Warm-season Annual Grasses as Pinpoint Grazing Opportunities

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Abstract

There is a need to determine the use of annual warm-season grasses (AWSGs) such as forage sorghum (FS), millets (M), sudangrass (SG), and sorghum-sudangrass hybrid (SSH) can be integrated for grazing or hay production when utilized with appropriate grazing management strategies. The objective of the study was to screen new cultivars with the potential for resistance to sugar cane aphid (SCA, *Melanaphis sacchar*) for biomass production and nutritive value in a one-cut system. Treatments consisted of 30 cultivars that included FS, SG, SSH, and millets (M). Treatments were replicated three times in a randomized complete block design. Cultivars influenced forage biomass production and nutritive values for crude protein (CP), neutral detergent fiber (NDF), and in vitro dry matter digestibility (IVTDMD). There was a low incidence of sugarcane aphids and no differences among brown-mid rib (BMR) non-BMR and types were observed.

Introduction

Bahiagrass (*Paspalum notatum* Flueggé) and bermudagrass (*Cynodon dactylon* L. Pers.) are the foundation of the cattle industry in the southern USA. Although these grasses tend to be very productive during the summer months, they tend to have a lower nutritive value compared to cool-season grasses and annual warm-season grasses (AWSG). To improve forage production and nutritive value of forage systems during the summer, annual warm-season grasses such as forage sorghum (FS), millets (M), sudangrass (SG), and sorghum-sudangrass hybrid (SSH) can be integrated for grazing or hay production when are utilized with appropriate grazing management strategies.

These AWSGs can be established using a conventional tillage or no-till approach. Using conventional tillage allows the reduction in competition from any existing vegetation while a no-till approach will require a chemical burndown with glyphosate or paraquat for successful establishment. These species can be established at seeding rates ranging from 15 to 25 lb per acre when soil temperatures are above 65 °F. In the southern USA, the best planting window ranges from May 1 to June 15, depending on location. Sorghum-sudangrass hybrids can be planted earlier than pearl millet due to better tolerance to low temperatures (Bates, 2021). Once established, fertilization can range from 30 to 60 lbs of N per acre. If regrowth occurs and there is adequate moisture, a second N application can occur in the middle of the summer.

Annual warm-season grasses can have a biomass production of 60 to 90 days depending on moisture, fertilization, and cutting or grazing management. Forage sorghum tends to have thicker stems, wider leaves, and greater growth height than SSH. Pearl millet has shorter growth than FS and SSH but has greater leaf production and thin stems (Jennings et al., 2020). Pearl millet also has a better potential to regrow following defoliation if enough stubble is left behind (Jennings et al, 2020). Crude protein levels of 9 to 21% have been reported for forage sorghum and pearl millet (Sleugh et al., 2006; Beck et al., 2007). Biomass production of pearl millet can range from 3600 to 4200 lb of dry matter (DM) per acre (Lemus, 2015).

Despite providing high biomass production, these AWSG can be impacted by insects and could cause toxicity to livestock under stress conditions (Strickland et al., 2017). On the other hand, under periods of frost, FS and SSH can accumulate prussic acid, which is released from a compound called dhurrin. In recent years, the forage fields of FS, SG, and SSH have been impacted by sugarcane aphids (SCA, *Melanaphis sacchari*) (Lemus and Teutsch, 2022). Sugarcane aphid is a pest that commonly affects sugarcane and sorghum, but in recent years, it has become a pest in FS, SG, and SSH across the southern USA (Thompson et al., 2021). Although pearl millet tends to be more resistant to SCA infestations, the aphids are a vector for the Yellow Mosaic Virus that can impact PM biomass production (Lemus and Teutsch, 2022). Teutsch et al. (2020) have indicated that the use of aphicides had a limited impact on sugarcane aphid damage and yield. There is a limitation on the number of AWSGs cultivars that are resistant to SCA. The objective of the study was to screen new cultivars with the potential for resistance to SCA for biomass production and nutritive value in a one-cut system.

