Nitrogen management for brown mid rib sorghum sudangrass: Results of the 2002 Mt Pleasant trial.

Q.M. Ketterings[1], T.W. Katsvairo[1], J.C. Cherney[1], and T.F. Kilcer[2]
[1]Dept. of Crop and Soil Sciences, Cornell University, [2]CCE Rensselaer County

Introduction

In an article by Kilcer and others published in "What's Cropping Up?" (2002) 12 (5): 6-9, we showed the results of a brown mid rib sorghum sudangrass (BMR) nitrogen (N) trial conducted in the cold and wet 2000 growing season on a Hoosic soil in Columbia County. Nitrogen application increased yields but little was gained by increasing the N application *at planting* beyond 100 lbs/acre. The greatest yields (15 tons/acre at 35% dry matter) were obtained when 200 lbs N/acre were applied *in split applications*. Split-applications increased the N fertilizer uptake efficiency (% of the fertilizer application that is taken up by the crop) and favors environmental stewardship. The highest N application in that study was 200 lbs N/acre and a yield plateau was not achieved at that application rate. Thus, further research was needed to determine optimum economic (split) N application rates.

Materials and Methods

In the 2002 growing season, we conducted a study at the Mt Pleasant Research Farm in Tompkins County, NY. The soil was a silt loam Bath-Volusia soil, representative of a large portion of Southern Tier New York soils. The pH of the soil was 6.2 and the soil organic matter content was 3.2%. The site was classified as medium in phosphorus (5 lbs/acre Morgan extractable P), medium in zinc (0.54 lbs Morgan extractable Zn/acre), and high in potassium, calcium and magnesium (142 lbs K/acre, 2355 lbs Ca/acre and 375 lbs Mg/acre). We investigated the effects of N application rate (0, 100, 200, 300, 400 and 500 lbs/acre split-applied in two applications) and three potassium application rates (0, 200, 400 lbs K_2O/acre split-applied in two equal applications as well) on yield and quality. Potassium was applied in the form of muriate of potash (60% K_2O). Nitrogen applications were in the form of ammonium sulfate (21% N). All plots received the equivalent of 45 lbs of P_2O_5/acre and the entire trial was replicated four times. Planting was done on June 14, 2002, using a John Deer grain drill at 60 lbs of seed per acre.

Figure 1: 2002 brown mid rib sorghum sudangrass NxK trial at Mt Pleasant, NY.

Late planting as a result of wet soil conditions in the early part of the season and drought mid to late season limited our management system to two cuts. First cut (3-3.5 inch cutting height) took place on July 30. The second cut was done on September 25. Harvesting was done when the plots that received 150 lbs N/acre per cut or more had reached a stand-height of 38-42 inches. Based on earlier field trials conducted in Columbia and in Delaware County (see the article by Cerosaletti and others in "What's Cropping Up?" (2002) 12(3): 1-3), we expected this stand height to provide optimum forage quality. We determined yield and took subsamples to determine moisture content, nutrient concentrations and forage feed quality. All samples were analyzed for total N, P, K, Ca, Mg, lignin, sugar, non-structural carbohydrates (NSC), neutral detergent fiber (NDF), digestibility of neutral detergent fiber (dNDF at 30 hr), and in vitro total digestibility (IVTD at 30 hr) at the forage laboratory of DairyOne Cooperative Inc. in Ithaca, NY. Milk2000 version 7.4, a software model developed at the University of Wisconsin, was used to estimate milk yields in lbs per ton and in lbs per acre. We used the alfalfa-grass Milk2000 worksheet with standard values for neutral detergent insoluble crude protein (NDICP; 2.4% on a dry matter basis) and ether extract (3.6% on a dry matter basis) as reported for sorghum sudangrass silage in the 2001 Nutrient Requirements for Dairy Cattle (National Research Council, 2001). The 30 hour dNDF was multiplied by 1.16 to obtain an estimate of the dNDF at 48 hours (J.H. Cherney, unpublished, 2003). Soil samples (0-8 inches) were taken at planting and immediately after the first and second harvests. Samples were analyzed for pH, Morgan extractable P, K, Ca, Mg, nitrate and soluble salts. In this article, we present and discuss the results of our N rate study. The effects of K application are discussed elsewhere on pages 6-7 of this issue.

