Cantaurus, Vol. 14, 15-18 May 2006 © McPherson College Division of Science and Technology

Germination of Five Wheat Varieties Over a Range of Salinities

Timothy D. Cox

ABSTRACT

Salinity is a growing problem for farmers around the world. The soil becomes saline by using poor irrigation water and the evaporation of irrigation water. When the water evaporates it leaves behind ions on the surface of the soil. Plants have a difficult time surviving in the saline environment. *Triticum aestivum* (wheat) is an important cultivated species. Its ability to get water has a direct correlation with how saline the soil is. In order to determine the importance of salinity, seeds were germinated and grown in five different concentrations on NaCl. My research showed that growth was inhibited with a higher salinity. The germination was delayed with a rise in salinity. I studied five different varieties of wheat that are planted in Kansas. I put them under five different concentrations of NaCl (0ppt, 2.5ppt, 5ppt, 8ppt and 10ppt NaCl). I germinated them in a 25C incubator and recorded shoot length and percent germination every 24h period. The Karl 92 variety proved to be the most tolerant throughout the experiment. I conclude that the five varieties of wheat show diversity for being salt tolerant.

Keywords: *Germination, Salinity, Wheat, Salinization, Triticum aestivum*

INTRODUCTION

Salinity is a problem that has an effect on about 20% of irrigated land (Chinnuasamy 2005). The productivity and quality of the crops are adversely affected. Environmental stresses, such as water deficit, increased salinity of soil, and extreme temperatures are major factors limiting plant growth and productivity. Learning more about salt tolerance would play a crucial part in feeding our vastly growing human population. The amount of land that is affected by salinity is 400 to 950 million hectares. This problem has affected lifestyles of many farmers who inhabit saline soils. I investigated the germination rates of five wheat varieties in Kansas over a range of salinities. I also looked at shoot growth daily and threshold concentration, which means how much salt the plant can take. In another study of the effects of salt and osmotic stresses on germination of wheat, concludes that germination was delayed and inhibited due to increased salt concentrations (Almansouri 2001). This study also tested against iso-osmotic solutions of mannitol and polyethylene-glycol, and its effects on germination. In McPherson County, *Triticum aestivum* varieties Jaggar, Jagalene, 2137, Karl 92, and Overley are commonly planted. Learning more about the tolerance to salinity will provide local farmers the information needed if salinity becomes a problem. Salinity is a rising problem all around the world. Irrigation waters evaporate and leave behind the ions in the soil. Overtime the ions accumulate, making the environment saline. The evaporation of saline waters at the soils surface concentrates the soils to the point where it affects the environment. The clearing of land also causes a problem. The deeply rooted trees are cleared and the roots no longer absorb water so the water table rises. The rising water brings with it ions in the soil. Once the water table reaches the surface it evaporates makes a saline environment. This process is called the charge/discharge effect. The ocean is the main source of salt, wind also contributing, for many of the saline environments in the world. In parts of Australia, salinity is a major growing problem for the environment. The National Land and Water Resources Audit estimates that 5.7 billion hectares have a high potential for dry land salinity and predicts this to rise to 17 million by 2050. In doing this research, a long-term goal would be to practice selective breeding, a process that selects the most tolerant plants. Selection parameters would be germination rates, shoot biomass and height, and moisture content of roots and shoots. In a study conducted by Veatch, Smith, and Vandemark, they questioned if improved productivity under saline conditions was due to unique responses to salinity or if it was simply the fact that the variety was highly productive in non-saline conditions as well. This experiment found that there was lack of differences in relative yield among accessions (A group of plants that are obtained from a single source at a single time.)examined, which provides evidence against the existence of a specific and unique response to salinity.

