MSU RESEARCH UPDATE:

Can Nitrogen Stabilizers Improve Nitrogen Management in Christmas Tree Plantations?

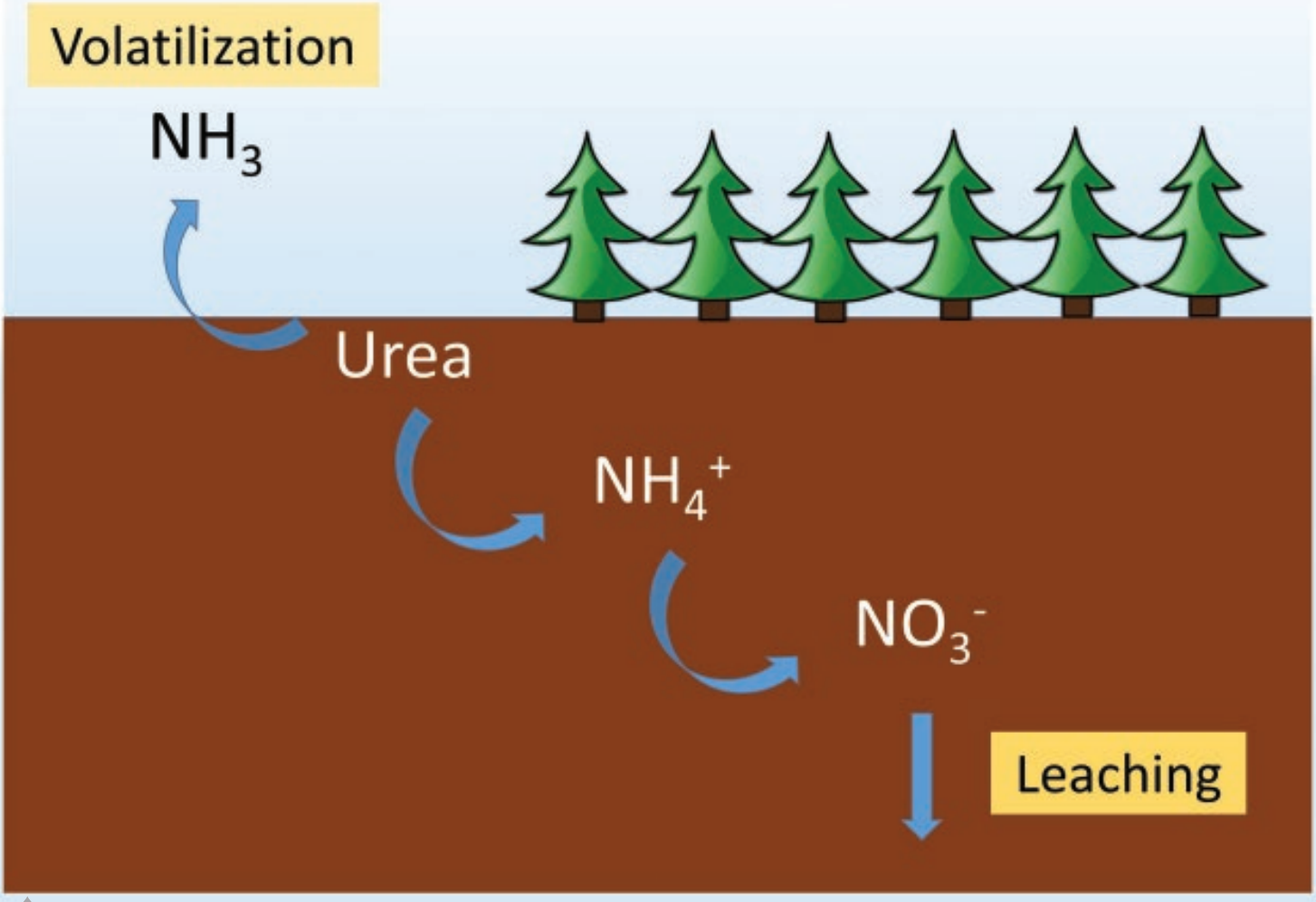
BERT CREGG, PROFESSOR AND EXTENSION SPECIALIST, MICHIGAN STATE UNIVERSITY, DEPARTMENT OF HORTICULTURE AND DEPARTMENT OF FORESTRY

DANA ELLISON-SMITH, RESEARCH TECHNICIAN, MICHIGAN STATE UNIVERSITY

JILL O'DONNELL, MICHIGAN STATE UNIVERSITY EXTENSION

FIGURE 1

Nitrogen added as urea may be lost from the soil due to volatilization of ammonia or through leaching of nitrate.



