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Heterosis and combining ability analysis for various morphological traits in rice hybrids

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Abstract
Combining ability and heterosis were conducted on 24 F1 hybrids along with eleven rice genotypes to identify the inheritance pattern of some morphological traits for selection of superior rice genotypes. The experiment was conducted according to line x tester mating design. Crosses R-1700-308-3-170-1 and R-1779-321-1-112-1 were identified as good general combiner for grain yield per plant. Crosses *viz.*, IR 58025A/R-1700-30803-170-1, IR79156A/R-1674-1823-2-1189-1, IR79156A/Reg-1649 and CRMS 31A/R-1892-486-151-1 were identified as good specific combiner for grain yield per plant. The cross IR 58025A/R-1700-308-3-170-1 was identified as promising hybrids on the basis of mean performance, heterosis estimation, GCA effects (of their corresponding parents) and SCA effects for grain yield per plant. In heterosis, among 24 hybrids, 11 crosses *viz.* IR79156A/R-1779-321-1-112-1, IR79156A/R-1892-486-151-1,IR79156A/R-2093-1536-1-660-1,IR79156A/AP-16, IR79156A/AP-18,CRMS31A/R-1700-308-3-170-1,CRMS31A/R-1779-321-1-112-1,CRMS31A/R-1892-486-151-1, CRMS31/R-2093-1536-1-660-1, CRMS31A/AP-16 and CRMS31A/AP-18, showed significant heterosis (over both mid) and IR58025A/ R-1700-308-3-170-1, IR58025A/ R-1779-321-1-112-1, IR58025A/ R-2093-1536-1-660-1, IR58025A/AP-16, CRMS31A/R-1892-486-151-1, CRMS31/R-2093-1536-1-660-1, were showed significant heterosis for grain yield and yield related traits. One cross IR 58025A/R-1700-308-3-170-1 was identified as promising hybrid.

Keywords: Heterosis, hybrid, combining ability, GCA, SCA

Introduction
Rice is the world's largest cultivated food crop. Rice is a member of family Poaceae and finds its home in South-East Asia and Asia, where more than 90% of world's rice is produced and consumed. Rice is a main staple food for more than 50% of the world population and forms the staple diet of about 2.7 billion people and it needs to be produced 50% more than what is produced now by 2050 to overcome with the growing demand (Ashikari *et al.*, 2005) [1].
Hybrids play an important role in enhanced yield production by heterosis breeding. Developing rice hybrids for both aerobic and drought prone situation is extremely essential to maintain the yields of rice for the present and the near future to keep the rice production sustainable for the growing population with the available depleting water resources. The performance of a hybrid mainly depends on choice of parents. Several methods like *per se* performance, genetic diversity, combining ability etc., have been attempted to select the parents. Among them combining ability analysis plays a powerful tool to estimate the value of a parent for the production of superior hybrid. It is also required to systematic studies the genetic potential of parents in hybrid combination in relation to general and specific combining abilities, which could be attributed to additive and non-additive components of gene action, respectively. Although, several statistical tools available to identify the combining ability and gene action governing various quantitative traits, line × tester analysis has been a most useful design.

Materials and Methods
The experimental materials comprised of three lines *viz.*, IR 58025A, IR 79156A and CRMS 31A and eight tester *viz.*, R -1674-1823-2-1189-1, R -1700-308-3-170-1, R -1779-321-1-112-1, R -1892-486-151-1, R -2093-1536-1-660-1, AP -16, AP -18 and Reg-1649 (Table 1). Total twenty four crosses were attempted by adopting L x T design (Kempthorne, 1957) [7].
Two check viz., Indira Barani Dhan and Indira Sona were included in the experiment to evaluate standard heterosis.

For the development of hybrids, three male sterile lines (CMS lines) used as female and eight male parents were sown in nursery. The nurseries were grown in different dates to ensure synchronization for hybridization. About 21 days old seedlings of total 24 hybrids and their 11 parents along with two check variety were planted in completely randomized block design with three replications during *kharif* 2016 season. Recommended package of practices was followed during the crop period. In each treatment, all essential observations were recorded on five randomly selected plants in all the replications for different traits. The mean value over five plants was considered for further statistical analysis. With the help of observed data, analysis for ANOVA, Heterosis and combining ability were calculated

Result and discussion

Analysis of variance

The analysis of variance reveled that variance due to treatments was highly significant for all the characters under study (Table 2 & 3). The variance due to parents was highly significant for all the characters under experiment. The variance due to hybrids was also found highly significant for most of the characters. The variance due to lines was found not significant for all the traits under study due to less number of entries except productive tillers/plant and panicle length. The variance due to testers was observed highly significant for most of the morphological traits. The variance due to line x tester was found highly significant for most of the characters. The analysis of variance suggested that there is sufficient variability available in the material under study. The significant differences among the lines, testers and lines x testers indicated that the treatments had wide genetic diversity among themselves. Also, significant variances due to line × tester's interaction for all the characters suggested the presence of sca variances among hybrids. Presence of highly significant GCA and sca variances for almost all the characters indicated the importance of both additive and non-additive gene in the expression of the characters. The ratio of σ2gca / σ2sca was less than unity for all the characters also suggested pre-ponderence of non-additive genetic variance. It indicated greater importance of non-additive gene action in their expression and indicated very good prospect for the exploitation of non- additive genetic variation for grain and its component characters through hybrid breeding. Similar finding have been also reported for treatments, parents, parents vs. crosses by Saidaiah *et al.* (2010) [8]; for treatments, parents, parents vs. crosses and hybrids by Saleem *et al.*, (2010) [9], Jarwar *et al.*(2012) [6]; for treatments and hybrids and testers except panicle length and lines vs. testers by Veeresha et al. (2013) [12] and Ghara *et al.*(2012) [3], Shiva Prasad *et al.* (2013) [11], Ghara*et al.* (2014) [4] for genotypes, lines, crosses, testers and line x tester interactions for days to 50% flowering, plant height, tiller number, panicle length, number of spikelet per panicle, spikelet fertility and grain yield traits.

Combining ability analysis for GCA and SCA effects

The GCA variance of parents and SCA variance of hybrids for the different characters are the important basic criteria for the selection or hybridization programme. The comparative variances due to general combining ability and specific combining ability for different characters under study and their ratio presented in the Table 4 & 5. The GCA variance was found highest for relative water content followed by total spikelets per panicle, sterile spikelets per panicle, pollen fertility percentage and spikelet fertility percentage. The SCA variance was found highest for fertile spikelets per panicle followed by days to 50% flowering, biological yield per plant, spikelet fertility percentage, relative water content, pollen fertility and number of sterile spikelet per panicle.

The magnitude of SCA variance was found higher than the GCA variance for most of the characters in the study, indicated the presence of predominance of non-additive gene action for the characters under study.

