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STUDIES ON SCREENING GENOTYPES FOR SALINITY STRESS TOLERANCE IN RICE GENOTYPES (*ORYZA SATIVA* L.)

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Abstract

Rice is one of the world's most important staple crops. Although rice is considered as a sensitive crop to salinity, it is one of the most widely grown crops in coastal areas. In the present, salinity is the second most widespread soil problem in rice growing countries next to drought and considers as a serious constraint to increased rice production worldwide. Worldwide, it is grown in an area of about 166 million hectares and in India it is of around 44.5 million hectares. 20 million tonnes in the account of production it is 754.6 million tonnes over the world and in India it is 164.2 million tonnes as per FAO Stat. Division, 2017. 17 per cent of the genotypes had acceptable tolerance at electrical conductivity (EC) of 10 dS/m at the seedling stage. Traditional cultivars are the most tolerant to abiotic stresses. There exists tremendous variation for salt tolerance within species in rice, providing opportunities to improve crop salt-stress tolerance through genetic means. Some attempts to develop salt-tolerant genotypes were based on highly tolerant traditional rice cultivars. It drastically reduces growth and yield of crop under salinity stress with the pH of 7.8 to 8.3 (Soil ECe- 4 dS/m and water ECe- 6.4 to 8.2 dS/m). The experiment was conducted in Augmenting Block Design with 6 blocks. The data were recorded on days to 50% flowering, plant height (cm), panicle length, number of tillers/plant, number of productive tillers/plant, filled grains, spikelet fertility (%), 1000 grain weight (g), SES Score of reproductive stage, grain yield (kg/ha). Based on the yield and yield attributing traits observed significant variability among 88 genotypes studied. The maximum grain yield per plant was recorded in CSSR 2016-IR18-17 followed by CSSR 2016-IR18-12, CSSR 2016-IR18-7, CST 7-1, CARI Dhan 7 and CARI Dhan 10. These genotypes were found to be promising for majority of the traits studied and gave a yield of more than 5 tonnes/ha under salinity stress condition of Annamalainagar salinity.

Keywords: Augmented Block Design, Rice (*Oryza sativa* L.),Salinity Stress, Tolerance

Introduction

Rice (*Oryza sativa* L. 2n = 2x = 24) is the most important cereal crop cultivated widely in many parts of the world, rice belongs to the tribe oryzae in the family poaceae. Genus *oryza* include 24 species of which only two species of Asian rice (*Oryza sativa*) and African rice (*Oryza glaberimma*) are cultivated. The amount of rice consumed by each of these people ranges from 275 – 650 g per day. It contains carbohydrate (78.2%), protein (6.8%), fat (0.5%) and mineral (0.6%). Rice is an important staple food crop that feeds one half of the world population. Worldwide, it is grown in an area of about 166 million hectares and in India it is of around 44.5 million hectares. 20 million tonnes in the account of production it is 754.6 million tonnes over the world and in India it is 164.2 million tonnes as per FAO Stat. Division, 2017. Rice is very sensitive to salinity stress during seedling and reproductive stages and is the most sensitive in cereal crop (**Aref** *et al*., 2012). Salinity is one of the major abiotic stress in arid and semi - arid regions and it affects 7% land area of about 93million hectare. If excessive amount of salt enters the plant, salt will eventually rise to toxic levels in the transpiring leaves, causes premature senescence, and reduces photosynthetic leaf area of plant resulted in reduced yield of crop. Tolerance of rice plant to salinity stress is a coordinated action of multiple stress responsive genes. The research work was carried out to identify suitable saline tolerant genotypes for coastal ecosystem. Saline Tolerant Breeding Network (STBN) comprises Eighty seven rice genotypes and the trial was conducted in Annamalai University, Annamalai nagar, Valambadugai coastal saline soil during *Kharif* 2018 with the pH of 7.8 - 8.5 and Electrical conductivity of 3.8- 4.54 $dSm^{-1.}$

