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Effect of different levels of salinity on morphological characteristics of some rice genotypes

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Abstract
The effect of salinity on morphological characters of some rice genotypes, i.e., Pant Basmati1, Pant Sugandh21, Pant Dhan 24, and CSR30 were analysed by a two factor Complete Randomized Design with three replications. The different morphological characters, such as plant height, total number of tillers, leaf number, and total dry matter (TDM), were analysed under control and 50,100 and 150 mM NaCl conditions. Results showed that plant height, total tillers, and total dry matter were significantly decreases with increasing salinity. The highest reduction in plant height, tiller number, leaf number, and total dry matter was found in Pant Basmati1, followed by Pant Sugandh21, Pant Dhan 24. Whereas the reduction rate was less in CSR 30 as compared to other genotypes. Overall results indicates that the Pant Basmati1 is more sensitive to salinity as compare to the other whereas CSR30 showed better performance.

Keywords: salinity, growth, yield, cultivars, rice

Introduction

Salinity is a worldwide problem in semiarid and arid regions that reduces plant growth and productivity. Worldwide 20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high salinity. It has been estimated that various causes including low precipitation, high humidity, poor quality water used for irrigation, and weathering of rocks, increase salinized areas about at the rate of 10%. It is also predicted that 50% of arable land will be salinized till 2050 [6]. Rice is major crop with great economic importance that globally covers area of 149.15 million ha land producing about 550.19 million tonnes, in India it is cultivated across an area of 44.6 million hectare. However, issues like scarcity of freshwater, environmental pollutions, and increased salinity in soil and water are major threats to reduced it yield. At present, salinity is the second major abiotic stress after drought that is the causes predominant hindrance to rice production [5]. Salinity causes osmotic and ionic toxicity effects on rice plant, ultimately leads to oxidative stress and nutrient deficiency in plant. Continuous salinity reduces turgor pressure of plant cell that leads to reduce cell growth. Osmotic stress is quickly recognised by plant after exposure to stress and leads to water and solute deficits [4]. Osmotic stress leads to stomata close that reduces plant ability to assimilate carbon dioxide and inhibits photosynthesis [16]. Accumulation of Salt like sodium (Na^+) and chlorine (Cl^-) resulting in premature senescence of leaves and later even plant death [10]. Na^+ toxicity has a negative effect on enzyme activities, effecting metabolism, including the Calvin cycle and other pathways [3]. Excess Na^+ accumulation in the cytoplasm imbalance uptake of potassium (K^+) and other macro and micronutrients, including nitrogen (N), phosphorus (P), potassium (K^+), calcium (Ca^{2+}) and zinc (Zn^{2+}). In addition to osmotic and ionic stresses, salt accumulation leads to produce reactive oxygen species (ROS), which can severely damage cellular structures and macromolecules such as DNA, lipids, and enzymes [14]. Salinity has harmful effect on rice over entire growth phases as reduced germination and seedling growth, difficulties in crop area establishment, leaf area development, decrease in dry matter production, delay in seed set and also even sterility can occur [17]. Negative effect of salinity on seedling growth, seedling establishment and grain yield components such as spikelet number, tiller number lead to a reduction in grain yield [15]. Development of management strategies is critical to reducing salinity impacts and increasing agricultural productivity. It is possible to achieve this by screening rice cultivars for salt tolerance and identifying traits associated with salt tolerance that can be incorporated into breeding programmes to develop tolerant cultivars. The current study was carried out to evaluate the effects of salinity on the growth characteristics of a four rice genotypes.

Material and Methods

The pot experiment was carried out at G.B Pant University of Agriculture and Technology Pantnagar, Uttarakhand, India during successive year 2018 and 2019.Four rice genotypes (Pant Basmati 1, Pant Sugandh21, Pant Dhan 24, and CSR30) were tested for tolerance to 50,100 and 150 mM NaCl and control tap water. Pant Basmati1, Pant Sugandh 21 and Pant Dhan 24 were procured from G.B.P.U.A.T. Pantnagar University, while CSR30 was from the Centre for Soil and Salinity Research Institute, Karnal, Haryana.

