UNIVERSITY OF FLORIDA

Water-Use Efficiency and Feedstock Composition of Candidate Bioenergy Grasses in Florida

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Description:
Florida ranks first in the USA in annual growth of plant biomass because of a large cultivatable land area, high rainfall, and long growing seasons. The development of high yielding production systems for energy crops that can be grown in Florida is considered essential for establishment of a sustainable biomass to energy industry. This is the case because long-term availability of sufficient amounts of reasonably priced biomass will be an important determinant of if and where new biofuel and bioenergy facilities will be built. Because of its size and large number of climatic zones, there will be large regional differences in what energy crops can be used at various locations in Florida and how they will perform. In this project, we are conducting applied research at locations throughout Florida with sweet sorghum, sugarcane, energycane, giant reed, miscanthus, erianthus, and elephantgrass to provide important agronomic practice, yield, water use, and chemical composition information for Florida growers, bioenergy producers, and policy makers. This information will support decision making regarding which crops are adapted to specific environments, which are best suited to particular management practices (e.g., irrigation or none), and which have the desired chemical composition for the intended bioenergy use.

Investigators in the project include Dr. Lynn Sollenberger and Dr. John Erickson (agronomists at University of Florida), Dr. Joao Vendramini (agronomist at the Range Cattle Research and Education Center at Ona, FL), and Dr. Robert Gilbert (agronomist at the Everglades Research and Education Center at Belle Glade, FL). Graduate students involved in carrying out project research include Jeff Fedenko, Arkorn Soikiew, and Chae-In Na, all of whom started their grazduate programs in August 2009. External collaborators include Speedling, Inc., which has provided planting material of miscanthus.

Budget: $191,981

Universities: UF

External Collaborators: Speedling, Inc.

Progress Summary

Miscanthus, giant reed, erianthus, sugarcane, elephantgrass, and energycane are being compared in regional trials throughout Florida. All plots were fully established by early summer 2009. Biomass yield of the grasses was quantified at the end of the growing season in December 2009.

Miscanthus yielded least at each location (2-5 tons dry biomass per acre), giant reed was generally intermediate (6-12 tons/acre), and elephantgrass, energycane, erianthus, and sugarcane yielded the most (13-17 tons/acre). Maximum ethanol production was estimated based on carbohydrate content. This ranged from approximately 80-90 gallons per ton of dry biomass for giant reed, elephantgrass, energycane and erianthus, but was 104 gal/ton for sugarcane bagasse. Our data show that elephantgrass, energycane, erianthus, and sugarcane outyield giant reed and miscanthus in terms of biomass and potential ethanol per acre.

Three sweet sorghums varieties including M81, Dale, and Topper 76-6 were planted at three dates during 2009 at three locations in Florida to assess the effects of planting date and location on biomass production, sugar composition, and sugar yield. Planting occurred on 13 March, 27 May, and 12 June 2009 at Belle Glade, 31 March, 5 May, and 9 June 2009 at Citra, and 7 April, 12 May, and 16 June 2009 at Ona. Across all sites, plant crop green yields ranged from 48 to 73.2 Mg ha^{-1}, with M81-E yielding better than Topper 76-6 which yielded better than Dale. The May planting date yielded most. Ratoon crop green yields were affected by all treatments, ranging from 5 to 67 Mg ha^{-1} with greater yields generally correlating to earlier initiation of ratoon. Juice brix values ranged from 8 to 19% across all treatments, averaging 14.4 and 13.1% in the plant and ratoon crops, respectively. Brix values were about 20% lower on the muck soil location compared to the sand soil locations and about 20% lower in M81-E compared to Dale and Topper 76-6. Combining plant and ratoon harvests, this translates to estimated ETOH yields of 2350 to 6780 L ha^{-1} yr^{-1}. Our results indicated that sweet sorghum production in Florida can be competitive with corn ethanol yields in the Midwest, but understanding genotype, environment and management will all be critical to optimizing sugar yields from sweet sorghum in Florida.

Characterization of water use occurred in sweet sorghum, elephantgrass, energycane, and giant reed during summer of 2009 and will continue in 2010. Measures of plant transpiration allow for direct measurement of crop water use under real-world field conditions. These data will be combined with stem density measurements, leaf area index measurements, and/or stem basal diameter measurements to calculate water use by each plot. These daily measurements will be integrated with climate data (measured at the site) to calculate seasonal water use by each crop. Thus, we will be able to directly compare crop water use during the growing season which will assist producers in selecting crops that are most sustainable for Florida. In addition, we will be able to couple seasonal crop water use data with yield data (e.g., biomass, lignocellulose and/or simple sugars) to estimate ethanol produced per unit of water used by the crop during production. Results from 2009 indicate that energycane and elephantgrass produce more biomass per unit of water than does giant reed.

The projects described above have been initiated for a second year in 2010 at all locations. Feedstock composition of samples collected in 2009 is currently being analyzed and will be available for presentation in the next several months.