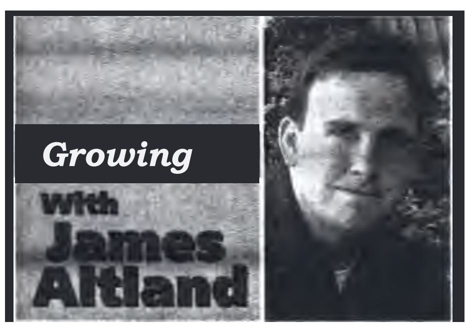
It's in the H20

High-quality irrigation water makes the Willamette Valley a great place to grow nursery stock

Researchers at Oregon State University are working to make fertilizer applications for containerized nursery crops more efficient and precise. Considering the broad spectrum of crops grown by Oregon nurseries, it would be impossible to prescribe a single set of fertilizer requirements for all container crops. Instead, we will first consider the sources of plant-available nutrients. A previous *Digger* article (June 2006) addressed the chemical properties of Douglas fir bark. This article will address water quality in the Willamette Valley, potential problems from water and which nutrients might he supplied in sufficient quantity from your irrigation source. Once nutrients from substrates and irrigation water are accounted for, nursery growers can more precisely apply fertilizers to match nutritional needs of their crops.

Plots similar to this were placed at 22 nurseries throughout Oregon to document the impact of water quality on crop growth.



Surveying the valley

We conducted a survey of water quality in the Willamette Valley in an effort to determine the effects of water on nursery crop growth. We identified 22 nurseries with varying degrees of water quality. Some claimed to have had water, while others thought that their water quality was excellent. While each nursery irrigated their crops with a combination of well water and runoff water captured in ponds, the original source of all water in this study was groundwater from a well (none of the water was from streams or rivers).

After collecting plant liners from several nurseries, we brought them to our research station, potted them in our own containers and substrate, and applied our own fertilizers. In March 2005, we then placed 12 containers of eight different species at each of the 22 nurseries. The plot at each nursery looked similar to the top photo on Page 36. We analyzed plant growth, substrate and foliar nutrient status and water quality in May, July and September.

A disappointing result of this experiment from a research perspective was that water quality at each of the participating nurseries was good to very good. Ideally, there would have been nurseries with a range of bad to good water, so that we could have observed the influence of each water type on crop growth. Surely, there are nurseries in the Willamette Valley with poor water quality. I've seen water analyses from several landowners with water that will not support plant growth. Despite this glitch in our experiment, we did learn a great deal about the quality and consistency of irrigation water in Oregon. The remainder of this article will discuss how some characteristics of water quality might influence your fertility decisions.

Water quality over time

Many nursery producers with whom I spoke commented on how their water changes throughout the summer. It is thought that during spring, when groundwater levels are high from spring rains and melting snow, water quality is good. As our dry summers progress and groundwater levels slowly decline, of bicarbonates, sodium and other dissolved salts increase and result in declining water quality. Our data does not support this claim. Irrigation pH, alkalinity and bicarbonates did not increase over time. In fact, these three parameters dropped between the July and September sampling dates. Sodium levels did increase at some nurseries, but levels were constant at most nurseries and even declined in a few locations.

Most Oregon nurseries obtain groundwater from the Central Willamette Basin; some obtain water from the Tualatin or Portland basins. These aquifers are subject to seasonal changes in water storage: winter precipitation charges the basins, and summer irrigation and natural flow drain the basins. Despite these cyclic changes, water quality parameters in our study were not measurably affected. This indicates that a yearly water quality analysis is sufficient to make decisions at your nursery.

Irrigation pH

Most of the water samples we collected had pH greater than 7. We generally perceive slightly acidic pH values (5.5 to 6.5) as being ideal for production of nursery crops in containers, and pH greater than 7 as being the cause of nutritional problems. Generally, this is a reasonable assumption for *substrate* pH. However, irrigation water pH must be interpreted differently than substrate pH. As a grower, you should be aware of substrate pH, which has a direct effect on nutrient availability and the overall growth of your crops. Contrary to this, irrigation pH has little bearing on the chemistry of your substrate or growth of your crops. Irrigation pH does not affect substrate pH. Irrigation water pH, high or low, should not be considered when making decisions about water filtration or other forms of water modification.

Table 1.
Irrigation water quality typical of the northern Willamette Valley.

	Units	Range found in Oregon nurseries[z]	
pH		6.9	7.5
Alkalinity	ppm	56.1	113.9
Hardness	ppm	58.7	132.3
Total dissolved solids	ppm	100.3	226.4
Electrical conductivity (EC)	dS/m	0.2	0.4
Sodium	ppm	7.2	22.7
Sodium absorption ratio (SAR)	–	0.4	0.8
Chloride	ppm	3.7	18.2
Potassium	ppm	1.4	4.8
Calcium	ppm	12.3	32.5
Magnesium	ppm	4.9	10.8
Sulfate	ppm	2.0	16.0
Iron	ppm	0.40	0.76
Manganese	ppm	0.00	0.05
Boron	ppm	0.00	0.07
Copper	ppm	0.00	0.00
Zinc	ppm	0.00	0.08

[z] Range was calculated as the 25th and 75th percentiles of data collected.

