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Effect of irrigation salinity on the growth and yield of two Aus rice cultivars of Bangladesh

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Abstract
The experiment was conducted to clarify the growth and yield response of two rice cultivars, BR55 and BR43 under salt stress. Six different concentrations of NaCl viz 50, 100, 150, 200, 250 and 300 mM and distilled water (control) were applied on the rice cultivars which were grown under pot culture condition. Growth parameters like plant height, tiller number, leaf number and leaf area were negatively affected by salinity in both cultivars. Salt stress caused a significant reduction in yield in both cultivars of rice. Growth reduction was higher in BR43 than in BR55.The reduction in yield and yield parameters were found to be lower in BR55 than those in BR43. The results obtained in the present study suggest that BR55 showed higher salt tolerance than in BR43.

Key words: Salinity, growth, yield, cultivars, rice.

INTRODUCTION

Saline soil is one of the serious abiotic stresses that causes reduced plant growth, development and productivity worldwide (Siringam *et al*., 2011). Approximately 7% of the world's total land area, 20% of the world's cultivated land area and nearly 50% of the world's irrigated land area are affected by salinity (Zhu, 2001). In Bangladesh, about 1.06 million hectares of arable lands are affected by soil salinity (SRDI, 2010). About one fifth of the total area of Bangladesh is affected by various degrees of salinity (Karim *et al*., 1982).

Salt stress has a major impact on plant growth and development. The major inhibitory effect of salinity on plant growth and development has been attributed to osmotic inhibition of water availability as well as the toxic effect of salt ions responsible for salinization. In the majority of plants, salt stress leads to changes in gene expression, leading to an increased synthesis of osmoprotectors and osmoregulators (Teixeira & Pereira, 2007). Salinity imposes two constraints on plants: the hyperosmotic effect (especially short-term stress) due to lower soil water potential, and the hyperionic effect (especially long-term stress) due to direct toxicity of ions over metabolism and nutrition imbalance of plants (Verma & Mishra, 2005; Duan *et al*., 2008).

Rice is the staple food for the people of Bangladesh and plays the most important role in the national economy. Bangladesh is the 4th largest country in Asia with respect to rice

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area and production (BBS, 2004). It occupies 74% of the total cropped area, accounts for 70% of the value of crop output and contributes 20% to GDP (BBS, 2001). It contributes 75.6% of the calorie, 66% of the protein and 17.8% of fat (FAOSTAT, 2001). Per capita cereal consumption is 150.4 kg of which share of rice is 91%. However, rice production may not achieve its goal due to natural disasters, soil salinity and ambient air pollution in Bangladesh. Thus, it is urgent for the researchers and policy makers to search alternative techniques for better utilization of stress-prone areas, like screening of salt tolerant cultivars might be the best approach to bring salinity prone areas under cultivation and will ensure the country's food security.

There is increasing evidence that salt stress has a significant effect on growth and yield of plants and rated as a salt sensitive crop. Inspite of extensive research or information data available or salinity impact on rice but quantitative effect of salinity on different growth stages, yield components is limited. The present study was aimed to clarify the effect of salinity on growth, development and yield of two contrasting salt tolerance rice cultivars at different stress duration.

MATERIALS AND METHODS

Plant materials: Two rice cultivars (*Oryza sativa* L.), BR55 and BR43 were used as plant materials. Rice seeds were collected from Bangladesh Rice Research Institute (BRRI). Both cultivars are Aus rice.

Treatments: Six different levels of NaCl solution (50, 100, 150, 200, 250 and 300 mM) and distilled water as control were applied in this experiment.

