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The Effects of NaCl on the Germination of *Brassica rapa* and *Atriplex patula*

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ABSTRACT

Plants grow in all types of environments. The purpose of this experiment is to find out at what salinity *Brassica rapa* and *Atriplex patula* will still germinate. Salinity treatments were chosen for this experiment from the salinity levels of eight soil samples from the Quivira National Wildlife Refuge. Rapid cycling *Brassica rapa* has been developed from traditional or natural *Brassicas*, reducing the average life cycle from a normal six to twelve months down to approximately thirty-five days (Williams, 1989). The first part of the experiment was the planting of seeds in potting soil and then watering them with different levels of NaCl. The second part of the experiment was to place the seeds of two different *Atriplex patula* plants and *Brassica rapa* plant into petri dishes and see if they would germinate. The *Brassica rapa* seeds that were planted in the soil only grew in three of the nine different solutions used: 0ppt, 2ppt, 5ppt, 8ppt, 10ppt, 18ppt, 25ppt, 30ppt, and 37ppt. Percentage of germination over time increased. Seeds germinated in solutions up to 25ppt, and grew in solutions up to 18ppt. The amount of germination in the petri dishes was far below the expected results. The salinity in the soils was checked over a period of four days while the plants were being watered by hand. An increase in the level of salinity may be the cause of the lack of germination in the petri dishes. The outcome of the experiment was not totally expected. The seeds tested differed in their response to salinity and in their survival after exposure to salinity.

INTRODUCTION

Plants grow in all types of environments. The environment is constantly changing, causing stress to which the plants must adapt. One example of this is that in certain environments the salt levels build up in the soil and reduce the growth and seed germination of the plants. In the salt marsh habitat, variable salinity is an additional environmental factor that can negatively affect seedling development, even of salt-tolerant species (White, 1996). The tolerance of seeds to salinity should be interpreted at two levels: (1) the ability to germinate at high salinities, and (2) the ability to recover and germinate after exposure to high salinity (Ungar, 1996).

Dormancy in seeds of halophytes is a significant factor in the ecophysiology of salt marsh species. It permits seeds to remain viable on the soil during periods when the environment is not suitable for germination. This is especially significant in the salt marsh habitat because flooding, hypersaline conditions, or burial of seeds by tidal deposition may make environments unsuitable for seed germination or the normal development of plants (Keiffer and Ungar, 1997).

The purpose of this experiment is to find out at what level of salinity the plants *Brassica rapa* and *Atriplex patula* will still germinate. *Atriplex patula* is a halophyte that grows in moderately saline soils, ranging from 0.2 to 1.3% total salts, in North America. (Ungar, 1996) *Atriplex patula* has been looked at to help saline drainage problems in the San Joaquin Valley, California. The sub-surface agricultural drainage water from farmlands with drainage-related problems located on the western side of the San Joaquin Valley is typically high in salinity (Watson, 1994). *Brassica rapa* is a salt-tolerant rapeseed which is one of the first crops grown on the unclaimed polder land in Holland (Williams et al., 1986).

MATERIALS AND METHODS

Rapid Cycling *Brassica rapa* has been developed from traditional or natural *Brassicas*, reducing the average life cycle from a normal six to twelve months down to approximately thirty-five days (Williams, 1989). *Brassica rapa* was chosen for this experiment because it has a rapid growing cycle.

The seeds were planted in potting soil and then watered. The potting soil was placed in quads which are four-celled planting units. The units are set up in groups of eight sets of four so that you can grow 16 plants in one group. The watering of the plants for the first seventeen days was done by hand from above. Water was dripped from pipets onto the soils until the soils were saturated. Salinity treatments were chosen for this experiment from the salinity levels of eight soil samples from Quivira National Wildlife Refuge. Quivira is a salt marsh that contains many types of habitats. The samples were taken from areas within Quivira that contained different levels of salinity. The NaCl solutions used to water the plants were 0ppt, 2ppt, 5ppt, 8ppt, 10ppt, 18ppt, 25ppt, 30ppt, and 37ppt. There were sixteen plants for each of the treatments. The soils were watered until they dripped and then placed above an empty reservoir on top of four stakes. These reservoirs were then placed in a growth chamber. The temperature of the chamber ranged from 68° to 72°F. To have optimal growing temperature, the *Brassica rapa* seeds needs to be maintained at 21° to 27°C (70° to 80°F) (Williams, 1989). The light cycle in the growth chamber was set up for 12 hours on and 12 hours off. The soils were watered daily to prevent drying.

