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Research Article

Screening of parents, hybrids and their progenies for yield under salinity in rice (*Oryza sativa* L.)

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Abstract
Eight parents along with 28 hybrids were evaluated under normal as well as saline soil conditions of Agricultural Research Station, Machilipatnam during *kharif* 2010 to study the effect of salinity on various yield components. The effect of salinity was evident through stunted growth, reduction in tillering, florets panicle^{-1}, spikelet fertility and grain yield plant^{-1}. The study of per cent reduction in performance of yield contributing traits including yield showed that, 1000-grain weight was least affected (5.95%) followed by spikelet fertility per cent (6.27), plant height (9.79%), panicle length (12.76%), panicle weight (17.22%), grain yield (30.25%), number of filled grains panicle^{-1}(31.20%) and number of productive tillers plant^{-1} (61.33%) in the increasing order of magnitude. Under saline soil environment SR26B and CSRC(S)7-1-4 were adjudged as the best donors for developing saline tolerant varieties coupled with high yield. Among the hybrids, SR26B x CST7-1, Swarna x CSRC(S)7-1-4 were superior under saline condition.

Key words: Rice, Salinity, Tolerance, Screening

Introduction

Rice is the major source of food for more than one third of the world's population. Rice is one of the most widely grown crops in coastal areas inundated with sea water during high tidal period (Akbar *et al.*,1972). Among the various factors limiting rice yield, salinity is one of the oldest and most serious environmental problems in the world (Mc William,1966). Rice is moderately susceptible to salinity. The degree of injury depends on the nature and concentration of salts, soil pH, water regime, method of planting, stage of the crop and duration of exposure to salt stress. High salt concentration in soil is the major constraint to rice production in India and Bangladesh (Mohammadi-Nejad *et al*., 2008). The loss of farm land due to salinisation is directly in conflict with the needs of the world population. Therefore, increasing the yield of rice in poor soils and in less productive salinised lands is essential for feeding the world.

In India, nearly 8.5 M ha are salt affected. Out of which 2.19 M ha are coastal saline and the yield reduction is estimated to the tune of 30 – 50 per cent (Babu *et al.*, 2005). Salinity and sodicity are gradually becoming constraints to rice production in coastal region of Andhra Pradesh. The salt affected soils in Andhra Pradesh are estimated to be 2.74 lakh ha (NRSC, 2010). It is probable that the salinisation now degrades as much land as is put under agriculture in new irrigation each year. Pressures on water use will ensure that the net productive irrigated land will go negative very soon and that secondary salinisation will become critical in Asia and as well as in the global level.

For rapid success in any hybridization programme, the choice of parents which can produce superior offsprings is very much essential. Empirically, the high yielding parents need not throw high yielding progenies. Differential behavior of parents and their progenies is a common occurrence. This warrants a detailed examination of the parents for their genetic architecture and behavior in cross combinations. Parental *per se* performance has been suggested as an useful index in rice for selection of parents for hybridization. The parents with high mean values are preferred for hybridization programme as they are expected to produce desirable high yielding segregants. (Verma *et al*., 1995 and Dwivedi *et al*., 1999).

Material and methods

Eight rice varieties which include two susceptible RP Bio-226 and Swarna, three moderately tolerant varieties CSR-27, CSR-30, CST-7-1 and three tolerant varieties CSRC(S)7-1-4, SR26B and CSRC(S)5-2-2-5) were crossed in a diallel fashion without reciprocals during kharif,2009 to generate 28 F1 hybrids crosses and hybrid progeny and allowed to self to get the F_2 seed during *kharif* 2009 and *rabi* 2009-10. Subsequently during rabi 2009-10 hybrids were raised and selfing was carried out to produce F_2 seeds.

Screening of parents along with 28 hybrids were carried out under normal as well as saline soil conditions of Agricultural Research Station, Machilipatnam during *kharif* 2010. The saline soils were of sandy loam in texture with an average electrical conductivity of 6.3 dS m^{-1} and pH of 7.9.The normal soil condition had an E.C of 0.24 dS m^{-1} and pH of 7.3. Nursery was grown under normal soil conditions and transplanted under saline soil conditions. The experiment was laid in randomized block design with three replications and from each replication, data were collected for yield contributing and physiological parameters on 15 randomly selected plants in parents and F_1s from normal and saline soil conditions.

The diallel set of 28 F_2 populations were also sown on the raised nursery beds during the same season and thirty day old seedlings were transplanted in 10 paired rows of 10 m length by adopting the spacing of 20 x 15 cm between and within row. The recommended agronomic, cultural and plant protection measures were adopted in conducting the experiment. Observations were recorded on 90 random plants in each F_2 population and the mean data were taken for analysis. Analysis of variance for each character for parents and F_1s'(*kharif*, 2010) was carried out using the method described by Panse and Sukhatme (1985). The significance test was carried out referring to 'F' table values given by Fisher and Yates (1967).