Pot preparation and management practices: Pot experiments were carried out in the experimental field of Botanical garden of Jahangirnagar University, Savar, Dhaka. Pots were filled with (12 kg per pot) air dried soil. The P^H value and cation exchange capacity of the soil were 7.12 and 0.20 (mg/100g dry soil) respectively. Before sowing 0.41 gm of TSP, 0.5 gm of MOP and 0.81 gm of gypsum per pot were incorporated into the soil and sufficient water was added to saturate the soil. The pots were kept under natural sunshine till harvesting. Seeds of uniform size were directly sown in pots. Distilled water was applied in all pots up to the emergence of seedlings. After seedling establishment distilled water in control pots and 12.5 mM NaCl solution were applied in salt treatment. When the first leaf appeared, actual amount of NaCl solution were applied at 3 days interval. The salt solution were applied till harvest. Regular watering and weeding were made to ensure equal environmental condition throughout the experimental period.

Measurement of growth and yield: Plant height, leaf number, tiller number and leaf area of two rice cultivars were measured at 10, 20, 30 and 40 days after treatment (DAT). Yield and yield contributing parameters like yield per plant, filled grain number per plant, total grain number per plant and panicle number per plant were recorded at final harvest.

Statiscal analysis: The experiment was arranged out in randomized block design with three replications. Statistical analysis of the collected data were performed using Analysis of Varience (ANOVA). All statistical analysis were performed with the SPSS statistical package (SPSS program 16.00). Tukey's HSD test was performed to identify significant differences among the treatments.

RESULTS AND DISCUSSION

Measurement of Growth

Plant height: Plant height decreased significantly with the increasing levels of NaCl (Table 1). Compared to control, the highest salinity level significantly reduced plant height by 31.74% for BR55 and 62.22% for BR43 at 10 DAT. Compared to control, under 300 mM NaCl concentration plant height at 20 DAT was reduced by 29.54% for BR55 and 33.20% for BR43. At 30 DAT, plant height was reduced 29.18%for BR55 and 35.60% for BR43compared to the control under 300 mM NaCl concentration. Compared to control, the highest salinity level significantly reduced plant height by 30.51% for BR55 and 35.01% for BR43 at 40 DAT. Salinity significantly reduced the plant height in both cultivars. However salinity induced reduction of plant height was higher in BR43 than that in BR55.

Inhibition of growth due to salt stress has been observed even in tolerant plant species (Mittler *et al.*, 2001). Shoot and root growth reductions are the most important agricultural indices of salt tolerance (Tuna *et al*., 2008). Earlier workers have reported reduction of plant height in rice under salt stress (Weon *et al.*, 2003; Islam *et al*., 2007). The salt induced reduction in plant height could be due to the negative effect of this salt on the rate of photosynthesis, the changes in enzyme activity (that subsequently affects protein synthesis) and also the decrease in the level of carbohydrates and growth hormones (Mazher *et al*., 2007).

Tiller number: Tiller number also significantly decreased with the increasing levels of NaCl (Table 2). Compared to control, the highest salinity level significantly reduced tiller number by 56.03% for BR55 and 69.96% for BR43 at 10 DAT. Compared to control, under 300 mM NaCl concentration, tiller number at 20 DAT was reduced by 47.52% for BR55 and 62.02% for BR43. At 30 DAT, tiller number was reduced by 43.07%for BR55 and 57.28% for BR43compared to the control under 300 mM NaCl concentration. Compared to control, the highest salinity level significantly reduced tiller number by 43.58%for BR55 and 54.54% for BR43at 40 DAT. However, salinity induced reduction of tiller number was higher in BR43 than that in BR55.

Zeng *et al*. (2003b) reported that salinity decreases number of tillers while imposing before panicle emergence. Eugene *et al*. (1994) reported that salinity stress strongly influenced the distribution of spike-bearing tillers. Nicolas *et al*. (1994) found that salt stress during tiller emergence can inhibit their formation and can cause their abortion at later stages.

