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Determining Optimal Establishment and Cultural Practices for Switchgrass Biomass Production in Texas

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Summary

Switchgrass (*Panicum virgatum* L.) has been selected by the U. S. Department of Energy for development as a biomass crop. Research is being conducted in the south-central United States. In Texas, trials are under way to evaluate cultivars, management practices, seed quality, and seedling growth characteristics. Early results indicate a positive response to nitrogen at rates up to 200 lb/acre and a smaller increase in yield in response to phosphorus fertilizer; maximum yields have been 10,000 lb/acre. Germination of fresh seed has been improved by treatment with sulfuric acid from 52 to 92%.

Introduction

In response to growing concerns over consumption of nonrenewable fuel sources, the U.S. Department of Energy, through the Biofuels Feedstock Development Program (BFDP), has initiated biomass technology research. Switchgrass was selected for its high yield potential, adaptation to marginal sites, and tolerance to moisture and nutrient limitations. Switchgrass is a native, warm-season perennial species adapted to an area west of the Rocky Mountains from Canada to Mexico. The overall biofuels program includes investigations into biomass production, economics, conversion into fuel, and environmental impacts. The agronomic part of the research in the south-central United States includes evaluation of cultural practices, plant physiology, plant breeding, and biotechnology at Auburn University, Virginia Tech, Texas A&M University, Oklahoma State University, and University of Tennessee (Fig. 1).

Procedures

Improvement of switchgrass cultural practices in Texas consists of cultivar evaluation, harvest management, and fertility × row spacing trials. These trials are being conducted at Beeville, College Station, Dallas, Knox City, Stephenville, and Temple. Field plots were established in 1992, and primary data collection began in 1993.

Keywords: switchgrass / biomass.

Seven switchgrass selections (Table 1), both upland and lowland ecotypes, are being evaluated at all locations. Kleingrass (*Panicum coloratum* L. cv. Selection 75) was included to provide a yield comparison. Plant measurements include biomass yield under either a one- or two-cut system, plant morphological composition at harvest, disease susceptibility, and stage of development throughout the growing season.

Switchgrass harvest management is being investigated at Dallas and Stephenville. The clipping frequency trial consists of four harvest systems with three autumn harvest dates (September, October, and November) within each system. For each system, plots were clipped beginning in May, except for System 4, which was deferred for autumn clipping. System 1 was clipped three times (May, June, July), System 2 was clipped twice (May, June), and System 3 was clipped once (May); all systems were then allowed to regrow for harvest in autumn. Measurements taken at each harvest are biomass yields, plant and tiller counts, crown weights, and total nonstructural carbohydrate concentration of crowns.

Nitrogen (N) and phosphorus (P) requirements of Alamo switchgrass are being evaluated at Beeville and Stephenville. Five fertilizer rates ranging from 0 to 200 lb/acre of N and 0 to 80 lb/acre P_2O_5 were applied to three different switchgrass row spacings in an incomplete factorial design. Data being taken include biomass yield, herbage nutrient concentration, canopy height, lodging, plant developmental stage at harvest, and plant and tiller counts.

Seed treatments for reducing post-harvest seed dormancy have been evaluated at the USDA Grassland Research Laboratory in Temple. Switchgrass is also being selected for deeper crown placement during seedling emergence at Temple.

Results and Discussion

Yield data from the fertility study at Stephenville indicate no significant differences among row spacings in 1992; however, the wider row spacings were numerically lower in yield (Table 2). The first 50 lb of N produced the greatest yield response; however,

