Alleviation of Nacl Induced Salinity in Rice (*Oryza Sativa* L.) Seedlings by Seed Osmopriming

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Abstract

Soil salinity is becoming a serious abiotic factor which limits the productivity of many crops worldwide. Seedling tolerance to salinity is critical for growth and development of rice. Therefore, it is essential to enhance the salinity tolerance by genetic improvements and agronomic methods. Seed priming is considered an easy, low cost, low risk and effective technique which enhances plant tolerance to the stressful environments. Therefore, a pot experiment was conducted to investigate the effect of different osmopriming treatments on salinity tolerance of rice seedlings. Rice variety At 362 was used for the experiment. Coconut water and fermented rice water was used as organic osmoprime solutions, whiles Ascorbic acid, KCl, KNO_3, $ZnSO_4$ and $CaCl_2$ 1 and 2 % solutions were used as inorganic osmoprime solutions. Water was used as the control. Two salinity levels *ie.* 50 and 100mM NaCl were also used. Completely Randomized Design (CRD) was used as experiment design with three replicates. Two weeks after salinity induction seedling height, root volume and shoot dry weight were recorded. Most of the organic and inorganic osmoprime agents increased measured variables compare to the seedlings produced from hydro primed seeds. Out of them 2% $CaCl_2$ showed greatest performances under stress conditions Therefore seed osmopriming may enable establishment of more salinity tolerant rice seedlings; however seedling survival and yield performances under field level should be investigated.

Keywords: Rice (*Oryza sativa* L.), Salinity tolerance, Seed pretreatment
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Introduction

Rice (*Oryzasativa L.*) as staple food of Sri Lankans, has a momentous role in food security in Sri Lanka and plays a major role in country's economy. Approximately 30% population engages in rice cultivation. Paddy production in the world is affected by various biotic and abiotic factors. Among the abiotic stresses, soil salinity has become a severe threat to food security in the developing world. In future it is expected that more agricultural lands will be salinity affected due to climate change. Salinity inhibits the growth especially in initial stage and eventually reduces the economic yield and quality of product (Li and Xu, 2007). It has been estimated that 20% of rice cultivated area of the world and half of the world's irrigated lands are affected by the salinity (Jamil *et al.*, 2012).

Seed priming is a simple and low cost hydration technique use for better crop stand and higher yields in a range of crops including rice (Farooq *et al.* 2006). It is also considered as a beneficial technique for the improved seed germination and growth under stress condition. According to Faros *et al.* (2006), rice seeds primed with KCl and $CaCl_2$ reported early emergence and seedling growth, better crop stand, increased kernel yield etc. Therefore, this experiment was done to investigate effect of seed osmopriming by various organic and inorganic solvents on the growth of rice seedlings under NaCl induced salinity.

Materials and Methods

A pot experiment was conducted during October 2014 at the Department of Crop Science, Faculty of Agriculture under protected house conditions. The experiment was laid out in CRD with three replicates. Rice variety At 362 (Samba Varity) was used. Before sowing seeds were soaked overnight separately in water (control) and different chemicals and organic solutions (coconut water, fermented milk water (lactic acid), fermented rice water Ascorbic acid 1&2%, KCl 1&2%, KNO_3 1&2%, $ZnSO_4$ 1&2%, $CaCl_2$ 1&2%). The ratio of seed weight to solution volume was 1:5 (g ml^{-1}) (Faros *et al.*, 2006). Then seeds were thoroughly washed with water and soaked another 2 hours in water before germination. After 2 days 10 germinated seeds were planted per small pot filled with paddy field soil. Two weeks after planting salinity was induced by using 50mM and 100mM NaCl solutions. Data was collected two weeks after induction of salinity. The seedling height was recorded from base of the plant to tip of the main stem. Oven dried plants under 65°C for 72 hours were used for shoot dry weight measurements. Gravimetric method was used to measure root volume. Data were statistically analyzed using analysis of variance (ANOVA) and mean separation was done using Dunnett's test.

Results and Discussion

It is well-known fact that various seed pretreatments increase the capacity of plant to adapt to abiotic stress conditions. In this experiment some osmopriming treatments showed significant effect on measured variables (Table 1). In unstressed condition significantly higher plant heights were observed in T4, T9, T10 and T13. However, except lactic acid (T3) treated all other plants showed comparatively higher plant height than control plants under unstressed conditions. Out of all treatments 2% KNO_3 showed the highest plant height under non stress condition. When increasing NaCl induced salinity stress, plant height was decreased. In both salinity levels $CaCl_2$ treated plants showed significantly higher plant heights. Except that $ZnSO_4$ and 2% KNO_3 treated plants showed significantly higher plant heights under 100mM NaCl. However, it is interesting to note significantly higher shoot weights was be recorded only in 2% $CaCl_2$ treated seedlings under both stressed and none stressed conditions.