MATERIALS AND METHODS

Germination and Shoot Length Study

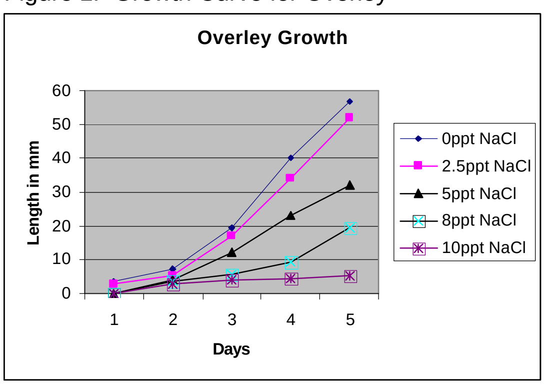
All the seeds were provided by the McPherson County Extension Office via K-State. I used 150 seeds of uniform size, that were surface sterilized with 5% hypochlorite solution for fifteen minutes, and washed three times in ionized water. The germination containers were sterile Petri dishes containing a single Whatman No 1 filter paper. Each dish contained 10 seeds of a certain variety. The amount of moisture given to each plate was approximately 5 mL of a certain saline concentration. The plate subjected to normal conditions was hydrated with deionized water. In order to avoid water loss, the germination plates were sealed with a colorless parafilm. The seeds were subjected to salinity levels of 0, 2.5, 5, 8, 10ppt (parts per thousand) NaCl. The seeds were allowed to germinate in the dark for a period of 5 days in a 25C incubator. The plates were arranged in a completely randomized block design. The germination was recorded daily, using radicle extrusion as the criterion. A seed was considered germinated if the radicle length is greater than or equal to 2mm long (Almansouri 2001). Percentage of germination was calculated against the percentage of germination under normal conditions. The growth of the shoot was recorded daily to test against tolerance. The most halophillic variety was noted.

RESULTS

Shoot Growth

I organized a graph for each variety I tested. I show days on the x-axis and length in mm on the y-axis. Each variety shows inhibition at the higher salinities.

Figure 1. Growth Curve for Overley



The graph shows that Karl 92 grew the best overall. These results may vary in the actual field because the real life environment is not simulated. Using actual soil and planting the seeds rather than just germinating them would have been a better study.

Jagger was the next best growing variety. This variety had one seed that wasn't viable (dead). This happened only in Jagger; it wasn't damaged or dropped, so I have no reason to suspect why.

Figure 2. Growth Curve for Jagalene

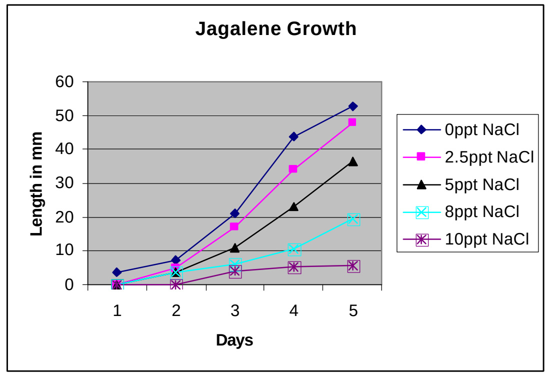


Figure 3. Growth Curve for 2137

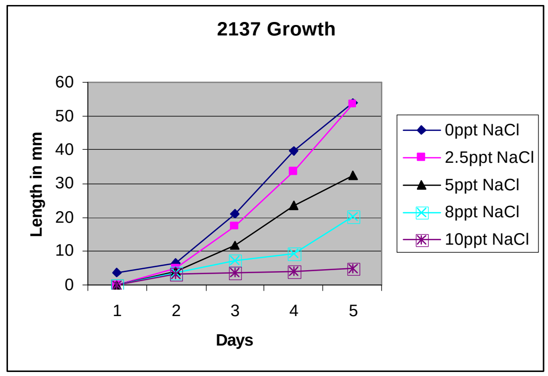


Figure 4. Growth Curve for Karl 92

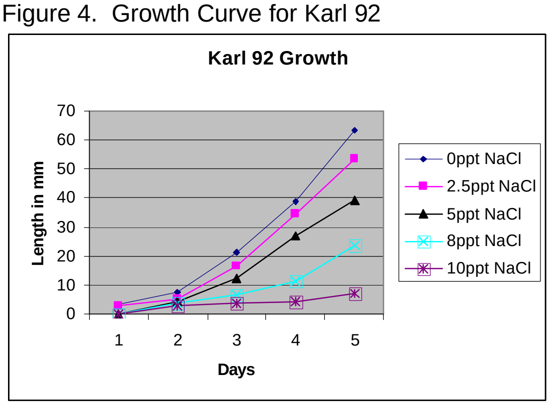
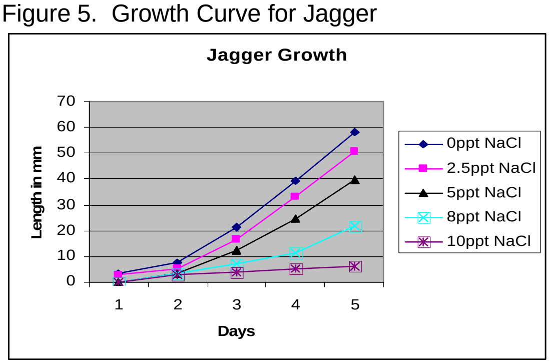


