MDARD Horticulture Fund Fiscal Year 2022 Final Report

Improving conifer plantation establishment: Impacts of seedling quality and pre-plant treatments

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SUMMARY: We conducted two sets of field trials to investigate options to improve survival of newly planted Fraser fir transplants in Christmas tree plantations and we conducted a nursery trial to investigate the utility of late season fertilization to nutrient load conifer transplants prior to lifting. For the plantation establishment trials, we initiated two sets of studies, one set in 2022 and one set in 2023, to investigate the effect of root dips and above-ground treatments on establishment of Fraser fir transplants. In the spring of each year, we installed plots in collaboration with four Christmas tree farms in Michigan. We subsequently evaluated trees for survival, growth, foliar nutrient concentration and soil moisture. In the 2022 trial, none of the root dips tested (DieHard, MycoApply, SoilMoist) improved tree survival or growth compared to the untreated control. Applying wood chip mulch increased seedling survival compared to trees that were not mulched at two out of the four farms. In the 2023 trial, application of wood chip mulch improved soil moisture during an early summer drought and improved tree survival at one farm. In the nursery trial, we applied late season fertilization in order to nutrient load Fraser fir and Canaan fir seedlings. Application of additional nitrogen, either as a blend or as ammonium sulfate, increased seedling nutrient content in the fall for Canaan fir but not for Fraser. In the spring of 2023, nutrient concentration was higher for both Fraser and Canaan fir that had received fall fertilization, compared to trees that had not been nutrient loaded.

BACKGROUND: Nearly all conifers grown for landscape nursery stock or Christmas trees in Michigan and the Great Lakes region are established by planting seedlings or transplants. Plant moisture stress after planting (transplant shock) can be a major limiting factor in the establishment of conifer plantations. Initial survival of newly planted conifers is related to several factors including weather immediately before and after planting, soil conditions, and planting stock quality (Grossnickle, 2005, 2018; Pinto et al., 2016). A variety of techniques and products have been promoted to improve transplant success. These include various root dips, shade blocks, and mulches. Root dips include polymers, bio-stimulants, and mycorrhizae. Polymer root dips are promoted to retain moisture in the root zone and prevent root desiccation before and after planting. Some studies have shown positive responses of transplants to root dips (Alm and Stanton, 1993; Magnussen, 1986), although results vary, and some studies have shown negative effects (Crous, 2017). Bio-stimulants include a range of products designed to enhance root growth after planting. These are often bio-based products that may include kelp extract,

plant hormones, and/or nutrients (Khan et al., 2009; Thompson, 2004). Mycorrhizal root dips include inoculum of endo- and/or ecto-mycorrhizae. All conifers that are grown as landscape trees and Christmas trees in Michigan form mycorrhizal associations. Off-the-shelf mycorrhizal inoculants are purported to improve root function of newly planted seedlings by augmenting mycorrhizal fungi that are native in the soil (Castellano, 1996; Rudawska et al., 2017). Mulch can also improve initial seedling survival and growth by reducing evaporation from the soil surface and reducing weed competition, resulting in increased soil moisture (Cregg et al., 2009; Landgren et al., 2021). In addition to approaches to improve below-ground conditions, artificial shading using shade blocks or shingles has been shown to reduce heat load and transpirational water loss of conifers in clear-cuts (Helgerson, 1989; Helgerson and Bunker, 1985; Petersen, 1982) and in regenerating the blast zone at Mount St. Helens (Logan, 1985).

OBJECTIVES: The overall objective of this project is to improve survival and growth of newly planted seedlings and transplants in conifer landscape nurseries and Christmas tree plantations. Our specific objectives are to 1) determine if root dips and related treatments at planting can improve seedling survival and growth by reducing tree stress following transplanting and 2) determine the relationship between seedling quality and seedling survival and growth following out-planting.

