MAINE

Nutrient Management in Mixed Forage Systems

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A six-year study in Maine reveals that mixed forage stands respond well to nutrients applied in either manure or fertilizer form. Management of nutrients in these stands can improve forage yield and quality and is essential for maintenance of soil fertility.

Across eastern Canada and the northeastern U.S., more than 5 million acres of land produces hay from mixed forage stands. Many of these stands are not managed to their full potential. Producers and crop advisers tend to undervalue their role in nutrient management, both in terms of the increased forage that could be produced and the capacity to utilize surplus manure nutrients. We conducted this study to determine the capacity of a mixed-species hayfield to respond to nitrogen (N), phosphorus (P) and potassium (K) in liquid dairy manure and commercial fertilizer and to examine the associated effects on soil test levels.

The mixed hayfield chosen for this study had produced hay for more than 30 years. Located in Stillwater, Maine, it comprised a mixture of species dominated by Kentucky bluegrass, timothy, and quackgrass, with smaller amounts of orchardgrass, reed canarygrass, white clover, and dandelion. The soil was a Lamoine silt loam with less than 2 percent slope, a soil type broadly distributed in Maine and often used for forage production. Soil pH was 5.9.

Over a six-year period from 1995 to 2000, we applied nutrients each year except 1997 and 2000, using four treatments:

1. control with no nutrients applied
2. N fertilizer only [ammonium nitrate (34-0-0)]
3. blended NPK fertilizer [34-0-0, triple superphosphate (0-46-0), and muriate of potash (0-0-60)]
4. liquid dairy manure (LD manure)

The rate of LD manure was chosen to supply 75 lb/A of N to the first cutting and 50 lb/A to the second cut, based on manure analysis and assuming 75 percent of the ammonium-N and 10 percent of the organic N were available. Total rates of liquid ranged from 3,600 to 8,700 gal/A. Rates of the two fertilizer treatments matched the rates of the respective nutrients in the manure treatment and were applied with the same timing. In some years, treatments 2, 3, and 4 also received an additional 50 lb/A of N as 34-0-0 following the second cut. In the four years when nutrients were applied, the rates averaged 150 lb N/A, 125 lb P_2O_5/A, and 280 lb K_2O/A.

While yields varied greatly from year to year, plots fertilized in any way yielded 37 percent more than the control (**Table 1**).

A balanced supply of nutrients is essential for sustainable forage production, even on marginal soils.

The NPK fertilizer treatment produced yields 11 percent higher than either the manure or the N only treatment. Manure nutrients may have been less available than anticipated, and over the course of the experiment, there appears to have been a benefit to the P and K.

Forage nutrient concentrations were also affected by treatments (**Table 1**). Nitrogen, and therefore crude protein, was higher in fertilized treatments than in the control. Phosphorus concentration was higher in the two treatments supplying P than in the N only treatment. Treatments supplying K increased forage K concentrations substantially, but did not raise the levels to where there might be concerns of excess for use in dry cow rations.

TABLE 1. Yield and nutrient concentration in mixed forage, six-year average, 1995-2000.

Nutrient treatment	Hay yield, ton/A	Nutrient concentration, % N	P	K
Control	2.8	1.7	0.29	1.5
N fertilizer	3.7	1.9	0.27	1.3
NPK fertilizer	4.1	1.9	0.30	2.0
LD manure	3.7	1.9	0.31	2.1

TABLE 2. Nutrient balance over six years and final soil test levels.

Nutrient treatment	Nutrient balance[1], lb/A P_2O_5	K_2O	Final soil test[2], lb/A P	K
Control	-217	-543	10	92
N fertilizer	-264	-622	9	88
NPK fertilizer	184	-16	13	116
LD manure	209	84	12	124

[1]Sum of nutrients applied in fertilizer and manure minus those removed in forage harvest.

[2]Modified Morgan soil test level in 2000. Initial soil test levels in 1995 were 15 lb/A for P and 134 lb/A for K.

Comparing nutrients supplied to those removed in harvested forage over the six years, both NPK fertilizer and LD manure supplied more P than was removed (see **Table 2**). However, in both cases soil test P did not increase. And where no P was added, soil test P declined. Fixation processes appear to be retaining P in the soil. To supply optimum P levels to crops in this soil and to maintain the soil test at its current level, additions may need to be higher than removals.

The LD manure resulted in a small excess of K supplied relative to that removed, while treatments supplying no K had very large deficits (**Table 2**). Changes in soil test K reflected the differences in nutrient balance.

The use of N, averaged over the six years, was highly profitable. Assuming a forage value of $60 per ton, N cost of $0.22 per pound, and application costs of $12 per acre per year, the net return was over $24 per acre, a 70 percent return on investment. While the incremental benefit in treatment 3 did not pay for the high rates of P and K used, NPK fertilizer was profitable compared to the zero input treatment. Obviously, where manure is available locally, it is the most economical source of nutrients, and P and K could be applied at these rates in a sustainable manner. If more expensive fertilizer sources were used for P and K, optimum rates would likely be lower, but some input would be essential for sustainable production. A study on a similar forage stand in New Brunswick found that an annual rate of 140-90-120 lb/A of N, P_2O_5 and K_2O was most profitable over a 26-year period, using commercial fertilizers exclusively. BC

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