Among the 3 lines, IR 58025A was identified as a good general combiner for grain yield per plant as it exhibited positive GCA effect with many desirable traits *viz.* days to 50% flowering, total number of spikelets per panicle, fertile spikelets per panicle, grain yield per plant, biological yield per plant, harvest index, flag leaf width, whereas, IR 79156A was identified as best general combiner for most of the traits *viz*., days to 50% flowering, plant height, panicle length, productive tillers per plant, number of sterile spikelets per panicle, number total spikelets per panicle and harvest index. Testers R-1700-308-3-170-1 and R-1779-321-1-112-1 were found to be good general combiner for grain yield per plant and yield attributing traits.

The usefulness of a particular cross in the exploitation of heterosis was judged by SCA effects. IR 58025A/R-1700-30803-170-1 showed highest SCA value followed by IR 58025A/R-1779-321-1-112-1, CRMS 31A/R-1892-486-151-1, and IR 79156A/Reg-1649 for grain yield per plant. Crosses viz., IR 58025A/R-1674-1823-2-1189-1, IR-79156A/R-2093-1536-1-660-1, IR 79156A/Reg-1649 and CRMS 31A/R-1892-486-151-1 were identified as promising hybrids for pollen fertility %, spikelet fertility %, number of fertile spikelets per plant and test weight based on SCA effects. Eleven crosses *viz.* IR79156A/R-1779-321-1-112-1, IR79156A/R-1892-486-151-1, IR79156A/R-2093-1536-1-660-1, IR79156A/AP-16, IR79156A/AP-18, CRMS31A/R-1700-308-3-170-1, CRMS31A/R-1779-321-1-112-1, CRMS31A/R-1892-486-151-1, CRMS31/R-2093-1536-1-660-1, CRMS31A/AP-16 and CRMS31A/AP-18, showed significant heterosis (over both mid) and IR58025A/ R-1700-308-3-170-1, IR58025A/ R-1779-321-1-112-1, IR58025A/ R-2093-1536-1-660-1, IR58025A/AP-16, CRMS31A/R-1892-486-151-1, CRMS31/R-2093-1536-1-660-1, found significant heterosis (over better parents) for grain yield and yield related traits. One hybrid IR 58025A/R-1700-308-3-170-1 was identified as promising hybrid on the basis of mean performance, heterosis, GCA effect (of their corresponding parents) and SCA effect for grain yield per plant.

Some of the similar finding are also reported by Ghara, *et al.* (2012) [3], Sharma *et al.* (2012) [10], Hasan *et al.* (2013) [5], Ghosh *et al.* (2013) and Verica *et al.* (2013) [13] and Bhadru *et al.* (2013) [2].

Heterosis

The heterobeltiosis for days to 50% flowering ranged from -0.36% (CRMS 32A/R -1779-321-1-112-1) to 30.04% (IR 79156A/R -1674-1823-2-1189-1). Among 24 hybrids, one hybrid showed significant negative heterosis and 23 hybrids showed significant positive heterosis for this trait (Table 6). Highest significant negative heterosis over better parent observed by cross CRMS 32A/R -1779-321-1-112-1 (-0.36). The mid parent heterosis for plant height ranged from -5.42 % (IR 58025A/R -2093-1536-1-660-1) to 27.13 % (IR 79156A/AP-18). Among 24 hybrids, 22 hybrids showed significant positive relative heterosis and 2 hybrids showed significant negative relative heterosis for plant height. In case

of panicle length, mid parent heterosis ranged from -20.85% (IR58025A/R-2093-1536-1-660-1) to -5.86 % (IR79156A/AP-16). Among 24 hybrids, 12 hybrids found significant negative relative heterosis and none of the hybrid showed significant positive relative heterosis for panicle length.

In Spikelet Fertility (%), **t**he mid parent heterosis ranged from -19.89 % (IR58025A/R-2093-1536-1-660-1) to 32.52 % (IR58025A/1700-308-3-170-1). Among 24 hybrids, 14 hybrids showed significant positive relative heterosis and 10 hybrids showed significant negative relative heterosis for this trait. The heterobeltiosis ranged from -31.46% (IR58025A/R-2093-1536-1-660-1) to 33.14% (IR58025A/Reg-1649). Among 24 hybrids, 10 hybrids showed significant positive better heterosis and 14 hybrids showed significant negative better heterosis for this trait. Similarly in Grain Yield per plant (g), the mid parent heterosis ranged from -19.58 % (IR58025A/R-1674-1823-2-1189-1) to 18.53 % (CRMS31A/R-1892-486-151-1). Among 24 hybrids, 11 hybrids showed significant positive relative heterosis and 5 hybrids showed significant negative relative heterosis for this trait. The heterobeltiosis ranged from -38.14 % (IR58025A/R-1674-1823-2-1189-1) to 7.97 % (IR58025A/R-1700-308-3-170-1). Some workers like Li *et al.* (2008), Vaithiyaligan and Nandarajan (2010), Tiwari *et al.* (2011), Mirarab *et al.* (2011), Kumar *et al.* (2012) [10], Patil *et al.* (2012), Gnanamalar and Vivekanandan (2013), Veeresha *et al.* (2013) [12], Srikrishna Latha *et al.* (2013), Pratap *et al.* (2013), Ghara *et al.* (2014) [4] and Seesang *et al.* (2014) also reported the similar findings.

Table 1: Details of parents used in the study

Genotypes	Parentage	Source
Female Parents		
IR 58025A (WA)	IR 48483A/Pusa 167-120-3-2	IRRI, Manila, Philippines
IR 79156A (WA)	IR68897A/IR72798-42-1-2	IRRI, Manila, Philippines
CRMS 31A (Kalinga)	Kalinga 1	CRRI, Cuttack
Male Parents		
R-1674-1823-2-1189-1	R1037-649-1-1/Phalguna	IGKV, Raipur (C.G.)
R-1700-308-3-170-1	Danteshwari/Amrit bhog	IGKV, Raipur (C.G.)
R-1779-321-1-112-1	Danteshwari/WGL-320100	IGKV, Raipur (C.G.)
R-1892-486-151-1	CN 1269-7-21/Vasumati	IGKV, Raipur (C.G.)
R-2093-1536-1-660-1	Samleshwari/TRC 87-251	IGKV, Raipur (C.G.)
AP-16	Ajam Dhan	Landrace
AP-18	Ramgali	Landrace
REG-1649	Dadbako	Landrace
Checks		
Indira barani dhan	Swarna/IR-42253	IGKV, Raipur (C.G.)
Indira sona	IR58025A/R-710-437-1-1	IGKV, Raipur (C.G.)

