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NITROGEN CONCENTRATION IN CELL WALL OF WARM-SEASON PERENNIAL GRASSES

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Abstract

The objectives of this experiment were to evaluate the influence of N fertilizer, age of regrowth, and season on concentration of N in cell-wall fractions of three warm-season perennial grasses (limpograss, [*Hemarthria altissima* (Poir.) Stapf et C.E. Hubb.], bermudagrass [*Cynodon* spp.], and bahiagrass [*Paspalum notatum* Flügge]. The herbage neutral detergent insoluble nitrogen (NDIN) fraction composed almost half of total N in these grasses. Though acid detergent insoluble nitrogen (ADIN) concentrations generally were 80 g kg^{-1} of total N or less, this fraction is indigestible and unavailable and composes a significant portion of a nutrient that may already be in short supply in warm-season grasses.

Keywords: bahiagrass, *Cynodon*, fertilizer, forages, *Hemarthria*, limpograss, *Paspalum*

Introduction

In discussing factors involved in predicting limiting nutrients for grazing livestock, Klopfenstein (1993) stated, "The largest unknown is the composition of the protein in the grass". The relative solubility and degradability of dietary N compounds are important determinants of the efficiency of microbial protein synthesis and economics of feeding animals with high nutrient requirements (Krishnamoorthy et al., 1991; Reid, 1994). The shortage of information in this area of study is more pronounced when considering warm-season grasses. The general objective of this work was to describe the cell wall N fractions in three warm-season perennial grasses under different management treatments.

Material and Methods

The experiment was conducted at the Beef Research Unit of the University of Florida located northeast of Gainesville, Florida (29^o 43’ N, 82^o 16’ W). The experimental period was May to September of 1994. The design used was completely randomized with treatments replicated three times and arranged as a split-plot experiment. Main plots were combinations of three grass species (limpograss cv. Floralta, bermudagrass cv. Tifton 85, and bahiagrass cv. Pensacola) with two seasons of growth (early and late summer). Subplots were combinations of three ages of regrowth (4, 6, and 8 wk) and two N fertilizer rates (17 and 50 kg N ha^{-1} applied each season at staging). Plot size was 2 m^2. Sampling was performed in July and September 1994. Two 0.25-m^2 quadrats were clipped per plot at the same stubble heights used at staging. A modified aluminum block digestion procedure (Gallaher et al., 1975) and semi-automated colorimetry (Hambleton, 1977) were used for all N determinations. Cell-wall N fractions analyzed were ADIN and NDIN. Analyses were performed according to the procedures of Goering and Van Soest (1970), where the N fractions were measured as the N remaining after neutral (NDF) or acid detergent fiber (ADF) analyses. Data were analyzed using analysis of variance in PROC GLM (General Linear Models Procedure) of the Statistical Analysis System (SAS; SAS Institute Inc., 1989). Comparisons among forage species were made using the F-protected LSD test ($P \leq 0.05$). Effects of age of regrowth ($P \leq 0.05$) were assessed using orthogonal polynomial contrasts. Season and N rate comparisons were made using the F test because there were only two levels of these factors. When there were three- or four-way interactions involving season, data were analyzed by season, and interaction or main effects are described within season.

Results and Discussion

Only species and N fertilizer rate affected NDIN, when the results were expressed as a proportion of total N. Approximately 40% of total N of these warm-season grasses was associated with NDF. The NDIN concentrations for limpograss in the current study (403 g kg^{-1} of total N) (Table 1) were less than those reported by Holderbaum (1989) (600 to 700 g kg^{-1}). Bermudagrass NDIN averaged 374 g kg^{-1} of total N, which was lower than the 580 g kg^{-1} reported by Brown et al. (1988) for four *Cynodon* genotypes. Sample processing in the current experiment may explain in part the lower NDIN concentrations observed. All samples were freezing dried before grinding. This process may make more N available to be solubilized by the neutral detergent solution. Van Vuuren (1993) reported that freeze drying and subsequent grinding rupture the cell wall and free more protein and intact chloroplasts than conventional forced-air drying.

Herbage ADIN is the N fraction insoluble in acid detergent solution and is largely unavailable to the animal (Goering et al., 1972). When ADIN was expressed as a proportion of total N, it was affected by two, three-way interactions (season by age by N and species by season by age). Bermudagrass and bahiagrass ADIN concentrations in total N increased linearly with increasing age in both seasons, but limpograss ADIN was not affected by age in early summer and increased only at 8 wk in late summer (Table 2). Concentrations of ADIN in limpograss were lower than means reported by Brown and Pitman (1991; 74 g kg^{-1} of total N) and by Holderbaum (1989; 200 g kg^{-1}), while those for bahiagrass were lower (4-wk regrowth) or similar (6- or 8-wk regrowth) to those reported by Brown and Pitman (1991; 83 g kg^{-1} of total N). Tifton 85 bermudagrass generally had values for ADIN intermediate between bahiagrass and limpograss.

It is important to note that more than 40% of total N was associated with NDF in limpograss and bahiagrass. The large proportion of N in NDF requires efficient microbial cellulolytic activity for the N to be made available. Klopfenstein (1993) considers ADIN as a reasonable measure of indigestible N. In the present experiment, limpograss ADIN varied relatively little due to treatment. Herbage ADIN in bahiagrass increased with higher N rates, and bermudagrass ADIN was affected to a greater degree than limpograss ADIN by age of regrowth and season. Though ADIN is present in relatively small amounts, it may have a significant impact on N status of animals grazing limpograss, forage that is often low or marginal in N.

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Table 1 - Main effects of N fertilizer rate and forage species on herbage neutral detergent insoluble N concentrations in total N. Data are means across seasons and ages of regrowth.

	N rate (kg ha^{-1})		
Species	17	50	Mean†
	g kg^{-1} of total N		
Limpograss	427	378	403 a
Bermudagrass	390	357	374 b
Bahiagrass	411	423	417 a
Mean‡	409	386	

† Forage species main effect means not followed by the same letter are different ($P \leq 0.05$) by LSD test (n=36).
‡ N fertilizer rates means across forage species are different (P= 0.0038; n=54).

Table 2 - Interaction effect of forage species and age of regrowth on herbage acid detergent insoluble N concentration in total N in the early and late summer seasons. Data are means across N fertilizer rates (n=6).

	Age of regrowth (wk)			
Species	4	6	8	OPC‡
	g kg^{-1} of total N (Early summer)			
Limpograss	42 b†	51 b	49 b	n.s.
Bermudagrass	42 b	41 c	54 b	L
Bahiagrass	57 a	77 a	83 a	L
	g kg^{-1} of total N (Late summer)			
Limpograss	42 b†	41 b	56 c	L,Q
Bermudagrass	53 ab	67 a	69 b	L
Bahiagrass	56 a	74 a	89 a	L

† Forage species means within age of regrowth not followed by the same letter are different ($P \leq 0.05$) by the LSD test.
‡ Orthogonal polynomial coefficients for ages of regrowth within species. L= Linear and Q=Quadratic.