Pot Preparation and Salt Treatment

15 day old Seedlings were transplanted into pots as one transplant per pot filled with washed sandy and loamy soil (5 kg dried /pot) and the experiment was arranged in a complete randomised design with four genotypes, 4 treatments (0, 50,100 and 150mM NaCl) within 3 replicates. To avoid osmotic shock, the solution was applied three times in a week. Tap water was used as a control treatment. Nitrogen fertilizer in the form of urea @ 100 kg/ha was top dressed in three splits *viz*. 50% after 15 days of transplanting, 25% at active tillering and 25% at panicle initiation (PI) stage. Sampling was done after 14 days of treatment. After the first sampling, all pots were irrigated with tap water.

Observations

Plant height (cm) Plant height from 3 plants was measured manually in a control and treated plants using a metre scale and an average plant weight was calculated.

Number of leaves: The number of leaves from each treatment was recorded manually and an average panicle length value was calculated.

Tiller number: Tiller numbers were calculated by averaging the number of shoots from each of the three replicates of each treatment, and effective tillers were counted.

The total dry matter: The total dry matter of the rice plant includes all its solid constituents except water. At maturity, the TDM in grams per plant was recorded.

Data analysis: Data were statistically analysed following RCBD design by using SPSS software (SPSS for WINDOW, Standard version 26.0). Basic statistical parameters such as mean, standard error was computed with two-way analysis of variance (ANOVA).

Result and Discussion

Different salinity levels (0,50,100 and 150mM NaCl) resulted in significant decrease in plant height, tiller number, leaf number and total dry matter at flowering stages, in all the genotypes during both the years 2018 and 2019.

Different salinity levels (0,50,100 and 150mM NaCl) resulted in significant decrease in plant height in all the genotypes (Figure 1a). The result of the mean comparison of plant height showed that the maximum plant height in both the year (2018 and 2019) was recorded in Pant Sugandh 21 (104-110cm) and Pant Dhan 24 (100.33-106cm).Genotype Pant Basmati1 exhibited, higher reduction in plant height in both the year at all levels of salinity as compare to the control, but lower reduction was achieved by genotype CSR 30 in all treatments. During both the years 2018 and 2019, highest reduction (21-19.7%) at 50mM NaCl was recorded in Pant Basmati1 followed by Pant Sugandh 21 (18.53-15.75%) and minimum reduction (7.13-3%) was found in CSR30. Similarly, both the year, highest reduction (34.12-46.19%) at 100mM NaCl was recorded in Pant Basmati1 followed Pant Sugandh 21(30.3-30%) and least reduction (18.4-17.6%) in CSR 30. At higher salinity level (150mMNaCl), highest reduction (58.53.51%) in plant height was recorded for Pant Basmat1 followed by Pant Dhan 24(39.8-52%) during successive years 2018 and 2019.While, less than 35% reduction was recorded in CSR30 (33.7-32.3%) both the year. Present results indicate that plant height reduced significantly with increase in salt concentration in rice genotypes. Present results are supported by author [13], they concluded that increasing salinity level from 3 to 15dsm^{-1} reduced electrical conductivity significantly. The plant height in rice genotypes however at low salinity level rate of reduction was comparative low in salt tolerant cultivars i.e., Pokkali, PVSB9 and PVSB19 as compare to salt sensitive cultivar. IR-20 and IR-50.

Tiller number of all the genotypes strongly influenced by the salt stress (Figure 1b). The result of the mean comparison of tiller number showed that maximum tiller number (8 and 7.3) both the year was recorded in CSR30. During 2018 and 2019, highest reduction (33.3-31.2%) in tiller number at 50 mM NaCl was recorded for Pant Basmati1 and minimum for CSR30 (16.16-18.1%). At 100mM NaCl, highest reduction (47.6-57.8%) in tiller numbers found in Pant Basmati1 during both the years and least reduction (29.1-27.2%) was achieved in CSR30. At highest salinity level (150mM NaCl), Pant Basmati 1 showed highest reduction (52.3-63.1%) in tiller number both the year. While, lowest reduction (41.6-40%) was recorded in CSR30 during both the years 2018 and 2019.Similar results reported by author [1], who showed that increasing salinity from 4.5 dSm^{-1} to 12.5 dS m^{-1} significantly (P< 0.05) reduced tiller numbers in all the genotypes. On the other hand, some tolerant cultivars i.e., BR1192-2B-3 and BR11, performed better up to 8.5 dSm^{-1} but poorly at 12.5 dS m^{-1}.

