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Studies on Heterosis for Grain Yield and Yield Component Characters in Salinity Tolerant Rice Genotypes

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ABSTRACT

The manifestation of hybrid vigour in 42 salinity tolerant rice hybrids for grain yield and yield component characters was investigated during *Rab*i 2016-17. The results revealed the hybrids to be high yielding with early duration with greater panicle length, compared to the parents. Among the lines, APMS 12A and among the salinity tolerant testers, MTU 1210 had recorded highest grain yield per plant and was found to be promising. Heterobeltiosis and standard heterosis more than 10 per cent was recorded for grain yield per plant, plant height, ear bearing tillers per plant, panicle length, filled grains per panicle, ill-filled grains per panicle and 100-seed weight. Among the salinity tolerant hybrids studied, APMS 12A x MTU 1153 and APMS 12A x MTU 1156 were observed to be high yielding and are therefore identified as potential hybrid combinations for further evaluation and commercial exploitation as salinity tolerant hybrids.

Key words: *Heterosis, Rice, Salinity tolerance, Yield, Yield Components*

Rice is an important staple food for more than half of the world's population and is referred to as "Global Grain" (Shalini and Tulasi, 2008). It has been estimated that the world will have to produce 60% more rice by 2030 than what it produced in 1995 (Babu *et al.* 2012). Heterosis breeding, particularly for abiotic stresses is one of the breeding methods which could enhance rice production significantly in the country. Among the abiotic stresses effecting rice production, salinity (both inland and coastal salinity) is considered to be second most important abiotic stress after drought, which affects rice production. Nearly 20 per cent of the world's cultivated area (800 million hectares) and nearly half of the world's irrigated lands are affected by salinity (Maser *et al*., 2002). In Andhra Pradesh, 2.74 lakh hectares of rice area is affected by salinity (NRSC, 2010). The success of hybrid rice programme for salinity tolerance therefore depends on the availability of male sterile and salinity tolerant restorer lines with good combining ability and exploitable levels of heterosis. The present study is an attempt in this direction to study the levels of heterosis of identified salinity tolerant restorers for grain yield and few important yield component traits.

MATERIAL AND METHODS

The experimental material comprised of three CMS lines, namely, APMS 6A, APMS 9A and APMS 12 A; and 14 salinity tolerant testers, namely MTU 1010, MTU 1153, MTU 1156, MTU 1121, MTU 1210, MTU 1032, IR 64, IR 7693-2B-7, MCM 223, MTU 1031, MCM 48, MCM 225 and MTU 1213 (Table 1) obtained from Regional Agricultural Research Station, Maruteru and Agricultural Research Station, Machilipatnam of Acharya N.G. Ranga Agricultural University and their 42 hybrids derived from the line x tester mating of the above three lines with the 14 testers.

The salinity tolerant hybrids and parents were evaluated along with the check, KRH-2 in a randomized block design with three replications for grain yield and yield component characters, namely, days to 50% flowering, days to maturity, plant height, total tillers per plant, ear bearing tillers per plant, panicle length, number of filled grains per panicle, number of ill-filled grains per panicle, spikelet fertility percentage, grain yield per plant and 100-seed weight at Regional Agricultural Research Station, Maruteru during *Rabi* 2016-17. The sowings were undertaken in the nursery during 1^{st} week of November, 2017 and transplanting of the seedlings was affected 25 days after sowing. The normal, healthy and vigorous seedlings of each genotype were transplanted in single row plots of 2m length, with a spacing of 20 x 15 cm and the crop was raised following recommended package of practices.