Table 2: Analysis of variance for different characters

			Mean sum of square	
S. No.	**Source of Variation**	**Replication**	**Genotypes**	**Error**
	DF	2	34	68
1	Days to 50% flowering	8.14	200.74**	3.71
2	Plant height (cm)	13.1	120.55**	5.65
3	Productive tillers	2.8	8.32**	1.08
4	Panicle length(cm)	1.23	8.22**	1.54
5	Total no. Of spikelets/panicle	109.96	2794.42**	43.63
6	No. of Sterile spikelets/Panicle	48.44	606.21**	25.25
7	No. of fertile spikelets/panicle	26.72	1202.15**	23.05
8	Spikelet fertility (%)	14.37	336.98**	27.45
9	Pollen fertility (%)	5.3	1463.53**	25.17
10	Test weight (g)	0.55	7.01**	0.66
11	Grain yield per plant (g)	2.96	29.32**	1.21
12	Biological yield per plant (g)	19.05	166.06**	10.01
13	Harvest index (%)	17.73	229.36**	8.54
14	Flag leaf width (cm)	0.02	0.03**	0
15	Chlorophyll content	7.64	31.34**	1.46
16	Relative water content	36.55	490.81**	22.92

Table 3: ANOVA for Line x Tester

Source of variance	df	Agro-Morphological Characters															
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Replication	2	8.14	13.10	2.80	1.23	109.96	48.44	26.72	14.37	5.30	0.55	2.96	19.05	17.73	0.02	7.64	36.55
Treatment	34	200.74**	120.55**	8.32**	8.22**	2794.42**	606.21**	1202.15**	336.98**	1463.53**	7.01**	29.32**	166.06**	229.36**	0.03**	31.34**	490.81**
Parents	10	174.28**	103.92**	17.22**	11.68**	5498.69**	1212.71**	2314.87**	395.94**	3438.38**	8.70**	50.92**	126.39**	591.53**	0.01**	13.32**	542.90**
Hybrids	23	216.32**	104.78**	3.49**	6.10**	1464.45**	355.97**	757.50**	205.33**	225.69**	6.44**	21.10**	186.32**	76.75**	0.04**	33.09**	430.31**
Parent vs. hybrid	1	107.15**	649.55**	30.33**	22.25**	6341.07**	296.74**	301.88**	775.45**	10185.47**	3.28*	2.38	96.96**	114.21**	0.00	171.34**	1361.78**
Lines	2	43.35**	59.69**	3.22	3.47	659.43**	497.72**	145.18*	276.69**	283.71**	10.07**	35.58**	251.02**	60.87**	0.10**	49.84**	1878.70**
Testers	7	307.08**	139.35**	5.14**	8.17**	4303.46**	726.24**	1895.55**	192.35**	315.37**	13.60**	35.44**	187.23**	38.96**	0.01**	42.11**	518.12**
Line x	14	195.64**	93.93**	2.70**	5.45**	159.95**	150.57**	275.95**	201.70**	172.56**	2.33**	11.86**	186.61**	58.16**	0.04**	26.19**	179.48**

Tester																	
Error	68	3.71	5.65	1.08	1.54	43.63	25.25	23.05	27.45	25.17	0.66	1.21	10.01	8.54	0.00	1.46	22.92
Variance of GCA		-148.913	-32.864	0.594	-1.898	625.041	364.595	-81.691	74.707	115.478	8.082	24.435	64.429	2.128	0.063	24.132	1709.482
Variance of SCA		63.977	29.427	0.540	1.303	38.773	41.773	84.300	58.083	49.130	0.557	3.550	58.867	16.540	0.013	8.243	52.187
Variance of GCA/		-2.328	-1.117	1.100	-1.456	16.120	8.728	-0.969	1.286	2.350	14.518	6.883	1.094	0.129	4.860	2.928	32.757
Variance of SCA																	

Table 4: General combining ability effects of parents for different agro-morphological characters

Parents	**Agro-morphological Characters**															
Line	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
IR-58025A (WA)	0.19	-1.20	-0.42	-0.42	4.57	1.89	2.68	-0.95	-1.55	-0.51	0.99*	1.25	1.50	0.05*	-0.40	-2.55
IR 79156A(WA)	-1.43	1.79	0.19	0.31	1.15	3.31	-2.15	-2.82	-2.39	-0.23	-1.36	-3.67	0.18	-0.07	-1.20	-7.29
CRMS 31A(Kalinga)	1.24	-0.59	0.24	0.11	-5.72	-5.19	-0.53	3.77	3.94	0.73	0.37	2.42	-1.67	0.02	1.60*	9.84**
SE (Lines)	0.39	0.49	0.21	0.25	1.35	1.03	0.98	1.07	1.02	0.17	0.23	0.65	0.60	0.01	0.25	0.98
Testers																
R-1674-1823-2-1189-1	2.15*	1.71	0.90*	1.19*	20.94**	9.81**	11.14**	-2.04	-3.95	-2.50	-4.32	-8.07	1.02	0.04**	-2.11	-17.24
R-1700-308-3-170-1	-5.63	-4.05	0.97*	0.59	5.94*	-4.08	10.03**	6.25**	8.52**	0.61	1.43**	2.87*	-0.33	-0.05	3.07**	-1.92
R-1779-321-1-112-1	-6.96	-3.98	-0.31	0.18	3.28	-4.19	7.47**	5.31*	7.81**	-1.03	1.98**	2.45	1.16	-0.02	2.87**	8.65**
R-1892-486-151-1	1.49	0.03	-0.81	-0.53	-19.61	-3.19	-16.42	-3.94	-3.29	-0.15	-0.34	-3.53	2.47*	0.06**	1.64**	1.30
R-2093-1536-1-660-1	-6.74	-1.93	-0.44	-1.13	-28.83	-7.19	-21.64	-5.32	-7.34	0.46	1.12*	6.47**	-3.79	0.00	-1.76	2.82
AP-16	9.26**	-1.72	-0.63	0.09	15.83**	6.58**	9.25**	-0.94	-1.81	0.64*	0.34	2.59*	-1.98	-0.01	-1.68	1.65
AP-18	2.93**	7.90**	-0.49	1.02*	-25.17	-11.64	-13.53	4.42*	3.78	0.56	0.76	-0.58	1.83	0.03*	-1.06	3.73
REG-1649	3.49**	2.05**	0.81	-1.40	27.61**	13.92**	13.69**	-3.74	-3.73	1.40**	-0.96	-2.20	-0.37	-0.04	-0.96	1.01
SE(Testers)	0.64	0.79	0.35	0.42	2.20	1.68	1.60	1.75	1.67	0.27	0.37	1.06	0.97	0.01	0.40	1.60

Table 5: Specific combining ability effects of hybrids for different agro-morphological characters

