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Douglas fir bark (DFB), pumice, and Canadian sphagnum peat moss are the primary soilless substrate components used in the Pacific Northwest for woody ornamental containerized crop production, however little is known about their effect on substrate physical properties. Growing a fast, quality crop in a container requires soilless substrate to have the correct balance of air and water to maximize crop growth. The objective of this study was to investigate the physical and hydrological properties of three substrate components and their mixtures. The experiment was a 3 × 3 factorial with three rates of peat and pumice (0%, 15%, and 30%) mixed with DFB, creating nine different soilless substrates. Air spaces (AS), total porosity (TP), container capacity (CC), and bulk density ( $D_b$ ), were determined using porometers. A pressure plate extractor was used to partition CC into available (AW) and unavailable water (UAW, e1.5 MPa). Moisture characteristic curves (MCC) were generated by measuring water along a continuous 120 cm column. These MCC were used to calculate easily available water (EAW) and water buffering capacity (WBC). The results indicate that, adding pumice to fir bark decreased or maintained equal CC, TP, AW, and WBC, but increased ( $D_b$ ). Adding peat to bark increased CC, TP and AW, but decreased AS and ( $D_b$ ). The moisture characteristic curves for the soilless substrates with higher percentage of peat moss resulted in increased container capacity with the largest proportion being EAW. The addition of pumice to bark resulted in similar CC as bark alone, however a greater proportion of water was easily available. These results will assist nursery growers in the Pacific Northwest to better understand the physical properties of different substrate components and their mixtures, and aid in their decision of which components should be used to create desired root environment for specific taxa and production management regimes.

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11:00–11:15 am

### Realizing Progressively Unavailable Water Content in Horticultural Substrates

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Horticultural substrates or soilless substrates are often erroneously named “potting soils,” yet have very little in common with true soils, both physically and chemically. Soilless substrates exhibit special and important physical characteristics that allow plants to exist in potentially stressful environmental conditions, such as plastic containers. The components of soilless substrates are typically organic in nature, but can also include processed inorganic and synthetic materials. Substrate mixtures are typically created from two or more components, and each substrate combination has different physical characteristics that play a role in determining porosity and water-holding capacity. However other factors, such as container geometry and age, play a significant role in determining these physical attributes. Water availability in soilless substrates is quite different than in soils, and becomes progressively unavailable at very low matric potentials, typically two magnitudes lower. We have performed water availability analyses on several substrates and substrate components using moisture sensors (Decagon Devices, Pullman, WA) and a customized desorption table.

Our results show that water availability was surprisingly low in some of these substrates and that most water is only available at matric potentials greater than 10 kPa, the point at which some studies have shown water stress in greenhouse crops. We have demonstrated that we can accurately monitor water availability in soilless substrates at these low matric potentials and schedule irrigations between 1 and 10 kPa.

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11:15–11:30 am

### Horticultural Evaluation of the Lesser-known Leatherwoods

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Although none of the three species of *Dirca* L. (leatherwood) is common in horticultural landscapes, two of the species are particularly obscure. *Dirca occidentalis* A. Gray is endemic in patchy populations near the San Francisco Bay, and *Dirca mexicana* Nesom & Mayfield is known to occur in only one population in the Sierra Madre Oriental of northeastern Mexico. We observed these species in their natural habitats, propagated them from seeds, and conducted experiments with seedlings in greenhouses and outdoors to determine their responses to production practices and their tolerances to environmental conditions. Monitoring over two years showed air temperature where *D. mexicana* is indigenous ranged from -2 °C to 35.5 °C, with weekly means of 7.4 °C to 18.1 °C. Despite *D. mexicana* being restricted in the wild to such a mild climate, both it and *D. occidentalis*, which occurs in USDA plant hardiness zone 9, have survived winters where we planted them in trials near the interface of USDA zones 4 and 5. Seeds of both species germinated readily after cold stratification. The resulting seedlings were established in treatments of 12 media, one of which promoted growth and health ratings more than the others, and seedlings of *D. occidentalis* showed a linear increase in health rating as the percentage of nitrogen supplied as nitrate vs. ammonium increased. Seedlings of *D. occidentalis*, the leatherwood species that our observations indicate is the showiest when in bloom, began to flower when they were as young as five years old. We conclude that *D. occidentalis* and *D. mexicana* are highly sensitive to horticultural production practices and to their placement in the landscape. Nonetheless, both species appear adapted for use beyond the limited areas in which they are native.

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11:30–11:45 am

### Growth and Physiology of Fraser Fir and Colorado Blue Spruce in Response to Mulch

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Weed control is a major concern for Christmas tree growers and