RECURRENT SELECTION FOR INCREASED SEED GERMINATION IN LITTLE BLUESTEM

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THE ABSTRACT

Water is essential for plant growth and under field conditions is often inadequate for satisfactory seed germination. The objective of this research was to improve the seed germination of little bluestem, *Schizachyrium scoparium*, lines 'NU-1', 'NU-2', 'UC-1', 'UC-2', 'UO-1', and 'UO-3' at low water potentials. Selection pressure consisted of germinating pure-seeds of each line in a water potential solution of –0.8 MPa for 7 d. Recurrent selection was used to create two synthetic populations for each line. Populations were designated as Syn-0 for the base population, and Syn-1 and Syn-2 for the first and second selected populations. Seeds were harvested from the 18 populations and cleaned to 98 ± 1% pure-seed. Four 50-spikelet samples for each of the 18 populations were germinated in deionized water having a potential of either 0 or –0.8 MPa for 7 d. The 7-d seed germination was analyzed separately by water potential with ANOVA. The data identified interactions among bluestem lines and selection populations at both water potentials ($P < 0.01$). At a water potential of –0.8 MPa, lines NU-2 and UO-3 did not have the same magnitude of increase in seed germination compared with other lines after two cycles of selection. Averaged across bluestem lines, the 7-d seed germination in a water potential of –0.8 MPa increased 600% after two cycles of selection to 21.0 ± 0.9% germination. At a water potential of 0 MPa, the 7-d seed germination of lines UO-1 and UO-3 diverged from their Syn-0 population's seed germination producing a line x selection population interaction. Similarly, averaged across lines, the 7-d seed germination in a water potential of 0 MPa increased 400% after two cycles of selection to 53.0 ± 1.4% germination. Thus, it was possible to select for increased seed germination in little bluestem using recurrent selection.

THE INTRODUCTION

Recurrent selection has been used successfully for population improvement and cultivar development in several cross-pollinated forage grasses. The use of phenotypic selection in isolated polycross nurseries allows for the removal of less desirable plant genotypes, thus increasing the frequency of superior genotypes in the next generation population. This breeding method has been used to increase seed size and seedling vigor in sand bluestem, *Andropogon hallii*, yield and forage quality in big bluestem, *A. gerardii*, forage yield in bahiagrass, *Paspalum notatum*, and leaf area expansion rate in tall fescue, *Festuca arundinacea*.

When establishing native grass seed, the odds of failure are often times greater than the odds of success. Some factors that contribute to stand failures include: inadequate seed-bed preparation, improper seeding depth, inferior seed quality, plant competition, and drought. Drought is by far the most frequent cause of establishment failure of native plants. Moisture stress has been shown to decrease seed germination and seedling growth in several plant species. Selecting seedlings from seeds that germinate under a moisture stress environment may create plant populations with better seed germination and stand establishment characteristics. A variety of chemical compounds have been used to simulate moisture stress during germination. Springer (2005) hypothesized that enough genetic variation is present in many cross-pollinated chaffy-seeded forage grasses to effectively breed and select cultivars with improved germination at low water potentials. The objective of this research was to improve the seed germination of little bluestem lines at a low water potential. Improving the seed germination of little bluestem at a low water potentials will increase the odds of establishment success.

LEST WE FORGET DROUGHT

The effects of drought are the most costly natural hazards affecting the USA with 6 to 8 billion dollars in damages annually (FEMA), primarily in crop losses. The cost does not include losses to public water supply, recreation and tourism, and ecosystem services.

- Mitigating the impacts of drought through planning and preparedness could save billions of dollars.
- The Great Plains are noted for their drought cycles
  - http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/pdiimage.html

THE METHODS

- The base populations consisted of six lines of little bluestem, ‘NU-1’, ‘NU-2’, ‘UC-1’, ‘UC-2’, ‘UO-1’, and ‘UO-3’. These lines were selected for their canopy structure, i.e., NU-not upright, UC-upright compact, and UO-upright open (Figure 1; Springer, 2012a).
- Selection pressure consisted of germinating pure-seeds of each line in a water potential solution of –0.8 MPa for 7 d (Springer, 2012b).
- Recurrent selection was used to create two synthetic populations for each line. Populations were designated as Syn-0 for the base population, and Syn-1 and Syn-2 for the first and second selected populations.
- Seeds were harvested from the 18 populations and cleaned to 98 ± 1% pure-seed.
- Four 50-spikelet samples for each of the 18 populations were germinated in deionized water having a potential of either 0 or –0.8 MPa for 7 d (Figure 2).
- The percentage 7-d seed germination was analyzed separately by water potential with ANOVA.

FIGURE 1-LITTLE BLUESTEM CANOPIES

Left - An upright-compact (**UC**) plant was defined by a columnar shape and erect culms.
Lower left - A not-upright (**NU**) plant was defined by a hemispherical shape and diffuse culms.
Below - An upright-open (**UO**) plant was defined by a caespitose shape and ascending culms. From Springer (2012a).

