# Performance of Germination Salt Tolerant Alfalfa on a Non-Saline Site

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## INTRODUCTION

Nine cycles of selection have been conducted for germination salt tolerance in alfalfa. This has resulted in populations that can germinate at salinities approaching those of sea water. Unfortunately, data from our research, as well as work in Australia, indicate that alfalfa which is salt-tolerant at germination does not necessarily tolerate salinity during seedling or mature plant growth. Additional breeding will therefore be required to develop alfalfa populations that will be able to remain productive and to tolerate conventional hayfield management following germination under saline conditions.

When attempting to improve seedling and mature plant salt tolerance, it might seem reasonable, at first, to concentrate on germplasm that is already salt tolerant at germination. Following this approach, tolerances at each growth stage could be concentrated in a single population in separate sequential breeding programs leading to a single population having true "field tolerance" to salt stress. The alternative would be to attempt to simultaneously select individual plants in a single breeding program based on their tolerance at each of the critical growth stages.

The first breeding approach might be quicker since germination salt tolerant populations exist and additional selection for this trait would not be necessary. Only seedling and mature plant tolerance would need to be considered in this situtation. However, the second strategy would be preferred if previous selection for salt tolerance at germination had in some way negatively affected the performance of the tolerant population.

The objective of this research was to determine if the latter was indeed true. That is, did recurrent selection for germination salt tolerance inadvertently result in unfavorable changes in important traits in the tolerant populations? The trait we chose to investigate in the tolerant populations was forage yield. Results of this study will make it possible to adopt the most rational of the two basic selection strategies outlined above for the improvement of post-germination salt tolerance.

## METHODS

During 1985, syn-2 seed was produced by hand-pollinating 40 syn-1 plants from the cultivar Mesa-Sirsa and each of the germination salt tolerant populations developed from this cultivar between 1978 and 1984 (cycles 1 - 7, referred to here as ST78 - ST84). Seed from each of the clones in a population were bulked and planted (approximately 250 seeds per plot) in Sept. of 1985 on a non-saline site (EC=0.58 dS/m) at the Campus Agricultural Center in Tucson.

Individual plots consisted of 5 rows, 1 m long, spaced 15 cm apart, with 15 cm between plots. Three replications were planted; all management closely approximated farmer practices. Beginning in April of 1986 fresh

weight yield was measured on each plot at roughly four week intervals until 30 Sep. (seven harvests). All conclusions were based on seasonal yield data.

## RESULTS

Data from this study indicate that selection for germination salt tolerance led to declines in forage yield potential under non-saline conditions. All salt-tolerant populations yielded less than the unselected parental population Mesa-Sirsa, although only the yields of ST81 and ST84 differed significantly from the yield of Mesa-Sirsa. Reductions in yield of 10 to 13% relative to Mesa-Sirsa, as observed for ST81 and ST84, suggest that at least late generation ST populations (i.e. after ST80) should probably not be used as starting points in breeding programs to improve seedling and mature plant salt tolerance. These populations are likely to be burdened by low yield potential which would probably severely limit their usefulness in all but the most highly saline conditions.

Table 1. Mean forage yield of germination salt tolerant populations (ST78- ST84) and their progenitor population ('Mesa-Sirsa') on a non-saline site (seven harvests in 1986).

| Population | Cycle of selection | Mean yield per cutting | |
|---|---|---|---|
| | | Fresh wt./plot (g)* | % of Mesa-Sirsa |
| Mesa-Sirsa | 0 | 1493 D | 100 |
| ST78 | 1 | 1423 CD | 95 |
| ST79 | 2 | 1413 BCD | 95 |
| ST80 | 3 | 1370 ABC | 92 |
| ST81 | 4 | 1302 A | 87 |
| ST82 | 5 | 1340 ABC | 90 |
| ST83 | 6 | 1387 ABC | 93 |
| ST84 | 7 | 1314 AB | 88 |

* Means followed by the same letter are not significantly different (5% LSD).

Long-term recurrent selection programs for improved stress tolerance often result in otherwise improved populations that have reduced yield potential. The accumulation of inbreeding during the selection process is the most common explanation for this phenomenon. Inbreeding generally becomes a more severe problem as the number of cycles of selection increases. Given this and the findings reported above, a breeding strategy which integrates selection for germination, seedling and mature plant salt tolerance within each cycle of a selection program would appear to represent the most logical approach for developing alfalfa populations with post-germination salt tolerance. In addition, to maintain high yields in non-stress environments, such a breeding program should be initiated with germplasm which has not been previously subjected to intense selection and therefore, is probably non-inbred.