

Germination Salt Tolerance in Alfalfa

A. K. Dobrenz, Dale Smith, Joe Stone and M. H. Schonhorst

Summary

Progress is being made in the development of alfalfa which will germinate at high salinity levels. This new "germination salt tolerant" alfalfa is being used to identify plants which are more salt tolerant after emergence and during early plant growth and development.

Salt Tolerance. The development of salt tolerant germplasm during the early stages of germination and seedling development of alfalfa is a major objective by scientists in the Plant Sciences Department at the University of Arizona. We evaluated seed from the SynCycle₄ experimental germplasm, facilitated the open pollination of the genotypes which could withstand 18,000 ppm NaCl concentration during germination and evaluated the salt tolerance of the seed which came from this fourth cycle of selection.

Salt tolerance during the early stages of plant development shows continuing progress through the third and fourth cycles of selection (Figure 1). Although we have developed germplasm which has a germination percentage over 50% at 13,500 ppm this is still probably not significant progress for severe salt conditions under field conditions. We are currently screening the 1981 cycle seed by germinating at 22,000 ppm NaCl which eliminates 99% of the population.

We are currently using the 1979 Arizona salt tolerant germplasm to identify individual plants that are more salt tolerant during the growth period immediately following first cut. Plants are irrigated with 2000 kg ha of Cl⁻ in the form of KCl immediately following first forage cut when plants are 18 cm tall. Dr. Dale Smith, Professor Emeritus of Agronomy, University of Wisconsin-Madison has conducted numerous trials on the response of alfalfa at the late seedling stage to several salts including KCl, NaCl, K₂SO₄ and Na₂HPO₄. The killing affect of NaCl and KCl was definitely the Cl⁻ ion and not Na⁺ or K⁺ (Table 1). Other points which have been elucidated by Dr. Smith's studies are:

1. Seedling plants were able to survive moderate Cl⁻ levels (453 to 907 kg Cl/ha) but survival was reduced markedly above this level. Individual genotypes survived as high as 2721 kg Cl/ha.
2. Tolerance to the Cl⁻ increased with age. Apparently with more foliage on the plant there was greater dilution of the Cl⁻ absorbed.
3. Seedling plants were able to tolerate high levels of Cl⁻ at moderate compared to high temperatures and lower available soil moisture was better for seedling survival than plants grown in soil near field capacity.
4. Chloride was found in much higher concentrations in leaves than stems. Plans treated with 2721 kg Cl⁻/ha had 9.22%, 6.33% and 1.69% Cl⁻ in the leaves, stems and roots, respectively compared with 1.22%, 0.94% and .85% in the same parts of the plants for the control treatment.

We are in our second cycle of selection for developing a germplasm which can tolerate high Cl⁻ levels following the germination and early seedling stage of development.

Table 1. Survival of Lew alfalfa with the application of some common salts at high rates.

Salts Applied	Treatments	Plant Survival, %	
		Exp. C	Exp. D.
KCl	2267 kgCl/ha as KCl (2500 kgK/ha)	17	17
NaCl	Same amount Cl ⁻ as from KCl; 2267 kgCl/ha	8	7
NaCl	Same amount total salt as KCl; 4767 kg/ha of NaCl or 2890 kg Cl/ha	3	11
K ₂ SO ₄	Same amount K as from KCl; 2500 kgK/ha	89	95
Na ₂ SO ₄	Same amount Na as from NaCl in Treatment 2; 1469 kgNa/ha	66	100
Na ₂ HPO ₄	Same amount Na as above	-	79
LSD, 0.05		9	12