Results and discussion

All the parents and hybrids were found to have grown shorter under saline condition compared to the corresponding favourable soil environment. Among the parents, RPBio-226 (29.11%) showed the highest reduction, while the lowest was perceived in CSRC(S)7-1-4 (2.25%). Among the hybrids, the highest decrease in plant height was shown by CSR-30 x CSRC(S) 7-1-4 (38.8%) and found to be susceptible to this abiotic stress. In contrast to the normal trend of reduction in plant height, the hybrids CST-7-1 x CSRC(S)5-2-2-5 (-3.02%) followed by RPBio-226 x CSRC(S)7-1-4 (-0.49%) and RPBio-226 x SR26B (-0.19%) displayed marginal increase in plant height under stressed environment, which might be due to involvement of at least one parent with salinity tolerance in the hybrid combination that had positively reflected in maintaining superior plant height in these hybrids (Tables 1 and 3). Among the F_2 progenies, the mean plant height increased to 105.59 cm and showed the meager chances to isolate shorter segregants (Table 2). Similarly, Islam *et al*. (2007) and Hasamuzzaman *et al*. (2009) also observed drastic reduction in plant height due to salinity.

On an average parents (6 days) and hybrids (6.9 days) exhibited delayed flowering under saline condition than under favourable situation. A slight increase of 1.86 days due to salinity stress was observed in CSR-30 x CST-7-1, while highest increase of 13.69 days was noticed in CSR-27 x CST-7-1, which indicated the effect of salinity in extending duration to flower among sensitive lines (Table 1 and 3). In a similar study the findings of Shereen *et al.* (2005) observed similar observation of delayed flowering due to this abiotic stress. Similarly among F_2 progenies CSR-27 x CSR-30(94) was earlier to flower, while SR26-B x CSRC(S)5-2-2-5 (115.69) was very late followed by RPBio-226 x CSR-27 and RPBio-226 x CST-7-1 (Table 2).

SR26B performed well under both the environments with an average number of panicles plant^{-1} of 10.67 and 9.67 under normal and saline situations, respectively with lowest reduction in bearing panicles (9.40 %) followed by CSRC(S)5-2-2-5 (12.92%) while RPBio-226 was highly susceptible with a reduction reaching to a tune of 57.13 per cent due to salinity (Table 1 and 3). Under stressed environment, the number of ear bearing tillers of hybrids were reduced to 6.35 from that of 11.76 shown under favourable environment. The promising hybrids for this trait were RPBio-226 x Swarna (14.33, normal) and Swarna x CSRC(S)5-2-2-5 (9.67, saline). The F_2 progenies of Swarna x CSRC(S)5-2-2-5 (8.67) fared well for this trait which was also promising in first filial generation (Table 2). The lower panicle yield under sub optimal conditions might be due to lesser accumulation of photosynthates to the reproductive parts. Sajjad (1984) and Heenan and Lewin (1988) also reported that salinity stress reduced the number of panicles. More than 30 per cent reduction of effective tiller production was also observed under similar situations by Zeng and Shannon (2000) and Hasamuzzaman *et al.* (2009).

All parental genotypes showed reduction in panicle length except SR26B which showed rather an increase of 5.68 per cent due to its genetic potentiality and tolerance ability under stressed environment and proven to be promising (Table 1 and 3). However, the lowest reduction of 1.17 per cent was found in CST7-1 x CSRC(S) 7-1-4 and the highest in CSR27 x CSR-30 (31.20%). There was no reduction in panicle length among the F_2 progenies (18.31) compared to that of F_1 hybrids (Table 2) and the longest panicle was noted in CSR-27 x CSR(S)5-2-2-5(23.03 cm), while the shortest was observed in Swarna x CSRC(S) 5-2-2-5 (12.90). It was observed that SR26B among the parents and SR26B x CST-7-1 as well as CST7-1 x CSRC(S) 7-1-4 among the hybrids appeared to be promising for this trait. Reduction in panicle length due to increased soil salinity was also observed by Sajjad (1984), Heenan and Lewin (1988), Khatun *et al.* (1995) and Hasamuzzaman *et al.* (2009).

Under both the soil conditions, the parent SR26B was superior with highest panicle weight, while RPBio-226 (1.24 g) was the poor performer. The lowest reduction in panicle weight was noticed in the cross combination SR26B x CST-7-1 and found to be more tolerant as this combination involved tolerant x moderately tolerant parents. Among the F_2 progenies, the segregants of CST-7-1 x CSRC(S)5-2-2-5 (3.24 g) were promising with superior panicle weight (Table 1 and 3). Further, seven F_2 progenies *viz*., CSR-27 x SR26B, CSR-27 x CSRC(S)5-2-2-5, CSR-30 x CSRC(S)5-2-2-5, CSRC(S)7-1-4 x CSRC(S)5-2-2-5, SR26B x CST-7-1, SR26B x CSRC(S)5-2-2-5 and CST-7-1 x CSRC(S)5-2-2-5 were superior with higher panicle weight (Table 2). The severe inhibitory effects of salt stress on panicle weight may be due to the differential competition in supply of carbohydrates between vegetative growth and constrained distribution to the developing panicles. The present findings are in line with the earlier works of Sajjad (1984), Heenan and Lewin (1988) and Khatun *et al*. (1995).

