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EFFECTS OF NaCl ON SEED GERMINATION IN SOME SPECIES FROM FAMILIES Brassicaceae and Solanaceae

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ABSTRACT. The ability of seeds to germinate at high salt concentration in the soil is crucial importance for the survival and perpetuation of many plant species. Therefore, we examined effects of different concentrations of NaCl (200, 400, 600 and 800 mM) on germination of four species from fam. Solanaceae and Brassicaceae (*Capsicum annum, Solanum lycopersicum, Brasica oleracea* and *Sinapis alba*). By this experiment, we wanted to determine which concentrations of salt would not interfere with germination of seeds these plants. The obtained results showed that seeds of all the species germinate only in the lowest concentration of NaCl (200 mM). However, after rinsing with distilled water, seeds of all the examined species, except *S. alba*, germinate in great number. When GA_3 was added, seeds of *C. annum* germinated in great number, but seeds of other plants did not germinate.

INTRODUCTION

Soil salinization is one of the major factors of soil degradation. Salinity inhibition of plant growth is the results of osmotic and ionic effects and the different plant species have developed different mechanisms to cope with these effects (MUNNS, 2002). Reduction in osmotic potential in salt stressed planta can be a result of inorganic ion (Na^+, Cl^- and K^+) and complete organic solute (soluble carbohydrates, amino acids, proline, betaines, etc.) accumulations (HASEGAWA *et al*., 2000). Although the relationship between osmotic regulation and salt tolerance is not clear, there is evidence that the osmotic adjustment appears, at least partially, to be involved in the salt tolerance of certain plant genotypes (NETO *et al*., 2004).

Plant species vary in how well they tolerate salt-affected soils. Some plants will tolerate high levels of salinity while others can tolerate little or no salinity. The relative growth of plants in the presence of salinity is termed their salt tolerance. A high salt level interferes with the germination of seeds. Salinity acts like drought on plants, preventing roots from performing their osmotic activity where water and nutrients move from an area of high concentration. Therefore, because of the salt levels in the soil, water and nutrients cannot move into the plant roots.

Perennial plants seem to handle salinity better than annual plants. In some cases, salinity also has a toxic effect on plant, because of the high concentration of certain salts in the soil. Salinity prevents the plants from taking up the proper balance of nutrients require for healthy growth.

Soil salinity is a worldwide problem hampering productivity of several agricultural crops. Many attempts have been made to alleviate the effect of sodium chloride on plant cells (HAWADA, 1994).

Germination is a critical part of plant life histories. The ability of their seeds to germinate at high salt concentration in the soil is therefore of crucial importance for the survival and perpetuation of these species. In saline habitats, seed germination takes place after high precipitation, i.e., under conditions of reduced soil salinity (KHAN and RIZVI, 1994). The ability of the soil seed bank to remain quiescent at a high salt level and to germinate immediately after salinity reduction (BAJJI *et al*., 2002) is very significant not only to halophytes, but also to other species in colonizing their environment. Although salinity stress mostly reduces the germination percentage and delays the onset of germination, its effects are modified by interactions with other environmental factors as temperature and light. Salinity can affect germination by affecting the osmotic component, which the ionic component, i.e., Na and Cl accumulation (ŽIVKOVIĆ *et al*., 2007).

In this paper, effect of different concentrations NaCl on germination seeds at four species from fam. Solanaceae and Brassicaceae was examined. It is known that the seeds of *Capsicum annum, Solanum lycopersicum, Brasica oleracea* and *Sinapis alba* germinate in the presence of certain concentrations of NaCl in the soil. By this experiment, we wanted to determine which concentrations of salt would not interfere with process of germination of seeds given plants.

MATERIALS AND METHODS

Seeds of *Capsicum annum, Solanum lycopersicum, Brasica oleracea* and *Sinapis alba* were obtained from agricultural pharmacies in bags, already a factory prepared for sowing. Many of 30 seeds of each species were placed in Petri dishes 6 cm in diameter with 2 ml of distilled water or NaCl solution. In this experiment used follows concentrations of NaCl: 200, 400, 600 and 800 mM. The fungicide Nistatin was supplied at a concentration of 500 mg L^{-1} in order to prevent fungal infections (ŽIVKOVIĆ *et al*, 2007). Seeds were germinated at 25 ± 2^{0}C in the dark.

Number of germinate seeds was determined every second day since the beginning of the experiment. After 15 days, all seeds were washed with distilled water and it was added per 5 ml GA_3 (gibberellic acid) in every Petri dishes. Gibberellic acid was purchased from Sigma and 1 mM solutions were prepared. The seeds are still kept in the dark the next 5 days. During this time, the percentage of germination was determined twice. Germination was scored for 20 days. Whole experiment was repeated three times.