Summary

In this project, we investigated the utility of nitrogen stabilizers in conifer nursery and Christmas tree production. We conducted a series of trials with field-grown trees to determine the effect of these products on tree growth and needle nutrient concentration. We also analyzed soil water samples periodically to assess the impact of nitrogen stabilizers on nitrate leaching. Nitrogen stabilizers did not improve tree growth or foliar nitrogen concentration and did not reduce nitrate-N leaching compared to conventional fertilization with urea or ammonium sulfate.

Background: What are nitrogen stabilizers and what is their potential benefit?

Growers often fertilize with urea as a primary nitrogen source because it is typically the lowest-cost form of nitrogen fertilizer. However, significant amounts of nitrogen in urea can be lost from the soil through volatilization or leaching before it can be taken up by trees (Fig. 1). In agronomic crops over 40% of applied N can be volatilized. Volatilization occurs when urea is converted to ammonia, which is lost as a gas from the soil surface. The conversion of urea to ammonia is catalyzed by urease, a naturally occurring enzyme. One group of nitrogen stabilizers are urease inhibitors. These products contain a compound (NBPT) that slows the rate at which urea is converted to ammonia and potentially volatilized. Nitrogen can also be lost due to leaching of nitrate. Ammonium in the soil is nitrified to nitrite and then nitrate. Both nitrite and nitrate have negative charges, so they do not bind to clay or organic matter in the soil and are readily leached. Nitrate that leaches below the root zone is unavailable for plant uptake so it represents 'wasted' fertilizer. Moreover, nitrate in ground water is an environmental pollutant, so minimizing leaching is important to good environmental stewardship. Nitrification of soil N is mediated through soil microbes and can be reduced by nitrification inhibitors.

Nitrogen stabilizers are products that contain urease inhibitors to reduce volatilization and/or nitrification inhibitors. In agronomic systems, nitrogen stabilizers can often reduce nitrogen losses and improve crop yields. However, there are many key differences between typical nursery or Christmas tree plantations and conventional agronomic farming that could affect the utility of N stabilizers. Conifer producers usually apply urea when conditions are unfavorable for volatilization (i.e., growers often fertilize early in the spring when soil temperatures are low and soil pH in conifer plantations are relatively low). Therefore, it is unclear if N stabilizers would benefit conifer growers in the Great Lakes region. Moreover, the addition of nitrogen stabilizers can increase the price of fertilizer by $10-$180 per ton compared to standard urea. In order to evaluate whether nitrogen stabilizers were worth the additional cost, we initiated a preliminary field study in 2013 and a larger trial in 2016. The objectives of the studies were to determine the effect of nitrogen stabilizers on growth and foliar nutrition of Christmas trees in comparison to trees that were not fertilizer or fertilized with conventional fertilizer.

2013 Preliminary study

In 2013, we initiated a trial with a cooperating grower (Badger Evergreen Nursery, Allegan, MI). Ten-tree row plots of Fraser fir trees (approx. 5' tall at the start of the trial) were assigned to one of 7 treatments:

- Control (no fertilizer)
- Ammonium sulfate – spring-only
- Ammonium sulfate – split-application
- Urea – spring-only
- Urea – split-application
- SuperU (stabilized nitrogen with urease inhibitor and nitrification inhibitor) – spring-only
- SuperU – split-application

All treatments were replicated 6 times (10 trees x 6 reps = 60 trees per treatment). We fertilized spring-only plots with 1 oz. of N per tree by hand each spring beginning spring of 2014 (Photo 1 & 2). Split applications were applied by hand as 0.5 oz. of N per tree in fall and spring beginning in fall 2013. Treatments were applied through 2016. We measured leader growth each year (Photo 3) and collected needle samples for nitrogen analysis in 2016.