Results and Discussion

Yields increased from less than 5 tons/acre (35% dry matter) without the addition of N to 10 tons/acre with N applications of 200-250 lbs of N per cut (Figure 2). Nitrogen application increased predicted milk yields (Table 1) mostly due to an increase in yield. The highest yields (this is not the same as economic optimum yield) were obtained with a 200-250 lbs N application per cut.

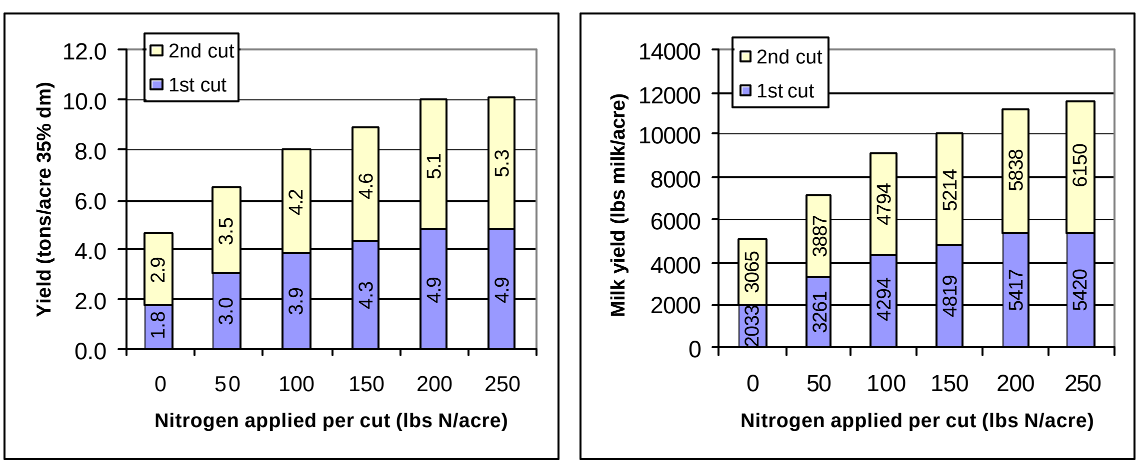

Figure 2: Brown mid rib sorghum sudangrass dry matter yield (left) and milk yield per acre (right) as affected by nitrogen rate at the Mt Pleasant Research Farm, NY, in 2002.

Forage quality, expressed in milk per ton, was not affected by applications over 100 lbs N/acre per cut. Nirogen addition did increase crude protein and lowered NDF but did not affect dNDF, IVTD and lignin concentration (Table 2). Milk per acre values strongly reflected the sorghum sudangrass silage yield with a correlation of 0.999 (R^2=0.97) between milk per acre and dry matter yield per acre. We, therefore, conclude that N fertilizer application rates did not affect overall forage quality and that it is reasonable to evaluate the economics based on yield alone or a combination of yield and quality (milk per acre predictions).

Table 1: Yield, predicted milk production, nitrogen uptake, nitrogen uptake efficiency, post-harvest soil nitrate and soluble salts as affected by N application rates in a 2-cut brown mid rib sorghum sudangrass trial at Mt Pleasant, NY, 2002.

Total N applied	Yield (35% dm)	Estimated Milk Production		N uptake	N uptake efficiency	Post harvest soil nitrate	Soluble Salts
lbs/acre	tons/acre	lbs/ton	lbs/acre	Lbs/acre	%	ppm	mmho
0	4.7 e	2672 b	5098 e	40 e	-	0 b	17 d
100	6.5 d	2717 b	7148 d	70 d	30 c	0 b	21 d
200	8.1 c	2774 ab	9088 c	109 c	34 b	0 b	25 d
300	8.9 b	2788 a	10032 b	151 b	36 ab	5 b	34 c
400	10.0 a	2803 a	11254 a	198 a	39 a	26 a	61 a
500	10.1 a	2843 a	11569 a	209 a	34 bc	26 a	50 b

Note 1: Milk yield was predicted using Milk 2000 (http://www.uwex.edu/ces/forage/articles.htm#milk2000).
Note 2: Average values *within columns* with different letters (a,b,c) are statistically different (α = 0.05)

Table 2: Effect of N application on quality of BMR sorghum sudangrass grown at the Mt Pleasant Research Farm, NY, 2002.

