EFFECT OF NITROGEN FERTILIZER RATE ON NITRATE CONTENT OF HYBRID SUDANGRASS HAYS

G.E. Selk[1], D.G. Wagner[2], G.L. Strickland[3], S.E. Hawkins[4], and S.Janloo[5]

Story in Brief

The effect of five different nitrogen fertilizer rates on nitrate accumulation in hybrid sudangrass hay was examined in a two year study. A common variety of Sudan X Sudan hybrid grass was grown in eastern and south central Oklahoma over two consecutive summers. The hay was grown after applying 0 lb actual nitrogen per acre, 2 or 3 split applications of 50 lb nitrogen per acre, 100 lb of nitrogen per acre, 150 lb nitrogen per acre, or 200 lb of nitrogen per acre. Hay samples showed significantly less nitrate in those that had 0 lb of nitrogen. Samples from plots that received 200 lb of nitrogen had significantly greater concentrations of nitrate than other plots. No difference between those plots with split applications or equal amounts of 100 or 150 lb of nitrogen in a single application was found. Year to year, cutting to cutting, as well as location variation in nitrate concentration was quite large.

(Key Words: Nitrogen Fertilizer, Nitrate, Sudangrass Hay.)

Introduction

Nitrate accumulation in sorghum forage may cause a toxicity and occasionally death to ruminant livestock that consume high nitrate hays. Nitrogen fertilizers are often used to increase forage yields when these types of hay crops are grown. The additional nitrogen available from the fertilizer may also enhance the accumulation of the potentially dangerous nitrate in the hay. However, very little research has been conducted to quantify the amount of nitrate accumulation that is directly related to nitrogen fertilizer usage under Oklahoma growing conditions. Therefore, plots of a common variety of sudangrass were grown after differing levels and timing of nitrogen fertilization. This study allowed for the comparison of different levels of

[1]Associate Professor, [2]Regents Professor, [3]Agriculturalist, Department of Agronomy, [4]Assistant Professor, Department of Agronomy, Purdue University, [5]Laboratory Technician

nitrogen fertilization as well as the comparison of two split applications of nitrogen versus a single application of nitrogen.

Materials and Methods

Varying levels of nitrogen fertilization for hybrid sudangrass were studied at two Oklahoma State University Agronomy Research Stations; one located at the Eastern Research Station near Haskell and another in the South-Central Research Station near Chickasha. The Eastern Research Station plots were planted on a Taloka silt loam soil. Whereas the South Central Research Station is located on a Reinach silt loam. The nitrogen fertilization rate study was conducted in two successive years. Three cuttings of hay were taken at each location in the first year. Three cuttings were obtained from the Eastern Research Station in year two; whereas, only two cuttings were available from the South Central Research Station in year two. Five fertilization treatments were replicated four times at each of the locations each year. Therefore a total of 220 samples were obtained. A randomized complete block design was used at each location. At time of planting both soil and moisture conditions were good at both locations for germination and emergence. The five levels of nitrogen fertilization studied were:

Treatment 1: No nitrogen fertilization applied

Treatment 2: Two or three split applications of 50 pounds of actual nitrogen per acre (50 pounds at planting time and 50 pounds per acre after each cutting)

Treatment 3: One application of 100 pounds of actual nitrogen per acre at planting

Treatment 4: One application of 150 pounds of actual nitrogen per acre at planting

Treatment 5: One application of 200 pounds of actual nitrogen per acre at planting.

The hybrid sudangrass variety utilized at both locations and both years was a "Sudan X Sudan" hybrid named Monarch V* . Planting date in year 1 was in late May for both locations. In year 2, the original planting in both Eastern Oklahoma and South Central Oklahoma was late May. However that planting was washed away at the Eastern Research Station and replanting took place in late June. Each location was cut prior to seed head exertion and plots in treatment 2 were top dressed to provide the additional nitrogen. The hays were harvested with the cutter bar height at 4 inches above the ground. Hay was harvested from each of the 15 feet by 9 feet plots, and an approximate 1

*Cal/West Seed

pound sample consisting of stems and leaves was labeled and taken to Stillwater for dry matter and nitrate concentration determination. Nitrate concentrations were determined by the salicyclic acid method described by Cataldo in 1975. Nitrate concentration for each sample was expressed as parts per million and adjusted to a 100% dry matter basis.

