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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 400 projects at a cost of $30 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Evaluating Poverty Grass (*Danthonia spicata*) for Golf Courses in the Midwest

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SUMMARY

Poverty grass (*Danthonia spicata* (L.) P. beauv. Ex Roem & Schult.) results presented here are part of ongoing studies to evaluate its adaptation for golf courses as part of low maintenance natural communities at Lincoln University of Missouri. Because its natural adaptation to shade and poor soils, poverty grass could be established in golf course roughs. However, among the challenges for adoption are the lack of commercially available seed and lack of information for long-term management as a turf that will be needed. Some of the summary highlights of this research include:

- High quality seed can be collected from natural stands with dense populations of poverty grass for commercial purposes.
- Poverty grass does not compete well with fast growing volunteer vegetation.
- Germination of poverty grass seed is affected by light, physical scarification, stratification, and temperature.
- Surveys should be conducted on land to be developed into golf courses before construction to assess how much poverty grass and other native vegetation is already present. By identifying its occurrence and abundance, costs of establishment, especially in rough areas could be reduced.

Most of the turfgrasses commonly used in lawns and golf courses in the United States are introduced species that require intensive and costly maintenance. Incorporating native vegetation within golf courses, especially in rough areas, may lessen their negative impact on the environment (8). Compared to introduced grasses, native vegetation usually has lower requirements for irrigation, fertilizers, or pesticides.

The Golf Course Superintendents Association of America offers environmental stewardship awards nationally and internationally to motivate golf course superintendents to adopt low-input maintenance methods that include the use of drought-tolerant grasses such as warm-season grasses and other perennial vegetation (3) that can provide habitat for native pollinators (9). In the Midwest and other parts of the country, warm-season grasses such as buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*) are being established in roughs where slightly taller vegetation can be used offering challenging opportunities for golfers (4, 8).

According to Audubon International, tall grasses can provide several benefits including golf course beautification, greater plant and animal diversity, and reduced costs for maintenance by reducing the use of fuel, pesticides, and other chemicals (1). Several of the major challenges with using native grasses, especially native cool-season grasses, include limited amounts of high quality seed and limited knowledge as to identification and propagation techniques for these grass-

Poverty grass is usually found in full sun to moderate shade environments in upland forests, upland prairies, and glades. It tolerates dry and acidic soil and also grows in rocky soils. *Photo credit:* Randy Tindall

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Seed production plots established with seedlings at Lincoln University, George Washington Carver Farm, Jefferson City, MO.

es. Preliminary results on genetic improvement of prairie junegrass (*Koeleria macrantha*) suggest that this species has the potential for adoption in golf course roughs and other low-input environment (12). However, more studies are needed to release cultivars that show good mowing quality and establishment rate among other characteristics such as drought and salinity tolerance.

Basic studies on poverty grass (*Danthonia spicata* (L.) P. beauv. Ex Roem & Schult.) that included germination improvement and evaluation of seed density requirements for field establishment, seed production, and shade tolerance were conducted at the University of Missouri (Columbia) and at Lincoln University (Jefferson City). Objectives were to determine its potential adaptability as a turfgrass in roughs in golf courses or lawns and to increase seed for commercial purposes.

Description of Poverty Grass

Poverty grass is a perennial native cool-season grass of short growth habit. It is a bunch grass that does not spread by rhizomes or stolons (13). It is widely distributed in North America and occurs naturally in 44 states in the USA, including Alaska, part of Canada, and Northern Mexico (6). It is a component of many plant communities across its range (2) and grows naturally with other low growing vegetation including lichens and mosses, pussytoes (*Antennaria spp.*), hairy wild petunia (*Ruelia spp.*), and bird-foot violet (*Viola pedata*, personal observations).

Poverty grass is usually found in full sun to moderate shade environments in upland forests, upland prairies, and glades. It tolerates dry and acidic soil and also grows in rocky soils. Seed can be collected from late June to July. One special characteristic to identify this grass, especially in the winter, is that the basal leaves of poverty grass become curly and strawlike. Upper leaves green up in early spring covering curly, dry leaves. There are approximately 400,000 seeds/lb. and seed is only commercially available in Missouri and few other locations in the country in limited quantities.

