Nitrogen fertilization and harvest management improve forage and crude protein content in Crabgrass

Pedreira, B.C.*; Barros, I.T.M.D.†; Yasuoka, J.I.*; Helwig, D.*; Farney, J.K.*; Sassenrath, G.F.*
*Kansas State University, Parsons, KS, 67357, USA; †Federal University of Mato Grosso, Sinop, MT, 78557-267, Brazil.

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Abstract

Crabgrass (*Digitaria* spp.) is an annual summer grass that can provide high-quality forage, but optimal management strategies are unclear. Our objective was to compare the yield and quality of crabgrass (Mojo and Quick-N-Big) under different nitrogen rates and harvest management. The experimental design was a randomized complete block with five treatments and three replications for each crabgrass variety, totaling fifteen experimental units for both Mojo and Quick-N-Big, in adjacent sites. Treatments were nitrogen rates (0, 100, and 200 lb N/acre) and harvest management (cut once or twice per year) for two growing seasons (2020 and 2021). Total forage accumulation (TFA) increased with nitrogen fertilization for both cultivars. Mojo had the highest TFA in the first year (7000 lb DM/a/yr) while Quick-N-Big TFA was the highest in the second year (7635 lb DM/a/yr). The highest crude protein (CP) content was obtained with the highest N dose, ranging from 10.5 to 13% for both cultivars. Based on these results, N fertilization and harvest management can contribute to improving forage yield and crude protein of crabgrass varieties during the growing season in forage systems.

Introduction

Crabgrass is a high-yielding summer annual that compliments cool-season forages or can be used as a cover crop for summer forage. It is tolerant to defoliation and has the potential to provide high-quality forage. For these reasons, crabgrass has been considered an alternative to producing hay. For the cultivars tested, 'Mojo' [*Digitaria ciliaris* (Retz.) Koeler] is a blend of 'Red River' and 'Impact' varieties, which has a later maturity when compared to Red River. 'Quick-N-Big' (*Digitaria aegyptiaca* Willd.) is another option recognized for its fast germination and high growth rate, reaching an adequate grazing or hay stage about two weeks earlier than Red River, and with higher forage accumulation (Dalrymple 2010).

In addition, fertility and harvest management play a major role in hayfields to enhance forage accumulation (FA) and nutritive value. Nitrogen (N) is the most limiting nutrient in forage systems, and N input increases tiller development, leaf length, and accumulation rates (Bourscheidt et al. 2019). Understanding the fertilization responses associated with harvest management is essential to develop adequate management for the hayfields.

Overall, annual summer forage hayfields in southeast Kansas are commonly harvested once or twice by the end of the growing season and some of them may be fertilized. However, combining N fertilization with harvesting management has the potential to increase forage accumulation and nutritive value. Our objective was to compare the yield and crude protein content of two crabgrass varieties (Mojo and Quick-N-Big) under different nitrogen rates and harvest management.

Methods

The research was carried out at the Southeast Research and Extension Center in Columbus, KS (37°21'N, -94°86'W). The climate is classified according to Köppen criteria as a humid subtropical climate (Peel, Finlayson, and Mcmahon 2007). The average annual temperatures ranged from 48.0 to 69.6°F. The predominant soil type in the field was Parsons loam (fine Albaqualfs molic, mixed, active, thermal) with 20 ppm of P, 96 ppm of K, and pH in H_2O of 5.2 (0-6", May 2020). The pastures were established in May 2020. The seed was sown at ¼ inch depth at a rate of 6 lb/a. In 2021, the treatments were applied to the same plots without the need for reseeding.

The experimental period was from 19 June to 9 October 2020 and from 24 May to 12 August 2021. The experimental design was a randomized complete block with five treatments, and three replications for each crabgrass variety, totaling fifteen experimental units for both Mojo and Quick-N-Big, in adjacent fields. Each plot was 60 ft long by 10 ft wide. The treatments were five of the six possible combinations between three nitrogen rates (0, 100, or 200 lb N) and two harvest management (harvesting once or twice per year): H1N0, harvest once without N fertilization; H2N0, harvest twice without N fertilization; H1N100, harvest once with 100 lb N/acre at the beginning of the growing season; H2N100, harvest twice with 100 lb N/acre at the beginning of the growing season; and H2N200, harvest twice with 100 lb N/acre at the beginning of the growing season + 100 lb N/acre after the first harvest.

Twice-harvested plots were clipped on 20 August and 9 October 2020 and on 7 July and 12 August 2021. The harvest-once plots were allowed to grow throughout the growing season and were clipped on 9 October 2020 and 12 August 2021.

In the first year (2020), the plots were fertilized with 100 lb N/acre on June 19, and the second N fertilization (100 lb N/acre) was applied on August 21 in the H2N200 treatment. The procedure was repeated in 2021, when the plots were fertilized on May 24, and the second N fertilization was applied in the H2N200 on July 9.