SR26B (145.33) had the highest number of filled grains panicle^{-1}, while RPBio-226 (75.33) was the poor performer. A mean reduction of 25.02 per cent in filled grains was observed among the parents with a lowest reduction of 10.11 per cent observed in SR26B. However, RPBio-226 showed the highest reduction of 58.23 per cent indicating its susceptible nature to this abiotic stress. The cross combination SR26B x CST-7- (176.0) showed superior performance due to its genetic superiority to endure the adverse environment (Table 1 and 3). This hybrid expressed consistently superior performance in F_2 generation also with higher (155.33) filled grains panicle^{-1}. By virtue of slight reduction of 7.89 per cent in number of filled grains panicle^{-1}, the hybrids Swarna x CSRC(S)7-1-4 was considered to be superior. However, severe reduction of 71.27 per cent due to edaphic stress was found in CSRC(S)7-1-4 x CSRC(S)5-2-2-5 even though both parents were tolerant to salinity (Table 2). This might be attributed to lack of specific gene combinations imparting tolerance to mitigate the adverse effect of the salinity stress. The progenies of CST-7-1 x CSRC(S)5-2-2-5 (153.67), CSR-27 x CSRC(S)5-2-2-5 (143.67) and CSRC(S)7-1-4 x SR26B (141.0) also had superior segregants with more filled grains panicle^{-1}. Earlier researchers *viz*., Oo and Lang (2005), Uddin *et al.* (2007) and Mohammadi-Nejad (2010) also observed similar reduction of the number of filled grains panicle^{-1} under saline soils.

The genotype CSRC(S)5-2-2-5 appeared to be superior (81.1) for spikelet fertility per cent, whereas, Swarna (68.90) was found to be inferior among the parents. A lesser reduction due to salinity was observed in SR26B and CST-7-1 for spikelet fertility among the parents and considered to be tolerant for this trait. Out of 28 hybrids tested, the cross combination SR26B x CST-7-1 showed superior spikelet fertility per cent of 84.73 whereas, RPBio-226 x Swarna (56.40%) was an inferior performer as it showed highest reduction of 37.73 per cent (Table 1 and 3). The reduced spikelet fertility might be due to failure of grain formation which could be caused by lack of pollen viability. Khatun *et al*. (1995) earlier reported that salinity reduces pollen viability and seed set. Similar findings were reported by Ali *et al.* (2004), Rao *et al.* (2008) and Hasumazzaman *et al.* (2009) in their studies on rice under saline soils.

The trait 1000-grain weight (g) is the least affected trait due to sub-optimal soil environment. The parental *per se* performance was same (20.88 g) under both the soil conditions. Among the eight parents tested, SR26B was superior and performed similarly (23.6 g) under both the soil conditions. In the same way the lowest test weight of 16.11 g and 14.37 g was recorded by RPBio-226 under both normal and saline soil environments, respectively. This is one of the important yield contributing parameters, which was found to be unaffected due to salt stress among parents, rather a slight increase of 1000-grain weight was also observed in case of CSR-27 (7.91%) followed by CSRC(S)7-1-4 (4.58%) and CSRC(S)5-2-2-5 (0.86%) due to their tolerance ability (Table 1 and 3). In spite of reduction in number of filled grains panicles^{-1}, these genotypes were able to compensate the yield loss by maintaining the weight of individual spikelet as well as higher spikelet fertility per cent by means of efficient translocation of photosynthates to the sink. Similarly, hybrids on average displayed a lower reduction of 7.60 per cent under stressed soil condition than their corresponding parents. The highest reduction was noted in CSRC(S)7-1-4 x SR26B (16.69%).This might be due to lower accumulation of carbohydrates and disturbed mineral absorption as a result of salt stress. However, among F_2 progenies Swarna x CSRC(S)7-1-4 (21.54 g) had shown superior performance (Table 2). The present findings are in accordance to the earlier reports of Oo and Lang (2005) and Rao *et al.* (2008).

Under stressed situation, the parents SR26B (22.38 g) and CSRC(S) 7-1-4 (20.22 g) were promising for grain yield plant^{-1}. Further, a lesser reduction in grain yield was noticed in SR26B (3.67%) followed by CSRC(S) 5-2-2-5 (9.85%) indicating their superiority to realize higher grain yield plant^{-1}. Out of 28 hybrids tested, SR26B x CST-7-1 recorded the highest grain yield under normal (30.42 g) as well as saline (26.19 g) soils, while Swarna x CSR-27(5.55 g) was a poor yielder under stressed environment (Table 1 and 3). However, SR26B x CST-7-1, Swarna x CSRC(S)7-1-4, CSRC(S)7-1-4 x SR26B and CSR-27 x CSRC(S) 5-2-2-5 were the top yielders under both the soil environments and were promising .

Among the hybrids evaluated, the lowest reduction in grain yield under saline conditions was observed in CSRC(S)7-1-4 x SR26B (5.99%) followed by CST7-1 x CSRC(S)5-2-2-5 (9.56%). In the later generation (F_2) also the cross combination *viz*., CSR-27 x CSRC(S)5-2-2-5(24.22) followed by CSRC(S)7-1-4 x SR26B (21.94 g), Swarna x

CSRC(S)7-1-4 (20.65 g) and SR26B x CST-7-1 (21.32 g) (Table 2) fared well and could able to maintain the superior grain yield plant^{-1}.

