RELATIVE FEED VALUE AND CRUDE PROTEIN OF SELECTED COOL AND WARM SEASON FORAGES IN RESPONSE TO VARYING RATES OF NITROGEN

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Introduction

Forages play a significant role in livestock nutrition and approximately 85% of all feed units are from forages. In well-managed systems, pasture and hay can supply year-round nutrition with minimal supplementation from other feeds (3,16). Hay, though expensive to produce (7), supplies growers with much-needed feed in winter months when pastures are dormant or not growing. Nitrogen (N) fertilization of grasses has been shown to increase yield (5,17,18). Application of N also decreases dead material and reduces concentration of Neutral Detergent Fiber (NDF) while increasing crude protein (4). Nitrogen fertilization favors grass development by increasing its competitive utilization of light, nutrients, and water (2). However if N is applied in excess of the plants' need, it can also leach below effective root zone (5).

Cool season forages produce most of their biomass during spring and early summer as well as early winter, while warm season forages are productive during hot summers, therefore filling in the slump left by cool season forages (1,8,13). Most of the warm season forages are photoperiod sensitive and determinate in growth, especially switchgrass and big bluestem. Once hay is harvested, it is important to determine the nutrient composition so as to match feeds to animal requirements. To most livestock farmers, crude protein (CP) and relative feed values (RFV) are the basis on how much hay to buy or feed livestock.

The objective of this study was to determine crude protein and relative feed values from a range of cool and warm season forages harvested as hay when grown under four different rates of nitrogen (0, 50, 100, & 150 lb N/acre). The results could be used in conjunction with other N-rate yield data as a basis for N recommendations to local beef and hay producers in the lower Midwest USA. The cool season forages used were: Fescue Kentucky 31 (*Festuca arundinacea*) Max Q™ fescue (friendly endophyte), CowPro fescue (endophyte free), Timothy (*Phleum pretense*), Smooth Bromegrass (*Bromus inermis*), and Orchard grass *(Dactylis glomerata)*. The warm season forages were: Bermudagrass (*Cynodon dactylon)* Var Ozark, Switchgrass *(Panicum virgatum)*, Eastern gamagrass *(Tripsacum dactyloides)*, Indiangrass *(Sorghastrum nutans)*, Little bluestem *(Schizachyrium scoparium)*, and Big bluestem *(Andropogon gerardii)*.

Research Design

The selected forages were established during the spring of 2002 (year 0), in 10 by 15 ft plots on-farm near LaDue Missouri following University of Missouri (MU) guidelines on rates for establishing forages (10), with actual harvesting starting in 2003 (year 1). The species were selected due to their widespread use by growers in the lower Midwest USA and the fact that there were no local yield data for growers. The experimental design was a randomized complete block with a 6 by 4 factorial arrangement in split plot design with the following levels: (a) four N levels = 0, 50, 100, 150 lb/acre applied once a year in the spring, (b) six cool season and six warm season forages (c) replication of 3 for a total of 12 plots for each grass species (144 total plots) in the study.

Soils in this region are predominantly Hartwell silt loams and Hartwell silty clay loams on 0-5% slopes *(Fine, mixed, active, thermic, Typic, Agriudols)*. These soils are somewhat poorly-drained to moderately well-drained and are formed in very thin loess and shale bedrock. They are best suited for grass and legume production for hay or pasture under medium water capacity. Soil test results showed a pH of 6.9 with all macronutrients and micronutrients adequate for forage production. Nitrogen source was ammonium nitrate applied between March 15 and April 15 for cool season forages and between April 15 and May 15 for warm season forages. Data were gathered for three hay cutting seasons (May-June) of each year from 2003-2005 when forages were at or near boot stage. Historically, farmers in this area harvest their cool season hay in June-July and warm season hay in July-August when it has already gone to seed. However, in this research, hay was harvested in May and June for cool and warm season forages, respectively.

