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Phosphorus Removal by BMR Sorghum Sudangrass

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Introduction

The December 2002 release of the Final Concentrated Animal Feeding Operation (CAFO) ruling from the US Environmental Protection Agency made animal agriculture fully accountable to the Clean Water Act. In New York, all CAFOs are required to develop and implement a Comprehensive Nutrient Management Plan (CNMP) which meets USDA-NRCS standards and specifications by January 2009. Nutrient management planning is guided by NRCS Standard NY590 which requires that all fields be assessed for their P runoff potential using the New York Phosphorus Index (NY PI). If the NY PI is classified as high (between 76 and 100), P applications through manure and/or fertilizer should not exceed P removal by the crop. For many forage crops, average nutrient concentration data are available through commercial forage testing laboratories. However, because BMR SxS is a relatively new crop for the region, accurate P removal rates have yet to be determined.

Our objectives were to determine P concentrations and P removal by BMR sorghum sudangrass as impacted by N and K application rates, stand height at harvest, dry matter yield and soil test P. The BMR SxS was grown in three different New York soil and climatic regions and over two very different years including the 2002 drought year and a very good 2003 growing season.

Materials and Methods

Seven field trials were conducted in New York at three different locations, Delaware County, Columbia County, and Tompkins County in 2002 and 2003 (Table 1).

Table 1: Soil types, pH, organic matter and soil test P for each of the seven BMR sorghum-sudangrass nitrogen, potassium and harvest stand-height studies conducted in New York.

Trial	County	Year	Study	Soil pH	Morgan soil test P lbs/acre	Morgan soil test P Classification	P addition lbs P_2O_5/acre
1	Tompkins	2002	N, K rates	6.2	5	Medium	45
2	Tompkins	2003	N, K rates	6.0	5	Medium	45
3	Columbia	2002	N rate	6.2	10	High	26
5	Columbia	2003	N rate	6.2	10	High	26
4	Columbia	2002	Height	6.2	10	High	26
6	Delaware	2002	Height	5.6†	20	High	20
7	Delaware	2002	Height	6.7	47	Very high	0

† Lime was applied to achieve a pH of 6.4.

The trials were part of a larger, multiple-year effort to determine stand height optimum for yield and quality and N and K requirements of the crop. The Delaware trials were stand height studies conducted on Chenango gravelly silt loam. The Tompkins County trials were N and K rate studies conducted on a Mardin silt loam. The three trials in Columbia County were conducted on Hoosic gravelly silt loam. Two of the three studies were N rate studies. The third study was a stand height study. At each location, trials were conducted as complete randomized block designs with N rate (0, 50, 100, 150, 200 and 250 lbs N/acre per cut) and/or stand height at harvest (30 to 80 inches) as the treatments and four replicates per treatment. At the Tompkins County site, the main plots (N rates) were split to include a K rate (0, 100 or 200 lbs K_2O/acre per cut) as well. The BMR SxS was planted with a seed density of 60-70 lbs seed/acre using conventional grain drills in the first two weeks of June with harvests at the end of July and the end of September. The subplots were 6 feet wide and 15 feet long of which an area of 3 x 5 feet was harvested. The Delaware County trials and the N rate studies in Columbia County were conducted on soils that had received manure in one or both of the past two years. The Tompkins County trials and the stand height study in Columbia County were conducted on soils that had not received any manure in recent years.

All trials were managed as a 2-cut system. Harvest took place when the predetermined stand height was reached (height studies) or when an optimum stand height of 45-50 inches was reached (N and K rate studies). Dry matter yields were measured and subsamples were analyzed for P.

Results and Discussion

The original treatment (stand height at harvest, N or K rate) or harvest number (first or second cut harvest) did not impact P concentrations in the forage with the exception of plots which did not receive fertilizer N; in the trials in Tompkins County the average P concentration was 0.33% without N addition versus 0.28-0.30% P with N application. Although values can vary considerably depending on plant species, plant age, and concentration of other mineral elements, a P concentration of 0.20% or greater is considered sufficient for adequate production. In the Columbia County trials where manure had been applied, the average P concentrations were 0.30% (2002) and 0.37% (2003) versus 0.25-0.27% (2002) and 0.27-0.34% (2003) when N had been applied. This decrease in P concentration of the forage with N application is most likely a dilution effect caused by the substantial (1.3 to 2.0 fold) yield increase upon the addition of just 50 lbs N/acre per cut.

