Grazier's Notebook

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Nitrogen Management in Rotationally Grazed Pastures

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Introduction

Split nitrogen applications have long been recommended on rotationally grazed pastures. Nitrogen applications in excess of approximately 50 units per acre for a single application are not utilized by pasture growth. One-half ton of pasture forage (a typical removal rate for a single grazing event) containing 20-25% crude protein removes 30 to 40 lbs of nitrogen per acre. Nitrogen applied in excess of this amount is lost through leaching or volatilization and is not captured in pasture re-growth. Consequently, multiple, small applications are recommended in rotationally grazed systems. The most efficient timing for these nitrogen applications to rotationally grazed pastures has not been established.

Nitrogen Management Trial

A nitrogen rate and timing study was conducted at the University of Wisconsin-River Falls in 2004 and 2005. The grass and legume mixtures used in this study were as follows: Kentucky bluegrass (KB) and white clover, smooth bromegrass (SB) and alfalfa, and orchardgrass (OG) and red clover. Nitrogen treatments consisted of single applications of 50 units per acre of nitrogen (as urea) on May 1, June 15 or August 1. Multiple nitrogen applications of 50 units per acre each were made on May 1 and June 15 (100 units per acre total) and on May 1, June 15 and August 1 (150 units per acre total). Before and after each grazing event, the pasture quantity was measured with a pasture plate to determine animal intake per acre. Results presented here are averaged over 2 years.

Which strategy produced the most forage?

Table 1 shows total yield for untreated plots and yield increases for each of the nitrogen application strategies. The greatest yield increases were recorded in the smooth bromegrass and orchardgrass pastures. The multiple nitrogen applications provided the greatest yield increases. However, a closer look shows that the June 15 applications contributed very little to this increase. For example, the May 1 and June 15 treatment increase was similar to the May 1 single application.

Table 1. Yield increases from nitrogen application

Species	Control Yield (lbsDM/acre)	May 1	June 15	August 1	May 1 + June 15	May 1 + June 15 + August 1
		Yield Increase (lbs DM/acre)				
KB	4365	246	14	232	710	885
SB	5293	1326	456	1002	1054	2019
OG	4654	1052	516	729	1062	1284

A more direct way to determine the most beneficial timing for nitrogen applications is to look at the increase in pounds of dry matter per pound of nitrogen applied. This is illustrated in Table 2. Once again the nitrogen response from Kentucky bluegrass was very small. Smooth bromegrass and orchardgrass responses were greatest with the single 50 unit application on May 1. The second greatest response came with the single application on August 1. Although multiple nitrogen applications provided more total forage, the increase per pound of nitrogen was less than the single applications on either May 1 or August1.

Table 2. Yield increases per pound of nitrogen					
Species	May 1	June 15	August 1	May 1 + June 15	May 1 + June 15 + August 1
	(lbs DM)/lb N				
KB	4.9	0.3	4.6	7.1	5.9
SB	26.5	9.1	20.0	10.5	13.5
OG	21.0	10.3	14.6	10.6	8.6

Which strategy provided the greatest economic return?

Table 3 show net return for each of the nitrogen application strategies. For the calculation of the net dollar return per acre from the nitrogen treatments, $120 per ton for hay ($137.93 per ton dry matter) and $322 per ton for urea were used. Net returns were negative or marginal for all applications in the case of Kentucky bluegrass. Net returns for smooth bromegrass and orchardgrass were positive in all cases. Single application on May 1 and 3-50 unit applications were among the strategies providing the greatest returns. The single application on June 15 provided the lowest net returns in all cases.

Table 3. Net dollar return per acre from nitrogen applications					
Species	May 1	June 15	August 1	May 1 + June 15	May 1 + June 15 + August 1
	Net $ Return/Acre for N Application				
KB	-0.53	-16.53	-1.50	13.97	8.53
SB	73.95	13.95	51.60	37.69	86.74
OG	55.05	18.09	32.78	38.24	36.05

What about the effect on pasture legume content?

A concern with nitrogen fertilization of mixed grass and legume pastures is that they may decrease the legume content due to increased grass competition. Table 4 shows the effects of nitrogen applications on legume content of the different pasture mixtures after receiving the various nitrogen treatments for 2 consecutive years. Decreases in legume content wee generally small. Averaged across the three grass species in the study, the multiple applications of 50 units on May 1, June 15 and August 1 resulted in the greatest decrease in legume content. The decrease in legume content is a result of increased grass competition. The largest decreases in legume content came in the red clover/orchardgrass pastures. Orchardgrass is a highly competitive grass and so resulted in the greatest legume decreases. The multiple nitrogen strategy resulted in the greatest dry matter yields and so resulted in the greatest decrease in legume content.

Table 4. Nitrogen application effects on legume content						
Species	Control	May 1	June 15	August 1	May 1 + June 15	May 1 + June 15 + August 1
	% Change					
KB	25	+2	-2	-5	-7	-10
SB	45	+3	-3	-2	-13	-8
OG	55	-17	-10	+3	+3	-20

Summary

Kentucky bluegrass responded very poorly to nitrogen fertilization in this study. This is likely due, in part, to significant levels of white clover in these plots. White clover in a very efficient nitrogen fixer and may have been providing adequate levels of nitrogen.

Three applications of 50 units of nitrogen each and a single application on May 1 provided the highest overall dry matter yield.

Single applications of 50 units of nitrogen on either May 1 or August 1 provided the greatest dry matter increases per pound of nitrogen applied.

The single 50 unit application on June 15 consistently provided the lowest dry matter increase and the lowest dry matter increase per pound of nitrogen applied.

The greatest returns per dollar spent on nitrogen were realized with the May 1 application and the 3-50 unit application. The lowest was from the June 15 single application.

Reductions in legume content due to nitrogen fertilization were not great. The largest reduction came from two consecutive years of 3-50 unit applications.

Recommendations

Maximum growth rates for perennial cool-season grasses occur when temperatures are in the mid to high seventies. As temperatures increase, growth rates slow because carbon lost to plant respiration exceeds that gained through photosynthesis. This is why we see a significant summer slump in our cool-season grass growth. It stands to reason then that the greatest response to nitrogen application would come during times of relatively cool temperatures and adequate soil moisture.

Based on the results of this study the optimum time to apply nitrogen is early May and early August.Mid-June applications are not productive because grass growth is slowed by heat and drought. It is important to realize that, in early May pasture growth may already be greater than the animals' ability to utilize it. Nitrogen applications at this time will only exacerbate this problem. In order to capture this increased growth, pastures will likely need to be mechanically harvested or stocked with very high stocking rates.

It is also important to keep in mind that this work was done at a single location in west-central Wisconsin. Optimum application times will need to be adjusted in other locations to correspond to times of greatest pasture growth rates.