Oregon Department of Agriculture and Oregon Association of Nurseries
Nursery Research Project Proposal 2019

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TITLE: Developing sterile forms of economically important nursery crops

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BACKGROUND:
Many of the staple nursery crops on which growers and landscapers rely have garnered increasing attention due to their spread from cultivation by seed dispersal. These are often very important crops such as maples, cherrylaurels, and barberries that can make up large portions of growers' sales. Furthermore, in the case of maples, Oregon is the national leader in production. As such, these crops can impact our state's whole industry. We have been developing sterile forms of maples, althea (*Hibiscus syriacus*), and cherrylaurels with considerable progress on all three crops.

Maples. Oregon is the leading producer of shade trees for the US and maples are among the most commonly produced and planted trees across the country. However, several important maple species have been identified as invasive and some have been banned including amur maple in Connecticut and Norway maple in Connecticut and Massachusetts. Recently I was speaking with a grower who relayed that Norway maple is now considered a noxious weed in New York, as well. Other economically important maple species also produce copious amounts of seed, such as trident maple and hedge maple. These species are not yet regulated but the potential remains unless sterile forms can be identified. I propose that development of sterile forms prior to regulation by government agencies will allow producers to continue to grow and market each of these species.

To my knowledge, we have developed the largest populations of triploids of Norway and amur plants anywhere. In 2018 we field planted 47 triploid norway maples and 157 triploid amur maples. These plants initially were growing extremely well and we selected five (5) genotypes of Norway to send to a cooperating nursery. In this way, we are simultaneously evaluating nursery production while waiting for these plants to flower. I will further discuss below, but the fields all appear to be highly infested with Verticillium wilt, which has "allowed" us to breed for resistance, as we have strong disease pressure.

We have a single trident maple triploid that has not flowered yet; however, in 2018 our tetraploid trident maples flowered, and we collected seed – unfortunately, we recovered only 2 triploids. The positive aspect is the tetraploid trident maples appear to be resistant to Verticillium and continue growing well and I expect to recover more triploids from the 2019 flowering. We also developed tetraploid hedge maples that will be fall planted 2020. This brings us to 4 species of maples for which we are making solid progress on developing sterile triploids: *Acer buergerianum*, *A. campestre*, *A. ginnala*, and *A. platanoides*.

2018 marked a transition in our process for developing sterile forms of Norway and Amur maples. To date, we have collected seed from tetraploids, screened to identify triploids, and then have grown them. This is a highly expensive and time-consuming process to analyze hundreds of seedlings but it was necessary to generate the scientific findings for publication and to confirm our system. With two years of data we attempted to change our model for these two species. During 2018 we direct seeded into field beds and allowed natural stratification and field germination. The plan was that we will then dig and space trees that look like they are promising, observe these for several years, again select trees, and only after we have identified trees with merit will we screen them for ploidy level. Unfortunately, this was unsuccessful, and we have returned to cold stratification and greenhouse production of liners to field plant.

Two other important events occurred during 2018-19: the increased prevalence of Verticillium wilt in our triploid fields and the flowering of triploid Amur maples. The virtual explosion of Verticillium has been a revelation. We have no choice but to breed for resistance and fortunately, we have surviving trees. Our current method of "inoculation" and screening is simply to plant trees and observe mortality or survival. Good news: we have surviving trees (Fig. 1). Further enouraging news is that there were 21 triploids that flowered and none of them set seed (Fig. 2). These trees are interplanted with many fertile diploids including 'Flame' and many seedlings from our program.

Fig. 1. Triploid Amur maple that flowered during 2019, produced no viable seed, and is showing verticillium resistance (left) and a triploid that flowered this year but was susceptible to verticillium (right).

Fig. 2. 21 triploid Amur maples flowered in 2019 and set no viable seed. This is not the end of testing – but points toward sterility.

Producing sterile maples on their own roots will be critical for reintroduction into areas where species are now banned. This is because a fertile seedling roostock presents a danger to escape cultivation, should the graft fail (or scion dies, rootstock outgrowth, etc.). As such, we have been attempting to optimize cutting propagation of superior genotypes of Norway maple (Fig. 3). Early tests are encouraging but we have much work to do to make it "production ready" and fit within current schedules.