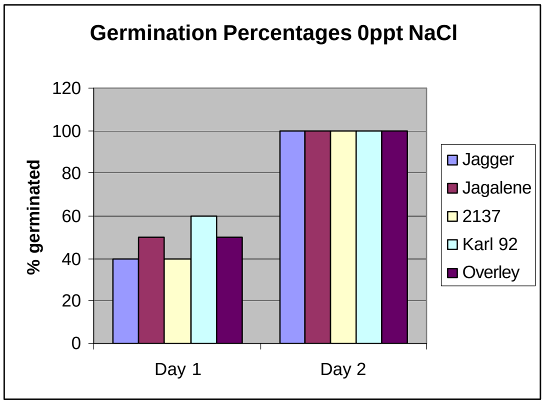
Figure 5. Growth Curve for Jagger



Germination Graphs

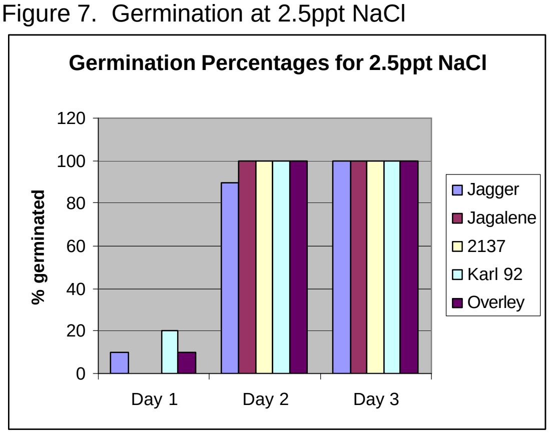
The germination tables shown are portraying the amount of days it took to reach 100% germination. After 100% germination the study was completed. Organizing the tables into certain salinities, the first table shows the germination percentages at 0ppt NaCl.

Figure 6. Germination at 0ppt NaCl



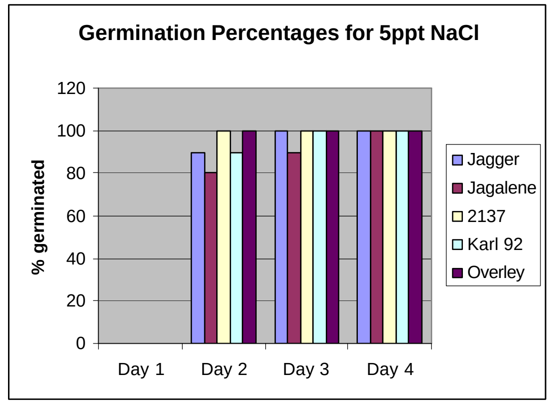
It took two days for 100% germination at 0ppt. The increase in salinity showed an increase of delayed germination, which tells me that it took the seeds longer to obtain the proper amount of water for germination. Table 7 shows the germination at 2.5ppt NaCl.

Figure 7. Germination at 2.5ppt NaCl



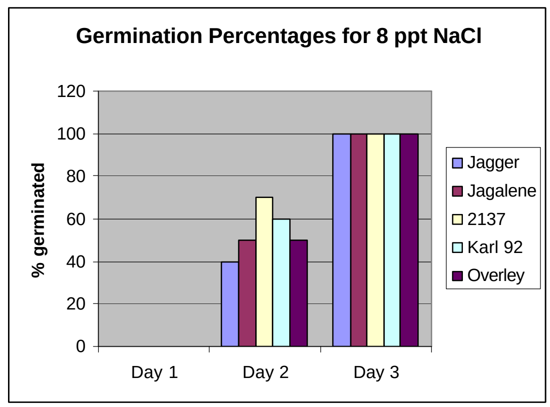
Jagger took three days to completely germinate at 2.5ppt NaCl. The next table shows the percent germination at 5ppt NaCl.