Table 1. Effects of different concentrations of salt (NaCl) on plant height (cm) of two rice cultivars BR55 and BR43 at different days after treatment

Treatments	Days after treatment (DAT)							
	10		20		30		40	
	BR55	BR43	BR55	BR43	BR55	BR43	BR55	BR43
0mM	70.16 ± 2.17a	65.44 ± 1.56a	82.53 ± 1.79a	77.65 ± 1.77a	93.52 ± 2.35a	86.45 ± 1.63a	102.38 ± 2.27a	95.07 ± 1.62a
50mM	67.56 ± 1.87a (96.29)	59.32 ± 1.78b (90.64)	78.07 ± 1.86b (94.59)	72.93 ± 2.59b (93.92)	89.34 ± 1.53a (95.53)	81.34 ± 1.93a (94.08)	97.26 ± 2.74b (94.99)	91.03 ± 2.22b (95.75)
100mM	62.76 ± 2.12b (89.45)	52.67 ± 2.65c (80.48)	73.03 ± 1.69c (88.48)	67.9 ± 2.38c (87.44)	82.76 ± 1.43b (88.49)	73.54 ± 2.03b (85.06)	91.04 ± 2.70c (88.92)	84.56 ± 1.93c (88.94)
150mM	58.88 ± 2.74c (83.92)	43.24 ± 1.89d (66.07)	68.02 ± 2.84d (82.41)	62.83 ± 2.32d (80.91)	77.34 ± 2.10c (82.69)	67.44 ± 1.56c (78.01)	86.24 ± 2.19d (84.23)	79.14 ± 2.50d (83.24)
200mM	53.23 ± 1.45d (75.86)	36.45 ± 2.34e (55.69)	64.08 ± 2.74e (77.64)	59.26 ± 2.85d (76.31)	73.23 ± 1.67cd (78.30)	62.96 ± 1.88cd (72.82)	80.17 ± 2.75e (78.30)	72.83 ± 2.87e (76.60)
250mM	50.47 ± 2.23de (71.93)	30.76 ± 2.56f (47.00)	61.11 ± 2.57ef (74.04)	55.25 ± 2.55e (71.15)	68.56 ± 1.96de (73.31)	58.56 ± 2.31de (67.73)	76.26 ± 2.81f (74.48)	67.26 ± 2.54f (70.74)
300mM	47.89 ± 1.42e (68.25)	24.72 ± 1.55g (37.77)	58.15 ± 2.04f (70.45)	51.87 ± 2.69e (66.79)	66.23 ± 1.18e (70.81)	55.67 ± 1.45e (64.39)	71.14 ± 2.73g (69.48)	61.78 ± 2.96g (64.98)
Cultivar Mean	58.7	44.65	69.28	63.95	78.71	69.42	86.35	78.81
CV%	13.98	32.23	12.51	14.18	12.59	15.88	12.57	14.84

***** Average value of 9 plants in each treatment.
***** Means in a column followed by the same letter do not differ significantly at 5% level and ± means standard deviation.
***** Values within parenthesis indicate percentage relative to the control.

Table 2. Effects of different concentrations of salt (NaCl) on tiller number of two rice cultivars BR55 and BR43 at different days after treatment

