

Field Evaluation of IR64 Mutants with Altered Responses to Salt Stress Under Saline and Normal Conditions

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More than 5,000 diexybotane M4 IR64 mutant lines were screened for salinity tolerance or sensitivity at the seedling stage from June 2003 to December 2005. Four tolerant and two sensitive mutants relative to the wild type IR64 (intermediate) were identified and advanced to the M₆ generation. The selected mutants were then evaluated in a series of field experiments conducted at different locations and during different growing seasons in the Philippines to assess their performance under natural field conditions. Experiments were conducted either under control conditions to compare the agronomic performance of the selected mutants or under saline field conditions to compare the yield responses of tolerant and sensitive mutants with that of IR64. The mutants were evaluated, along with wild type IR64 and two other checks, sensitive IR29, and highly tolerant FL 478.

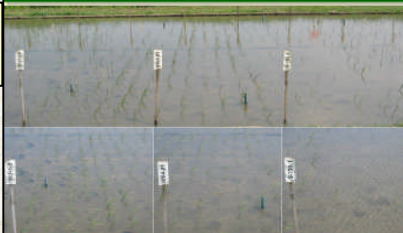
Materials and methods



Field preparation for testing the performance of the mutants and checks in saline and normal (control) fields at IRRI. In the saline treatment, 3-wk-old seedlings were transferred to the saline soil with EC of about 7 dS m⁻¹. EC was maintained between 6 to 7 dS m⁻¹ by either adding saline or normal water to the soil.

Performance of sensitive and tolerant mutants and IR64 under saline field conditions

Selected tolerant and sensitive mutants showed consistent responses to salt stress under natural saline field conditions.

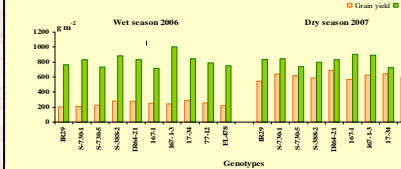


Results

I. Performance under normal field conditions

Growth, yield, and yield components of IR64 mutants and checks under normal field conditions were evaluated during the wet season of 2006 at IRRI. The data are means of four replications with 10 subsamples per replication.

Genotype	Plant height (cm)	Culm length (cm)	Panicle length (cm)	Tiller no. per panicle	Straw yield (t/ha)	Grain yield (t/ha)	Biomass (t/ha)	No. of fertile panicles per m ²	Total no. of panicles per m ²	Weight of fertile panicles per m ²	No. of spikelets per panicle	Grain fertility (%)	No. of filled grains per panicle	Weight of filled grains per panicle (g)	HI (%)	1000 grain weight (g)	
IR29	95.1	55.2	21.4	40.8	3100	3019	767.8	312.2	393.8	322.2	77.2	37.6	48.2	1.06	0.77	26.2	25.18
S-730-1	84.0	55.7	22.1	41.6	4259	2114	819.6	295.0	365.0	321.4	80.8	46.0	56.1	1.40	0.91	26.3	24.28
S-730-5	84.1	54.5	21.5	41.6	4380	2228	734.4	296.8	326.2	297.1	76.6	40.8	54.0	1.09	0.81	30.1	23.91
S-388-2	87.9	52.3	22.8	41.6	4578	282.8	844.4	281.3	392.5	343.3	78.2	51.6	61.8	1.22	0.93	28.7	25.59
IR64-21	90.1	56.2	21.1	41.6	4461	276.54	810.8	301.3	316.3	306.6	77.4	47.2	61.6	1.28	1.06	31.0	23.82
167-1	83.2	55.1	22.1	42.1	4041	231.78	720.4	251.2	298.4	326.6	64.3	38.7	66.3	0.90	0.76	35.6	23.84
167-1-3	87.0	54.6	22.4	43.9	4087	283.38	1003.1	271.9	351.3	312.9	79.7	44.9	61.8	1.13	0.90	25.2	24.17
17-34	90.5	57.3	22.0	37.0	4548	290.36	843.0	283.4	334.5	375.3	74.7	49.4	64.2	0.98	0.83	34.5	23.26
17-12	88.7	57.3	22.3	41.9	3894	281.28	800.3	317.2	370.8	355.3	62.9	46.5	55.2	1.39	1.14	32.0	24.44
FL478	94.1	56.2	22.1	38.1	3862	259.49	793.9	342.7	364.7	318.1	82.3	44.6	53.2	1.00	0.82	28.3	24.17



Grain yield and biomass production of the genotypes in a normal field were evaluated during the wet season of 2006 and dry season of 2007 at IRRI. Values are means of four and two replications in 2006 WS and 2007 DS, respectively. Vertical bars indicate LSD.

