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CHANGES IN ELECTRICAL CONDUCTANCE OF LEACHATES FROM WHEAT SEEDS PRETREATED IN WATER AND SODIUM CHLORIDE

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Abstract

Wheat seeds of two different cultivars viz., Inqalab and Pasban, pretreated in water for 2, 6, 16 and 24 hours or 5, 10, 20, 30% concentration of NaCl solution for 2 days were used for studying the changes in electrical conductance of their leachates. Seeds pretreated in water for upto 24 hours showed 97-99% germination with 35-75% reduction in germination in NaCl pretreated seeds. After one year storage, 2 and 6 hours pretreated seeds showed decreased germination and 16 and 24 hours pretreated seeds did not germinate. However, salt treatment at all its concentrations had little effect in further loss in seed germination in one year old seeds. Electrical conductance (E.C.) of leachates of the pretreated seeds during the initial six hours of start of imbibition did not prove a good method for the determination of germinability of seeds before or after one year of storage. Instead of E.C. measurements, nature of electrolytes effluxed during imbibition might be indicator of the germinability status of wheat seeds.

Introduction

Germination performance of wheat seeds kept under various kinds of stresses has been reported (Ahmed *et al.*, 1989; Petruzzelli & Taranto, 1989; Dell'Aquila & Tritto, 1990; Ahmad & Ibrar, 1996). Ahmad *et al.*, (1989) have shown an increased rate of germination by 16-42% when seeds were soaked for 12 hours as compared to control. Similarly, Aschermann-Koch *et al.*, (1992) reported that presoaking wheat seeds for 12 hours and then drying improved germination rate and better results were observed in seed lots with low vigour. Recently, Ahmad & Ibrar (1996) have shown that six hours presoaking was the best treatment for better germination. The present report describes the effect of presoaking in water and salt pretreatment on the germination and E.C. of leachates of imbibing seeds.

Materials and Methods

Wheat seeds of two different cultivars viz., Inqalab and Pasban were used. Seeds after soaking in distilled water for 2, 6, 16 and 24 hours and in 5, 10, 20 and 30% NaCl solution for 2 days were dried to their original moisture content of 8 $\pm$ 2% and stored at room temperature. Seeds were placed in 9 cm diameter Petri dishes containing two layers of filter papers soaked with distilled water and incubated at 16 $\pm$ 1°C. Protrusion of radicle was considered as marker for the germination of seeds.

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Table 1. Germination profile of control and pretreated wheat seeds.

Wheat cvs.	Control	Pretreatment in water				Pretreatment with NaCl			
		2h	6h	16h	24h	5%	10%	20%	30%
Before storage					Germination %				
Inqalab	99	99	98	99	99	25	35	30	40
Pasban	98	98	97	98	99	35	30	60	65
After one year storage at 25±5°C									
Inqalab	98	70	65	0	0	25	30	50	45
Pasban	99	60	55	0	0	45	35	45	55

s.d. ± 5% (n=3).

For the measurement of E.C., sets of 15 seeds were immersed in 10 ml double distilled water (E.C. < 10μS/cm) and E.C. measured at 16 ± 1°C with a pre-calibrated conductivity meter (Milwaukee-CON1000) E.C. is expressed as μS/cm/seed.

Results

Seed germination: Seeds presoaked (treated) in water showed 97-99% germination whereas treatment with NaCl showed an inhibitory effect giving a germination 25 to 65% in both the cultivars (Table 1). After one year of storage at 25 ± 5°C, seeds treated in water for 2 h and 6 h duration exhibited 30-45% reduction in germination and seeds from 16 h and 24 h treatment did not germinate (Table 1). No significant changes in germination occurred in NaCl pretreated seeds compared with the values obtained before storage. It indicates that damage to water treated seeds has been immense which resulted in complete loss of viability in 16 and 24 h treated seeds. Salt treated seeds, on the other hand, did not show further loss in germinability.

Rate of seed germination: Rate of seed germination of water pretreatment seeds was higher or equal to that of control (Table 2). A 2 h pretreatment, showed highest rate of germination in wheat cv. `Inqalab'. Pretreatment for 16 h and 24 h also showed increasing rate of seed germination. Higher the concentration of NaCl solution used for pretreatment, higher the rate of seed germination was observed (Table 2).

When the seeds were stored for 1 year and re-germinated, lower rates of seed germination were observed in all the pretreated seeds including the untreated ones. Rate of seed germination of untreated control seeds was 25% lower than the seeds examined one year before. The seeds did not lose their viability showing 97-99% germination (Table 1) and the spread of germination increased during one year of storage. Rate of seed germination significantly declined in all the pretreated seeds about 3 times in 2 h and 6 h pretreated seeds compared with untreated ones stored for one year. In NaCl pretreatment higher the concentration of NaCl during the pretreatment there was significant reduction in the rate of seed germination. This study suggests that salt seed pretreatment not only increase the spread of germination, but depending upon the concentration of the salt solution, treatment may result in loss of vigour too.

Table 2. Rate of germination of wheat seeds.