RESULTS

Figure 1 shows the effect of distilled water and different concentrations NaCl in the medium on the germination of all four examined species. As evident, the largest percentage of germinate was at distilled water at all species (especially at *Solanum lycopersicum* L.). Seeds kept all the time in a medium containing 200 mM and higher concentrations of NaCl germinate in significantly smaller number. The extent of germination at lower NaCl concentrations varied for different species. Seeds of *Brassica oleracea* had the greatest percentage of germination in concentration of 200 mM NaCl (56%), while seeds of *Solanum lycopersicum* and *Capsicum annum* germinated in very low percentage (under 10 %) in the same concentration. In the concentration of 400 mM NaCl seeds of cabbage and tomatoes were germinated but in low percentage. Only the seeds of *Solanum* *lycopersicum* were germinated in 600 mM NaCl, while in the highest concentration of 800 mM seeds of any plant species did not germinate.

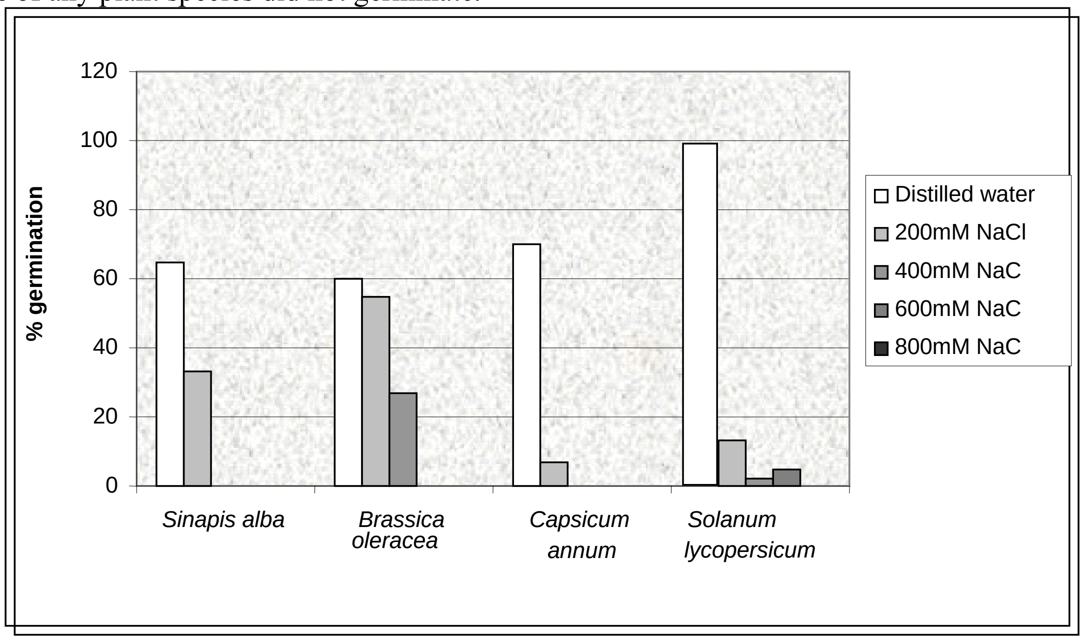

Fig. 1. Seed germination in distilled water and NaCl

After rinsing with distilled water, seeds of *S. lycopersicum* and *C. annum* germinated in greater number from all of used concentrations of NaCl (Figure 2). Seeds of *B. oleracea* germinated in smaller number, while seeds of *Sinapis alba* did not germinate.

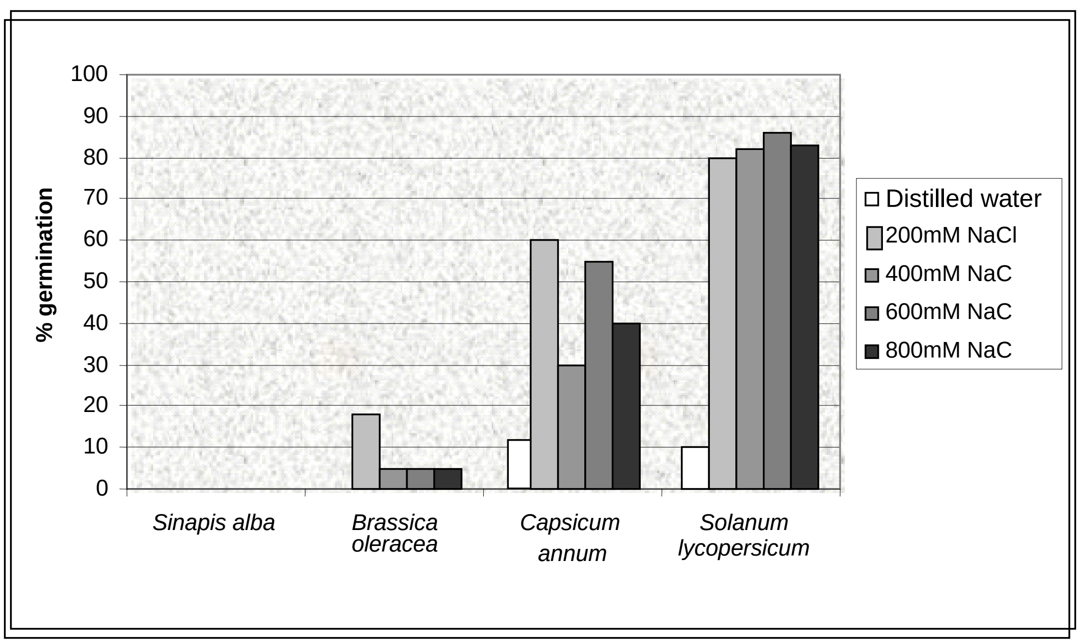

Fig. 2. Seed germination after rinsing with distilled water

Figure 3 showed effect of gibberellic acid on seed germination. When GA_3 was added, seeds of *C. annum* germinated in great number, seeds of *S. lycopersicum* significant smaller (under 5%), but seeds of other plants did not germinate.