Methodology

The research was carried with 88 genotypes of which 81 genotypes are the test entries and seven are check varieties *viz.,* CSR-10, CSR 27, CSR 36, CST 7- 1, PUSA 44, Sambha Sub-1, and Local Check TRY-1. The research work was carried with Augmented Randomized complete Block design (Augmented RCBD) with Six blocks. Each block consist of 17 test entries and two to five check varieties. The trial was carried out in farmers field of Valambadugai Saline soil, Annamalainagar, Cuddalore district. The data were collected for yield and yield contributing characters *viz.,* Days to 50 per cent flowering, plant height at maturity, number of tillers per plant, number of productive tillers per plant, , panicle length, number of filled grains per panicle, spikelet fertility, 1000 grain weight, and Grain yield per plant.

Result and Discussion

Days to 50 per cent flowering (days)

The days to 50 per cent flowering ranged from 78 days - 131 days among the 88 rice genotypes. The maximum days to 50 per cent flowering was recorded in CR3898-113-4-2-1(131 days). The minimum days to 50 per cent flowering was recorded in PAU 3835-36-6-3-3-4(78 days) followed by CR 3878-245-2-4-1 (81 days), CSR 2016-IR18-7(82 days), CSR2016-IR18-6 (83 days), CSR 2016-IR18-1(84 days) and CSR-2748-441-193(85 days) respectively. The mean value of days to 50 per cent flowering was noted at 94.89 days among the 87 rice genotypes (Table 2).

Plant height at maturity (cm)

The plant height at maturity data revealed significant variation among the 88 rice genotypes. The plant height ranged from 69 cm to 137 cm with the mean plant height of 107.61 cm. The minimum plant height was recorded in CSR 2016-IR18-8 (69 cm) followed by CSR 2016-IR18-8 (69 cm), CSR 36 (80.3 cm), PUSA 44 (89 cm), Sambha Sub - 1 (90 cm), CR 2859-S-B-2-1-B-7 (91 cm). The maximum plant height at maturity was recorded in CR3884-244-8-5-11-1-4 (131 cm) (Table. 2).

Number of tillers per plant

The number of tillers per plant ranged from 9 to 23 among the rice genotypes. The maximum number of tillers per plant was recorded in CR 3882-7-1-6-2-2-1 (23) followed by Samba Sub -1 (21), RP-5694-36-9-5-1-1 (19), CSR 2016-IR18-11 (18), CSR36 (17) and NDRK 11-20 (16) (Table 10). The minimum number of tillers per plant was recorded in RP 5687-420-111-5-4-2-1 (9), the mean of number of tillers per plant among the genotypes was observed *i.e.* 14.94 (Table. 2).

Number of productive tillers per plant

The Number of productive tillers per plant ranged from 8 to 23 among the 88 rice genotypes. The maximum number of productive tillers per plant was recorded in CR 3912-221-3-1 (22) followed by CR 3882-7-1-6-2-2-1 (19), Samba Sub - 1 (19), CSR 2016- IR 18- 17 (17), CARI Dhan 6 (16) and CSR 27 (15). The minimum number of productive tillers per plant was recorded in RP 5687-420-111-5-4-2-1 (8). Mean value of number of productive tillers per plant among the rice genotypes was noted as 13.12 (Table 2).

Panicle length (cm)

It is evident from the data that the panicle length varied from 18 cm to 27 cm among the 88 rice genotypes. The maximum panicle length was recorded in RP-5683-101-85-30-2-3-1(27 cm) and followed by CSR 2016-IR18-11(26 cm), CSAR 1620 (25 cm), TR 05043 (24 cm), Sambha Sub - 1 (23 cm) and RP 5690-20-6-3-2-1(22 cm) respectively, while minimum panicle length was recorded in RAU720 (18 cm). Average panicle length was observed as 22.58 cm (Table.2).

