Missisquoi Water Quality

Demonstration results from the Lower Missisquoi Water Quality Project in Franklin County, Vermont

Optimizing Manure and Nitrogen Fertilizer Applied to Grass Hay Crops

Introduction and Background

A common practice on grass hay crops is to use a triple blend fertilizer regardless of nutrient needs by the crop. In addition, manure is often applied with little regard to its contribution of nutrients. After years of this practice, many fields, particularly those nearest manure sources, have soil P levels in the high to excessive range. In order to evaluate manure and fertilizer strategies that would optimize yields while reducing the risk of excessive phosphorus loading to the soil, a demonstration trial was initiated in 1992 in Bakersfield, VT on the dairy farm of Neil Doane. The study was conducted on this site for three consecutive years.

The demonstration site was a 25 year old stand of mixed grass species predominantly orchardgrass with some timothy and bluegrass. The soil was a Missisquoi loamy sand that tested high in P and medium in K. Potash was added to the whole study area in all three years to assure adequate soil test levels. The forage was cut three times per year and evaluated for yield, crude protein, nutrient uptake and recovery, and economics.

Methods

The manure used in the trial was a semi-solid manure from the Doane Farm. Manure was applied by Mr. Doane using a side delivery manure spreader. There were three manure treatments within the study: 1) a no manure control referred to as **NONE**, 2) manure applied once per year after the first cut (averaging 8 - 11 tons per year) referred to as **LOW**, and 3) manure applied three times per year (in the spring at

early green up and after the first and second harvests (averaging 28 - 32 tons per year) referred to as **HIGH**. Manure and manure nutrient application rates are provided in Table 1.

Each manure treatment plot was 20 x 20 feet. Alleyways between each plot were 10 feet wide to accommodate equipment. Plastic sheets were placed adjacent to each manure plot to catch manure to determine application rates and used for nutrient analysis. Each manure treatment was replicated four times.

Within each manure plot, subplots were arranged (5 X 20 feet) in order to apply four rates of N fertilizer: 0, 45, 90, and 135 lb N/a in 1992 and 0, 60, 120, and 180 lb N/a in 1993 and 1994, split evenly in 3 applications (early spring, after 1st cut, and after 2nd cut). The source of N was ammonium nitrate (34-0-0) and was hand applied prior to any manure treatments.

Yields for each treatment were determined at each harvest using a custom designed small plot flail harvester (Carter Harvester^{TM}) and a forage sample was collected to determine dry matter, N, P, and K. Soil tests were taken on selected treatments at the beginning of the trial and at least once per year during the duration of the trial. Rainfall was determined at the test site.

Table 1. Application rates and nutrients applied from manure at Daones site, Bakersfield, VT.

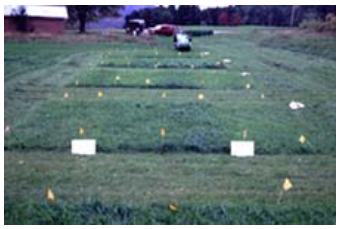
Year	Manure Treatments *	DM	Rate	Organic Nitrogen	Ammonia Nitrogen	P_2O_5	K_2O
		%	t/a	lb/a	lb/a	lb/a	lb/a
1992	Low	21.4	10.7	71	50	54	102
	High	19.2	28.2	201	148	124	262
1993	Low	28.9	8.3	55	15	85	74
	High	20.5	31.7	201	115	204	268
1994	Low	27.6	8.3	52	17	45	88
	High	21.8	30.6	184	77	150	242

- Low - one application per year; High - three applications per year

Results

Yield - In all three years, there was a significant yield increase to the Low and High manure treatments compared to the control regardless of fertilizer N applications (Figure 1). Since soil test levels were high for P, and K fertilizer was applied to the whole study area, it is likely that the yield response to the manure treatments can mainly be

attributed to nitrogen. There was also an additional yield increase to added N fertilizer regardless of manure treatment; thus, the best optimum yields were obtained with a combination of manure and N fertilizer.



