GROWING KNOWLEDGE

Series content is coordinated by Dr. Jay Pscheidt, professor of botany and plant pathology at Oregon State University in Corvallis, Oregon.

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Figure 1: Various tree varaieties were removed from cold storage and planted at the North Willamette Research and Extension Center for research. PHOTO COURTESTY OF OREGON STATE UNIVERSITY

The cold shoulder season

Nursery growers effectively use cold storage to support sales of deciduous trees

BY REBECCA SHERIDAN AND LLOYD NACKLEY

PLANTS IN THE PACIFIC NORTHWEST experience a wide range of temperatures, from hot, dry summers to cold, wet winters. Deciduous plants grow when conditions are favorable. They enter dormancy when environmental conditions are too cold, dark, or otherwise unsuitable for growth.

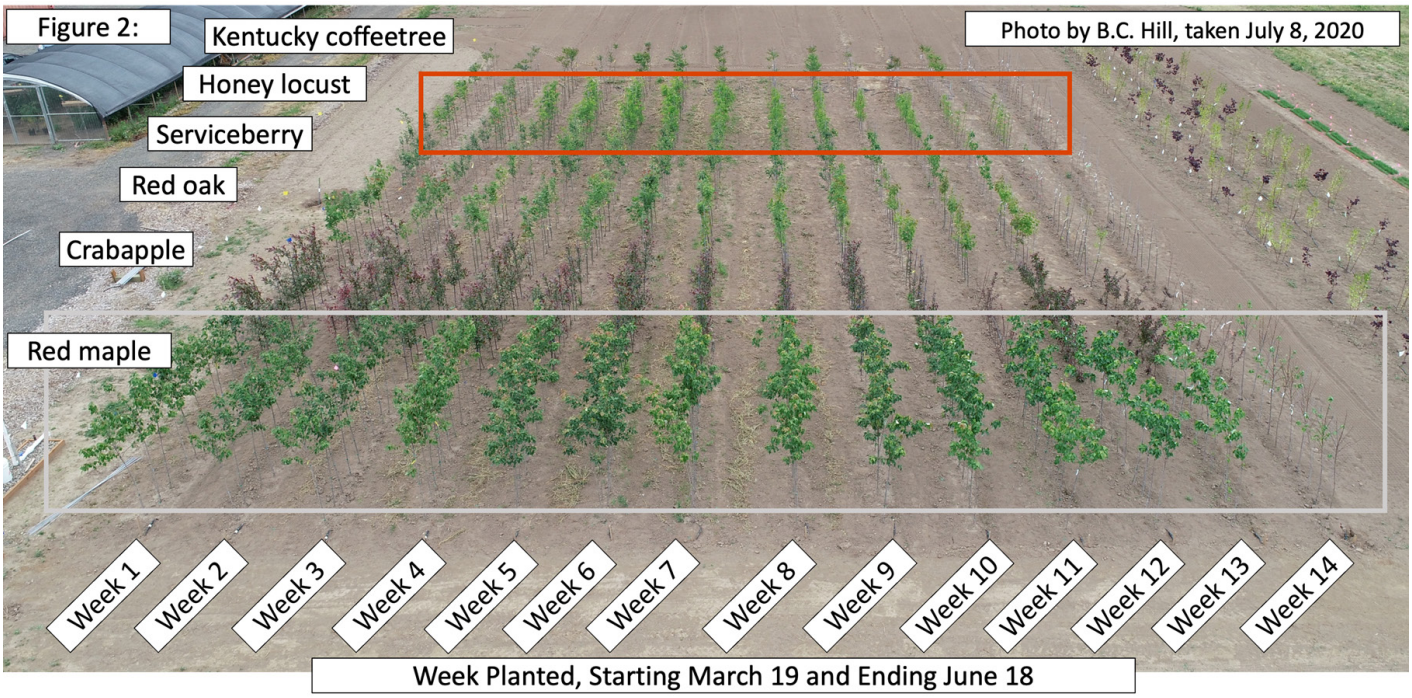
Deciduous trees, such as maples, crabapples, birches, elms, many oaks and others are some of the most valuable and most common types of trees grown in Oregon.