Filled grains per panicle

The filled grains per panicle ranged from 71 to 173 among the rice genotypes. The maximum filled grains per panicle was recorded in Sambha Sub-1 (173) followed by KR 15006 (150), CARI Dhan - 1 (142), CR 3912-221-1-3-1 (140), PAU 4254-14-1-2-2-2-4-1 (136) and CSR 2016-IR18-1(135). The minimum number of filled grains per panicle was recorded in CST-1 (71). Mean value of filled grains per panicle among the rice genotypes was observed *i.e.* 100.02 (Table.2).

Spikelet fertility (%)

Data showing spikelet fertility of rice genotypes in table revealed that there was significant variation in tomato genotypes. The spikelet fertility ranged from 63 per cent - 92.2 per cent. The maximum spikelet fertility was recorded in CSR2016-IR18-11 (92.2 per cent) followed by CR 3912-221-1-3-1 (90.2 per cent), NDRK 11-20 (89.54 per cent), SambaSub1 (86 per cent), RP5690-20-6-3-2-1 (84 per cent) and CSR 36 (83 per cent). The minimum spikelet fertility was recorded in CSR 2016-IR18-8 (63 per cent). Mean value of spikelet fertility among the rice genotypes was observed *i.e.* 84.85 per cent (Table. 2).

1000 Seed weight (gm)

The 1000 seed weight ranged from 20.5 gm to 29.6 gm among the 88 rice genotypes. The maximum 1000 seed weight was recorded in CSR 2016-IR18-1 (29.6 gm) followed by CSR 36 (28 gm), CSAR1620 (27 gm), CARI Dhan 6 (26 gm), CR 3898-113-4-2-1 (25 gm) and CR 2851-S-B-1-B-B-1(24 gm). The minimum 1000 seed weight was recorded in CSRC(S) 47-7-b-b-1-1 (20.5). The mean value of 1000 seed weight was noted as 24.09 gm (Table. 2).

Grain yield per plant

The data indicated large genetic variation in grain yield per plant among rice genotypes. The grain yield per plant ranged from 1450 kg- 5890 Kg among 87 rice genotypes (Das *et al.,* 2001). The maximum grain yield per plant was recorded in CSSR 2016-IR18-17 (5980 Kg) followed by CSSR 2016-IR18-12 (5890 Kg), CSSR 2016-IR18-7 (5870 Kg), CST 7-1 (5850 Kg), CARI Dhan 7 (5780 Kg) and CARI Dhan 10 (5670 Kg) . The minimum grain yield per plant was recorded in IR84649-81-4-1-3B-CR3397-S-B-4B-1 (1450 Kg). The mean value of 1000 seed weight was noted as 3702 Kg (Table 2).

Genetic Parameters

The genetic parameters *viz.,* PCV, GCV, Heritability, Genetic advance and Genetic advance as per cent of mean are given in table 3. In the present study, indicates that grain yield recorded high PCV and GCV (33.93, 33.76) followed by grains per panicle (27.33, 27.27), productive tillers per plant (26.43, 20.09) and high PCV for number of tillers per plant (23.94) (Das *et al.,* 2001 and Majumdar *et al.,* 1971). The traits 1000 Seed weight (17.19, 14.73), Panicle length (13.94, 10.82), and Plant height (14.17, 13.93) recorded moderate PCV and GCV. However, these two traits days to 50 per cent flowering (10.97, 9.92) and spikelet fertility (7.57, 7.24) recorded lowest PCV and GCV. High heritability and genetic advance as per cent of mean was observed for all the characters except productive tillers per plant (Burton,1952). This indicating the predominance of additive gene action for all the traits. High heritability was recorded in grain yield (99.96%) followed by filled grains panicle (99.57%), plant height (96.62%), days to 50 % flowering (81.85%), 1000 Seed weight (73.39%), total tillers (61.62%) and panicle length (60.22%).

