Germination of mechanically scarified neoteric switchgrass seed

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Abstract

Stand establishment from neoteric switchgrass (*Panicum virgatum* L.) seed can be hindered due to dormancy. The objective of this study was to evaluate the effect of mechanical scarification on germination and seedling emergence of neoteric (1- to 18-month-old) switchgrass seed. Scarification for 15 or 30 seconds in a Forsberg cylinder scarifier significantly increased 14-day germination percentage for 1- to 5-month-old seed of 5 cultivars. The magnitude of increase in seedling emergence due to scarification varied across cultivars. Four-month- and 18-month-old seed lots of 'Sunburst' and a North Dakota ecotype (NDE) exhibited significant increases in germination and seedling emergence after scarification. Scarification increased overall mean germination percentage for 3 lots of Sunburst and 2 lots of NDE by 73%. Field studies are needed to determine the usefulness of mechanical scarification as a preplant treatment for neoteric seed.

Key Words: *Panicum virgatum* L., seedling vigor, stand establishment, seed coat, lemma, palea

Switchgrass is generally easier to establish than many other native grasses, but neoteric seed lots often exhibit delayed and sporadic germination and emergence due to seed dormancy. Assuming proper seedbed preparation and utilization of appropriate herbicides and planting equipment, seeds that germinate promptly after planting produce seedlings that generally have the benefit of temperature, light, and moisture conditions conducive to rapid seedling growth.

The seed coat or outer coverings of the embryo are partially responsible for dormancy in various grasses (Burton 1939, Byers 1973, Fendall and Carter 1965, Laude 1951, Sautter 1962, Wright 1973, Zemetra et al. 1983). Coverings of the embryo may inhibit germination by interfering with water uptake or gas exchange, by containing chemical inhibitors, by acting as a barrier against escape of inhibitors from the embryo, by modifying light reaching the embryo, or by exerting mechanical restraint (Bewley and Black 1982).

The seed unit of switchgrass is a floret with a shiny, glabrous, firm lemma and palea that tightly enclose the caryopsis. Sautter (1962) reported an 84% increase in emergence after rubbing switchgrass seeds between emery cloths to remove the lemma and palea, and Byers (1973) showed hull removal increased germination by 60%. These studies indicated a high degree of the dormancy was caused by floret bracts.

The objective of this study was to evaluate mechanical scarification for increasing rapid germination and seedling emergence, measured at 14 days after planting, in neoteric seed lots of switchgrass.

Materials and Methods

Experiment I

This experiment consisted of: (1) laboratory germination trials conducted in February, April, May, and July 1983, and (2) seedling

emergence trials conducted in the greenhouse in January, February, and April 1983.

Seed lots used were: (1) 'Sunburst' stored at 7° C and 43% RH since harvest in September 1981 (81-cold); (2) Sunburst stored at room temperature since harvest in September 1982 (82-room); (3) Sunburst stored in cold storage at 7° C and 43% RH since harvest in September 1982 (82-cold); (4) NDE (a North Dakota ecotype) stored at 7° C and 43% RH since harvest in August 1981 (81-cold); and (5) NDE stored at room temperature since harvest in August 1982 (82-room).

At each planting date, random 5-g samples from each lot were subjected to: (1) no scarification (0); (2) 15 seconds of scarification in a Forsberg cylinder-type scarifier^a equipped with 2/0 emery cloth; or (3) 30 seconds of scarification (procedure same as 2). Three 100-seed (fertile floret) replicates of each seed lot × scarification time combination planted on 2 blotters moistened with 0.2% KNO₃ solution in covered 10 cm × 10-cm plastic germination boxes were placed in completely randomized designs on shelves in alternating (15° C/16 hr; 30° C/8 hr) and constant 20° C temperature germinators on each date. Photosynthetic photon flux in the alternating temperature germinator was supplied with fluorescent bulbs at approximately 5 μmol photons/m²/sec (400–700 nm) during the 30° C period. The germinator set at constant 20° C was not equipped with lights. Germination was determined at 14 days. Seeds were considered germinated if both radicle and coleoptile were visible.

Germination percentage data were analyzed as a factorial arrangement of germinator temperatures, scarification times, and seed lots in a randomized complete block design with planting dates serving as blocks. The analysis was conducted on mean germination percentages of the three 100-seed replicates of each germinator temperature × scarification time × seed lot combination within each planting date.

