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The effect of salinity on seed quality of wheat

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Abstract

Effect of salinity on sprouting water uptake, ion uptake and metabolic efficiency of wheat seeds in the variety kanchan were studied in Jaydebpur. The treatments were 0, 4, 8, 12 and $16dS^{-m}$ salinity level. The experiment was set in CRD with four replications. There were 50 seeds per petridish. Seeds were moistened with saline solution. Germination was recorded up to 72 hours with an interval of 12 hours. Water absorption rate was recorded up to 42 hours with an interval of 6 hours. Accumulation of Na^+ and Cl^- ions were measured at 36 hours. Germination percentage decreased in high salinity level. Water uptake also decreased with an increase of salinity level but it was not so much drastic upto $8dS^{-m}$. Accumulation of Na^+ and Cl^- increased when the seeds were treated with $4dS^{-m}$ to $16dS^{-m}$ saline solution. The result indicated that salinity induced delay and decrease in sprouting percentage through lower water uptake and higher accumulation of Na^+ and Cl^- .

Keywords: Salinity, Wheat, Water uptake, Seed metabolic efficiency, Ion uptake

Introduction

The economy of Bangladesh depends on Agriculture crops which contributes to the GDP. More than 30% of cultivable area of the country is located in the coastal belts. Out of 2.85 million hectares of the coastal and off-shore areas about 0.83 million hectares are affected by salinity at different levels (Karim and Ahmed 1990). Agricultural land used in those areas is very poor. Cultivation of Transplanting Aman rice is the major crop. Cultivation of winter crop is very limited due to a number of reasons; non-availability of suitable salt tolerant crop varieties is the major one (Begum *et al.,* 2006).

According to James *et al.,* (1983), salinity affect plant growth by reducing water uptake due to osmotic effect as influenced by the concentration of certain ions that have a characteristic toxic effect on plant metabolism. Crop plants are more severally affected by salinity at early stage. Barley, wheat and corn are more sensitive to salinity during seed germination (Anonymous, 1990). The objectives was to identify the effect of salinity on germination of wheat through water uptake, mobilization of seed reserves and uptake of Na^+ and Cl^-.

Materials and Methods

An experiment was carried out in the physiology laboratory, Agronomy division of Bangladesh Agricultural Research Institute, Joydebpur in the year 2008, to find out the effect of salinity on germination, water uptake, ion uptake and metabolic efficiency of wheat seed (variety Kanchan). The seeds were sterilized by 0.1% $HgCl_2$ for one minute and then washed thoroughly with tap water and finally with distilled water. Seeds were thoroughly mixed and moisture percentage was determined. The experiment was set in completely randomized design (CRD) with four replications. There were five salinity levels viz., 0, 4, 8, 12 and $16dS^{-m}$. The filter paper of each Petri dish was moistened with 7ml saline solution. Fifty surface sterilized seeds were placed on Petri dish containing filter paper. Number of seed sprouted was recorded at 12, 24, 36 and 72 hours. Water uptake rate was measured from 1 to 42 hours with an interval of 6 hours. At 96 hours of setting, the sprouted seeds were separated into root, shoot and the residual and their dry weight were recorded. Seed metabolic efficiency was measured following the procedure as described by Rao and Sinha (1993). The accumulation of Na+ and Cl^- were measured from the seeds colleted after 36 hours of soaking. Sodium and chloride ions were collected by boiling the seeds with distilled water and the amount of Na^+ was measured by using flame analyser (Gallenkamp model FGA-330c). Chloride ions were measured by titration with $AgNO_3$ using potassium chromate as an indicator. The statistical variation was studied by standard deviation.

Results and Discussion

Sprouting percentage of the seeds decreased with an increase of salinity level (Table 1). Sprouting of seeds was started after 24 hours of setting in all the treatments except at 16dS^{-m}, where it started at 36 hours. In the control, 75% of the seeds were sprouted at 24 hours and germination was completed by 36 hours. In case of 8dS^{-m} and 12dS^{-m} only 20% and 15% seeds were germinated at 24 hours and finally 98% and 76% seeds were germinated at 72 hours. Delayed in germinated under higher salinity level have been reported by Begum *et al.,* (1996, 2000) in maize and Sultana *et al*., (1999) in Barley. Figure 1 represents the relative germination percentage as compared to control. A 24% and 35% decrease in germination percentage observed as compare to control at 12 and 16 dS^{-m}.