Treatments	Days after treatment (DAT)							
	10		20		30		40	
	BR55	BR43	BR55	BR43	BR55	BR43	BR55	BR43
0mM	6.55 ± 0.56a	6.66 ± 0.63a	8.88 ± 0.78a	8.77 ± 0.83a	10.33 ± 1.20a	9.88 ± 1.02a	12.00 ± 1.00a	11.00 ± 1.00a
50mM	5.88 ± 0.73ab (89.77)	5.33 ± 1.00ab (80.03)	8.11 ± 0.92ab (91.32)	7.44 ± 1.01ab (84.83)	9.88 ± 0.47a (95.64)	9.11 ± 0.98ab (92.02)	11.22 ± 1.39ab (93.50)	10.11 ± 1.36ab (91.90)
100mM	5.11 ± 1.03ab (78.01)	4.22 ± 0.43abc (63.36)	7.55 ± 0.88bc (85.02)	6.11 ± 0.92bc (69.66)	9.11 ± 0.78ab (88.18)	8.33 ± 0.65abc (84.31)	10.44 ± 0.88bc (87.00)	9.22 ± 1.09bc (83.81)
150mM	4.88 ± 0.24ab (74.50)	3.88 ± 0.78abc (58.25)	6.77 ± 0.66cd (76.23)	5.44 ± 0.88c (62.02)	8.66 ± 1.17abc (83.83)	6.88 ± 1.08bcd (69.63)	9.66 ± 1.00cd (80.50)	8.00 ± 1.22cd (72.72)
200mM	3.99 ± 0.92ab (60.91)	3.11 ± 1.26bc (46.69)	5.77 ± 0.66de (64.97)	5.00 ± 1.32cd (57.01)	7.00 ± 0.75bc (67.76)	6.11 ± 0.48cd (61.84)	8.88 ± 0.92de (74.00)	6.77 ± 0.83de (61.54)
250mM	3.33 ± 0.61b (50.83)	2.77 ± 0.56bc (41.59)	5.00 ± 0.70e (56.30)	4.00 ± 0.70de (45.61)	6.33 ± 0.94bc (61.27)	5.55 ± 1.00cd (56.17)	7.88 ± 1.05ef (65.66)	5.88 ± 0.78ef (53.45)
300mM	2.88 ± 0.84b (43.96)	2.00 ± 0.54c (30.03)	4.66 ± 0.86e (52.47)	3.33 ± 0.70e (37.97)	5.88 ± 0.62c (56.92)	4.22 ± 0.73d (42.71)	6.77 ± 0.83f (56.41)	5.00 ± 1.11f (45.45)
Cultivar Mean	4.66	3.99	6.67	5.72	8.17	7.15	9.55	7.99
CV%	33.5	43.21	25.04	34.64	22.92	29.47	20.74	29.01

***** Average value of 9 plants in each treatment.
***** Means in a column followed by the same letter do not differ significantly at 5% level and ± means standard deviation.
***** Values within parenthesis indicate percentage relative to the control.

Leaf number: Salinity disturbed seriously the production of leaf, which was depicted in the stiff reduction in leaf number/plant (Table 3).Compared to control, the highest salinity level significantly reduced leaf number by 56.46% for BR55 and 60.94% for BR43 at 10 DAT. Compared to control, under 300 mM NaCl concentration leaf number at 20 DAT was reduced by 49.23% for BR55 and 58.03% for BR43. At 30 DAT, leaf number was reduced 45.82%for BR55 and 58.22% for BR43compared to the control under 300 mM NaCl concentration. Compared to control, the highest salinity level significantly reduced leaf number by 44.67% for BR55 and 57.21% for BR43 at 40 DAT. However, under salinity stress reduction of leaf number was higher in BR43 than that in BR55.

Green leaves and dry matter production per plant were reported to be reduced with the increase in soil salinity (Bal & Dutt, 1984). Inhibition of the formation of leaf primordia under salt stress could be the probable reason for low leaf number (Alamgir & Ali, 2006). The decrease of leaf numbers may be due to the accumulation of sodium chloride in the cell walls and cytoplasm of the older leaves.

Leaf area: Salinity significantly decreased the production of green leaf area (Table 4).Compared to control, the highest salinity level significantly reduced leaf area by 51.03% for BR55 and 60.34% for BR43 at 10 DAT. Compared to control, under 300 mM NaCl concentration leaf area at 20 DAT was reduced by 45.18% for BR55 and 55.36% for BR43. At 30 DAT, leaf area was reduced 42.36%for BR55 and 56.36% for BR43compared to the control under 300 mM NaCl concentration. Compared to control, the highest salinity level significantly reduced leaf area by 42.09% for BR55 and 55.23% for BR43 at 40 DAT. However, reduction in leaf area at different salinity level were higher in BR43 than that in BR55.

Salinity has been reported to decrease leaf area tremendously (Wankhade *et al*., 2013). The decrease in leaf area, found in this study could be explained by the negative effect of salt on photosynthesis that leads to the reduction of plant growth and leaf growth (Netondo *et al*., 2004).

