Germination, Forage Yield, and Seed Production of American Sloughgrass (*Beckmannia syzigachne*)

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Abstract

Germination, forage yield, and seed production characteristics were studied in American sloughgrass (*Beckmannia syzigachne* (Steud.) Fern.), a valuable wetland forage species in the northwestern and northcentral states. Germination of field-collected caryopses from northeastern Montana, stored at 7°C for 60 days postharvest, was significantly ($P<0.05$) higher under alternating temperatures (7° C for 15 h and 21° C for 9 h in each 24-h period) than at constant 21°C. Germination percentages greater than 60% were found for freshly harvested greenhouse-produced spikelets and caryopses after 14 days in complete darkness, and no significant differences were detected between complete darkness and 15 h dark/9 h light treatments under alternating temperatures. Greenhouse-produced caryopses were significantly heavier and exhibited significantly higher germination than caryopses from field collections. A Montana field collection and a seed increase of that collection significantly ($P<0.05$) outyielded a local South Dakota collection for both forage and seed at Brookings, South Dakota. Overall mean dry matter forage and mature seed yields were 2,700 and 540 kg/ha, respectively. Forage yields at early-head of the seed increase population planted at 15, 18, and 21 kg/ha were not significantly different and had an overall mean of 5,000 kg/ha. These preliminary data indicate that the potential of *B. syzigachne* as a cultivated forage for cropland depressions in the Northern Great Plains does not appear to be limited by complex germination requirements, low forage yield, or weak seed production.

American sloughgrass (*Beckmannia syzigachne* (Steud.) Fern.) is the North American native of a bispecies genus that is widespread in the cooler parts of Eurasia and North America. *B. syzigachne* is present in marshes and along ditches throughout the northwest and northcentral states and is occasional in the Northeast (Gould and Shaw 1983). It frequently colonizes denuded wetland soils resulting from mud flat exposure, livestock grazing, or tillage (Walker and Coupland 1968, Stewart and Kantrud 1971, Millar 1973, 1976). As early as 1896, Beal pointed out that *B. syzigachne* was a forage of some prominence west of the Mississippi River. It is palatable to livestock (Hitchcock 1951, Stevens 1963) and is frequently hayed or grazed (Clarke and Tisdale 1945). Forage nutritional data (Clarke and Tisdale 1945, National Academy of Science 1971) indicate it is high in protein and nonstructural carbohydrates. Studies in the USSR (Komarov 1963) indicated that *Beckmannia eruciformis* (L.) Host. was similar to timothy in forage quality, gave satisfactory hay yields, good aftergrowth, and was tolerant of salinity. Several authors (Hitchcock 1951, Moss 1959, and Koyama and Kawano 1964) have pointed out strong morphological similarities between *B. syzigachne* and *B. eruciformis*, and Hulten (1968) considered them to be synonymous.

Hoffman et al. (1980) reported low germination percentages for *B. syzigachne*, obtaining a high of 26% from disseminules that had overwintered dry and were tested under ambient April light and temperatures at Vermillion, South Dakota. They also indicated that darkness inhibited germination.

In a preliminary study, Boe and Evans (1981) reported intact spikelets and caryopses freed from spikelet bracts exhibited poor germination at room temperature and disappointing emergence in greenhouse plantings. However, they did observe up to 91% germination in 15 days under an alternating temperature regime of 7°C for 15 hours and 21°C for 9 hours.

Our objectives were: (1) to investigate germination characteristics of *B. syzigachne*, and (2) to investigate forage yield and seed production potentials of *B. syzigachne* in field plantings near Brookings, S. Dak.

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Materials and Methods

Germination Studies

Spikelets were collected along a creek in northeastern Montana, near Outlook, in August 1979, 1980, and 1981 and along a pond near Brookings, S. Dak., in August 1982. Germination studies were conducted on spikelets and caryopses from Montana collections and on spikelets and caryopses produced in the greenhouse from the 1979 and 1980 collections. A South Dakota Seed Blower was used to separate inert matter from spikelets containing caryopses. A rubber threshing board was employed to free caryopses from spikelet bracts. Spikelets and caryopses were considered germinated when coleoptiles were visible. Analyses of variance were conducted on germination percentages transformed by the arcsine transformation (Sokal and Rohlf 1969).

