.98 *	-68.07 *	-55.98 *	-68.07 *	-30.07 *	9.71 *
CMS 59A x CR dhan 311	706.67 *	505.00 *	1.71	42.51 *	-47.44 *	-44.29 *	-59.46 *	-70.59 *	-59.46 *	-70.59 *	-22.87 *	21.00 *
CMS 59A x IET 28713	-13.33	-35	31.20 *	83.83 *	2.22	8.34	48.26 *	7.56	48.26 *	7.56	20.01 *	88.28 *
CMS 59A x IET 28694	406.67 *	280.00 *	-12.39	22.75	-32.81 *	-28.79 *	-48.78 *	-62.84 *	-48.78 *	-62.84 *	-35.87 *	0.61
CMS 59A x IET 27984	133.33	75	-30.77 *	-2.99	-16.11 *	-11.08	-42.86 *	-58.54 *	-42.86 *	-58.54 *	4.52	63.98 *
CMS 64A x IET 28701	526.67	370.00 *	-8.55	28.14	-39.42 *	-35.80 *	-38.87 *	-55.65 *	-38.87 *	-55.65 *	-58.97 *	-35.63 *
CMS 64A x CR dhan 310	333.33 *	225.00 *	-3.85	34.73 *	-24.78 *	-20.28 *	-19.05	-41.27 *	-19.05	-41.27 *	-49.74 *	-21.15 *
CMS 64A x CR dhan 411	240.00 *	155	7.26	50.30 *	-14.56	-9.44	-27.03 *	-47.06 *	-27.03 *	-47.06 *	5.87 *	66.09 *
CMS 64A x DR dhan 48	166.67	100	-11.54	23.95	-13.99	-8.84	-31.27 *	-50.14 *	-31.27 *	-50.14 *	-14.05 *	34.84 *
CMS 64A x CGZR 1	553.33 *	390.00 *	3.42	44.91 *	-36.47 *	-32.67 *	-46.07 *	-60.88 *	-46.07 *	-60.88 *	-49.76 *	-21.18 *
CMS 64A x CR dhan 315	406.67 *	280.00 *	-38.46 *	-13.77	-51.82 *	-48.93 *	-74.26 *	-81.33 *	-74.26 *	-81.33 *	13.32 *	77.78 *
CMS 64A x IET 28703	26.67	-5	-11.97	23.35	-3.15	2.65	78.64 *	29.60 *	78.64 *	29.60 *	-39.43 *	-4.98
CMS 64A x IET 28704	500.00 *	350.00 *	-6.84	30.54	-36.04 *	-32.21 *	-20.59	-42.39 *	-20.59	-42.39 *	-27.00 *	14.52 *
CMS 64A x CR dhan 311	480.00 *	335.00 *	-3.42	35.33 *	-33.42 *	-29.43 *	-41.83 *	-57.80 *	-41.83 *	-57.80 *	-16.77 *	30.57 *
CMS 64A x IET 28713	146.67	85	-17.52	15.57	-13.53	-8.35	-60.10 *	-71.06 *	-60.10 *	-71.05 *	14.71 *	79.96 *
CMS 64A x IET 28694	220	140	6.84	49.70 *	-13.65	-8.48	-34.23 *	-52.29 *	-34.23 *	-52.29 *	-46.08 *	-15.41*
CMS 64A x IET 27984	366.67 *	250.00 *	-52.99 *	-34.13 *	-60.93 *	-58.59 *	-15.7	-38.84 *	-15.7	-38.84 *	14.67 *	79.89 *
CMS 69A x IET 28701	173.33	105	13.25	58.68 *	-9.49	-4.07	42.21 *	3.17	42.21 *	3.17	-50.31 *	-22.04 *
CMS 69A x CR dhan 310	466.67 *	325.00 *	-23.08 *	7.78	-43.65 *	-40.27 *	-27.54 *	-47.43 *	-27.54 *	-47.43 *	-27.14 *	14.30 *
CMS 69A x CR dhan 411	726.67 *	520.00 *	9.83	53.89 *	-44.94 *	-41.65 *	10.81	-19.61 *	10.81	-19.61 *	17.93 *	85.02 *
CMS 69A x DR dhan 48	233.33 *	150	6.84	49.70 *	-14.42	-9.29	18.92	-13.73	18.92	-13.72	-32.42 *	6.02
CMS 69A x CGZR 1	406.67 *	280.00 *	-10.68	25.15	-31.05 *	-26.92 *	6.56	-22.69 *	6.56	-22.69 *	-49.55 *	-20.86 *
CMS 69A x CR dhan 315	600.00 *	425.00 *	2.99	44.31 *	-39.42 *	-35.80 *	-65.12 *	-74.70 *	-65.12 *	-74.70 *	14.71 *	79.96 *

Contd..

Crosses	Chaff grains		Total Grains		Spikelet fertility %		Yield (kg/plot)		Yield (kg/ha)		Zn (ppm)	
	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312	CR dhan 411	US 312
CMS 69A x IET 28703	140	80	-26.92 *	2.4	-15.45	-10.39	78.64 *	29.60 *	78.64 *	29.60 *	-45.56 *	-14.59 *
CMS 69A x IET 28704	186.67	115	-51.71 *	-32.34 *	-36.14 *	-32.32 *	-36.55 *	-53.97 *	-36.55 *	-53.97 *	-57.73 *	-33.69 *
CMS 69A x CR dhan 311	346.67 *	235.00 *	-44.02 *	-21.56	-48.91 *	-45.85 *	-44.53 *	-59.76 *	-44.53 *	-59.76 *	-61.82 *	-40.11 *
CMS 69A x IET 28713	113.33	60	-30.34 *	-2.4	-13.62	-8.45	90.86 *	38.47 *	90.86 *	38.47 *	11.35 *	74.70 *
CMS 69A x IET 28694	433.33 *	300.00 *	-9.4	26.95	-33.68 *	-29.71 *	25.10 *	-9.24	25.10 *	-9.24	-49.12 *	-20.18 *
CMS 69A x IET 27984	153.33	90	6.41	49.10 **	-9.84	-4.44	109.78 *	52.19 *	109.78 *	52.19 *	19.24 *	87.06 *

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