Sorghum Biomass Yield for Biofuel Production in Iowa

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Introduction

The sorghum biomass yield trial conducted at the ISU Southeast Research Farm, Crawfordsville, Iowa, during the summer 2015, is part of the sorghum breeding program at ISU. The long-term goal of this program is developing high-yielding sorghum germplasm to be used as lignocellulosic feedstock. The specific objectives of this research project were:

1) To determine the performance of ISU materials relative to commercial hybrids.
2) To determine the correlation between plant height, lodging, and plant density with final biomass yield.
3) To determine the potential productivity of each of the sorghum types evaluated: grain, dual purpose, forage (with grain), and photoperiod sensitive (no grain) sorghums.

Materials and Methods

A total of 579 hybrids were planted June 3, 2015, at Crawfordsville in a completely randomized block design. Each hybrid was planted at a density of 140,000 plants/ha, in a two-row plot with two replications. Row spacing was 30 in. and plot length was 15 ft. Hybrids included:

a) Grain type (G): 7 hybrids
b) Dual purpose (DP): 11 hybrids
c) Forage type (F): 335 hybrids
d) Photoperiod sensitive (PS): 226 hybrids

Plots were harvested October 29 and 30, 2015, using an experimental forage chopper adapted with a Harvest Master weigh system. A sample of wet biomass was collected manually for each plot and dried to constant weight to estimate moisture content. Total plot weight was expressed as tons (Tn) dry matter per hectare (DM yield). Plant height and lodging were determined at harvest time while stand counts were recorded three weeks after planting. Lodging was visually determined using a 1-5 scale (1 no lodging, 5 completely lodged).

Results and Discussion

Traits analyzed were yield, height, dry matter content (%), and lodging. Table 1 shows there was a significant variation in all traits analyzed, with a maximum single plot yield of 40.028 Tn/ha dry matter.

As reported in previous years, grain sorghums were, in general, the shortest group (mean = 1.32 m), followed by dual purpose sorghums (mean = 2.10 m). Forage and photoperiod sensitive sorghums had similar mean and maximum heights.

As expected based on the different composition of the biomass (grain vs. vegetative tissue), grain sorghums had the highest percent dry matter (mean = 51.33%), followed by dual purpose types (mean = 45.23%). The small difference in dry matter percentage observed in forage vs. photoperiod sensitive sorghums is due to both the presence of grain in the total biomass of forage sorghums, and the fact photoperiod sensitive hybrids continue to grow and thus, maintain more water content throughout the growing season until the first killing frost.

Even though plant height and lodging have been reported as significantly and positively

correlated in previous years, we did not find that level of association between the traits in 2015 (Table 2). Lodging and DM yield were significantly and negatively correlated while plant height and DM yield, as expected, were positively and significantly correlated. Lodging and plant height were not significantly correlated. Even though it is logical to expect taller materials to lodge more easily, the presence/absence of grain on top of a tall stem and the tolerance/susceptibility to root lodging and stem diseases affected this apparent obvious effect of height on standability. Final plant density (stand counts) was significantly and positively correlated with DM yield (r = 0.12), but the correlation was low because of the tillering capacity that compensates for the difference in planting density.

Several experimental hybrids had higher or similar yields to the best commercial hybrids (only highest yielding hybrids are shown in Figure 1 relative to best commercial hybrids). This project confirmed results from previous trials about the effect of different traits on final biomass yield. It also provided additional evidence of the good performance of ISU inbred lines in hybrid combinations for further selections in the sorghum breeding program.

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Table 1. Summary of hybrid performance by sorghum type.

Sorghum type[a]	Trait	Mean	Range	Std. dev
G	DM yield (Tn/ha)	6.43	2.60- 15.95	3.5
	Height (m)	1.32	1.0-1.6	0.15
	Lodging (1-5)	1.57	1-5.00	1.1
	Dry matter (%)	51.33	30.8-61.31	7.4
DP	DM yield (Tn/ha)	11.05	0.3-28.1	5.6
	Height (m)	2.10	1.9-2.5	0.12
	Lodging (1-5)	1.33	1-4	0.91
	Dry matter (%)	45.2	31.8-52.8	5.3
F	DM yield (Tn/ha)	15.5	0-33.3	5.1
	Height (m)	3.23	1.4-4.3	0.42
	Lodging (1-5)	1.42	1-5	0.88
	Dry matter (%)	37.3	22.6-55.4	5.5
PS	DM yield (Tn/ha)	18.6	1.5-40.0	5.4
	Height (m)	3.19	1.7-4.2	0.39
	Lodging (1-5)	1.44	1-5	0.83
	Dry matter (%)	30.44	22.4-52.5	4.4

[a]G = grain type; DP = dual purpose; F = forage type; PS = photoperiod sensitive.

