Using Fertilization, Irrigation, and Harvest Strategies to Maximize 'Alamo' and 'Cave-in-Rock' Switchgrass Biomass Yield in the Southern Ozarks

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service
"Helping People Help the Land"

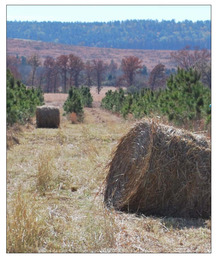
A.A. Jacobs[1/], J.R. King[1/], T.E. Pratt[1/], L.D. Goff[1/], and J.L. Douglas[2/]

[1/]Conservation Agronomist/Assistant Manager, Conservation Agronomist/Manager, and Biological Science Technicians, USDA-NRCS Booneville Plant Materials Center, Booneville, AR; Plant Materials Specialist, USDA-NRCS, Central National Technology Support Center, Fort Worth, TX

USDA, Natural Resources Conservation Service, 6883 South State Highway 23, Booneville, AR 72927. Alayna.Jacobs@ar.usda.gov

Introduction

Switchgrass (*Panicum virgatum* L.) is recognized as a model perennial bioenergy feedstock for marginal land where water and nutrient availability prevent the production of conventional row crops. Switchgrass may offer a source of income for producers on these lands in the southern Ozarks, either as forage for livestock or bioenergy feedstock. However, information about how switchgrass yield and forage quality respond to management practices is lacking in this region.

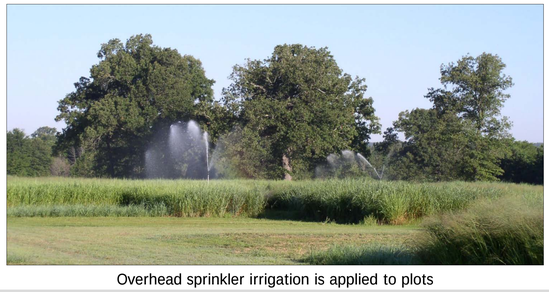

Switchgrass hay bales

Switchgrass can grow to six feet tall

Objectives

The objective of this study was to evaluate the effect of management factors on biomass yield and forage quality. This information will be used to develop Natural Resource Conservation Service (NRCS) recommendations for simultaneously maximizing switchgrass forage quality for use as a feedstock or dry matter production for biofuels.

- switchgrass cultivars: 'Alamo' and 'Cave-in-Rock'
- annual harvest frequency: one and two cut systems
- fertility sources: poultry litter and commercial fertilizer
- Irrigation: summer sprinkler irrigation and no irrigation


Overhead sprinkler irrigation is applied to plots

Poultry litter manually spread at 2 ton/acre in plots

Materials & Methods

Site Preparation

- Soil nutrients brought up to uniform levels of nitrogen (N), phosphorus (P), and potassium (K) in 2007
- 40ft x 40ft plots arranged in randomized complete block design with four replications
- 'Alamo' and 'Cave-in-Rock' drilled at 5 pounds pure live seed (PLS) per acre in 2008
- Irrigation applied to all plots in establishment year

Switchgrass harvested in December

Grab samples of harvested switchgrass collected

Treatments

- Irrigated plots received 2 inches per week of overhead sprinkler irrigation during the growing season from 2008-2012
- Fertilized plots received 2 tons per acre poultry litter (~50 lb/acre N, P, K) and corresponding amount of N, P, and K as custom-mixed commercial fertilizer of 17-17-17 from 2008-2012
- Half of each plot harvested once per year, half harvested twice a year (December harvest vs. June + December harvest) from 2008-2012

Biomass Yield

- Mechanical harvester with on-board scale used to measure biomass production
- Yield determined by harvesting a 3ft x 10ft swath from the center of the plot

Forage Quality

- Forage quality estimates of crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) determined from June harvest
- Crude protein determined by multiplying percent nitrogen by 6.25. Percent total digestible nutrients determined by: TDN = 73.5 + 0.62(%CP) – 0.71(%ADF)