Experiment 1: This experiment was initiated 28 April 1981. Spikelets and caryopses produced in the greenhouse in March 1981 and not previously exposed to a cold period were placed on blotters moistened with deionized water in germination trays. A factorial arrangement of treatments within a completely randomized design was employed. Half the germination trays were kept in darkness at 7°C for 15 hours and were subsequently transferred to a laboratory bench facing a large north window from 0800 to 1700 hours each day. Temperatures in the laboratory were noted at 0800, 1200, and 1700 hours and averaged 21 ± 1°C. Ambient light entered through the window and no auxiliary lighting was employed. The remaining trays were double-wrapped with aluminum foil to occlude light, but subjected to the same temperature fluctuation. Two replications of 50 caryopses and 50 spikelets were used for each treatment. Germination was noted at 14 days.

Experiment 2: This experiment was initiated 30 November 1981. Caryopses from the 1981 field harvest, stored at 7°C since immediately after harvest, were placed in germination trays in a completely randomized design with a factorial arrangement of 4 light and temperature treatment combinations. Temperature effects employed were: (1) the alternating regime of Experiment 1, and (2) constant 21°C. Light effects employed were the same regime as Experiment 1. Unwrapped trays that were kept in the laboratory were covered with black plastic from 1700 to 0800 hours, while the unwrapped trays subjected to the alternating temperatures regime were kept in darkness at 7°C for the same period each day. Three replications of 100 caryopses/treatment combination were used. Germination was noted at 14 and 21 days.

Experiment 3: This experiment was initiated 10 March 1982. Caryopses from 1979, 1980, and 1981 field collections, and 1980 and 1981 greenhouse increases of 1979 and 1980 field collections, all stored at 7°C since immediately after harvest, were subjected to the temperature and light regime described in Experiment 1 (15 h dark/7°C and 9 h light/21°C). Three replications of 100 caryopses/lot were used. Germination was noted at 14 and 21 days. Weights were determined for 2 random 50-caryopses samples from each lot.

Forage Yield, Seed Production, and Field Germination Studies

In November 1981 the initial forage yield trial (Trial 1) was planted on a Lamoure silty clay loam, nearly level [fine-silty, mixed (Calcareous), frigid Cumulic Haplaquolls] soil approximately 2.0 km north of Brookings. Three different seeding rates (13, 18, and 23 kg/ha) of the 1981 field-collected lot were planted in a randomized complete block design. Planting was done with a 4-row (30-cm row-spacing) belt seeder equipped with double-disc openers and depth bands. Individual plot size was 1.2 by 6.3 m. On 9 July 1982, 2 replicates in Trial 1 were harvested for forage yield. Plants were in late-boot to early-flower stages. On 2 August 1982, the third replicate of Trial 1 was harvested for seed yield.

In November 1982, 2 additional 3-replicate yield trials were planted near Brookings. Trial 2 was planted adjacent to Trail 1, and was comprised of 3 seed lots as follows: (1) 1981 Montana field collection (MT81); (2) 1982 field collection from a pond near Brookings (BP82); and (3) 1982 seed increase at Brookings from the 1981 Montana field collection (SD82). Seeding rate was 18 kg/ha. Trial 3 was planted on a Vienna loam, nearly level [fine-loamy, mixed Udic Haploborolls] on the Agronomy Farm near the SDSU campus, and incorporated 3 different seeding rates (15, 18, and 21 kg/ha) of the 1982 seed increase material (SD82). Planting method and plot size for Trials 2 and 3 were as described for Trial 1. Trials 2 and 3 were hand-weeded once during June 1983. On 11 July 1983, Trial 3 was harvested for forage yield. Plants were in late-boot to early head stages. Trial 2 was harvested on 3 August 1983 for forage and mature seed yields. Forage moisture samples were taken from each plot at harvest time for later calculation of dry matter yields. Panicles were disarticulated by hand and fertile spikelets were separated from inert material with a South Dakota Seed Blower. Seed yields were determined based on total weight of fertile spikelets from each plot.