Table 2. Correlation coefficients between all traits.

	Yield	Lodging	Height
Yield	-		
Lodging	-	-	
	0.321*		
Height	0.384*	0.048	-

*Indicates significance at the P < 0.01.

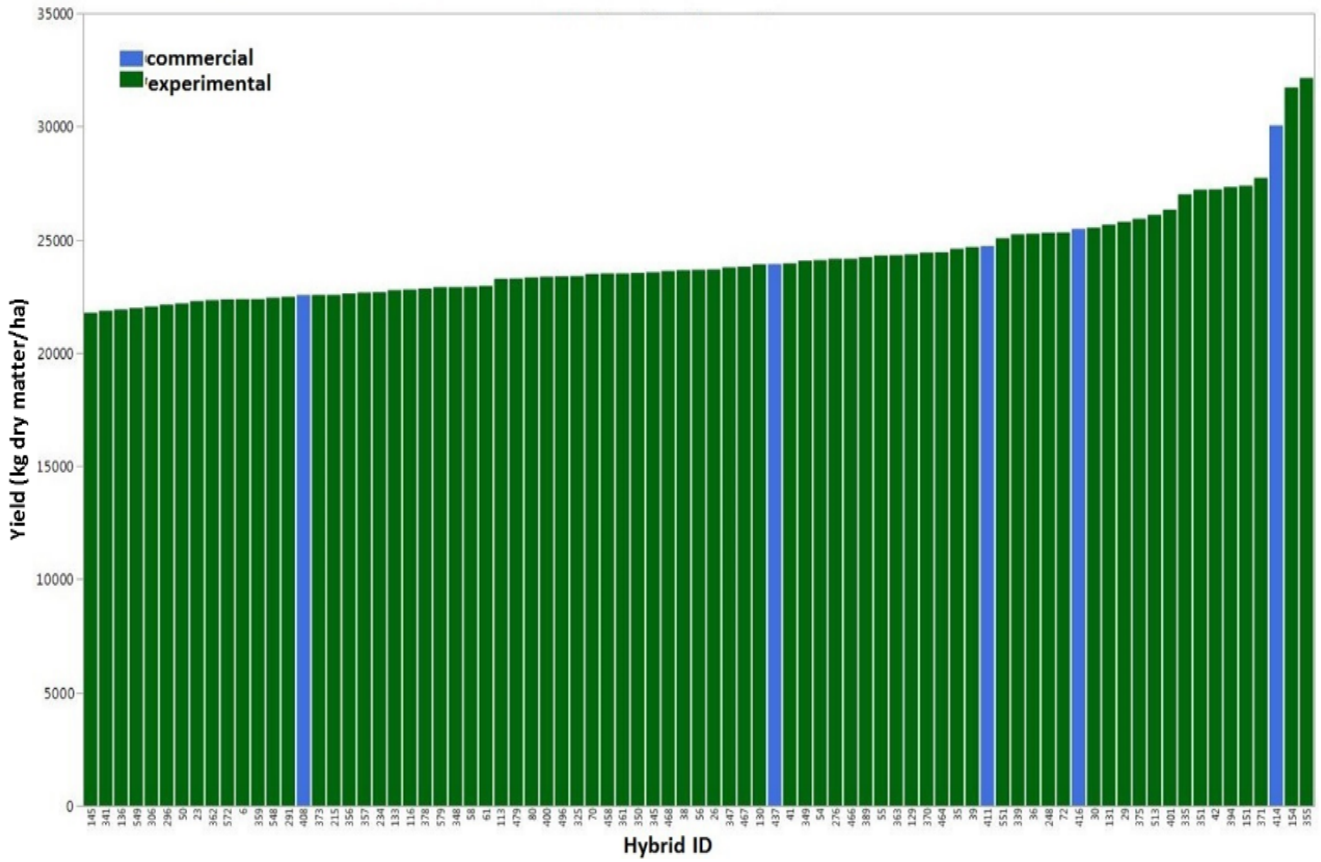

Figure 1. Biomass yield of experimental and commercial sorghum hybrids. Yields are averaged over replications.