Yield and Nitrogen Removal By Bioenergy Crops on Swine Effluent Sprayfields in the Coastal Plain Region of North Carolina

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Introduction

The swine industry in North Carolina produces large quantities of waste effluent, which is commonly applied to fields ("sprayfields") of coastal bermudagrass (*Cynodon dactylon* L.) for hay production. Dedicated bioenergy crops, such as switchgrass (*Panicum virgatum*) and giant miscanthus (*Miscanthus x giganteus* L.), are promising alternatives to coastal bermudagrass if these grasses can maintain high yields and adequate nitrogen (N) removal. Unlike more common bioenergy cropping systems, maximum N removal is an advantage on sprayfields due to nutrient management guidelines. The primary objective of this experiment to determine the biomass yield and N removal of dedicated biomass crops, including switchgrass, giant miscanthus, sweet sorghum, and high-biomass sorghum (*Sorghum* spp.) grown on swine effluent sprayfields in the North Carolina Coastal Plain region.

Methods

Research plots were established in 2011 and 2012 at 3 on-farm locations (Goldsboro, Cottle, Prestage) in eastern NC. Treatments were arranged in a split-plot randomized complete block design with main plots of five crop cultivars: coastal bermudagrass (CB), giant miscanthus (MG), switchgrass (SG, cv. 'Colony'), high-biomass sorghum (FS, cv. Blade 'ES5200') and sweet sorghum (SS, cv. MSU 'M81-E'). For perennial grasses, subplots were six different harvest times (May & Oct, June & Oct, July & Oct, Aug & Oct, Oct, and Dec). Sorghum plots were only harvested in September each year. Each of the treatments were replicated three times. Swine effluent application was managed by the farm cooperators. Plant tissues were collected from subplots at each harvest to determine N uptake.

Results

Table 1. ANOVA table for the yield response the of perennial grasses to the harvest treatments.

Source	Site		
	Goldsboro	Prestage	Cottle
	F test probility		
Species	**	**	**
Harvest	**	**	**
Species*Harvest	**	**	**

* * significant at α=0.01 level

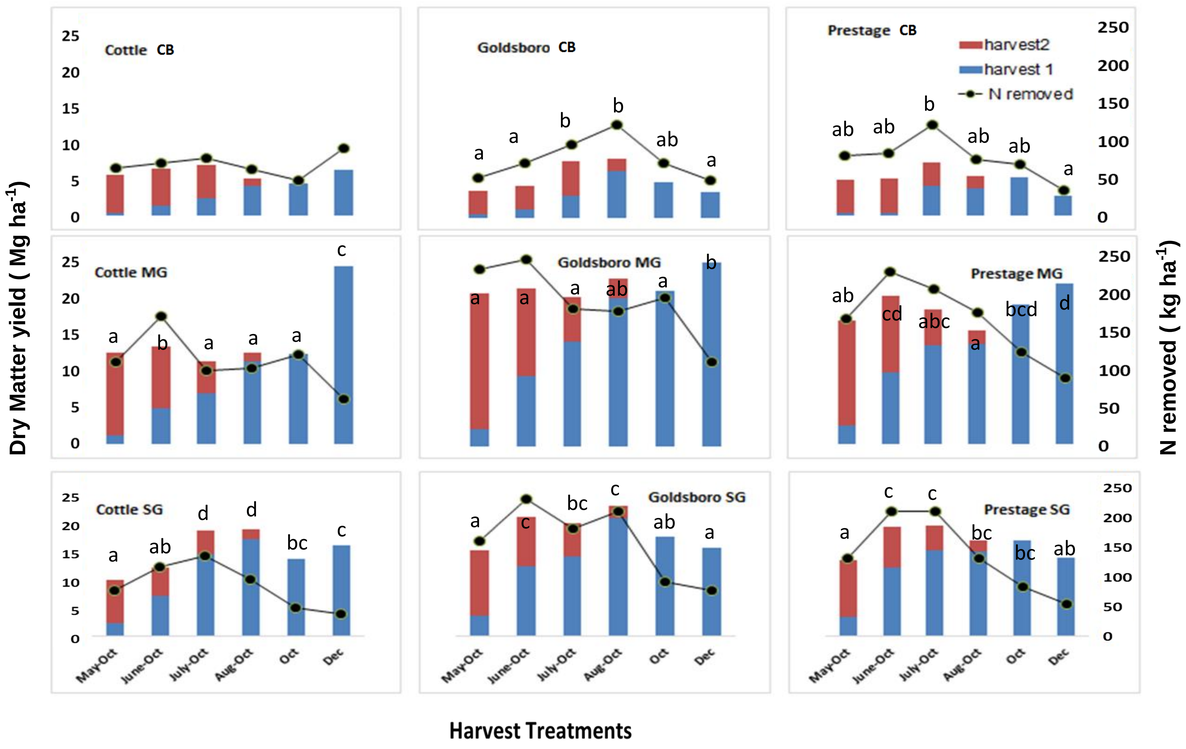

Figure 1. Biomass dry yield and N removal for the harvest treatments at the 3 on-farm sites. Treatment dry yield means labelled with the same letter for a given crop/site combination are not different at α=0.05.

Results

Table 2. The approximate amounts of inorganic N applied as effluent and harvest treatments with the best yields and the most N removal for each species at each of the three sites.

Site	Inorganic	Best yield			Most N removal		
	N applied	Miscanthus	Switchgrass	Sorghums	Miscanthus	Switchgrass	Sorghums
	kg ha^{-1}	Mg ha^{-1}			kg ha^{-1}		
Cottle	90	24.4 (Dec)	19.0 (July&Oct)	9.6 (FS)	179 (June&Oct)	168 (July&Oct)	67 (FS)
Goldsboro	213	24.6(Dec)	22.4 (Aug&Oct)	23.5 (SS)	269 (June&Oct)	258 (June&Oct)	157 (SS)
Prestage	246	22.2(Dec)	22.2 (June&Oct)	15.5 (SS)	246 (June&Oct)	224 (June&Oct)	146 (FS)

Table 3. Dry matter yield and N removal for forage and sweet sorghum. Sorghums were harvested annually in September. Mean separation of yield was performed and no differences were detected between the two sorghum types at each site, α=0.05.

	Site					
	Cottle		Goldsboro		Prestage	
Crop	FS*	SS*	FS	SS	FS	SS
Yield (Mg ha^{-1})	9.5	6.7	23.3	19.5	16.7	13.1
N removal (kg ha^{-1})	66	41	154	144	140	120

(*FS=forage sorghum, SS*=sweet sorghum)

Summary

- Dry biomass yields of both switchgrass and giant miscanthus were significantly greater than traditionally-planted coastal bermudagrass.
- Harvest timing was critical for determining N removal and total biomass production. Across all three farm sites, the June & Oct cutting treatment for both miscanthus and switchgrass removed the most N.
- Switchgrass achieved the highest yield with the Aug & Oct harvest in two of the three farm sites, with a mean yield of 19.7 Mg ha^{-1} across all sites. Giant miscanthus yield was highest with the sole harvest in December, with a mean yield of 23.1 Mg ha^{-1} across all sites. Sorghum yields for both cultivars varied among sites, with a maximum yield of 23.3 Mg ha^{-1} and N removal of 154 kg ha^{-1} by forage sorghum at the Goldsboro site.