MDARD Horticulture Fund
Fiscal Year 2016 Final Report

Proposal Title: Alternative nutrient management strategies for Christmas tree and conifer nursery production

Principle Investigator: Bert Cregg

Name: Bert Cregg
E-mail: cregg@msu.edu
Mail Address: 1066 Bogue St
East Lansing 48824
Telephone: 517-353-0335
Fax: 517-353-0890

Co-Investigators: Jill O'Donnell, Erin Lizotte, Dana Ellison

Synopsis of Project:
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 quality. We also investigated the impact of nitrogen stabilizers on nitrate leaching. Nitrogen stabilizers did not improve growth, foliar nitrogen concentration and did not reduce nitrate-N leaching compared to conventional fertilization with urea or ammonium sulfate.

Background
Proper nutrition is critical to growth and quality of conifer nursery stock and Christmas trees. Efficient fertilizer management is also important to reduce environmental impacts and prevent nutrient contamination, especially nitrogen (N) and phosphorus (P) to surface water and N leaching to groundwater. Alternative fertilizer products used in agronomic or horticultural production systems have been increasingly marketed to conifer producers and Christmas tree growers. These products include 'stabilized' nitrogen products, i.e., urea fertilizers treated with urease and/or nitrification inhibitors, which can potentially reduce nitrogen losses and increase grower efficiency.

We initiated field studies with the following objectives:

Objective 1. Determine the effect of urea treated with a urease inhibitor and/or nitrification inhibitor on growth, and foliar nutrition of Fraser fir and Black hills spruce trees.

Objective 2. Determine the effect of urea treated with a urease inhibitor and/or nitrification inhibitor on N loss to leaching.

Nitrogen stabilizers

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 (Figure 1). At each farm we established replicated 10-tree row plots (5-tree row plots at Gwinn's) of 7 nitrogen fertilization treatments (Table 1). The treatments included an unfertilized control, two standard fertilization treatments (urea or ammonium sulfate) and four stabilized nitrogen products (Instinct®, Nitrain™ Express, SuperU®, or ESN®). 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. Grower-cooperators followed their standard cultural practices and were responsible for managing plots, except fertilization. In July 2016 we installed suction lysimeters (SSAT vacuum tubes 24", Irrometer Company, Inc., Riverside CA) at two farms (Dutchman and Gwinn's). We installed one lysimeter per plot (42 per farm). Lysimeters were installed approximately 24" from the base of a tree near the center of each treatment plot (Figure 2). Lysimeters were inserted to a depth of approximately 15" and were installed at an angle to reduce the potential for rainwater to channel down the tubes (Figure 3). We applied 70 mbar of vacuum to each lysimeter after installation using a hand pump. Soil water samples were collected from the lysimeters periodically and the vacuum was re-applied after each sampling event (Table 2). Water samples from the lysimeters were sent to the MSU Plant and Soils laboratory for nitrate analysis. Ammonium concentration was determined for 2016 samples but was below detectable limits in most cases, so this analysis was discontinued. Current year shoot growth was measured at all farms in 2017 and foliar samples were collected in October 2016.

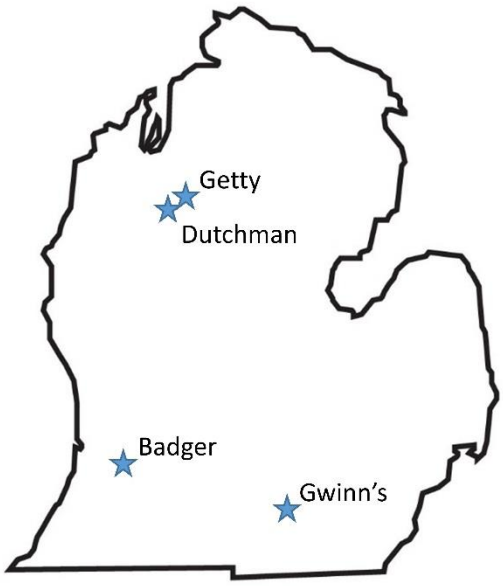

Figure 1. Location of nitrogen fertilizer stabilization plots in Michigan.

Table 1. Fertilizer treatments for nitrogen stabilizer trial

Treatment	**Fertilizer***
Control	None
Ammonium sulfate	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

Lysimeter installation. Figure 2 (top) auguring pilot hole. Figure 3 (Right) inserting lysimeter sampling tube.

Table 2. Schedule of treatment applications, lysimeter installation and lysimeter sampling

Farm	Species	Fertilizer treatments applied	Lysimeters installed	Lysimeter sample dates
Getty	Fraser fir	May 2016 May 2017	n/a	
Badger	Fraser fir	May 2016 May 2017	n/a	
Dutchman	Black hills spruce	May 2016 May 2017	July 7, 2016	July 17, 2016 August 2, 2016* August 12, 2016 August 24, 2016 September 2, 2016 September 8, 2016 September 23, 2016 April 18, 2017* April 28, 2017 May 10, 2017 May 19, 2017* May 26, 2017 June 1, 2017* June 7, 2017* June 14, 2017* June 29, 2017* July 7, 2017 July 14, 2017 July 20, 2017August 9, 2017*
Gwinn	Fraser fir	May 2016 May 2017	July 12, 2017	July 19, 2016 July 27, 2016 August 15, 2016 August 17, 2016* August 30, 2016* September 13, 2017* September 28, 2017* October 13, 2017* May 1, 2017* May 3, 2017* May 10, 2017* May 22, 2017* June 6, 2017 June 28, 2017 June 12, 2017 August 1, 2017

*dates on which leachate samples were recovered

Growth and foliar nutrition

After two years of fertilization, current year shoot growth in 2017 did not vary among treatments at three of the farms sampled (Dutchman, Getty and Gwinn) (Table 3). At the Badger farm, trees fertilized with Super U (urea + urease inhibitor and nitrification inhibitor) had greater shoot growth than trees fertilized with Nitrain (Urea + urease inhibitor only). Shoot growth of trees fertilized with all other products was similar at Badger.