Mean, range, GCV, PCV, heritability (broad sense), genetic advance and genetic advance expressed as percent of mean for nine characters are presented in Table 3. In general estimates of PCV were higher compared to that of all characters studied, reflecting the influence of environment on the expression of these traits. Similar results were also reported by (Das *et al.,* 2001 and Majumdar *et al.,* 1971). The difference between genotypic and phenotypic coefficient of variation was less for all characters studied except productive tillers per plant and total tillers per plant, indication of the more influence of the environment over this two characters. The slight difference between GCV and PCV was also reported by Mustafa and Isheikh (2007), Kole *et al.* (2008) and Mulugeta Syoum *et al.* (2012). The genotypic coefficient of variability was found maximum for grain yield (kg/ha) followed by filled grains per panicle, productive tillers per plant, total tillers/plant, 1000 seed weight, plant height, panicle length, and minimum spikelet fertility followed by days to 50% flowering by Karthikeyan (2003). High values of PCV and GCV for grain yield was earlier reported by Panwar *et al.* (2005), Karthikeyan *et al.* (2010). The heritability was found highest in all the characters except productive tillers/plant. High heritability were observed for grain yield, filled grains/panicle, plant height, spikelet fertility, days to 50% flowering, seed weight, total tillers/plant, productive tillers/ plant. The study indicated that the genetic coefficient of variation along with heritability give clear picture of amount of advance to be accepted from selection.

Table 1 : Analysis of Variance for yield and its contributing traits in Rice 87 Genotypes

Source of variation	Degrees of Freedom	Days to 50% flowering	Plant height (Cm)	Total tillers /plant	Productive tillers per plant	Panicle length (cm)	Filled grains per panicle	Spikelet fertility (%)	1000 seed weight	Grain Yield kg/ ha
Replication	2	2.47	3.12	5.05	11.41	2.46	4.86	4.66	11.28	11518.62
Genotype	101	285.75**	681.69**	28.56**	2 5.92**	21.83**	2234.75**	116.75**	42.33**	4733667.27**
Error	202	19.67	7.86	4.91	5.07	3.94	3.17	3.54	4.56	655.59

Table 2 : Mean Performance of rice genotypes for yield and its contributing traits