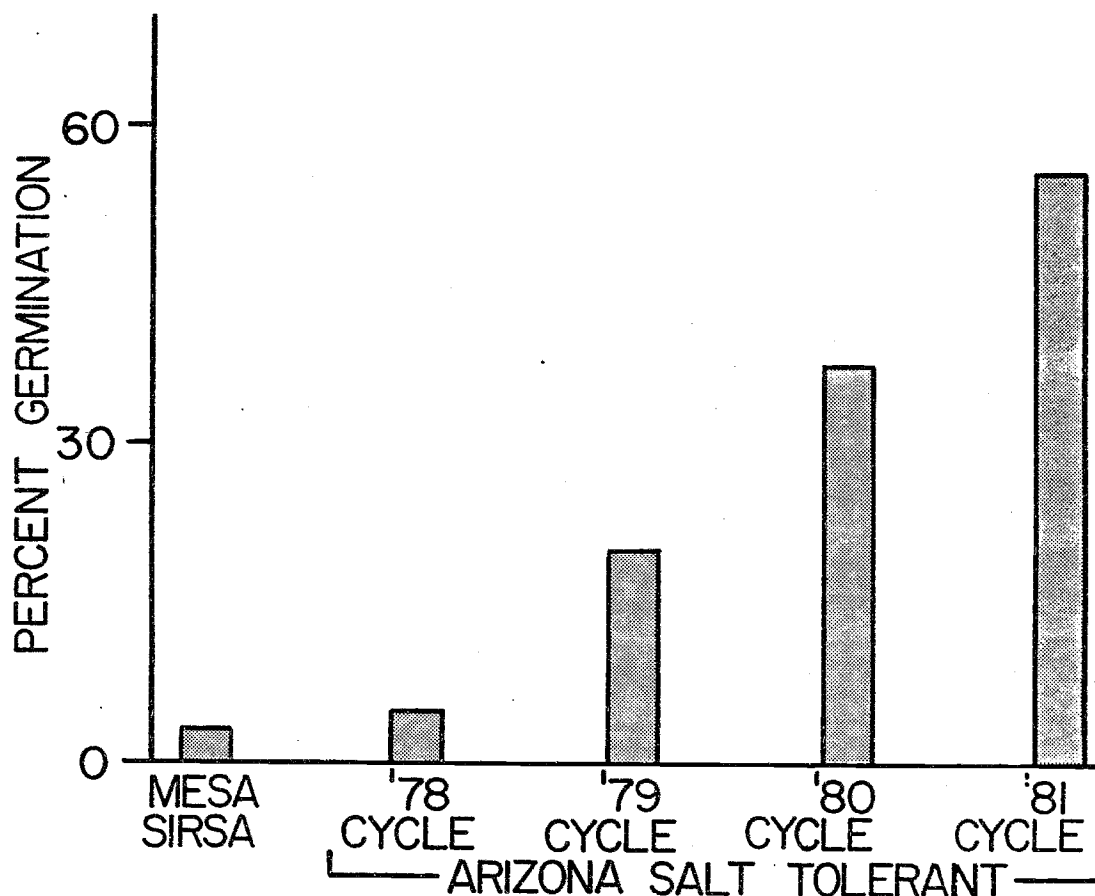


Figure 1. Germination percentages for 'Mesa Sirsa' and the 1978, 1979, 1980 and 1981 Arizona salt tolerant alfalfa. Germination was accomplished at 25 C with 13,500 ppm NaCl.

Relationship Between Germination Salt Tolerance and Drought Tolerance in Alfalfa

S. G. Allen and A. K. Dobrenz

Summary

Five alfalfa germplasm sources representing a wide range of tolerance to NaCl during seed germination were tested for ability to germinate under polyethylene glycol (PEG)-induced drought stress conditions. Germination of all germplasms decreased as the osmotic potential of the germination solutions decreased from -3 to -9 bars. AZ Salt Tolerant 1981, the most salt tolerant germplasm tested, exhibited the highest germination in the PEG solutions. The results suggest a strong positive relationship between the ability to germinate in highly saline conditions and under low soil moisture situations.

Researchers at the University of Arizona have developed a series of germination salt tolerant alfalfa lines through a mass selection breeding program. The original selections were made from the cultivar 'Mesa Sirsa'. After four cycles of selection, germination in NaCl solutions with an osmotic potential of -12.5 bars was nine times greater than the original source population, Mesa Sirsa.