The USDA Forest Service initiated a study in 2007 to increase seed production in a natural stand at Superior National Forest in Minnesota by adding more seed (10). Preliminary results in 2008 showed promising results. In Minnesota, poverty grass seedlings established well on a cliff-edge with 68% survival three years after planting (7). Because poverty grass can be found growing in dense stands and the seed matures in early summer before most native grasses and forbs seed mature, poverty grass seed can be collected from natural prairies and open woodlands without much seed contamination. In Missouri, seed is mostly collected from natural stands. Seed production of poverty grass harvested from four natural prairie stands with histories of being hayed in early summer was similar in 2006 and 2008 (42 and 44 lb./acre, respectively (Mervin Wallace, personal communication).

Seed Collection and Seed Production Plots

During the first year of the study, seed was purchased from commercial nurseries in Missouri and in Minnesota. Price was $30 per pound from Missouri Wildflowers and $90 per pound from Prairie Moon Nursery who dry-cold stratify their seed before shipping. In 2008, poverty grass seed was collected from seven locations in Missouri that included prairie remnants and open woodlands.

Microscopic examination of seed from most sites shows a high percentage of viable seeds. However, germination rates can be low if not treated. Seed obtained from a natural prairie was 89% dormant and had 94% viability. Van den Grinten (11) processed seed through a hammermill for seedling production to establish them in the field with poor results. We produced seedlings in the greenhouse in plug trays from all collections to establish seed production plots in 2009. Seedlings were mulched and are hand weeded to control volunteer vegetation. Seed will be collected in 2010. Production plots were also established in 2007 and 2008 in other locations, but volunteer vegetation outcompeted poverty grass seedlings.

Seed Germination Studies

A series of growth chamber experiments were conducted to improve germination in 2007 and 2008. Experiments were conducted twice using experimental units consisting of 30 seeds placed on sterile plastic Petri dishes. Seeds were scarified (brushed) by repeated pulsing for 30 seconds inside a blender. Stratification consisted of placing seed in petri dishes lined with moist filter

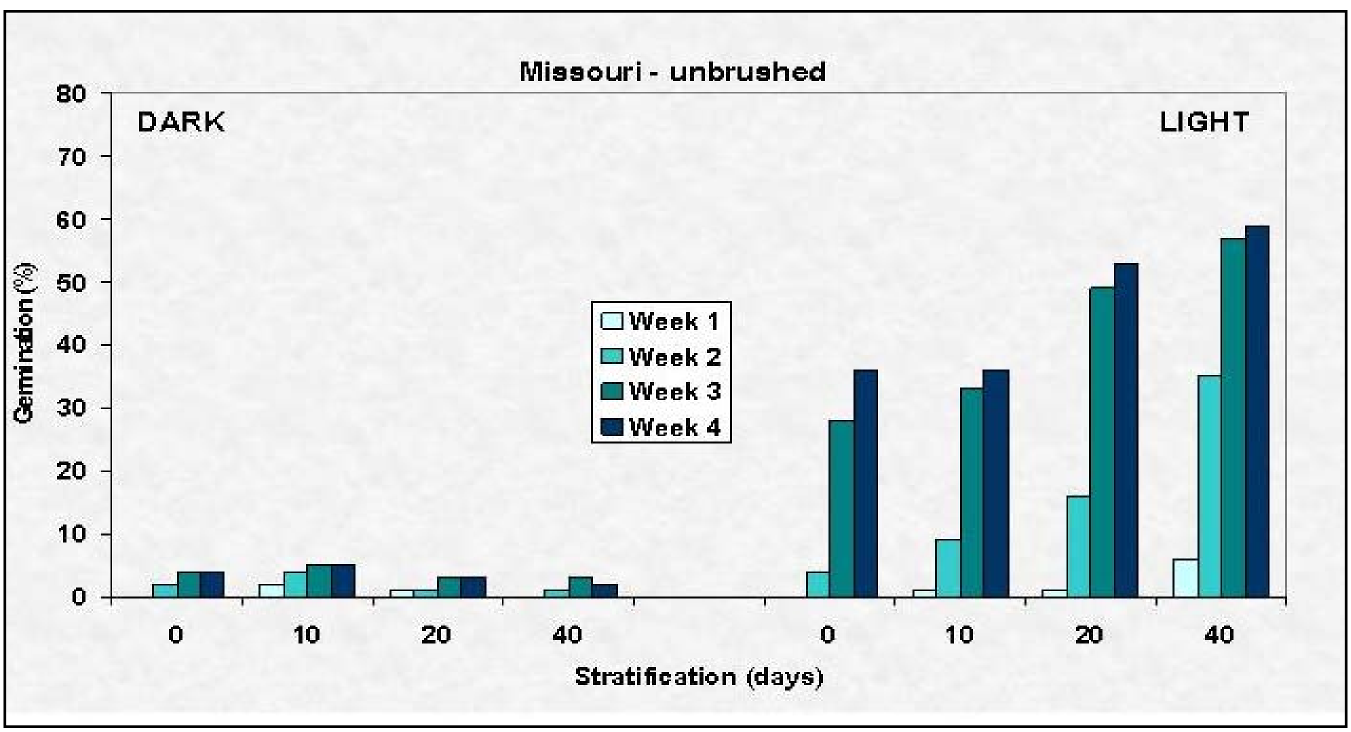


Figure 1. Percent germination for non-scarified Missouri seed stratified for 0, 10, 20, or 40 days germinated in the dark or light environments.

