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Sorghum Biomass Yield Trial for Ethanol Production

Maria G. Salas Fernandez
Iowa State University, mgsalas@iastate.edu

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Abstract

This research project is part of the sorghum breeding program for biofuel use at ISU, which has the ultimate goal of releasing sorghum lines/germplasm for public use. The program was initiated in September 2008, and in 2010 the first set of experimental biomass hybrids were tested.

Keywords

RFR A1077, Agronomy

Disciplines

Agricultural Science | Agriculture | Agronomy and Crop Sciences

Sorghum Biomass Yield Trial for Ethanol Production

RFR-A1077

Maria Salas Fernandez, assistant professor
Department of Agronomy

Introduction

This research project is part of the sorghum breeding program for biofuel use at ISU, which has the ultimate goal of releasing sorghum lines/germplasm for public use. The program was initiated in September 2008, and in 2010 the first set of experimental biomass hybrids were tested. The objectives of this research project were:

1. to determine biomass yield potential of different sorghum types: grain vs. forage vs. photoperiod sensitive (non-flowering) hybrids.
2. to determine biomass yield of experimental sorghum hybrids generated in the sorghum breeding program, as lignocellulosic feedstock for ethanol production, and compare them with commercial hybrids.
3. to test the effect of plant height on biomass yield.

Materials and Methods

A total of 69 hybrids were planted in three locations (Lewis, Crawfordsville, and Ames) in a completely randomized block design with two replications per location. Experiments were planted from May 19 to May 25 with a density of 140,000 plants/ha. Hybrids included six commercial grain sorghums, nine commercial, and 19 experimental forage sorghums, and one commercial and 35 experimental photoperiod sensitive sorghums. Each material was planted in a two-row plot, with a 30-in. row spacing and 15-ft row length. Total biomass was harvested before the first killing frost using an experimental forage chopper adapted with a Harvest Master system to record total plot

weight. A sample of each plot was collected and dried to estimate moisture content. This information was used to express biomass yield as total dry matter per hectare. Plant height was also recorded for each plot.

Results and Discussion

As expected, grain sorghum was the group with the lowest yield on average over the three locations. The photoperiod sensitive sorghum group had the highest yield (Table 1). Ames was the lowest yielding location, significantly different from Crawfordsville and Lewis, which was the highest yielding location (Table 2).

Biomass yields, averaged over the three locations, ranged from 5 Tn/ha to a maximum of 27 Tn/ha of dry matter (Figure 1). Most of the experimental photoperiod sensitive hybrids (91%) yielded more than any of the commercial hybrids (Figure 1). The only commercial photoperiod sensitive hybrid included in the experiment flowered and set seed late in the season, so it actually behaved as a forage sorghum.

There was a significant variation in plant height ranging from 96 cm to 421 cm, with grain sorghums having, as expected, the shortest plants and photoperiod sensitive sorghums the tallest. Plant height was significantly and positively correlated with biomass yield ($r = 0.72$, $P < 0.0001$), confirming published results from different species including sorghum. Therefore, it is clear that plant height is an important trait to select when breeding for high biomass materials. Lodging could be an undesirable characteristic associated with plant height, but in our studies, lodging was also visually measured and a negative association was not found (data not shown).

This project provided the first experimental data to select sorghum breeding lines appropriate for biomass production in Iowa. Experimental hybrids need to be re-tested in subsequent years and new hybrids and new populations will be created based on this information. Our results confirmed that photoperiod sensitive sorghums were the most productive as lignocellulosic feedstock and that plant height is a useful trait to select in our breeding program.

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Table 1: Average biomass yield for each sorghum type.^a

Sorghum type	Mean biomass yield (Tn dry matter/ha)
Grain	7.5a
Forage	16.0b
Photoperiod sensitive	21.4c

Table 2: Average biomass yield per location.^a

Location	Mean biomass yield (Tn dry matter/ha)
Ames	14.9a
Crawfordsville	18.3b
Lewis	20.6c

^a Biomass yields not connected by the same letter are significantly different at $P \leq 0.05$ (Tukey-Kramer test).

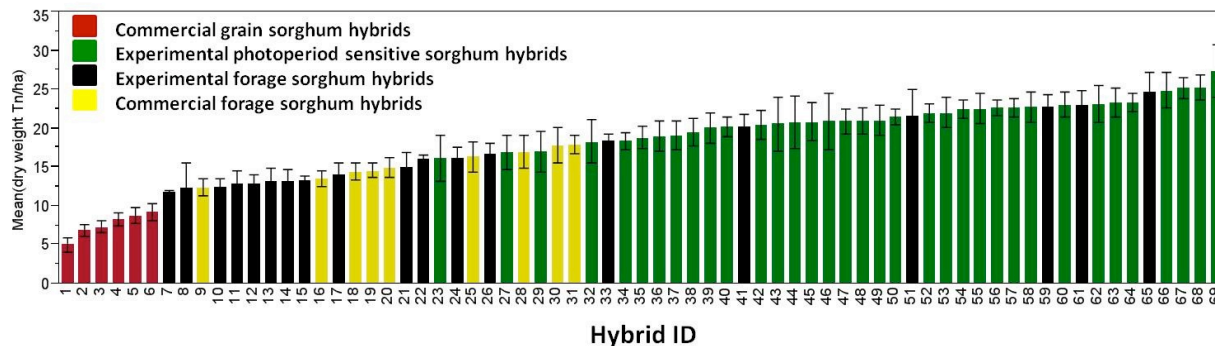


Figure 1: Biomass yield of experimental and commercial sorghum hybrids. Yields are averaged over replications and locations. Error bars represent one standard error from the mean.