There were no consistent trends in P concentration of the forage when N had been applied. Average P concentrations over the two cuts in each location ranged from 0.24% at one of the 2002 Delaware County sites where the soil tested very high in P but where no additional P fertilizer was used, to 0.31% for the 2003 trials (Table 2). Phosphorus concentrations from individual plots ranged 0.15% to 0.53% with an overall average of 0.29% P (dry matter basis) if the plots without N application were included and 0.28% when N limited plots were excluded. Differences in P concentration among trial sites in New York in 2002 and 2003 were not explained by soil test P level. The forage P concentration was less than 0.20% in two instances (Delaware County stand height trials) only. In both cases, harvest took place at stand heights of 54 and 55 inches and dry matter yields of 2.9 to 3.3 tons/acre.

Phosphorus removal was linearly related to dry matter yield in both cuts. Across all sites and trial years, P removal by the crop was estimated as:

$$\text{P removal (lbs } P_2O_5\text{/acre)} = 4.8 + 11.6 * \text{yield (tons dry matter/acre)} \ (r^2=0.85)$$

Thus, 85% of the variability in P removal rates across all trials was explained by yield alone (Fig. 1). According to this equation, a BMR SxS crop with 5.6 tons of dry matter (16 tons at 35% dry matter) would remove about 70 lbs P_2O_5/acre. This is 8 lbs P_2O_5/acre more than the 62 lbs of P_2O_5/acre estimated for a similar corn silage yield using an average corn silage P concentration of 0.24% of dry matter. However, actual P removal rates for BMR SxS ranged from 50 to 90 lbs P_2O_5/acre. The additional variability in P concentrations and removal for the individual trials shown in Fig. 1 was not explained by N (beyond a 50 lbs N/acre application) or K application rate, stand height at harvest, 1st or 2nd cut, or soil test P, although at one of 2002 Delaware County sites (site 6), P concentrations tended to decrease slightly with stand-height at harvest (r^2=0.53). Additional research is needed to identify location differences that may have resulted in varying P concentrations in harvest.

