Investigating the Potential of Genetic Selection to Reduce Cone Formation in Fraser Fir Christmas Tree Plantations



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Early cone production of Fraser fir trees remains a major concern for Christmas tree growers in Michigan and the Great Lakes region. Individual plantation-grown Fraser fir trees can produce hundreds of cones, and growers have reported over 1,000 cones on large trees. Fir cones disintegrate in the fall, leaving unsightly stalks that reduce the salability of trees. Moreover, developing cones utilize the tree's photosynthetic energy reserves and reduce shoot and needle growth if they are not removed. Presently, growers remove cones by hand using picking crews, which has become a major cost for growers.

Over the past 15 years, researchers from MSU have investigated a range of approaches to managing cone formation in Fraser fir Christmas tree plantations. For example, research in our program found that application of plant growth regulators (PGRs), particularly GA-inhibitors such as paclobutrazol, can reduce cone formation by up to 40% (Cregg et al., 2022). In addition, spraying newly-emerging cones with herbicides containing pelargonic acid and related compounds can stop cone development and prevent cones from maturing (Cregg et al., 2018). However, each of these cultural approaches to managing cones have limitations. Application of PGRs can be expensive and stopping cones with pelargonic acid and related products is only possible in a narrow time window between cone emergence and vegetative bud break. A more sustainable and broadly applicable approach to managing cone formation is the identification of Fraser firs that are genetically predisposed to produce fewer cones or begin coning at a later age. Past experience and research from conifer seed orchards demonstrate that the production of strobili (conifer reproductive structures) varies widely among trees and is controlled by genetics as well as environmental conditions (Adams and Kunze, 1996; Burczyk and Chalupka, 1997; Crain and Cregg, 2018). Therefore, it seems reasonable that selecting and breeding trees for reduced coning is possible.



Former MSU Tree Improvement Manager Paul Bloese collects seed from the MSU Fraser fir seed orchard.

Installation of the progeny test at Korson's Tree Farm.

Where to begin?

For genetic improvement efforts involving forest trees the process often starts with identifying superior trees in native stands or plantations – a process known as phenotypic selection. However, at this point in the process, it's impossible to know if the selected trees are superior to trees around them because of genetics or simply because they may have grown in a slightly more favorable environment than their neighbors. Therefore, in order to determine the genetic value of trees, tree improvement specialists conduct progeny trials. As the name implies, progeny trials are plantations in which the identity of one parent tree or both parents are known. Most commonly, the maternal parent (the tree from which seed were collected) is known and the progeny are referred to as an open-pollinated (or half-sibling) family – that is, every tree in the family has at least half of their genes in common. In advanced tree improvement programs, seed orchard managers conduct controlled pollinations from known male parents to produce full-sibling families.

In order to determine if selecting Fraser fir for reduced coning is feasible, Pascal Nzokou and Paul Bloese from the MSU Department of Forestry identified individual Fraser fir trees with few or no cones in a 10-year-old Christmas tree plantation in the early 2010s. Nearly all of the other trees remaining in the plantation were coning heavily. Sixty-six of the non-coning trees were selected and transplanted to the MSU Horticulture Teaching and Research Center (HTRC) near Lansing, MI, to develop a seed orchard of Fraser fir. After several years of monitoring the planting, the trees eventually began to produce cones. We collected seed from a sub-sample of trees in the orchard in 2017, 2019, and 2021 (Fig. 1). The seeds were maintained as single-tree collections (i.e., open-pollinated families) and were grown as 2 + 2 bare-root stock by a cooperating nursery (Peterson's Riverview Nursery, Allegan, MI) (Fig. 2). The seed lots from the 2017 and 2019 seed collections were relatively small (a few dozen trees per family) and the progeny are currently under evaluation in a container nursery at the MSU HTRC. The 2021 cone crop, in contrast, yielded several thousand seed. Thanks to the efforts of Peterson's nursery, the 2021 seed crop produced over 3,000 trees from 14 open



Sowing seed at Peterson's Riverview Nursery. Pin flags indicate individual seed lots.



