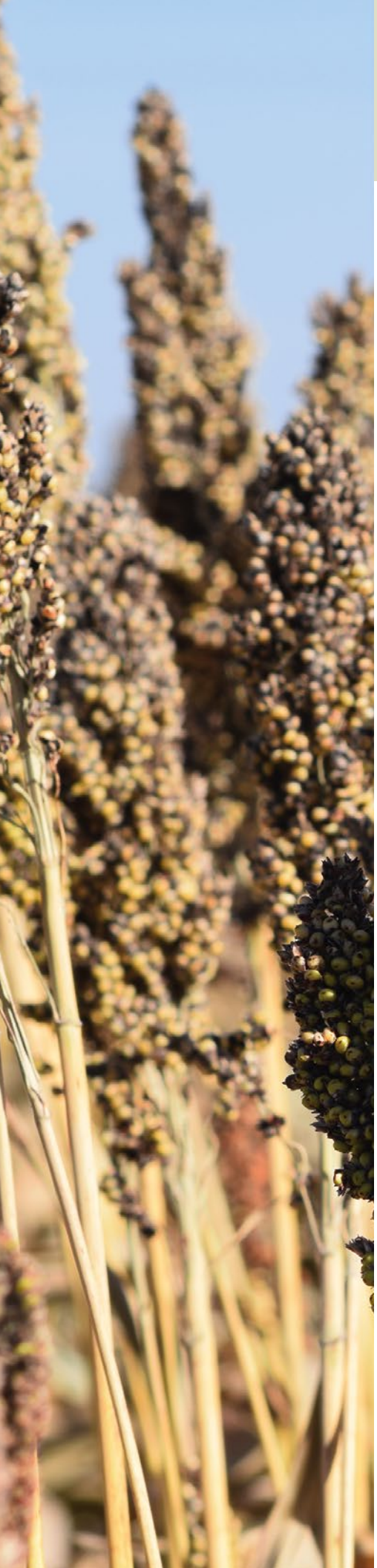

Sorghum Breeding Program for Biofuel Production

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The Iowa State University (ISU) sorghum breeding program was initiated in 2009 with the ultimate goal of developing germplasm adapted to the Midwest for the production of biomass as lignocellulosic feedstock. The development of parental lines to create photoperiod sensitive (PS) hybrids was prioritized to maximize biomass yield and improve lodging resistance.

In 2019, the pollen parent lines IA100RPS and IA101RPS were released as elite inbreds that generate superior hybrids with high biomass yield and excellent standability. Current experimental hybrids from the ISU sorghum breeding program are compared with commercially available sorghums and those derived from the ISU elite lines IA100RPS and IA101RPS.

Materials and Methods

In 2021, performance of experimental hybrids was evaluated at Agricultural Engineering/Agronomy Research Farm (AEA) (Boone), the Southeast Research and Demonstration Farm (Crawfordsville) and Neely-Kinyon Memorial Research and Demonstration Farm (Greenfield). A total of 119 entries were planted in a randomized complete block design with two replications per location at a target density of 140,000 plants/ha. Hybrids were planted May 27 (AEA Farm), June 3 (Neely-Kinyon) and June 4 (Southeast) in four-row plots, with 30 in. row spacing and 10-ft. row length.

Total biomass, expressed as metric ton of dry matter (DM) per hectare, was obtained by harvesting entire plots before the first killing frost using an experimental forage chopper adapted with a Harvest Master system. A biomass sample of each plot was collected and dried to constant weight to estimate moisture content. Harvest dates were October 15 (Boone), October 20 (Greenfield) and October 22 (Crawfordsville). Data on plant height, stand counts and lodging scores (visual rating 1-5 scale) were manually collected. Performance of experimental hybrids was compared with commercially available dual purpose, forage and PS sensitive sorghum hybrids from multiple seed companies.

Results and Discussion

There was significant variation in all traits (yield, height, percentage of dry matter and lodging) between and within sorghum types (Table 1). Crawfordsville was the location with more severe lodging (mean = 3.0 vs 1.6 and 1.4), and thus, lower biomass yield (mean = 21.4 Tn/ha vs 25.9 and 24.5 Tn/ha).

Dual purpose sorghums were, in general, the shortest, with a mean height of 2.2m, followed by forage sorghums (mean=3.3m) and PS hybrids as the tallest group (mean = 4.3m). Both plant height and biomass yield were significantly and negatively correlated with lodging ($r = -0.43$, $P < .0001$; $r = -0.66$ $P < .0001$, respectively). Even though taller plants would be expected to lodge more frequently, the presence of grain on terminal inflorescences reduces standability. Therefore, grain producing dual purpose and forage sorghums, which are shorter than PS types, had higher lodging scores (2.5 and 2.9 vs 1.6), which explains the negative correlation between the two traits.

Plant height was the characteristic most highly correlated with yield ($r = 0.69$, $P < .001$). Increases in plant height and lodging tolerance are the cause of biomass yield improvements in the sorghum breeding program over the years.

Dual purpose sorghum was the group with the higher average DM content, due to the large percentage of biomass allocated to grain. However, genetic variation exists within the PS group to improve DM content and thus, dry biomass yield per unit of land (Table 1).

Several ISU experimental hybrids had higher yields than commercially available sorghums (Figure 1), and thus, the seed and pollen parents of those hybrids are promising elite germplasm for future release.

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Table 1: Table 1: Summary of hybrid performance over the three testing sites.

	Biomass yield (Tn/ha DM)			Plant height (m)		Dry Matter (%)		Lodging (scale 1-5)	
Sorghum type	N	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dual purpose	32	14.9	2.2-29.1	2.2	1.7-2.8	37.3	22.8-48.7	2.5	1-5
Forage	146	16.1	2.1-36.5	3.3	2.0-4.7	31.5	20.5-47.8	2.9	1-5
Photoperiod sensitive	412	27.4	6.5-39.0	4.3	3.0-5.0	30.5	22.6-37.7	1.6	1-5

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