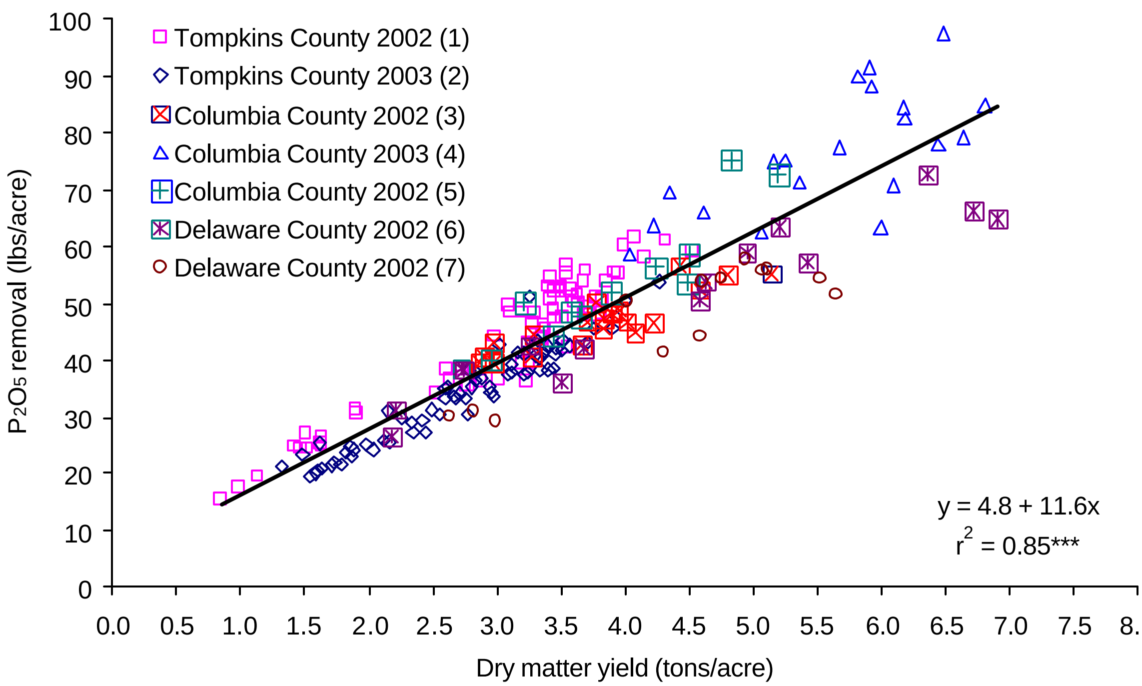

Figure 1: Phosphorus removal by brown midrib sorghum-sudangrass versus dry matter yield for 7 field trials conducted in 2002-2003 in 3 regions of New York State.

Summary and conclusions

Differences in yields across 3 locations and two years of field trials explained 85% of the variability in P removal rates. The average P concentration across all sites was 0.28% P. A crop of 5.6 tons of dry matter would remove 70 lbs P_2O_5/acre. This is the P_2O_5 equivalent of 5000 gallons of liquid manure assuming an average P concentration in the manure of 13.6 lbs P_2O_5 per 1000 gallons, the average manure composition of 503 samples analyzed in 2003 by Dairy One (Paul Sirois, personal communication). However, SxS P concentrations of individual plots ranged from 0.15% to 0.53% indicating that producers need to analyze their forage for P concentration and determine yields to obtain accurate values for P removal by this crop in addition to sample manure to determine manure application rates for environmentally-sound nutrient management planning.

Additional Articles on BMR Sorghum Sudangrass in NY

1. Ketterings, Q.M., G. Godwin, J.H. Cherney, S. Beer, and T.F. Kilcer (2004). Potassium management for brown mid rib sorghum sudangrass. Results of two years of studies at the Mt Pleasant Research Farm. "What's Cropping Up?" 14(3): 4-5.
2. Ketterings, Q.M., G. Godwin, J.H. Cherney, S. Beer, and T.F. Kilcer (2004). Nitrogen management for brown mid rib sorghum sudangrass. Results of two years of studies at the Mt Pleasant Research Farm. "What's Cropping Up?" 14(2): 5-6.
3. Kilcer, T.F., Q.M. Ketterings, P. Cerosaletti, P. Barney, and J.H. Cherney (2003). Cutting height management for brown mid rib sorghum sudangrass. "What's Cropping Up?" 13(4): 4-6.
4. Ketterings, Q.M., T.W. Katsvairo, J.H. Cherney, and T.F. Kilcer (2003). Nitrogen management for brown mid rib sorghum sudangrass: Results of the 2002 Mt Pleasant trial. "What's Cropping Up?" 13(2): 1-3.
5. 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 trial. "What's Cropping Up?" 13(2): 6-7.
6. Kilcer, T.F., Q.M. Ketterings, T.W. Katsvairo and J.H. Cherney (2002). Nitrogen management for sorghum sudangrass: how to optimize N uptake efficiency? "What's Cropping Up?" 12(5): 6-9.
7. Cerosaletti, P., Q.M. Ketterings and T.F. Kilcer (2002). 2001 Delaware County brown mid rib sorghum sudangrass trials "What's Cropping Up?" 12(3): 1-3.

Acknowledgments

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For Further Information

For further information on BMR sorghum sudangrass in NY contact Thomas Kilcer at the Rensselaer Cooperative Extension Office at tfk1@cornell.edu or 518-272-4210. All above mentioned articles are downloadable from the BMR sorghum sudangrass website at http://nmsp.css.cornell.edu/projects/bmr.asp.