Nutrition Management: Nitrogen

It costs how much? Trends in fertilizer prices and options to soften the blow

BERT CREGG, PROFESSOR, DEPARTMENT OF HORTICULTURE AND DEPARTMENT OF FORESTRY, MICHIGAN STATE UNIVERSITY

BILL LINDBERG, MICHIGAN STATE UNIVERSITY EXTENSION CHRISTMAS TREE EDUCATOR

The cost of fertilizer has risen dramatically over the last several years (Figure 1). As an example, the United States Department of Agriculture reports that urea costs were about $350 per ton in 2019. Today that same ton of urea will be near $1,000, a 185% increase in three years. Similar increases have occurred for other fertilizer products. While the reasons for price increases may be complex, the impact to growers is straightforward. Growers will experience increased fertilizer expenses and decreased profit margins. While the immediate future does not show reductions in fertilizer prices, growers can re-evaluate their nutrient management practices to determine if efficiencies may be gained to off-set higher costs.

***Photo 3** — Poor tree color and thin crown density are often indicators of nutrient issues.* Credit: Dr. Bert Cregg, Michigan State University

Maintaining adequate tree nutrition is important for producing quality trees in a reasonable time, however over- or mis-application can result in higher expenses, potential environmental harm, and provide little or no tree response. In this article, we will outline some of the key factors growers can consider in optimizing nitrogen fertilization. In a subsequent article, we will discuss management of additional nutrients such as phosphorus and potassium.

The start of a sound nutrient management program involves understanding the requirements of the tree species that you are growing. Tree species that are commonly grown in the Great Lake region vary widely in their relative response to nutrients. In general, fir trees are more sensitive to low soil fertility compared to spruces or pines that may require lower nutrient levels. Scotch pine is known for growing well in nutrient poor sites.

As in most agricultural crops, nitrogen (N) is the most limiting nutrient for growth of Christmas trees. Nitrogen is used ubiquitously within plants as a component in many important internal structures such as proteins, enzymes, and chlorophyll. Adequate foliar nitrogen levels are often associated with many positive tree attributes, including good shoot growth, high bud density, and good needle color (Photo 2). Trees with inadequate nitrogen levels often exhibit reduced growth, thin crown density, and poor needle color (Photo 3). Nitrogen in soils is highly dynamic and soil N levels can change rapidly due to nitrification, leaching, and other processes. As a result, soil test reports typically do not include nitrogen as they do other key soil nutrients. Therefore, Michigan State University Extension recommends nitrogen application rates based on age of tree and tree species (Figure 4). It is important to note that university extension services and other refences do not recommend fertilizing newly planted seedlings or transplants. While this recommendation may seem counterintuitive, transplants are typically fertilized heavily at nurseries and have sufficient nitrogen reserves stored in tissue for the first year. Moreover, additional fertilizer applied too close to the tree may cause fertilizer burn from osmotic stress (Photo 5). This may be more pronounced