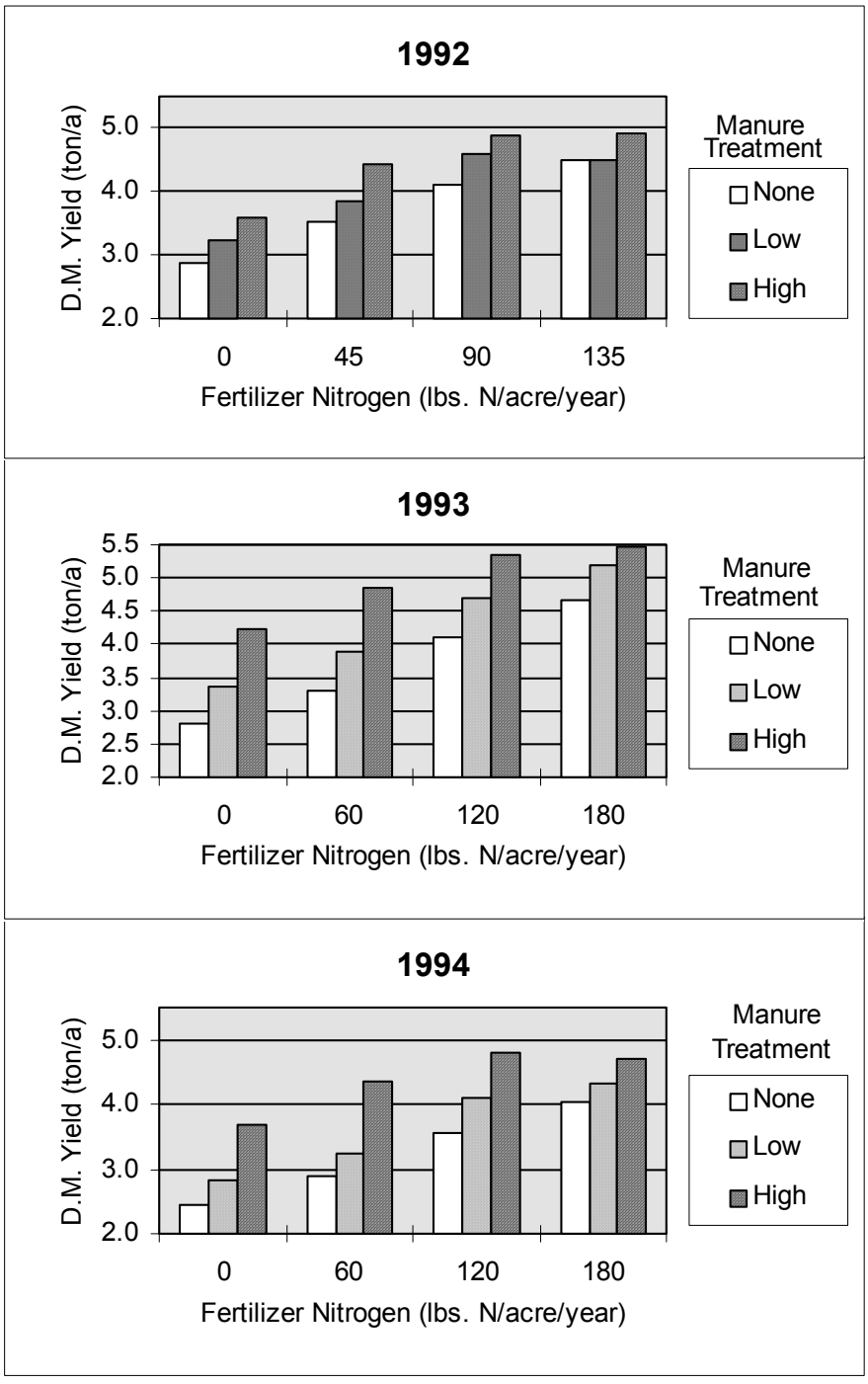


Figure 1. Dry matter yields for manure and nitrogen fertilizer combinations, Bakersfield, VT.