Data were recorded on five random competitive plants tagged for each entry in each replication and the average values were computed. Observations for days to 50% flowering and days to maturity were recorded on plot basis. In contrast, data on grain yield per plant and other yield component characters were recorded at the time of harvesting and the mean values were calculated. Further, observation

Table 1. Details of parents studied in the present investigation

S. No.	Genotype	Salient features
Lines		
1	APMS 6A	130 days duration, short grains
2	APMS 9A	135 days duration, medium slender grains
3	APMS 12A	135 days duration, medium slender grains
Testers		
1	MTU 1010	120 days duration with long slender grain type and resistance to Brown Plant Hopper and Blast
2	MTU 1153	120 days duration with long slender grain type, non-lodging and possess two weeks dormancy, non-shattering and resistant to blast and Brown Plant Hopper
3	MTU 1156	120 days duration with long bold grain type with non-lodging and possess two weeks dormancy, non-shattering and resistance to blast and Brown Plant Hopper
4	MTU 1121	135 days duration, non-lodging and possess 2-3 weeks dormancy, Non-shattering and tolerant to Bacterial Leaf Blight, Blast and Brown Plant Hopper
5	MTU 1210	135 days duration, strong culm, medium slender grain type, non-lodging possess two weeks dormancy, higher head rice recovery percentage and tolerant to Brown Plant Hopper and Blast
6	MTU 1229	150 days duration, possess three weeks dormancy, non-lodging and tolerant to Brown Plant Hopper and Bacterial Leaf Blight
7	MTU 1032	155 days duration, medium slender grain type and tolerant to Brown Plant Hopper and Bacterial Leaf Blight
8	IR64	120 days duration, long slender grain type, resistant to blast and tolerant to lodging
9	IR7693-2B-7	125 days duration, long slender grain type and salinity tolerant
10	MCM 223	127 days duration, medium slender and tolerant to salinity
11	MTU 1031	155 days duration, medium slender grain type and tolerant to Brown Plant Hopper and Bacterial Leaf Blight
12	MCM 48	120 days duration ,medium slender grain type and salinity tolerance
13	MCM 225	130 days duration medium slender grain type and salinity tolerant
14	MTU 1213	120 days duration with long bold grain type

on 100-seed weight was taken by weighing 100 random well filled grains. Heterosis over mid-parent, better parent and the commercial hybrid check, KRH-2 were obtained for each hybrid and for each character, as per the procedures out lined by Liang *et al.* (1972) and their significance was tested using t-test suggested by Snedecor and Cochran (1967). Further, in the present investigation, the parent with lower value was considered as better parent for the negative traits, namely, days to 50% flowering, days to maturity, plant height and ill-filled grains per panicle.

RESULTS AND DISCUSSION

A perusal of the results on analysis of variance (Table 2) revealed significant mean squares for the genotypes and hybrids for grain yield and yield contributing characters studied, indicating the existence of sufficient variation in the material under investigation. Further, the parents and parents vs. crosses component of variation was also significant for majority of the characters indicating the prevalence of significant levels of heterosis for grain yield per plant and majority of yield contributing characters in the material studied.

A critical analysis of the results on *per se* performance of the genotypes for grain yield and yield component characters (Table 3) revealed the salinity tolerant hybrids to be high yielding, relatively early and with greater panicle length, compared to both the lines and testers. Greater range was also noticed for

Table 2. Analysis of variance (ANOVA) for different traits in rice

Source of variation	Degrees of freedom	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Total tiller per plant	Ear bearing tillers per plant	Panicle length (cm)	Filled grains per panicle	Ill- filled grains per panicle	Spikelet fertility (%)	Grain yield per plant (g)	100-Seed weight (g)
Replications	2	2.87	2.87	31.15	1.8	2.15	1.03	17.51	11.6	5.67	2.53	0.04
Genotypes	59	232.27**	236.79**	819.99**	4.54**	3.66**	14.80**	18002.36**	2234.70**	1156.56**	223.64**	0.31**
Parents	16	464.00**	467.71**	1783.74**	2.52	2.63	13.67**	30099.69**	1951.20**	950.76**	277.75**	0.46**
Hybrids	41	141.06**	145.03**	434.66**	4.56**	4.11**	13.47**	13719.29**	2298.25**	220.70**	192.10**	0.26**
Parents vs. Crosses	1	263.90**	304.26**	1198.50**	36.31**	1.88	87.26**	51.09	4165.50**	2075.65**	651.15**	0.05
Error	118	1.69	1.67	15.27	1.49	1.54	2.74	24.67	8.86	4.77**	2.74	0.02

*,**Significant at 5 and 1 per cent levels, respectively

the hybrids, compared to both lines and testers, with regards to grain yield along with yield components, namely, filled and ill-filled grains per panicle, spikelet fertility percentage and 100-seed weight studied. However, relatively lower mean values were noticed in the salinity tolerant hybrids with regards to total tillers per plant and ear bearing tillers per plant, compared to the testers.

