Changes in Needle Nutrient Concentration

Over Multiple Christmas Tree Crop Cycles

by John Hart, Rick Fletcher, Chal Landgren, Linda Brewer, Mike Bondi and Steve Webster

Current Christmas tree production practices of intensive pruning, fertilizing and pest control began approximately 40 years ago in western Oregon and Washington. The industry has grown to be one of Oregon's top ten agricultural commodities with a farm gate value of $160 million in 2002. Some Christmas tree fields are entering their sixth rotation of continuous production.

With advancing rotations some growers are reporting yields less than expected, given continued improvement in farming practices. A host of improvements such as pruning, genetics, fertility and pest control should help plantations be much more productive than their counterparts of the past 40 years. Some growers say this is not the case, which raises the question if the sites are possibly becoming less productive. Common complaints about older fields include fewer top quality trees, uneven tree growth and increase of insects and diseases. Reasons given to explain this trend include triazine herbicide accumulation, lack of mycorrhizal colonization, soil erosion and compaction, missing or "unbalanced" nutrients and loss of organic matter.

Little field data has been collected to test the validity of the proposed causes of the alleged decline in productivity. In the spring of 2001 our team of OSU and WSU researchers measured soil properties and initiated a systematic evaluation of the region wide trends. We sampled 44 fields and attempted to segregate young and old rotations based on soil chemical data, soil physical data, mycorrhizal evaluation and triazine residue. Results of triazine residue and mycorrhizal tests showed no significant trend between early and late rotations. Significant trends were apparent for soil physical properties, but the only soil chemical measurements that differed between rotation ages were soil test potassium and calcium in the 3- to 12-inch sampling depth.

During the late summer and early fall of 2002 we obtained needle samples from 32 of the Christmas tree plantations from which soil nutrient and other measurements were gathered in 2001. Needles were not obtained from plantations less than one or two years of age because for the first one or two years in the field seedlings reflect conditions inherited from the nursery rather than ambient field conditions.

The average needle concentration of most nutrients from first rotation trees was above the OSU critical concentration (Table 1). The average concentration of phosphorus was only slightly, 0.01 percent, below the OSU critical level and the same for both rotations. The fact that needle and soil phosphorus is the same for both early and late rotations shows it is not decreasing with rotation age and not contributing to the decline in productivity. The sub-standard needle phosphorus concentration with ample soil test P raises the concern that the OSU critical needle concentration for phosphorus might be high.

Table 1. High, low, standard and average Christmas tree needle nutrient concentration.

Nutrient	OSU Critical Concentration	Average Needle Concentration		Range	
		First Rotation	Late Rotation	First Rotation	Late Rotation
N	1.4-1.6	1.66	1.59	1.32-2.03	1.30-2.00
P	0.15	0.14	0.14	0.10-0.21	0.11-0.20
K	0.80	0.68	0.72	0.28-0.95	0.37-1.15
S	0.06	0.11	0.11	0.08-0.14	0.08-0.14
Ca	0.25	0.46	0.42	0.25-0.80	0.27-0.62
Mg	0.07	0.12	0.12	0.07-0.17	0.06-0.17

Growers should continue to monitor phosphorus, adding phosphorus fertilizer between rotations when soil tests show phosphorus is low, but not be surprised if tree needle phosphorus concentration does not increase after a fertilizer phosphorus application.

The average potassium concentration for both rotation ages was substantially lower than the OSU critical concentration and probably caused by very dry late summer conditions. The lowest needle concentrations of nitrogen, phosphorus and potassium likely limited growth of trees in both rotations.

Needle nutrient concentration from second rotation trees was similar to first rotation needle nutrient concentration. The average nitrogen concentration for later rotation trees was not significantly lower than nitrogen concentration from first rotation trees and sufficient for growth and color development. For sufficient needle color, we recommend 1.6 percent N in needles of Douglas-fir Christmas trees and 1.4 percent N in needles of Noble-fir Christmas trees a year before harvest.

Needle calcium concentration for all fields sampled was above the OSU critical level for calcium. Although not all fields were sampled, we expected, based on soil test calcium, some low needle calcium concentrations would be found. Our expectations were not realized, as the low soil test calcium values did not relate to low needle calcium concentration as shown in Figure 1. Even though all needle calcium concentrations were sufficient, growers should be cautious about declining soil test calcium.

The average needle concentration for nearly all micronutrients was above the OSU critical level (Table 2) on all sites. These findings align with results from sampling of other fields over the past couple of decades. The concentration of boron from some fields was below the OSU critical level, suggesting the need for remedial treatment.

The average manganese concentration was significantly higher in late rotations than first rotations. Manganese was the only element measured to have a significantly higher average concentration in late rotations than first rotations ($p = 0.068$). Needle manganese concentration increases as soil pH decreases (Figure 2). Even though we did not measure a significant decrease in soil pH with rotation age, the increase in needle manganese is an indicator that growers should measure soil pH between rotations.

Table 2. High, low, standard, and average Christmas tree micronutrient needle nutrient concentration.

Nutrient	OSU Critical Concentration	Average Needle Concentration		Range	
		First Rotation	Late Rotation	First Rotation	Late Rotation
B	15	18	19	9-34	10-52
Cu	3	6	5	3-10	3-9
Mn	25	325	416	83-570	140-1010
Zn	10	26	27	19-33	13-36

Summary

No single nutrient problem was established for the study fields. The increase in tissue manganese with rotation age is an industry trend and not likely the factor responsible for decline in Christmas tree productivity. Some early and late rotation fields have also produced trees with nitrogen, phosphorus, potassium and boron needle concentration low enough to limit tree growth. Growers should monitor tissue annually from the third year that the trees are in the field to the year before harvest.

About the Authors: *Except for Webster, who is a retired WSU forestry extension agent, all of the authors of this article are with Oregon State University Extension Service.* ▲

Figure 1. The relationship of soil calcium from the surface three inches and Christmas tree needle calcium concentration.

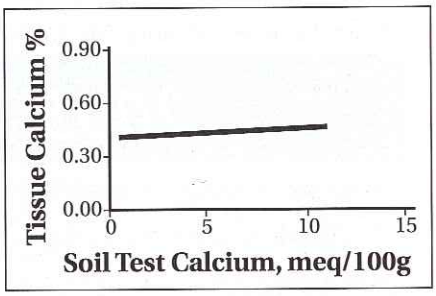

Figure 2. The relationship between soil pH in the surface three inches and Christmas tree needle manganese concentration.