For seedling emergence trials in the greenhouse, three 25-seed replicates from the same 5-g seed lot × scarification time samples used for germination trials were planted in completely randomized designs in a 3-soil [Vienna loam (fine-loamy, mixed udic haploborolls): 1-sand mixture in 10 cm diameter × 15 cm clay pots at a depth of about 1.5 cm. The NDE 81-cold lot was not included in the January trial. Pots were watered as needed, and seedling emergence was determined at 14 days. Plants were considered emerged if at least the coleoptile was visible. The thermostat in the greenhouse was set at 23° C, but higher temperatures occurred during mid-day under sunny conditions. No supplementary lighting was used. Since the NDE 81-cold lot was not included in the January trial, seedling emergence data were analyzed by individual planting dates as factorial arrangements of scarification times and seed lots in completely randomized designs with 3 replications.

All effects were considered fixed.

Experiment II

In this experiment germination trials were conducted in October and November 1983 and January 1984, and a seedling emergence trial was conducted in the greenhouse in October 1983 on Sunburst, 'Pathfinder', 'Dacotah', 'Summer', and 'Forestburg' seed harvested in September 1983 from a seed yield trial at Brookings,

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S.Dak. Sampling scarification procedures, and germination and emergence data collection were conducted as in Experiment I. Seed was kept under cold storage during the 4-month period.

Germination and seedling emergence percentage data were analyzed as for Experiment I, but cultivars, since they represented a range in the genetic variability that exists among switchgrass populations from the northern and central Great Plains, were considered random.

Results and Discussion

Experiment I

Highly significant ($P \leq 0.01$) differences were found among treatment means in each of the 4 main effects (i.e., scarification time, planting date, germinator temperature, and seed lot) for 14-day germination percentage, but scarification time $\times$ seed lot and scarification time $\times$ seed lot $\times$ germinator temperature interactions were also highly significant ($P \leq 0.01$).

Scarification for 15 seconds significantly increased 14-day germination percentage over the nonscarified treatment for all seed lots in the 15/30° C and 20° C germinators, with the exception of Sunburst 81-cold and 82-room lots in the 15/30° C germinator. Increases in germination percentage due to 15-sec scarification ranged from 5% for Sunburst 81-room to 36% for NDE 82-room in the 15/30° C germinator. Scarification for an additional 15 seconds had little effect on germination percentage of all 5 seed lots, with the only significant increase in germination percentage occurring for NDE 82-room in the 20° C germinator (Table 1).

Table 1. Germination at 14 days of nonscarified and scarified seed of 5 lots of switchgrass tested at 2 temperature regimes.

Lot	Temperature	Seconds of scarification		
		0	15	30
	° C	----- % -----		
Sunburst				
81-cold	15/30	73	82	82
	20	32	61	67
82-room	15/30	69	74	71
	20	38	56	55
82-cold	15/30	32	55	55
	20	7	36	39
NDE				
81-cold	15/30	30	51	55
	20	13	32	33
82-room	15/30	8	44	51
	20	2	13	28
LSD (0.05)			10	

Fourteen-day germination percentage was significantly higher in the 15/30° C germinator than the 20° C germinator for all seed lot $\times$ scarification time combinations other than the nonscarified NDE 82-room lot (Table 1). Ahring et al. (1959) found constant 20° C resulted in less than 50% germination of 6-month-old switchgrass seed, while an alternating temperature of 20/35° C produced 88% germination. Nakamura (1962) also noted the effectiveness of alternating temperatures for germination of switchgrass.

Germination percentage increased with aging of seed from February to July. The mean of the July trial (49%) was significantly ($P \leq 0.05$) higher than means of the February (42%), April (44%), and May (45%) trials.

The higher germination percentage of Sunburst 82-room compared to Sunburst 82-cold in both germinators (Table 1) suggested dormancy in Sunburst dissipated faster under room temperature than under cold storage conditions. Coukos (1944) found big

bluestem (*Andropogon gerardii* Vitman) and little bluestem [*Schizachyrium scoparium* (Michx.) Nash] retained dormancy longer if kept under low temperature and relative humidity.

Significant scarification time $\times$ seed lot interactions for each planting date indicated the effect of scarification on seedling emergence in the greenhouse was not uniform across lots (Table 2).