METHODS

Objective 1. Determine the effect of root dips and related treatments at planting

2022 study

In spring 2022 we established plots in collaboration with four MCTA member farms (Wahmhoff Farms Nursery, Gobles, MI; Holiday Acres Tree Farm, Milford, MI; Badger Evergreen Nursery, Allegan, MI; Ed Dunneback and Girls Farm Market. Grand Rapids) At each farm, 75-150 Fraser fir transplants were assigned to one of four root dip treatments (Myco-apply, DieHard, SoilMoist, or untreated control (Table 1). We applied root dips by dipping seedling roots into each product mixed in 5-gallon plastic buckets per labeled recommended rates (Fig. 1). Care was taken to prevent cross-contamination between treatments when applying dips and during planting. Cooperating farms machine-planted the seedlings using their usual equipment and procedures. After all seedlings were planted, we applied one of four above-ground treatments: wood chip mulch, fertilizer (10 g of controlled release fertilizer, Osmocote plus 15-9-12, 5–6-month release), fertilizer + mulch or untreated control. We applied mulch around each tree to a depth of 3” in an 8” radius around each tree (0.33 sq ft).

Figure 1. Applying root dips prior to planting.

Table 1. Root dips for 2022 MSU seedling establishment trials

Root Dip Treatment	Product composition	Rate	Manufacturer
DIEHARD™ Ecto Root Dip	88% Copolymer of Acrylamide/Potassium Acrylate; 2% Yucca Schidigera; 4% Humic Acids; 2% Kelp Extract; 0.33% Microbes Ectomycorrizae, Scleroderma, Bacillus, Trichoderma, etc.); 0.2% K_2O; 0.00061% Mo	6 oz (170 g)/ 5 gal H_2O	Horticultural Alliance (Sarasota, FL)
MycoApply® Injector Ecto	18.72% Ectomycorrhizal fungi & Humic acids; 81.28% inert	5 g/ 5 gal H_2O	Mycorrhizal Applications (Grants Pass, OR)
SoilMoist™ Fines	99.7% Crosslinked Polyacrylamide; 0.3% inert	2.5 oz (100 g)/ 5 gal H_2O	JRM Chemical Inc. (Cleveland, OH)
Control	100% water	5 gal H_2O	Mother Nature

2023 Study

Planting procedures and treatment application were similar for the 2023 study installations with these modifications: Root treatments included addition of Biochar and a fertilizer treatment (Table 2), while the SoilMoist Treatment was dropped. For the above-ground treatments we replaced the fertilizer treatments with shade blocks (Fig. 2).

Table 2. Root dips for 2023 MSU seedling establishment trials

Root Dip Treatment	Product composition	Rate	Manufacturer
DIEHARD™ Ecto Root Dip	88% Copolymer of Acrylamide/Potassium Acrylate; 2% Yucca Schidigera; 4% Humic Acids; 2% Kelp Extract; 0.33% Microbes Ectomycorrizae, Scleroderma, Bacillus, Trichoderma, etc.); 0.2% K_2O; 0.00061% Mo	6 oz (170 g)/ 5 gal H_2O	Horticultural Alliance (Sarasota, FL)
MycoApply® Injector Ecto	18.72% Ectomycorrhizal fungi & Humic acids; 81.28% inert	5 g/ 5 gal H_2O	Mycorrhizal Applications (Grants Pass, OR)
BEST PAKS® 20-10-5 fertilizer packet	20% N, 10% P205, 5% K2O. 2% Ca, 2% Mg, 3% S, 0.25% Cu, 0.90% Fe, 0.25% Mn, 0.002% Mo, 0.15% Zn	One 10-gram packet/ tree	Simplot Professional Products (Lathrop, CA)
Biochar	Medium grade biochar	2 cups/tree	Biochar Now, LLC (Loveland, CO)
Control	100% water	5 gal H_2O	Mother Nature

Figure 2. Fraser fir transplant shaded by shade block.

Results

2022 study

Overall survival was good (90% or higher) at all four locations. None of the root dips that were applied before planting affected seedling survival at the end of the 2022 growing season. Mulch increased seedling survival at two of the four farms (Chart 1). In contrast, application of control release fertilizer decreased seedling survival at three of the four farms (Chart 2). Mulching did not affect foliar nitrogen concentration of foliar samples collected at the end 2022 at any of the farms, indicating that nutrient ‘tie-up did not occur in response to mulch.

Chart 1. Mean first-year seedling survival of Fraser fir transplants planted at four Christmas tree farms in Michigan in response to wood chip mulch.