Increasing salinity reduces leaf number in all the genotypes have been shown in Figure 1c Results showed that during both the year 2018 and 2019, maximum number (40.33) of leaves at control were found in Pant Basmati1 followed by CSR30(34-39.33). In both the year 2018 and 2019, highest reduction (34-29.7%) was achieved in Pant Basmati1 followed by Pant Sugandh 21 (25-23.9%) and least reduction (13.7-14%) recorded in CSR30.At 100mM NaCl, maximum reduction (48-43.79%) in leaf number recorded in Pant Basmati 1 followed by Pant Sugandh 21(38-46%) and minimum reduction (24.5-26.2%) obtained in CSR30 during 2018 and 2019.both the year 2010 and 2019, Pant Basmati1 showed highest reduction (61.9-59%) in leaf number at 150mM NaCl and minimum recorded in CSR30(39.2-42%). Present results showed that genotype Pant Basmati 1 showed highest reduction in all the salinity levels. Whereas, rate of reduction was comparatively low for CSR30 at all salinity level. Present results are in agreement with author [9], who showed that at higher salinity (above 100mM NaCl) leaf number in rice genotypes reduces significantly. Salt sensitive cultivar i.e., BR55 and BR43 showed above 50% reduction in leaf number. Inhibition of formation of leaf primordia could be due to the accumulation of sodium chloride in the cell walls and cytoplasm [7].

Figure1d shows that the TDM significantly (P< 0.05) decreases with increasing salinity levels up to150mM NaCl for all the genotypes. The highest TDM was recorded in Pant

Sugandh 21 (12.49-13.7g/plant) followed CSR30 (12.13-11.96g/plant) at the control condition. At 50mM NaCl, maximum reduction (20.4-20.6%) in TDM was recorded in Pant Basmati1 both the year and minimum recorded in CSR30 (6.5-7.1%). At 100mM NaCl, maximum reduction (36.9-34.7%) in TDM was recorded for Pant Basmati1 both the year. While, minimum was found in CSR30 (16.8-15.2%). Similarly, at higher salinity (150mM NaCl), Pant Basmati 1 showed maximum TDM reduction (59.1-58.9%) in both the year. While, CSR 30 showed less than 35% reduction in TDM both the year. Based on total dry matter, present results revealed that Pant Basmati1 is more susceptible genotypes as compare to the other. While CSR30 showed tolerance to some extent. Similar pattern of results was found in previous study that showed increased salinity gradually decreased total dry matter in rice genotypes, whereas salt tolerant cultivars BR11 showed better performance till 15.62 dsm^{-1} as compared to other [12]. Decrease in growth parameters in salinized plants may be due to a combination of factors. The salinity inhibits photosynthesis by limiting the carbohydrate supply required for growth and development. A second possibility is that salinity inhibited growth by decreasing turgor in continuing to expand tissues due to reduced water potential in the root medium. A third possibility is that the root response to salinity was to suppress growth via long-distance signals. The fourth possibility is that the concentration of specific ions in the growth medium can disrupt mineral supply. It may be excess or a deficiency, which could have directly affected growth [8].

Correlation analysis

Correlation coefficient between four characters i.e., Plant height (PH), Tiller number (TN), Leaf number (LN) and Total dry matter (TDM) among all the genotypes of rice under three different salt stress condition (50mM,100Mm, 150mM of NaCl) for two successive years 2018 and 2019 are presented in Table 1

Results showed that both the year, all the characters showed positive correlation with each other. However, under 50mM NaCl concentration, plant height showed significant positive correlation with TDM (0.982*). Whereas under 100mM NaCl concentration, plant height was positively correlated with all other four characters but significate positive correlation was found with TN (0.973*) and TDM (0.991*) for the year 2018.During 2019, significant positive correlation (0.990*) was recorded between TDM and TN. Under 150mM NaCl, LN showed significant positive correlation (0.979*) with TDM and TN (0.962*) during 2018.Whereas, plant hight showed significant positive correlation with tiller number (0.972*) and leaf number (0.977*) during year 2019, under stress condition of 150mM of NaCl concentration. Differences in the significance of correlation between parameters in year 2018 and 2019 might be due to environmental variability. These results were in conformity with author [11], they showed that plant height was positively correlation (0.31) with tiller number and total dry matter (0.12). Similarly, author [2] concluded that in rice plant height positively corelated (0.39) with tiller number.