The watering system for the controls was made by placing the cells that contain the seeds and soil on a water mat which is placed on top of a reservoir. This

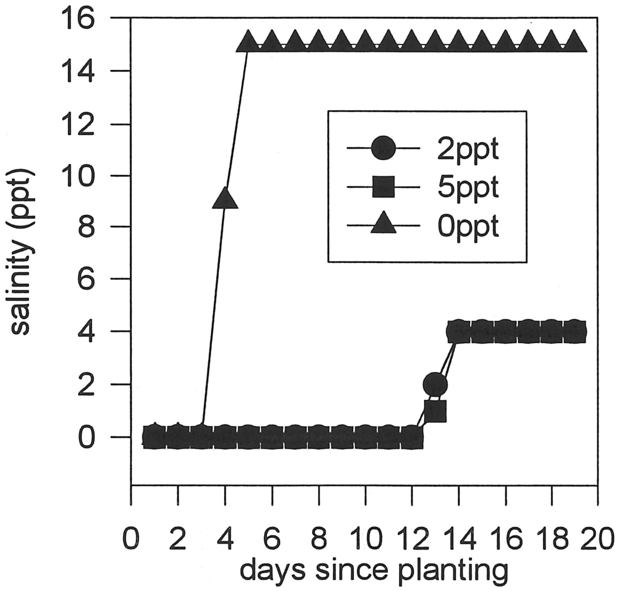

Figure 1. This graph shows the days of germination for the *Brassica rapa* seeds in the soil, it also displays the days that the plants died in the 2ppt and 5ppt soils.

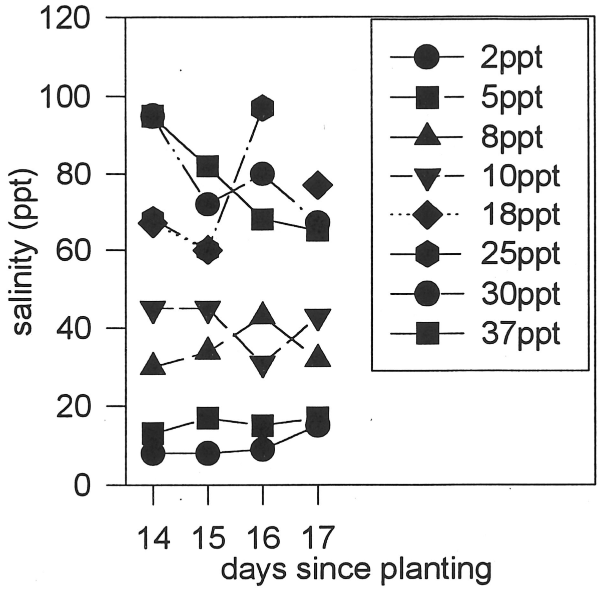

Figure 2. This graph shows the change in salinity levels from days 14-17 of the soils in which the *Brassica rapa* seeds were planted.

watering system is based on capillary action. Once the water mat is wet, it continues to draw water from the reservoir. Water moves from the mat into the potting soil by wicks that extend through the bottom of each cell of the quad. (Williams, 1989). After the plants had been watered this way for 17 days, the treatment for 12 of the 16 plants from each of the eight saline groups was changed so that they were watered in the same way as the controls. The other four plants in each of the eight groups were watered the way they had been and then the soil was tested for the salinity level. The salinity levels were tested for four days in a row to see how the salinity levels in the soils changed.

The second part of the experiment was to place the seeds of two different *Atriplex patula* plants and a *Brassica rapa* plant into petri dishes and see if they would germinate. Fresh seeds of *Atriplex patula* were obtained from plants that were originally collected from Quivira National Wildlife Refuge, a highly saline location,

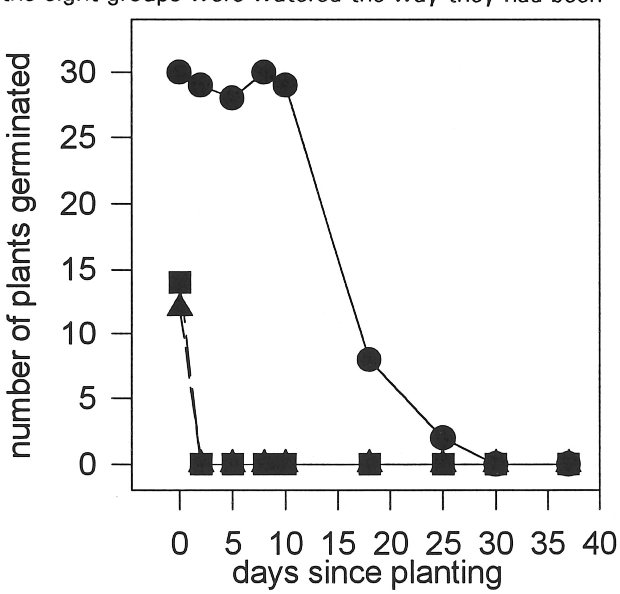

Figure 3. This graph displays the germination of *Brassica rapa* and two *Atriplex patula* plants. The graph plots the percent of germination vs. the salinity (ppt), for the nine different solutions.