The best genotype identified for parents and hybrids based on their *per se* performance is also presented in Table 3 for the different traits studied. A perusal of these results revealed APMS 6A to be best line for filled grains per panicle; APMS 9A for days to 50 per cent flowering, days to maturity and plant height; and APMS 12 A for grain yield per plant, total and ear bearing tillers per plant, panicle length, spikelet fertility percentage and 100-seed weight. Among the salinity tolerant testers, MTU 1210 for grain yield; MCM 48 for days to 50 per cent flowering, days to maturity and spikelet fertility percentage; MTU 1010 for plant height, total and ear bearing tillers per plant; MCM 223 for panicle length, filled grains per panicle, and spikelet fertility percentage; and MTU 1153 for 100-seed weight. Among the salinity tolerant hybrids, APMS 12 A x MTU 1156 and APMS 12 A x MTU 1153 for grain yield per plant; and APMS 6A x MTU 1156 for days to 50 per cent flowering and days to maturity had recorded superiority, compared to the check, KRH-2.

A perusal of the results also revealed considerable levels of heterobeltiosis and standard heterosis for majority of the traits studied (Table 4). Heterobeltiosis and standard heterosis more than 10 per cent were recorded for grain yield per plant, plant height, ear bearing tillers per plant, panicle length, filled grains per plant, ill-filled grains per panicle and 100-seed weight. Heterobeltiosis was observed to an extent of 178.04 per cent for grain yield per plant. Similar high levels of heterobeltiosis for grain yield per plant were reported earlier (Dar *et al*, 2015). Further, significant and desirable levels of heterosis were also noticed in several salinity tolerant hybrids for the different traits studied (Table 4). Eighteen hybrids had displayed significant heterosis over the better parent for grain yield per plant. Several workers have also reported similar significant and desirable heterosis for yield in rice (Srivastava and Jaiswal, 2016).

Table 3. ***Per se*** **performance of parents and hybrids for grain yield and yield component characters in rice**

Character	Mean			Range			Best genotype		
	Lines	Testers	Hybrids	Lines	Testers	Hybrids	Lines	Testers	Hybrids
Grain yield per plant	15.01	19.77	24.71	12.39-18.33	8.07-43.10	11.10-46.77	APMS 12A	MTU 1210	APMS 12 A x MTU 1156 APMS 12 A x MTU 1153
Days to 50 % flowering	97.55	92.26	88.18	95.33-101.67	78.33-116.00	75.33-103.67	APMS 9A	MCM 48	APMS 6A x MTU 1156
Days to maturity	127.6	120.97	119.44	125.55-131.66	108.33-146.00	105.33-133.67	APMS 9A	MCM 48	APMS 6A x MTU 1156
Plant Height	111.7	110.61	111.11	103.52-121.34	83.00-157.80	92.33-138.00	APMS 9A	MTU 1010	APMS 6A x MTU 1031
Total tillers per plant	9.77	12.12	10.16	8.33-11.66	7.40-24.90	8.00-12.67	APMS 12A	MTU 1010	APMS 6A x MTU 1032 APMS 6A x MTU 1031 APMS 12A x MTU 1213
Ear bearing tillers per plant	7.66	10.22	8.03	6.33-9.66	5.40-22.90	6.00-10.67	APMS 12A	MTU 1010	APMS 6A x MTU 1031 APMS 6A x MTU 1032
Panicle length	24.47	24.93	26.41	23.09-25.33	19.60-29.50	22.33-31.00	APMS 12A	MCM 223	APMS 12 A x MTU 1032
Filled grains per panicle	106	224.61	209.5	131.66-154.33	105.33-460.00	122.33-483.33	APMS 6A	MCM 223	APMS 12 A x MTU 1229
Ill-filled grains per panicle	17.72	38.88	40.92	14.33-21.33	9.33-73.67	8.00-140.67	APMS 12A	MCM 48 MCM 223	APMS 12A x MTU 1153
Spikelet fertility	89.65	86.18	84.59	87.55-90.80	74.94-93.75	61.88-98.15	APMS 12A	MCM 48 MCM 223	APMS 12 A x MCM 48
100-seed weight	2.3	1.97	2.08	1.86-3.05	1.55-2.58	1.13-2.84	APMS 12A	MTU 1153	APMS 12 A x IR 64

