USDA-ARS

Evaluation of Warm-Season Annuals for Grazing in Wisconsin

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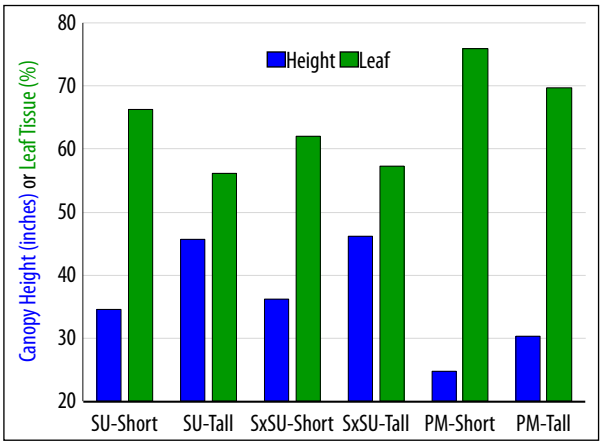
Experimental Concept. Grazing-based dairy operations require productive, high-quality forages that can support the nutritional needs of mid-lactation dairy cows. In this study, six summer-annual cultivars were compared for growth characteristics, yield, quality, and in-situ fiber digestibility across three harvest cycles at Prairie du Sac and Marshfield, WI. Two cultivars each of sudangrass (SU), sorghum-sudangrass (S×SU), and pearl millet (PM) were planted in early June at both locations during 2016 and 2017. Within each forage type, one cultivar exhibited a distinctly shorter growth habit, either by possessing the brachytic dwarf trait (SU and S×SU), or it was described as having a leafy, compact structure (PM), while the other entry exhibited taller growth characteristics. All cultivars except the tall-growing PM entry possessed the *bmr6* mutant, which is known to reduce concentrations of lignin and improve fiber digestibility relative to conventional cultivars. Within each growth cycle, forages were sampled for six consecutive weeks beginning when plants reached a canopy height of ~16". Primary and regrowth cycles were harvested for evaluation in 2016, but weather conditions permitted only a single (primary growth) evaluation during 2017.

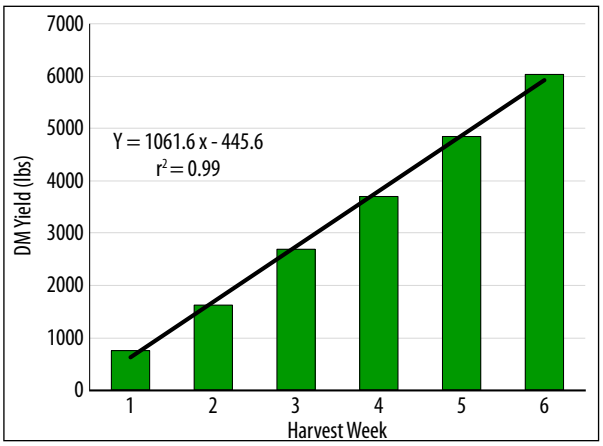
Canopy Height and Leaf Percentage. From a grazing perspective, maximizing the percentage of leaf tissue is generally advantageous. As expected, canopy height increased and the percentage of leaf decreased across harvest dates. Averaged across all forage cultivars and harvest cycles, canopy height ranged 17-52", and corresponding percentages of leaf from 86% down to 49% of plant dry matter (DM). It should be emphasized that these growth characteristics included contributions from dwarf or short-growing cultivars, and plants were evaluated specifically within a context of suitability for grazing; therefore, sampling during each growth cycle was terminated before physiological maturity, and these data are not necessarily appropriate for other forage applications, such as harvest for silage. A more unique observation was the relationship between tall- and short-growing cultivars within each forage type (Figure 1). Two important points are quickly evident: within all forage types, there was the same inverse relationship between canopy height and leaf percentage as noted previously; and these effects were more pronounced in PM cultivars compared to other forage types.

Figure 1. Canopy height and percentages of leaf tissue for warm-season annuals in Wisconsin.