Hybrids	**Agromorphological Characters**															
IR-58025A	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
IR58025A/R-1674-1823-2-1189-1	-10.53	3.87**	0.60	0.70	-9.90	-10.56	0.65	7.02*	6.72*	1.01**	-3.45	-16.34	12.12**	-0.15	-1.06	8.57**
IR58025A/R-1700-308-3-170-1	2.25	0.05	-0.55	-2.09	-1.90	-5.33	3.43	5.33	3.56	-0.10	2.78**	4.35*	0.90	0.00	1.49*	6.32*
IR58025A/R-1779-321-1-112-1	4.25**	2.10	-0.33	1.83*	8.43*	-2.56	10.99**	5.55	4.65	-0.16	1.51*	1.11	1.24	-0.02	2.16**	5.58
IR58025A/R-1892-486-151-1	-0.86	-2.29	0.75	0.50	4.99	4.44	0.54	-3.49	0.54	-1.08	-0.77	1.75	-3.83	0.29**	-1.71	-6.40
IR58025A/R-2093-1536-1-660-1	3.36**	-5.12	-1.14	-1.14	-3.13	6.78*	-9.90	-11.57	-11.09	-0.49	-0.34	1.09	-2.24	-0.08	-1.61	-12.86
IR58025A/AP-16	5.36**	-3.84	0.24	0.43	3.88	-0.33	4.21	2.09	2.68	0.24	0.52	6.97**	-5.48	-0.03	1.50*	-1.12
IR58025A/AP-18	3.36**	1.69	-0.25	-0.14	3.21	-1.44	4.65	3.76	2.76	0.55	0.38	4.97*	-4.73	-0.03	2.79**	3.50
IR58025A/Reg-1649	-7.19	3.53*	0.68	-0.07	-5.57	9.00	-14.57	-8.71	-9.83	0.04	-0.63	-3.90	2.02	0.01	-3.57	-3.60
IR79156A																
IR-79156/R-1674-1823-2-1189-1	7.76**	-5.21	0.92	-0.95	3.51	8.69**	-5.18	-6.26	-7.23	0.49**	2.04**	2.22	-0.36	0.01	1.20	4.10
IR-79156/R-1700-308-3-170-1	-3.13	1.93	0.91	0.04	-5.15	4.92	10.07**	-6.99	-4.03	0.98**	-2.17	-3.86	-0.64	-0.02	2.25**	-3.43
IR-79156/R-1779-321-1-112-1	-2.13	-3.97	-0.14	-1.24	-9.49	0.36	-9.85	-3.88	-4.99	-0.08	-1.46	1.36	-3.86	-0.03	1.39	-3.28
IR-79156/R-1892-486-151-1	-4.57	4.90**	0.36	-0.40	0.74	3.36	-2.63	-6.02	-6.89	-0.63	-1.10	-1.99	0.04	-0.17	2.05**	-1.02
IR-79156/R-2093-1536-1-660-1	-4.68	-3.84	-0.01	1.39	8.63*	-7.31	15.93**	14.77**	14.06**	0.10	0.13	-3.33	3.16	0.05*	-1.05	9.50**
IR-79156/AP-16	-11.35	5.81**	-0.49	-1.06	-0.38	1.92	-2.29	-1.71	-1.28	-0.27	0.42	-2.77	3.79*	-0.02	-3.10	2.26
IR-79156/AP-18	2.65*	6.16**	-0.63	0.91	3.63	0.47	3.15	-0.44	1.64	-0.53	-0.64	-2.27	1.62	0.08**	-4.22	-4.95
IR-79156/Reg-1649	15.43**	-5.79	-0.93	1.32	-1.49	12.42	10.93**	10.53**	8.71**	-0.07	2.78**	10.65**	-3.75	0.11**	1.45*	-3.18
CRMS 31A																
CRMS-31A/R-1674-1823-2-1189-1	2.76*	1.34	-1.52	0.26	6.39	1.86	4.53	-0.76	0.51	-1.50	1.41*	14.12**	-11.77	0.14**	-0.13	-12.67
CRMS-31A/R-1700-308-3-170-1	0.88	-1.99	-0.36	2.06**	7.06	0.42	6.64*	1.66	0.47	-0.88	-0.60	-0.49	-0.27	0.01	-3.74	-2.90
CRMS-31A/R-1779-321-1-112-1	-2.13	1.86	0.47	-0.59	1.06	2.19	-1.14	-1.68	0.34	0.24*	-0.05	-2.47	2.62	0.05*	-3.54	-2.29
CRMS-31A/R-1892-486-151-1	5.43**	-2.61	-1.11	-0.10	-5.72	-7.81	2.08	9.50**	6.35*	1.70**	1.87**	0.24	3.79*	-0.12	-0.34	7.41*
CRMS-31A/R-2093-1536-1-660-1	1.32	8.96**	1.16	-0.25	-5.50	0.53	-6.03	-3.20	-2.98	0.39**	0.20	2.24	-0.92	0.04	2.62**	3.36

CRMS-31A/AP-16	5.99**	-1.97	0.24	0.63	-3.50	-1.58	-1.92	-0.38	-1.41	0.03	-0.94	-4.20	1.70	0.05*	1.60*	-1.14
CRMS-31A/AP-18	-6.01	-7.85	0.88	-0.77	-6.83	0.97	-7.81	-3.33	-4.40	-0.02	0.26	-2.70	3.12	-0.05	1.42	1.45
CRMS-31A/Reg-1649	-8.24	2.26	0.24	-1.25	7.06	3.42	3.64	-1.82	1.12	0.03	-2.15	-6.75	1.73	-0.12	2.12**	6.78*
SE (Hybrids)	1.11	1.37	0.60	0.72	3.81	2.90	2.77	3.03	2.90	0.09	0.64	1.83	1.69	0.02	0.70	2.76

*= Significant of p=0.05 level. **= Significant of p=0.01 level

1. Days to 50% flowering, 2.Plant height (cm), 3. Productive tillers per plant, 4. Panicle Length (cm) 5. Total number of spikelets/Panicle, 6. Number of sterile spikelets/Panicle, 7. Number of Fertile spikelets/panicle 8. Spikelet fertility (%) 9. Pollen fertility (%), 10. Test weight (g), 11. Grain Yield (g) per plant, 12. Biological Yield (g) per plan, 13. Harvest index (%), 14. Flag leaf width (cm), 15. Chlorophyll content, 16. Relative water content