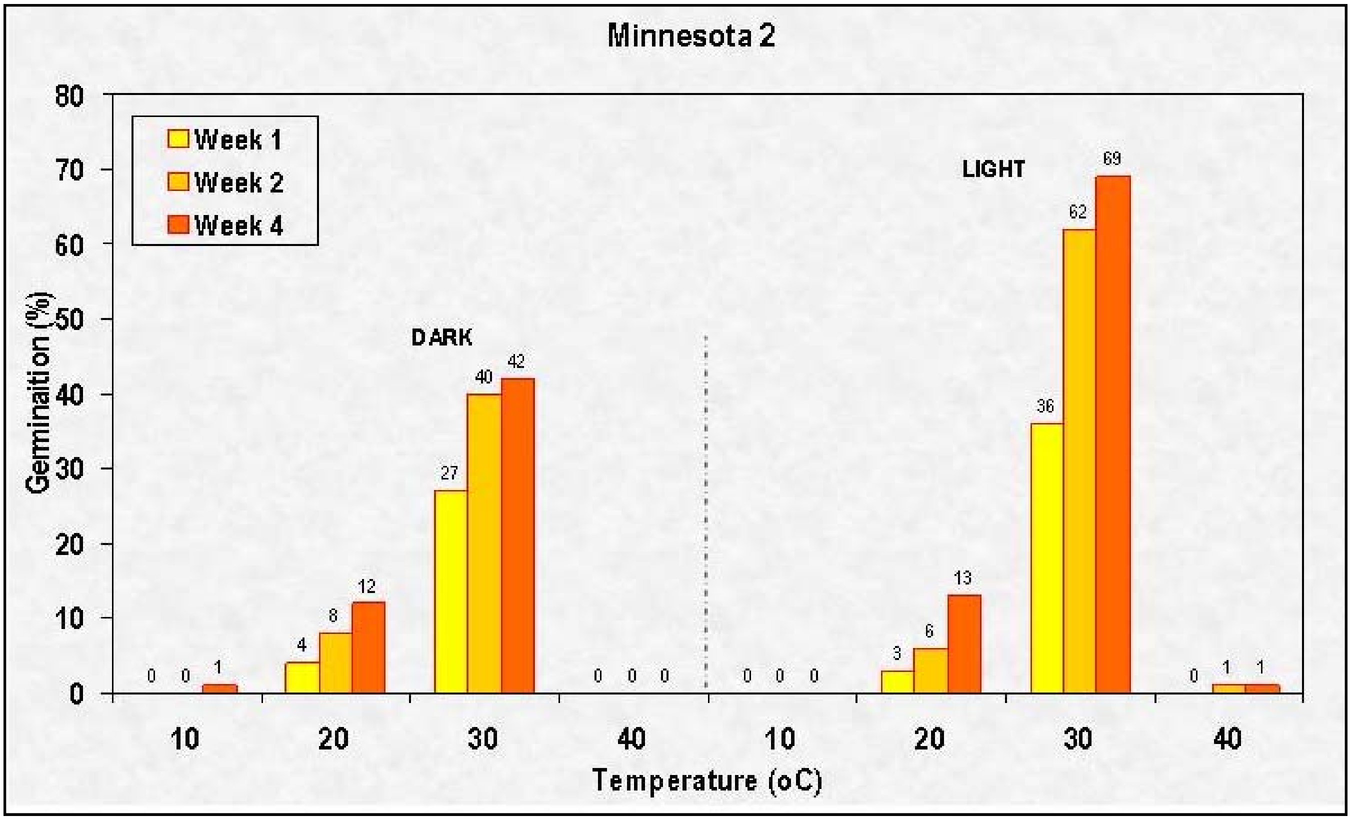


Figure 2. Germination at 10, 20, 30, or 40º C in the light or dark for Minnesota seed source.

paper before setting in a walk-in cooler (3-5º C) without light. For germination, petri dishes were moved to a walk-in growth chamber (25º C) and set under Gro-lux lamps. Petri dishes were covered with a layer of heavy duty aluminum foil for darkness treatments. Seed was checked weekly to count and remove germinated seed (radicles >1 mm). After four weeks, remaining non-germinated seed was also counted and recorded.

