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EFFECT OF DIFFERENT SALINE LEVELS ON GROWTH AND YIELD ATTRIBUTES OF MUTANT RICE

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ABASTRACT

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A pot experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, to find out the growth and yield attributes of mutant rice under varied saline levels. Three rice genotypes viz. Q-31, Y-1281 and MR-219 were used as tests materials. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. Six salinity levels namely 15dSm^{-1}, 12 dSm^{-1}, 9 dSm^{-1}, 6 dSm^{-1}, 3 dSm^{-1} with a control were imposed in this experiment. The results indicated that all the growth and yield contributing characters of rice genotypes such plant height, number of tiller hill^{-1}, effective tillers hill^{-1}, panicle length, filled grain panicle^{-1}, 1000-grain weight (g), grain yield hill^{-1}(g) decreased with increased levels of salinity compared to control. Among the genotypes, MR-219 showed best performance in respect of yield and yield contributing characters up to 6 dSm^{-1} and showed Y-1281 intermediate status. The genotypes Q-31 and Y-1281 showed its susceptibility to salinity stress. Thus MR-219 was found best salt tolerant genotype than others.

Key words: salinity stress, mutant rice, salt tolerant

INTRODUCTION

Among the various factors limiting rice yield, salinity is one of the oldest and most serious environmental problems in the world (Mcwilliam, 1986). In Bangladesh, over thirty percent of the net cultivable area is in the coastal area. Out of 2.85 million hectare of the coastal and off-shore areas, about 0.833 million hectares are arable lands, which constitute about 52.8 percent of the net cultivable area in 64 thanas of 13 districts (Karim *et al.*, 1990). This area is largely affected by varying degrees of salinity and decreased the agricultural productivity seriously. As reclamation of saline soils is laborious and almost impossible, development or selection of salt tolerant crop species is one of the possible means for extension of crop area. Generally, salinity affects the growth of rice plant at all stages of its life cycle. But it is more pronounced on reproductive stage than on vegetative stage consequently decreased the grain yield (Afridi *et al.,* 1988). Excessive soluble salts in soils or in irrigated water may reduce the efficiency of water uptake by crop plants. Plant height, total number of tillers, panicle length, grain weight per panicle, 1000-seed weight and quality and quantity of grains decreased progressively with increase in salinity levels (Abdullah *et al.*, 2001). Rice is moderately susceptible to salinity, since most rice plants are severely injured at an EC 8-10 dSm^{-1}. Yield losses due to salinity are amounted to 30-50 percent and our farmers normally grow local varieties due to unavailability of salt tolerant high yielding varieties (HYV). Therefore, to keep pace with the population growth and food productions, the yield per unit area needs to be increased for minimizing the yield gap. Grain yield decreased with increasing salinity levels. Appropriate salt tolerant high yielding varieties that can fit into the rice-growing ecosystem in the coastal areas of Bangladesh will boost up the country's rice production. Study on the response of rice to salinity stress may be helpful in breeding salt tolerant cultivars by identifying physiological features potential salinity tolerance. Therefore, the present experiment was conducted to identify the characters responsible for salinity of two mutants along with their mother.

MATERIALS AND METHODS

A pot culture experiment was carried out in Bangladesh Institute of Nuclear Agriculture (BINA) during T. Aman season from July to November, 2003. Each pot contained 8.0 kg of dried soil, belongs to the Sonatola series of Grey Flood Plain under the Old Brahmaputra Agro-Ecological Zone (UNDP and FAO, 1988). The p^H value, cation exchange capacity (CEC) and electrical conductivity (EC) of the soil were 6.44, 6.78meq/100 g soil and 0.6 dSm^{-1}, respectively. Three rice genotypes Q-31, Y-1281 and MR-219 were used in the present in this experiment. Earthen pots of 24.5 cm top diameter, 14 cm bottom and 30 cm depth were used, which pot was filled with 8 kg sun-dried soil. A polythene lining was provided inside the pots. N, P, K and S applied at rate of 60-8-30-4 kg/ha in the form of Urea, TSP, MP and Gypsum according to Fertilizer Recommendation Guide (BARC, 1997).

The following salinity treatments namely control, 3, 6, 9, 12 and 15 dSm^{-1} were imposed in the experiment. Salinity treatments were given at 33 days after transplanting (DAT). EC was measured by the electrical conductivity bridge at room temperature and calculated to the standard temperature of 25^0 C. The p^H and CEC soil were analyses following the methods of (Jackson, 1982) and (Black, 1965), respectively. Data were collected plant height (cm), number of tiller hill^{-1}, effective tillers hill^{-1}, panicle length (cm), filled grain panicle^{-1}, 1000-grain weight (g), grain yield hill^{-1}(g). The collected data were statistically analyzed by MSTAT-C package program develop by (Russel, 1986).