Materials and Methods

This preliminary study was conducted at Henry H. Level Animal Research Farm at Mississippi State University. The predominant soil is a Marietta sandy loam. Treatments consisted of 30 cultivars that included FS, SG, SSH, and millets (Table 1). Treatments were replicated three times in a randomized complete block design resulting in 90 experimental units. The study was established on July 12, 2022, at a rate of 20 lb pure lives seed per acre using an ALMACO plot drill (ALMACO, Nevada, IA) and the plot size was 6 ft x 10 ft. Phosphorus, potassium, and lime were applied at planting according to soil test recommendations. Plots were fertilized with urea ammonium sulfate at 50 lb N per acre when plants reached three inches after emergence. Plots were rated weekly for aphid damage three weeks after emergence until harvest on a scale of 1 to 9 (Sharma et al., 2001; Teutsch et al., 2020). Cultivars were harvested using a Wintersteiger Cibus F harvester (Wintersteiger AG, Austria) at the boot stage on September 9, 2022. Biomass subsamples were dried at 140 °F for 72 h and ground to pass a 1-mm screen. Biomass subsamples were analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), 48-h in vitro true dry matter digestibility (IVTDMD), lignin, and water-soluble carbohydrates (WSC) using a Foss DS2500 NIR instrument (Foss North America, Eden Prairie, MN). Samples were analyzed using the 2022 grass-hay equation from the NIRS Forage and Feed Testing Consortium (Berea, KY). Data were analyzed using harvest frequency as a repeated measure for each of the dependent variables. Nutrient removal was estimated for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg). Data were tested and normality and homogeneity of variance were subjected to ANOVA using SAS PROC GLIMMIX procedure of SAS (SAS 9.4) and the least significant difference was used to determine treatment differences at $\alpha = 0.05$.

Results and Discussion

Biomass Production

Warm, dry weather is optimal for SCA reproduction. The environmental conditions were not conducive for populations of SCA during the 2022 growing season. Across all cultivars, the SCA mean was 1.8. There were just a few aphids present on the lower one or two leaves with no apparent damage to the leaves. There was a significant difference in forage biomass among cultivars in the study ($P < 0.0001$) (Table 1). Millets had a 36% lower mean biomass production compared to the mean biomass production of the other three species (4000 lb DM ac^{-1} vs. 6285 lb DM ac^{-1}). Cultivars F7103 (SSH) sand FSG214 (M) had the greatest (8837 lb DM ac^{-1}) and lowest (2104 lb DM ac^{-1}) biomass production, respectively, in the study (Table 1). Despite no differences in SCA tolerance, cultivars with the AphidAxe gene had a 17% biomass yield increase compared to susceptible SCA cultivars. There was no overall significant difference in biomass production between BMR and Non-BMR forage types. However, Non-BMR types had a slight biomass yield advantage over the BMR types.

Nutritive Value

Crude protein was affected by forage species (P = 0.0168) with millets having greater concentration compared to the rest of the species. Cultivars affected CP (P = 0.0019), NDF (P = 0.0396), and IVTDMD (P = 0.0047) concentrations (Table 1). Such differences could be related to the stage of maturity since the study was harvested when 50% of the cultivars exhibited the boot stage. The neutral detergent fiber was affected by species (P = 0.0006) with millets having 4% lower NDF concentration than FS, SG, and SSH. Nutritive values for CP, ADF, NDF, IVTDMD, and WSC were not impacted by BMR type or sugarcane aphid tolerance. Despite BMR-type cultivars being present in the study, they did not exhibit greater IVTDMD.

Conclusions and/or Implications

A total of 35 genotypes of AWSGs were screened for SCA damage but little impact was found under 2022 environmental conditions on aphid density and damage. Most of the yield differences were related to cultivars rather than their classification type. Differences in nutritive value were more related to the maturity stage of each cultivar. Further studies along with planting dates need to be conducted to determine SCA thresholds that could impact economic returns. There is also a need to determine how leaf:stem ratio could impact the aphid population and how insecticides available for forage production could affect aphid populations based on application method and rates. Further studies related to N applications and plant sugar content are necessary across cultivars are also necessary to determine aphid population changes.