Effect of Light, Scarification, and Stratification on Seed Germination

Scarification, stratification, and light environment during germination all affected germination of Missouri seed. Average germination was higher for scarified or non-scarified seed when exposed to light than when maintained in a dark environment (Figure 1). For non-scarified seed, stratification increased germination. However, for scarified seed, germination was overall the highest and was not affected by stratification. Darkness produced low germination on stratified seed.

Germination in the light for scarified seed from Missouri pretreated with 0, 10, 20, and 40 days of cold-moist stratification was 64, 66, 62, and 59 %, respectively, compared to 35, 36, 53, and 59 %, respectively, for non-scarified seed. Germination was less than 5% for non-scarified seed in the dark. Germination of scarified seed declined from 40 % without stratification to less than 20 % for seed stratified for 40 days.

Temperature Effect on Seed Germination

To test effects of germination temperature, cold-dry stratified seed from from Minnesota was grown under four temperature treatments (10, 20, 30, and 40º C). At week 4, few seeds had germinated in either the light or dark at 10 or 40º C (Figure 2). Best germination (69%) was achieved at 30º C in the light. No differences were found for seed germination at 20º C in light and dark environments.

Seed Density Trials

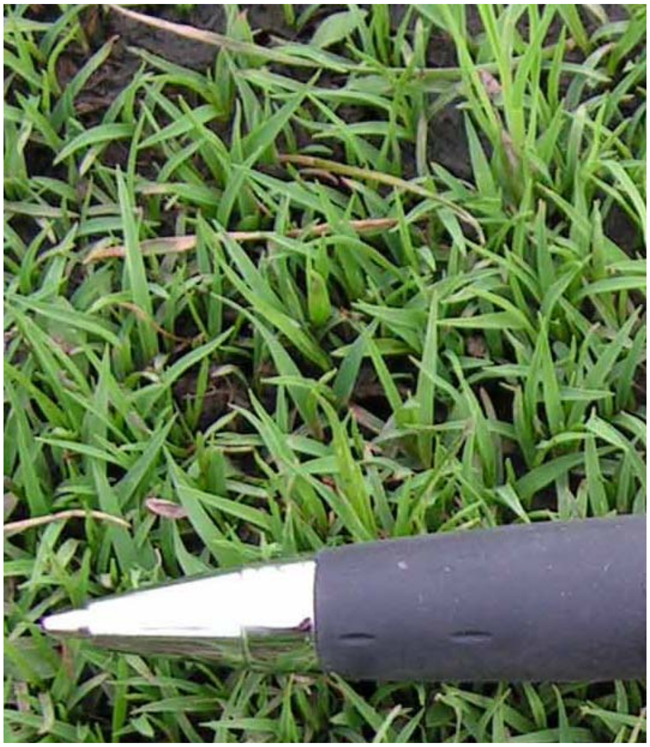
Plots were established on a silt loam soil at the University of Missouri Bradford Research and Extension Center in early June 2007. Half of the plots were tilled before planting and the other half were raked to remove dead vegetation before broadcasting the seed. Plots were broadcast seeded with 1000, 2000, or 3000 PLS /sq. ft. using scarified Missouri seed. Plots were mulched with a light layer of grass clippings at the time of seeding.

Seedling emergence occurred within 10-15 days after planting with an average temperature of 23º C. Forty days after seeding, ground cover for plots was 32, 29, and 49 % for 1000, 2000, and 3000 PLS/sq. ft., respectively. To control volunteer vegetation, low concentration applications of 2, 4-D and hand-weeding was done. Visual observations suggest that 2,4-D did not affect growth of 4-month-old poverty grass seedlings. Poverty grass seedlings in both raked and tilled plots failed to compete with the aggressive volunteer vegetation that emerged from the seedbank on this nutrient-rich site.