RESULTS AND DISCUSSION

Plant height

The plant height was significantly decreased with increasing salinity levels. After 35 days after transplanting (DAT), the plant heights were 62.63, 58.70, 51.52, 47.98, 29.01 cm for 0 .6 (control), 3, 6, 9, 12 dSm^{-1} of salinity levels respectively (Table 1a). Similar trend in plant height was found in subsequent growing periods. After 65 DAT, the highest plant height was in control which gradually decreased and become the lowest at the highest salinity level of 12.0 dSm^{-1}. Similar result was reported by (Khan *et al.*, 1997) and (WeonYoung *et al.*, 2003) in different genotypes and cultivars of rice.

Table 1a. Effect of different salinity levels on plant height and tiller production of rice genotypes

Salinity levels (dSm^{-1})	Plant height (cm)			Number of tillers hill^{-1}		
	35 DAT	65 DAT	At maturity	35 DAT	65 DAT	At maturity
Control (0)	62.63	80.86	85.76	5.22	8.89	10.56
3	58.70	73.29	81.03	4.10	7.38	9.00
6	51.52	67.04	73.83	3.22	5.11	6.67
9	47.98	56.55	64.17	2.00	2.89	2.00
12	29.01	35.17	--	1.00	1.33	--
$LSD_{0.05}$	2.53	2.51	3.67	0.40	0.33	0.42

Salinity showed significant variation in plant height in different genotypes where the genotype Q-31 showed longer plant height structure throughout the whole growth period, and the genotype MR-219 showed the intermediate status (Table 1b). The interaction effects between salinity stresses and genotypes on the plant height indicated that at control, all varieties were different for the plant height but tolerance capability to salinity varied significantly. Reduction of the plant height with increasing salinity was comparatively lower in Y-1281 over other two genotypes. Genotype Y-1281 was the lowest tolerant to salinity in respect to the plant at all along the growth periods. The results indicated the effect of salinity on plant elongation was different, which might be due to genetic potentiality of the genotypes.

Number of tillers hill $^{-1}$

The number of tillers hill $^{-1}$ was significantly varied due to effects of salinity stresses. At 35 days after transplanting (DAT), the number of tillers hill $^{-1}$ was the highest (5.22) in control condition and the minimum number of tillers hill^{-1} (1.00) was obtain from 12 dSm^{-1} level of soil salinity and than decreased significantly with increasing salinity levels (Table 1a). Similar trend of number of tillers hill $^{-1}$ was observed in subsequent growth periods. The present result agrees with the findings several researchers. (WeonYoung *et al*., 2003) and (LingHE *et al*., 2000) stated that the number of tillers hill $^{-1}$ decreased with increasing salinity levels in rice. Performance of genotypes for the production of tiller under salinity stresses varied significantly (Table 1b).In all growth stages, the highest number of tillers hill^{-1} were in MR-219 compared to other genotypes. It might be due to the higher tiller production potentially of the MR-219 under salinity stresses. The interaction effect of genotypes and salinity levels in relation to tillers hill^{-1} was found significant at 35 DAT, 65 DAT and at maturity stage (Table 1c). At 35 DAT, the maximum number of tillers hill^{-1} (6.00) was found in MR-219 at control condition and the minimum number of tillers hill^{-1} (1.00) was found in the same genotype at 12 dSm^{-1} salinity level. At maturity stage, the maximum number of tillers (14.67) was found in MR-219 at control and the minimum number of tillers (4.00) was found in Q-31 at 6 dSm^{-1} level of soil salinity.

Table 1b.Varietal performance on some morphological parameters under different salinity levels of rice genotypes

Variety/genotypes	Plant height (cm)			Number of tillers hill^{-1}		
	35 DAT	65 DAT	At maturity	35 DAT	65 DAT	At maturity
Q-31	52.27	60.03	67.33	2.44	2.95	2.78
Y-1281	30.21	36.83	41.04	2.21	3.79	4.06
MR-219	42.45	59.60	54.18	3.11	6.06	7.28
$LSD_{0.05}$	1.79	1.77	1.74	0.29	0.14	0.29

Table 1c. Interaction between genotypes and salinity levels on plant height and number of tillers hill^{-1} at different days after transplanting (DAT)