Under continuous salinity stress, the loss of grain yield results from a combination of reductions in plant stand, spikelet number panicle^{-1} and fertility per cent. Among all the contributing components, fertility per cent was found to be most severely affected and thus caused significant reduction in total yield of grain. In addition to fertility, panicle length and panicle number are the two important parameters affected that contribute to grain yield. Many researchers who worked for rice under saline conditions viz., Mishra *et al*. (1996), Ali *et al.* (2004), Natarajan *et al*. (2005), Oo *and Lang* (2005), Uddin *et al*. (2007) and Mohammadi-Nejad (2010) also found severe reduction in grain yield.

From the current study, it was observed that salinity affected all yield components. This was evident through changes in flowering duration, stunted growth, low tillering, lower number of spikelets panicle^{-1}, low spikelet fertility, test weight and grain yield plant^{-1}. Among the traits tested, 1000-grain weight was least affected (5.95%) followed by spikelet fertility per cent (6.27), plant height (9.79%), panicle length (12.76%), panicle weight (17.22%), grain yield (30.25%), number of filled grains panicle^{-1} (31.20%) and number of productive tillers plant^{-1} (61.33%) in the increasing order of magnitude. It was further noted that salinity delayed the flowering by about 6.74 days (Table 3). It was further observed that tolerant genotypes and hybrids expressed a lesser reduction in the performance of yield and its contributing parameters.

Under saline soil environment SR26B and CSRC(S)7-1-4 were adjudged as the best for yield attributes and can be used as a donor for construction of saline tolerant varieties coupled with high yield. Among the hybrids, SR26B x CST7-1, Swarna x CSRC(S)7-1-4 were superior under saline condition. Moreover, these two cross combinations also fared well in F_2 generation also indicating the chances of identifying superior segregant with salt tolerance.

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Table 1. ***Per se*** **performance of eight parents and 28F_1hybrids of rice for yield and its components under saline and normal soil conditions**

Genotypes	Plant height (cm)		Days to 50% flowering		No. of productive tillers plant^{-1}	
Parents	**Saline**	**Normal**	**Saline**	**Normal**	**Saline**	**Normal**
RPBio-226	72.73	102.60	107.33	108.00	4.00	9.33
Swarna	80.13	96.07	131.33	122.00	5.67	10.33
CSR-27	101.23	107.63	107.00	98.33	6.33	9.00
CSR-30	90.50	95.03	109.00	101.33	3.67	6.33
CSRC(S)7-1-4	103.03	105.40	120.33	111.00	7.24	10.00
SR26B	103.70	111.30	108.00	104.00	9.67	10.67
CST-7-1	92.77	96.30	108.00	102.33	7.00	10.67
CSRC(S)5-2-2-5	101.93	106.10	121.00	113.33	8.33	9.57
Mean	**93.25**	**102.55**	**114.00**	**107.54**	**6.49**	**9.49**
Hybrids						
RPBio-226 × Swarna	89.00	96.83	107.67	102.33	5.67	14.33
RPBio-226 × CSR-27	90.27	95.77	115.00	106.67	5.67	12.33
RPBio-226 × CSR-30	101.00	109.80	101.67	93.67	6.33	13.00
RPBio-226 × CSRC(S)7-1-4	115.17	114.60	105.00	100.00	8.33	12.00
RPBio-226 × SR26B	104.67	104.47	112.33	105.67	6.00	11.33
RPBio-226 × CST-7-1	100.43	102.40	103.00	93.00	5.00	10.33
RPBio-226 × CSRC(S)5-2-2-5	94.37	107.50	112.33	103.67	5.00	13.00
Swarna × CSR-27	77.03	100.27	108.00	103.00	6.33	13.33
Swarna × CSR-30	88.80	106.27	107.00	97.67	5.67	9.00
Swarna × CSRC(S)7-1-4	108.03	111.30	108.33	105.00	7.00	12.00
Swarna × SR26B	103.37	110.30	110.33	104.33	6.33	10.00
Swarna × CST-7-1	90.03	102.77	115.00	107.67	6.33	13.33
Swarna × CSRC(S)5-2-2-5	88.13	105.70	119.33	109.67	9.67	12.33
CSR-27 × CSR-30	87.97	105.47	99.33	94.67	6.00	11.67
CSR-27 × CSRC(S)7-1-4	83.90	100.90	112.00	104.33	6.33	13.00
CSR-27 × SR26B	104.33	115.20	116.00	109.67	4.67	12.33
CSR-27 × CST-7-1	103.33	108.53	119.00	104.67	8.00	10.33
CSR-27 × CSRC(S)5-2-2-5	100.63	103.23	107.67	99.67	5.33	10.33
CSR-30 × CSRC(S)7-1-4	72.50	118.47	108.00	101.33	4.00	12.67
CSR-30 × SR26B	81.43	109.30	110.00	99.00	4.33	13.33
CSR-30 × CST-7-1	99.20	105.57	109.67	107.67	6.33	10.33
CSR-30 × CSRC(S)5-2-2-5	103.67	107.20	107.67	100.67	6.00	13.00
CSRC(S)7-1-4 × SR26B	101.47	113.00	117.67	110.67	9.00	12.36
CSRC(S)7-1-4 × CST-7-1	103.43	121.37	113.33	107.00	4.33	11.12
CSRC(S)7-1-4 × CSRC(S)5-2-2-5	102.83	108.37	117.33	105.33	9.00	10.67
SR26B × CST-7-1	103.13	109.07	108.00	101.00	9.33	11.33
SR26B × CSRC(S)5-2-2-5	100.43	107.30	116.67	112.67	6.67	10.24
CST-7-1 × CSRC(S)5-2-2-5	100.13	97.20	105.33	101.00	5.00	10.33
Mean	**96.38**	**107.08**	**110.45**	**103.27**	**6.35**	**11.76**
General mean	**95.69**	**106.07**	**111.24**	**104.22**	**6.38**	**16.55**
S.E ±	2.25	2.67	1.39	2.26	0.50	0.10
C.D (5%)	6.37	7.53	3.92	6.38	1.41	1.99
C.V (%)	4.09	4.36	2.16	3.76	13.48	7.39