Genotype/Designation/ Character	Days to 50% flowering	Plant height (Cm)	Total tillers /plant	Productive tillers per plant	Panicle length (cm)	Filled grains per panicle	Spikelet fertility (%)	1000 seed weight	Stress score at reproductive stage	Grain yield Kg/ha
PAU 7114-3480-1-1-1-0	94	103	14	12	22	104	89	20	3	3500
CSR10	99	92	13	12	24	87	79	22	4	2980
RP 5694-36-9-5-1-1	83	99	19	16	23.5	118	93	28	2	4140
NDRK 11-20	85	102	16	12	21.5	120	90	29	2	5340
CST7-1	82	124	13	11	19.8	71	75	18	4	1910
CSR 2016-IR18-9	95	134	15	13	22.3	84	86	24	3	3460
CSR 2016-IR18-3	91	104	18	17	26	130	93	28	2	4930
CSR 2016-IR18-5	102	128	13	10	18	106	79	20	4	2760
PAU 4254-14-1-2-2-2-4-1	88	118	19	18	24	136	91	26	2	4450
CSR 2016-IR18-14	105	129	17	15	19	102	86	19	3	3620
CR 3912-221-1-3-1	89	102	19	22	23	140	91	27	2	5356
CR 3884-244-8-5-11-1-1	106	128	17	15	23	68	79	21	4	2130
CSR 2016-IR18-11	93	106	22	19	26	129	92	24	2	5430
CSR36	95	99	17	13	18	118	83	22	3	4126
RP 5690-20-6-3-2-1	90	116	23	18	22	99	84	20	3	2756
TR 05043	89	103	14	13	24	90	83	17	4	2650
IR 83421-6-B-3-1-1 CR 3364-S-2B-14-2B-1	94	99	17	15	21	64	86	15	5	1540
TR 09027	94	93	18	15	24	105	91	24	2	3900
Local Check(TRY 2)	93	134	17	14	19	99	70	21	3	2820
RP 5440-302-100-7-6-3-2	84	103	16	14	24	89	93	18	3	3450
CSR 2016-IR18-1	99	97	23	19	26	135	92	32	2	5680
CSR27	99.3	104	14	13	24	129	83	23	4	2680
RP-5683-101-85-30-2-3-1	98	95	19	17	27	93	92	25	2	5340
Sambha Sub1	88	94	21	18	23	117	86	24	3	3570
CR3882-7-1-6-2-2-1	94.7	95	23	19	26	173	90	27	1	5690
CSR 2016-IR18-8	88	69	11	10	19	79	64	18	3	1866
CARI Dhan 6	89	131	17	16	24	125	89	26	3	4650
CR 2859-S-B-2-1-B-7	84	92	10	9	20	61	68	19	4	1950
CR 2851-S-B-1-B-B-1	94	91	13	10	24	109	90	23	2	4850
CSAR1620	96	88	19	16	25	89	92	27	3	4700
KR15006	93	91	15	13	26	150	90	23	2	4300
CR 2843-1-S-1-6-B-S-B-1	86	89	14	9	19	63	79	17	4	1810
CARI Dhan 11	95	104	13	11	23	90	90	29	2	4400
PUSA44	113	88	18	15	26	89	87	17	3	2600
KS -12	104	99	16	15	19	99	84	32	2	4950
CSR-2748-4441-193	85	96	13	12	23	73	82	24	2	2860
TR 09030	94	107	14	12	21	72	83	25	3	3600
CST7-1	95	99	16	14	23	159	90	29	2	5850
Sambha Sub1	89	90	19	18	19	120	90	25	4	4120
CSR36	95	80	16	14	23	132	89	28	2	4720
CR 3898-113-4-2-1	131	120	12	10	21	69	83	25	2	3570
CR 2851-S-1-6-B-B-4	85	99	16	15	27	147	96	29	2	5120
CSR 2016-IR18-6	83	97	14	13	21	123	65	22	3	2670
CR 3881-4-1-3-7-2-3	94	114	14	12	21	70	83	32	2	4150
CSR27	94	93	17	15	26	123	86	24	3	3760
CR 3883-3-1-5-2-1-2	89	135	15	13	24	87	89.7	25	2	4670
CR 3904-162-1-5-1	112	119	10	9	16	56	80	24	4	3890
Local Check	98	103	18	15	25	89	90	29	2	5780
CSR-2748-4441-195	86	99	14	11	19	58	78	28	5	2120
RP-320-4-3-2-1	85	113	15	14	20	90	90	18	4	2450