Fertilizer product did not affect nitrogen concentration of foliar samples collected in October 2016 (Table 4). Nitrogen concentrations of foliar samples in all treatments, including unfertilized control, were above sufficiency levels (~1.5% N). This suggests that inherent fertility on the sites was relatively high, likely due to past management practices on the sites.

Table 3. Mean shoot growth (m) of Fraser fir and Black hills spruce trees in response to nitrogen fertilizer products at four farms in Michigan

	Farm			
Product	Badger (Fraser fir)	Dutchman (Black hills spruce)	Getty (Fraser fir)	Gwinn (Fraser fir)
Am. sulfate	0.35ab	0.29	0.39	0.37
Control	0.33bc	0.33	0.40	0.45
ESN	0.36ab	0.31	0.41	0.45
Instinct	0.33bc	0.31	0.40	0.44
Nitrain	0.29c	0.34	0.41	0.44
SuperU	0.39a	0.35	0.39	0.38
Urea	0.35ab	0.33	0.41	0.44

NOTE: means within a column followed by the same letter are not different at $p<0.05$ level.

Table 4. Mean foliar nitrogen concentration (% dry weight) of Fraser fir and Black hills spruce trees in response to nitrogen fertilizer products at four farms in Michigan

	Farm			
Product	Badger (Fraser fir)	Dutchman (Black hills spruce)	Getty (Fraser fir)	Gwinn (Fraser fir)
Am. sulfate	1.70	2.09	1.91	1.93
Control	1.59	1.95	1.76	1.87
ESN	1.65	1.98	1.84	1.75
Instinct	1.59	2.10	1.87	1.67
Nitrain	1.69	2.02	1.88	1.87
SuperU	1.69	2.06	1.80	1.93
Urea	1.70	1.99	1.85	1.83

Nitrate leachate sampling

Concentration of nitrate-N in leachate collected in suction lysimeters varied widely across the sampling period (Tables 5 and 6). Nitrate was lowest in the unfertilized control plots but did not differ among the fertilizer treatments. A seasonal pattern was evident in the nitrate concentrations, with low concentrations occurring in spring and higher concentrations occurring in late summer and fall. Many sampling events failed to yield leachate samples from the lysimeters. This likely reflects low soil moisture associated with several relatively dry periods at both locations. In addition, at the Gwinn farm the Fraser fir trees were large (>2 m) and likely intercepted a large portion of rainfall before it was able to reach to the depth of the lysimeter samplers.

Summary

Fertilizing with 'stabilized' nitrogen did not increase growth or foliar nitrogen concentration of conifers at the four sites in Michigan, compared to standard fertilization with untreated urea or ammonium sulfate. Fertilization increased nitrate concentration of leachate collected in late summer, regardless of the fertilizer product used. The relatively high proportion of sampling events in which we were unable to collect leachate, however, suggests that leaching is relatively infrequent in plantations in the later part of the production cycle.

Table 5. Mean Nitrate concentration (ppm) of water samples collected from suction lysimeters at Gwinn's Tree Farm, Morton, MI. 2016-2017

	Sample date									
Product	8/17/2016	8/30/2016	9/13/2016	9/28/2016	10/13/2016	5/1/2017	5/3/2017	5/10/2017	5/22/2017	Overall
AMS	28.17	19.98	20.20			0.00	0.00	0.00		11.39
Control	0.69	0.00	0.04		0.02	0.00	0.00	0.00	0.03	0.10
ESN	8.87	11.73	5.39	3.56		0.00	0.76	0.36	0.01	3.83
Instinct	6.13	27.83	2.25	12.38		0.96	0.25	0.48		7.18
Nitrain	8.69	4.84	12.61	11.33		0.19	0.09		0.47	5.46
Super U	19.28	34.74	16.48		37.75	0.02	0.00		0.79	15.58
Urea	11.75	19.51	1.85	0.00	0.01	0.00	0.00			4.73

Table 6. Mean Nitrate concentration (ppm) of water samples collected from suction lysimeters at Dutchman Tree Farms, Morton, MI. 2016-2017

	8/2/2016	4/18/2017	5/19/2017	6/1/2017	6/7/2017	6/14/2017	6/27/2017	8/9/2017	Overall
AMS	65.10					0.93	27.97	76.28	42.57
Control	28.50		0.29	2.76	0.04	0.52	1.33	10.17	6.23
ESN	44.10			3.03	6.87	16.44	66.38		27.36
Instinct	88.00	0.64			0.20	25.73	50.70		33.05
Nitrain	72.60		7.56		1.25	4.28	61.01	13.59	26.71
Super U	57.70		0.66		0.22	5.54	72.55		27.33
Urea	69.90			0.04	0.23	15.19	62.24		29.52