Considering the amount of N applied from the manure especially the High treatment (Table 1), the yield response to manure alone (no N fertilizer) was not as high as one would expect from comparable application rates of fertilizer N. This was probably due to the combination of a very slow release of the organic N and a high rate of ammonia volatilization from the surface applied manure. It should be noted that this trial only utilized semi-solid manure. Liquid manure, or slurry, could possibly have better N utilization and show greater yield response to manure.

There was evidence of some N carryover from the manure treatments. Over time, there was less response to additional N for the high manure application rate. In 1995, a residual harvest was made (no treatments applied that year) and the Low and High manure treatments plots clearly out yielded the control plots.

Forage Quality - Crude protein (%N x 6.4) of the forage generally increased with increases in both N fertilizer and manure rates (Figure 2). Analysis of fiber components (acid detergent fiber and neutral detergent fiber) showed no significant differences in treatments.

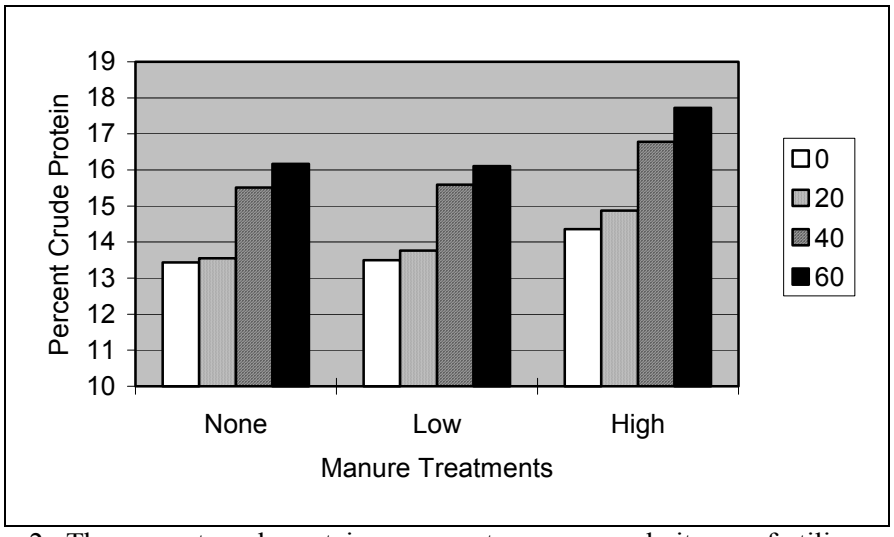


Figure 2. The percent crude protein response to manure and nitrogen fertilizer treatments (0 to 60 lbs./cutting) of the second harvest in 1993.

Phosphorus management - Phosphorus balance was controlled by manure application rates and crop nutrient uptake, which was primarily influenced by yield. After three years of repeated treatments, the *Low* and *High* manure treatments resulted in a total application rate of 178 and 484 lb. P_2O_5 /acre, respectively. The greatest amount of P_2O_5 taken up was from the High manure treatment at the highest N rate of 180 lb. N/a/yr. Uptake was lowest when no manure or N fertilizer (control) had been applied. However, the net phosphorus balance (P added in manure minus P uptake by the crop) showed that the *High* manure treatment resulted in far greater amounts of P applied to the

system than removed (Figure 3). Nitrogen fertilizer (0 verses 180 lbs N/acre) improved P balance somewhat, but not enough to compensate for the high residual P due to the high manure rates. P application at the low rate of manure was well balanced with crop P uptake and the treatments receiving no manure resulted in the greatest net removal of P since none was added.