Interaction (genotypes × salinity levels)	Plant height (cm)			Number of tillers hill^{-1}		
	35 DAT	65 DAT	At maturity	35 DAT	65 DAT	At maturity
V_1S_1	72.32 a	93.35 a	98.00 a	5.33 ab	7.00 de	7.67 e
V_1S_2	65.58 b	81.33 b	91.00 b	4.33 cd	4.67 f	5.00 g
V_1S_3	62.96 bc	76.00 c	82.00 c	3.00 e	3.33 g	4.00 h
V_1S_4	59.15 c	59.50 e	72.00 d	1.00 f	1.67 hi	0.00 i
V_1S_5	53.60 d	50.00 gh	0.00 g	1.00 f	1.00 j	0.00 i
V_1S_6	0.00 i	0.00 i	0.00 g	0.00 g	0.00 k	0.00 i
V_2S_1	50.12 de	65.17 d	69.17 d	4.33 cd	8.00 c	9.33 cd
V_2S_2	46.87 ef	57.77 e	66.10 de	3.33 e	6.67 e	8.67 d
V_2S_3	44.22 fg	51.87 fg	60.00 e	3.00 e	4.67 f	6.33 f
V_2S_4	40.03 g	46.16 h	51.00 f	1.67 f	2.00 h	0.00 i
V_2S_5	0.00 i	0.00 i	0.00 g	0.00 g	0.00 k	0.00 i
V_2S_6	0.00 i	0.00 i	0.00 g	0.00 g	0.00 k	0.00 i
V_3S_1	65.45 b	84.07 b	90.10 b	6.00 a	11.67 a	14.67 a
V_3S_2	63.66 bc	80.77 b	86.00 bc	4.6 bc	10.67 b	13.33 b
V_3S_3	47.38 ef	73.25 c	79.50 c	3.67 de	7.33 d	9.67 c
V_3S_4	44.75 f	64.00 d	69.50 d	3.33 e	5.00 f	6.00 f
V_3S_5	33.44 h	55.50 ef	0.00 g	1.00 f	1.67 hi	0.00 i
V_3S_6	0.00 i	0.00 i	0.00 g	0.00 g	0.00 k	0.00 i

V_1= Q-31, V_2= Y-1281, V_3= MR-219, S_1 = 0 dSm^{-1}, S_2 = 3 dSm^{-1}, S_3 = 6 dSm^{-1}, S_4 = 9 dSm^{-1}, S_5 = 12 dSm^{-1} & S_6 = 15 dSm^{-1}
In a column figures having similar letter (s) do not differ significantly as per DMRT

Number of effective tiller hill $^{-1}$

The effect of salinity on effective tillers formation was highly significantly (Table 2a). The maximum number of effective tillers hill $^{-1}$ (7.45) was obtain from control and the minimum number was at 9 dSm^{-1} level of soil salinity. The effective tillers were decreased drastically at 9 dSm^{-1} level of soil salinity. Akbar *et al.* (1972) have also reported similar results. Among genotypes, MR-219 produced the maximum number of effective tillers hill $^{-1}$ (Table 2b). Y-1281 and Q-31 were similar in producing effective tiller. Thus, MR-219 showed more tolerance than other genotypes. The interaction between salinity stresses and genotypes on the effective tiller showed that MR-219 was the best and produced the highest number of effective tiller per hill compared to other two genotypes under increasing salinity stresses (Table 2c).

Table 2a. Effect of different salinity levels on yield and yield contributing parameters of rice genotypes

Salinity levels (dS m^{-1})	Effective tillers hill^{-1} (no.)	Panicle Length (cm.)	Filled grain panicle^{-1} (no.)	1000-grain wt.(g)	Grain yield hill^{-1} (g)
Control (0)	7.45	19.26	58.00	20.54	9.18
3	5.78	17.56	48.00	18.26	5.14
6	4.44	15.83	39.33	16.17	3.09
9	1.00	5.11	14.00	4.67	0.59
$LSD_{0.05}$	0.80	2.09	2.46	1.57	2.78

Table 2b. Varietal performances of yield and yield contributing parameters under different salinity levels of rice genotypes

Variety/genotypes	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield hill^{-1} (g)
Q-31	2.06	8.34	20.17	8.85	1.67
Y-1281	2.50	8.63	24.33	9.42	2.42
MR-219	4.78	11.9	35.17	11.55	4.92
$LSD_{0.05}$	0.56	1.48	1.73	1.11	1.97

Length of panicle (cm)

The increasing salinity stress significantly decreased the panicle length (Table 2a). The highest panicle length (19.26) cm was obtained in control which gradually decreased with increasing salinity and attained to the lowest (5.11) cm at 9 dSm^{-1}. Similar results were reported by (Marassi *et al*., 1989) in rice. The panicle length was different among genotypes under salinity stress. The highest panicle length was recorded genotypes MR-219 over Q-31 and Y-1281 (Table 2b). This variation might be due to genetic character of genotypes.