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Table 1 Contd.....

Genotypes	Panicle length (cm)		Panicle weight (g)		No. of filled grains panicle^{-1}	
Parents	**Saline**	**Normal**	**Saline**	**Normal**	**Saline**	**Normal**
RPBio-226	16.56	22.13	1.24	2.81	75.33	180.33
Swarna	19.93	22.47	2.68	2.80	80.67	155.33
CSR-27	20.95	22.64	3.11	3.62	111.67	132.67
CSR-30	17.13	19.71	2.28	3.42	86.33	98.67
CSRC(S)7-1-4	23.77	23.53	3.61	4.28	136.33	151.67
SR26B	23.25	22.00	3.87	3.67	145.33	168.33
CST-7-1	21.59	22.37	2.45	2.87	110.33	128.33
CSRC(S)5-2-2-5	21.50	22.40	2.97	3.14	135.00	159.67
Mean	**20.58**	**22.16**	**2.78**	**3.33**	**110.12**	**146.88**
Hybrids						
RPBio-226 × Swarna	15.40	19.07	1.72	3.18	94.67	165.33
RPBio-226 × CSR-27	16.57	20.97	2.82	3.14	92.67	137.33
RPBio-226 × CSR-30	19.70	21.40	3.01	3.15	102.67	130.33
RPBio-226 × CSRC(S)7-1-4	17.17	19.27	3.73	3.25	105.00	127.33
RPBio-226 × SR26B	16.90	18.73	1.92	2.87	97.67	144.33
RPBio-226 × CST-7-1	15.67	21.33	2.80	3.03	91.67	150.33
RPBio-226 × CSRC(S)5-2-2-5	18.73	21.90	3.13	2.89	106.33	168.00
Swarna × CSR-27	16.53	21.20	0.95	2.45	121.67	137.67
Swarna × CSR-30	18.10	20.47	1.45	2.19	85.00	126.67
Swarna × CSRC(S)7-1-4	20.57	21.47	3.43	4.00	163.33	177.33
Swarna × SR26B	19.60	22.13	2.28	2.76	117.67	166.00
Swarna × CST-7-1	16.20	22.20	1.62	2.05	76.33	160.00
Swarna × CSRC(S)5-2-2-5	21.60	24.87	1.40	2.65	104.67	182.00
CSR-27 × CSR-30	16.47	23.93	0.68	1.85	88.33	127.33
CSR-27 × CSRC(S)7-1-4	15.57	20.47	1.96	2.16	107.00	188.00
CSR-27 × SR26B	20.38	24.60	3.25	3.16	75.33	108.00
CSR-27 × CST-7-1	19.73	23.70	2.89	3.02	119.00	171.67
CSR-27 × CSRC(S)5-2-2-5	22.17	24.20	3.37	3.97	144.33	168.67
CSR-30 × CSRC(S)7-1-4	17.17	22.90	1.15	1.72	65.00	130.00
CSR-30 × SR26B	15.00	16.77	1.03	1.28	61.00	107.33
CSR-30 × CST-7-1	16.77	21.93	2.03	1.71	80.67	129.00
CSR-30 × CSRC(S)5-2-2-5	21.20	22.50	2.12	2.33	100.00	125.67
CSRC(S)7-1-4 × SR26B	21.97	26.70	3.85	4.07	140.00	178.00
CSRC(S)7-1-4 × CST-7-1	12.23	16.97	1.47	4.59	51.33	178.67
CSRC(S)7-1-4 × CSRC(S)5-2-2-5	23.57	24.93	4.00	4.03	123.67	225.67
SR26B × CST-7-1	24.87	23.63	3.74	3.86	176.00	229.00
SR26B × CSRC(S)5-2-2-5	22.43	22.10	2.83	3.24	121.00	172.67
CST-7-1 × CSRC(S)5-2-2-5	22.53	22.80	3.21	3.40	148.33	196.00
Mean	**18.74**	**21.90**	**2.42**	**2.93**	**105.73**	**157.44**
General mean	**19.15**	**11.22**	**2.50**	**3.02**	**106.70**	**155.09**
S.E ±	0.86	0.98	0.19	0.18	6.36	9.32
C.D (5%)	2.42	2.76	0.53	0.50	17.95	26.30
C.V (%)	7.76	7.72	13.08	10.23	10.33	10.44

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Table 1. Contd..