Table 4. Heterobeltiosis and standard heterosis for grain yield and yield component characters in rice

Character	Heterobeltiosis			Standard heterosis		
	Range	No. of desirable heterotic hybrids	Best hybrid combination	Range	No. of desirable heterotic hybrids	Best hybrid combinations
Grain yield per plant	-51.32 to 178.04	18	APMS 6A x IR 64	-73.78 to 10.48	2	APMS 12A x MTU 1156 APMS 12A x MTU 1153
Days to 50% flowering	-24.59 to 15.69	35	APMS 6A x MTU 1121	-25.77 to 2.98	40	APMS 6A x MTU 1156
Days to maturity	-18.99 to 11.14	35	APMS 6A x MTU 1121	-19.39 to 0.77	39	APMS 6A x MTU 1156
Plant Height	35	26	APMS 12A x MCM 48	-25.74 to 10.99	31	APMS 6A x MTU 1031
Total tillers per plant	-31.43 to 35.71	6	APMS 6A x MTU 1032	-33.33 to 5.56	-	-
Ear bearing tillers per plant	-37.33 to 33.33	1	APMS 6A x MTU 1156	-37.93 to 10.34	-	-
Panicle length	-24.28 to 27.04	8	APMS 6A x MCM 225	-2.90 to 34.78	25	APMS 6A x MCM 225
Filled grains per panicle	-67.46 to 100.28	17	APMS 12A x MTU 1229	-44.73 to 118.37	12	APMS 12A x MTU 1229
Ill-filled grains per panicle	-90.94 to 479.07	18	APMS 9A x MCM 223	-63.64 to 539.39	8	APMS 12 A x MCM 48
Spikelet fertility	-31.40 to 7.58	8	APMS 9A x MCM 223	-32.22 to 7.51	4	APMS 12 A x MCM 48
100-seed weight	-55.53 to 19.06	3	APMS 6A x IR 7693-2B-7	-49.70 to 26.79	1	APMS 12A x IR 64

Table 5. Details of promising hybrids identified

Hybrid	Characterization of parents with regards to *per se* performance	Grain yield per plant (g)	Heterobeltiosis (%)	Standard heterosis (%)	Significant and positive standard heterosis recorded for other characters
APMS 12 A x MTU 1156	High x Low	46.77	154.42**	10.48**	Days to 50 per cent flowering, days to maturity, plant height, panicle length, ill-filled grains per panicle, spikelet fertility percentage and grain yield per plant
APMS 12 A x MTU 1153	High x High	46.65	154.50**	10.21**	Days to 50 per cent flowering, days to maturity, plant height, panicle length, ill-filled grains per panicle and grain yield per plant

*,** Significant at 5 and 1 per cent levels, respectively

A perusal of the results on heterosis revealed the salinity tolerant hybrids, APMS12A x MTU 1156 and APMS12A x MTU 1153 to be promising and high yielding in the present study (Table 5) with significant and positive heterobeltiosis and standard heterosis more than 10 per cent for grain yield per plant. These hybrids had also recorded desirable levels of standard heterosis for days to 50 per cent flowering, days to maturity, plant height, panicle length and ill-filled grains per panicle. Characterization of these desirable hybrids for the different traits, including grain yield per plant with regards *to per se* performance of their parents revealed the hybrids to involve at least one good parent.

CONCLUSION

It can be concluded that the results on *per se* performance and heterosis revealed the potential of APMS 12A x MTU 1153 and APMS 12A x MTU 1156 hybrids for commercial exploitation as salinity tolerant hybrids.

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