The Oregon nursery industry takes advantage of plant dormancy periods to dig, store, and ship trees. However, uprooting and moving a tree hundreds of miles from where it was growing the previous season is very unnatural.

For this reason, nursery growers have to care for the dormant trees in ways that will allow for the dormant trees to regrow where they are planted. The timing of storage and shipping can have a big impact on the viability of dormant trees.

Putting trees into cold storage

Large cold storage facilities give nursery growers some flexibility to ship trees only when the conditions on the con-



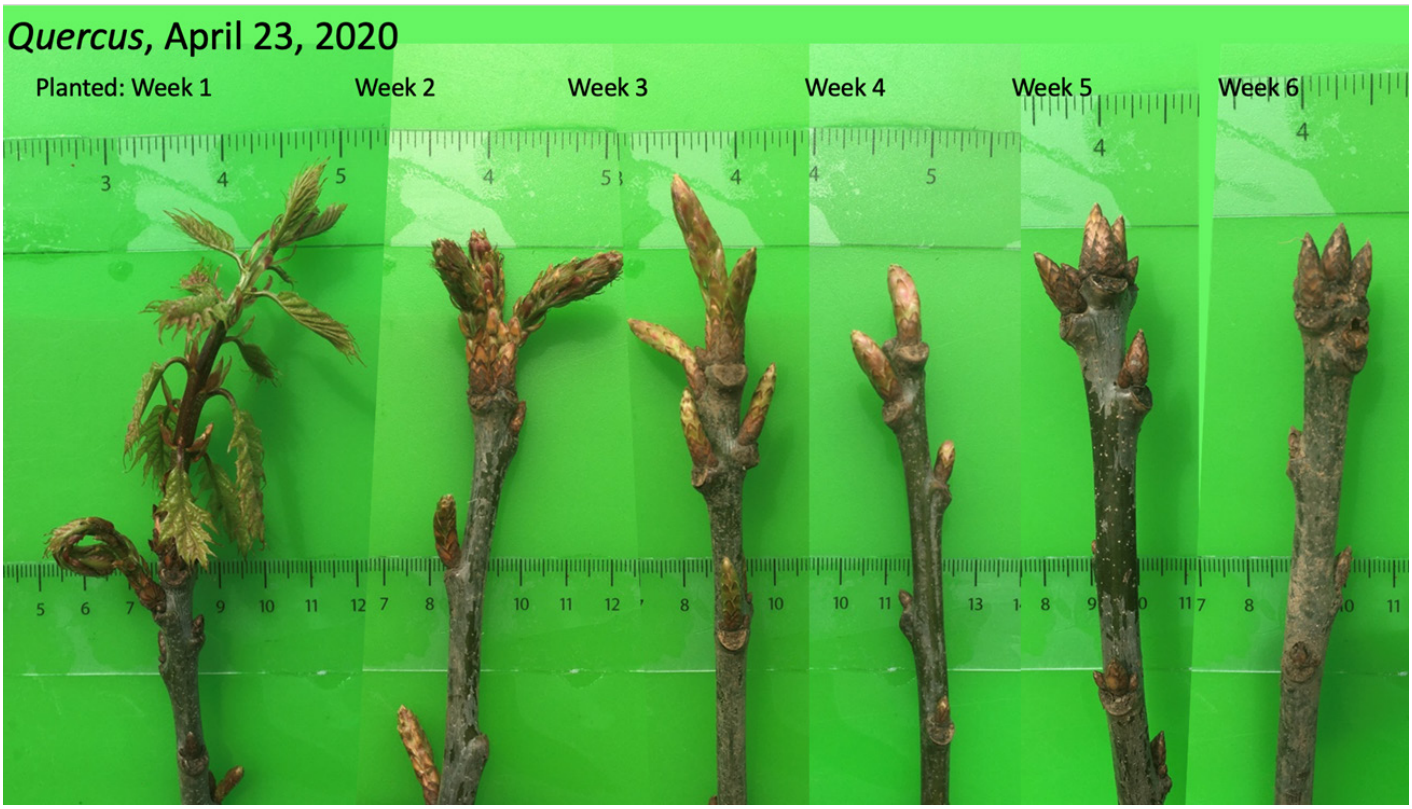
sumer's end are suitable for planting. For example, trees destined for the Midwest can be held until the region's colder, longer winter is over.