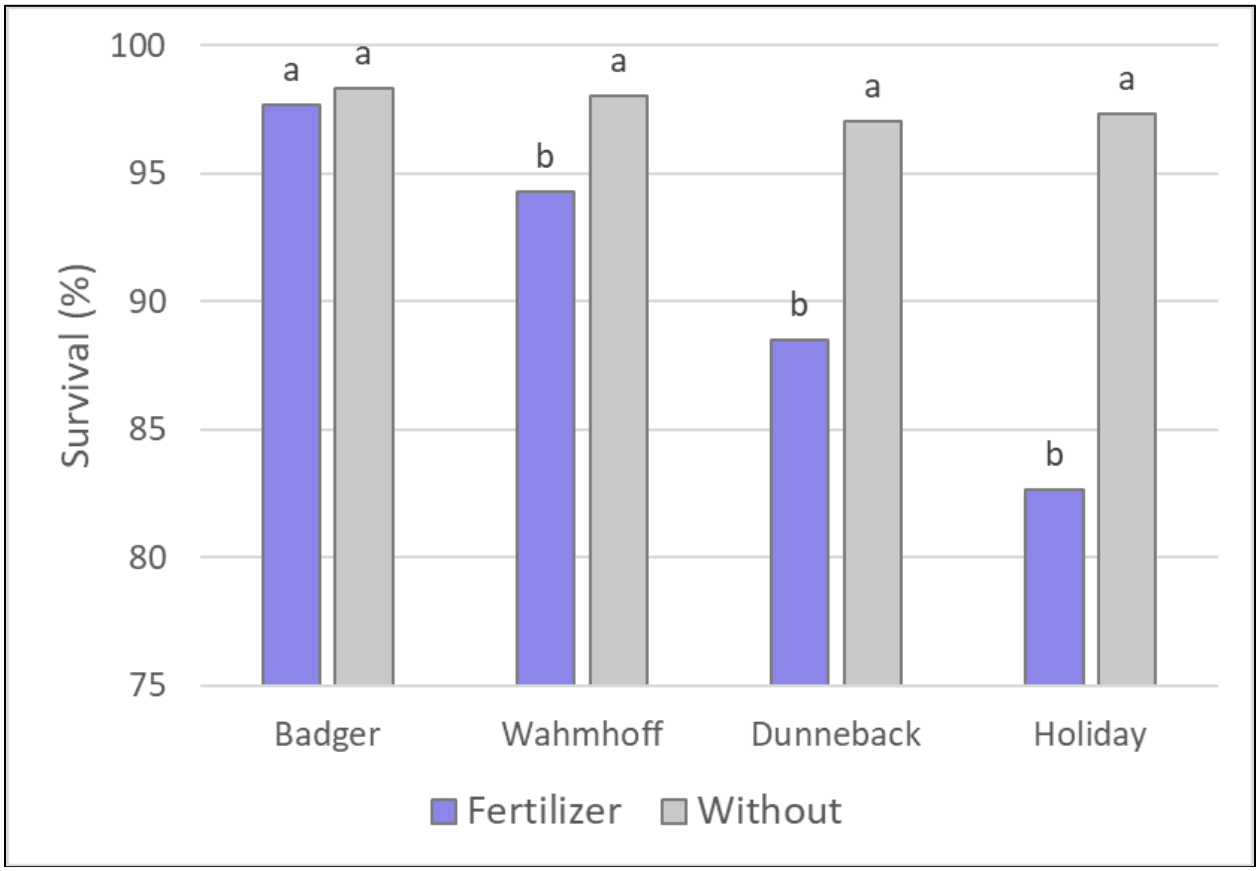


Chart 2. Mean first-year seedling survival of Fraser fir transplants planted at four Christmas tree farms in Michigan in response to fertilization with controlled release fertilizer.

2023 Study

Weather conditions were hot and dry in the late spring and early summer of 2023. For example, at Allegan, near the Badger and Wahmhoff farms, only 0.51" of rain was recorded between May 3 and June 24. During the same period, daily high temperatures exceeded 80 deg. F on 20 days. Mulch improved volumetric soil moisture in the upper 6" of soil during this time at the two farms near Allegan (Chart 3). Despite the drought conditions in late spring and early summer, survival was generally high for all farms and there was no effect of root treatment or above-ground treatments, except at the Badger farm, where mulch increased survival from 92.2% to 99.5%.