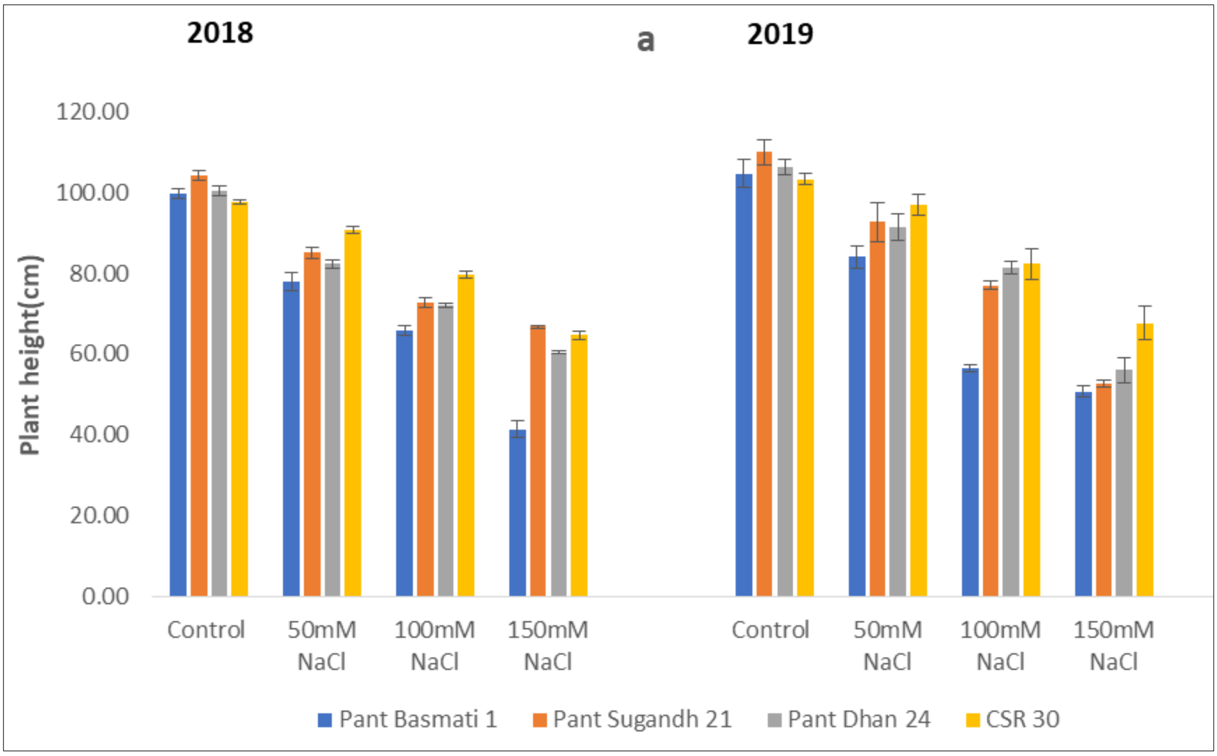

Fig 1: Effect of different levels (50,100 and 150mM NaCl) of salinity on (a) Plant height (cm),(b)Tiller number,(c)Number of leaves and (d) total dry matter of four rice genotypes at flowering stage during successive year 2018 and 2019.

Table 1: Correlation coefficients between Growth parameters (Plant height, Tiller number, Leaf number and Total dry matter) of rice genotypes under 50,100 and 150mM NaCl rice seedlings

		2018				2019			
		PH	TN	LN	TDM	PH	TN	LN	TDM
50mM NaCl	PH	1	0.930	0.457	0.982*	1	0.807	0.338	0.884
	TN		1	0.483	0.888		1	0.262	0.924
	LN			1	0.287			1	.009
	TDM				1				1
100mM NaCl	PH	1	0.973*	0.694	0.991**	1	0.802	0.262	0.710
	TN		1	0.762	0.943		1	0.461	0.990*
	LN			1	0.714			1	0.473
	TDM				1				1
150mM NaCl	PH	1	0.639	0.645	0.771	1	0.972*	0.977*	0.850
	TN		1	0.962*	0.922		1	0.901	0.940
	LN			1	0.979*			1	0.728
	TDM				1				1

Plant height (PH), leaf number (LN), tiller number (TN), Total dry matter (TDM).
** Significant at 1% level of probability, * Significant at 5% level of probability.

