Attachment C

Christmas Tree Promotion Board

Final Research Report

CTPB Project Number: 18-02-CAES

Project Title: Enhanced Establishment and Growth of Bareroot Transplants Using Controlled-Release Fertilizers

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Final Report

Introduction

Most Christmas tree growers currently do not fertilize trees at the time of planting, probably from concern that salts from fertilizers can injure roots. Bare-root transplants during the year of planting usually turn yellow and have poor growth, signaling that they experience stress, and possibly indicating that there are mineral deficiencies during that year. The hypothesis central to this work is that the absorptive roots of bare-root transplants are insufficient for being able to obtain adequate plant nutrients to support plant health in the year of planting. Therefore, providing complete fertility by mixing controlled release fertilizers into soil while planting should compensate for these deficiencies and allow the trees to reach their full genetic potential for growth that year. However, because excessive salts from fertilizers application could injure these same roots, finding the optimum fertilizer application rate for controlled-release fertilizers needs to be found. Optimizing fertilizer application at the time of establishment is expected to set the growth of trees on a trajectory that will lead to earlier harvest than with conventional practices, and might replace the need for higher fertilizer use once the trees are established, thus having a large impact in overall nitrogen application requirements to grow the trees to a harvestable size.

Methods

Experiments were conducted on three farms in 2019 to determine the optimum amount of fertilizer in replicated plots, either in groups of 10 trees per plot (Brooklyn site), or as single tree replicates (Broad Brook and Voluntown sites), arranged in a randomized complete block design. The fertilizer used at all three participating farms was Nutricote 18-6-8 Type 100 (designed for release over 100 days with moderate soil temperatures, henceforth referred to as CRF for controlled-release fertilizer). The quantity of fertilizer applied was 0, 13.6, or 27.2 g per tree (0, 1 or 2 level tablespoons). Fertilizer was added to and mixed with the soil dug to make the planting hole, and used to refill the hole while planting. Species tested included Fraser fir, balsam/Canaan fir, Douglas-fir, Colorado blue spruce, and Meyer spruce. One farm (Broad Brook site) included a fungicide root dip (pyraclostrobin, Pageant DF, 0.36 oz. of formulated product added to two gallons in the root dip at the time of planting) in a factorial design, and included coated urea treatments (one teaspoon of ESN, 44% N, Nutrien Ag Solutions) as an N source for comparison with the slower-release nursery fertilizer. The Broad Brook site also included 2 fl. oz. per 2 gallons of root dip of an insecticide (UpStar Gold, 7.9% bifenthrin) to protect against root injury by white grubs.

Measurements of tree color (0 – 4 scale, with 0 = brown, 1 = dying and yellow, 2 = yellow, 3 = yellowish green, 4 = healthy green), number of terminal plus top whorl buds, and terminal growth in cm were taken in September of 2019, and bud survival was measured during the summer of 2020. Note that all trees were fertilized in the spring of 2020 as per each farm's normal practices. Data were subjected to analysis of variance.

Treatments

Broad Brook Site

1. No fertilizer, no fungicide
2. 1 Tbsp CRF, no fungicide
3. 2 Tbsp CRF, no fungicide
4. 1 tsp ESN, no fungicide
5. No fertilizer + fungicide
6. 1 Tbsp CRF + fungicide
7. 2 Tbsp CRF + fungicide
8. 1 tsp ESN + fungicide

Species planted (single plant replicates)

1. Balsam fir, 3-2 transplants, 9 inches tall at planting (12 replicates)

2. Bracted balsam fir, 3-2 transplants, 9 inches tall at planting (12 replicates)

3. Meyer spruce, 4 inches at planting (6 replicates)

Brooklyn Site

1. No fertilizer
2. 1 Tbsp CRF, no fungicide
3. 2 Tbsp CRF, no fungicide

Species planted (10 plants per plot)

1. Fraser fir (3 replicates)
2. Canaan fir (3 replicates)
3. Douglas-fir (3 replicates)
4. Colorado blue spruce (3 replicates)

Voluntown Site

1. No fertilizer
2. 1 Tbsp CRF, no fungicide
3. 2 Tbsp CRF, no fungicide

Species planted (50 single-tree replicates)

1. Fraser fir (16 inches tall at time of planting)

Results

Broad Brook site

Application of pyraclostrobin fungicide with the root dip at the time of planting did not affect the growth or color of the balsam firs, but did slightly reduce the number of whorl buds, from 4.3 to 3.9 buds ($p = 0.04$). The strain of balsam fir strongly influenced the number of whorl buds with the standard balsam having more buds than the bracted balsam (4.6 vs. 3.5 buds), more terminal growth (13.1 vs. 10.2 cm), but yellower color (ratings of 3.4 vs. 3.7).

Fertilizer type influenced growth. Trees receiving ESN did not differ statistically from the trees that did not receive fertilizer. The growth response of the firs was optimized with the 13.6 g (1 Tbsp.) quantity of CRF having the greatest terminal growth (10.5, 13.3, and 11.3 cm growth for 0, 1, and 2 Tbsp. fertilizer, respectively; $p = 0.02$). The color ratings of these trees was 3.31, 3.66, and 3.78, respectively. Growth in 2020 was maximized with the 1 Tbsp of CRF per tree. Averaged across both types of balsam firs, the terminal growth was 17.1, 19.7, 17.6, and 17.6 cm for the 0, 1, and 2 Tbsp of CRF and the 1 tsp of ESN treatments, respectively.

