One of the effects of salts on seed germination is to lower the osmotic potential of the germination media. This creates a physiological drought condition for the germinating seed, making it more difficult for the seed to absorb water from the surrounding media, a situation closely resembling low soil moisture. A study was initiated in 1982 to determine if selection for germination salt tolerance had any effect on the ability of alfalfa seed to germinate under laboratory simulated drought conditions.

Seed of each of the four Arizona Salt Tolerant cycles (1978, 1979, 1980, and 1981), as well as Mesa Sirsa, were germinated at 26°C on filter paper disks saturated with distilled water and polyethylene glycol (PEG) solutions ranging from -3 to -9 bars osmotic potential. PEG is an inert, high molecular weight compound that has no biological effect on the seed. It lowers the osmotic potential of the germination media, mimicking drought conditions, but does not penetrate the seed coat or directly inhibit the physiological processes involved in seed germination.

The germination results for each germplasm were calculated as a percentage of their germination in distilled water since inherent differences in percent germination existed among the germplasm sources. Germination of all germplasm sources decreased as the osmotic potential of the germination media decreased from -3 to -9 bars (Table 1). The general trend of the results indicate that as salt tolerance increased so did the ability to germinate in PEG. AZ Salt Tolerant 1981, the most salt tolerant of the material tested, had the highest percent germination in PEG. Conversely, Mesa Sirsa and AZ Salt Tolerant 1978, the two germplasms least tolerant of salt, showed the poorest germination in the PEG solutions.

The results suggest that there is a strong association between ability to germinate in highly saline conditions and low moisture conditions. Successful selection for increased salt tolerance during germination appears to result in greater drought tolerance as well. Studies are currently under way to examine the relationship between salt tolerance and drought tolerance during the seedling and mature plant growth stages in alfalfa.

Table 1. Adjusted[1] percent germination of five alfalfa germplasm sources in polyethylene glycol solutions.

Germplasm	Germination (% of Control) Osmotic Potential (bars)			
	-3	-5	-7	-9
Mesa Sirsa	77.0	18.8	1.1	0.0
AZ Salt Tolerant 1978	37.9	15.7	1.1	0.5
AZ Salt Tolerant 1979	78.7	48.4	9.0	1.1
AZ Salt Tolerant 1980	72.7	59.0	20.9	2.1
AZ Salt Tolerant 1981	93.3	62.6	29.1	11.7

[1]Germination percentages are calculated as percent of the control germination in distilled water.

Tissue Culture of Salt Tolerant Alfalfa

Morena H. Seitz and J. O. Anderson

SUMMARY

Work is currently in progress to evaluate the potential of plant tissue culture as a technique for selecting salt tolerant alfalfa. Preliminary results indicate that low levels of sodium chloride (Ψ = -6 bar) stimulate growth of both highly selected germplasm and the controls. At this stage of research, there appears to be little difference in response to salt between selected material and the unselected controls.

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Plant tissue culture techniques show great promise as tools for plant selection and breeding, especially considering space, time, and money limitations currently imposed on research. At this time, research is needed to positively correlate the results of artificial selection in both field studies and in vitro plant cultures.

In Arizona, salt tolerance is a desired trait in alfalfa. Previously selected seed for salt tolerance at germination are now being utilized in several ways. Initially, germination tests are conducted on various cycles of salt tolerant Mesa Sirsa (courtesy of Dr. A.K. Dobrenz, University of Arizona) using several sodium chloride concentrations ranging from water potentials of -13 bars to -22 bars (approximately 15, 360 ppm - 25,990 ppm). The surviving seedlings, along with some foundation seedling controls, are then used to initiate both root and shoot cultures when these seedlings exhibit the unifoliate leaf (approximately one week of age). After several months in tissue culture (when culture volumes are sufficient for analysis), samples are transferred to a B5-2+A media that contains sodium chloride at Ψ = -6 bars. Growth rate surveys and protein analysis are then conducted over a time course of two months. Results of growth rate studies using a packed cell volume microtechnique seem to indicate no significant difference in response to salt between Cycle 1 and the control. Further studies on Cycle 6 are currently underway.

In addition, similar studies on the response of excised radicles to sodium chloride are being conducted. Alfalfa seedlings of the various cycles of salt selection are germinated in pure water. Radicles are then excised in uniform lengths (one centimenter). Placement of these root tips in Hoagland's solution with or without sodium chloride then follows. Elongation rates are determined after four days. Initial results indicate that sodium chloride stimulate growth in both the controls and Cycle 6 material, but that the increase in length in Cycle 6 is greater than in the unselected controls. Further investigation of this response at higher salt concentrations and in intermediate cycles of salt tolerance seed is currently in progress.

Future work with tissue culture may also yield information on the physiological and/or morphological changes that occur in salt tolerant species. This could then be utilized to "engineer" a desired plant that can be obtained from tissue culture via regeneration techniques.

Photosynthetic Acclimation to Temperature in Alfalfa

E. R. Bartlett and A. K. Dobrenz

Summary

Four alfalfa cultivars were grown at low temperatures, 20/15C (day/night) and high temperatures, 32/26C (day/night). Photosynthetic measurements were conducted using a specialized plant chamber, at 18, 25, and 32C. Initial results indicated that there is a wide variation in the ability of alfalfa plants to acclimate photosynthetically to temperature.

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Certain plant species have the ability to adjust their photosynthetic response in accordance with seasonal temperatures. Plants possessing acclimation capabilities are able to maintain a relatively constant rate of photosynthesis throughout the year, although the mean daily temperature can vary by more than 25C from summer to winter.

A study was conducted to investigate the acclimation potential of alfalfa. Clones of plants from four cultivars 'Mesa Sirsa', 'Moapa 69', Hairy Peruvian' and 'Vernal' were randomly selected for cuttings. The plants were grown in two environmental growth chambers set at varying temperatures; a low temperature of 20/15C (day/night) and a high temperature of 32/26C photosynthetic measurements were made using a specialized plant chamber designed with an outer jacket connected to a water bath which maintained the varying test temperatures.

Results of this study are shown in Figure 1. Hairy Peruvisn appeared to have the highest acclimation potential when grown at low temperature and measured at low temperature, it's photosynthetic rate averaged 16.1 mg CO_2 dm^{-2} hr^{-1}. When grown at high temperature and measured at high temperature its photosynthetic rate averaged 15.0 mg CO_2 dm^{-2} hr^{-1}.

The other cultivars tested appeared to have a more limited ability, to acclimate photosynthetically. Moapa-69 had the lowest acclimation potential. Plants grown at low temperature and measured at low temperature had an average photosynthetic rate of 16.9 mg CO_2 dm^{-2} hr^{-1}. The plants grown and measured at high temperature had an average photosynthetic rate of 25.0 mg CO_2 dm^{-2} hr^{-1}.

Although this was a limited study, the evaluation of photosynthesis as well as other physiological characteristics over a wide temperature range shows potential, as a selection tool. In view of alfalfa's genetic make-up, adaptability to temperature may vary widely within a single population.