Table 6: Mid parent Heterosis, Heterobeltiosis and Standard heterosis

	1.Days to 50% Flowering				**2.Plant height (cm)**				**3. Productive tillers**			
Hybrids	**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**	
			Indira baranidhan	**Indira sona**			**Indira baranidhan**	**Indira sona**			**Indira baranidhan**	**Indira sona**
IR-58025A												
IR58025A/R-1674-1823-2-1189-1	-5.90**	1.83**	8.14**	3.33**	15.24**	8.31**	21.46**	-9.84**	-12.74**	-33.51**	3.73**	1.21**
IR58025A/R-1700-308-3-170-1	2.988**	7.30**	13.95**	8.89**	6.48**	2.18**	9.64**	-18.61**	-31.12**	-42.02**	-9.54**	-11.73**
IR58025A/R-1779-321-1-112-1	3.50**	8.03**	14.73**	9.63**	6.44**	-0.07**	12.31**	-16.63**	-35.08**	-50.53**	-22.82**	-24.69**
IR58025A/R-1892-486-151-1	7.94**	11.68**	18.60**	13.33**	9.57**	6.03**	11.82**	-17.00**	-30.71**	-46.01**	-15.76**	-17.81**
IR58025A/R-2093-1536-1-660-1	4.26**	7.30**	13.95**	8.89**	-5.42**	-15.49**	5.91**	-21.38**	-45.14**	-57.97**	-34.43**	-36.03**
IR58025A/AP-16	15.42**	27.01**	34.88**	28.89**	3.59**	-1.46**	7.71**	-20.04**	-34.89**	-48.40**	-19.49**	-21.45**
IR58025A/AP-18	9.12**	17.88**	25.19**	19.63**	19.82**	12.53**	26.39**	-6.18**	-38.59**	-51.33**	-24.06**	-25.91**
IR58025A/Reg-1649	-0.85**	6.94**	13.57**	8.52**	13.91**	5.98**	21.46**	-9.84**	-18.83**	-33.51**	3.73**	1.21**
IR79156A												
IR-79156/R-1674-1823-2-1189-1	15.04**	30.04**	27.52**	21.85**	6.93**	1.61**	13.95**	-15.41**	-7.64**	-31.36**	15.36	12.56
IR-79156/R-1700-308-3-170-1	-0.73**	7.91**	5.81**	1.11**	11.07**	7.80**	15.68**	-14.13**	-15.41**	-30.87**	16.18	13.36
IR-79156/R-1779-321-1-112-1	-1.27**	7.51**	5.43**	0.74**	1.69**	-3.47**	8.49**	-19.46**	-30.23**	-48.15**	-12.86**	-14.98**
IR-79156/R-1892-486-151-1	6.23**	14.63**	12.40**	7.41**	20.45**	17.90**	24.33**	-7.71**	-31.71**	-48.15**	-12.86**	-14.98**
IR-79156/R-2093-1536-1-660-1	-2.39**	4.74**	2.71**	-1.85**	-1.76**	-11.30**	11.16**	-17.48**	-30.58**	-48.15**	-12.86**	-14.98**
IR-79156/AP-16	0.69**	15.81**	13.57**	8.52**	17.27**	12.80**	23.31**	-8.47**	-39.20**	-53.09**	-21.16**	-23.08**
IR-79156/AP-18	10.68**	24.90**	22.48**	17.04**	27.13**	20.72**	35.58**	0.64**	-39.20**	-53.09**	-21.16**	-23.08**
IR-79156/Reg-1649	24.91**	40.71**	37.98**	31.85**	5.44**	-0.82**	13.66**	-15.63**	-31.79**	-45.68**	-8.71**	-10.93**
CRMS 31A												
CRMS-31A/R-1674-1823-2-1189-1	7.33**	14.59**	24.81**	19.26**	9.34**	6.22**	19.12**	-11.57**	-9.01**	-19.77**	-14.10**	-16.19**
CRMS-31A/R-1700-308-3-170-1	1.38**	4.27**	13.57**	8.52**	1.31**	0.57**	7.92	-19.89**	-5.63**	-5.81**	0.83**	-1.62**
CRMS-31A/R-1779-321-1-112-1	-3.28**	-0.36**	8.53**	3.70**	3.39**	0.33**	12.76**	-16.30**	1.10**	-10.85**	-4.56**	-6.87**
CRMS-31A/R-1892-486-151-1	14.28**	16.73**	27.13**	21.48**	6.24**	6.09**	12.19**	-16.72**	-28.63**	-35.27**	-30.70**	-32.38**
CRMS-31A/R-2093-1536-1-660-1	1.93**	3.56**	12.79**	7.78**	7.33**	-1.05**	24.01**	-7.95**	7.42**	-4.65**	2.08**	-0.40**
CRMS-31A/AP-16	15.74**	25.62**	36.82**	30.74**	3.00**	1.31**	10.75**	-17.79**	-10.88**	-17.44**	-11.61**	-13.76**
CRMS-31A/AP-18	-0.50**	6.05**	15.50**	10.37**	5.87**	2.78**	15.43**	-14.32**	-1.25**	-8.52**	-2.07**	-4.45**
CRMS-31A/Reg-1649	-2.01**	4.27**	13.57**	8.52**	9.50**	5.26**	20.64**	-10.45**	2.81**	-0.78**	6.22**	3.64**

*= Significant of p=0.05 level. **= Significant of p=0.01 level

	4. Panicle Length(cm)				**5. Total spikelets/Panicle**				**6. Sterile spikelets/Panicle**			
Hybrids	**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**	
			Indira baranidhan	**Indira sona**			**Indira baranidhan**	**Indira sona**			**Indira baranidhan**	**Indira sona**
IR-58025A												
IR58025A/R-1674-1823-2-1189-1	-2.25	-11.83**	29.93	10.81**	-26.19**	-37.23**	-2.46**	-26.35**	-41.57**	-62.11**	16.86**	-46.82**
IR58025A/R-1700-308-3-170-1	-18.15**	-24.01**	11.97**	-4.50**	-17.66**	-41.39**	-8.92**	-31.23**	-56.97**	-72.27**	-14.46**	-61.07**
IR58025A/R-1779-321-1-112-1	-4.32	-11.35**	30.63	11.41**	-16.60**	-36.83**	-1.85**	-25.88**	-52.70**	-69.14**	-4.82**	-56.69**
IR58025A/R-1892-486-151-1	-9.21**	-18.76**	19.72**	2.10**	-30.74**	-52.48**	-26.15**	-44.24**	-37.39**	-59.77**	24.09*	-43.53**
IR58025A/R-2093-1536-1-	-20.85**	-26.76**	7.92**	-7.96**	-47.12**	-62.77**	-42.15**	-56.32**	-38.56**	-61.72**	18.07**	-46.27**