Root volume was slightly increased with increased salinity level but further increase of salinity stress, root volume reduced (Table 1). Under two stress levels highest root volume was observed in 2% $CaCl_2$ and values were significantly differ with control treatment. T12 treatment *i.e.* 1% $CaCl_2$ also showed significantly higher root volumes under stressed conditions. Out of these results, 2% $CaCl_2$ gave highest performances under NaCl induced salinity. Controversial results were found by Demir and Arif (2003) that the root growth was more badly influenced by salinity than shoot growth. This could be the varietal difference.

Salinity stress mainly effects on early growth of plant seedlings. Sometimes salinity reduces the seed germination also. According to Demir and Arif (2003) the excessive ions might be toxic for mobilization of reserves; radicle emergence and early growth of seedlings. Different studies have been done to identify the salinity effects on growth performances of field crops. As a result of these studies, it revealed that considerable changes occur in plant physiology have impact on plant growth. In this experiment also salinity stress resulted in growth retardation in plant

Table 1: Growth characteristics of rice seedlings produced by treated seeds under NaCl induced salinity

	Plant height (cm)			Root volume (ml)			Dry weight (g)		
Treatments	0mM	50mM	100mM	0mM	50mM	100mM	0mM	50mM	100mM
Water (T1)	39.67	25.83	16.07	4.70	6.27	5.67	0.38	0.13	0.03
Coconut water (T2)	41.00	27.63	17.33	4.90	6.97	5.90	0.31	0.12	0.03
Lactic acid (T3)	39.00	25.60	15.43	4.02	6.47	4.97	0.33	0.13	0.03
Fermented rice water (T4)	46.67*	27.90	18.33	9.64	7.27	6.91	0.39	0.14	0.03
Ascorbic acid 2% (T5)	44.33	25.97	15.93	4.12	7.23	5.13	0.30	0.16	0.06
Ascorbic acid 1% (T6)	40.33	25.10	14.03	5.78	6.93	5.53	0.34	0.14	0.05
$ZnSO_4$ 2% (T7)	40.67	33.73	23.33*	3.81	8.67	4.17	0.39	0.17	0.06
$ZnSO_4$ 1% (T8)	41.00	33.20	22.93*	7.01	8.47	6.83	0.38	0.15	0.07
KNO_3 2% (T9)	50.67*	32.63	22.63*	5.23	7.43	6.93	0.21	0.16	0.06
KNO_3 1% (T10)	45.33*	32.13	21.87	5.10	7.27	6.65	0.24	0.15	0.06
$CaCl_2$ 2% (T11)	40.00	38.83*	27.67*	8.12*	12.93*	8.47*	0.42*	0.27*	0.10*
$CaCl_2$ 1% (T12)	42.67	36.50*	27.20*	7.82*	11.47*	8.27*	0.33	0.18	0.10*
KCl 2% (T13)	44.67*	33.27	21.83	5.85	7.37	7.83*	0.31	0.13	0.05
KCl 1% (T14)	41.33	32.07	21.53	4.71	7.57	5.9	0.35	0.15	0.04

*Symbol within a column represent significant difference between treatments and water controls with $p<0.05$

Due to reduction of water up take or ionic imbalance owing to toxic effects of sodium (Na+) and chloride (Cl-) ions. It has been reported that leaf area reduced consistently and significantly as salinity increase (Farooq *et al*, 2006) Salinity stress also affect to the chlorophyll content in plant. In some plants chlorophyll content increased due to the deposition of NaCl in the chloroplast (ex: pearl miller, mustard, sugar beet and cabbage), but it has been documented that the chlorophyll content decreased in plants such as tomato, radish, rice and pea (Jamil *et al.*, 2012). Furthermore, rice is sensitive especially at young seedling stage, where varying degree of mortality occurs at 50 mM NaCl and about 50% of 14 days old seedlings may die in most salt sensitive varieties within ten days of salinity stress (Jamil *et al.*, 2012). Therefore, salinity strongly affects seed germination and early seedling growth, photosynthesis and protein synthesis.

Many researchers found that seed priming can be used as a method to reduce the negative impact from salinity for plants. Jamil *et al.*, 2012 reported that seed priming with $CaCl_2$, KCl and KNO_3 reduced the Na+ uptake of plants and/or increased the uptake of K^+/Ca^{2+} compared to hydropriming under salinity. According to them these chemicals alleviate the NaCl stress on early seedling growth and improved salt tolerance is associated with increased absorption of essential nutrients and restricted absorption of toxic elements. Moreover, Ca^{2+} can increase membranes antioxidant proteins like Cu/Zn SOD and other stress induced dehydrins proteins. Kathiresan *et al.* (1984) also observed substantial effect on plant growth of sunflower primed after $CaCl_2$.

Therefore, it can be confirmed that seed osmopriming is important in stress tolerance and 2% $CaCl_2$ can be used to increase seedling tolerance of At362 rice variety to NaCl induced salinity.

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