In October 1983, six 60-cm² plots were randomly selected within the 2 middle border rows of Trial 3. The border rows had not been harvested for seed, and mature spikelets produced in those rows had disarticulated from the rachis in August. Within each of these plots, which were excavated to a depth of 2.0 cm, numbers of fall-germinated seedlings and nongerminated spikelets were determined after the soil had been carefully removed in the laboratory by rinsing on a fine-mesh screen.

Results and Discussion

Germination Studies

Experiment 1: Greenhouse-produced spikelets and caryopses previously stored at room temperature for 45 days post-harvest, when subjected to alternating temperatures and complete darkness, exhibited mean germination percentages comparable to those in uncovered trays (Table 1), indicating darkness did not severely inhibit germination.

Experiment 2: Caryopses subjected to the alternating temperature regime achieved significantly higher ($P<0.05$) germination percentages than those maintained at 21°C (Table 1). Within each of the 2 temperature treatments, no difference was detected between trays kept in the dark and those exposed to ambient April light from 0800 to 1700 hours each day. Alternating temperatures have been shown to enhance germination of numerous range grasses (Toole 1940). However, McElgunn (1974) reported that 10 grass species averaged higher germination at constant 21°C than at 7°C for 12 hours and 18°C for 12 hours.

Table 1. Effects of temperature, spikelet bract removal, and seed source on laboratory germination of American sloughgrass.*

Treatment	Days 14	Days 21
	%	
Experiment 1[1]		
Caryopses; 15 h dark/9 h light	61 a	
Caryopses; dark	48 a	
Intact spikelets; 15 h dark/9 h light	42 a	
Intact spikelets; dark	65 a	
Experiment 2		
Alternating temperature[1]; dark	47 a	—
Alternating temperature; 15 h dark/9 h light	35 a	43 a
Constant 21°C; dark	1 b	1 b
Constant 21°C; 15 h dark/9 h light	2 b	3 b
Experiment 3[2]		
1980 greenhouse	96 a	96 a
1981 greenhouse	91 a	92 a
1979 field	57 b	60 b
1980 field	60 b	62 b
1981 field	70 b	71 b

*Mean in same column followed by a different letter are significantly different at the the 5% level. — indicates missing data.
[1]Temperatures employed were 7°C for 15 h and 21°C for 9 h in each 24 h period.
[2]Temperature and light treatments employed were 7°C in dark for 15 h and 21°C in light for 9 h in each 24 h period.

Experiment 3: The highest germination percentages were found for the greenhouse-produced lots (Table 1). After 14 days, the 1980 and 1981 greenhouse-produced lots exhibited mean germination percentages of 96 and 91%, respectively. Greenhouse-produced caryopses were significantly ($P<0.05$) heavier than caryopses from field collections. Mean 50-caryopses weights were 16.8 and 13.2 mg for greenhouse-produced and field-collected lots, respectively. Higher germination percentages and faster germination rates for large compared to small seed have been reported for numerous range (Green and Hansen 1969) and pasture (Kneebone 1972) grasses.

Forage Yield, Seed Production, and Field Germination Studies

No significant differences in forage yield in 1982 were detected among the 3 planting rates in the 1981 trial. The overall dry matter forage yield mean was 2,800 kg/ha. The overall seed yield mean was 650 kg/ha.

