Ornamental tree fertility guidelines for bare-root shade and flowering tree production for the Northern Willamette Valley

Shade or flowering trees in the Pacific Northwest for bare-root sales are grown primarily in the Northern Willamette Valley, which receives on average 37.5 inches of rain from November to April. Soils within the Willamette Valley vary from sandy loam to clay loam. Over 1500 species and cultivars of Oregon ornamental trees are grown from tissue culture plantlets or grafted on rootstock. In almost all production cycles, trees are grown from a single bud occurring on a one-year old liner. This bud is grown into a whip or branched tree over a 1 to 4 year production cycle. Shade or flowering trees have 1 to 3 flushes, which is considered indeterminate growth. A quality tree and grade is based on height, caliper and branch structure or tree form. Consumers judge trees during production on plant health as a function of aesthetics; therefore a low threshold for any nutrient deficiency exists.

There is little existing data regarding shade tree fertility recommendations. Ornamental tree fertility in the Northern Willamette Valley remains in its infancy as Oregon State University researchers and extension agents have just begun to investigate nutrient removal, fertilizer timing, and subsequent crop response. Recommendations herein are based on other relevant production guides and current practices of nurseries within the Willamette Valley. The focus of the guide is the four factors that affect the efficacy of fertilization: timing of application, placement of application, rate of application, and source of fertilizer.

To accurately manage crop fertility, you must know the soil type and texture, pH, organic matter, and extractable nutrient content at your site. Site-specific soil physiochemical properties are now available online via the Web Soil Survey (WSS; websoilsurvey.nrcs.usda.gov). Your local USDA Natural Resources Conservation office or consultant can provide greater detail or smaller scale soil maps as needed. Soil should be tested regularly to monitor soil pH as well as between cropping cycles to ensure adequate soil nutrient supply with the exception of nitrogen. More information on how to test soil is described in Oregon State University extension publication EC 628 titled 'Soil Sampling for Home Gardens and Small Acreages'. Sampling laboratories and interpretation of soils tests is described in extension publications EM 8677 titled 'Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis' and EC 1478 titled 'Soil Test Interpretation Guide', respectively

Nitrogen

Readily available forms of nitrogen (N), such as Urea, are used to supply nitrogen during ornamental tree production. Ideally nitrogen fertilizer applied in a dry form should be accompanied with water to move the fertilizer to the root zone. Slow release forms of nitrogen have not yet been proven to be as effective in the Pacific Northwest as conventional practices for field use. A starting recommendation for a broadcast application rate of nitrogen is 125 pounds per acre, however it is recommended nitrogen be applied in spilt applications via band, side-dress or fertigation to the area of the expected root zone as determined by tree size and production practices.

The application rate of nitrogen should be reduced proportionally to application area when banding, side-dressing, or fertigating. If using liquid feed as the application method, ≤ 60 lbN/A should be applied at the initiation of root growth as well as at peak growth when nutrient uptake occurs readily. Nutrient uptake and use is species or cultivar dependent. In addition, nutrient uptake will depend on the climate and soil environment from year to year. Root growth and nutrient uptake can occur before bud break and continue during leaf out and throughout the season. Growers can test the efficiency of current nitrogen fertilizer practices by conducting soil tests on drier soils in late August or early September, before receiving 1 inch of rainfall. The soil and your production system remain dynamic over time and may require adjustment to ensure optimal fertilization.

Phosphorus

Phosphorus (P) moves very little in the soil profile, therefore conventional fertilizers such as superphosphates, ammonium phosphates, or potassium phosphates are commonly top dressed and incorporated between cropping cycles. Bray (phosphorus soil test method for acidic or neutral soils) phosphorus is used to determine the need and quantity of phosphorus between cropping cycles as follows:

Bray P Soil Levels (ppm)	Apply Phosphrus?	Amount P_2O_5 to Apply (per acre)
0 to 20	Yes	100-125 lb
20 to 35	Maybe	60-100 lb
35+	No	No

Potassium

Traditionally potassium is top-dressed to incorporate potassium as salts between cropping soils since soil potassium does not decrease rapidly during a perennial cropping cycle. Soil testing is used to determine potassium fertilizer rates as follows:

K Soil Levels (ppm)	Apply Potassium?	Amount K_2O to Apply (per acre)
0 to 100	Yes	150 lb
100 to 200	Maybe	0-150 lb
200+	No	None

It should be noted that potassium can be applied as potassium chloride, which will also provide the essential element chloride (soil application threshold <4 ppm), which is believed to potentially help with shoot tip dieback and increase crop turgor pressure.

Calcium, Magnesium, Sulfur and pH

Calcium and Magnesium are essential elements, however they often are not regularly considered when correcting soil fertility. Calcium and magnesium soil concentration and availability are commonly dealt with as a function of pH. Soil pH is adjusted based on soil pH and SMP (Shoemaker, MacLean, and Pratt) lime requirement test. pH is altered by the addition of dolomite or lime.

