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HARVEST MANAGEMENT OF SWITCHGRASS GROWN FOR BIOMASS

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Summary

Field trials in Texas with switchgrass (Panicum virgatum L.) were initiated in 1992 as part of the Biofuels Feedstock Development Program sponsored by the U.S. Department of Energy. Harvest timing and frequency of 'Alamo' switchgrass are being evaluated at Dallas and Stephenville. Maximum yields at Dallas (3 ton/acre) were obtained by harvesting in summer with the final harvest in September or October. At Stephenville, maximum yields (5 ton/acre) were obtained by deferring harvest until September or October. Proper harvest management of switchgrass grown for biomass in Texas will require additional investigation.

Introduction

In response to growing concerns over consumption of nonrenewable fuel sources, the U.S. Department of Energy through the Biofuels Feedstock Development Program, has initiated biomass technology research. The biofuels program includes investigations into biomass production, conversion into fuel, economics and environmental impacts. Switchgrass was selected for biomass research because of its high yield potential, adaptation to marginal sites, and tolerance to water and nutrient limitations. Switchgrass has been reported to be sensitive to clipping frequency (Beaty and Powell, 1976) and timing (Anderson and Matches, 1983). Our objective was to determine the response of switchgrass to several clipping frequencies and timing of final harvest in autumn.

Materials and Methods

Switchgrass harvest practices in Texas are being evaluated at Dallas and Stephenville. Field plots were established in 1992 and primary data collection initiated in 1993. The experimental design is a split plot with three replications. This trial consists of four harvest frequency systems as whole plots with three autumn harvest dates (September, October and November) as split plots within each system. System 1 was clipped three times (May, June, July), System 2 was clipped twice (May, June), and System 3 was clipped once (May), while System 4 was not harvested during summer. In the autumn, one-third of each plot was harvested in either September, October or November.

Keywords: biomass / management / switchgrass.

Biomass, plant and tiller counts, and crown weights were measured at each harvest. Plots were clipped to a 6-in. stubble height and dried in a forced air oven. Crowns were dug from two 6-in. sections of row in each plot and composited to obtain a crown sample. Soil was removed from crowns by washing in cold water. Tillers and roots were trimmed to 3 in. above and below the soil surface, respectively. All senescent material was removed from crowns. Samples were placed in an oven at 220°F for 1 hr to halt enzymatic activity (Smith, 1981) before drying at 131°F for 48 hr in a forced air oven to determine crown weight.

Results and Discussion

Biomass yield. Data presented are from a single year and additional data are being collected. Switchgrass response to harvest management during 1993 differed ($P<0.05$) between Dallas and Stephenville. Maximum yields at Dallas were realized by harvesting 1 to 3 times in summer (Systems 1, 2 or 3) and taking the autumn harvest in September or October (Table 1). When final harvest was in November total yield was 620 lb/acre lower. There was severe damage to switchgrass stands by rodents at Dallas, primarily in the single-cut plots. Elongating culms were chewed off and there were fewer reproductive tillers in multiple-cut plots during regrowth. It is unlikely that stand damage would be as severe in extensive plantings. Damage may have had a larger influence on plots deferred for a single harvest in autumn, due to a higher number of reproductive tillers.

Biomass yields at Stephenville were lower if multiple harvests were taken during the summer (Table 1), which is the opposite of that observed at Dallas. Regrowth at Stephenville was limited by low rainfall during late June and July (Table 2). Yields of Systems 1, 2 and 3 were reduced by 50% lower than those in System 4 harvested only once in autumn. Delaying final harvest until November reduced biomass yields by 1,050 lb/acre at Stephenville, similar to the response found at Dallas. Similar declines in standing biomass yields of switchgrass have been reported in Virginia. Parrish and Wolf (1993) suggested that the decline in biomass yields may be due to above-ground components being translocated to the below-ground portion of the plant.

