Paper ID: 994
Theme 4. Biodiversity, conservation and genetic improvement of range and forage species
Sub-theme 4.1. Plant genetic resources and crop improvement

Efficacy of current breeding programs to improve North American native grass species for forage and conservation use in the south eastern United States

Jesse Morrison*, Brian Baldwin
Mississippi State University, Mississippi State, USA
*Corresponding author e-mail: jesse.morrison@msstate.edu

Keywords: Dual-purpose, Seed Quality, Selection

Introduction

North American native warm-season grasses (NWSG) have received much attention over the last 25 years for their ability to persist under hot, dry conditions and thrive in marginal soils. Native warm season grasses are believed to have been growing on the central and south eastern plains of the United States since the Holocene era (between 11,500 and 2,000 years BP) thus the Southeast is the centre of diversity for these grasses (Casler, 2012). Modern production of many species has been slow to evolve due to inherent dormancy characteristics that hinder germination and establishment. With increased research, many species have shown promise for use as forage and hay crops, pasture, wildlife habitat and in land reclamation sites.

Native warm-season perennial grasses are slow to establish, making the seedlings poor competitors with weeds, especially weedy annual grasses. This establishment lag is due largely to seed dormancy, an important obstacle to the domestic cultivation of these grasses. Seed dormancy is present in all native grass species and provides a selective advantage under varying environmental conditions. The advantage of seed dormancy insures that some seed will remain viable, but not germinate under environmentally favourable conditions. All NWSG do not exhibit the same types or levels of dormancy, nor do they maintain their dormancies with the same severity (Chancellor, 1984).

Materials and Methods

Breeding to reduce seed dormancy is an option to aid in germination and establishment of native grass species. It is a first step in public/producer acceptance of these crops, and a necessary step in the generation of populations for further selection and domestication. Breeding programs using genotypic recurrent selection [half-sib selection] and phenotypic recurrent selection [recurrent restricted phenotypic selection] have been used to manipulate medium to high heritability traits such as biomass production, forage quality and height in switchgrass, big bluestem [*Andropogon gerardii* Vitman] and Indian grass [*Sorghastrum nutans* (L.) Nash] (Burton, 1974; Vogel and Pedersen, 1993). Selection against seed dormancy, being a low heritability trait (because of large environment effects), has been largely ignored.
A majority of breeding efforts have focused on switchgrass, the dominant species of the Great Plains. Casler (2012) notes 35 well known germplasm releases. Of these, 22 have been released with minimal or no selection; 13 have been part of significant selection programs, predominantly for increased biomass and digestibility. Eight of these 13 have been released since 2006. Breeding efforts to enhance establishment included: one variety selected for reduced seed dormancy, and one for large seed size/mass.

Results and Discussion

A search of the literature yields few attempts to breed for reduced seed dormancy, only once in a North American native. Burleson *et al.*, (2009) released switchgrass germplasm with reduced post-harvest seed dormancy derived from the cultivar, Alamo. Four cycles of recurrent selection for "immediacy" of germination were carried out. The 14-day germination percentage of cycle 4 seed was ten times greater than the base Alamo population. Equal quantities of seed from these 24 plants were bulked to constitute TEM-LoDorm germplasm.

Jones (2004) compared both genotypic and phenotypic recurrent selection to increase germination percentage in switchgrass, big bluestem and Indian grass. It was concluded that although genotypic selection was more efficient in a single generation of selection for all species tested, the limited numbers of parents comprising the elite genotypic crossing block would result in inbreeding issues during additional cycles of selection that were necessary for reduced seed dormancy.

Table 1: Research has been conducted in breaking seed dormancy in native grass species using laboratory techniques including moist stratification, mechanical scarification, chemical and hormonal treatments and various other means.

	Species											
	Switchgrass				**Indian grass**				**Big bluestem**			
	Treatment*											
	MST	MSC	C/H	OT	MST	MSC	C/H	OT	MST	MSC	C/H	OT
% Germ	60	82	71	70	29	29	47	47	55	36	80	32
Author	1	11	14	8	7	7	6	6	1	16	15	16
% Germ	62	60	84	79	65	31	73	29	34	.	80	54
Author	9	9	15	9	18	16	15	16	10	.	15	13

* Abbreviations: MST = Moist stratification; MSC = Mechanical scarification; C/H = Chemical and/or hormonal; OT = Other

Conclusion

Exogenous methods to ameliorate seed dormancy are ineffective, involve the use of caustic chemicals, or reversible upon drying. These techniques add cost; requiring neutralizing bases, expensive chemicals, aqueous treatment and re-drying of seed; and only circumvent the problem. The need for breeding programs with increased selection pressure for precocious germination is evident in NWSG. Poor seed quality only exacerbates the issue of poor germination and seed supply in some native species. Genetically reducing seed dormancy in these native grasses is an important step in domestication to allow expanded use in agricultural or conservation systems.

References

Burleson, B. L., C. R. Tischler and W. R. Ocumpaugh. 2009. Breeding for reduced post-harvest seed dormancy in switchgrass: Registration of TEM-LoDorm switchgrass germplasm. *J. Plant Reg*. 3:99–103.

Burton, G.W. 1974. Recurrent restricted phenotypic selection increases forage yields of Pensacola bahia grass. *Crop. Sci*. 14:831-835.

Calser, M. D. 2012. Switchgrass breeding, genetics and genomics. IN Switchgrass: A Valuable Biomass Crop for Energy. A. Monti (Ed). Springer-Verlag, London.

Chancellor, R. J. 1984. The role of seed dormancy in weed control. Schweiz, Landwirtsch. Forsh. 23:69-75.

Fulbright, T. 1988. Effects of temperature, water potential, and sodium chloride on Indian grass germination. *Range Mgmt*. 41 (3): 207-210.

Jones, K. D. 2004. Selection for reduced seed dormancy in three native grass species. Ph.D. diss. Plant and Soil Sci., Mississippi State Univ. May.

Vogel, K. P. and J. F. Pedersen. 1993. Breeding systems for cross-pollinated perennial grasses. In: Plant Breeding Reviews, 11 Jules Janick (Ed.). John Wiley and Sons, New York (1993), pp. 251–274