Wheat cvs.	Control	Pretreatment in water				Pretreatment with NaCl			
		2h	6h	16h	24h	5%	10%	20%	30%
Before storage					Germination %				
Inqalab	10.0	20.0	10.0	15.2	16.0	1.8	5.6	6.0	7.0
Pasban	10.0	12.5	10.0	14.4	16.0	1.5	4.8	5.5	9.6
After one year storage at 25±5°C									
Inqalab	7.5	3.5	3.3	0	0	1.7	3.0	4.5	2.3
Pasban	7.5	3.5	3.7	0	0	2.3	3.5	2.3	2.8

Rate of seed germination of untreated control seeds is taken as arbitrary unit of 10. s.d. ± 0.95 (n=3).

Effects on electrical conductance of imbibing seeds: E.C. of leachates measured during the initial six hours of commencement of imbibition of pretreated seeds before and after one year storage showed an insignificant difference in E.C. values for their respective treatments during the period for both the cultivars. In untreated control seeds, E.C. was higher (17.59 to 20.12 μS/cm/seed) in both the cultivars compared with that of water pretreated seeds. As the time of pretreatment increased, changes in conductance in leachates were observed and values ranged from 12.4 to 7.84 μS/cm/seed for Inqalab and 8.36 to 9.25 μS/cm/seed for Pasban. E.C. measurements after storage exhibited reductions possibly due to the loss of ions or volatile electrolytes during the storage.

E.C. values in 5% and 10% NaCl pretreated seeds were higher than that of their respective controls for both the cultivars e.g., 38.81 μS/cm/seed in 10% and 25.25 μS/cm/seed in 5% treated seeds of Inqalab. After 1 year storage, the E.C. of salt treated seeds increased and values were more than double for Inqalab (115.77 μS/cm/seed in 10% and 60.68 μS/cm/seed in 5% treated ones). Similar patterns have been observed for Pasban with smaller differences (Table 3).

Discussion

The results demonstrate that both the water and salt pretreatment showed adverse effects on the viability of seeds when stored for 1 year and that E.C. measurements did not prove a reliable indicator of the vigour of seeds. Seeds soaked (treated) in water for 2 h and 6 h showed 97-99% germination since the seeds remained in dehydration tolerant phase and drying of these seeds did not destroy the protein synthetic machinery of seeds. During 16 h and 24 h pretreatment, most of the prestored synthetic machinery had been active previous to presoaking (pretreatment) which resulted in 97-99% seed germination, however, after storage, `signals and messages' for re-germination of seeds have been lost. Impairment of protein synthetic machinery, increased lipid peroxidation, membrane damage, reduced activity of mitochondria, lesions in DNA and RNA and several other factors may be possible causes of loss of vigour and viability of these seeds (Bewley & Black, 1986). Petruzzelli & Taranto (1989) have suggested that altera-

Table 3. E.C. of leachates measured during initial six hours of imbibition.

Wheat cvs.	Control	Pretreatment in water			Pretreatment with NaCl	
		2h	6h	24h	5%	10%
Before storage						
Inqalab	17.59	12.40	11.93	7.84	25.25	38.81
	±1.62	±2.02	±1.66	±0.77	±1.59	±4.1
Pasban	20.12	8.36	8.28	9.25	35.85	53.99
	±2.54	±0.86	±0.69	±0.73	±4.99	±6.76
After one year storage at 25±5°C						
Inqalab	19.35	10.55	6.38	5.04	60.68	115.77
	±2.88	±1.8	±1.13	±1.04	±8.92	±15.65
Pasban	18.48	7.35	4.63	4.09	40.33	74.18
	±2.75	±0.91	±0.78	±0.77	±6.54	±11.51

15 seed were immersed in 10ml double distilled water and E.C. measured at 16±1°C at zero min, 30min, 1h, 2h, 3h, 4h and 6 hours. There values were added and their mean expressed in terms of specific conductance (μS/cm/seed). Error is s.d. (n=6).

tions occurring in non-embryonic structures play a significant role in the loss of wheat seed viability which might be mediated by failing nutrient supply or by the involvement of some inhibitor or toxic substances. Also it has been demonstrated that alterations in membrane systems due to dehydration in water presoaked (pretreated) seeds result in loss of vigour and viability (Bewley & Black, 1986).

One year old NaCl pretreated seeds exhibited a similar germination profile as observed soon after the pretreatment indicating that maximum damage has been done to the seed during the 2 days pretreatment period as the rates of germination were slightly lower than the pretreated seeds tested just before storage. E.C. values indicated that damage had been done to the membrane systems and other macromolecules which collectively had contributed to loss of vigour and viability. Once the damage due to NaCl pretreatment occurs, it is irreversible but this salt treatment may protect seeds against further damage to the membrane system. Leopold & Willing (1984) have suggested that salt treatments have osmotic effects, nutritional effects and toxic effects depending upon the concentrations of salts and components of salt and duration of treatment. Similar suggestions could be made in the germination performance of pretreated seeds and their effects on macromolecular synthesis based on the presented data. It is most probable that macromolecular synthesis has been adversely affected due to cytotoxic effects of salts which have caused the reductions in vigour and viability of pretreated seeds.

The results indicate that the water pretreatment increases rates of germination but salt treatments alter the membrane properties resulting in lower germination profiles and germination rates. Storage for one year results in loss of vigour and viability especially in 16 h and 24 h pretreated seeds. Measurements of E.C. do not predict the

vigour and viability of seeds. Further studies are needed to determine the nature of electrolytes in leachates which may prove an indicator of the physiological state of the prerequisite for successful germination.

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