660-1												
IR58025A/AP-16	-6.45**	-16.85**	22.54**	4.50**	-10.33**	-32.08**	5.54**	-20.31**	-29.13**	-53.91**	42.17	-35.31**
IR58025A/AP-18	-10.11	-15.53**	24.48	6.16**	-37.27**	-56.83**	-32.92**	-49.35**	-61.66**	-76.56**	-27.71**	-67.11**
IR58025A/Reg-1649	-16.19**	-23.90**	12.15**	-4.36**	-21.96**	-30.69**	7.69**	-18.68**	-2.04**	-34.37**	102.41	-7.89**
IR79156A												
IR-79156/R-1674-1823-2-1189-1	-2.34	-9.09**	25.00	6.61**	-9.25**	-15.51**	6.77**	-19.38**	34.92**	-0.44**	91.56	-12.83**
IR-79156/R-1700-308-3-170-1	-3.60	-7.55**	27.12	8.41**	-11.64**	-32.80**	-15.08**	-35.87**	-9.29**	-33.63**	27.71	-41.89**
IR-79156/R-1779-321-1-112-1	-10.23**	-14.08**	18.14**	0.75**	-23.96**	-37.91**	-21.54**	-40.75**	-22.59**	-42.39**	10.84**	-49.56**
IR-79156/R-1892-486-151-1	-6.38**	-13.57**	18.84**	1.35**	-27.51**	-47.16**	-33.23**	-49.58**	-10.61**	-34.88**	25.30*	-42.98**
IR-79156/R-2093-1536-1-660-1	-4.75	-8.96**	25.18	6.76**	-30.92**	-48.14**	-34.46**	-50.51**	-46.12**	-62.43**	-27.71**	-67.11**
IR-79156/AP-16	-5.86**	-13.70**	18.67**	1.20**	-4.58**	-22.08**	-1.54**	-25.65**	9.00**	-19.22**	55.42	-29.28**
IR-79156/AP-18	0.33	-2.56**	33.98	14.27**	-30.41**	-49.11**	-35.69**	-51.44**	-35.40**	-56.17**	-15.66**	-61.62**
IR-79156/Reg-1649	-4.23	-10.24**	23.42	5.26**	-12.30**	-14.29**	8.31**	-18.22**	-12.44**	-32.37**	30.12	-40.79**
CRMS 31A												
CRMS-31A/R-1674-1823-2-1189-1	0.75	-7.03**	30.29	11.11**	-25.44**	-38.49**	3.08**	-22.17**	0.80**	-23.75**	36.14	-38.05**
CRMS-31A/R-1700-308-3-170-1	2.71	-2.39**	36.80	16.67**	-23.02**	-46.38**	-10.15**	-32.16**	-39.70**	-54.79**	-19.28**	-63.27**
CRMS-31A/R-1779-321-1-112-1	-9.27**	-13.94**	20.60*	2.85**	-33.88**	-51.16**	-18.15**	-38.20**	-36.34**	-51.42**	-13.25**	-60.53**
CRMS-31A/R-1892-486-151-1	-6.79**	-14.70**	19.54**	1.95**	-51.68**	-67.50**	-45.54**	-58.88**	-59.31**	-69.64**	-45.78**	-75.33**
CRMS-31A/R-2093-1536-1-660-1	-12.99**	-17.59**	15.50**	-1.50**	-60.03**	-72.46**	-53.85**	-65.15**	-45.08**	-60.86**	-30.12**	-68.20**
CRMS-31A/AP-16	-0.62	-9.67**	26.59	7.96**	-27.91**	-46.75**	-10.77**	-32.62**	-17.41**	-37.25**	12.05**	-49.01**
CRMS-31A/AP-18	-8.09	-11.56**	23.95	5.71**	-57.26**	-71.17**	-51.69**	-63.52**	-55.17**	-68.96**	-44.58**	-74.78**
CRMS-31A/Reg-1649	-16.43**	-22.36**	8.80**	-7.21**	-23.77**	-34.45**	9.85**	-17.05**	10.54**	-12.28**	56.62	-28.73**

*= Significant of p=0.05 level., **= Significant of p=0.01 level

	7. Fertile spikelets/panicle				**8 Spikelet Fertility (%)**				**9. Pollen Fertility (%)**			
Hybrids	**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**	
			Indira baranidhan	**Indira sona**			**Indira baranidhan**	**Indira sona**			**Indira baranidhan**	**Indira sona**
IR-58025A												
IR58025A/R-1674-1823-2-1189-1	-16.56**	-20.86**	-9.09**	-11.29**	8.63**	11.55 **	-6.79**	20.57**	190.51	45.25**	-14.91**	-26.28**
IR58025A/R-1700-308-3-170-1	15.59**	-9.75**	-7.03**	-9.27**	32.52**	16.25**	2.05**	32.01**	100.25	0.12**	-3.91**	-16.75**
IR58025A/R-1779-321-1-112-1	11.29**	-3.73**	-0.83**	-3.23**	26.23**	7.61**	1.08**	30.76**	104.00	2.00**	-3.43**	-16.34**
IR58025A/R-1892-486-151-1	-24.79**	-45.05**	-43.39**	-44.76**	3.24**	-6.73**	-23.44**	-0.97**	101.82	0.91**	-21.46**	-31.95**
IR58025A/R-2093-1536-1-660-1	-54.12**	-63.90**	-62.81**	-63.71**	-19.89**	-31.46**	-36.16**	-17.42**	40.83	-29.58**	-40.00**	-48.02**
IR58025A/AP-16	4.09**	-9.75**	-7.03**	-9.27**	9.60**	-6.77**	-11.95**	13.90**	89.19	-5.41**	-17.16**	-28.23**
IR58025A/AP-18	-17.34**	-36.62**	-34.71**	-36.29**	21.74**	3.79**	-2.51**	26.11**	95.10	-2.45**	-10.45**	-22.42**
IR58025A/Reg-1649	-34.33**	-40.33**	-24.79**	-26.61**	-18.18**	33.14**	-30.19**	-9.70**	152.39	26.19**	-34.24**	-43.03**
IR79156A												
IR-79156/R-1674-1823-2-1189-1	-28.96**	-32.37**	-22.31**	-24.19**	22.25**	-30.83**	-27.11**	-5.72**	130.71	15.35**	-32.43**	-41.46**
IR-79156/R-1700-308-3-170-1	-13.11**	-32.35**	-29.75**	-31.45**	-2.27**	-5.43**	-16.98**	7.39**	79.45	-10.27**	-13.89**	-25.39**
IR-79156/R-1779-321-1-112-1	-24.76**	-35.14**	-32.65**	-34.27**	-2.38**	-8.52**	-14.07**	11.16**	77.75	-11.13**	-15.86**	-27.10**
IR-79156/R-1892-486-151-1	-38.30**	-55.03**	-53.31**	-54.44**	-13.94**	-13.95**	-29.35**	-8.60**	76.68	-11.66**	-31.24**	-40.43**
IR-79156/R-2093-1536-1-660-1	-22.39**	-39.12**	-36.78**	-38.31**	10.33**	3.79**	-3.32**	25.07**	108.33	4.17**	-11.24**	-23.10**
IR-79156/AP-16	-12.04**	-24.00**	-21.07**	-22.98**	-8.86**	-14.81**	-19.55**	4.07**	76.22	-11.89**	-22.84**	-33.15**
IR-79156/AP-18	-27.66**	-44.69**	-42.56**	-43.95**	1.52**	-4.87**	-10.64**	15.59**	90.03	-4.99**	-12.78**	-24.44**
IR-79156/Reg-1649	-12.28**	-20.00**	0.83**	-1.61**	-0.15**	10.81**	-6.88**	20.46**	232.78	66.39	-13.29**	-24.88**
CRMS 31A												
CRMS-31A/R-1674-1823-2-1189-1	-34.15**	-43.98**	-8.26**	-10.48**	12.25**	-15.46**	-10.91**	15.25**	187.54	43.77**	-15.78**	-27.03**
CRMS-31A/R-1700-308-3-170-1	-16.09**	-43.22**	-7.03**	-9.27**	11.57**	5.93**	3.46**	33.84**	106.17	3.08**	-1.07**	-14.29**