***Figure 1** — Average prices of common fertilizer products over time*

Credit: United States Department of Agriculture, Bloomberg

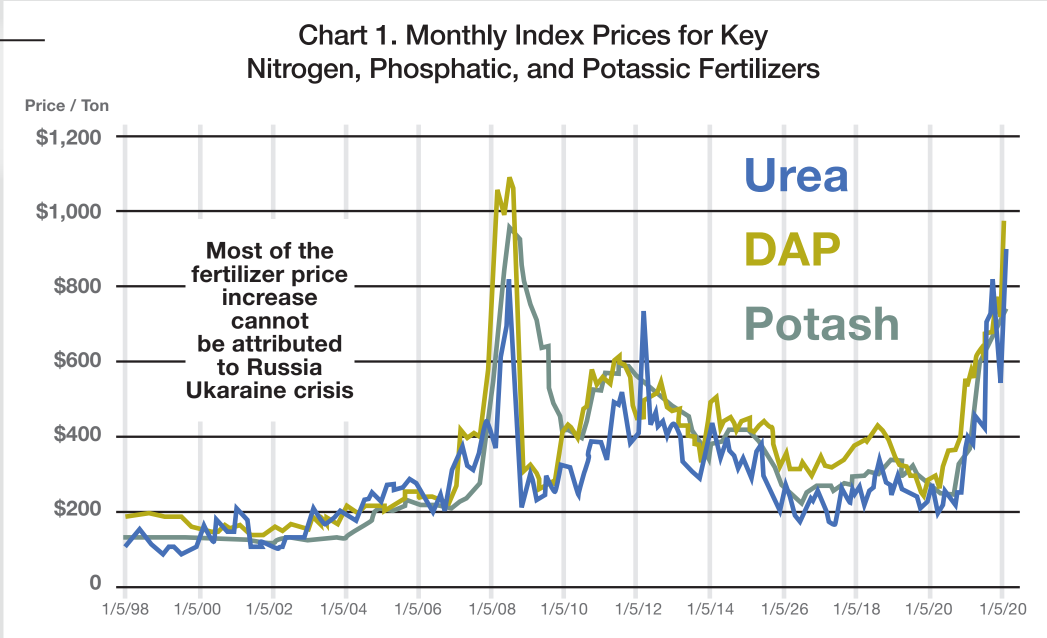

***Photo 2** — Proper tree nutrition is essential to tree color, growth, and uniformity*

Credit: Dr. Bert Cregg, Michigan State University

Species	Year*	Rate (actual N)**	Rate/ac.***
Douglas fir◆		.25-.75 oz. tree	20-60 lbs. per acre
Fraser fir and other fir species	Year 2	.25 oz./tree	20 lbs. per acre
	Year 3	.5 oz./tree	40 lbs. per acre
	Year 4-5	.75 - 1 oz./tree	60-75 lbs. per acre
	Year 6-7	1 oz./tree	75 lbs. per acre
	Year 8	1.5 oz./tree	115 lbs. per acre
	Year of harvest	2 to 3 oz./tree	125-175 lbs. per acre (spring plus additional amounts in August for color depending on size of tree)
Pine◆ (White and Scotch)		.25-.5 oz./tree	20-40 lbs. per acre
Spruce	Year 2	.25 oz./tree	20 lbs. per acre
	Year 3	.5 oz./tree	40 lbs. per acre
	Year 4-8	.5 oz.-.75 oz./tree	40-60 lbs. per acre

◆ additional nitrogen may not be needed. If growth or color is poor, use foliar analysis to determine nitrogen needs.
* all species - nitrogen is **not** recommended during the first growing season.
** apply nitrogen in the spring two weeks prior to bud break
*** based on 1200 trees per acre

Figure 4 *— MSU Christmas tree nitrogen recommendations based on species and age of tree*

Photo 5 *— Damaged Christmas tree from fertilizer placement*
Credit: Anonymous grower

on transplants as they have also undergone stress involved with planting. Current studies at MSU are underway to further examine the effect of fertilization at planting, but to date additional nitrogen fertilizer on first year transplants has not demonstrated benefits in improving tree establishment.

Good nitrogen management also involves understanding the factors that control soil nitrogen availability. Some soils inherently have more nutrients and nutrient holding capacity than others. This is also true for nitrogen availability. Nitrogen can be applied via fertilizer, but it can also be made available through the decomposition of organic matter and the release of plant-available N (mineralization). Mineralization is a complex process, but other factors being equal, soils with high organic matter can provide a greater portion of the needed annual nitrogen use than soils with low organic matter. Growers may consider reductions of nitrogen fertilizer rates (10%) on soils with relatively high organic matter (>5%) and then monitor crop growth (i.e., foliar tissue samples) to determine if nitrogen levels are still sufficient.

The timing of nitrogen fertilizer is important for crop uptake. Nitrogen fertilizers should be made prior to budbreak in the spring. There are several reasons that make this timing a good application window. At this point tree roots are undergoing their most active growth for the year. More root development will lead to a greater amount of nutrient capture. In addition, the tree's peak nutrient demand will start once budbreak occurs. Finally, urea, the most commonly applied nitrogen fertilizer, is subject to nitrogen loss through volatilization. Volatilization is more pronounced when soil temperatures are above 70 deg. F and the urea fertilizer is not washed into the soil soon after application. Applying N in the early spring reduces the likelihood that these conditions will be favorable for volatilization. If fertilizer is applied after budbreak, care should be taken to avoid fertilizer coming into direct contact with new needles, as they have not developed a strong cuticle and may be subject to injury. Split applications of nitrogen (i.e., applying a portion in the spring and a portion in the early summer) may be beneficial especially on light textured soils. These soil types are prone to leaching of N and splitting applications can increase overall uptake.