Crown size. Crown mass at Dallas was 0.69 g/crown compared to 2.85 g/crown at Stephenville (Table 3). Average crown mass differed at Dallas between final harvests but not summer harvest frequency (Table 3). Crown mass at Dallas decreased by 18% as final harvest was delayed from September to November. At Stephenville, crown mass was 50% lower when harvested 2 to 3 times in the summer as compared to no summer harvest.

Plant and tiller number. Plant and tiller numbers were not determined at Dallas. At Stephenville,

plant (4 plants/ft of row) and tiller (12 tillers/plant) numbers did not differ ($P>0.05$) between number of summer harvests or date of final harvest.

Conclusions

Maximum dry matter yields were obtained at Dallas by harvesting in summer and autumn, whereas any summer harvest decreased yields at Stephenville. Delaying the final harvest decreased yields at both locations. Limited field evaluations suggest that harvest management of Alamo switchgrass may be site specific or dependent on rainfall amount and distribution as indicated by these preliminary results.

Acknowledgement

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Literature Cited

Anderson, B. and A.G. Matches. 1983. Forage yield, quality, and persistence of switchgrass and Caucasian bluestem. Agron. J. 75:119-124.

Beaty, E.R. and J.D. Powell. 1976. Response of switchgrass (Panicum virgatum L.) to clipping frequency. J. Range Manage. 29:132-135.

Parrish, D.J. and D.D. Wolf. 1993. Managing switchgrass for sustainable biomass production. p. 34-39. *In* Liquid Fuels From Renewable Resources. Proc. Alternative Energy Conf., Nashville, TN. Dec. 14-15, 1992. Am. Soc. Agric. Eng. St. Joseph, MI.

Smith, D. 1981. Removing and analyzing total nonstructural carbohydrates from plant tissue. Res. Rep. R2107. Univ. Wisc. Madison, WI.

Table 1. Total biomass yield of Alamo switchgrass in response to number of harvests and date of final autumn harvest.

Summer Harvests	September	October	November	Mean
Dallas	---------- lb dry matter/acre ----------			
May, June, July	5350	5390	5460	5400a[1]
May, June	4960	5160	4600	4910abc
May	5490	5500	4560	5180ab
None	4690	4550	3460	4230c
Mean	5120A	5150A	4520B	
Stephenville				
May, June, July	3890	4190	3910	4000b
May, June	3400	3820	3340	3520b
May	5750	4520	4070	4780b
None	9610	9950	7030	8860a
Mean	5660A	5620A	4590B	

[1] Means within a column or row for each location followed by the same letter are not significantly different at the 0.10 level.

Table 2. Monthly precipitation at Dallas and Stephenville during 1993.

	Dallas	Stephenville
	---------- in. ----------	
January	2.04	2.19
February	6.58	4.04
March	1.51	2.47
April	4.54	3.96
May	2.58	1.57
June	4.32	2.24
July	0.00	0.00
August	2.85	1.94
September	4.33	5.20
October	6.10	4.58
November	2.28	1.09
December	2.53	1.36
Total	39.66	30.64
Long-term Average	35	29

Table 3. Crown mass of Alamo switchgrass in response to number of harvests and date of final autumn harvest.

Summer Harvests	September	October	November	Mean
Dallas	---------- g/crown ----------			
May, June, July	0.72	0.54	0.48	0.58a[1]
May, June	0.72	0.81	0.44	0.66a
May	0.63	0.80	0.52	0.65a
None	0.76	0.98	0.88	0.87a
Mean	0.71AB	0.78A	0.58B	
Stephenville				
May, June, July	3.04	1.68	2.04	2.25b
May, June	2.54	2.15	2.00	2.23b
May	2.28	2.34	3.59	2.74ab
None	4.20	4.07	4.23	4.17a
Mean	3.02A	2.56A	2.97A	

[1] Means within a column or row for each location followed by the same letter are not significantly different at the 0.05 level.