The mutants and their parent showed similar performance under control field conditions, clearly reflecting their apparent similarity to the wild type, as was observed when using SSR IDs for IR64. These results also proved that there was no apparent yield penalty as a result of these mutations since both the sensitive and tolerant mutants performed almost in the same way as did the wild type in normal fields at both seedling and reproductive stages.

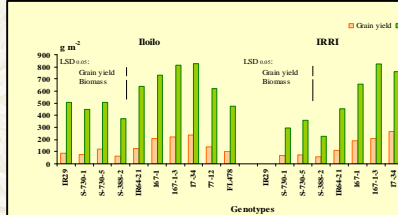
II. Performance under natural saline field conditions

The effects of salinity on growth, grain yield and biomass of IR64 mutant lines and checks were evaluated under natural saline field conditions during the wet season of 2006 at Ajuy-Iloilo. Data are means of four replications with 10 subsamples per replication.

Genotype	Plant height (cm)	Culm length (cm)	Panicle length (cm)	SPAD	SES scores at flowering	SES scores at maturity	Survival rate (%)	Reproductive		Grain yield (t/ha)	Biomass (t/ha)
								Tiller no. per m ²	Grain yield (t/ha)		
IR29	79.3	51.2	21.7	38.8	7.0	73.7	299.8	268.3	86.56	509.9	
S-730-1	73.1	47.0	22.6	43.0	3.1	8.1	72.9	289.4	241.4	75.08	450.3
S-730-5	73.8	47.0	22.7	43.2	2.1	7.0	72.4	267.5	239.4	120.95	509.5
S-388-2	76.6	50.0	24.4	42.8	2.1	5.9	63.2	256.9	219.8	61.81	371.3
IR64-21	77.3	52.4	24.2	40.6	1.6	5.9	64.1	319.5	278.2	123.67	638.4
167-1	77.3	51.1	23.7	42.9	1.8	5.3	74.0	346.3	303.1	209.77	730.2
167-1-3	77.5	51.3	23.4	40.4	2.1	2.9	75.4	337.8	305.2	222.70	813.2
17-34	80.0	56.4	24.3	43.4	1.3	2.4	76.8	345.6	316.6	237.70	825.8
17-12	78.7	53.1	24.7	44.1	1.5	5.4	60.1	277.2	244.9	138.47	619.1
FL478	94.6	50.9	25.3	47.7	2.9	6.1	55.7	158.9	142.5	100.77	475.2

The effects of salinity on yield components and harvest index of IR64 mutant lines and checks under natural saline field conditions during the wet season of 2006 at Ajuy-Iloilo. Data are means of four replications with 10 subsamples per replication.

Genotype	No. of fertile panicles per m ²	No. of sterile panicles per m ²	Total no. of panicles per m ²	Weight of fertile panicles per m ² (g)	No. of spikelets per panicle	No. of filled grains per panicle	Grain fertility (%)	Weight of spikelets per panicle (g)	Weight of filled grains per panicle (g)	HI (%)	1000 grain weight (g)	
IR29	186.5	95.8	282.3	154.01	93.6	48.7	45.4	1.26	0.95	16.9	17.19	
S-730-1	151.0	95.6	246.7	132.91	64.9	38.6	44.8	0.94	0.75	15.6	18.40	
S-730-5	171.4	57.5	221.5	187.60	79.2	43.6	44.7	1.10	0.86	20.0	19.15	
S-388-2	76.8	128.2	185.6	75.43	92.8	51.6	27.6	0.77	0.59	9.0	14.13	
IR64-21	201.3	78.1	279.4	237.16	95.9	52.2	46.0	1.39	0.92	20.3	18.39	
167-1	235.5	71.5	307.0	261.11	286.59	80.7	59.4	55.4	1.32	1.17	27.7	19.50
167-1-3	275.8	57.1	333.9	309.17	97.1	63.4	57.6	1.43	1.26	27.7	19.51	
17-34	267.4	72.9	340.3	353.43	102.3	60.1	60.0	1.44	1.47	27.7	19.79	
17-12	236.5	64.5	276.0	235.19	101.7	58.5	46.8	1.31	1.13	23.1	17.16	
FL478	98.2	45.8	146.29	164.29	102.6	60.9	42.1	1.68	1.30	17.8	21.67	



Grain yield and biomass production under saline field conditions during the wet season of 2006 at Iloilo and the dry season of 2007 at IRRI. Data are means of four and two replications at Iloilo and IRRI, respectively.