FIGURE 2 - LITTLE BLUESTEM GERMINATION

THE RESULTS

- The data identified interactions among bluestem lines and selection populations at both water potentials (*P* < 0.01, Figure 3 and Figure 4).
- At a water potential of –0.8 MPa, lines NU-2 and UO-3 did not have the same magnitude of increase in seed germination compared with other lines after two cycles of selection (Table 1 and Figure 3).
- Averaged across bluestem lines, the 7-d seed germination in a water potential of –0.8 MPa increased 600% after two cycles of selection to 21.0 ± 0.9% germination.
- At a water potential of 0 MPa, the 7-d seed germination of lines UO-1 and UO-3 diverged from their Syn-0 population's seed germination producing a line x selection population interaction (Figure 4).
- Similarly, averaged across lines, the 7-d seed germination in a water potential of 0 MPa increased 400% after two cycles of selection to 53.0 ± 1.4% germination (Table 1).

FIGURE 3 - LITTLE BLUESTEM GERMINATION at – 8 MPa

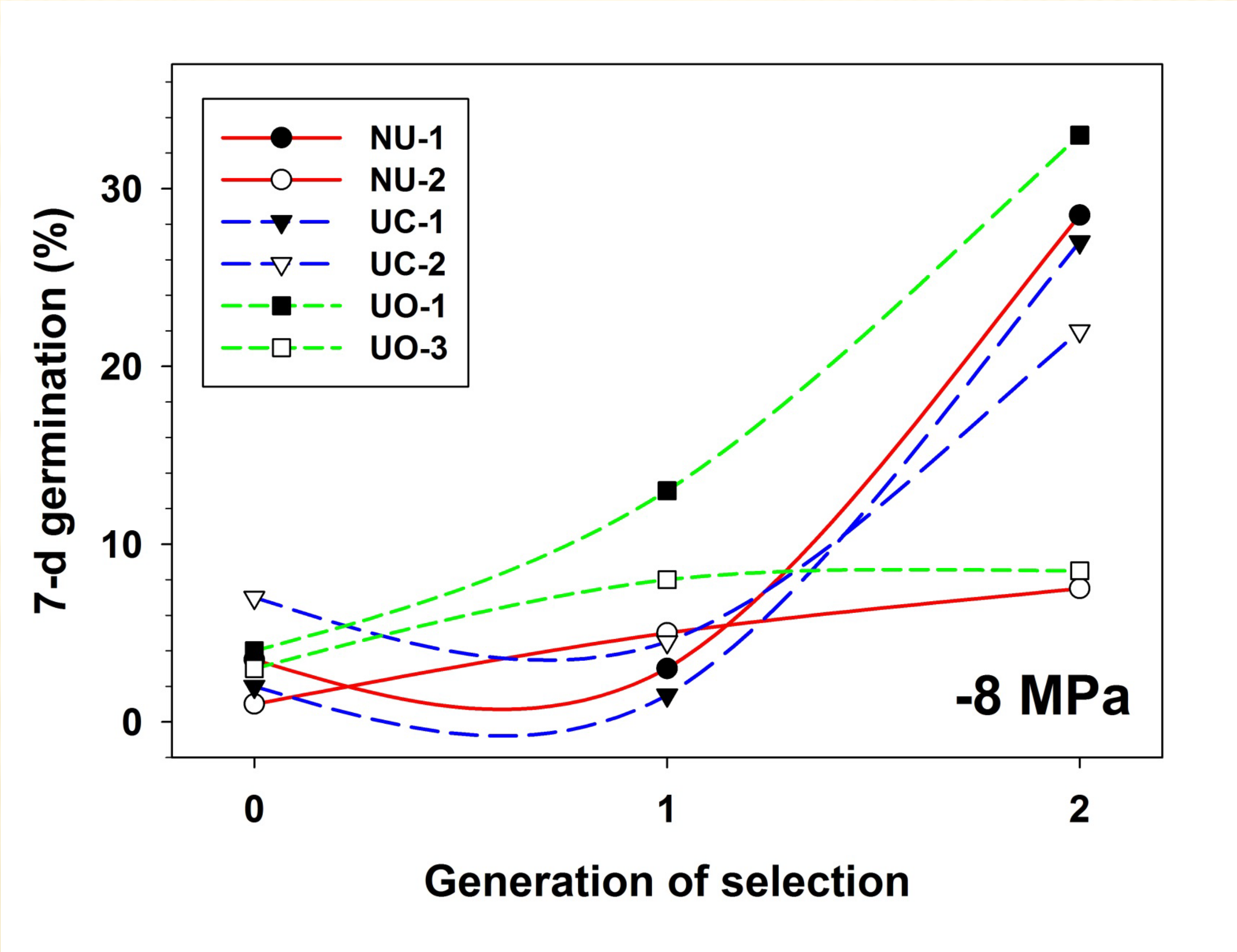

FIGURE 4 - LITTLE BLUESTEM GERMINATION at 0 MPa

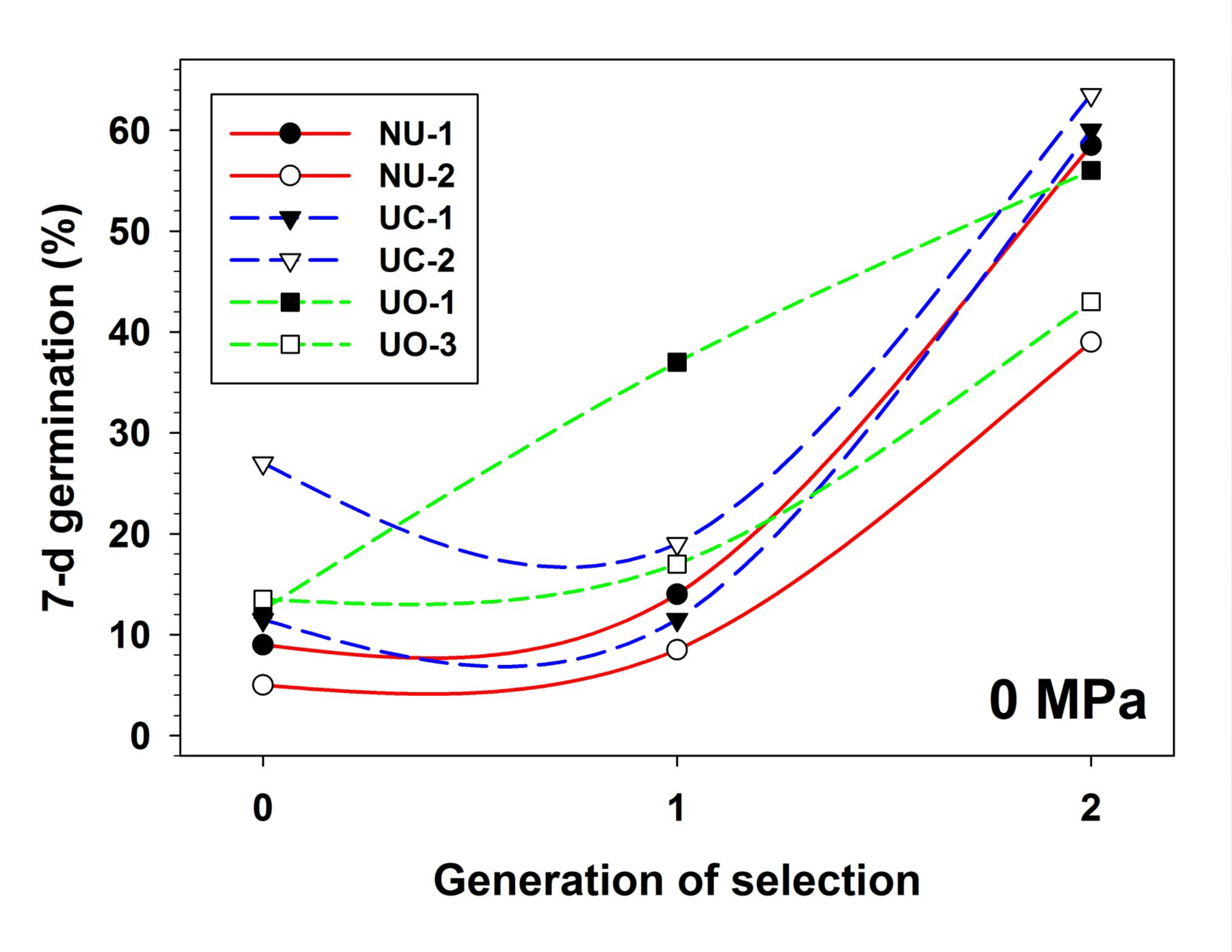

TABLE 1 - LITTLE BLUESTEM GERMINATION

Water Potential	Selection Generation	NU1	NU2	UC1	UC2	UO1	UO3	0
		- % -						