CRMS-31A/R-1779-321-1-112-1	-32.91**	-51.05**	-19.83**	-21.77**	1.99**	0.04**	-2.29**	26.40**	106.92	3.46**	-2.05**	-15.14**
CRMS-31A/R-1892-486-151-1	-48.37**	-66.69**	-45.45**	-46.77**	11.60**	2.70**	0.31**	29.76**	136.19	18.09**	-8.09**	-20.37**
CRMS-31A/R-2093-1536-1-660-1	-65.88**	-76.79**	-61.98**	-62.90**	-14.67**	-16.65**	-18.59**	5.31**	78.61	-10.69**	-23.91**	-34.07**
CRMS-31A/AP-16	-31.99**	-50.29**	-18.59**	-20.56**	-5.20**	-6.76**	-8.93**	17.80**	92.97	-3.51**	-15.50**	-26.79**
CRMS-31A/AP-18	-58.06**	-71.99**	-54.13**	-55.24**	-1.56**	-3.45**	-5.69**	21.99**	90.80	-4.60	-12.43**	-24.13**
CRMS-31A/Reg-1649	-35.26**	-42.72**	-6.20**	-8.47**	15.50**	-18.22**	-14.62**	10.45**	227.03	63.51*	-14.79**	-26.18**

*= Significant of p=0.05 level, **= Significant of p=0.01 level

	10.Test weight (g)				**11. Grain Yield (g)**				**12. Biological Yield (g)**			
Hybrids	**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**	
			Indira baranidhan	**Indira sona**			**Indira baranidhan**	**Indira sona**			**Indira baranidhan**	**Indira sona**
IR-58025A												
IR58025A/R-1674-1823-2-1189-1	-3.67**	-4.68**	-0.33**	-15.95**	-19.58**	-38.14**	-32.87**	-52.75**	-55.74**	-56.37**	-48.13**	-59.06**
IR58025A/R-1700-308-3-170-1	-2.91**	-9.72**	9.80**	-7.41**	45.22	7.97**	29.56	-8.81**	10.27**	7.24**	27.49**	0.63**
IR58025A/R-1779-321-1-112-1	-5.52**	-7.70**	1.19**	-14.67**	39.71	3.43**	25.74	-11.50**	0.61**	-0.13**	18.73**	-6.29**
IR58025A/R-1892-486-151-1	-5.08**	-6.71**	1.01**	-14.82**	24.81	-2.82**	1.91**	-28.27**	5.72**	-10.86**	5.98**	-16.35**
IR58025A/R-2093-1536-1-660-1	-2.91**	-7.72**	7.09**	-9.69**	35.16	4.56**	11.65**	-21.42**	21.37**	7.91**	28.29**	1.26**
IR58025A/AP-16	0.53**	-5.03**	11.66**	-5.84**	27.72	-4.30**	12.17**	-21.05**	33.60**	11.93**	33.07**	5.03**
IR58025A/AP-18	0.98**	-5.11**	12.84**	-4.84**	32.19	0.16**	13.56**	-20.07**	16.27**	1.54**	20.72**	-4.72**
IR58025A/Reg-1649	1.50**	-5.44**	14.53**	-3.42**	20.08	-7.16**	-0.70**	-30.11**	-8.26**	-19.57**	-4.38**	-24.53**
IR79156A												
IR-79156/R-1674-1823-2-1189-1	-9.12**	-13.89**	-1.52**	-16.95**	-4.48**	-23.08**	-16.52**	-41.25**	-26.92**	-26.95**	-15.54**	-33.33**
IR-79156/R-1700-308-3-170-1	-1.08**	-4.03**	16.72**	-1.57**	-1.78**	-23.77**	-8.53**	-35.62**	-15.69**	-16.89**	-3.90**	-24.15**
IR-79156/R-1779-321-1-112-1	-8.00**	-9.90**	3.04**	-13.11**	4.44**	-19.31**	-1.91**	-30.97**	-7.57**	-8.16**	7.57**	-15.09**
IR-79156/R-1892-486-151-1	-5.92**	-8.42**	4.73**	-11.68**	2.64**	-16.25**	-12.18**	-38.19**	-13.53**	-26.26**	-14.74**	-32.70**
IR-79156/R-2093-1536-1-660-1	-3.23**	-3.93**	11.49**	-5.98**	17.79*	-4.56**	1.91**	-28.27**	1.84**	-8.34**	5.98**	-16.35**
IR-79156/AP-16	-4.73**	-6.03**	10.47**	-6.84**	8.24**	-15.28**	-0.70**	-30.11**	0.04**	-15.23**	-1.99**	-22.64**
IR-79156/AP-18	-6.73**	-8.52**	8.79**	-8.26**	6.87**	-15.34**	-4.00**	-32.43**	-10.33**	-20.75**	-8.37**	-27.67**
IR-79156/Reg-1649	-2.01**	-4.74**	15.38**	-2.71**	21.08	-1.95**	4.87**	-26.19**	15.65**	2.62**	18.65**	-6.35**
CRMS 31A												
CRMS-31A/R-1674-1823-2-1189-1	-5.32**	-8.91**	-6.76**	-21.37**	-7.65**	-17.79**	-10.78**	-37.21**	11.69**	10.34**	27.49**	0.63**
CRMS-31A/R-1700-308-3-170-1	3.75**	-7.78**	12.16**	-5.41**	6.20**	-9.42**	8.69**	-23.50**	5.49**	5.30**	18.73**	-6.29**
CRMS-31A/R-1779-321-1-112-1	7.20**	-0.15**	9.46**	-7.69**	10.96**	-5.87**	14.43**	-19.46**	-1.70**	-3.54**	12.99**	-10.82**
CRMS-31A/R-1892-486-151-1	19.73**	12.17**	21.46**	2.42**	18.53**	7.13**	12.34**	-20.93**	8.24**	-6.71**	5.18**	-16.98**
CRMS-31A/R-2093-1536-1-660-1	11.95**	1.60**	17.91**	-0.57**	16.26**	4.23**	11.30**	-21.66**	30.43**	18.73**	33.87**	5.66**
CRMS-31A/AP-16	10.19**	-0.57**	16.90**	-1.42**	0.26**	-13.65**	1.22**	-28.76**	13.08**	-3.18**	9.17**	-13.84**
CRMS-31A/AP-18	8.86**	-2.28**	16.22**	-2.00**	10.80**	-3.22**	9.74**	-22.77**	4.39**	-6.71**	5.18**	-16.98**
CRMS-31A/Reg-1649	11.98**	-0.28**	20.78**	1.85**	-7.98**	-17.56**	-11.83**	-37.94**	-9.41**	-18.73**	-8.37**	-27.67**