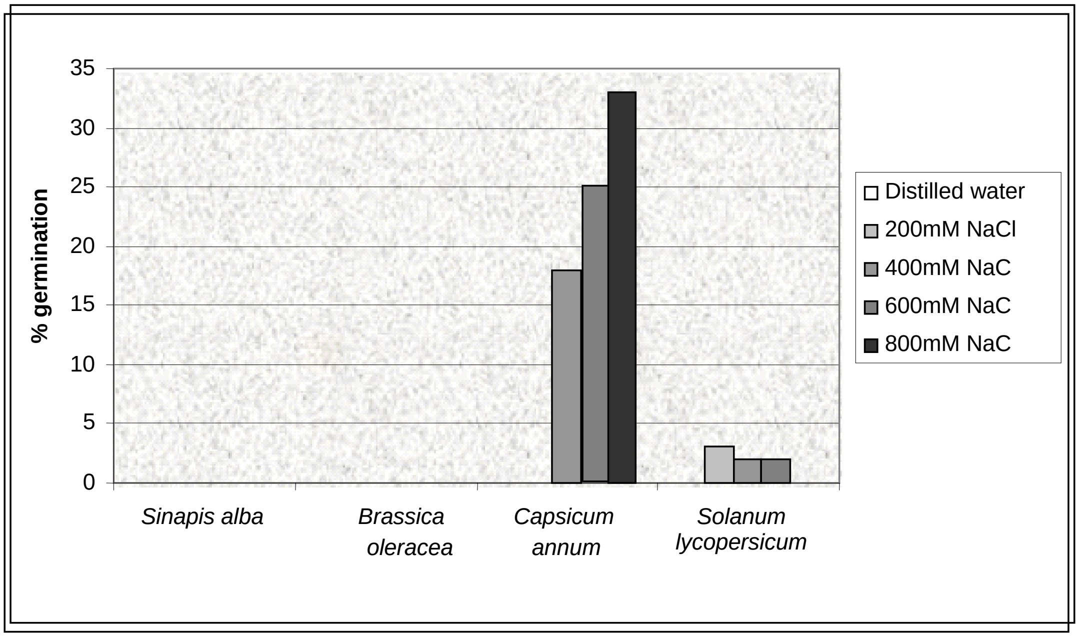

Fig. 3. The effect of gibberellic acid on seed germination

DISCUSSION

Plants display great diversity with regard to soil salinity tolerance. Species distribution and survival mainly depend on the seed ability to complete germination and the seedling ability to develop successfully under unfavorable conditions (ŽIVKOVIĆ *et al*., 2007). Most seeds are located near the soil surface. Salt concentration in the soil surface changes over time. Continuous water evaporation causes surface salt deposition (UNGAR, 1991), while rain dissolves and washes away salt deposits and provides enough water for germination. In the course of evolution, seeds have adapted to such changes, staying viable at high soil salinity and being able to germinate under appropriate external conditions (KHAN and UNGAR, 1997).

The groups of plants that are well adapted to saline habitats are called halophytes. Their seeds germinate well in freshwater and the germination is similar to that of seeds of non-adapted species. However, they differ from them in ability to germinate at higher salt concentrations in the soil. Salinity tolerance of many perennial halophytes dependant on a variety of abiotic factors (BASKIN and BASKIN, 1998).

Our preliminary results showed that seeds of *S. alba, B. oleracea, S. lycopersicum* and *C. annum* germinated at low concentrations of NaCl (200 mM), while at higher concentrations seeds these species were inhibited. Although species from families Solanaceae and Brassicaceae are not typical halophytes, their seeds germinated well at a moderately elevated salt concentration. However, none of seeds germinated if kept in concentrations of 400, 600 and 800 mM of NaCl. However, these seeds remained viable, and after rinsing with distilled water and transferred in medium free of NaCl, they germinated in significant number (except seeds of *S. alba)*. Published data show that the effect of NaCl on seed germination is mostly osmotic (LOERCHER, 1974; REYNOLDS, 1975), but the nature of its effect is unknown.

It is known that the effect of salts on plants leads to physiological drought. It can be concluded that salt reduces the water potential of soil solution, which prevents the supply of water by plants. They in the salty soils receiving large amounts of salt in root cells, and thus reduces the water potential, so it increases the absorption of water in physiological drought conditions.

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