Figure 8. Germination at 5ppt NaCl



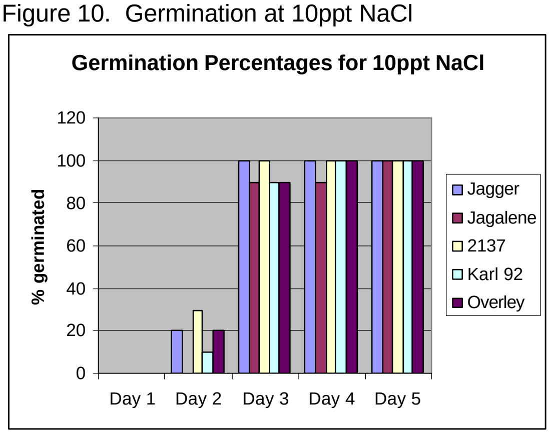
The seeds showed 0% germination on day one for 5ppt NaCl. Table 9 is showing germination percentages at 8ppt NaCl.

Figure 9. Germination at 8ppt NaCl



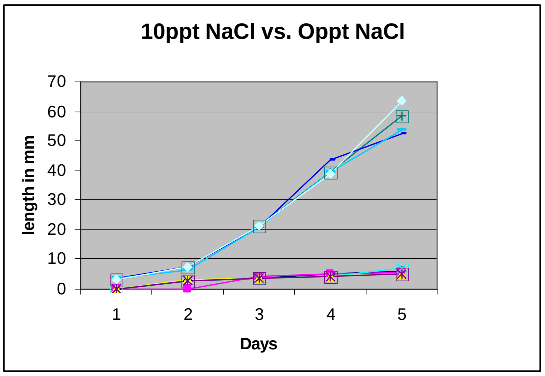
This table is interesting because it shows a better germination rate at 8ppt than at 5ppt NaCl. This does not correlate to my hypothesis and I have evidence for human error and this needs to be repeated. The next graph shows the germination at 10ppt.

Figure 10. Germination at 10ppt NaCl



This table shows that 10ppt NaCl inhibits the germination process the most. This is sufficient evidence to support my hypothesis. The next graph shows the difference between the shoot lengths at 0ppt NaCl against 10ppt NaCl.

Figure 11. Length differences 10ppt NaCl vs. 0ppt NaCl



The differences in lengths are immense. The bottom lines represent the 10ppt NaCl. The diagonal lines represent the lengths at 0ppt NaCl.

DISCUSSION

The motivation for doing this project is based on information I obtained in articles explaining the immense problem of salinity. Further study could be done with this project. Overley did surprisingly bad which is not common. In McPherson County, Overley is one of the better producing varieties. A study should be done on the productivity of the variety with respect to salinity. This would simulate a better growing environment out in a field rather than in a germination plate. Also figuring out the threshold concentration which means the amount of NaCl the plant gets so it doesn't germinate or grow at all. It was concluded that salinity effects the germination by delaying the process, but not causing crenation of the cells. Crenation is when the cells lose all the water and shrink; it is the opposite of the cells having too much water. My research proved my hypothesis true that with an increase in salinity correlates to a decrease in shoot extrusion length.

LITERATURE CITED

Almansouri M, Kinet J M, Lutts S, 2001 Effects of salt and osmotic stresses on germination in duram wheat (*Triticum durum* Desf.). Plant and Soil 231: 243-251.

Al-Niemi T, Campbell W, Rumbaugh M, 1992 Response of Alfalfa Cultivars to Salinity during Germination and Post-Germination Growth. Crop Sci. 32: 976-980.

Chinnuasamy V, Jagendorf A, Zhu J K, 2005 Understanding and Improving Salt Tolerance in Plants. Crop Sci. 45: 437-448.

Peel M, Waldron B, Jensen K, Chatteron J, Horton H, Dudley L, 2004 Screening for Salinity Tolerance in Alfalfa: A Repeatable Method. Crop Sci. 44: 2049-2053.

Rumbaugh M, Johnson D, Pendery B, 1993 Germination Inhibition of Alfalfa by Two-Component Salt Mixtures. Crop Sci. 33 1046-1050.

Veatch M, Smith S, Vandemark G, 2004 Shoot Biomass Production among Accessions of *Medicago truncculata* Exposed to NaCl. Crop Sci. 44:1008-1013.