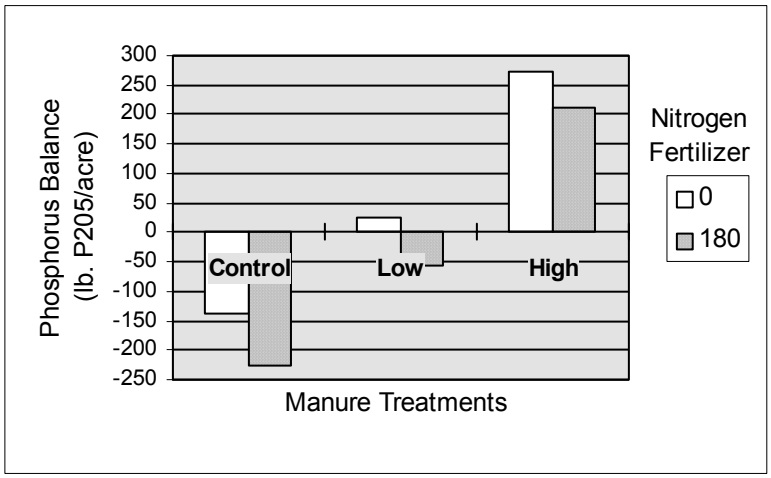


Figure 3. Phosphorus balance (lb. P_2O_5 added minus lb. P_2O_5 removed) of manure and selected nitrogen fertilizer treatments (0 verses 180 lbs. N/year) for the total three years of the study.

Soil test P was influenced by manure and, to a lesser degree, N treatments (Figure 4). Over the 3-year period, the medium and zero manure treatments showed a decline in available P (modified Morgan's extract) while the high manure treatment increased. Only at the last sampling date (October 1994), was there significant manure by N interaction. At the high manure rate, available P was lower with the application of 180 lbs N/acre as compared to the zero N application (probably due to differences in yield and P removal rates). However, available soil P was still higher for this treatment than the initial soil P and far higher than medium and zero manure treatments at the last sampling.

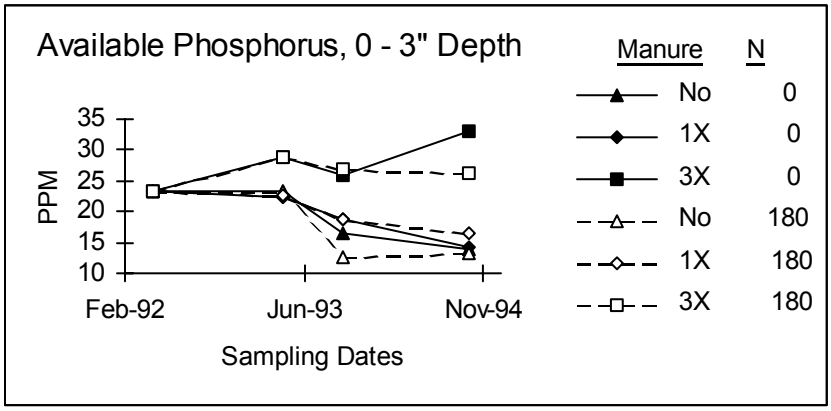


Figure 3. Soil test P (Modified Morgan extract) of manure and selected nitrogen fertilizer treatments (0 verses 180 lbs. N/year).

Summary

This study demonstrated that a combination of manure and N fertilizer provided a compliment of nutrients providing good results for perennial grass production and forage quality. At even high rates of semi-solid manure used, additional N fertilizer was needed to achieve maximum yields. (Liquid manure may have produced different results.) Manure can provide adequate amounts of P and K, depending on analysis and application rates. In this demonstration, the initial soil test was high in phosphorus and, therefore, none was required. However, at moderate rates of manure (8 - 10 tons/acre) in combination with N fertilizer, optimum yields were achieved with no negative impact on P loading. In fact, soil test P levels decreased over time.

Project Cooperators:

The Lower Missisquoi Water Quality Project is a cooperative effort among, the following participants:

- Missisquoi Watershed Project Area Farmers
- UVM Extension System
- USDA Farm Services Agency
- USDA Natural Resource Conservation Service
- Vermont Department of Agriculture, Food and Markets
- Franklin County Natural Resource Conservation District

For More Information:

This factsheet is the sixth in a series on the Lower Missisquoi Water Quality Project. To obtain other factsheets or for more information on the project, contact:

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