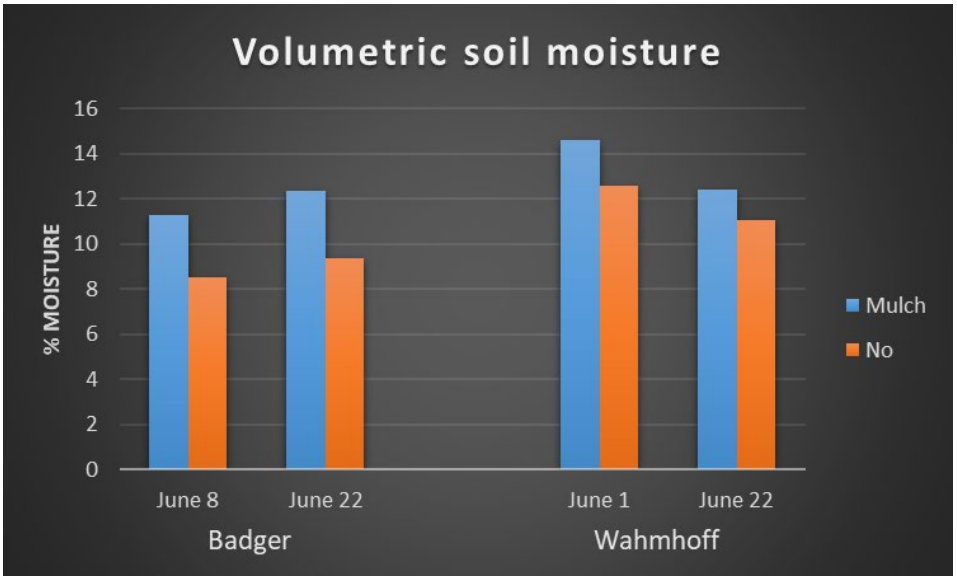


Chart 3. Mean volumetric water content at 0-6" depth at two Christmas tree farms near Allegan, MI in June, 2023. Trees were either mulched (Mulch) or left unmulched (No).

<u>Objective 2. Determine the relationship between seedling quality and seedling survival and growth following out-planting</u>

In addition to examining the effects of pre-plant dips and above-ground treatments on seedling survival and growth, we initiated an investigation on seedling quality on subsequent out-planting performance of Fraser fir and Canaan fir. In cooperation with Northern Pines Nursery (Lake City, MI) we applied three rates of fertilizer (25, 50, or 75 lbs. N per acre) on September 29, 2022 to 4' x 15' nursery bed sections of each species using either ammonium sulfate (AMS) or the nursery's standard fertilizer blend (11-8-14, N-P-K). Foliar samples were collected from transplants in each bed on November 11, 2022 to determine foliar N. The seedlings were lifted by the nursery on April 25, 2023 and trees were tagged based on the nutrient loading treatments Fig. 3). After lifting, we measured stem caliper and height on 50 trees per treatment. We took digital photos of a subset of trees for each group in order to determine root/shoot ratio (Fig. 4). Foliar samples were also collected for foliar N determination. The trees were placed into cold storage and out-planted at the nursery on May 17, 2023 by the farm's crew (Fig. 5)

Figure 3. Lifting and sorting transplants April 25, 2023.