CR 3880-10-1-9-2-2-1	93	127	12	9	23	88	89	26	2	5450
RAU 1397-14	89	119	15	13	24	79	86	24	4	2970
PAU 3835-36-6-3-3-4	78	97	10	12	21	89	77	24	4	4230
CSAR 1610	86	115	12	12	27	78	89	27	5	3600
CSAR 1604	95	106	12	8	21	93	79	24	2	3970
KR 15016	86	90	10	9	17	77	83	19	2	2660
CARI Dhan 10	90	121	16	16	21	142	92	28	2	5670
IR10206-29-2-1-1	109	118	15	12	24	97	84.3	25	4	2780
CR 3437-1*-S-200-83-1	85	91	13	11	20	103	90.7	26	3	3670
CR 2851-S-B-1-2B—1	125	132	10	9	22	25	78.7	20	2	1790
PUSA44	91	111	11	10	19	90	89.7	24	4	1890
CR 2839-1-S-10-B2-B-43-2B-1	121	118	13	12	21	78	82	21	4	2670
KR 15010	106	100	13	12	24	119	89	26	2	3890
CSR 2016-IR18-17	86	96	18	17	28	154	90	28	2	5980
CR3884-244-8-5-6-1-1	107	136	17	12	24	90	77	26	4	3820
RP 5687-420-111-5-4-2-1	103	97	9	9	18	79	88	21	4	3240
CSR10	96	91	16	13	21	132	87.3	26	2	4860
CSR 2016-IR18-10	118	126	17	13	23	112	79	20	3	2450
CSR10	97	107	16	13	21	123	86.7	21	3	4560
CSR 2016-IR18-18	112	109	12	12	20	89	79.3	19	4	2230
CR3884-244-8-5-11-1-4	89	137	16	14	26	80	90	27	1	5450
CSR RIL-01-IR165	84	102	10	8	20.7	76	80	23	2	2560
NDRK 11-21	104	116	14	12	24	93	84.5	28	3	4120
CSR-C27SM-117	90	102	18	17	24	125	82.3	24	2	3450
CR3881-M-3-1-5-1-1-1	105	89	17	14	25	78	82.3	29	5	2980
CSR 2016-IR18-12	85	97	18	17	23	123	88	32	2	5890
PAU 3835-12-1-1-1	87	109	15	14	29	79	91	20	4	2120
CSR27	85	123	17	16	24	89	72	23	5	1780
CR 3887-15-1-2-1	99	127	14	11	25.7	90	85	22	2	5870
CSR 2016-IR18-7	82	92	10	8	19	70	80	20	5	2126
CSR36	104	102	16	15	27	138	90.1	29	2	5340
IR52280-117-1-1-3	87	101	12	11	21	121	87	23	4	2120
PUSA44	97	131	12	11	23	117	79	24	4	3650
CR 3890-35-1-3-4	104	135	12	11	24	86	87.5	24	2	5570
CSRC(S)47-7-B-B-1-1	85	93	17	17	24	78	78	28	5	2360
CST7-1	108	125	12	10	23.7	80	89.3	21	4	2140
Sambha Sub1	91	90	13	13	26	89	78	26	3	3360
CR 3878-245-2-4-1	81	124	17	16	24	156	85	24	4	5460
CSR-2748-197	94	95	12	12	24	78	80.3	29	4	2563
IR84649-81-4-1-3B-CR3397-S-B-4B-1	98	98	15	10	20	70.7	78	18	5	1450
PAU 5563-23-1-1	86	98	11	9	18	76	80.7	26	5	2980
CR3903-161-1-3-2	98	96	15	13	23	123	80.2	23	4	4260
NDRK 11-24	93	131	13	14	22	109	84.2	24	4	3190
CARI Dhan 7	94	114	18	17	25	156	92.7	28	1	5780
Local Check TRY -2	97	125	13	12	25	134	90.3	27	3	4780
CSR 2016-IR18-15	103	134	14	12	23	112	89	24	2	3920
CSR 2016-IR18-2	101	125	12	10	22	109	78	22	4	2630
NDRK 11-22	97	99	17	16	20.3	89	80.5	22	5	2230
CSAR 1628	98	112	13	11	19	67	85	19	3	3860
RAU 720	103	123	10	9	18	82	89	24	5	4680
CSR 2016-IR18-16	85	104	15	13	25	85	90	23	3	3873
CSR RIL-01-IR75	103	108	13	10	22	78	86	24	4	3110
Mean	94	107.61	14	13	22.58	100	84.85	24.09		3702
SE	2.56	1.62	1.28	1.30	1.15	1.03	1.09	1.23		14.78
CD(5%)	7.10	4.49	3.55	3.61	3.18	2.85	3.01	3.42		40.98
CV(%)	4.67	2.61	14.83	17.17	8.79	1.78	2.22	8.87		20.69

Table 3 : Genetic parameters for different traits

Character	**Days to 50% flowering**	**Plant height (Cm)**	**Total tillers /plant**	**Productive tillers per plant**	**Panicle length (cm)**	**Filled grains per panicle**	**Spikelet fertility (%)**	**1000 seed weight**	**Grain Yield kg/ ha**
PCV	10.97	14.17	23.94	26.43	13.94	27.33	7.57	17.19	33.93
GCV	9.92	13.93	18.79	20.09	10.82	27.27	7.24	14.73	33.76
Heritability	81.85	96.62	61.62	57.78	60.22	99.57	91.42	73.39	99.96
Genetic Advance	1.53	1.96	1.00	0.90	0.96	2.05	1.80	1.30	2.06
Genetic advance as % of mean	1.61	1.82	6.67	6.89	4.26	2.05	2.12	5.38	1.06

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