2006 Trends in Fraser Fir Soil Fertility

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As Fraser fir production has matured in North Carolina, the types of nutritional problems growers must deal have become more diverse. There are still deficiency issues with new fields or cleared forestland that are being prepped for Fraser fir production. On the other end of the spectrum, there are older fields in which some nutrients are high or excessive after years of fertilizer or lime applications. Different nutrient requirements occur in soils that range from mineral clay loams to high-elevation organic soils. In the balancing act of long-term soil fertility, achieving optimum levels requires care and a willingness to adjust applications field by field. Awareness of soil fertility trends on a regional basis can raise red flags for the conscientious manager and point toward potential issues on certain sites or with particular nutrient applications.

The data used for this article was drawn from 3,642 soil reports as summarized for the six major Fraser fir counties and provided by Dr. Jeana Myers at the NCDA & CS Soil Testing Laboratory. The soil report summaries not only provided data on the seven nutrients listed on our soil reports but also the six chemical and physical properties measured in the standard soil test. The county summaries provided the percentage of soil reports that fell within ranges of percent or index as shown on grower reports. Certainly the raw number of reports by county — of which Ashe County samples make up 47% — is interesting as an indicator of the quantity of fields being managed for Christmas tree fertility.

Major Fraser Fir Growing County	Number of Soil Reports in 2006
Alleghany	701
Ashe	1,700
Watauga	197
Avery	545
Mitchell	240
Jackson	259
Total	3,642

What makes soil report nutrient summaries interesting is not just where the center falls (hopefully near the recommended optimum), but the number of soil reports that occur at the extremes. Differences among counties are also instructive even though they represent both baseline differences in soils and cumulative fertilizer use not just from Christmas tree production but all previous crops.

Patterns of Soil Characteristics

Among soil properties, the weight to volume ratio (W/V) and the Cation Exchange Capacity (CEC) are particularly useful when reviewing a report.

Soil Property	Distribution of Soil Reports				
W/V (g/cm^3)	0 - .54	.55 - .74	.75 - .94	.95 - 1.29	1.3 +
	3.36	1.73	47.40	47.36	0.16

The weight to volume ratio increases as a soil changes from organic, to clay, to sand. If the weight to volume ratio is less than .8, it's a good indication that the soil is at the more organic end of the spectrum. Of course, the color of soil that went into the box is also a good indication with dark brown or black soils having the highest organic component. These soils can have very high CEC's that can run into problems if treated using normal recommendations. In fact, low W/V linked with high CEC's can justify a reduction target pH and in calcium and magnesium applications. About 6% of the Fraser fir soil samples in 2006 exhibited low weight to volume ratios indicative of these organic sites with 83% of soils falling in the range of more typical clay loam and silt loam mineral soils.

Soil Property	Distribution of Soil Reports				
CEC (meq/200 cm^3)	0 - 2.9	3.0 - 5.9	6.0 - 9.9	10.0 - 14.9	15 +
	10.3	13.4	54.7	20.1	1.6

In the 2006 summaries, about 24% of soils exhibited low CEC's, 22% high CEC's, and 55 % a normal range of CEC's (about CEC = 8). This range indicates the number of sites that need to be handled differently from the norm. The percentage of high CEC samples may be somewhat elevated by those soil samples collected after a recent lime application.

CEC is a measure of a soil's ability to hold nutrients and buffer salts. Chemical exchange sites in clay particles or organic matter provide the locations that bind the nutrients to the soil. Without these exchange sites, positively charged nutrients

including nitrogen, potassium, calcium, magnesium, and most micronutrients will leach out of the soil. Thus, sandy soils require smaller applications of fertilizer both to reduce the risk of salt injury and to avoid unnecessary losses to nutrient leaching. Many clayey or organic soils with high CEC's need larger applications to change nutrient balances, but once applied, nutrients stay around with lower risk of salt injury to plants. Depending on how your fields test, you might want to use very different fertilizer application strategies.