N applied per cut	Crude Protein	IVTD	Lignin	NDF	dNDF
lbs N/acre	---------------------------------% dm			--------------------------------	% NDF
First Cut					
0	8.61 f	81.5 a	4.78 a	66.2 a	71.8 a
50	9.75 e	79.9 a	4.65 a	66.1 a	69.7 a
100	11.22 d	80.4 a	4.83 a	66.2 a	70.3 a
150	14.76 c	80.6 a	4.57 a	63.8 b	69.7 a
200	16.48 b	80.0 a	4.63 a	62.2 c	68.2 a
250	19.08 a	81.8 a	4.68 a	62.1 c	70.3 a
Second Cut					
0	7.05 e	77.9 a	4.10 a	66.7 a	66.9 a
50	9.62 d	80.3 a	3.65 b	64.0 b	69.3 a
100	12.77 c	80.5 a	3.94 ab	62.5 b	69.0 a
150	15.46 b	81.2 a	3.64 b	60.6 c	69.2 a
200	18.87 a	81.7 a	3.68 ab	59.5 c	69.3 a
250	18.79 a	81.8 a	3.83 ab	59.4 c	69.3 a

Note 1: Average values *within columns* with different letters (a,b,c) are statistically different (α = 0.05)

Nitrogen uptake efficiencies were low (Table 1) and comparable to those observed with the study in Columbia County in 2000. In 2000, heavy rains early in the season may have been responsible for the low N uptake efficiency whereas in 2002 the low N uptake efficiencies were most likely due to the severe drought. The residual N level (N left in the soil profile following the second cut) is an environmental concern with application rates greater than 200 lbs N per cut.

Conclusions

Nitrogen fertilization of BMR sorghum sudangrass did not affect lignin, digestibility or fiber digestibility of the forage, but reduced the NDF concentration. As expected, fertilization of a grass with N resulted in a significant increase in crude protein content. Since dry matter yield was highly correlated with milk yield, the changes in NDF and CP due to N fertilization had little impact on milk yield. The results of this year's trial suggest that the optimum N rate is less than 200 lbs/acre per cut in a 2 cut system where no manure is applied but N uptake efficiencies were low. The drought may have impacted fertilizer response and a slightly earlier planting date would likely increase N utilization and yield. Continuation of N trials on multiple sites (soil types, manure histories, and climatic conditions) and over multiple years and an economic analysis of the results are needed to determine optimum economic and environmental N rates. This trial will be repeated in the 2003 growing season.

References

1. Cerosaletti, P., Q.M. Ketterings and T.K. Kilcer (2002). 2001 Delaware County BMR sorghum sudangrass trials "What's Cropping Up?" 12(3): 1-3.
2. Guyer, P.Q. and D.D. Duey (1986). Estimating corn and sorghum silage value. Univ. of Neb. Coop. Ext. Publ. G74-99-A, Univ. of Nebraska, Lincoln, NE.
3. Kilcer, T.F., Q.M. Ketterings, T.W. Katsvairo and J.C. Cherney (2002). Nitrogen management for sorghum sudangrass: how to optimize N uptake efficiency? "What's Cropping Up?" 12(5): 6-9.
4. National Research Council (2001). Nutrient requirements of dairy cattle. 7^{th} edition. National Research Council. National Academy Press, Washington, D.C. 408 pages.

Acknowledgments

This research was funded by a research grant from the Phosphate and Potash Institute and Townsend and Garrison Inc. Ammonium sulfate used in the trial was donated by Honeywell Inc.

For Further Information

For further information on BMR sorghum sudangrass projects in New York contact Thomas Kilcer at the Rensselaer Cooperative Extension Office at tfk1@cornell.edu or 518-272-4210. You could also visit the BMR sorghum sudangrass website at http://nmsp.css.cornell.edu/projects/bmr.asp.