Designing Biomass Cropping Systems for Sustainable Bioenergy Production

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Rationale

- Biofuels are an alternative source of transportation fuels produced by organic materials
- Second generation biofuels will come from cellulosic materials from dedicated biomass crops
- An understanding of the impact these crops have on the soil is extremely important in terms of the sustainability of growing fuels from dedicated biomass crops

Objectives

- Determine nutrient use efficiencies of various biomass energy crops and various nutrient sources
- Determine the effect of various biomass energy crops and various nutrient sources on soil health properties such as to include soil organic carbon, microbial activity, and aggregate stability
- Monitor changes in soil health attributes over time
- Monitor yields over time

Eastern gamagrass (variety Bumpers) in 2nd year of production, 2010

Plant height ranged from 0.8 to 1.3 m

Treatments

Biomass species

- switchgrass (*Panicum virgatum*)
- switchgrass/big bluestem (*Andropogon gerardii*) mix
- eastern gamagrass (*Trispsacum dactyloides*)
- photoperiod sensitive high biomass sorghum (*Sorghum bicolor*)
- high biomass sorghum rotation with soybean

Nitrogen sources

- urea
- poultry litter
- municipal biosolids
- no nitrogen

Experimental design

5 plant species by 4 nitrogen sources with 4 replications

Analyses/properties monitored

- Biomass yield
- Nitrogen use efficiency
- Nitrogen uptake
- Biomass carbon
- Soil carbon and nitrogen
- Microbial activity
- Active soil carbon
- C and N mineralization
- Aggregate stability
- Infiltration rates
- Runoff water quality

Harvest of high biomass sorghum at the ASU Farm Complex, Jonesboro, AR 2009

Switchgrass (variety Alamo) in 2nd year of production, 2010

Plant height ranged from 1.3 to 2.1 m

Preliminary Data

Table 1. Effect of fertilizer sources on high biomass sorghum plant heights, dry matter yield, and N uptake.

Fertilizer Source	†Mean Plant Height	†Mean Dry Matter	†Avg. Nitrogen Uptake
	(m)	(Mg/ha)	(kg/ha)
urea	4.41[a]	23.13[a]	153.80[a]
poultry litter	4.27[ab]	24.35[a]	109.64[ab]
biosolids	3.98[b]	21.78[a]	107.19[b]
none	3.45[c]	17.30[b]	62.67[c]

†Means with the same letter within a column are not significantly different at the 0.05 level of significance

Table 2. Effect of nitrogen source and bioenergy crop on β glucosidase activity.

β glucosidase activity (μg g^{-1} soil h^{-1}) 0-10 cm soil depth								
Cropping systems	No N applied		Urea		Poultry litter		Biosolids	
	2009	2010	2009	2010	2009	2010	2009	2010
Gamagrass	92.93	109.93	133.18	162.49	135.94	163.55	110.19	133.37
Biomass Sorghum	121.78	140.41	112.61	135.71	125.95	168.28	124.19	147.6
Biomass Sorghum rotation	117.63	134.77	159.81	171.84	101.22	133.84	113.58	167.37
Switchgrass mix	134.88	168.44	132.84	181.8	140.50	204.04	134.07	165.17
Switchgrass	94.64	120.96	107.77	154.67	132.12	192.76	116.64	157.54

Bioenergy Research plots at the ASU Farm Complex, Jonesboro, AR

Plots were established Spring 2009

Plots are 7.3 by 27.4 m

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