Measurement of Yield

Yield number per plant (filled grain weight): Salinity significantly decreased the grain yield (Table 5). At all levels of salinity the absolute grain yield of BR55 was significantly higher than BR43.Compared to control, the highest salinity level significantly reduced yield number per plant by 67.1% for BR55 and 76.68% for BR43. Salinity induced significant higher reduction of grain yield was observed in BR43 than that in BR55. Thus, this results summarized that BR43 is highly sensitive to salt stress than BR55.

Reduction in yield due to salt stress has been reported by Zeng & Shannon (2000a) and Cha-um & Kirdmanee (2010). Rice yield is often decreased with increasing salinity especially when experienced in the early development stages (Menete *et al*., 2008). Salinity affected the grain yield through a reduction in various components such as spike number and grain number in most of the genotypes (Saqib *et al*., 2012).

Table 3. Effects of different concentrations of salt (NaCl) on leaf number of two rice cultivars BR55 and BR43 at different days after treatment

Treatments	Days after treatment (DAT)							
	10		20		30		40	
	BR55	BR43	BR55	BR43	BR55	BR43	BR55	BR43
0mM	29.33 ± 1.73a	24.43 ± 2.57a	36.11 ± 2.08a	32.55 ± 2.65a	42.66 ± 1.23a	39.62 ± 1.56a	49.00 ± 2.00a	47.00 ± 3.39a
50mM	25.11 ± 2.10ab (85.61)	21.67 ± 2.89ab (88.70)	32.11 ± 1.90b (88.92)	29.55 ± 3.00a (90.78)	38.44 ± 1.67ab (90.10)	35.86 ± 1.96ab (90.50)	44.88 ± 2.31b (91.59)	40.33 ± 3.27b (85.80)
100mM	22.55 ± 2.54bc (76.88)	19.34 ± 1.67abc (79.16)	30 ± 1.22b (83.07)	24.22 ± 2.58b (74.40)	36.22 ± 2.19b (84.90)	30.43 ± 2.18bc (76.80)	41.77 ± 0.88bc (85.24)	36.33 ± 3.27b (77.29)
150mM	19.11 ± 1.82cd (65.15)	16.59 ± 2.48bc (67.90)	27.11 ± 2.31c (75.07)	21.44 ± 2.78bc (65.85)	34.11 ± 1.56bc (79.95)	26.34 ± 2.48cd (66.48)	38.88 ± 2.14cd (79.34)	31.11 ± 3.17c (66.19)
200mM	17.99 ± 2.37cde (61.33)	14.88 ± 1.74bcd (60.90)	23.11 ± 1.53d (63.99)	19.33 ± 2.39cd (59.38)	29.33 ± 1.92cd (68.75)	22.75 ± 1.98de (57.42)	35.88 ± 1.90d (73.22)	27.22 ± 2.43cd (57.91)
250mM	14.44 ± 1.35de (49.23)	12.56 ± 2.67cd (51.41)	20.11 ± 2.20e (55.69)	16.00 ± 2.59de (49.15)	26.22 ± 1.72de (61.46)	18.78 ± 1.65ef (47.40)	31.11 ± 2.26e (63.48)	23.44 ± 3.08de (49.87)
300mM	12.77 ± 2.42e (43.53)	9.54 ± 1.47d (39.05)	18.33 ± 2.17e (50.76)	13.66 ± 2.12e (41.96)	23.11 ± 1.20e (54.17)	16.55 ± 1.47f (41.77)	27.11 ± 2.14f (55.32)	20.11 ± 3.10e (42.78)
Cultivar Mean	20.18	17	26.69	22.39	32.87	27.19	38.37	32.22
CV%	28.72	31.49	23.83	30.78	20.75	30.65	19.4	29.24

***** Average value of 9 plants in each treatment.
***** Means in a column followed by the same letter do not differ significantly at 5% level and ± means standard deviation.
***** Values within parenthesis indicate percentage relative to the control.

