Pasture Fertilization: Dealing with the High Price of Nitrogen
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The high price of nitrogen fertilizer this year has consequences for all of us in agriculture. While crop farmers will feel the effects far more than grass farmers, we’d all be wise to evaluate nitrogen (N) management strategies in a year when urea is going to cost us $250/ton.

Grass loves nitrogen and N fertilization tends to result in a gratifying, consistent response in greenness and growth. But nitrogen fertilizer can also be a crutch—an easy way to cover up for mistakes and sloppy pasture management. It’s not the answer for low cost, long term productivity. This might be a good year to fine tune nitrogen management and look for a balance between legumes and nitrogen fertilization. In his book “Grass Productivity,” Andre Voisin has a lot to say about nitrogen, legumes, and general fertility. His book is a treasure trove of long forgotten research that has important implications for today’s grass farmers. As with any research results, we should test them out under our own unique conditions to determine the value of a particular practice to our operations.

How much nitrogen does a pasture need and how much can be supplied by legumes in the sward? Getting a handle on how much N is fixed by legumes is tricky. Plowing down a solid stand of alfalfa or white clover can provide up to 250 pounds of nitrogen per acre. But how much is available in a living, mixed sward and when is it available? Two approaches have been used to answer these questions. Voisin and others have estimated potential nitrogen ‘transfer’ from legumes to grasses by comparing yields and nitrogen content of pure stands of grasses with pure stands of clover versus 50-50 mixes. More recently, scientists have investigated this question using N\textsuperscript{15}, a radioactive isotope of nitrogen which can be traced in plant tissue. Results of these studies vary, but in general, they all provide evidence that a 50% stand of red or ladino clover probably makes available 60 to 100 pounds of nitrogen per acre for uptake by associated grasses over the course of a growing season.

The nitrogen fixed by legume plants becomes available for uptake by grasses primarily through two means: the natural turnover of root tissue of the legume plant, and the consumption and subsequent excretion of leaf tissue by grazing animals. This nitrogen is not as readily available as fertilizer nitrogen, rather it is released gradually as the plant tissue and/or manure breaks down—nature’s time release fertilizer.

Few graziers rely entirely on legumes for the nitrogen needs of their pastures, but the amounts available from this ‘free’ source are significant and shouldn’t be discounted. At the other end of the spectrum, we’ve all heard of European and New Zealand graziers who apply up to 250 pounds or more of actual N per acre per year. So, what is the right amount? What can you get by with when cutting costs is the goal? How can we maximize the value of the N we apply? And how can it be applied if we wish to maximize the contribution of legumes? The short answer to all these questions is: it depends. It depends on your goals, your soil type, the legumes and grasses you’re working with, the climate, and your grazing system, among other things. Developing a nitrogen fertilization program for your system should take all these factors into consideration. A few guidelines apply to all situations.

Nitrogen is most effective when balanced with appropriate levels of other major nutrients. If you haven’t soil tested in a few years, you might want to send in a sample (our recommendation is every 3 years). If phosphorus (P) and potassium (K) are limiting, your N applications will be far less effective. Maintenance levels for P\textsubscript{2}O\textsubscript{5} are 45 to 60 lb; for K\textsubscript{2}O a sward needs 200 to 250 lb.
Referring back to Voisin, we read about a study in which either P and K or N or both were applied to a sward. P and K alone increased yield by 33%. Together, N, P, and K increased yield by 70%. Maintaining appropriate levels of all major nutrients improves the overall health of the sward. Phosphorus, potassium, and pH are especially important to legumes.

As most of us know, phosphorus and potassium are ‘banked’ in the soil and, when maintained at appropriate levels, are fairly readily available to a well-rooted sward. Nitrogen is a different sort of animal. It occurs in the soil in organic forms or as simple compounds such as ammonium or nitrate. Organic N is made available very slowly over the growing season. As it breaks down, it converts to ammonium and then to nitrate. Nitrate is the form which plants take up and nitrate is not retained in the soil over the long term.

All forms of nitrogen fertilizer are pretty ephemeral in the soil. In fact, you can assume that your N application, whatever amount it may be, will be taken up or lost to the system via leaching or volatization over the course of a single grazing cycle. Putting on all your N at once like we do with corn is not a good idea. A spring application of 100 pounds of N to a pasture is probably a waste of at least 50 pounds.

To maximize nitrogen fertilization, Voisin suggests that it should be applied in small amounts spread over the grazing season. His research shows that as little as 18 pounds of N per grazing cycle can optimize pasture growth and yield. If we apply this amount after each grazing event, the total for the season would add up to between 100 and 150 pounds over the course of 5 to 8 rotations, which coincides with UW Extension recommendations for pasture fertilization.

A split application of 5 to 8 separate applications may be the ideal, but few graziers manage quite so intensively. If we want to reduce the number of applications, how much can we put on at one time and what are the key times to apply nitrogen? A good threshold for a single application is no more than 50 pounds of actual N. Any more than this amount cannot be taken up quickly enough and is probably lost through leaching or volatilization.

A look at seasonal grass and legume growth will give us guidance for timing. For convenience, let’s divide the grass growing season into four parts corresponding with the growth curve of the grasses. The first is early season (April and early May) when the soil is cool and growth is slow. The second is the reproductive period (May and June) when the bulk of cool season grass growth occurs, 50% or more depending on the species. This is followed by a decline in growth in July and August (sometimes called the ‘summer slump’), and finally a smaller surge of dry matter production in early fall. The legume growth curve has only one peak, a little later in the season with a significant portion of its dry matter production occurring in June and July. Legumes not only fix nitrogen and improve palatability and forage quality, but they can help maintain pasture yields later into the summer season.

A small application of N in early spring can be effective in getting growth started as weather warms up in April, but only if warm weather and timely rains come. Larger applications in later spring should be considered carefully. By May, grass has shifted into high gear and depending on your need for hay, applications of N in spring may be worth skipping. Under adequate moisture conditions, pastures in this region produce up to twice as much forage as we can use in May and June. Making hay for winter feeding is a standard practice to conserve this excess forage. So, when N prices are high, we should ask ourselves how much additional hay do we need? And how does the cost of N fertilizer and putting up the hay compare to buying winter feed?
As the summer becomes warmer and drier, the pasture moves into the ‘summer slump’ period. N fertilization during this period will improve grass yield provided that adequate moisture is available. If the months of July and August are both hot and dry, grass response may not warrant the expense of a nitrogen application. In addition, large applications in June and July are likely to favor grasses over legumes.

Probably the most important time to fertilize with N is in August for fall growth for late season grazing, for stockpiling, or for building reserves for spring. Depending on temperatures and moisture availability, a light September fertilization may be effective as well.

In summary, we can assume that a mixed pasture sward with a high legume content will have available up to 100 pounds of N from legume fixation. In times of high prices, we should make the most of this ‘free’ nitrogen and perhaps cut back to no more than 100 pounds of additional N, applied in a split application. More, smaller applications are generally more effective than a few large ones and nitrogen applications should be targeted to those times when temperature and moisture conditions are right for grass growth (and we can assume that this will vary from year to year). With nitrogen fertilization, as with most other aspects of grass farming, flexibility and management are the keys to a healthy sward and well-functioning system.

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