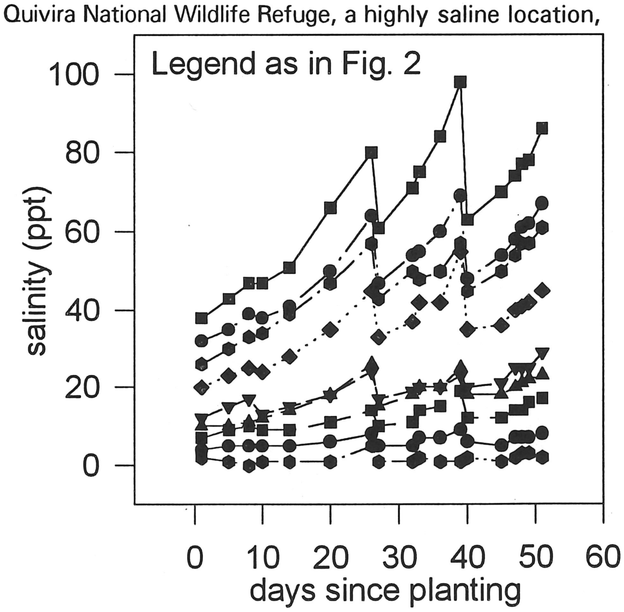

Figure 4. The salinity levels in the petri dishes containing the *Brassica rapa* seeds, as the saliniy level changed in the petri dishes over the course of 51 days.

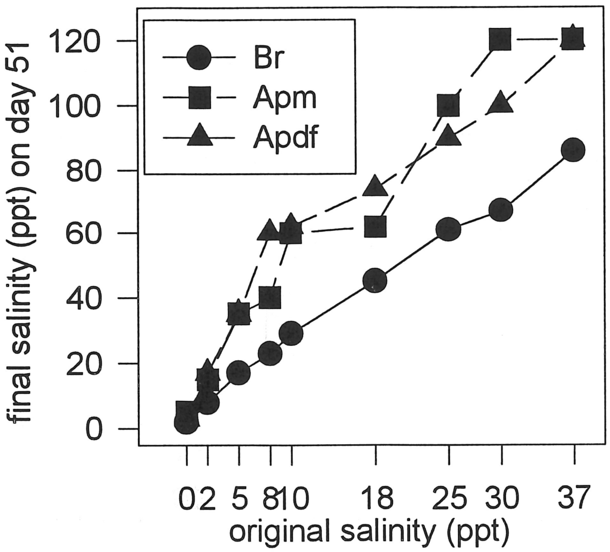

Figure 5. This graph shows the salinity levels for all of the petri dishes, on day 51, the final day of the experinment.

and Dr. Frye's yard, an area of low saline conditions. The seeds were separated into nine groups of 30 to be placed in petri dishes. The seeds were then watered with the nine different solutions to see in which they would germinate. Solution was added each day to overcome for evaporation. The petri dishes were placed in the growth chamber, using the same conditions that were used for the *Brassica rapa* in the growth chamber.

RESULTS

The *Brassica rapa* seeds that were planted in the soil only grew in three of the nine different solutions. After 15 days the plants that were growing in the 2ppt and the 5ppt soils died. Figure 1 shows the rate of the germination of the *Brassica rapa* seedlings over time.

The salinity in the soils was checked over a period of four days while the plants were being watered by hand. This was before the plants were changed over to the capillary watering system. In the germination of seeds in the soils it seems that, because of the accumulation of salinity in the soil, the seeds were unable to germinate. The test seemed to show that the salinity level in the soils was not constant and the level increased over time (Figure 2).

The amount of germination in the petri dishes was far below the expected results. Plants did not germinate in the salinity levels above 18ppt. The germination of the seeds was not all in one day but there were a number of seedlings that germinated (Figure 3). Germination of most of the *Brassica rapa* seeds occurred within three days in 0ppt to 18ppt. At 25ppt *Brassica rapa* seeds germinated within thirteen days.

The salinity during the growing cycle for the *Brassica rapa* seeds in the petri dishes showed a steady increase (Figure 4). Algae started to grow in the 2ppt and 5ppt *Brassica rapa* petri dishes thirty-one days after the seeds where put in the solutions. The salinity for the *Atriplex patula* seeds was only checked on the day the experiment was ended. Figure 5 shows the results of the increase in the salinity for all of the petri dishes on day 51.

DISCUSSION

Previous investigations with halophytes indicated that seeds may be less salt tolerant than growing plants (Ungar, 1996). The ability for halophytes to germinate under saline conditions was examined in this experiment. The seeds tested in this study responded differently to salinity and in their survival after exposure to salinity. Most of the seeds for *Atriplex patula* did not germinate as well in the higher levels of salinity as did the *Brassica rapa*. One of the reasons for this could have been the increase in salinity due to evaporation of the NaCl solution in the petri dishes.

An inability to reverse the inhibitory effect of NaCl at very high salinities indicates that metabolic processes are being directly affected by salt stress (Khan et al., 1984). When the seeds were taken off of the salinity treatment and watered with 0ppt solution the above mentioned process did not occur. The idea of relieving the stress caused by the high salinity levels was not tested in the petri dishes.

Salt concentration had the greatest effect on seed germination of any of the factors examined in this study. Germination was highest in water or at low salinities with increasing suppression as salinity increases (Mikhiel et al., 1992). The increase in salinity seemed to inhibit the germination of the seeds in the petri dishes and the soil.

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