At harvest, a 42-inch swath was removed from the center of each plot with a flail type mower, weighed and recorded and a sub-sample collected and dried to constant weight indoors for dry matter determination and for nutrient analysis. Crude protein and relative feed values were then tabulated over the three year period and analysis of variance (ANOVA) procedures were conducted using the GLM procedure of SAS (12) to test the differences on effect of N treatment on crude protein and relative feed value within each grass species. Student-Newman-Keuls range test procedure was used for mean separations because it is relatively conservative. Differences reported in this paper are at the $P<0.05$ level of significance. Relative feed values were calculated as follows (6)

$$RFV = (\%DDM \times \% DMI) / 1.29 \text{ where}$$
$$\%DDM = 88.9 - (\%ADF)(0.779) \text{ and}$$
$$\%DMI = 120 / \%NDF$$

[ADF=acid detergent fiber, NDF=neutral detergent fiber, both obtained from forage nutrient analysis]

Forage Establishment

Variable climatic conditions played a major role in establishment and yearly forage yields for all the grasses within the years. Monthly precipitation and average temperature for 2002-2005 are reported in Table 1. Air temperatures were above normal and precipitation below normal during the establishment period (year 0) when the forages were seeded. During this time, most of the precipitation that came during the summer months (June- September) came in one or two rainfall events leaving many days dry and hot (Table 1). This was a challenge to grass seedlings that were not fully established and deep rooted. Timothy succumbed to the drought and lost up to 85% of its seedlings and had to be reseeded in the fall of year-0. All the other forages including MaxQ and CowPro persisted the dry season in year 0 and were not reseeded. For the warm season forages, Bermuda grass had to be irrigated in the first year after sprigging to survive. Eastern gamma grass was the hardest hit as it had lower germination rates than the rest, and germinated later than other warm season forages and had to be re-seeded in the second year. However, warm season grasses persist better in dry weather and heat than cool season grasses (8) and, therefore, the stands were not affected much by the drought.

Table 1. Monthly total precipitation and average air temperature at Windsor Missouri, (10 miles away from the study site), during the 2002-2005 (year 0 – year 3). Historic averages represent 30 years of data

	Monthly Total Precipitation					Avg. Air Temperature				
Month	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Historic avg.**	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Historic avg.**
	----------*Inches*----------					----------^oF----------				
Jan	2.5	0.6	1.7	5.5	1.6	34	26	29	31	28
Feb	0.8	0.5	1.0	2.9	2.0	37	30	32	39	34
Mar	1.2	3.1	5.5	0.9	3.1	39	43	47	42	44
Apr	3.9	3.8	2.6	2.2	3.7	57	56	56	56	55
May	6.6	5.1	8.3	2.4	5.2	61	64	66	64	64
Jun	3.4	2.8	5.4	7.3	4.5	75	71	70	75	73
Jul	2.2	1.3	7.5	1.3	3.9	80	80	74	79	78
Aug	3.0	3.9	5.2	7.7	3.7	78	81	71	79	76
Sep	2.6	6.7	3.7	1.1	4.3	73	66	69	72	68
Oct	2.7	3.7	4.3	2.6	3.6	53	56	58	58	57
Nov	0.5	3.1	3.7	1.7	3.4	41	45	48	47	44
Dec	1.1	2.9	1.2	0.4	2.1	36	36	34	26	33
Annual	30.6	37.3	50.1	35.8	40.9	55	55	55	56	55

Crude Protein

Percent CP for all forage species are shown in Table 2 and Figures 1 and 2. There is a distinct difference noticeable between cool and warm season forages when looking at CP. All the cool season forages show a progressive increase in CP with increasing rate of N. There were also no significant differences in CP among the cool season forages for all rates of N used except for endophyte free CowPro fescue at 100 and 150 lb N/acre compared to the no N-control (Table 2).

For warm season forages, CP figures were all over across the board but two general trends were observed. Crude protein values increased with increasing N rates except for switchgrass, eastern gamagrass, and bermudagrass. Eastern gamagrass and little bluestem showed higher but non significant CP values for no N-control plots compared to forage that received 50 lb. N/acre. This is not unusual in warm season forages. Actually, studies have shown some quadratic response in which the no-N control had a greater CP concentration than plots receiving moderate rates of N. This response has been attributed to the fact that plots receiving little or no N produce much less total growth, but that growth tends to be dominated by leaf material (15). Other researchers have found that forage CP was negatively correlated with yield and have emphasized that the negative associations found between forage yield and quality factors have to be considered in developing hay quality factors especially for warm season grasses (9). This trend shows that N use in hay production is primarily advantageous in increasing yield but does not uniformly increase CP or RFV at the same ratio.

Relative Feed Values (RFV)

Relative feed values for both cool and warm season forages are shown in Table 3 and Figure 1 and 2. Despite minor differences in RFV within each species in cool and warm season forages, there were no significant differences in RFV in all forage species in this study relative to rate of N used (Table 3). However, for cool season forages, RFV were close to or above 100, a value equivalent to full bloom alfalfa. These values indicate that quality of the forage grasses were sufficient to ensure relatively high intake by livestock (11,14). For warm season forages, RFV were all below 100 but above 80. This trend in CP and RFV levels among cool and warm season forages was expected. In general annual forages are more nutritious than perennial forages, while cool season forages rate higher in nutrition than warm season forages.

