Production of Napiergrass (*Pennisetum purpureum* Schum) for Bioenergy under Organic versus Inorganic Fertilization in the Southeast USA

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Abstract

Napiergrass (*Pennisetum purpureum* Schum.) is a perennial forage grass that is being considered for use as a feedstock for the emerging bioenergy industry in the Southeast USA. Poultry litter is a readily available source of nutrients that could be used as a low cost fertilizer for biomass crops. The purpose of this study was to compare biomass production and nutrient uptake of napiergrass fertilized with poultry litter, inorganic fertilizer, or unfertilized control. Effects of poultry litter application on soil composition and surface runoff were also assessed. Biomass yields of the two fertilized treatments were not significantly different. In the third and fourth seasons the unfertilized control plots yielded less than the fertilized treatments. In only the first two harvests biomass N concentration was greater in the inorganic treatment than in the control. Increases in soil C and N pools were observed over the course of the study for all treatments, with the greatest C increase in the inorganically fertilized plots. From 24 runoff events, the mean concentrations of NH_4 and NO_3 were greatest in runoff from the plots receiving poultry litter and least from the control plots. The mean concentrations of PO_4 and Cl were greatest in runoff from the plots receiving inorganic fertilizer and least from the control plots.

Materials and Methods

Napiergrass cultivar Merkeron was planted in fall 2006 near Tifton, GA on gently sloping plots. The soil at the site is Tifton loamy sand ((fine-loamy, kaolinitic, thermic Plinthic Kandiudults). Plastic dividers were placed between plots, and automated collection units were placed at the bottom of each plot to measure surface runoff. Beginning in spring 2007 approximately 84 kg ha^{-1} N was applied as poultry litter or equivalent inorganic fertilizer yearly. Inorganic P and K were also applied in amounts equivalent to the poultry litter (approximately 1:1:1 ratio). No supplemental irrigation was applied, except immediately after planting. The experimental design was a randomized complete block with three replications. Biomass was harvested each winter after senescence. Biomass N and C concentrations were measured by dry combustion in a Vario EL-III Universal CHNOS Elemental Analyzer (Elementar Analysensysteme, Hanau, Germany) using approximately 5 mg dried, ground tissue. Soil cores were taken from each plot yearly in the spring to early summer, just before fertilizer application. Soil N and C concentrations were also measured by dry combustion using 50 mg dry soil.

Results

Figure 1. Yearly biomass yields of napiergrass fertilized with chicken litter (84 kg N/ha), equivalent inorganic fertilizer, or unfertilized control.

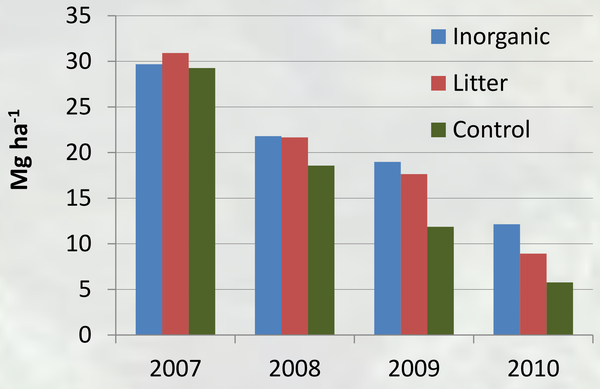

Figure 2. Biomass N concentration at harvest (post-senescence) of napiergrass.

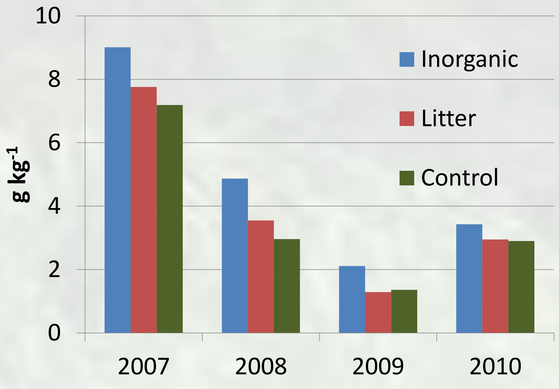

Figure 3. Yearly N removal by biomass harvest of napiergrass.

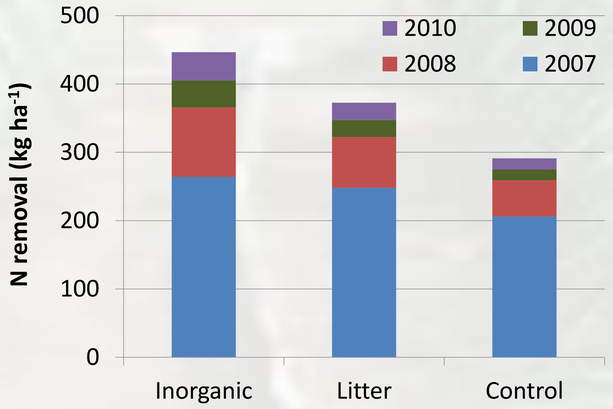

Figure 4. Change in soil N and C pools in napiergrass plots over five years (2007 – 2011) sampled at three depths.

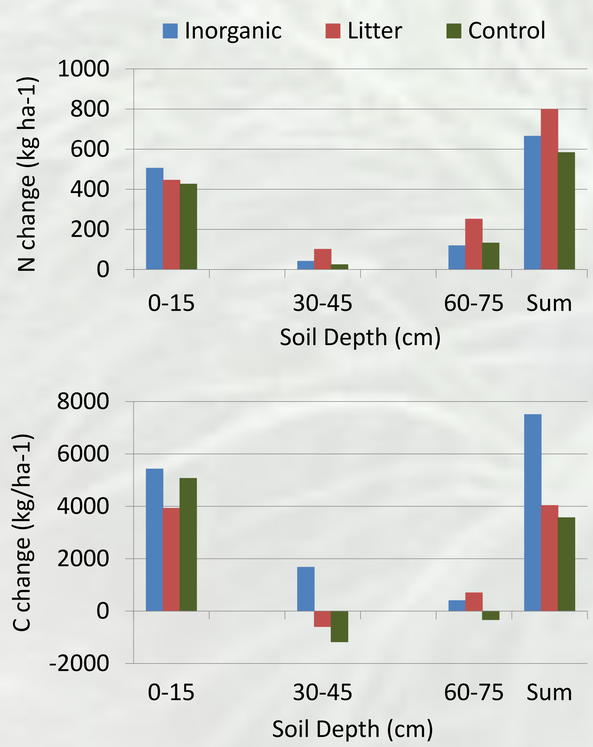

Table 1. Average surface runoff nutrient concentrations for 24 natural runoff events in napiergrass plots.

	Inorganic	Litter	Control
	mg L^{-1}		
NH_4	5.12	5.69	5.04
NO_3	2.00	2.69	1.34
PO_4	0.59	0.49	0.38
Cl	9.27	8.16	6.01

Conclusions

Fertilizer source (litter versus inorganic) did not affect biomass yield of napiergrass, though total N removal was lower in litter-fertilized plots than inorganically fertilized plots. Poultry litter can be used as a fertilizer for biomass crops such as napiergrass in the Southeast, though a higher application rate may be needed to sustain high yields. Napiergrass production increased soil C and N pools in all treatments, with C gains from 3500 to 7500 kg ha^{-1}.