Conclusion

From the results of the present investigation, it can be concluded that tiller number, plant height, leaf number, and total dry matter are significantly affected by NaCl stress, with lesser effects on CSR30, while Pant Basmati1 was affected most. Comparably less reduction in Plant height, tiller number, leaf number and TDM under increasing salt stress in CSR30 as compared with other cultivars, suggested that this genotypes CSR30 shown to be tolerant to a certain extend.

References

1. Alam MZ, Stuchbury T, Naylor RE, Rashid MA. Effect of salinity on growth of some modern rice cultivars. J Agron. 2004;3(1):1-10.
2. Bhutta MA, Munir SA, Qureshi MK, Shahzad AN, Aslam KA, Manzoor H *et al*. Correlation and path analysis of morphological parameters contributing to yield in rice (*Oryza sativa*) under drought stress. Pak J Bot. 2019;51(1):73-80.
3. Cheeseman JM. The integration of activity in saline environments: problems and perspectives. Funct. Plant Biol. 2013;40(9):759-774.
4. Fricke W, Akhiyarova G, Veselov D, Kudoyarova G. Rapid and tissue-specific changes in ABA and in growth rate in response to salinity in barley leaves. J Exp. Bot. 2004;55(399):1115-1123.
5. Ghosh B, Md NA, Gantait S. Response of rice under salinity stress: a review update. Rice Res. Open Access. 2016;4(2):1-8. https://doi.org/10.4172/2375-4338.1000167
6. Jamil M, Bashir S, Anwar S, Bibi S, Bangash A, Ullah F, Rha ES, *et al*. Effect of salinity on physiological and biochemical characteristics of different varieties of rice. Pak. J Bot. 2012;44(1):7-13.
7. Khanam T, Akhtar N, Halim MA, Hossain F. Effect of irrigation salinity on the growth and yield of two Aus rice cultivars of Bangladesh. Jahangirnagar Univ. J Biol. Sci. 2018;7(2):1-12.
8. Lazof D, Bernstein N. The NaCl induced inhibition of shoot growth: the case for disturbed nutrition with special consideration of calcium nutrition. Adv Bot Res. 1998;29:113-189. https://doi.org/10.1016/S0065-2296(08)60311-0
9. Mazher AA, El-Quesni EF, Farahat MM. Responses of ornamental and woody trees to salinity. World J Agric. Sci. 2007;3(3):386-395.
10. Munns R, Tester M. Mechanisms of salinity tolerance. Annu. Rev. Plant Biol. 2008;59:651-681. https://doi.org/10.1146/annurev.arplant.59.032607.092911
11. Ndour D, Diouf D, Bimpong IK, Sow A, Kanfany G, Manneh B, *et al*. Agro-morphological evaluation of rice (*Oryza sativa* L) for seasonal adaptation in the Sahelian Environment. Agron. 2016;16(8):1-19.
12. Purnendu G. Effect of salinity on some yield attributes of rice. Pak J Biol Sci. 2004;7(5):760-762. https://doi.org 10.3923/pjbs.2004.760.762
13. Razzaque MA, Talukder NM, Islam MS, Bhadra AK, Dutta RK. The effect of salinity on morphological characteristics of seven rice (*Oryza sativa*) genotypes differing in salt tolerance PJBS. 2009;12(5):406-412.
14. Shabala S, Pottosin I. Regulation of potassium transport in plants under hostile conditions: implications for abiotic and biotic stress tolerance. Physiologia plantarum. 2014;151(3):257-279.
15. Shannon MC, Rhoades JD, Draper JH, Scardaci SC, Spyres MD. Assessment of salt tolerance in rice cultivars in response to salinity problems in California. Crop Sci. 1998; 38(2):394-398.
16. Wegner LH, Stefano G, Shabala L, Rossi M, Mancuso S, Shabala S *et al*. Sequential depolarization of root cortical and stelar cells induced by an acute salt shock–implications for Na^+ and K^+ transport into xylem vessels. Plant Cell Environ. 2011;34(5):859-869.
17. Zhao F, Zhang H. Salt and paraquat stress tolerance results from co-expression of the Suaeda salsa glutathione S-transferase and catalase in transgenic rice. PCTOC. 2006;86(3):349-358.