However, even dormant trees have limits to the length of time they can be kept in cold storage. We must understand the limits to cold storage so that growers can ensure they are shipping healthy, high-quality trees to their customers.

Drying or desiccation is one change that can occur in plant tissues over time in storage. Drying can cause water stress to the plant so severe, it can limit growth after planting or even kill the trees.

There are two ways to track water relations in plant tissues.

The first way, **water content,** describes the amount of water in the plant relative to the dry plant tissue. Water content can be measured on any plant tissue,



including stems or roots.

A second way to quantify plant water relations is the plant's **water status**, which describes the energy gradient to move water through a plant. The xylem, the water vessels in a plant's stem, are like a series of tiny, pressurized pipes. If the plant gets too dry, the pressure change on the xylem can create cracks that will prevent water movement, which hinders plant function and growth.

By measuring both water content and water status, we can learn if the plants were losing bulk water, or if they were crossing thresholds in terms of water potential that would have long-term negative impacts. With this in mind, we wanted to know if tree stems and roots are drying out during the spring shipping window, so we can better understand the limits to cold storage.

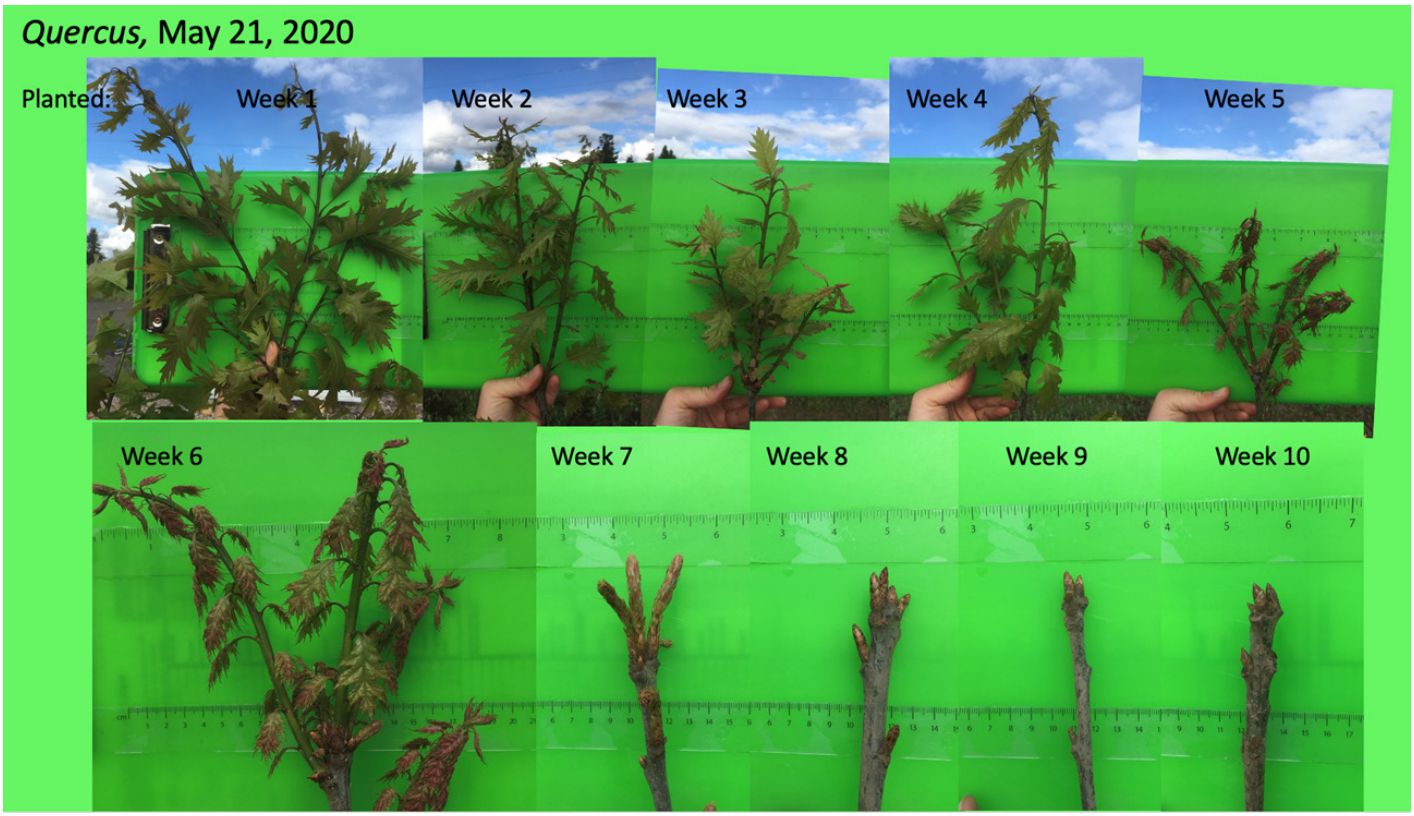
Our study

We focused on the storage period from March through June, because this is the most likely period for when trees will be taken out of storage for planting. We established a collaborative project supported by **J. Frank Schmidt & Sons Co.** production team, including production horticulturist Sam Doane, farm manager Richard Lang, inventory supervisor Claudia Gomez, and the excellent crew at the storage facility in Barlow, Oregon.

Additional trees were donated or purchased from Bailey Nurseries, **Hans Nelson and Sons Nursery Inc.**, and **Willamette Nurseries Inc.** Beginning March 19, 2020, we removed trees from cold storage every week. In storage, the temperature was kept above freezing and the roots were loosely covered with a shredded, light-weight mulch. We studied six varieties:

- Red Sunset® maple (*Acer rubrum* 'Franksred')
- Prairie fire crabapple (*Malus* 'Prairifire')
- Red oak (*Quercus rubra*)
- Autumn Brilliance® serviceberry (*Amelanchier* × *grandiflora*)
- Skyline® honeylocust (*Gleditsia triacanthos* 'Skycole')
- Kentucky coffee tree (*Gymnocladus dioicus*)

Each week, we measured stem water content, root water content, and stem water potential on seven trees. At the same time points, we planted 10 trees of each variety at **North Willamette Research and Extension Center** (Aurora, Oregon). We measured height three times: at planting (March–June), in late August, and in December,