Some growers also apply a fall application of nitrogen with the goal of enhancing the color of trees prior to harvest. Before making fall N applications, a foliar nutrient analysis can provide useful information on foliar N concentration and determine if a pre-harvest fertilization may be beneficial. Samples should be taken and submitted in October, as nitrogen levels have stabilized. Foliar nitrogen concentrations of 1.5% to 1.6% are deemed sufficient for most conifers. Research trials in the Pacific Northwest analyzed the use of fall nitrogen fertilizer to improve needle color. No difference in tree foliar nitrogen content or needle color was found between the non-treated control and those receiving an additional fall nitrogen application.

Fertilizer applications can be made by dry (granular) or liquid forms. Liquid products are generally more expensive per unit of nutrient applied than granular products. However, some liquid applications can reduce labor costs by combining fertilization with other activities in the field (ex. through drip fertigation or combined with herbicide application) and those benefits may offset an initial higher cost. Growers considering foliar applications need to be certain that the product being applied is designed for foliar use and that the treatment will not cause foliage damage. In general, it is very difficult to use foliar fertilization to supply large quantities of macronutrients, such as nitrogen, versus correcting a micronutrient need.

For growers that use dry fertilizer, there are a couple formats in which to purchase product. Growers can select from pre-mixed or custom-made blends. Pre-mixed bags come in various analysis (ex. 19-19-19) and generally sized in 50-pound bags. Advantages to pre-mixed bags are ease of storage, movement, and ability to purchase in small volumes. Disadvantages include higher unit costs and inability to precisely match fertilizer application to nutrient needs. For example, if we have a 5-year-old Fraser fir block, the nitrogen (N) application rate would be about 60 pounds of N per acre (Photo 4). For our example, a hypothetical soil test indicated that no additional phosphorus or potassium is needed. To apply the 60 pounds per acre of N using 19-19-19 pre-mixed bags, a grower would need to apply 315 pounds per acre (60/0.19=315) of product. This would also apply 60 pounds of phosphorus and potassium, both of which are unnecessary. Custom made blends can more precisely match nutrient needs with soil test recommendations and often at a reduced price. Once blended, these products are stored in bulk bags or fertilizer tender carts. Advantages to custom blended fertilizer include lower unit costs, ability to choose specific products, and match needs indicated in soil tests. Disadvantages include larger volume of fertilizer (usually minimum amounts between 1,000 and 2,000 pounds) and lack of long-term storage.

Animal manure can be used as a nutrient source for Christmas tree production. Application and incorporation of manure between tree rotations is usually the most feasible, due to the logistics of material handling. The specific nutrient content can vary widely between manure samples and a laboratory analysis can determine specific nutrient levels and thereby use rate. Although organic sources of fertilizer have not been widely used in Christmas tree production, this can be an option to reduce synthetic fertilizer inputs. An added benefit is that not all N in animal manure will be plant available immediately. Similar to organic matter decomposition, the process of mineralization from inaccessible to accessible plant forms of nitrogen can take several years before completing. This could space out some of the nitrogen demand of trees as they establish. Downsides to manure application include the possible addition of weed seeds. Additionally, some manures are high in phosphorus, which depending on your soil reports, you may or may not need. Over application of phosphorous can be an environmental hazard.

Finally, the use of certain cover crops can be used to produce organic soil nitrogen. Legumes (ex. clovers, vetches, alfalfa) can fixate atmospheric nitrogen into plant available forms through a specialized root partnership with bacteria. There are

Photo 6 *— Clover cover crop growing into Christmas tree rows*
Credit: Bill Lindberg, Michigan State University Extension

many scenarios possible for the use of legume cover crops in Christmas tree plantations, from pre-planting and tilling into the soil to the use as a permanent row middle during the rotation. It is important to note that the cover crop tissue needs to decompose prior to the nitrogen being made available to the Christmas tree roots. The actual amounts of N generated vary and will be based on age of cover crop stand, specific species used, and overall stand productivity. The use of cover crops does require maintenance, as they can grow aggressively and become highly competitive with Christmas trees (Photo 6).