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Short Communication

Evaluation of rice (*Oryza sativa* L.) mutant derivatives for salt tolerance in saline vertisols of Tungabhadra command

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For larger proportion of the human population in the world, rice is the most staple food. With ever growing world population, the food production has to be increased substantially and paddy production has to go up from the present 585 million tones to 810 million tonnes by the year 2025 [1]. Similarly, the Indian rice production has to be increased from 90 to 140 million tonnes [2]. This could be achieved either through increased productivity or increased crop area. Good rice lands in peri-urban areas are fast declining due to rapid urbanization and industrialization. The increase in area to meet the demand of rice will have to come from stress inducing marginal lands and problem soils like saline, sodic, saline-sodic, acidic soils etc. Salinity has become a problem in most of the irrigated commands due to unscientific water management, poor drainage practices, violation of cropping pattern etc in the command. The adoption of crops/varieties tolerant to saline conditions is likely to augment the productivity of crop and help the farmers to raise crops in saline soils as reclamation of the saline soil is cost prohibitive.

The extent of problem soil in Karnataka is around 10% of the total command area. The problem soil in Tungabhadra project (TBP) command is nearly 53,415 ha (14.5% of irrigated area) and is increasing at a faster rate [3], where paddy is the major crop. In adaptive trials, the salt tolerant rice variety CSR 10 (released by Central Soil Salinity Research Institute, Karnal), which performed will in saline-sodic soils of northern India failed to perform well in saline vertisols of TBP. Thus, there is need for the identification of location specific salt tolerant genotypes suitable for saline vertisols of TBP.

In the present investigation, an attempt was made to critically evaluate the rice mutant derivatives supplied by the Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre (BARC), Trombay, Mumbai for salinity tolerance, in the TBP command area.

The TSR lines, which were used in the present study, were derived from crossing TSSR 15 (a high yielding, fine grain mutant induced from irradiating 'White Luchai' with 225 Gy gamma rays) with 'Burarata' (a salt tolerant, coarse grain variety). The segregating populations were screened in the laboratory under continuous illumination for germination percentage and seedling height in 250 mM NaCl solution at BARC, Trombay, Mumbai. Promising ones were compared with known salt tolerance check varieties *viz.,* Kalarata, Burarata, Pokali and Co 43 under the same conditions. Surviving seedlings were then transferred to the field after 10-12 days. At harvest 1-3 plants per progeny were selected based on grain quality and yield per plant and advanced to the next generation as plant to progenies. This procedure to screen in laboratory initially and transfer to field was repeated from F_2 to F_6 generations and the promising ones were designated as TSR 1 to TSR 30. These lines *viz.,* TSR 2, TSR 7, TSR 8, TSR 9, TSR 11, TSR 12, TSR 14, TSR 16, TSR 22, TSR 23, TSR 24, TSR 27, TSR 28, TSR 29 and TSR 30 were further evaluated along with IR 30864 (salinity check)

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and BPT 5204 (popular yield check) under natural saline soils at Agricultural Research Station, Gangavati during *kharif* 2000 (unreplicated), 2001 and 2002. The soil salinity was in the range of 6.00 -11.50 dS/m. The pH of soil during the experimentation was in the range of 8.12 - 8.43 (Table 1).

Table 1. Soil characteristics of the experimental site at Agricultural Research Station, Gangavati

	Year	Preplanting		Transplanting		Flowering		Ripening	
		ECe	pH	ECe	pH	ECe	pH	ECe	pH
1	2000	6.00	8.12	5.32	8.32	3.96	8.20	5.80	8.40
2	2001	10.40	8.17	6.50	8.20	5.60	8.18	9.50	8.22
3	2002	11.50	8.32	9.60	8.30	5.45	8.25	11.40	8.43

Note: ECe = Electrical conductivity of saturated soil extract, dS/m

During *kharif* 2000, the trial was conducted in relatively low saline soils in single replication to know the behaviour of these lines under saline soils. During 2001 and 2002 the experiments were conducted in RBD with two replications. Thirty-five days old seedlings raised in non-saline soil were transplanted at a spacing of 20 x 10 cm. The genotypes received all the recommended agronomic and plant protection measures for their healthy growth. During *kharif* 2002, the same experiment was also conducted in normal soil (ECe<4.0 dS/m) to know the extent of yield reduction in each genotype under saline soil over normal growing conditions. Observations were recorded on days to 50% flowering, plant height (cm), productive tillers per hill, panicle length (cm), chaffy grains per panicle and grain yield per plot. During *kharif* 2002, sodium and potassium in plant shoot and root was estimated as suggested by Muhr *et al.* 1965 [4] in all the genotypes at the time of harvest and the data were subjected to statistical analysis by adopting complete randomized block design [5].