Irrigation water alkalinity will affect substrate pH. Alkalinity is a measure of the acid-neutralizing ability of water and is usually measured as the concentration of carbonates and bicarbonates. Carbonate levels in the water we measured were low, while bicarbonate levels were relatively high but well within good water quality standards. Bicarbonates react with hydrogen ions (H^+) to form carbon dioxide and water. Carbon dioxide is a gas and dissipates into the atmosphere. Net reduction in H^+ concentration causes an increase in substrate pH (see *Digger,* October 2002). Almost all water sources in the Willamette Valley have some level of alkalinity; consequently, substrate pH of most container substrates will gradually rise over time. The higher the alkalinity level in irrigation water, the faster substrate pH will rise over time.

Electrical conductivity (EC) is a measure of the dissolved salts in irrigation water. Some labs report total dissolved salts (TDS). The two units are interchangeable where one can be calculated from the other with the following formula: TDS (ppm) = 640 x EC (dS/m). Water pumped from streams filled with melting snow water can be very pure. But most irrigation water in Willamette Valley nurseries is pumped from groundwater and contains moderate levels of dissolved salts.

Any salt dissolved in water will increase EC readings. Many salt types in irrigation water are beneficial to plant growth, including calcium, magnesium, iron and others. Some salt types can be detrimental to plant growth, most notably sodium. Regardless of the type of salt dissolved in irrigation water, if total salt levels are too high they can have an adverse effect on a plant's ability to absorb water (see *Digger,* February 2004). High-quality irrigation water should have EC levels below 0.75 dS/m (480 ppm TDS). All water samples evaluated in our study were below 0.75 dS/m throughout the summer.

Sodium

Sodium can be a serious problem in some regions of the Willamette Valley (see *Digger,* February 2004). It was not recorded in high levels in our experiment. Sodium should be below 70 ppm for most crops, especially sensitive crops such as azaleas and rhododendrons. High sodium becomes increasingly problematic if calcium or magnesium levels are low in irrigation water or the substrate. Sodium absorption ratio (SAR) is a calculated value that compares the total amount of sodium in irrigation water with the total amount of calcium and magnesium. As sodium levels increase relative to calcium and magnesium, SAR also increases. SAR levels should be below 3 in high-quality irrigation water. SAR

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of irrigation sources we measured were well below 1.

Macronutrients

Nitrogen, phosphorus and potassium levels in irrigation water were low. Levels in irrigation water are far less than what is added with a controlled-release fertilizer or liquid-feed programs. Irrigation water should not be considered a significant source of nitrogen, phosphorus or potassium in a fertility program.

Secondary nutrients

Calcium levels were far below what would be considered toxic for plant growth. However, they were shown to be sufficiently high that supplemental calcium may not be necessary for many crops. Let's assume that irrigation is applied daily for six months in a growing season at a rate of 0.5 in/day. This irrigation rate would result in approximately 42 L of water passing through a No. 1 container. Water containing 30 ppm of calcium applied daily over the course of the growing season would result in the equivalent calcium of 3 lb/yd^3 limestone. This would probably be a sufficient for most nursery crops.

Similar to calcium, magnesium levels in irrigation water may be sufficient to support crop growth. Calcium and magnesium can compete for plant uptake, and thus should be applied in a ratio of 2:1 to 5:1 (calcium-magnesium). Coincidentally, dolomitic lime has a calcium-magnesium ratio of 2:1, making it an ideal lime source for container producers. Likewise, water samples we collected in Oregon had a calcium-magnesium ratio of approximately 2.5:1.

Lime applications to container crops serve two purposes (see *Digger,* March 2003). First, lime is a source of calcium and magnesium (if using dolomitic lime). Lime will also cause an increase in substrate pH. Before making lime applications, consider the alkalinity, calcium and magnesium levels of your irrigation water. Is alkalinity high enough to cause a gradual increase in substrate pH? Is there sufficient calcium and magnesium in the irrigation water and at an appropriate ratio to support crop growth? Perhaps lime is not needed. As substrate or soil pH increases, phosphorus and many micronutrients become less available. Our recent research shows that this is particularly true for Douglas fir bark. If lime is not necessary in the substrate, perhaps it does more harm than good by making many nutrients less available to the crop.

Sulfate levels are relatively low in irrigation water. Research at Virginia Tech found that pin oak *(Quercus palustris)* and Japanese maple *(Acer palmatum)* growth was maximized with application of 10 ppm of sulfate. Some irrigation sources in our study probably contain sufficient sulfate to meet crop needs. Even if irrigation water has lower than 10 ppm, sulfate is provided as a component of many fertilizer products, including micronutrient packages and controlled-release fertilizers. Sulfur deficiency from low sulfate levels is rare.

Micronutrients

Micronutrient levels in irrigation water were all low. Only iron was consistently measurable in our study, but even it was far lower than what is required by nursery crops. Consequently, Douglas fir bark contains an abundance of available micronutrients (see *Digger,* June 2006), providing that substrate pH is sufficiently low.

Summary

Oregon is an excellent environment for nursery crop production. This is due to many factors, one of which is an abundant supply of high-quality water. It is fair to say that most regions of the north Willamette Valley have irrigation water suitable for container plant production. Sodium and EC levels should be monitored because of their detrimental effects on crop growth. Alkalinity, calcium and magnesium should be considered for their potential impact on liming decisions. From my research on Oregon substrates and irrigation water, these are the most important considerations when interpreting water analyses for container nursery production.

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