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Effects of growth stage and growing degree day accumulations on triticale forages: 1. Dry matter yield, nutritive value, and in vitro dry matter disappearance

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ABSTRACT

The use of triticale (X *Triticosecale* Wittmack) in dairy-cropping systems has expanded greatly in recent years, partly to improve land stewardship by providing winter ground cover. Our objective was to establish relationships relating indices of nutritive value with growth stage or accumulated growing degree days >5°C for triticale forages grown in central Wisconsin. Replicated 3.7-m × 9.1-m plots were established following removal of corn for silage (fall 2015) and soybeans (fall 2016) and then harvested at various growth stages the following spring. Plants were assigned a numerical growth stage based on a linear staging system suitable for use as an independent regression variable. Response variables [e.g., dry matter (DM) yield, indices of nutritive value, and parameters from in vitro DM disappearance kinetics] were regressed on growth stage and growing degree days using linear, quadratic, cubic, or quartic models. For spring 2016, the mean DM yield at the boot stage (3,804 kg of DM/ha) was only 30% of that observed at the soft dough stage of growth (12,642 kg of DM/ha). Although yields were reduced during spring 2017, primarily due to spring flooding, the relationship between respective yields at these growth stages was similar (1,453 vs. 5,399 kg of DM/ha). Regressions of DM yield (kg/ha) on growth stage for 2016 were explained by a cubic model ($Y = 0.0663x^3 - 9.44x^2 + 595x - 9{,}810$) compared with a simple linear response for 2017 ($Y = 103x - 3{,}024$); in both cases, coefficients of determination were very high ($R^2 \geq 0.934$). Many nutritional and in vitro DM disappearance characteristics were affected by the juxtaposition and balance of 2 generally competing factors: (1) increased concentrations of structural plant fiber coupled with concurrent lignification as plants matured and (2) the accumulation of highly digestible carbohydrate during seed head development. A comparison of respective energy yields between the boot and soft dough stages of growth for 2016 (2,488 vs. 8,141 kg of total digestible nutrients/ha) and 2017 (1,033 vs. 3,520 kg of total digestible nutrients/ha) suggests that yields of energy are greater at soft dough stage and are mostly driven by DM yield. An informed harvest management decision for lactating cows may still favor a boot-stage harvest because of superior nutritional characteristics, a need to plant double-cropped corn expeditiously, or both. Harvest timing of triticale forages for other livestock classes would appear to be more flexible, but prioritizing a subsequent double crop may reduce the effects on DM yield to a secondary consideration.
Key words: double cropping, harvest timing, nutritive value, triticale

INTRODUCTION

The use of triticale (X *Triticosecale* Wittmack) in dairy-cropping systems has expanded greatly in recent years, partly in response to environmental pressures, such as a desire to capture N from land-applied manure or to improve stewardship of the land by providing winter ground cover. However, triticale also is recognized as a valuable forage crop (McCormick et al., 2006; Gibson et al., 2007; Baron et al., 2012) with the potential for use across a range of livestock classes, but appropriate use of triticale requires proper synchronization of forage nutrient composition with the nutrient demands of each livestock class. Generally, triticale functions as a winter-annual forage; most production scenarios in the north-central United States focus on fall establishment after removal of corn for silage or soybeans (Schwarte et al., 2005; Gibson et al., 2007), followed by harvest as silage the following spring or early summer. However, when this production strategy is used, accumulation of

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DM during spring is affected negatively by delayed fall planting dates, which has been attributed to inadequate leaf area, and reduced light interception that subsequently reduces the rate of spring growth (Schwarte et al., 2005).