The differences among the genotypes were statistically significant for grain yield during both the years, both under stress and normal situations. Among

Table 2. Performance of rice mutants under saline soils of TBP

S.No.	Mutants/genotype	Grain yield under saline soil (kg/ha)				Grain yield under normal soil (kg/ha)	% yield reduction in saline soils
		2000*	2001	2002	Mean	2002	2002
1.	TSR 2	3200	1812	2793	2602	5508	49.3
2.	TSR 7	5333	1979	5302	4205	6819	22.2
3.	TSR 8	3467	1854	2883	2735	6146	53.1
4.	TSR 9	6800	2854	5169	4941	6310	18.1
5.	TSR 11	6533	2667	3993	4397	6107	34.6
6.	TSR 12	5867	3438	3528	4278	5983	41.0
7.	TSR 14	3667	771	3131	2523	5763	45.6
8.	TSR 16	2000	4854	3247	3367	5253	38.2
9.	TSR 22	6333	-	3383	4858	5950	56.9
10.	TSR 23	5000	4583	2919	4167	6063	51.8
11.	TSR 24	2867	1417	3781	2688	5855	35.4
12.	TSR 27	3467	5313	2110	3712	7058	70.1
13.	TSR 28	2333	3270	2380	2661	4994	52.3
14.	TSR 29	5200	3645	3567	4137	4557	21.7
15.	TSR 30	3867	4000	2853	3573	4723	39.6
16.	IR 30864 (C)	4533	3854	4069	4152	7150	43.1
17.	BPT 5204 (c)	4000	3646	2280	3309	5112	55.4
	CD (0.05)	*	760	1398		1146	
	CV (%)		15.00	19.10		9.58	

***** Unreplicated trial

the lines screened, TSR 9 (4941 kg/ha) recorded higher yields (Table 2) indicating its ability to withstand salinity stress. It recorded 19% higher yield as compared to IR 30864 (4152 kg/ha) and 49% higher yield than BPT 5204 (3309 kg/ha), the popularly cultivated variety in the command. Other genotypes, *viz.,* TSR 22 (4858 kg/ha) and TSR 11 (4397 kg/ha) were also found promising for salinity. TSR 16 followed by TSR 7 showed less chaffy grains per panicle. The low spikelet sterility in saline soils in rice indicates the tolerance of genotype to saline conditions. Under saline conditions high sterility of panicle with complete deformation of lemma and palea into paper white structure has been reported [6]

The Na/K ratio, which is used as one of the criteria to indicate the tolerance/susceptibility to salinity in many crops, revealed that the genotypes *viz.,* TSR 2 and TSR 12 recorded lower Na / K ratio in shoot (Table 3) indicating selective partitioning and accumulation of K than Na for normal cell functions under saline soil. Salt tolerant varieties of rice showed much lower increase of Na compared with sensitive ones and with minimum reduction in K uptake, resulting in a low Na / K ratio or higher K / Na ratio [7]

The performance of genotype in its most favoured stress free environment and optimum combination of all inputs is its yield potential. When this is disturbed such as under stress situations, yield reduction occurs. The evaluation of genotypes simultaneously in saline soil and normal soil (ECe<4.0dS/m) revealed that the reduction in grain yield of genotypes *viz.*, TSR 7 (22%), TSR 9 (18%) and TSR 29 (22%) was quite low compared to IR 30864 (35.5%) and BPT 5204 (55.4%). This signifies the potential of these genotypes to perform equally well in saline soils. The minimum reduction in yield of these genotypes makes them suitable for saline stress conditions.

The genotype TSR 9 recorded comparatively higher Na / K ratio in shoot, but exhibited lower yield reduction in saline soil. From the present study, it is concluded that TSR 9 was found tolerant to salinity and could be profitably cultivated in saline soils of TBP and it could also be used as a donor parent to improve salinity tolerance.

Table 3. Mean growth parameters and Na /K ratio of different rice mutants under saline soils of TBP

S.No.	Mutants/genotype	DFF	Plant height(cm)	Productive tillers /hill	Panicle length (cm)	Chaffy grains/panicle	Na/K in root	Na/K in shoot
1	TSR 2	104	56.1	13.0	14.9	11.7	0.72	0.22
2	TSR 7	93	52.5	11.3	17.1	3.9	0.58	0.40
3	TSR 8	92	50.8	9.6	15.4	7.8	0.67	0.39
4	TSR 9	92	65.2	9.7	15.9	11.5	0.83	0.38
5	TSR 11	97	58.7	12.4	19.2	8.5	0.68	0.39
6	TSR 12	101	61.9	12.2	18.2	8.5	0.54	0.23
7	TSR 14	99	52.7	-	-	9.4	0.69	0.33
8	TSR 16	96	68.0	12.7	20.3	3.4	0.82	0.41
9	TSR 22	119	55.2	-	-	9.0	0.66	0.31
10	TSR 23	110	60.8	14.1	19.4	20.0	0.68	0.36
11	TSR 24	94	59.6	11.6	20.1	5.9	0.80	0.36
12	TSR 27	115	53.0	14.4	17.7	7.9	0.94	0.36
13	TSR 28	103	50.3	15.4	14.7	9.0	0.70	0.42
14	TSR 29	102	70.4	13.9	17.8	11.4	0.74	0.50
15	TSR 30	100	69.8	14.6	17.8	8.5	0.84	0.38
16	IR 30864 (C)	96	67.4	11.5	17.5	8.7	0.64	0.39
17	BPT 5204 (C)	115	54.0	10.6	16.4	9.3	0.78	0.31
	CD (0.05)		9.9	2.7	2.5	3.0	0.27	0.11
	CV (%)		7.4	11.2	7.2	19.1	19.0	14.5

Note : DFF = days to 50% flowering

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ANNOUNCEMENT

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The Indian Society of Genetics and Plant Breeding in association with the University of Agricultural Sciences (UAS), Bengaluru is organizing a National Seminar on “Contemporary Approaches to Crop Improvement” at UAS, GKVK, Bengaluru in the month of April 2011. Papers on topics related to the theme area of the Seminar will be called for in the last week of December 2010.