Photo 1. *Weighing fertilizer for application.*

Photo 2. *Fertilizer was applied by hand around each tree.*

Photo 3. *Assessing leader growth.*

FIGURE 2

Location of nitrogen fertilizer stabilization plots in Michigan.

What we found

Leader growth was not affected by any of the fertilization treatments. Trees fertilized with SuperU did not grow more than trees fertilized with urea or ammonium sulfate. In addition, there was no advantage in splitting applications for any fertilizer. Fertilization, regardless of N source, increased foliar N compared to the unfertilized controls but there was no difference in tissue N concentration among the fertilization treatments.

2016 Nitrogen stabilizer trial

In spring 2016 we established field plots on four tree farms in Michigan: Getty Tree Farm, Manton MI; Dutchman Tree Farm, Manton, MI; Badger Evergreen Nursery, Allegan, MI; and Gwinn's Tree Farm, Horton, MI (Fig. 2). All plots were in Fraser fir fields, except for the trees at Dutchman, which were Black hills spruces. At each farm, we established replicated 10-tree row plots (5-tree row plots at Gwinn's) of seven nitrogen fertilization treatments (Table 1). The treatments included an unfertilized control, two standard fertilization treatments (urea or ammonium sulfate), one polymer coated urea product (ESN®) and three stabilized nitrogen products (Instinct®, Nitrain™ Express, SuperU®). We applied all fertilizer at the rate of 1 oz. of actual nitrogen per tree. Fertilizer was applied by hand and spread evenly in a 2' radius around each tree. All treatments were replicated 6 times at each farm. Trees were approximately 5' tall at the time of initial treatment. Fertilizer was applied in May 2016 and all treatments were re-applied in May 2017 and May 2018, except for the plots at Gwinn's, where harvesting began in late 2017. Grower-cooperators followed their standard cultural practices except fertilization. Current year shoot growth was measured in 2016, 2017, and 2018 and

TABLE 1

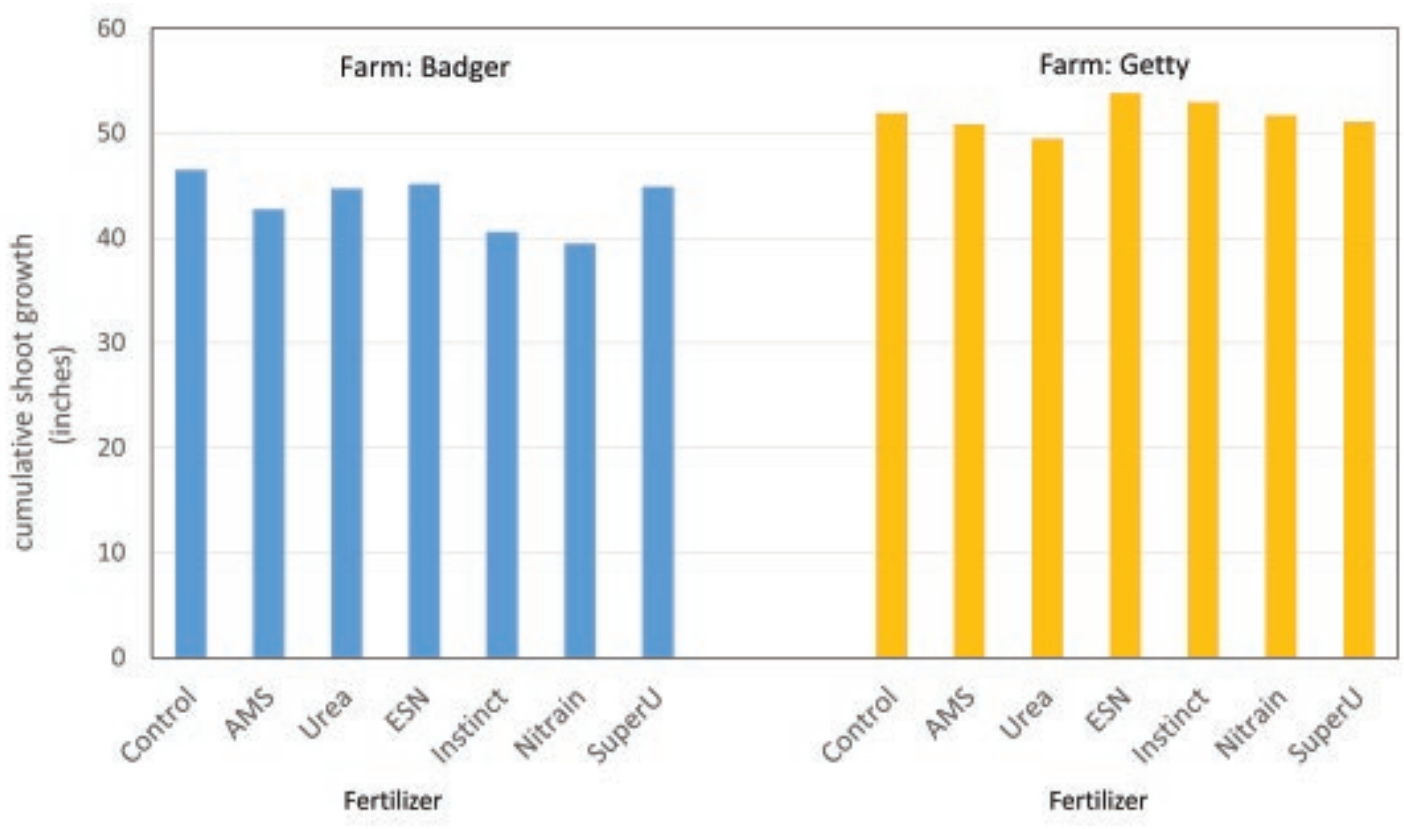
Fertilizer treatments for 2016 nitrogen stabilizer trial