after the trees had dropped their leaves. We also tracked the trees for mortality.

We assumed that there would be a "must-plant-by-date" after which the trees would not re-grow. Contrary to our expectations, we did not see a drying trend in any of the varieties we tested over the 14 weeks we collected data. This was the case for both the stem water content and the root water content.

We also did not see any directional changes in the stem water potential, even as the trees sat for longer and longer in cold storage. This indicates that the cold storage environment we tested was not desiccating the trees. We saw high establishment rates for these varieties. At all 14 weeks of planting in this project, the trees broke bud and initiated growth. There was occasional mortality among the planted trees, but it did not appear to be related to the water status of the trees at planting or the timing of planting.

When spring and early summer 2020 are remembered in the North Willamette Valley, we most likely think back to the early days of the COVID-19 pandemic and the racial justice protests in Portland. Few might remember the weather, except perhaps those of us whose business and livelihoods are connected to the seasons. Farmers may recall that it felt like winter was never here yet summer would never come.

Compared to weather data collected from the years 1895–2020, spring 2020 (April–June) was warm above historical averages and June was above average for wet. These are conditions that favor deciduous trees, and most plants for that matter. This meant that this was an above-average year to plant late. It wasn't great for the experiment, but was great for the trees kept long in storage. We did not observe any changes within our experimental set-up.

We had one chance accident that allowed us to confirm that our methods were sound. We removed the *Amelanchier* from the storage facility four weeks before the end of the project. We kept the remaining samples covered by a tarp in a shed, without any temperature or humidity control. Over the last four weeks, both the stem water content and the stem water declined in the *Amelanchier* samples. This anecdote suggests that trees are vulnerable to drying if the storage conditions are less than ideal.

Our research continues to pursue an understanding of the impacts of cold storage on tree performance. Our field observations captured an interaction between time in storage and planting date that has an effect on tree phenology and growth after planting. There was a sequential effect of bud break and flowering based on the time of planting. Although the differences in bud break from early-planted trees did not affect the height growth in the first year we expect the reduced growth time will become more evident in year two.

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