0 MPa	0	9.0	5.0	11.5	27.0	12.5	13.5	13.1 a*
	1	14.0	8.5	11.5	19.0	37.0	17.0	17.8 b
	2	58.5	39.0	60.0	63.5	56.0	43.0	53.3 c
-0.8 MPa	0	3.5	1.0	2.0	7.0	4.0	3.0	3.4 a
	1	3.0	5.0	1.5	4.5	13.0	8.0	5.8 a
	2	28.5	7.5	27.0	22.0	33.0	8.5	21.0 b

* Means followed by the same letter within a water potential treatment are not significantly difference at $P \leq 0.05$ (LSD test).

THE DISCUSSION

- It is possible to select for increased seed germination of little bluestem at a low water potential.
- It should be possible to select additional generations (Syn-3, etc.); but care must be taken to avoid inbreeding depression.
- Given the amount of genetic variation within most cross-pollinated chaffy-seeded grass species, selecting for increased germination at a low water potential would be an effective tool for breeding superior genotypes with increased seed germination.
- Whether the increased germination reported herein for little bluestem results in greater stand establishment remains to be seen and is worthy of researching.

Cited Literature

Springer, T.L. 2005. Germination and early seedling growth of chaffy-seeded grasses at negative water potentials. Crop Sci. 45:2075-2080.

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