Lifting 2 + 2 families. Flagging indicates individual families.

pollenated families and more than1,500 additional trees from seed collected from the seed orchard that was bulked together in a single lot.

Keeping track of who's who

In early April 2026, a crew from Peterson's lifted the 2 + 2 stock of open-pollinated families and the bulked seed lot from the seed orchard. The crew worked carefully to maintain the identity of each lot as trees were lifted and placed into separate, labeled totes (Fig.3). The trees were transported to a packing shed at the nursery for labeling and sorting. Each tree was tagged individually with a label that included the destination farm (more on that later), the family ID number, and tree number (Fig. 4). Each tree label also included a radio frequency identification (RFID) tag that allows the tree ID information to be accessed without stooping down to read the printed tag. After tagging, trees from the individual seed lots and the bulked seed lot were assembled into replicate groups (reps) of 50 trees, along with a check lot of nursery-run trees from Peterson's nursery. Due to the differences in the availability of seed from each parent tree, the number of trees from each seed lot within a rep varied from 1 to 7.

Getting the trees to the field

In late April and May 2026, trees were distributed to three cooperating Christmas tree farms: Gwinn's Tree Farm, Horton, MI, Badger Evergreen Nursery, Allegan, MI, and Korson's Tree Farm, Sidney, MI (Figs. 5-7). At each farm, trees were planted by the farm's planting crews using their standard planting procedures. At Allegan and Sidney, the crews installed 30 reps of 50 trees (1,500 trees), and at Horton, the crew planted 25 reps of 50 trees (1,250 trees total) due to space constraints. MSU personnel have mapped each planting using the RFID tags and assessed initial height for each tree.

Next steps

We will continue to monitor the trees and assess survival and height growth annually. Once the plantations begin to produce cones, we will assess coning frequency (% of trees that produce cones) and cone density (number of cones per tree) each year until harvest. We will also work with the cooperating growers to assess tree form and overall



MSU Graduate Research Assistant Bhuwan Joshi (left) and MSU Extension Christmas Tree Educator Bill Lindberg tag and sort trees.



Close-up of tree identification at Badger Evergreen Nursery.

quality. These measurements will help us determine the heritability of coning traits and support the development of a breeding program focused on reduced coning.

In addition to the operational-scale plantations, the seed collection from the orchard has also provided genetic resources for additional studies. For example, we are currently utilizing open-pollinated families from the MSU seed orchard in greenhouse trials to assess variation among families in drought tolerance as part of the A GIFT SEED (Accelerated Genetic Improvement of Fir Through Sequencing, Economics, Extension, & Diagnostics) program sponsored by the USDA Specialty Crop Research Initiative (Fig. 8). The linkage with A GIFT SEED opens the potential for developing genetic markers that may aid in future selection of trees with reduced coning, improved drought tolerance, improved needle retention, and other key traits.

A big thank you

The installation of the progeny plantings this spring represents the culmination of literally years of effort. We are especially appreciative of the efforts of Josh and Jerry Peterson and the staff at Peterson's Riverview Nursery for growing the transplants, maintaining the family identities, and generally putting up with a lot of disruptions. We also thank Mike Gwinn, Kevin Mohrland, and Rex Korson and their crews for installing and maintaining the test plantations. Thanks to Dr. Tom Fernandez for providing the RFID tags and MSU facilities managers Mitchell Fox and Randy Klevickas for providing critical logistical support. We gratefully acknowledge support for this research from the Michigan Christmas Tree Association research fund, the Real Christmas Tree Board research fund, Michigan Department of Agriculture and Rural Development, MSU Project GREEEN, and 'A GIFT SEED' USDA SCRI award 2024-51181-432333.

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Completed progeny test installation at Gwinn's tree farm (Photo: Mike Gwinn).



Progeny from the MSU Fraser fir seed orchard are subjects for a study of drought tolerance in a greenhouse trial at the MSU Forestry Tree Research Center.