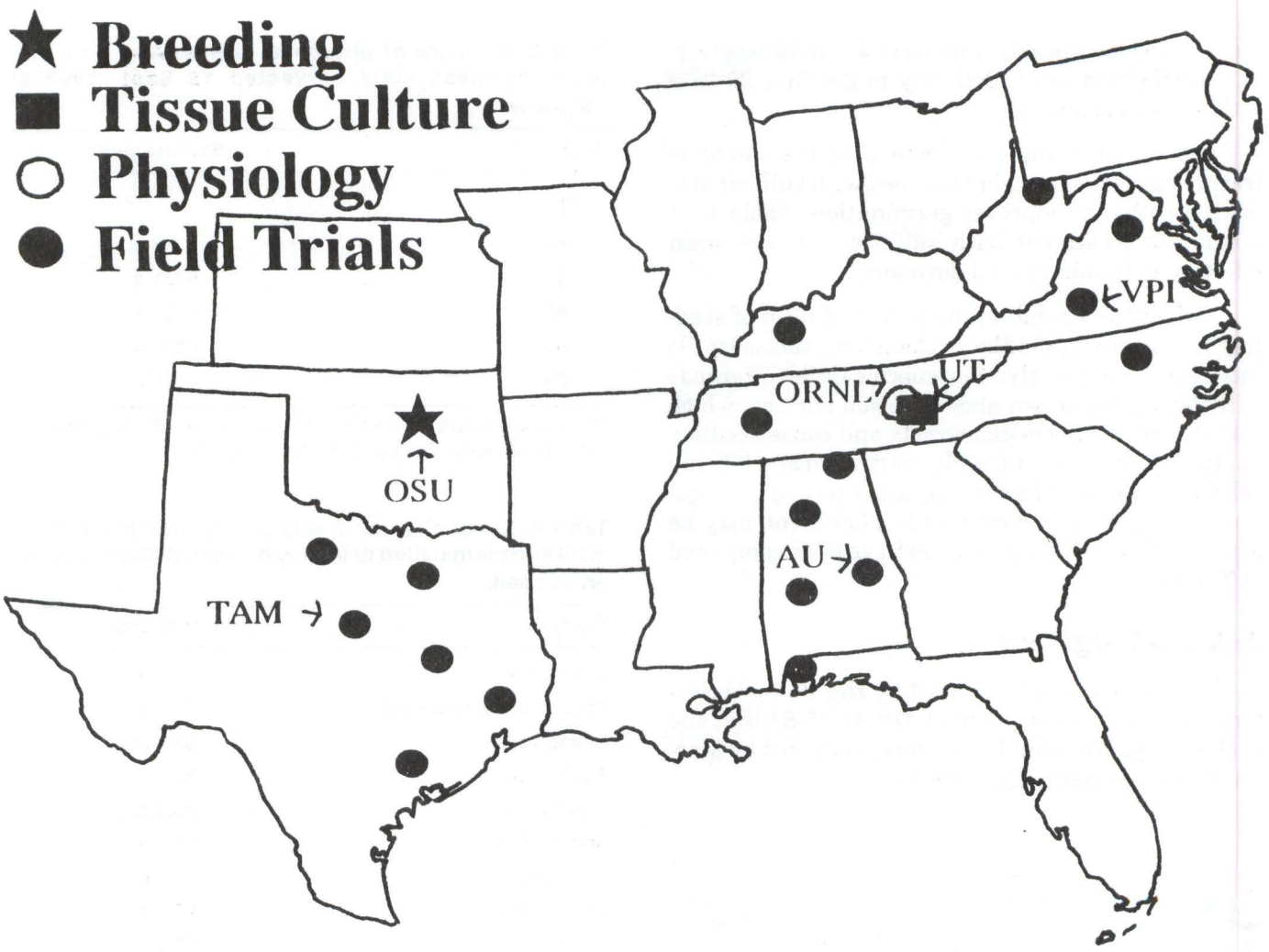

Figure 1. Switchgrass research projects in the south-central United States.

Table 1. Switchgrass cultivars undergoing evaluation as a biomass crop in Texas.

Cultivar	Ecotype
Alamo	Lowland
Blackwell	Upland
Caddo	Upland
Cave-in-Rock	Intermediate
Kanlow	Lowland
PMT-279	Lowland
PMT-785	Lowland

Table 2. Influence of row spacing on Alamo switchgrass biomass yield harvested 15 Sept. 1992 at Stephenville.

Row spacing	Biomass yield
.....in.	..lb DM/acre ..
7	8689 a*
14	7755 a
28	7708 a

*Means followed by the same letter are not significantly different at the 0.05 level, Duncan's multiple range test.

yield increased linearly from 50 to 200 lb N/acre (Fig. 2). Switchgrass responded only to the first 20 lb of P_2O_5 applied (Table 3).

Results at Temple indicate that treatment of freshly harvested switchgrass seed with sulfuric acid or chloroethanol improves germination (Table 4). A 10-minute treatment with sulfuric acid was most effective in breaking seed dormancy.

Switchgrass exhibits the panacoid form of seedling emergence typified by an elongating subcoleoptile internode. Frequently, the subcoleoptile internode will elevate the crown above the soil surface, which may desiccate adventitious roots and cause seedling death. This trait is genetically controlled and is being selected for reduced subcoleoptile internode elongation; hence, deeper crown node placement may be possible. Two cycles of selection have been completed at Temple.

Acknowledgment

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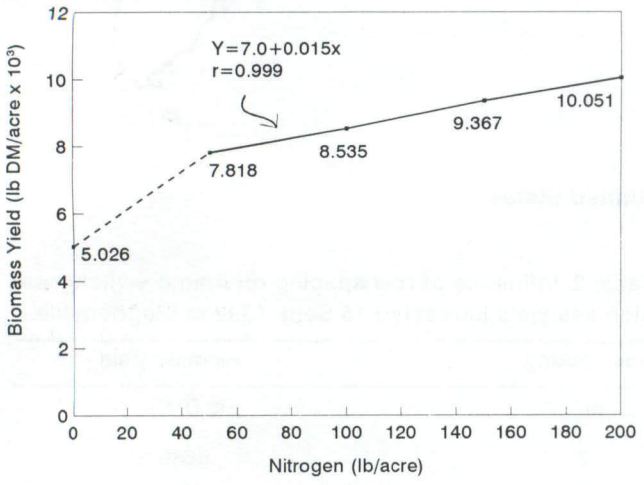

Figure 2. Influence of nitrogen rate on Alamo switchgrass biomass yield harvested 15 Sept. 1992.

Table 3. Influence of phosphate rate on Alamo switchgrass biomass yield harvested 15 Sept. 1992 at Stephenville.

P_2O_5 rate	Biomass yield
..lb/acre ..	...lb DM/acre...
0	6898 b*
20	8771 a
40	8081 a
60	8396 a
80	8568 a

*Means followed by the same letter are not significantly different at the 0.05 level, Duncan's multiple range test.

Table 4. Effect of sulfuric acid and chloroethanol treatments on germination of freshly harvested Alamo switchgrass seed.

Treatment	Germination
Acid 10 min	91.8 a*
Chloro 10 min acid 5 min	90.0 ab
Chloro 15 min	88.7 ab
Acid 5 min	86.8 ab
Acid 20 min	86.8 ab
Chloro 10 min	85.5 b
Acid 15 min	84.7 b
Chloro 5 min	73.0 c
Control	52.2 d

*Means followed by the same letter are not significantly different at the 0.05 level, Duncan's multiple range test.