Data were analyzed by utilizing analysis of variance to test for main effects of treatment, year, location, and cutting. All possible two-way interactions of main effects were examined and then removed from the regression model if non-significant. Least squares treatment means were compared by examining "protected least significant differences".

Results and Discussion

The mean nitrate concentration across all treatments for each location and cutting from both years is presented in Table 1.

Year, location, cutting, and fertilizer treatment were all significant sources of variation for nitrate content of the samples. ($P < .05$) There were no significant two-way interactions among treatments and the other main effects. However, significant ($P < .05$) interactions between year and location, year and cutting, and location and cutting were present. These interactions could be attributed to weather stresses that occurred in each of the two years, but at different times and to differing degrees of severity at the two locations. Table 2 illustrates the monthly rainfall for the two locations each year.

Table 1. Least squares means of nitrate concentrations (ppm) across all treatments for each research station and cutting in 1990 and 1991.

	Location	
	Eastern	South Central
Year 1		
Cutting 1	5144	3685
Cutting 2	5301	4978
Cutting 3	5547	5330
Year 2		
Cutting 1	21382	4210
Cutting 2	1427	6204
Cutting 3	8954	N/A

Table 2. Monthly rainfall totals for Eastern Oklahoma Research Station and South Central Oklahoma Research Station in 1990 (year 1) and 1991 (year 2).

	Eastern Research Station									
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Year 1	4.07	3.09	5.44	7.64	7.38	0.86	2.65	1.42	8.30	1.77
Year 2	0.81	0.06	1.10	2.36	6.56	3.51	0.97	0.51	5.15	4.59

	South Central Research Station									
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
Year 1	1.92	5.00	6.42	5.21	5.59	1.92	2.47	3.48	2.76	1.90
Year 2	1.49	0.05	1.51	3.28	6.72	3.80	3.41	3.75	9.88	3.47

Drought stressed sudangrass plants have been shown to be nitrate accumulators. The lack of rainfall at the Eastern Oklahoma Research Station in the summer months of the second year of the study resulted in greater nitrate concentrations in the first cutting of the second year.

Because there were no significant interactions of treatment with year, location, or cutting, least squares means of the treatments across both years, both locations, and all cuttings are presented in Table 3.

This data clearly illustrates that nitrogen fertilization affects nitrate accumulation in hybrid sudangrass hays. Treatment 2 (50 pounds nitrogen applied in two or three split applications) versus treatment 3 (100 lb of nitrogen applied at planting) or treatment 4 (150 lb of nitrogen applied at planting) revealed no signifcant difference in nitrate accumulation. Therefore the practice of splitting nitrogen applications in order to reduce nitrate toxicity appears to be questionable. Applying 200 lb of nitrogen per acre resulted in increased concentrations of nitrate compared to all treatments except where 150 lb were applied.

Table 3. Least squares means of nitrate concentrations (ppm) of hybrid sudangrass grown under different nitrogen fertilization schemes.

Treatment				
0 lb. N	50 lb. 2-3 X	100 lb	150 lb	200 lb
3631^{a}	6282^{b}	6098^{b}	7083^{bc}	8432^{c}

^{a,b,c} Means with different superscripts are different ($P < .05$).

Nitrogen fertilization increased nitrate content of hybrid sudangrass hays grown under differing rainfall amounts and in different locations of the state. As large as these increases due to fertilization were, they were still not as large as the differences noted between cuttings. The differences due to cuttings were unquestionably related to weather differences wherein hot, dry weather caused plant stress that resulted in even greater changes in nitrate accumulation. Splitting the application of nitrogen did not show a significant decrease in nitrate accumulation in the sudangrass hays tested in this study.

Literature Cited

Cataldo, D. A., et al., 1975. Rapid colorimetric determination of nitrate in plant tissue by nitration of salicylic acid. Commun. Soil Science and Plant Analysis, 6(1), 71-80.