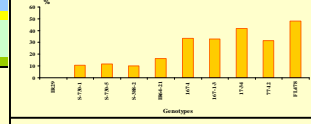
In saline fields, tolerant mutants consistently had better growth, higher survival, and higher grain yield and biomass. Conversely, the sensitive mutants consistently had lower survival rate, poor growth, and lower grain yield and biomass production.

III. Performance under normal and saline field conditions at IRRI

The growth, yield, and yield components of IR64 mutant lines and checks under control and saline field conditions were evaluated during the dry season of 2007 at IRRI. Data are means of two replications.

Genotype	SES	Survival (%)	Plant height (cm)	Culm length (cm)	Panicle length (cm)	Tiller no. per m ²	Grain yield (t/ha)	Biomass (t/ha)	HI (%)	1000 grain weight (g)	
Normal	1	100	96.7	72.6	22.3	510.9	549.68	837.7	1187.4	39.68	23.14
S-730-1	1	100	91.0	66.1	22.8	584.3	642.22	816.4	1166.9	42.88	23.71
S-730-5	1	100	91.8	66.4	22.2	470.3	618.70	738.1	1156.9	45.60	23.62
S-388-2	1	100	97.3	72.3	24.3	532.2	583.72	796.4	1180.2	41.98	24.60
IR64-21	1	100	95.2	69.6	23.4	491.2	606.96	800.1	1232.0	48.88	24.79
167-1	1	100	91.7	66.8	23.0	560.9	569.64	900.9	1470.2	38.82	26.46
167-1-3	1	100	90.8	67.7	23.9	581.0	627.60	800.6	1193.0	41.34	26.70
17-34	1	100	91.7	73.7	23.1	489.8	644.44	728.3	1157.2	46.96	25.83
17-12	1	100	100.0	74.0	24.0	486.4	672.62	798.7	1190.3	43.28	25.16
FL478	1	100	99.0	69.6	22.6	416.2	472.96	609.2	1176.6	40.92	24.17
Mean	1	100	94.87	69.79	23.39	516.46	600.97	828.26	1423.88	42.11	25.74

Grain yield of IR64 mutants and checks in normal and saline fields during the dry season of 2007 at IRRI.



Relative grain yield of IR64 mutants and checks in saline fields during the dry season of 2007 at IRRI.

This experiment confirmed the results from normal and saline field experiments at IRRI and Iloilo. No significant differences were observed among the mutants and IR64 under nonstress conditions. Nonetheless, salinity resulted in substantial reduction in yield and biomass production of the mutants and checks. Grain yield and most yield components were significantly reduced by salinity. Salinity significantly reduced biomass and tiller number, grain yield, and yield attributes such as panicle and spikelet number, grain fertility, 1,000-grain weight, and harvest index.

The tolerant IR64 mutants are potential varieties for areas with high salinity problems during crop establishment as in coastal India and Bangladesh. These mutants have good grain quality as that of the popular variety IR64 and could potentially be released as new varieties in target areas amid further evaluation and acceptance by farmers.

Conclusions

- The performance of the sensitive and tolerant mutants was similar under normal conditions and with IR64 in terms of yield and yield components over two seasons.
- Salinity dramatically reduced yield and yield components in all genotypes, but the sensitive and tolerant mutants behaved differently under salt stress.
- The extent of damage and yield reduction was much higher in sensitive mutants than in tolerant mutants and IR64.
- Under salinity, the tolerant mutants 167-1-3 and 17-34 had the highest grain yield and the sensitive mutants S-730-1 and S-388-2 had the lowest grain yield, thus confirming their genetic differences.
- The tolerant mutants 167-1-3 and 17-34 are potential new varieties for coastal saline areas since they share the same genetic background with popular variety IR64.