Switchgrass for Biomass Production

Monroe Rasnake
University of Kentucky

D. Parrish
Virginia Polytechnic Institute & State University

Garry D. Lacefield
University of Kentucky

D. Wolf
Virginia Polytechnic Institute & State University

The XIX International Grassland Congress took place in São Pedro, São Paulo, Brazil from February 11 through February 21, 2001.

Proceedings published by Fundacao de Estudos Agrarios Luiz de Queiroz

ID # 13-09

SWITCHGRASS FOR BIOMASS PRODUCTION

M. Rasnake[1], D. Parrish[2], G. Lacefield[1], and D. Wolf[2]
[1]University of Kentucky, College of Agriculture, Princeton, Kentucky
[2]Virginia Polytechnic Institute & State University, Blacksburg, Virginia

Abstract

Six cultivars of switchgrass (*Panicum virgatum*) were established in 1993 at Princeton, Kentucky, USA. Two harvest systems were used: two cuttings per year in mid-June and November and one cutting per year in November. Biomass yield and stand survival were evaluated. Lowland cultivars produced more biomass than upland cultivars in both cutting managements. Upland cultivars did better in a two cut system while the other cultivars showed little difference. Excellent stands of all cultivars were maintained under both cutting managements.

Keywords: Biomass, Switchgrass, Biofuels

Introduction

There is interest in the US and other countries to develop renewable energy resources to supplement or replace non-renewable sources (Samson, 1991; Tietz, 1991; Graham, 1993). Switchgrass has been identified as the species with the greatest potential for biomass production because of high yields, perennial growth, low nutrient requirements and ability to grow on marginal land (Graham, 1993; Parrish, et al., 1993). It also has multiple additional uses as livestock feed, wildlife habitat, and soil conservation. Some research has been conducted with switchgrass (McKenna and Wolf, 1990; Parrish, et al., 1993; Reed, et al., 1993; Parrish, et al., 1997), but more is needed on management systems, cultivar selection, and fertility needs. This research is part of a multi-state project coordinated through Virginia Polytechnic Institute and State University with funding provided by the United States Department of Energy through the Oak Ridge National

Laboratory in Knoxville, TN.

Materials and Methods

Plots were no-till seeded in 1993 at Princeton, Kentucky (37° 08' N Latitude; 87° 50' W Longitude) on a Zanesville silt loam soil (Fine-silty, mixed, mesic Typic Fragiudalf). The soil was tested and lime, phosphate, and potassium added as needed (100 kg/ha P_2O_5 and K_2O). Six cultivars of switchgrass (Ball, et al., 1996) including two upland entries (Cave-in-Rock and Shelter) and four lowland entries (Alamo, Kanlo and two experimental lines from North Carolina) were seeded in 2.4 x 6.1 m plots. Eight sets of these plots were seeded in order to provide for two harvest managements and four replications. The two harvest managements included two cuttings per year (in June and November) and one cutting per year (in November). Nitrogen was applied at a rate of 100 kg/ha in April for the one-cut and 50 kg/ha in April followed by 50 kg/ha after the first cut of the two-cut treatments. Samples were weighed at each cutting to determine biomass yields and subsamples taken for moisture analysis. This paper will discuss the results of six years of research.

Results and Discussion

The dry matter yields [Mg (tonne)/ha] of switchgrass cultivars are shown in Table 1 for the one-cut management and Table 2 for the two-cut management. The two upland cultivars tended to be lower yielding than the lowland cultivars in the one-cut management. However, in the two cut management, Cave-in-rock compared favorably with the lowland cultivars. Shelter had the lowest yield overall while Alamo was the highest. Except for the first year (1994), yield differences between the two cutting managements were small and inconsistent. The two-cut management was better in two years, while the one-cut management was better in three years. It appears this may be due to rainfall in July and August in that the one-cut system does best in dry years while the two-cut system does best in wet years.

The upland cultivars showed more of a difference in favor of the two-cut system. However, most of this difference was due to the Cave-in-rock cultivar. The differences due to cutting management were small for the lowland and experimental cultivars. The experimental lines did a little better with one cutting while the lowland cultivars did better with two cuttings.