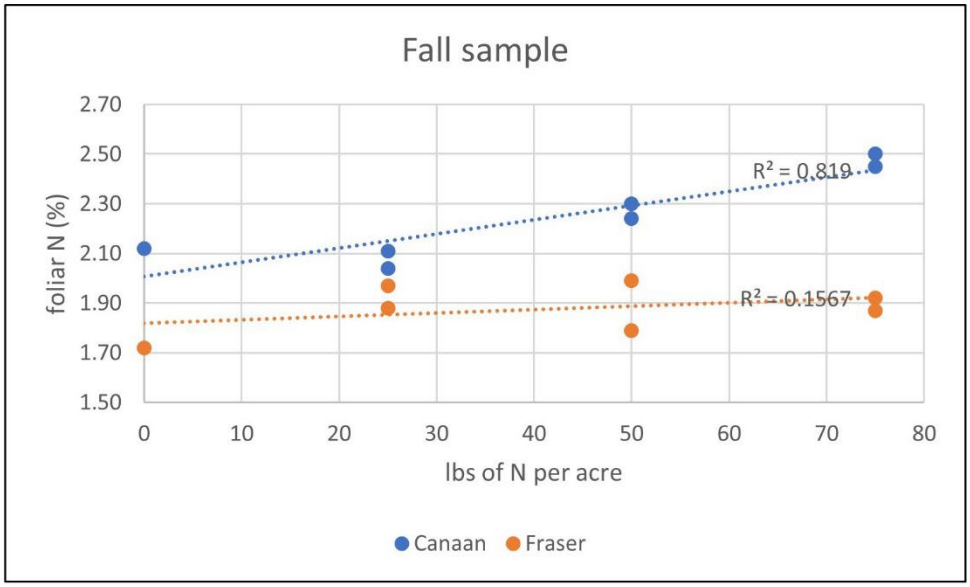
Figure 4. Digital photos of transplants will be analyzed using image analysis software to estimate root:shoot ratio.


Figure 5. Planting transplants from nutrient loading treatments at Northern Pines nursery, May 17, 2023.

Data analyses will include assessments of effects of nursery treatments on subsequent out planting success (survival, shoot and caliper growth) and correlations between seedling quality parameters (e.g., caliper, sturdiness index, nutrient content) and out planting success.

Results

Foliar N concentrations of Canaan fir transplants were more responsive to late season addition of fertilizer in the nursery beds than Fraser fir (Chart 4) on the fall 2022 sampling date, indicating these trees readily took up the additional fertilizer. Foliar N levels were lower for both species in the spring. However, on the second date foliar N increased for both species in response to fertilizer, indicating that nutrient loading had occurred.



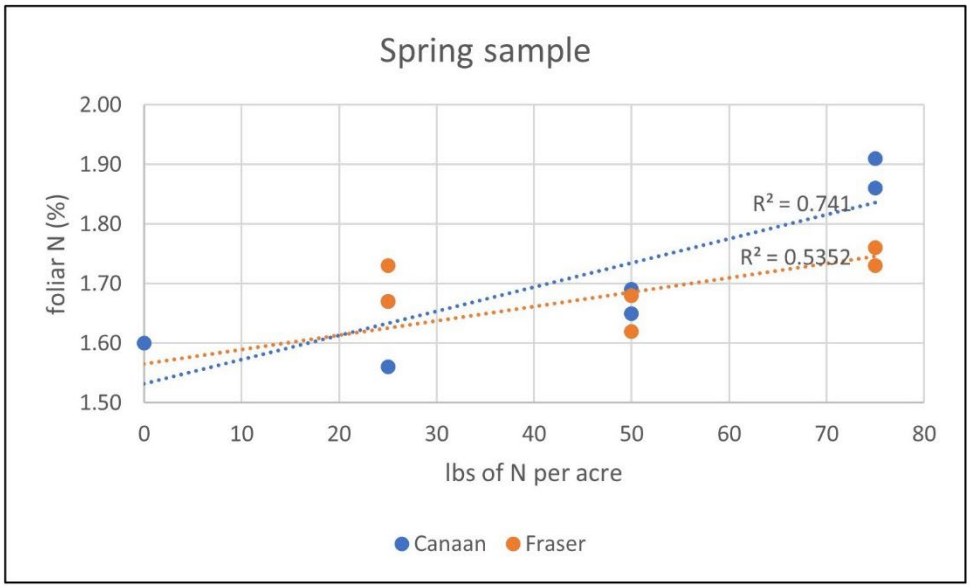


Chart 4. Foliar Nitrogen concentration of Canaan and Fraser fir seedlings fertilized with 0, 25, 50, or 75 lbs. of N per acre in Fall 2022. Foliar samples were collected on November 11, 2022 (fall sample) or April 25, 2023 (Spring sample).