Fig. 3. Example of a superior genotype of Norway maple triploid showing verticillium resistance (left). It was one of 5 selections that have been propagated using chip budding. On the right is a rooted cutting on September 3, 2019, 2-weeks from sticking. Wounding, stock plant handling, IBA type and application, timing, and cutting environment are all factors being tested to optimize cutting propagation so disease resistant and sterile cultivars may be grown on their own roots.

Our goals for maples are 1) to continue developing more triploids from which superior clones may be selected that exhibit various trait combinations such as leaf colors (new growth, growing season, fall color), growth forms (fastigiate, standard, columnar, etc.), and Verticillium resistance; 2) continue testing fertility of our triploids; 3) continue optimizing cutting propagation (and explore micropropagation), especially for Norway maple. I will expand our grower trials with superior clones that exhibit acceptably reduced fertility.

Cherrylaurels. Groups such as the Native Plant Society of Oregon are giving more attention to common cherrylaurel as an invasive species and currently consider it a medium-high impact species. Portuguese laurel shares many of the same outstanding characters as common cherrylaurel such as tolerance to sun and shade and pH adaptability but is more tolerant to heat and drought stress and is not susceptible to leaf shothole disease. Fruit development is also prolific in this species and it has started to receive similar attention as common cherrylaurel regarding invasive potential. **Our goals are to 1) develop sterile forms of common cherrylaurel that exhibit the typical phenotype that consumers are used to and 2) develop sterile hybrids of common cherrylaurel x Portugese cherrylaurel that exhibit shothole disease resistance that are also sterile.** We have developed polyploids of both species and we had a single inflorescence from a Portuguese polyploid (16x) in 2019. Assuming this plant produces adequate flowering in 2020, we will begin crossing 'Otto Luyken' and 'Schipkaensis' with this polyploid.

Rose-of-sharon (althea). The US National Arboretum introduced four rose-of-sharon cultivars described as sterile triploids including 'Diana', 'Minerva', 'Aphrodite', and 'Helene'. These cultivars have since been observed to produce substantial amounts of seed. Our breeding program has investigated several aspects of reproductive behavior of these and other cultivars. Of particular interest was 1) what is the actual ploidy level of available cultivars, 2) what is the relative fertility of available cultivars, and 3) how are ornamental traits such as eye spot, double flowers, and flower color inherited? To a great degree, we have answered all three questions and transitioned the focus to cultivar development based on the scientific knowledge we generated.

We have identified ploidy levels and fertility of most commercially available cultivars. We also have developed many pentaploid (5x) plants – 18 of which were tested in controlled crosses during 2016. Testcrosses from 5x plants developed in 2012 and 2013 were found to have an average of 1.1 seeds per capsule compared to 18 seeds per capsule in 4x plants typically found in the industry. This is a 94% reduction in fertility. In 2015 and 2016 we developed hundreds more 5x plants. These plants all will have similar reduction in fertility and have a broad range of ornamental traits, as we developed them from a broad background. We have approximately 50 selections of 5x plants that are equal or superior to industry standards – a subset of these were propagated by stem cuttings. During 2018 we made extensive observations of these plants under production conditions and discarded plants that showed seed set. Due to the rapid time to flower, thus ability to test fertility, propagation, and all aspects of performance, time to release should be short. In 2019, we reduced the number of selections and became aggressive in selection. We currently have approximately 20 accessions that are seedless and exhibit a variety of flower types, growth forms, and generally are less chlorotic than industry standards. Even though there are outstanding breeding programs working on althea (e.g. Van Huylenbroek et al. in Belgium) I am not aware of any other programs generating sterile 5x plants. We also have been working at higher ploidy levels (6x, 7x, 8x) to investigate whether these plants have production merit to complement their reduced fertility. In 2019, we made several hundred crosses of 4x x 8x plants to generate more diversity at the 6x level – currently we are limited to 'Azurri Satin' and 'Pink Giant'. Release of these plants should represent a competitive advantage for Oregon growers.

Budget Summary

Salary	
Tyler Hoskins (3 months)	$12,136
Other payroll expenses	$7,889
Undergraduate students	$5,000
Other payroll expenses	$600
Services and Supplies	
Growing supplies, lab kits, etc.	$3,500
Total	**$29,125**