Table 2. Percent crude protein three-year average for cool and warm season forages fertilized with different rates of nitrogen near Ladue Missouri

Cool Season Forages						
N-Rate	**Timothy**	**MaxQ fescue**	**CowPro fescue**	**Smooth Brome**	**Orchard grass**	**Fescue K-31**
lb/acre	--------------------------------%--------------------------------					
0	7.92a**	6.79a	6.37b	7.76a	8.42a	6.37a
50	8.09a	7.14a	7.04ab	7.76a	8.47a	7.42a
100	8.20a	7.61a	7.92a	8.20a	8.98a	7.80a
150	8.44a	7.85a	7.99a	8.28a	9.18a	7.85a
Warm Season Forages						
N-Rate	**Bermuda**	**Switch Grass**	**Eastern Gama**	**Little Bluestem**	**Indian**	**Big Blue Stem**
lb/acre	--------------------------------%--------------------------------					
0	6.28ab**	4.80a	5.99a	5.08a	3.68b	4.76a
50	6.03b	4.80a	5.83a	4.81a	3.91ab	4.89a
100	5.98b	5.33a	6.51a	4.86a	4.39ab	5.02a
150	7.07a	5.04a	6.25a	5.74a	4.73a	5.26a

*******Values within a column followed by the same letter do not differ significantly (P ≤ 0.05, Student-Newman-Kuhls, (SNK), Multiple Range Test).*

Table 3. Relative feed values three-year average for cool and warm season forages fertilized with different rates of nitrogen near Ladue Missouri

Cool Season Forages						
N-Rate (lb/acre)	**Timothy**	**MaxQ fescue**	**CowPro fescue**	**Smooth Brome**	**Orchard grass**	**Fescue K-31**
0	105a**	100a	101a	93a	110a	96a
50	104a	101a	101a	92a	106a	98a
100	101a	104a	101a	94a	106a	98a
150	103a	101a	99a	93a	104a	97a
Warm Season Forages						
N-Rate (lb/acre)	**Bermuda Grass**	**Switch Grass**	**Eastern Gama**	**Little Bluestem**	**Indian Grass**	**Big Blue Stem**
0	93a**	92a	89a	84a	88a	89a
50	92a	92a	89a	84a	85a	88a
100	93a	90a	91a	84a	88a	90a
150	93a	88a	87a	84a	88a	98a

*******Values within a column followed by the same letter do not differ significantly (P ≤ 0.05, Student-Newman-Kuhls, (SNK), Multiple Range Test).*