Dolomite contains both calcium and magnesium and lime contains only calcium. If no pH adjustment is needed and calcium is < 1,000 ppm (5 meq/100g soil), then 500 lbs gypsum (calcium sulfate) can be applied per acre. If extractable magnesium is < 100 ppm (0.08 meq/100g soil), then 15 to 30 lb per acre of magnesium sulfate can be applied; however this may be cost prohibitive.

Sulfur, another essential crop nutrient, is routinely applied to crops as sulfate or SO4. This form of the nutrient is available to the plant and does not affect soil pH. Sulfur can also be added as gypsum or in other fertilizer salts containing sulfate such as ammonium sulfate or potassium sulfate. Sulfate may also be applied via the irrigation water, which may contain notable amounts of sulfate. Elemental sulfur is another form of sulfur. This form of sulfur is used to adjust soil pH. The conversion of elemental sulfur to sulfate is dependent on soil microbial activity, temperature, moisture, and pH. Therefore, elemental sulfur should be applied as far ahead of planting as possible.

Specific recommendations on elemental sulfur application and effect on soil pH decline can be found in Oregon State University extension publication EM 8857-E titled 'Acidifying soil for crop production west of the Cascade Mountains.' Sulfur soil tests provide little information on soil sulfur status or availability; therefore foliar tests are recommended to determine if sulfur is available. Sulfur should be routinely applied between cropping cycles at a rate of > 20 lb per acre to ensure adequate sulfur is available. Sulfate can also be applied during the cropping cycle as part of a liquid fertilizer or top-dressed and accompanied with irrigation or rain.

Micronutrients

Soil micronutrients are not regularly monitored unless a deficiency or toxicity is suspected. Micronutrient deficiencies in shade trees are not common with the

exception of manganese or iron and are usually diagnosed with soil and foliar analysis. Micronutrients, not including molybdenum, decrease with increasing pH. Most shade tree species produced in the Willamette Valley grow best in moderately acidic soil (pH 5.5 to 6.5), with some nursery crops such as azaleas, rhododendrons and red maple requiring more acidic soil (lower pH). Iron and manganese are very difficult to supply via fertilization because soil pH controls availability to the plant regardless of nutrient applications to the soil. Thus, the key to solving these deficiencies is to reduce soil pH.

Details of manganese deficiency, manganese application, and soil pH adjustment can be found in Oregon State University extension publication EM 8905-E titled 'Managing manganese deficiency in nursery production of red maple'. Soil micronutrients are not regularly monitored unless a deficiency or toxicity is suspected. Soil and foliar analysis can be used as a diagnostic tool. Recommended soil test application thresholds are in the below table. Iron is not included because iron deficiency can only be diagnosed via foliar analysis.

Element	Application Threshold
Boron*	1.0 ppm
Zinc*	1.0 ppm
Manganese*z	1.5 ppm

***Based on DTPA extract**

[z]DTPA Manganese is recommended to be > 20 ppm when growing red maples which readily exhibit manganese deficiency

Conversions

To convert column 1 into column 2, *divide by*	Column 1	Column 2	into column 1, multiply by
390	ppm K	meq K/100 g soil	390
200	ppm Ca meq	meq Ca/100 g soil	200
121	ppm Mg meq	meq Mg/100 g soil	121
1	meq/100 g soil	cmol/kg soil	1
2*	lb/acre (7 inch depth)	ppm	2*
3.5*	lb/acre (1 foot depth)	ppm	3.5*
43.56	lb/acre lb/1,000 sq ft		43.56
43,560	square feet	acres	43,560
2.471	acres	hectares	2.471
2.29	P	P2O5	0.437
1.20	K	K2O	0.830

*These values vary with soil bulk density.

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We provide the Northern Willamette Valley Bareroot Ornamental Shade Tree Fertilizer Guide as an addendum to the Best Management Practices Guide for Climate Friendly Nurseries, a publication by the Climate Friendly Nurseries Project. For more information, and for updates and additions to this work, please visit the Climate Friendly Nurseries Project website at www.climatefriendlynurseries.org.

Further information from which this document was based can be found in OSU Extension Circular EM9013-E, Bareroot Shade, Flowering, and Fruit Trees FertilizerGuide.

Related OSU Extension materials

EM 8856-E	Christmas tree nutrient guide
EM 8905-E	Managing manganese deficiency in nursery production of red maple
PNW 513	Nitrogen Uptake and Utilization by Pacific Northwest Crops
EC 628	Soil Sampling for Home Gardens and Small Acreages
EC 1478	Soil Test Interpretation Guide
PNW 570-E	Monitoring Soil Nutrients Using a Management Unit Approach
EM 8677	Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis
EM 8857-E	Acidifying soil for crop production west of the Cascade Mountains
FG 52-E	Fertilizer and Lime Materials Fertilizer Guide
PNW 597-E	Irrigation Water Quality for Crop Production in the Pacific Northwest
EM 8739	Cover Crop Dry Matter and Nitrogen Accumulation in Western Oregon
PNW 508-E	Fertilizing with Biosolids

Organic Fertilizer and Cover Crop Calculator (http://smallfarms.oregonstate.edu/organic-fertilizer-calculator)