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Breeding for Non-Invasive Nursery Crops: Status of Cultivars and Regulation

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Summary

Breeding for noninvasive plants is discussed. The author proposes that the nursery industry should not wait for the attention generated by invasive plants to turn to regulation, but to be proactive and take ownership of the issue. The goal of regulation on this issue should be to prevent the further spread of invasive species but to allow production and sale of plants that have been proven to present little or no ecological risk. Methods for reducing fertility, testing for fertility, and current regulations and the future are discussed.

INTRODUCTION

Most of us would say that good landscape plants are resilient to biotic and abiotic stresses, thrive over a broad range of environments and soils. They are vigorous – certainly producers want plants that finish quickly. We want them to be beautiful with copious flowers and fruit to beautify our landscapes and attract wildlife into the garden. As it turns out, these traits that make great landscape plants are shared by plants

that have escaped cultivation and become notorious spreaders and, in some cases, invasive weeds. I shall not debate at what point a plant should be called various names due to degrees of problems – free seeding, nuisance, weedy, naturalized, invasive. Regardless of definitions, there is no dispute that there is much attention on the plants in nursery industry regarding their spread from seed. I propose that we should not wait for the attention to turn to regulation, but to be proactive and take ownership of the issue.

Regulation and the industry's role

I believe the goal of regulation on this issue should be to prevent the further spread of invasive species but to allow production and sale of plants that have been proven to present little or no ecological risk. The proving is critical to this point, and I will address below. Decisions should be based on data that are regionally appropriate, but we need to apply a framework nationally. We are a national and international industry in which plants bred and produced in Oregon are shipped worldwide. The data I generate in Corvallis should not be taken as the final word on how plants may perform in disparate climates and should be tested in regions that differ in important ways such as increased precipitation, longer growing seasons, etc.

It is fortunate that in my experience most state nursery groups have positive relationships with their respective departments of agriculture and we certainly want to maintain those. In addition to the open dialogue with regulators, we should take other steps including to:

1) Not waiting for regulation but addressing the issue within your organization – make it an agenda item to discuss among your nursery and landscape associations
2) Stop growing plants that we all know are highly invasive
3) Support development of and adopt seedless cultivars
4) Educate consumers and the gardening public about the steps our industry has taken on the issue.

We are THE Green Industry, and we should be out in front of folks telling them the actions we are taking to be stewards of the land.

In some circles the discussion surrounding the use of non-native vs. native can get contentious. Individuals on both sides often have strong opinions that are valid and can be backed by science. However, I encourage us all to remember that we all share the same goals when we set out into the garden or urban landscape – that is to install plants that thrive in the environment where they are sited to achieve the ecosystem services that plants render. If you are using the examples of 'Bradford' pear or purple loosestrife as examples of "sterile" plants that became invasive, you are using erroneous and inaccurate examples. The fact is these plants were never sterile, they were self-incompatible and are extremely different from the examples I will provide below that have been developed through modern breeding practices and evaluated to confirm their reduced seed/seedling production.

Methods for reducing fertility

Common methods of reducing fertility in landscape plants includes ploidy manipulation (changing the number of sets of chromosomes), wide hybridization, mutation (gamma radiation, X-rays, chemicals), and

biotechnology (transformation, gene editing, targeted mutation). Common examples of triploids include food crops such as seedless watermelon and bananas. Ploidy manipulation has also been applied in landscape plants such as flowering pear (Phillips et al., 2016; *Pyrus* × *triploida* 'NCPX2' PP 30788 Chastity™), maples (Contreras and Hoskins, 2020), spirea (*Spiraea* 'NCSX1' PP 28313 Candy Corn ™), *Hypericum androsaemum* (Trueblood et al., 2010), trumpetvine (Oates et al., 2014), barberry (Brand and Durocher, 2022), althea (Lattier and Contreras, 2022), among others.

Mutation breeding involves exposing plants or plant parts with meristems to physical mutagens such as gamma radiation or chemical mutagens such as ethyl methanesulfonate. There is a long history of using mutation breeding in a wide variety of ornamental crops (reviewed Melsen et al., 2021) and recently we showed efficacy of gamma radiation to reduce seed set of *Galtonia candicans* (Contreras and Shearer, 2020).