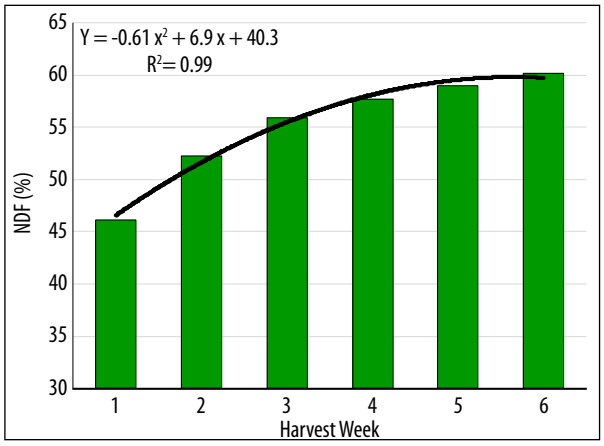
DM Yield. With the nitrogen-fertilization protocol used for each growth cycle (60 lbs N/ac), yields of DM (all locations and growth cycles) ranged across harvest dates from 745 up to 6,038 lbs DM/ac, increasing as expected with plant maturation (Figure 2). These increases across harvest dates corresponded to a consistent 1,062 lbs DM/week, with very little variability within the overall data set (r^2 = 0.99). Furthermore, canopy height was positively associated with DM yield. Within forage types, tall-growing cultivars out-yielded dwarf or short-growing entries by ~900 lbs DM/ac overall; however, the within-type differential was not consistent, and was greater for SU (1,424 lbs DM/ac) compared to S×SU (714 lbs DM/ac) or PM (576 lbs DM/ac) cultivars. It should also be noted nitrate concentrations in these forages were generally safe for grazing, but varied with harvest cycle and were potentially problematic without some additional precautions on Week 1 harvest dates.

Figure 2. Linear relationship for warm-season annuals in Wisconsin.



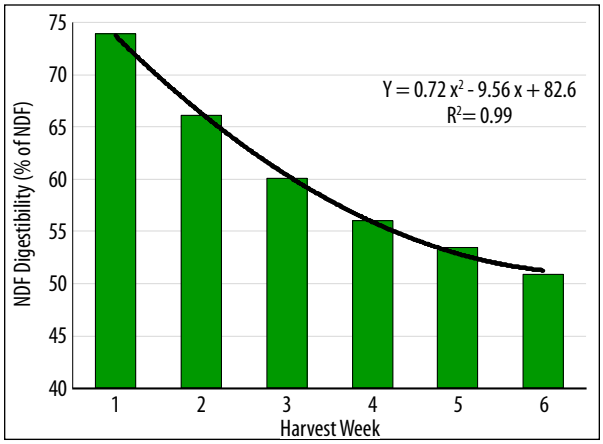
NDF. Concentrations of structural fiber within these summer-annual forages increased across harvest dates as plants matured. Unlike DM yield, the response for neutral detergent fiber (NDF) was curvilinear (quadratic), in which NDF increased most rapidly between early harvest intervals, but rates slowed later in each harvest cycle. Overall, the relationship between NDF and harvest week was very close, indicating virtually all variability in the data set can be explained simply on the basis of harvest week (R^2 = 0.99; Figure 3). While increasing NDF over time is entirely predictable, it was interesting that neither forage type, nor cultivar, had much effect on NDF concentrations. However, for the two harvest cycles in 2016, there was a differential of 8.2 percentage units between concentrations of NDF within stem (62.1%) and leaf (53.9%) tissues.

Figure 3. Curvilinear relationship for warm-season annuals in Wisconsin.



In-Situ NDF Digestibility. Although concentrations of NDF were explained primarily on the basis of harvest week, and not cultivar, ruminal in-situ digestibility of NDF was clearly influenced by cultivar. Shorter-growing cultivars exhibited greater NDF digestion for SU (59.1 vs. 57.1%) and S×SU (61.1 vs. 59.0%) cultivars compared to their tall-growing cohorts. The overall margin for PM cultivars was greater (3.4 percentage units), but this margin also likely was supported by the additional contrast of conventional vs. *bmr6* traits. The effects of harvest date (Figure 4) were essentially the inverse of those described in Figure 3 for accumulation of NDF. The response across both locations and all cultivars was a curvilinear function of harvest week, where the maximum fiber digestion occurred for Week 1 (74.0% of NDF), while the minimum was observed for Week 6 (50.9% of NDF). Overall, this relationship was again noteworthy with respect to the minimal variability about the regression curve (R^2 = 0.99), indicating that time (maturity) was an almost exclusive factor explaining fiber digestibility.

Figure 4. Curvilinear relationship between 48-hour in situ digestibility of NDF and harvest week for warm-season annuals in Wisconsin.



Summary. Within forage type, taller-growing cultivars frequently exhibited yield advantages over dwarf or shorter-growing cultivars, but the shorter-growing cultivars generally had greater percentages of leaf tissue, which is an especially relevant characteristic within a grazing context. Although assessed before physiological maturity, DM yield was positively related to canopy height, and increased linearly at a rate of 1,062 lbs DM/ac/week across the three harvest cycles. Forage type and cultivar had relatively minor effects on concentrations of NDF, but these concentrations were 8.2 percentage units lower in leaf compared to stem tissue. Finally, NDF digestibility was greater for shorter-growing cultivars by an average of 2.5 percentage units of NDF when considered across all locations, cultivars, and harvest weeks. Generally, the dwarf or shorter-growing cultivars, as well as PM cultivars, which were evaluated under the conditions of this trial, displayed characteristics more suitable for a grazing application, but selection on this basis would require a compromise with yield.