Genotypes	Spikelet fertility(%)		1000-grain weight(g)		Grain yield (g plant^{-1})	
Parents	**Saline**	**Normal**	**Saline**	**Normal**	**Saline**	**Normal**
RPBio-226	71.67	83.77	14.37	16.11	9.32	22.93
Swarna	68.90	86.10	20.55	21.51	11.06	26.60
CSR-27	75.40	79.90	23.15	21.46	11.87	17.98
CSR-30	74.83	80.40	19.72	20.03	12.29	14.58
CSRC(S)7-1-4	79.27	81.87	22.70	21.71	20.22	23.09
SR26B	79.70	80.63	23.61	23.60	22.38	23.23
CST-7-1	76.03	84.07	20.14	20.03	13.28	16.42
CSRC(S)5-2-2-5	81.10	82.67	22.80	22.61	17.38	19.28
Mean	75.86	82.43	20.88	20.88	14.73	20.51
Hybrids						
RPBio-226 × Swarna	56.40	90.57	13.16	16.38	7.79	19.96
RPBio-226 × CSR-27	74.57	85.20	16.65	20.55	6.83	22.97
RPBio-226 × CSR-30	70.03	65.70	19.39	19.83	13.22	19.94
RPBio-226 × CSRC(S)7-1-4	80.43	87.33	20.01	21.98	15.85	20.55
RPBio-226 × SR26B	64.17	76.73	18.09	19.27	9.27	19.18
RPBio-226 × CST-7-1	76.60	84.23	20.68	22.04	13.04	21.88
RPBio-226 × CSRC(S)5-2-2-5	80.17	86.43	23.60	21.86	16.15	21.26
Swarna × CSR-27	60.90	85.97	18.43	19.92	5.55	14.47
Swarna × CSR-30	66.13	79.97	20.01	21.65	11.08	15.33
Swarna × CSRC(S)7-1-4	78.00	80.47	23.72	22.64	24.22	27.15
Swarna × SR26B	69.43	74.20	20.06	21.65	17.30	22.20
Swarna × CST-7-1	66.23	63.93	16.29	19.35	8.76	21.27
Swarna × CSRC(S)5-2-2-5	60.10	70.73	19.27	21.81	12.78	20.68
CSR-27 × CSR-30	62.17	75.23	21.02	22.32	9.96	15.22
CSR-27 × CSRC(S)7-1-4	59.80	74.33	23.30	24.45	6.31	12.74
CSR-27 × SR26B	74.43	80.47	22.80	22.72	12.87	20.87
CSR-27 × CST-7-1	77.93	81.37	20.60	21.06	15.78	23.38
CSR-27 × CSRC(S)5-2-2-5	79.53	81.00	20.48	22.69	22.17	25.65
CSR-30 × CSRC(S)7-1-4	59.80	71.90	17.92	22.20	13.10	17.24
CSR-30 × SR26B	57.37	67.37	20.53	19.98	12.65	16.43
CSR-30 × CST-7-1	77.27	82.53	19.48	21.15	8.79	16.87
CSR-30 × CSRC(S)5-2-2-5	74.70	81.87	20.65	22.77	11.54	17.23
CSRC(S)7-1-4 × SR26B	78.23	82.43	19.65	23.59	23.64	25.14
CSRC(S)7-1-4 × CST-7-1	59.13	69.20	16.43	18.80	9.52	12.48
CSRC(S)7-1-4 × CSRC(S)5-2-2-5	73.87	80.60	23.13	24.41	18.58	22.80
SR26B × CST-7-1	84.73	87.97	23.73	24.85	26.19	30.42
SR26B × CSRC(S)5-2-2-5	75.20	80.23	19.98	21.37	19.48	22.84
CST-7-1 × CSRC(S)5-2-2-5	82.80	80.83	21.83	25.70	21.64	23.93
Mean	70.72	78.89	20.03	21.68	14.07	20.36
General mean	71.86	76.67	20.22	21.50	14.22	20.39
S.E ±	2.92	2.43	0.50	0.77	1.33	1.51
C.D (5%)	8.23	5.28	1.42	2.17	3.76	4.25
C.V (%)	7.04	6.85	4.31	6.20	16.24	12.80

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Table 2 . *Per se* performance of 28 F_2 progenies of rice for yield and its components under saline soil conditions