*= Significant of p=0.05 level. **= Significant of p=0.01 level

	13. Harvest index (%)				14. Flag leaf width (cm)			
Hybrids	**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**	
			Indira baranidhan	**Indira sona**			**Indira baranidhan**	**Indira sona**
IR-58025A								
IR58025A/R-1674-1823-2-1189-1	80.70	37.64**	29.10**	15.21**	-7.14**	-9.28**	-18.75**	5.43
IR58025A/R-1700-308-3-170-1	30.52**	-4.72**	1.69**	-9.25**	1.26**	0.00	-14.56**	10.87
IR58025A/R-1779-321-1-112-1	38.15**	1.72**	5.67**	-5.70**	4.99	2.41	-12.50**	13.54
IR58025A/R-1892-486-151-1	9.74**	-24.17**	-2.54**	-13.02**	27.72	26.21	10.44	43.31
IR58025A/R-2093-1536-1-660-1	6.11**	-24.39**	-12.70**	-22.09**	-3.70**	-4.90**	-18.75**	5.43
IR58025A/AP-16	-13.55**	-42.20**	-15.84**	-24.89**	0.00	-2.30**	-12.50**	13.54
IR58025A/AP-18	6.18**	-26.57**	-5.89**	-16.01**	2.41	2.41	-12.50**	13.54
IR58025A/Reg-1649	23.65**	-12.71**	4.04**	-7.16**	0.00	0.00	-14.56**	10.87
IR79156A								
IR-79156/R-1674-1823-2-1189-1	31.05**	5.56**	-1.00**	-11.65**	-1.26**	-6.98**	-16.69**	8.11
IR-79156/R-1700-308-3-170-1	16.40**	-10.55**	-4.53**	-14.80**	-7.69**	-9.98**	-25.00**	-2.68**
IR-79156/R-1779-321-1-112-1	13.77**	-11.74**	-8.30**	-18.17**	-3.93**	-5.15**	-22.94**	0.00
IR-79156/R-1892-486-151-1	10.88**	-19.84**	3.02**	-8.06**	-10.01**	-14.29**	-25.00**	-2.68**
IR-79156/R-2093-1536-1-660-1	11.37**	-16.67**	-3.80**	-14.14**	2.54	0.00	-16.69**	8.11
IR-79156/AP-16	0.04**	-30.29**	1.51**	-9.41**	-6.15**	-11.58**	-20.81**	2.76
IR-79156/AP-18	13.30**	-18.02**	5.07**	-6.23**	6.30	2.41	-12.50**	13.54
IR-79156/Reg-1649	0.37**	-25.68**	-11.43**	-20.96**	6.30	2.41	-12.50**	13.54
CRMS 31A								
CRMS-31A/R-1674-1823-2-1189-1	-17.02**	-25.29**	-29.93**	-37.46**	17.09	11.65	0.00	29.76
CRMS-31A/R-1700-308-3-170-1	1.45**	-13.58**	-7.76**	-17.69**	3.84	2.55	-14.56**	10.87
CRMS-31A/R-1779-321-1-112-1	13.72**	-2.04**	1.77**	-9.17**	7.69	7.69	-12.50**	13.54
CRMS-31A/R-1892-486-151-1	5.27**	-16.61**	7.18**	-4.35**	-1.26**	-4.79**	-16.69**	8.11
CRMS-31A/R-2093-1536-1-660-1	-12.62**	-27.89**	-16.74**	-25.70**	6.34	5.03	-12.50**	13.54
CRMS-31A/AP-16	-15.82**	-36.20**	-7.10**	-17.10**	4.87	0.00	-10.44**	16.22
CRMS-31A/AP-18	2.63**	-18.62**	4.30**	-6.92**	2.51	0.00	-14.56**	10.87**
CRMS-31A/Reg-1649	-0.67**	-19.04	-3.51**	-13.89**	-7.54**	-9.80**	-22.94**	0.00

*= Significant of p=0.05 level., **= Significant of p=0.01 level

	15.Chlorophyll content				16. Relative water content			
Hybrids	**MP**	**HB**	**Standard Heterosis**		**MP**	**HB**	**Standard Heterosis**	
			Indira baranidhan	**Indira sona**			**Indira baranidhan**	**Indira sona**
IR-58025A								
IR58025A/R-1674-1823-2-1189-1	-14.40**	-17.91**	26.40**	3.18**	-36.70**	-42.01**	-35.69**	-27.92**
IR58025A/R-1700-308-3-170-1	3.52**	1.69**	56.57	27.81**	-11.44**	-26.74**	-18.75**	-8.94**
IR58025A/R-1779-321-1-112-1	7.22**	2.87**	58.39	29.30**	5.59**	-15.27**	-6.03**	5.31**
IR58025A/R-1892-486-151-1	-10.32**	-10.58**	38.49	13.06**	-27.73**	-37.82**	-31.03**	-22.71**
IR58025A/R-2093-1536-1-660-1	-18.17**	-18.41**	25.62**	2.55**	-33.41**	-43.57**	-37.41**	-29.86**
IR58025A/AP-16	-6.56**	-10.30**	38.10	12.74**	-20.04**	-31.25**	-23.75**	-14.54**
IR58025A/AP-18	-4.11**	-5.49**	45.52	18.79**	-11.76**	-23.44**	-15.09**	-4.83**
IR58025A/Reg-1649	-20.50**	-21.37**	21.07**	-1.17**	-26.65**	-34.90**	-27.80**	-19.08**
IR79156A								
IR-79156/R-1674-1823-2-1189-1	-14.80**	-21.73**	32.12	7.86**	-50.50**	-56.13**	-47.59**	-41.26**
IR-79156/R-1700-308-3-170-1	-1.39**	-7.32**	56.44	27.71**	-34.92**	-47.69**	-37.50**	-29.95**
IR-79156/R-1779-321-1-112-1	-1.85**	-9.79**	52.28	24.31**	-18.16**	-36.11**	-23.66**	-14.44**
IR-79156/R-1892-486-151-1	-7.27**	-11.09**	50.07	22.51**	-30.02**	-41.59**	-30.21**	-21.79**
IR-79156/R-2093-1536-1-660-1	-22.42**	-26.04**	24.84**	1.91**	-13.16**	-28.57**	-14.65**	-4.35**
IR-79156/AP-16	-24.59**	-30.66**	17.04**	-4.46**	-25.26**	-37.66**	-25.52**	-16.52**
IR-79156/AP-18	-27.70**	-31.82**	15.09**	-6.05**	-32.50**	-43.22**	-32.15**	-23.96**
IR-79156/Reg-1649	-13.84**	-18.49**	37.58	12.32**	-35.17**	-44.26**	-33.40**	-25.36**
CRMS 31A								
CRMS-31A/R-1674-1823-2-1189-1	-7.95**	-12.83**	37.84	12.53**	-47.95**	-52.33**	-47.11**	-40.72**
CRMS-31A/R-1700-308-3-170-1	-6.11**	-8.96**	43.96	17.52**	-7.00**	-23.08**	-14.65**	-4.35**
CRMS-31A/R-1779-321-1-112-1	-3.91**	-8.96**	43.96	17.52**	12.11**	-10.06**	-0.21**	11.84**
CRMS-31A/R-1892-486-151-1	-3.11**	-4.11**	51.63	23.78**	7.74**	-7.30**	2.84**	15.27**
CRMS-31A/R-2093-1536-1-660-1	-3.64**	-5.18**	49.94	22.40**	5.91**	-10.26**	-0.43**	11.59**
CRMS-31A/AP-16	-2.39**	-7.48**	46.30	19.43**	-3.30**	-16.86**	-7.76**	3.38**
CRMS-31A/AP-18	-3.80**	-6.41**	47.99	20.81**	2.10**	-11.42**	-1.72**	10.14**
CRMS-31A/Reg-1649	-2.11**	-4.44**	51.11	23.35**	3.24**	-8.39**	1.64**	13.91**

*= Significant of p=0.05 level. **= Significant of p=0.01 level

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