Switchgrass plots harvested in the spring

Results & Discussion

Yield

Table 1. Three year average dry matter yield for Alamo and Cave-in-Rock switchgrass by fertility treatment and harvest system

Treatment combination	Yield							
	2008		2009		2010		2011	
	2-cut (June & Nov)	1-cut (Nov)	2-cut (June & Dec)	1-cut (Dec)	2-cut (June & Dec)	1-cut (Dec)	2-cut (June &Dec)	1-cut (Dec)
	lb/acre							
Alamo Comm. Fert.	15693	10400	25086	15815	14153	12976	14071	14263
Alamo Litter	18993	11853	23732	15423	12877	12664	13610	9249
Alamo Irrig. Comm. Fert.	11340	10633	24846	13411	13524	14632	13959	13462
Alamo Irrig. Litter	18027	14600	27460	12467	16642	14892	12966	7806
Cave-In-Rock Comm. Fert.	10753	7280	24211	7313	12082	7858	12956	12561
Cave-in-Rock Litter	13533	8227	20747	9643	10571	8971	9883	6643
Cave-In-Rock Irrig. Comm. Fert.	12347	8440	22076	9438	11436	8447	11646	11426
Cave-In-Rock Irrig. Litter	16807	8287	23516	8619	12012	10524	9645	7782
Mean	14687	9965	23959	11516	12912	11371	12342	10399
$LSD_{(0.05)}$	3323	2277	NS	3330	3539	3461	2260	3109

Dry matter yields differed among treatment combinations. Alamo generally produced significantly more biomass than Cave-in-Rock in all treatments.

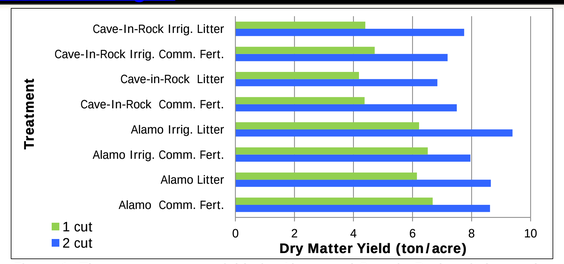
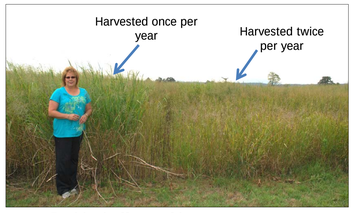


Figure 1: Three year average yields for Alamo and Cave-in-Rock switchgrass by harvest system from 2008-2011

Three-year averages show that the top-performing treatment combination was Alamo with irrigation and poultry litter fertilization; however, this yield did not significantly differ from Alamo treatments with irrigation and commercial fertilizer, and non-irrigated with commercial fertilizer. (Table 1).

Yields were significantly greater for both cultivars using the two-harvest regime, and produced roughly 50% more biomass than single-harvest regimes within treatments (Figure 1). Switchgrass regrowth in plots cut twice a year was slower than in plots cut only once a year. Alamo treatments under the two-harvest regime yielded >2 ton/acre more biomass than treatments under the single harvest regime.



Residual effects of harvest systems on switchgrass regrowth in 2012

Forage Quality

In June harvests, forage quality estimates were similar across treatments with Cave-in-Rock providing a slight increase in CP and TDN (8 vs 9; 55 vs 56) over Alamo. Irrigation provided minimal benefits, which may indicate switchgrass can be productive under climatic condition and rainfall as a low input feedstock for forage and biofuel in the southern Ozarks.

Conclusion

Irrigation provided minimal benefits, which may indicate switchgrass can be productive under climatic condition and rainfall as a low input feedstock for forage and biofuel in the southern Ozarks.

USDA IS AN EQUAL OPPORTUNITY PROVIDER AND EMPLOYER