Forage and seed yield data obtained in 1983 from the 2 1982 yield trials are presented in Table 2. In Trial 2, significant differences were found among seed sources for both forage and seed yields. Seed sources of Montana origin significantly ($P<0.05$) outyielded the local field collection for both forage and seed. Mean forage

Table 2. Mean dry matter forage and seed yields in 1983 for two American sloughgrass yield trials planted at Brookings, SD in November 1982.*

Seed source	Trial 2 Forage yield	Trial 2 Seed yield	Trial 3 Seeding rate	Trial 3 Forage yield
	——kg/ha——			
SD 82	3250 a	620 a	15	4330 a
MT 81	2850 a	560 a	18	5380 a
BP 82	1990 b	440 b	21	5300 a

*Means in the same column followed by different letter are significantly different at the 5% level.

yields ranged from 3,250 to 1,990 kg/ha for the 1982 seed increase of material collected in Montana in 1981 and the local collection, respectively. In Trial 3, no significant differences were detected among the 3 planting rates. Although initial emergence appeared to be positively associated with planting rate in Trial 3, failure to detect differences in forage yield among planting rates may be due to this species' high tillering capacity. Overall dry matter yield means were 3,240 (forage plus seed) and 5,000 kg/ha for Trials 2 and 3, respectively. Differences in harvest time may partially explain these yield differences, since Trial 3 was harvested at early-head while Trial 2 was harvested at seed maturity when general vegetative deterioration was quite evident. Also, the highest yielder in Trial 2 (SD 82) was the seed source for the planting rate study (Trial 3).

Numbers of seedlings and nongerminated spikelets obtained in October 1983 from 6 sample plots within the border rows of the 1982 Trial 3 averaged $54{,}399.8 \pm 6{,}248.0$, and $65{,}985.4 \pm 17{,}668.8/m^2$, respectively. Percent germination of spikelets (calculated as total number of seedlings/(total number of seedlings + total number of nongerminated spikelets obtained from the 6 plots)) was 45%. This percentage was determined from spikelet numbers and was not adjusted to represent only those spikelets that contained caryopses. Since 100% caryopses set in field-grown spikelets seems unlikely, field germination percentage calculated for caryopses may be expected to be somewhat higher. However, Boe and Evans (1981) reported 100% self-fertility and caryopses set in inflorescences of greenhouse-grown plants.

Conclusions

The potential forage values of many native species are unrealized. However, several factors that may limit the number of natives that can be profitably incorporated into cultivated forage systems are: (1) complex germination requirements that inhibit rapid and uniform germination, (2) low forage yield potential, and (3) poor seed production. This preliminary research was aimed at determining if any of these factors were characteristic of *B. syzigachne*, a native species recognized as a valuable component of wetland forage.

We observed 45% germination in the field in October for spikelets that had matured and disarticulated in the summer, and up to 96% germination for freshly harvested caryopses under alternating temperatures in the laboratory. These data indicated a lack of complex seed dormancy characteristics in the germplasm studied. Nonrestrictive germination requirements and prolific seed production capabilities may be important characteristics associated with this species' ability to rapidly colonize exposed mudflats and disturbed wetlands. Dix and Smeins (1967) reported that *B. syzigachne* was commonly found in cropland depressions in eastern North Dakota. The seed unit that disarticulates from the rachis at maturity is a firm, glabrous, free-flowing spikelet that presents no difficulties for conventional planting equipment.

Forage and seed yields under dryland conditions at 2 locations were similar to long-term averages for smooth bromegrass (*Bromus inermis* Leyss) in the same area (Ross and Krueger 1976). This indicated that high yielding stands of *B. syzigachne* could be successfully established from dormant plantings made after freeze-up.

In the Northern Great Plains, there is a need for more efficient utilization of seasonal wetlands where cropping with cereal or row crops is unpredictable due to high spring-time moisture levels, and where dense sod-forming perennial grasses, such as reed canarygrass (*Phalaris arundinacea* L.) and creeping foxtail (*Alopecurus arundinaceus* Poir.), are not desired. These data indicate that *B. syzigachne's* potential for utilization as a pasture or hay crop does not appear to be limited by complex germination requirements, low forage yield potential, or poor seed production. At this point, more extensive ecotype collection and evaluation for forage yield and quality and adaptability to short-term forage production in seasonal wetlands seems warranted.

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