Table 2. Seedling emergence of 5 mechanically scarified and nonscarified seed lots of switchgrass 14 days after planting in the greenhouse.

Scarification time	Lot	Month of test in 1983		
		January	February	April
Seconds	Sunburst	----- % -----		
0	81-cold	24	19	73
15	"	36	55	84
30	"	35	49	72
0	82-room	11	9	87
15	"	12	33	73
30	"	27	13	60
0	82-cold	4	3	55
15	"	17	19	68
30	"	29	17	49
	NDE			
0	81-cold	— ¹	11	43
15	"	—	31	60
30	"	—	41	67
0	82-room	0	0	32
15	"	32	28	51
30	"	37	36	64
LSD (0.05)		13	14	13

¹Not included in this test.

Scarification for 15 or 30 seconds significantly increased seedling emergence for both NDE lots in all 3 trials. Although 15- or 30-sec scarification treatments significantly increased 14-day seedling emergence percentage of Sunburst 82-room and 82-cold in January, all 3 Sunburst lots in February, and the 82-cold lot in April, the effect of scarification was less consistent for Sunburst than for NDE lots. The considerably higher emergence percentage in April was likely due to warmer daytime soil temperature in the greenhouse due to increased daylength and higher ambient light intensity.

Experiment II

Scarification significantly ($P \leq 0.01$) increased germination percentage of the 5 cultivars. Mean germination percentages for 0-, 15-, and 30-sec scarification treatments were 9, 39, and 39%, respectively.

As was found in Experiment I, germination percentage was significantly ($P \leq 0.01$) higher in the 15/30° C than the 20° C germinator (38 and 20%, respectively), and also increased with aging of the seed. Mean germination percentages for October and November 1983 and January 1984 tests were 20, 26, and 41%, respectively.

Germination percentage differed ($P \leq 0.01$) among cultivars and ranged from 22 to 36% for Forestburg and Pathfinder, respectively. Tetrazolium tests were not conducted on the remaining nongerminated seeds, therefore these data do not necessarily reflect viability differences among cultivars.

Highly significant ($P \leq 0.01$) differences were found among scarification times and among cultivars for seedling emergence in the greenhouse in October 1983, but a highly significant ($P \leq 0.01$) scarification time $\times$ cultivar interaction indicated the effect of scarification was not consistent across cultivars. As was found in Experiment I, 15-sec scarification generally increased emergence, but increasing scarification time to 30 seconds had either no effect or a negative effect depending on the cultivar (Table 3).

Table 3. Seedling emergence of nonscarified and mechanically scarified neoteric seed of 5 switchgrass cultivars 14 days after planting in the greenhouse.

Cultivar	Scarification time		
	0 sec	15 sec	30 sec
	----- % -----		
Sunburst	3	33	27
Pathfinder	20	59	33
Summer	7	9	5
Dacotah	0	6	10
Forestburg	4	20	19
LSD (0.05)		12	

Conclusions

Our results demonstrated that mechanical scarification of neoteric switchgrass seed increased 14-day germination and seedling emergence in the greenhouse. The effect of scarification on seed unit structure was not evaluated, but since lemmas and paleas generally remained intact after scarification, the abrasion appeared not to be severe. Scarification may have weakened fibers in the lemma, thus decreasing restriction in water uptake and embryo expansion caused by the tight seal formed by the lemma and palea (West and Marousky 1989).

In only 1 case (Sunburst 82-room seedling emergence in April) did we observe a negative effect of 15-sec scarification on 14-day germination and seedling emergence. However, since the effect of an additional 15 seconds of scarification was not consistent across seed lots, the length of time of scarification that produces the greatest increase in rapidity of germination and seedling emergence may be seed lot dependent. Acid scarification of freshly harvested kleingrass (*Panicum coloratum* L.) seed differentially stimulated or hindered germination of certain genotypes (Tischler and Young 1983).

McWilliams (1950) showed that germination percentage of switchgrass increased with age of seed up to 4 years. Planting neoteric seed is not recommended if older high quality seed is

available. However, in periods of high demand neoteric seed may be all that is available. Field studies comparing emergence rates and stand establishment characteristics of scarified and nonscarified lots of neoteric seed of switchgrass need to be conducted. Development of simple, mechanical seed treatment procedures that increase speed of seedling emergence of switchgrass would be beneficial throughout the Great Plains.

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