In each growing season, forage accumulation (FA) was quantified (once or twice, depending on the harvest treatment) by sampling a 3 by 15 ft area in each plot using a flail harvester (Carter®) at 2.5-inch stubble height. Total forage accumulation (TFA) was calculated by summing the FA in each year. The FA samples were dried at 130°F in a forced air dryer until constant weight and weighed. Samples were sent to a commercial laboratory for quality analysis of crude protein (CP) content.

The data was analyzed using a mixed-models method with a parametric structure in the covariance matrix, through the MIXED procedure of SAS 9.4 (Littell et al. 2006) with repeated measurements and using the maximum likelihood restricted method. Block was considered as random effects, whereas treatment, year, and treatment × year interaction were fixed effects. Each cultivar was analyzed separately. Linear predictor and quantile-quantile plots of the residues were used to verify homogeneity of variance and error normality. The Akaike information criterion was used to choose the covariance matrix (Wolfinger 1993), and the denominator degrees of freedom were corrected using the method of Satterthwaite (Satterthwaite 1946). The least square means were used to compute the means of the fixed effects and comparisons were performed using the probability of the difference of the t-test ($P < .05$).

Results and Discussion

The TFA was affected by the treatment × year interaction for both varieties ($P = .0449$ and $P < .0001$ for Mojo and Quick-N-Big, respectively; Table 1). For Mojo, in the first year, TFA did not differ between H1N0, H2N0, and H1N100, which had lesser values than H2N100 and H2N200. In the second year, H2N200 and H2N100 again had the greatest TFA. However, H1N100 differed from H2N0 and H1N0. Quick-N-Big, in the two years, TFA in the H1N100, H2N100, and H2N200 were greater than H1N0 and H2N0. However, in 2021, H2N100 differed from H1N100 and H2N200. The higher productivity can be attributed mainly to the nitrogen effects, which promote a significant increase in enzymatic reaction rates and plant metabolism (Taiz and Zeiger 2009), and the morphogenic and structural characteristics of pastures (Pedreira et al. 2017).

In addition, H1N0 and H2N0 had less TFA in the second year for both cultivars. The first year was the establishment year, during which the soil was tilled in preparation for seeding. Tillage and soil disturbance are some of the main drivers of microbial diversity, contributing to additional nutrient mineralization (Lienhard et al. 2013). The importance of mineralization and turnover of soil organic matter in soil fertility is well known (Craswell and Lefroy 2001), and the greater mineralization of nutrients in the first year may have supported the great TFA for Mojo and Quick-N- Big in the treatments without N fertilization.

Table 1. Total forage accumulation (lb DM/acre/year) for Mojo and Quick-N-Big

Treatment	**MoJo**		**Quick-N-Big**	
	2020	**2021**	**2020**	**2021**
H1N0	4205 Ba	1795 Cb	2780 Ba	1745 Cb
H2N0	3945 Ba	2270 Cb	2370 Ba	1405 Cb
H1N100	4180 Ba	4440 Ba	3515 Ab	7540 Aa
H2N100	6760 Aa	6090 Aa	3540 Aa	4660 Ba
H2N200	7000 Aa	6920 Aa	3405 Ab	7635 Aa
Standard error	485	485	150	550

Upper-case letters compare means among treatments and lower-case letters compare means between years for each cultivar ($P < 0.05$).

There was a treatment effect for CP in Mojo ($P < .0001$; Table 2), and a treatment × year interaction in Quick-N-Big ($P = .0012$; Table 2). For Mojo, the treatments that were harvested once (H1N0 and H1N100) had lower CP values. Conversely, the twice-harvested treatments had greater CP content and among them, the CP content was the greatest when associated with 200 lb/acre of N.

For Quick-N-Big, the CP contents were similar across years, except for H1N100. The H1N100 had the lowest value in the second year when it was similar to H1N0. Overall, the greater values were registered for H2N100 and H2N200, and the lower for H1N0.

Table 2. Crude protein for Mojo and Quick-N-Big

Treatment	**MoJo***	**Quick-N-Big**	
		2020	**2021**
	- - - - - - - - - - - - -	%	- - - - - - - - - - - - -
H1N0	4.7 C	4.5 Ca	5.0 Ca
H2N0	7.5 B	7.0 Ba	7.6 Ba
H1N100	5.5 C	7.2 Ba	4.7 Cb
H2N100	7.7 B	9.7 Aa	8.9 Aa
H2N200	10.5 A	10.5 Aa	10.6 Aa
Standard error	0.5	0.4	0.4

*There was no treatment × year interaction. Upper-case letters compare means among treatments and lower-case letters compare means between years for each cultivar ($P < 0.05$).

Conclusions and/or Implications

Nitrogen fertilization and harvest management can contribute to improving forage yield and crude protein of crabgrass varieties during the growing season in forage systems. Harvest management is key to achieving greater yield and increased CP content. The increased CP content may improve animal performance.

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