Table 1. Effect of different levels of salinity on the percentage of seed sprouting in wheat (Kanchan) germination in wheat

Salinity levels (dS^{-m})	% seed sprouted			
	24 hrs	36 hrs	72 hrs	96 hrs
0	75 ± 3	100	100	100
4	30 ± 1.5	100	100	100
8	20 ± 3	90 ± 2	98 ± 2	98 ± 2
12	15± 1.5	70 ± 2	76 ± 2	76 ± 2
16	0	20 ± 2	65 ± 2	65 ± 2

The results of water uptake by the seeds from 1 to 42 hours have been shown in the Table 2. It was observed that water absorption by the seeds increased with the advancement of time. The rate of absorption at different salinity levels was identical during 1, 6 and 12 hours. But with the advancement of time, the rate differed significantly from treatment to treatment. It was further observed that absorption was linearly decreased with the increased salinity level (Fig. 2). The results indicated that salinity at higher level hinders in water absorption thereby influencing on germination percentage and also time required for germination. Kirkham *et al.,* (1969) reported higher resistance to water flow under high salt condition and it was suggested that high concentration of salt reduced the permeability of root membrane. Water content of salt stressed maize plants was significantly lower than in the untreated control as reported by Radi *et al*., (1989).

Table 2. Effect of different levels of salinity on water uptake by wheat seeds

Salinity levels (ds^{-m})	Water uptake (g/g)								
	1hrs	3 hrs	6 hrs	12 hrs	18hrs	24 hrs	30hrs	36hrs	42 hrs
0	0.192±.02	0.197±.05	0.260±.01	0.380±.01	0.540±.01	0.540±.01	0.702±.01	0.762±.02	0.979±.04
4	0138 ±.01	0.188±.01	0258±.02	0.367±.02	0.510± .05	0.510±.005	0.570±.09	0.597±.05	0.700±.10
8	0.08±.01	0.191±.01	0261±.003	0.360±.02	0.512±.005	0.512±.02	0.556±.03	0.566±.01	0.583±.03
12	0.085±.01	0.181±.01	0.239±.01	0.321±.03	0.471±.02	0.471±.01	0.529±.01	0.533±.01	0.533±.08
16	0.120±.01	0.193±01	0.128±.003	0.319±.02	0.420±.03	0.375±.01	0.439±.01	0.471±.05	0.471±.03

Dry weight of radical decreased with an increase of salinity level and 54% to 91% decrease was observed under salinity stress (8dS^{-m} - 16dS^{-m}). Similarly 40% to 85% decrease in plumule dry weight of wheat recorded under salinity stress ranging from 4dS^{-m} to 16dS^{-m} as compared to the control (Table 3). Decreased in dry weight of plumule and radical under salinity were also observed in maize (Begum *et al.,*1996, 2000).

At lower salinity level, the percentage of seed reserves utilized by the root and shoots were almost similar to the control. But the utilization of seed reserves decreased by 4 to 26% with the increase of salinity level from 4 to 16dS^{-m} EC. In case of sorghum, a slower mobilization of seed reserves like protein and reduced level of amino acid were observed with the increase in salinity level (Khan and Naqvi, 1984).

The amount of unutilized food reserves increased progressively with the increase in salinity. A 77% food reserves remain unutilized under the control condition during germination, while at $16dS^{-m}$ a 83% food reserves were remain unutilized as because as salinity inhibits the hydrolysis of seed reserves (Ramana and Ram, 1978). Under higher salinity level, higher percentage of seed reserves was used for respiration. Under controlled condition it was 11%; whereas the percentage of seed reserves used for respiration was 15% at 16dS-m. Wheat plants need 3 to 4% more energy to survive under salinity stress (Ed-Barrett-Lennard *et al.,* 1990).

Table 3. Effect of different levels of salinity on seed metabolic efficiency in wheat

Salinity levels (dS^{-m})	Root dry wt.g/100 seedlings	Shoot dry wt.g/100 seedlings	Amount of utilized seed reserves (%)	Amount of unutilized seed reserves (%)	Seed reserves used for respiration (%)	Seed metabolic Efficiency
0	0.34±.02	0.25±.02	23	77.00	11	1.09
4	0.36±.02	0.25±.02	22	77.50	10	1.20
8	0.15±.02	0.10±.02	21	79.00	15	0.35
12	0.16±.02	0.10±.01	17	83.00	12	0.40
16	0.03±.01	0.04±.02	17	83.00	15	0.11

Accumulation of Na^+ increased with an increase in salinity level. A 50% to 9-fold increase of Na^+ was observed under salinity ranging from 4dS-m to 16dS-m (Table 4). Similar increase of Cl- was also observed with an increase of salinity level. It was about 10-fold to 24-fold over control under salinity condition of 4dS-m to 16dS-m (Fig. 3). Torres–Schumann *et al.,* (1989) observed an increase in Na^+ and Cl^-content by the cotyledons of tomato seed under salinity condition.