Meyer spruce did not have consistent enough responses to find significant differences among treatments.

Brooklyn Site

Canaan fir showed no benefit in color, length of new growth, or number of buds from the incorporation of fertilizer at the time of planting.

The remaining three species showed similar responses, with significant fertilizer dose effects on color, and with non-statistically significant trends related to fertilizer dose effect on new growth.

Fraser fir showed fertilizer response optimized with the 1 Tbsp quantity, for color, new growth, and the number of whorl buds. The values for color ratings: 2.9, 3.5, and 3.7($p = 0.01$); for new growth: 9.4, 12.6, and 11.0 cm; for buds: 4.06, 4.20, and 3.96 for 0, 1 and 2 Tbsp of fertilizer.

Douglas-fir had a highly significant effect of fertilizer dose on color ($p < 0.0001$) and color ratings of 3.0, 3.9, and 4.0 as quantity of fertilizer increased. New growth also increased with fertilization (11.7, 12.2, and 12.9), but there was too much variability for this variation to be deemed statistically significant.

Colorado blue spruce had a highly significant effect of fertilizer dose on color (ratings of 3.6, 3.9, and 3.9; $p < 0.01$), and insignificant effects on new growth (11.4, 12.5, and 13.4 cm new terminal growth) for 0, 1 and 2 Tbsp of fertilizer, respectively.

Voluntown Site

Initial height among treatment groups did not differ at the time of planting. Growth (mean ± s.e.) during 2019 was 7.3 ± 0.4, 9.5 ± 0.5, and 10.0 ± 0.4 cm for the 0, 1, and 2 Tbsp. applications of CRF, respectively ($p < 0.001$). The number of buds did not differ among treatments. Color differed among treatments, with ratings of 3.00 ± 0.11, 3.68 ± 0.08, and 3.88 ± 0.05, respectively ($p < 0.001$). There was no evidence of increased transplant mortality or bud abortion related to fertilizer application rate. Growth in the 2020 field season increased with fertilizer application the previous year, with terminal growth of 13.9, 16.3, and 17.9 cm for the 0, 1, and 2 Tbsp, respectively ($p < 0.02$).

Discussion

The application of 1 Tbsp of controlled release complete nursery fertilizer appeared to benefit the initial establishment and growth of bare-root transplanted Christmas trees of all species and at all sites, based upon the overall improvement of color and a modest increase in terminal growth. At the Voluntown and Brooklyn sites, failure of preemergent weed control during 2019 resulted in the 2 Tbsp dose of fertilizer having the best response, probably because weed growth and competition for fertilizer prevented salt injury to the tree roots. This is in contrast to the Broad Brook site, in which the 2 Tbsp. dose of fertilizer resulted in reduced growth relative to the 1 Tbsp. amount. Concerns about excess fertility leading to salt damage, resulting in tree mortality, and the potential for delayed onset of dormancy leading to additional bud abortion were not realized. On the other hand, dramatic gains in growth expected during the second year after planting were not realized, either. The terminal growth improvement over two years amounted to about 2 – 3 inches of increased height. Expressed as percent increase of growth relative to the unfertilized control group, the growth improvement seems more remarkable, with about 20% improved growth of balsam fir with 1 Tbsp CRF fertilizer at the Broad Brook and Voluntown sites, and 32% increased terminal growth of Fraser fir with the 2 Tbsp dose at the Voluntown site. The growth rates measured of these trees suggest that early gains in growth compound over time. Taller transplants had significantly greater terminal growth, irrespective of fertilization, and improved growth during the year of planting translated into continued greater shoot elongation the following year. Therefore, even though the gains in growth appear modest, the overall improvement in color and growth may translate into better tree growth throughout the production cycle and could reduce the time required to grow a salable tree.

Using a controlled release fertilizer with a release profile of 100 days does appear advisable, as the use of a shorter-term release source of urea did not benefit the growth of transplants. Also, including pyraclostrobin in a root dip at the time of planting, and at the concentration tested, did not help the trees. Growers should recognize that competing weed vegetation may interfere with making fertilizer available to trees. There could be risks from applying fertilizer of any kind during years in which there is drought stress, and irrigation to provide for optimum tree growth must be considered if fertilizer is incorporated at the time of planting.

Summary of Research Report for Public Release by CTPB

Christmas tree growers usually observe that transplants turn yellow during the year of planting. Mixing one tablespoon of a controlled release complete fertilizer with the soil surrounding the roots of a tree as it is planted corrects the symptoms of mineral deficiencies during the first year following planting, and provides a modest increase in growth that year. Growth in the second year was also improved. The overall economic benefit of this practice will have to be assessed based upon the time that it takes to grow the tree to harvest and the quality of the resulting trees.

Fig. 1. Mixing a complete, slow-release nursery fertilizer into the soil around the root system of bare-root transplants at the time of planting can improve their color and overall growth. The Fraser fir on the left received no fertilizer, while the one on the right did. The growth of weeds, due to failure of control with the preemergent herbicide, competed with the trees for access to the mineral nutrition provided by the fertilizer.