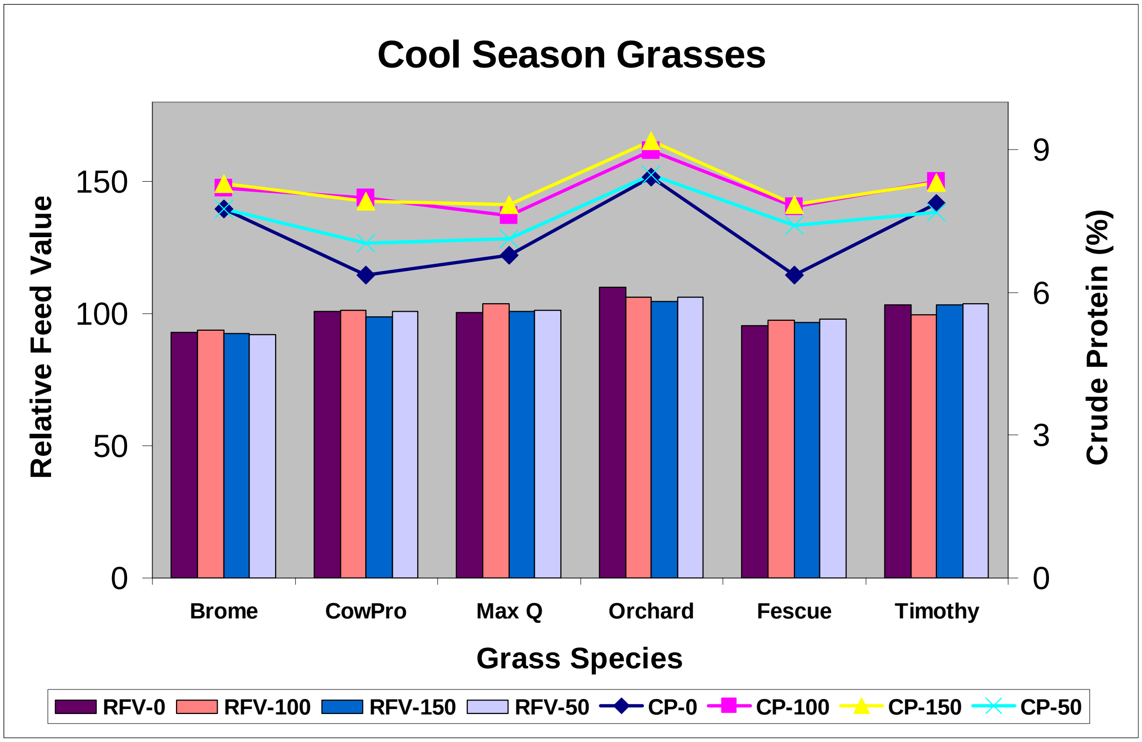

Figure 1. Percent crude protein and relative feed values for cool season forages fertilized with different rates of nitrogen near Ladue Missouri

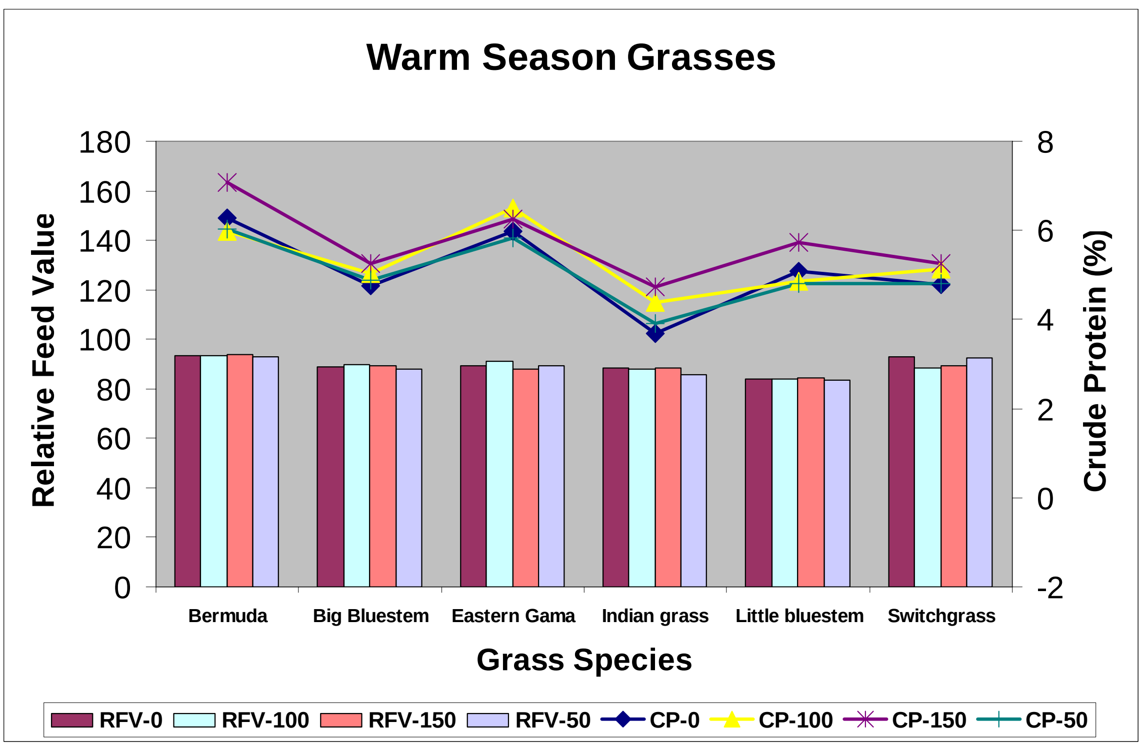

Figure 2. Percent crude protein and relative feed values for warm season forages fertilized with different rates of nitrogen near Ladue Missouri

Conclusion & Recommendations

With increasing prices for nitrogen fertilizer, producers must be aware of and use good economic principles in purchasing and applying fertilizers to their forages. While forage yields generally increase with increasing rates of N, we found from this study that CP and RFV do not change significantly with increasing rates of N used in this study. Therefore, the benefit of using more N is advantageous largely in producing more biomass, and therefore more feed at a given nutritional level for livestock. These results are especially important for those who feed hay in winter and use CP or RFV as a basis for buying or making hay. By using nitrogen wisely to raise more hay that has good levels of CP and RFV, one can reduce input costs and increase animal productivity.

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