TREATMENT	FERTILIZER*
Control	None
Ammonium sulfate (AMS)	Ammonium sulfate
Urea	Urea only
Instinct®	Urea + nitrification inhibitor
Nitrain™ Express	Urea + urease inhibitor
SuperU®	Urea + urease and nitrification inhibitor
ESN®	Polymer coated urea

**1 oz. of N applied per tree each spring prior to budbreak*

FIGURE 3

Cumulative shoot growth from 2016 to 2018 of Fraser fir trees at Badger Evergreen and Getty Tree Farm in response to annual fertilization with various products. See Table 1 for list of products.



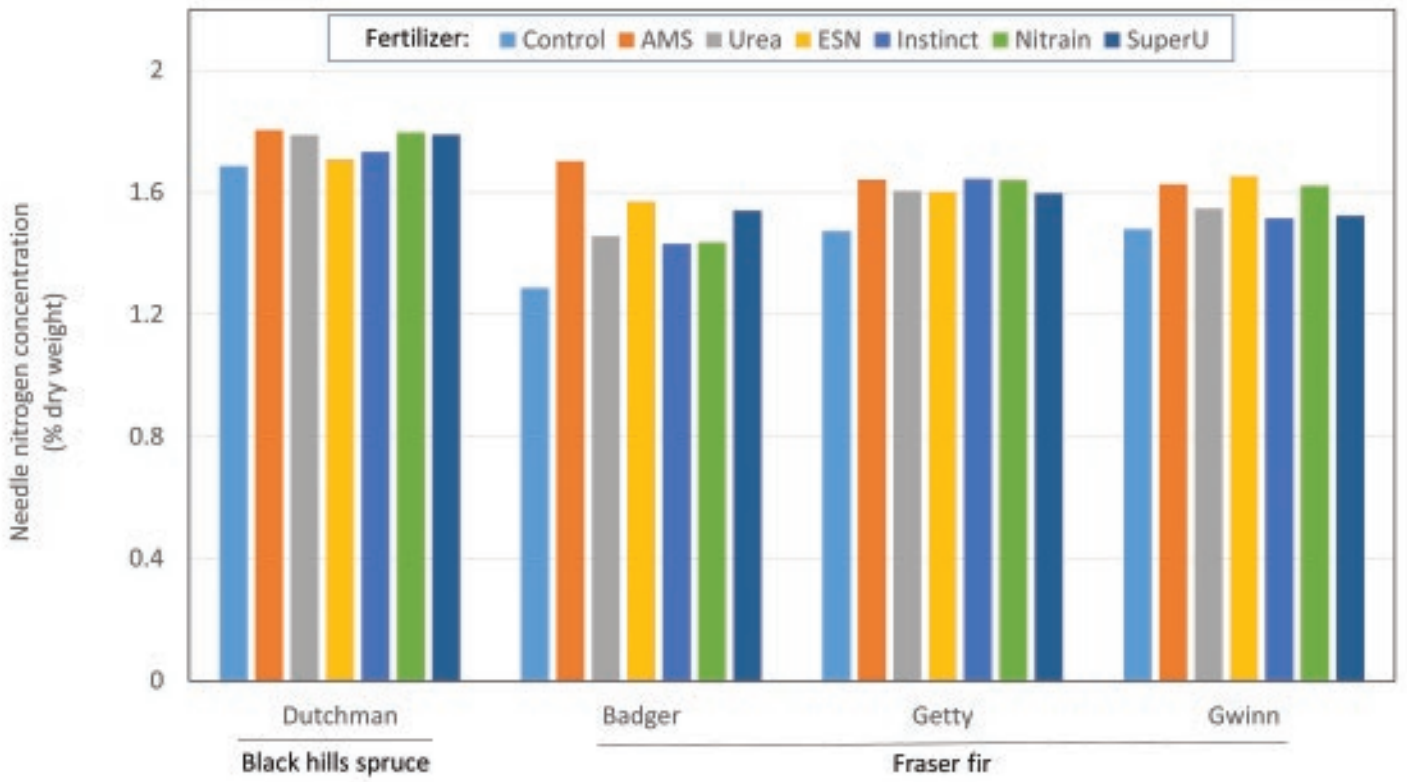
foliar samples were collected for nitrogen analysis in October 2016, 2017 and 2018.

What we found

None of the stabilized nitrogen products or the coated urea (ESN) increased growth or improved needle nitrogen concentration compared to conventional fertilization with urea or ammonium sulfate. Cumulative 3-year shoot growth from 2016 to 2018 for trees at Getty Tree Farm and Badger Evergreen is presented in Figure 3 (Harvest began at Gwinn's in late 2017 and growth data were not collected at Dutchman in 2017 due to shearing). Trees grew as well or better when fertilized with urea or ammonium sulfate as with any of the alternative N sources. It is also noteworthy that there

FIGURE 3

Needle nitrogen concentration in 2017 of Black Hills spruce and Fraser fir trees at four farms in response to annual fertilization with various products. See Table 1 for list of products.



was no difference in shoot growth between unfertilized trees (control) and any fertilizer treatment. This trend was consistent on the other farms when growth was measured (2016-17 at Gwinn's and 2016 & 2018 at Dutchman). Needle nitrogen analysis of needles collected in fall 2017 is presented in Figure 4. Overall, fertilization increased needle N concentration compared to not fertilizing (control) but the coated urea and the stabilized-N fertilizers did not increase needle N compared to standard fertilization. In addition, we collected soil leachate samples periodically on a subset of plots and found elevated nitrate levels on all plot except controls.

What it means

Alternative nitrogen sources (N stabilized fertilizers or coated urea) did not provide any benefit over conventional sources of nitrogen despite their additional costs. Potential N losses due to volatilization are low in Christmas tree systems and can likely be addressed through standard best practices such as avoiding urea fertilization in hot weather and incorporating fertilizer when possible. Nitrate leaching, in contrast, can be an issue in conifer production, particularly on light textured soils. The lack of a growth effect from our fertilization treatments suggests that previous nitrogen additions, soil organic matter and internal N reallocation within trees was adequate to meet amount of N needed for growth. Fertilization provided a small increase in foliar N but it is possible that lower rates of N addition could have provided a similar results.

Acknowledgements

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