Stands were checked visually each year and no problems were encountered. The two experimental cultivars started out with poor stands, but the size of individual plants compensated to produce good yields. In the one-cut system, these cultivars grew in excess of three meters tall.

For purposes of biomass production, the best management system included lowland cultivars of switchgrass harvested once each year. This system produced high dry matter yields (15 Mg/ha) with a minimum of labor and other inputs. Since switchgrass is a long-lived perennial that can produce high yields on marginal soils with low inputs, it does have great potential as a biofuels crop.

References

Ball, D.M., Hoveland C.S., and Lacefield G.D. (1996). Southern Forages. Phosphate & Potash Institute, Norcross, GA.

Graham, R. (1993). Projecting the impact of energy crops. In Energy Crops Forum. Oak Ridge National Laboratory, Oak Ridge, TN. Summer 1993.

McKenna, J.R. and Wolf D.D. (1990). No-till switchgrass establishment as affected by limestone, phosphorus and carbofuran. J. Prod. Agric. **3:**475-479.

Parrish, D.J, Wolf D.D. and Daniels W.L. (1993). Perennial species for optimum production of herbaceous biomass in the Piedmont. Management Study Trial Report to Oak Ridge National Laboratory, Virginia Tech, Blacksburg, VA.

Parrish, D.J., Wolf D.D. and Daniels W.L. (1997). Switchgrass as a biofuels crop for the Upper Southeast: Variety trials and cultural improvements. Report to Oak Ridge National Laboratory,

Virginia Tech, Blacksburg, VA.

Reed, R.L., Sanderson M.A., Hussey M.A., Ocumpaugh W.R., Reed J.C., Tischler C.R. and Young B.A. (1993). Determining optimal establishment and cultural practices for switchgrass biomass production in Texas. PR-5090. Texas Agric. Exp. Stn. pp. 32-34.

Samson, R. (1991). Switchgrass, a living solar battery for the prairies. In Sustainable Farming. Fall 1991. pp. 4-8. Quebec, Canada.

Tietz, N. (1991). Forages for fuel. Hay and Forage Grower. Overland Park, KS. May 1991. pp. 36-38.

Table 1 - Biomass yields of switchgrass at Princeton, KY. One-cut management with only one harvest at the end of the season in November

Cultivar	1994	1995	1996	1997	1998	1999	Av.
	---------- Mg (tonne)/ha ----------						
Alamo*	9.6	20.6	16.4	11.3	11.6	16.3	14.3
Kanlo*	9.7	19.3	16.4	11.0	14.6	15.2	14.4
Cave-in-Rock**	8.6	12.0	11.3	10.0	12.1	12.9	11.2
Shelter**	7.6	12.1	9.1	8.0	11.8	12.0	10.1
NC-1*	7.7	19.6	14.5	11.2	13.4	13.4	13.3
NC-2*	7.8	18.7	16.2	11.7	16.1	14.9	14.2
LSD 0.05	1.4	2.4	1.6	2.2	2.1	3.4	

* = lowland
** = upland

Table 2 - Biomass yields of switchgrass at Princeton, KY. Two-cut management with one harvest in June and one in November

Cultivar	1994	1995	1996	1997	1998	1999	Av.
		---------- Mg (tonne)/ha ----------					
Alamo*	16.0	19.6	14.5	13.4	16.0	13.6	15.5
Kanlo*	15.9	17.1	14.0	12.5	15.8	11.5	14.5
Cave-in-Rock**	15.7	14.3	12.7	10.9	14.8	11.4	13.3
Shelter**	11.0	12.9	10.0	8.2	12.9	9.1	10.7
NC-1*	9.2	15.2	12.3	13.0	15.3	13.6	13.1
NC-2*	11.7	16.2	12.7	11.7	15.3	13.8	13.6
LSD 0.05	1.4	2.4	1.6	2.2	2.1	3.4	

* = lowland
** = upland