Table 4. Effects of different concentrations of salt (NaCl) on leaf area (cm^2)/plant of two rice cultivars BR55 and BR43 at different days after Treatment

Treatments	Days after treatment (DAT)							
	10		20		30		40	
	BR55	BR43	BR55	BR43	BR55	BR43	BR55	BR43
0mM	38.31 ± 2.53a	38.68 ± 2.45a	49.35 ± 2.31a	47.30 ± 3.41a	58.45 ± 1.78a	55.78 ± 1.67a	66.51 ± 2.10a	61.12 ± 2.59a
50mM	35.74 ± 1.64ab (93.29)	33.42 ± 1.66ab (86.40)	46.54 ± 2.66a (94.30)	42.02 ± 3.29b (88.83)	55.64 ± 1.93a (95.19)	49.56 ± 1.59b (88.84)	62.53 ± 2.92b (94.01)	53.53 ± 2.55b (87.58)
100mM	31.83 ± 2.85bc (83.08)	28.87 ± 1.27bc (74.63)	41.25 ± 2.55b (83.58)	38.02 ± 2.94b (80.38)	49.34 ± 2.34b (84.41)	43.87 ± 2.32c (78.64)	55.23 ± 3.22c (83.04)	47.62 ± 2.49c (77.91)
150mM	28.43 ± 2.47cd (74.21)	23.45 ± 2.80cd (60.62)	37.36 ± 1.70c (75.70)	33.72 ± 2.67c (71.28)	44.71 ± 2.52bc (76.49)	38.53 ± 2.56d (69.07)	49.96 ± 2.25d (75.11)	41.66 ± 3.00d (68.16)
200mM	24.81 ± 1.56de (64.76)	20.43 ± 2.74de (52.81)	34.44 ± 2.61c (69.78)	28.85 ± 2.93d (60.99)	41.53 ± 1.70cd (71.05)	33.74 ± 2.76e (60.48)	46.54 ± 2.55d (69.97)	36.47 ± 1.95e (59.66)
250mM	21.72 ± 2.62ef (56.69)	17.64 ± 2.59e (45.60)	30.07 ± 1.98d (60.93)	24.61 ± 2.40e (52.02)	36.57 ± 2.38de (62.56)	29.98 ± 1.78e (53.74)	41.45 ± 1.79e (62.32)	32.45 ± 1.42f (53.09)
300mM	18.76 ± 1.93f (48.96)	15.34 ± 1.84e (39.65)	27.05 ± 2.18d (54.81)	21.11 ± 1.89e (44.63)	33.69 ± 1.84e (57.63)	24.34 ± 1.42f (43.63)	38.51 ± 2.49e (57.90)	27.36 ± 2.58g (44.76)
Cultivar Mean	28.51	25.4	38	33.66	45.7	39.4	51.59	42.88
CV%	24.78	32.72	21.05	25.88	19.67	26.92	19.51	26.6

***** Average value of 9 plants in each treatment.
***** Means in a column followed by the same letter do not differ significantly at 5% level and ± means standard deviation.
***** Values within parenthesis indicate percentage relative to the control.

Table 5. Effects of different concentrations of salt (NaCl) on yield/plant and yield attributes of two rice cultivars BR55 and BR43 at final harvest