Several previous studies have attempted to provide some guidance concerning proper agronomic or harvest management for triticale. These studies have used a wide scope of perspectives that include (1) assessment of fall growth alone (Coblentz and Walgenbach, 2010), (2) assessment of fall and spring growth combined (Maloney et al., 1999; McCormick et al., 2006), (3) multiple species comparisons established in monocultures or mixtures (Cherney and Marten, 1982a; Khorasani et al., 1997; McCormick et al., 2006), (4) focused emphasis on the effects of plant maturity on forage quality (Khorasani et al., 1997; Cherney and Marten, 1982a,b), (5) assessment of simulated grazing or haying scenarios on DM yield (Drake and Orloff, 2005), (6) N and P fertilization strategies and their subsequent effects on forage quality (Harmoney and Thompson, 2005), (7) timing of seeding dates and their effects on fall and spring DM yield and associated forage quality (Griggs, 2006), and (8) substitution of triticale for corn silage in diets of midlactation cows (Harper et al., 2017). Generally, recommendations for harvest of high-energy forage suitable for dairy cows are to cut when the flag leaf is fully emerged but no seed heads are visible (Kilcer et al., 2010). When this harvest schedule has been used, triticale silage has been successfully substituted for corn silage at a rate of 10% of dietary DM (Harper et al., 2017). Historically, harvests at the late milk to early dough stages of growth also have been common (McDonald et al., 1991; McCartney and Vaage, 1994; Kennelly and Weinberg, 2003). Using that management scheme, triticale silage was found to be less acceptable than barley or oat silage for beef heifers and sheep, based primarily on poor palatability and reduced DMI (McCartney and Vaage, 1994). Additional perspective is needed to relate indices of nutritive value to growth stage or growing degree days (**GDD**) for spring harvests of triticale forages established the previous fall after removal of corn for silage or soybeans. From a practical perspective, this production scenario has proved to be somewhat challenging throughout central Wisconsin. Growing seasons are relatively short, and soils are heavy and poorly drained; both of these conditions complicate the processes of removing a corn silage or soybean crop, applying dairy manure, and establishing a subsequent triticale double crop for harvest the following spring. Our objectives were to establish relationships relating indices of nutritive value with growth stage or accumulated GDD for triticale forages grown under a challenging double-cropping environment in central Wisconsin.

MATERIALS AND METHODS

Forage Establishment and Management

2015–2016. Thirty 3.7-m × 9.1-m plots were established in 5 field blocks (6 plots/block) on a Loyal silt loam soil at the University of Wisconsin Marshfield Agricultural Research Station, located near Stratford, Wisconsin (44°39′ N, 90°08′ W). Blocks were established based on soil topography (slope). ‘Forerunner’ triticale (Legacy Seeds, Scandinavia, WI) was no-till drilled (model 1206NT; Great Plains Manufacturing, Salina, KS) into each plot of residual corn silage stubble (without tillage) at a seeding rate of 108 kg/ha on September 30, 2015. Immediately before planting, the plot area received 56,100 L/ha of dairy slurry via a broadcast-type tank spreader. Soil samples were taken by block to a 0.15-m depth the following spring (April 19); tests indicated pH = 7.1 ± 0.19, OM = 3.8 ± 0.29%, P = 99 ± 5.1 mg/kg, and K = 229 ± 28.7 mg/kg (University of Wisconsin Soil and Forage Laboratory, Marshfield, WI). Plots were broadcast fertilized with urea (46-0-0) at a rate of 52 kg of N/ha on May 2.

2016–2017. Thirty 3.7-m × 9.1-m plots were established in 5 field blocks on a Withee silt loam soil, again at the University of Wisconsin Marshfield Agricultural Research Station. The actual number of field blocks in the study was reduced to 4 because 1 block was lost due to flooding damage created by wet conditions during April 2017 (Table 1). ‘Forerunner’ triticale was not available before establishment in 2016; therefore, ‘Tri-Cal’ triticale (Byron Seeds LLC, Rockville, IN) was substituted and no-till drilled into soybean stubble as described previously at a seeding rate of 108 kg/ha on October 22, 2016. No dairy slurry was applied during the fall of 2016, in part because the previous crop was soybeans. Soil samples were taken by block to a 0.15-m depth the following spring (May 7); tests indicated pH = 7.1 ± 0.05, OM = 3.4 ± 0.13%, P = 26 ± 3.9 mg/kg, and K = 129 ± 4.6 mg/kg. Plots were then broadcast fertilized with urea (46-0-0) at a rate of 52 kg of N/ha on May 8.

Weather. All weather data (Table 1) reported for this project were obtained from the University of Wisconsin Marshfield Agricultural Research Station, and 30-yr monthly means for temperature and precipitation were obtained from NOAA (2002). Growing degree days were calculated using the averaging method with a 5°C base temperature: GDD = [(maximum daily temperature − minimum daily temperature)/2] − 5°C,