Hybrids	PH (cm)	DFF	PT	PL (cm)	PW (g)	NFGP $^{-1}$	SF (%)	TW (g)	GY (g)
RPBio-226 × Swarna	91.93	103.33	5.33	15.87	1.97	82.33	58.00	14.43	7.67
RPBio-226 × CSR-27	97.80	107.67	6.67	16.93	2.59	87.00	78.93	16.31	5.64
RPBio-226 × CSR-30	109.33	94.33	6.33	19.07	1.51	93.00	58.53	18.26	13.07
RPBio-226 × CSRC(S)7-1-4	117.70	100.00	7.00	18.43	2.02	99.33	73.10	18.72	13.30
RPBio-226 × SR26-B	109.83	106.33	4.67	19.67	1.73	90.00	60.13	17.55	11.67
RPBio-226 × CST-7-1	98.07	99.00	5.67	15.90	2.54	78.67	73.73	20.39	11.60
RPBio-226 × CSRC(S)5-2-2-5	102.37	111.00	4.00	20.43	2.03	111.00	76.23	20.64	17.91
Swarna × CSR-27	96.73	103.00	5.67	17.33	1.25	112.33	58.17	16.47	7.44
Swarna × CSR-30	108.17	104.00	6.67	19.87	1.21	81.00	77.07	19.19	6.38
Swarna × CSRC(S)7-1-4	111.80	106.67	5.33	20.57	2.12	133.67	69.73	21.54	20.65
Swarna × SR26-B	104.80	108.00	6.33	20.33	1.76	111.00	65.70	19.01	18.56
Swarna × CST-7-1	105.70	106.33	6.67	15.70	1.63	79.67	57.03	15.77	10.09
Swarna × CSRC(S)5-2-2-5	103.47	113.67	8.67	22.33	1.73	104.00	59.63	14.41	11.16
CSR-27 × CSR-30	108.73	94.00	4.67	12.97	0.97	86.67	64.00	13.68	6.65
CSR-27 × CSRC(S)7-1-4	106.00	104.67	7.00	15.03	1.31	102.67	56.07	19.67	10.34
CSR-27 × SR26-B	113.83	110.33	6.67	21.23	2.84	77.33	69.83	19.71	14.10
CSR-27 × CST-7-1	109.17	111.00	6.67	18.43	2.62	118.67	76.00	16.67	15.11
CSR-27 × CSRC(S)5-2-2-5	102.80	109.00	6.00	23.03	3.05	143.67	74.90	19.65	24.22
CSR-30 × CSRC(S)7-1-4	111.87	104.00	3.67	13.10	1.44	64.33	54.83	16.89	2.78
CSR-30 × SR26-B	111.00	105.00	3.67	12.97	1.12	51.00	52.63	14.72	3.49
CSR-30 × CST-7-1	105.90	107.33	6.00	16.67	2.38	86.33	71.57	15.65	8.29
CSR-30 × CSRC(S)5-2-2-5	100.87	102.33	5.33	16.67	2.12	98.00	74.60	20.63	9.63
CSRC(S)7-1-4 × SR26-B	104.43	107.33	8.33	19.80	3.21	141.00	76.03	20.54	21.94
CSRC(S)7-1-4 × CST-7-1	112.17	113.33	7.67	12.90	1.90	52.00	54.63	15.66	2.63
CSRC(S)-7-1 × 4CSRC(S)5-2-2-5	106.17	105.00	3.67	21.90	3.04	121.33	69.07	14.44	18.63
SR26-B × CST-7-1	103.73	100.00	8.00	22.33	3.13	155.33	77.17	20.52	21.32
SR26-B × CSRC(S)5-2-2-5	101.43	115.67	7.33	20.43	2.92	114.33	72.07	19.84	18.60
CST-7-1 × CSRC(S)5-2-2-5	100.63	100.67	5.00	22.77	3.24	153.67	75.77	15.90	19.32
Mean	**105.59**	**105.46**	**6.02**	**18.31**	**2.12**	**101.05**	**67.33**	**17.75**	**12.58**
S.E±	4.34	2.83	0.55	1.14	0.16	6.28	2.97	0.53	1.50
C.D(5%)	12.23	7.99	1.55	3.22	0.46	17.71	8.38	1.49	4.24
C.V(%)	7.30	4.57	15.52	10.53	12.53	10.55	7.44	4.98	19.98

PH (cm): Plant height; DFF: Days to 50% flowering; TT: Number of tillers plant^{-1}; PT: Number of productive tillers plant^{-1}; PL (cm): Panicle length; PW(g): Panicle weight; NFGP^{-1}: Number of filled grains panicle^{-1}; SF (%): Spikelet fertility per cent; TW (g): 1000-grain weight; GY (g): Grain yield (g plant^{-1}).

Table 3. Per cent reduction in the *per se* performance of parents and hybrids for yield and its components under saline soil conditions