Treatments	Yield/plant (gm)		Panicle no./plant		Total grain no./plant		Filled grain no./plant	
	BR55	BR43	BR55	BR43	BR55	BR43	BR55	BR43
0mM	6.08 ± 0.07a	4.29 ± 0.07a	6.9 ± 1.00a	6.7 ± 1.00a	551.6 ± 7.50a	388.8 ± 8.00a	390.5 ± 5.00a	275.3 ± 5.00a
50mM	5.11 ± 0.05b (84.04)	3.35 ± 0.07b (78.08)	6.6 ± 1.00a (95.65)	5.8 ± 1.00ab (86.56)	501.7 ± 6.00b (90.95)	341.9 ± 8.00b (87.93)	328.4 ± 3.00b (84.10)	215.2 ± 5.00b (78.16)
100mM	4.21 ± 0.06c (69.24)	2.80 ± 0.05c (65.26)	5.7 ± 1.00ab (82.60)	5.3 ± 1.00abc (79.10)	462.9 ± 7.00c (83.91)	326.2 ± 10.00bc (83.89)	270.7 ± 5.00c (69.32)	180.9 ± 5.00c (65.71)
150mM	3.40 ± 0.05d (55.92)	2.37 ± 0.07d (55.24)	4.6 ± 1.00ab (66.66)	4.5 ± 1.00abc (67.16)	437 ± 7.00d (79.22)	315.8 ± 8.00cd (81.22)	218.2 ± 4.00d (55.87)	152.6 ± 5.00d (55.43)
200mM	2.91 ± 0.05e (47.86)	1.91 ± 0.06e (44.52)	4.1 ± 1.00ab (59.42)	4.2 ± 1.00abc (62.68)	417.7 ± 7.00e (75.72)	306.5 ± 5.00cde (78.83)	187.1 ± 2.00e (47.91)	123.7 ± 3.00e (44.93)
250mM	2.12 ± 0.05f (34.86)	1.51 ± 0.06f (35.19)	3.5 ± 1.00b (50.72)	3.5 ± 1.00bc (52.23)	409.6 ± 6.00ef (72.44)	286.1d ± 6.00e (76.15)	136.3 ± 3.00f (34.90)	97.4 ± 2.00f (35.37)
300mM	2.00 ± 0.05g (32.89)	1.00 ± 0.06g (23.31)	3.1 ± 1.00b (44.92)	2.4 ± 1.00c (35.82)	399.8 ± 5.00f (71.42)	263.1 ± 9.00e (73.79)	117.8 ± 2.00g (28.88)	66.8 ± 4.00g (27.89)
Cultivar Mean	3.65	2.48	4.92	4.62	452.07	323.17	234.85	160.27
CV%	41.02	40.8	33.16	36.83	12.19	10.29	40.96	41.43

***** Average value of 9 plants in each treatment.
***** Means in a column followed by the same letter do not differ significantly at 5% level and ± means standard deviation.
***** Values within parenthesis indicate percentage relative to the control.

Panicle number per plant: Salinity decreased seriously the panicle number per plant (Table 5). At all levels of salinity the absolute panicle number of BR55 was significantly higher than BR43. Compared to control, the highest salinity level significantly reduced panicle number per plant by 55.07% for BR55 and 64.17% for BR43. Therefore, significantly higher salt induced reduction of panicle number per plant was observed in BR43 than that in BR55.

Results obtained from this study showed that salinity-induced reduction in the panicle number per plant was mainly attributed to that in the tiller number per plant (Kamal *et al*., 2015). Similarly, Beatriz *et al*. (2001) showed that water and soil salinity decrease the number of panicles.

Total grain number per plant: Salinity significantly decreased the total grain number per plant (Table 5). Compared to control, the highest salinity level significantly reduced total grain number per plant by 27.51% for BR55 and 32.33% for BR43. Therefore, significantly higher salt induced reduction of total grain number per plant was observed in BR43 than that in BR55. In the present study, the salinity-induced reduction in the grain yield of two rice cultivars resulted from that in the number of panicle per plant (Zeng & Shannon, 2003).

Filled grain number per plant: Salinity decreased the filled grain number per plant (Table 5).Compared to control, the highest salinity level significantly reduced filled grain number per plant by 69.83% for BR55 and 75.73% for BR43.Salinity induced drastically reduction of filled grain number per plant was observed in BR43 than that in BR55. Reduction in filled grain number per plant in this study due to salinity-induced disturbance of source sink relationship of crop plants (Greenway & Munns, 1980; Blum, 1988). Reduction in grain number per plant in rice have also been reported (Zaibunnisa *et al*., 2002).

This study indicates that BR55 showed relatively higher tolerance to salinity than BR43 on the basis of growth and yield performance. Therefore, further research should be focused on bio-molecular mechanisms involved in salinity tolerance for the determination of key pathways controlling salinity tolerance in plants.

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