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Table 1. Characteristics, biomass production, and nutritive value (CP, NDF, and IVTDMD) of annual warm-season grasses evaluated at Starkville, MS during the 2022 growing season.

Type[1]	*Cultivar*	*Genetic Characteristics[2]*	*Maturity (d)[3]*	*SCA Tolerance[4]*	*Yield (lb DM ac^{-1})*	*CP (% DM)*	*NDF (% DM)*	*IVTDMD (% DM)*
FS	Sweet Bee	Non-BMR	55-60	Low	6015	11.4	63.4	11.4
FS	ADV F8322	AphidAxe	90-100	High	7864	11.6	66.4	11.6
FS	ADV F7424	BMR-6, BD	90-100	High	5781	11.9	65.3	11.9
FS	ADV F7103	BMR-6, BD	55-66	Low	6113	12.3	66.3	12.3
FS	F8484IG	Non-BMR	95-100	Low	5190	12.3	66.6	12.3
FS	ADV F7232	BMR-6, BD	95-100	Low	7179	12.3	66.5	12.3
FS	SEA905	BMR-6, BD	70-85	Low	5982	12.4	65.8	12.4
FS	F7401	BMR-6, BD	95-100	Low	8837	12.7	64.9	12.7
FS	Fiber Pro 50	BMR-6, BD	85-80	Low	5836	13.9	65.1	13.9
FS	AF7301	BMR-6, BD	95-100	Low	6466	14.1	63.2	14.1
FS	AF7102	Non-BMR	85-90	Low	4937	16.8	60.3	16.8
M	FSG315	BMR-6, BD	60-65	Medium	5479	12.9	65.1	12.9
M	Brown Top Millet	Non-BMR	45-60	Medium	5066	13.3	64.5	13.3
M	Japanese Millet	Non-BMR	40-50	Medium	3638	14.2	64.3	14.2
M	Prime360	BMR-6, BD	45-60	Medium	4848	14.2	63.5	14.2
SG	AS9301	BMR-6, BD	55-60	Low	7464	12.3	67.0	12.3
SG	AS9302	BMR-6, BD	55-65	Low	6340	12.8	65.8	12.8
SSH	FSG214	BMR-6, BD	50-55	Low	4957	11.5	66.3	11.5
SSH	Green Grazer V	Non-BMR	63-65	Low	2104	11.7	65.5	11.7
SSH	S6218	BMR-6, BD	50-60	Low	6633	11.8	65.0	11.8
SSH	Sugar Pro 55	BMR-6, BD	30-45	Low	6465	11.9	66.7	11.9
SSH	S6402	BMR-6, BD	65-70	Low	7713	11.9	67.7	11.9
SSH	S6501	BMR-6, BD	70-85	Low	7818	11.9	66.2	11.9
SSH	ADV S6404	BMR-6, BD	65-70	Low	7877	12.4	65.8	12.4
SSH	ADV S6520	BMR-6, BD, Aphix	70-85	High	6890	12.5	65.4	12.5
SSH	SS 275	Non-BMR, Aphix	80-90	High	6463	12.8	65.9	12.8
SSH	PS951	Non-BMR	70-80	Low	6657	12.9	65.9	12.9
SSH	ADV S5501	BMR-6, BD	75-85	Low	5281	13.5	63.9	13.5
SSH	Graze-it	Non-BMR	55-65	Low	2529	13.6	61.8	13.6
SSH	S6401	BMR-6, BD	95-100	Low	7383	13.9	64.0	13.9
				$LSD_{0.05}$[5]	2281	2.0	2.1	2.0

[1]FS = forage sorghum; M = millet; SG = sudangrass; SSH = sorghum-sudangrass hybrid. [2]BD = brachytic dwarf; Aphix = AphidAxe sugarcane resistant gene. [3]Maturity is days to boot stage from seeding. [4]Estimate Sugarcane Aphid Tolerance. [5]Least significant difference at α=0.05.