Number of filled grain panicle^{-1}

Filled grain per panicle was decreased significantly due to increased of salinity. The highest filled grain per panicle (58.00) was recorded at control condition and the lowest filled grain per panicle (14.00) was recorded at 9 dSm^{-1} level of soil salinity. Zaibunnisa *et al*. (2002) and Zaman *et al*. (1997) reported that filled grain per panicle decreased by salinity, which was partially supported by this result. The interaction effects between salinity levels and genotypes, presented in (Table 2c), showed that MR-219 was more tolerant followed by Q-31and Y-1281 genotypes in producing number of filled grain per panicle.

Table 2c. Interaction between genotypes and salinity levels on yield and yield contributing characters of rice genotypes

Interaction (genotypes × salinity levels)	Effective tillers hill^{1}(no.)	Length of panicle (cm.)	Filled grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield hill^{-1} (g)
V_1S_1	6.00 de	18.20 ab	49.00 cd	20.43 a	6.00 bc
V_1S_2	4.00 fg	16.87 b	46.00 de	17.00 bc	3.06 bcd
V_1S_3	2.33 h	15.00 b	27.00 f	15.67 cd	0.98 cd
V_1S_4	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_1S_5	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_1S_6	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_2S_1	6.67 cd	17.63 b	56.00 b	20.06 a	7.49 b
V_2S_2	5.00 ef	18.24 b	48.00 cd	19.39 ab	4.65 bcd
V_2S_3	3.33 gh	15.92 b	42.00 e	17.08 bc	2.38 bcd
V_2S_4	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_2S_5	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_2S_6	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_3S_1	9.67 a	21.95 a	69.00 a	21.14 a	14.10 a
V_3S_2	8.33 ab	17.57 b	51.00 c	18.40 abc	7.71 b
V_3S_3	7.67 bc	16.56 b	49.00 cd	15.75 cd	5.92 bc
V_3S_4	3.00 gh	15.33 b	42.00 e	14.01 d	1.77 cd
V_3S_5	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d
V_3S_6	0.00 i	0.00 c	0.00 g	0.00 e	0.00 d

V_1= Q-31, V_2= Y-1281, V_3= MR-219, S_1 = 0 dSm^{-1}, S_2 = 3 dSm^{-1}, S_3 = 6 dSm^{-1}, S_4 = 9 dSm^{-1}, S_5 = 12 dSm^{-1} & S_6 = 15 dSm^{-1}
In a column figures having similar letter (s) do not differ significantly as per DMRT

1000-grain weight (g)

With increasing salinity levels the 1000-grain weight was found to be decreased, the highest 1000-grain weight (20.54g) was found in control and the lowest (4.67g) at 9 dSm^{-1} level of soil salinity (Table 2a). Zaman *et al*.(1997) and Aoki and Ishikawa (1971) reported that 1000-grain weight decreased with increasing the levels of salinity. The highest grain weight was noticed in MR-219 followed by Q-31and Y-1281. The interaction effects between salinity levels and varieties showed that MR-219 was dominant in producing grain weight under salinity stresses, followed by Q-31and Y-1281 which was highly susceptible (Table 2c).

Grain yield hill $^{-1}$ (g)

The effect of salinity on grain yield hill^{-1} was significant, the highest grain yield hill^{-1} (9.18 g) was found in control and the lowest grain yield hill^{-1} (0.59 g) was found in 9 dSm^{-1} level of soil salinity (Table 2a). WeonYoung *et al*. (2003) reported that grain yield decreased with raising salinity. Depending on genotypes, the best yield performance was found in MR-219 (Table 2b). The highest grain yield hill^{-1} (4.92 g) was recorded in MR-219 and the lowest

(1.67 g) was recorded in Q-31. The interaction effect of salinity levels and genotypes in relation to grain yield $hill^{-1}$ was found to be significant (Table 2c). The highest grain yield $hill^{-1}$ (14.10 g) was found in MR-219 at control condition and the lowest (0.98 g) in Q-31 at 6 dSm^{-1} level of soil salinity. The growth, yield and yield contributing characters such as plant height, leaf area, total number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, panicle length, number of filled grain $panicle^{-1}$, 1000-grain weight $hill^{-1}$, grain yield $hill^{-1}$ were gradually decreased with increasing salinity levels.

Results of the experiments clearly indicated that MR-219 showed best performance in respect to yield and yield contributing characters up to 6 dSm^{-1} and Y-1281 was intermediate. The genotypes Q-31 and Y-1281 showed its susceptibility to salinity stress. Q-31 showed the best performance over the varieties only plant height, but yield is very low. Thus MR-219 was found best salt tolerant genotype than others.

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