Parents	PH (cm)	DFF	PT	PL (cm)	PW (g)	NFGP-1	SF (%)	TW (g)	GY (g)
RPBio-226	29.11	0.60	57.13	25.17	55.81	58.23	14.44	10.84	59.33
Swarna	16.59	-7.65	45.14	11.31	4.40	48.07	19.98	4.45	58.41
CSR-27	5.95	-8.81	29.63	7.48	14.08	15.83	5.63	-7.91	33.97
CSR-30	4.77	-7.57	42.11	13.09	33.27	12.50	6.92	1.55	15.73
CSRC(S)7-1-4	2.25	-8.41	27.60	-1.01	15.72	10.11	3.18	-4.58	12.42
SR26B	6.83	-3.85	9.40	-5.68	-5.45	13.66	1.16	-0.06	3.67
CST-7-1	3.67	-5.54	34.40	3.46	14.53	14.03	9.56	-0.57	19.14
CSRC(S)5-2-2-5	3.93	-6.76	12.92	4.03	5.62	15.45	1.90	-0.86	9.85
Mean	**9.07**	**-6.01**	**31.61**	**7.09**	**16.56**	**25.02**	**7.96**	**0.00**	**28.22**
Hybrids									
RPBio-226 x Swarna	8.09	-5.21	60.46	19.23	45.96	42.74	37.73	19.67	60.98
RPBio-226 x CSR-27	5.74	-7.81	54.04	20.99	10.30	32.52	12.48	19.01	70.26
RPBio-226 x CSR-30	8.01	-8.54	51.28	7.94	4.65	21.23	-6.60	2.19	33.73
RPBio-226 x CSRC(S)7-1-4	-0.49	-5.00	30.56	10.90	-14.67	17.54	7.90	8.95	22.87
RPBio-226 x SR26B	-0.19	-6.31	47.04	9.79	32.91	32.33	16.38	6.16	51.69
RPBio-226 x CST-7-1	1.92	-10.75	51.60	26.56	7.80	39.02	9.06	6.16	40.38
RPBio-226 x CSRC(S)5-2-2-5	12.22	-8.36	61.54	14.46	-8.29	36.71	7.25	-7.94	24.02
Swarna x CSR-27	23.17	-4.85	52.49	22.01	61.28	11.62	29.16	7.46	61.66
Swarna x CSR-30	16.84	-9.56	37.04	11.56	33.74	32.89	17.30	7.56	27.70
Swarna x CSRC(S)7-1-4	2.74	-3.17	41.67	4.19	14.18	7.89	3.07	-4.77	10.79
Swarna x SR26B	6.29	-5.75	36.67	11.45	17.37	29.12	6.42	7.34	22.08
Swarna x CST-7-1	12.39	-6.81	52.49	27.03	21.27	52.29	-3.60	15.83	58.82
Swarna x CSRC(S)5-2-2-5	16.62	-8.81	21.60	13.14	47.11	42.49	15.03	11.67	38.18
CSR-27 x CSR-30	16.59	-4.93	48.59	31.20	63.49	30.63	17.37	5.85	34.56
CSR-27 x CSRC(S)7-1-4	16.85	-7.35	51.28	23.91	9.55	43.09	19.55	4.72	50.46
CSR-27 x SR26B	9.43	-5.78	62.15	17.17	-2.96	30.25	7.55	-0.37	38.31
CSR-27 x CST-7-1	4.79	-13.69	22.56	16.74	4.20	30.68	4.22	2.17	32.50
CSR-27 x CSRC(S)5-2-2-5	2.52	-8.03	48.37	8.40	15.18	14.43	1.81	9.74	13.54
CSR-30 x CSRC(S)7-1-4	38.80	-6.58	68.43	25.04	33.14	50.00	16.83	19.31	24.02
CSR-30 x SR26B	25.50	-11.11	67.49	10.54	19.32	43.17	14.84	-2.77	23.04
CSR-30 x CST-7-1	6.03	-1.86	38.69	23.56	-18.52	37.47	6.38	7.90	47.89
CSR-30 x CSRC(S)5-2-2-5	3.30	-6.95	53.89	5.78	8.88	20.42	8.75	9.30	33.03
CSRC(S)7-1-4 x SR26B	10.21	-6.33	27.18	11.73	5.33	21.35	5.10	16.69	5.99
CSRC(S)7-1-4 x CST-7-1	14.78	-5.92	61.03	27.90	68.02	71.27	14.55	12.62	23.72
CSRC(S)7-1-4 x CSRC(S)5-2-2-5	5.11	-11.39	15.65	5.48	0.75	45.20	8.35	5.22	18.51
SR26B x CST-7-1	5.44	-6.93	17.62	-5.22	3.02	23.14	3.68	4.52	13.91
SR26B x CSRC(S)5-2-2-5	6.40	-3.55	34.90	-1.51	12.65	29.92	6.27	6.52	14.74
CST-7-1 x CSRC(S)5-2-2-5	-3.02	-4.29	51.60	1.17	5.58	24.32	-2.43	15.07	9.56
Mean	**9.99**	**-6.95**	**46.04**	**14.41**	**17.29**	**32.85**	**10.35**	**7.60**	**30.88**
G. Mean	**9.79**	**-6.74**	**43.14**	**12.76**	**17.22**	**31.20**	**6.27**	**5.95**	**30.26**

PH (cm): Plant height; DFF: Days to 50% flowering; PT: Number of productive tillers plant^{-1}; PL (cm): Panicle length; PW(g): Panicle weight; NFGP^{-1}: Number of filled grains panicle^{-1}; SF (%): Spikelet fertility per cent; TW (g): 1000-grain weight; GY (g): Grain yield (g plant^{-1}); SES: SES for visual salt injury; RSR: Root /shoot ratio; HI (%): Harvest index per cent; Na^+/K^+ R: Sodium Potassium ratio;SPAD: SPAD chlorophyll meter readin