A second study was established in the fall after pre-treating site with glyphosate to kill existing vegetation in late summer. Plots were broadcast seeded with 1000, 2000, or 3000 PLS/sq. ft. in October at the University of Missouri Turf Research Center in Columbia. Seedling emergence occurred within 15 days after planting when

Seed Source	Light	Flowering Plants	Foliage Dry Wt	Plant Dry Wt
	(% of full sun)	(%)	(grams)	(grams)
SW Missouri	100	72	2.93	3.15
Grazed Prairie	80	50	2.28	2.38
	70	76	2.59	2.75
	50	67	2.67	2.81
	20	28	1.07	1.09
Callaway County	100	56	5.14	5.25
Hayed Meadow	80	24	4.03	4.04
Central MO	70	20	3.42	3.48
	50	24	4.08	4.12
	20	8	2.79	2.80
Boone County	100	16	3.43	3.46
Open Woodlot	80	12	3.78	3.79
Central MO	70	28	2.51	2.53
	50	13	3.68	3.69
	20	12	2.77	2.78
SE Missouri	100	12	2.31	2.32
Prairie	80	4	2.74	2.74
	70	12	1.81	1.83
	50	10	2.71	2.71
	20	4	1.86	1.86

Table 1. Percent of plants flowering and mean annual dry weight with and without flowering culms for four Missouri sources of poverty grass (*Danthonia spicata*) grown under five light levels in a well-drained loamy soil.



Fifteen day-old seedlings of poverty grass growing in the field in early spring.

air temperatures averaged 14º C. Seedlings remained green until the first killing frost in November. Percent ground cover in late April for plots seeded with 1000, 2000, and 3000 PLS/sq. ft. was 21, 21, and 30%, respectively, and in late May, it was 24, 25, and 27%, respectively.

The seed bank in this plot was contaminated with red clover (*Trifolium pratense*) and tall fescue (*Festuca arundinaceae*). Excessive growth of these two species again outcompeted poverty grass seedlings. Remedy (triclopyr) and 2,4-D applications offered some control of red clover with no visible toxicity on poverty grass seedlings. Recently, poverty grass was seeded at a rate of 1000 seed/sq. ft. on a poor and dry demonstration site on a residential garden in the fall. Three years after seeding, percent ground cover is about 80%.

Shade Tolerance

Unlike poverty grass growing in prairies under full sun, poverty grass growing in open woodlands must adapt to shaded environments. Two experiments were established to determine the effect of shade and source of seed on plant growth and seed production.

During the first experiment, three grass seedlings were planted in white 6-inch diameter pots filled with Metro-Mix® with good drainage. Light weight structures covered with shade cloth were built to provide shade (20, 45, 70, and 100% of sunlight), similar to light provided at ground level in closed canopy forest, open woodlands, savanna, and open ground, respectively. This experiment was established at the University of Missouri, Bradford Research Center in Columbia in early spring 2008. Plants were watered as needed and were clipped to a 2.5 cm stubble in the fall to determine biomass. The experiment was a completely randomized block design with four light level treatments and three replications using only one source of seed.

For the second experiment, four sources of seed collected in Missouri were established under five light levels (20, 50, 70, 80, and 100% of sunlight) at Lincoln University's George Washington Carver Research Farm located in Jefferson City in spring 2009. At this site, plots were established on a well drained loamy alluvium. Planting site was sprayed with glyphosate in fall 2008 and twice in

Demonstration plot established with poverty grass seed in a lawn.

the spring 2009. Once the site was cleaned of other grasses and forbs, three-month-old seedlings were planted in mid- to late-May into the 0.9 x 0.9 meter plots.

Each plot was divided in four subplots (each subplot had five plants of the same accession). Plots were mulched with a very fine wood mulch and hand-weeded to suppress weeds. Seedlings were watered during establishment and as needed. Plots were covered with similar wood shade frames used for the first experiment describe above. Plant diameter, height, survival, and number of flowering culms were determined in early fall. Plants were clipped to a 2.5 cm stubble to determine dry weight in late fall.

Significant differences were found among the four seed sources collected across Missouri for percentage of plants flowering during their first growing season and average plant dry weight with and without the flowering culms (Table 1). There was a trend for plants under full sunlight to have the highest forage yields. However yields for plants under 50 to 80 percent of full sunlight were seldom statistically different. Forage yields markedly declined under 20 percent of full sunlight.

Conclusions

Because poverty grass does not compete well with fast growing volunteer vegetation in rich soils, it is recommended to establish it in stands with poor, dry, and rocky soils. Poverty grass could be grown in roughs or other areas in golf courses where taller grasses can offer challenges to golfers. Poverty grass' natural appearance, especially in the winter, can help to beautify golf courses. The addition of pussytoes, birdfoot violet, and other short forbs, will provide a pleasant environment to golfers and habitat for desirable wildlife such as native pollinators. The Native Plants Program at Lincoln University will continue evaluating long term management practices in stands of poor soil in golf courses and lawns and its tolerance to shaded environments for use in golf courses or other natural or maintained environments.

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