Nitrogen management for brown mid rib sorghum sudangrass: Results of two years of studies at the Mt Pleasant Research Farm

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Introduction

In the 2002 growing season, we conducted a study at the Mt Pleasant Research Farm in Tompkins County, NY, on the effects of N application rate (0, 100, 200, 300, 400 and 500 lbs/acre split-applied in two applications) and potassium application rate (0, 200, 400 lbs K_2O/acre split-applied in two equal applications as well) on yield and quality of brown mid rib sorghum sudangrass. The results of the 2002 growing season were published in "What's Cropping Up?" (2002) 13 (2): 1-3 and 6-7. The same trial was repeated in 2003. In this article we report on the N application effects on yield and quality in both trial years.

Materials and Methods

The soil was a silt loam Bath-Volusia soil, representative of a large portion of Southern Tier New York soils. At the start of the trial, the pH of the soil was 6.2 and the soil organic matter content was 3.2%. The site was initially 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, 2,355 lbs Ca/acre and 375 lbs Mg/acre). 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 in 2002 and on June 9 in 2003 using a John Deere grain drill at 60 lbs of seed per acre. In 2002, first and second harvest took place on July 30 and September 25, respectively. Both times, cutting height was 3-3.5 inch and harvest was initiated when the plots that received 150 lbs N/acre per cut had reached a height of 38-42 inches. In 2003, the first harvest was done on July 31 (35 inch stand height) and the second cut took place on September 26th when a stand height of 45 inches was reached.

We determined yield and took subsamples to determine moisture content, nutrient concentrations and forage feed quality. All samples were analyzed for total N, P, and K, neutral detergent fiber (NDF), and digestibility of neutral detergent fiber (dNDF at 30 hr) at the forage laboratory of DairyOne Cooperative Inc. in Ithaca, NY. Milk2000 version 7.54, a software model developed at the University of Wisconsin, was used to estimate milk yields in lbs per ton and in lbs per acre (http://www.uwex.edu/ces/forage/pubs/milk2000.xls). 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_{water}, Morgan extractable P, K, Ca, Mg, nitrate and soluble salts. As mentioned above, in this article, we present and discuss the results of our N rate study. The effects of K application will be addressed in another article.

Results and Discussion

In 2002, dry matter yields increased to 9.8 tons/acre (35% dry matter) with the addition of 200 lbs of N or more from 4.2 tons/acre without N applications. In 2003, 4.7 tons/acre were produced without the addition of N while a maximum yield was obtained with the addition of 150 lbs N/acre per cut. Greater N applications did not result in yield increases; rather a yield decrease was seen with the addition of 250 lbs N as compared to 150 lbs N/acre. This could be caused by elevated soluble salt levels and suboptimum pH (5.0-5.3) after two growing seasons with ammonium sulfate applications greater than 150 lbs N/acre per cut without further lime application. Table 1 shows the yields averaged over the two years.

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, averaged over 2002 and 2003.

Total N applied	Yield (35% dm)	Estimated Milk Production		N uptake	N uptake efficiency	Postharvest nitrate	Soluble Salts
lbs/acre	tons/acre	lbs/ton	lbs/acre	lbs/acre	%	ppm	mmho
0	4.4 d	3179 a	4929 c	40 e	-	0 d	15 d
100	7.5 c	3126 a	8168 b	75 d	36 ab	0 d	19 cd
200	8.9 ab	3107 a	9693 a	110 c	35 ab	0 d	24 c
300	9.7 ab	3102 a	10481 a	160 b	40 a	6 c	36 b
400	9.9 a	3099 a	10705 a	179 a	35 ab	18 b	51 a
500	9.7 ab	3134 a	10638 a	190 a	30 b	24 a	50 a

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 ($\alpha = 0.05$)

Table 2: Effect of N application on quality of BMR sorghum sudangrass grown at the Mt Pleasant Research Farm, NY, 2002 and 2003 growing season.

N applied	Crude Protein	NDF	dNDF
Lbs N/acre	(%of DM)	(% of DM)	(% of NDF)
Per cut	First Cut 2002 and 2003 Combined		
0	8.29 d	64.7 a	82.9 a
50	9.39 d	64.7 a	78.8 ab
100	11.29 c	64.2 a	78.3 b
150	15.82 b	62.1 b	77.2 b
200	16.90 b	61.7 b	77.0 b
250	18.79 a	61.0 b	77.5 b
	Second Cut 2002 and 2003 Combined		
0	7.54 d	64.2 a	78.4 a
50	8.77 d	62.5 b	78.9 a
100	10.90 c	61.4 b	77.5 a
150	13.71 b	59.3 c	77.0 a
200	15.47 b	59.1 c	76.6 a
250	16.18 a	58.7 c	77.8 a

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

Nitrogen addition increased crude protein and lowered NDF but did not affect dNDF once N was applied (Table 2). In both years, milk/acre strongly reflected sorghum sudangrass silage yield (r^2=0.99 in 2002 and r^2=0.97 in 2003). Predicted milk production in lbs/acre increased from about 5,000 lbs of milk per acre without N addition to 10,705 lbs of milk (first and second cut and both years combined) with the addition of 200 lbs of N/acre per cut.

Nitrogen uptake ranged from about 40 lbs of N without N fertilizer addition to 190 lbs of N/acre (2-year average) when 500 lbs of N were applied. Nitrogen uptake efficiencies were low in both years (Table 1). Averaged over two years, the economic optimum N rate assuming fixed costs of $178/acre, a nitrogen fertilizer cost of $0.30/lb and a forage value of $100 per ton dry matter, was 135 lbs N/acre per cut. Residual N levels (N left in the soil profile following the second cut) were of environmental concern with application rates greater than 150 lbs N per cut or greater in both years.

Conclusions

Nitrogen fertilization of BMR sorghum sudangrass reduced NDF but did not affect the fiber digestibility of the forage. As expected, fertilization of a grass with N resulted in a significant increase in crude protein. Dry matter yield was highly correlated with milk yield so the changes in NDF and CP due to N fertilization seemed to have little impact on milk yield. Averaged over the two years, the optimum economic N rate was 135 lbs N/acre per cut. Application rates greater than 150 lbs N/acre per cut are undesirable as these cause high end-of-season nitrate levels.

The N recommendation for corn for this particular site is 90 lbs N for the season given a yield potential of 16 tons of silage at 35% dry matter. Results so far (on a site that has no manure history) suggest that this crop should be fertilized as an intensively managed grass rather than corn and that corn fertilizer N recommendations need to be tripled for optimum yield of brown mid rib sorghum sudangrass. However, trials in Columbia County indicate that N fertilizer applications can be reduced to no more than 50 lbs N/acre per cut where manure was applied recently. Nitrogen recommendations for this crop should not be based on results from just two years and only one or two locations. The trial at the Mt Pleasant Research Farm will be continued in 2004 and similar trials will be conducted in St Lawrence, Jefferson, Clinton and Essex County this coming growing season.

References

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2. Ketterings, Q.M., T.W. Katsvairo, J.H. Cherney and T.F. Kilcer (2003). Potassium management for brown mid rib sorghum sudangrass. Results of the 2002 Mt Pleasant trials. "What's Cropping Up?" 13(2): 6-7.
3. National Research Council (2001). Nutrient requirements of dairy cattle. 7th edition. National Research Council. National Academy Press, Washington, D.C. 408 pages.

Acknowledgments

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