Table 4. Effect of different levels of salinity on accumulation of Na^+ and Cl^- ions

Salinity levels (dS^{-m})	Accumulation of ions (m equiv. g^{-1}. dry tissue)	
	Na^+	Cl^-
0	0.008±0.0001	0.043±0.001
4	0.012±0.0003	0.484±0.01
8	0.045±0.002	0.524±0.05
12	0.058±0.003	0.950±0.07
16	0.078±0.002	1.092±0.09

Seed sprouting is associated with the mobilization of seed reserves and also utilization of the reserved food material of the endosperm. From the result it is revealed that under salinity condition uptake of water by the seeds reduced and subsequently inhibits the hydrolysis of seed reserves and thus affects the hydrolysis of seed reserves and also seed metabolic efficiency and thus ultimately delayed and also decreases the germination. The result indicated that salinity induced delay and decrease in germination percentage through lower water uptake and higher accumulation of Na^+ and Cl^-.

Fig.1. Relative germination as percentage of control

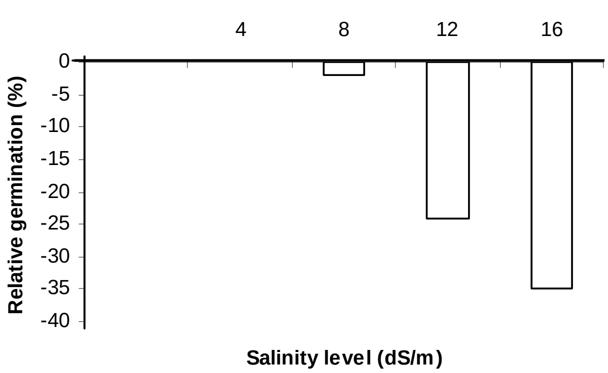
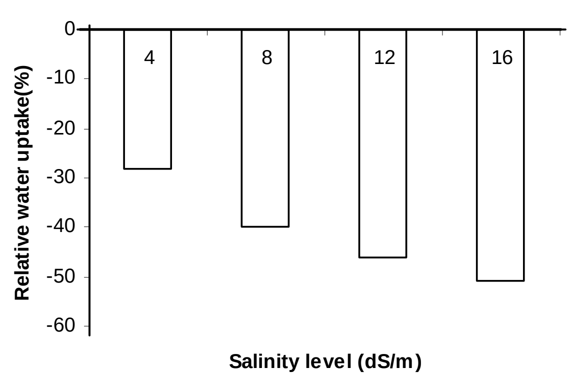
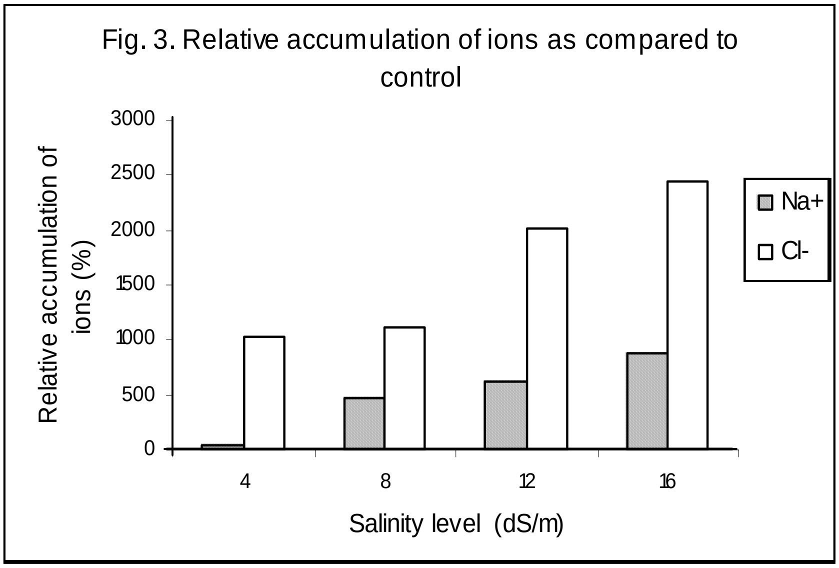


Fig.2. Relative water uptake as compared to control





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