Testing for fertility

Regardless of the method of reducing seed production, it is important to properly evaluate plants in an appropriate region(s) and using appropriate methods. We have shown that interspecific hybrids of *Buddleja* are not necessarily less fertile than cultivars of *B. davidii* (data not shown) and Phillips et al. (2016) demonstrated that triploid pears ranged from 0.74% to 13.6% fertility compared to fertile diploids. Thus, the breeders' job is not done when generating a mutant, a hybrid, or a triploid – proper testing is crucial.

To address the issue of testing and introducing seedless or nearly seedless cultivars of weedy/invasive species, we are assembling a working group of individuals from Oregon, North Carolina, Florida, Michigan, and perhaps additional states/regions to prepare a white paper to coordinate and lead on a consistent set of guidelines for testing. The impetus for this is the number of new cultivars that are being introduced that exhibit reduced fertility but there is no coordinated set of rules for evaluating them. This leads to situations in which a plant may be banned in one state but allowed in the neighboring state. While we are not calling for national regulation of species through top-down legislation, we do want a national discussion and framework for breeders and growers to have a common set of standards for evaluation. Interstate commerce is a hallmark of our industry, and we need to have a common understanding of targets, if not common regulation for specific species.

Here is not the place to establish guidelines but there are some general rules that should be followed for testing. First, it is important to document flowering. That may seem obvious but, in some cases, plants can be very slow to flower in a particular region and may give the false impression of sterility. For instance, we have generated many triploid Norway maples over the past 10 years that have yet to flower. These cannot be said to be sterile on the basis that they have not flowered. Plants should be tested in the region where the end user will be growing them. Amur maples from my program have been shown to set no viable seed in Corvallis, OR but considering they will (we hope) be planted in landscapes of the upper Midwest and New England, it is important that we document their reduced fertility in those regions. Plants

should be tested under appropriate conditions. I have observed that when irrigated, butterfly bush cultivars may continue flowering and setting seed until frost – often toward the end of October. However, during 2022 we withheld irrigation and plants were nearly done flowering by the first week of September. This change in phenology will have an obvious impact on seed production. Cultivars being tested should be replicated. This means to ascertain reliable information that there needs to be multiple plants of the cultivar being tested, ideally separated into repeated blocks. In cases where plants are insect pollinated, there should be presence of pollinators documented. For all plants, regardless of sex expression (perfect flowers, monoecy, dioecy, etc.), there should be fertile pollinizers of different genotypes present to prevent incompatibility leading to artificially reduced fertility.

Current regulations and the future

There are a number of states that are now working with the industry to adopt amendments that exempt specific cultivars where species previously were banned. In Oregon, OAR 603-52-1200 banned *Buddleja davidii*. This was enacted in 2004, and later in 2009 it was amended to allow for cultivars that exhibit 98% reduction in fertility or were confirmed to be hybrids. The amendment has allowed for the introduction of 14 cultivars to be grown and sold in Oregon. As previously stated, we have found that some hybrids exhibit substantial fertility on par with traditional cultivars. In Ohio there is approval to grow seedless flowering pear with the stipulation that it cannot be grafted onto seedling *P. calleryana*. Based on this common-sense regulation, I expect similar rules may be put in place for budded maples such as Norway maple. There are four barberry (*Berberis thunbergii*) cultivars approved in New York along with two *Miscanthus sinensis* and two *Euonymus fortunei* cultivars. I found an online document for request to exempt a specific cultivar from CMR 01-001 Chapter 273 regulation – while I do not have specifics on their threshold, it provides another example for which state regulators are open to exemptions in whole species bans.

The stakes for such amendments and exemptions are high. It seems to me that if these conditional approvals are done well that we can benefit all parties involved; plants will remain in cultivation where planted and not impact native ecosystems, growers will benefit from economically important taxa, and end users will benefit by resilient and beautiful plants. On the other hand, if it is found that amendments are failing to control new invasions or are found to continue exacerbating the situation, I fear these will be held up as data that cultivar approvals for these species are ineffective and this could endanger future opportunities to introduce cultivars that truly seedless (or nearly so). I believe we need an approach in which the industry is willing to give up cultivars that are weedy, departments of agriculture and other regulators should continue their collaborative approach, and we need to keep generating sound data to help guide regulation and outreach. If we can achieve a set of rules that are stringent enough to prevent future escape but allows cultivars that present no ecological threat then we can have profitable production, resilient landscape plants, while protecting our native ecosystems.

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