CEC Influence on Pounds of Ca /Acre

CEC	55% Ca	45% Ca
4	783 #	641 #
8	**1570 #**	1283 #
16	3136 #	**2566 #**

Acceptable levels of Ca fall between 1500 and 3000 pounds of Ca per acre.
Red = Too High Blue = Too Low

Patterns Among the Major Nutrients

Of the major nutrients, soil reports provide levels of phosphorus (P) and potassium (K) based on chemical extraction. Nitrogen is based on crop optimums developed from agronomic research – not highly variable levels of nitrogen in biologically active soil. Both P and K are presented as indexes for which a level of 75 to 100 is considered sufficient for Christmas tree production.

Distribution of Soil Reports by P Index				
0-10	**11-25**	**26-50**	**51-100**	**100+**
14.2	9.6	13.5	23.5	39.1

Levels of phosphorus reported across the region exhibited high and low extremes. Fifty-three percent of Christmas tree soil samples in the six major Fraser fir counties exhibited adequate or high levels of P. The percentage of soil reports with P indices over 100 ranged from 50% in Alleghany County to 33% in Jackson County. Rather than being a problem, these high P levels in samples collected from the top 4 to 6 inches of soil are necessary to overcome the phosphorus fixing capacity of most mountain soils. Only after this fixing capacity is met, does phosphorus move down in the soil profile and become more available to actively growing roots.

Even with high P levels in the surface, phosphorus can be deficient deeper in the soil profile. Soils that have low P indices in standard top-four-inch samples may be severely deficient deeper in the soil. Thirty-five percent of the Christmas tree soil samples had P indices below 50 with 13% being severely deficient (P = 0 – 10). Watauga had the greatest number of samples deficient in P (39%) and Jackson County the fewest (17%). Without knowing more about field conditions, we cannot distinguish among those soil reports that are new fields with low P characteristic of native soils and those that have low P from inadequate fertility. But in either case — low P indices are a red flag for increased phosphorus application. Where possible, deep incorporation of P at planting can greatly benefit slow availability of this nutrient.

Distribution of Soil Reports by K Index				
0-10	**11-25**	**26-50**	**51-100**	**100+**
0.0	1.3	16.9	54.2	27.6

Mountain soils tend to have adequate levels of potassium (K) and the soil report summaries followed suit. Only 1% of samples were deficient and 17% low. Twenty-eight percent of samples were very high with indices above 100. Avery, Ashe, and Watauga Counties exhibited the highest percentages of very high K samples. Jackson County exhibited the highest percentage of samples in the marginal range (25-50). If soils in a region tend to be lower due to their parent material, greater attention may be needed regarding K. Conversely, where K tends to be higher, adding too much can lead to possible problems including salt burn or deficiencies of zinc, copper, manganese, calcium, or magnesium if those nutrients are not also very high in the soil. Over reliance on materials such as 10-20-20 or even triple-17 can lead to excess K particularly where K levels are naturally high.

Levels of pH, Calcium, Magnesium, and Manganese

Few values on the soil report are more closely related than pH and the percent calcium (Ca) and magnesium (Mg) levels. Both Ca and Mg will raise the pH unless counterbalanced with an equal addition of an acid as with the sulfur in Gypsum. Both Ca and Mg are provided in our most common liming material used to raise pH – dolomitic Lime. Some of the

most tenacious fertility problems that growers contend with involve the interaction of pH and these two liming nutrients on the availability of other nutrients, particularly Manganese.

Distribution of Soil Reports by pH				
0-4.9	**5.0 -5.4**	**5.5 -5.9**	**6.0 -6.4**	**6.5+**
24.3	35.6	32.2	6.1	1.7

The recommended pH of 5.0 to 5.8 can be a difficult target to achieve. Most native unfertilizeded soils contend with low pH issues. So when found, high pH's usually result from lime application — either from previous land uses such as pasture or tobacco, or from long term Christmas tree production. Eight percent of all Christmas tree soil samples were above the optimum range, 68% were within the target range, and 24% were very low. Alleghany (13%), Ashe (10%), and Jackson (9%) Counties had more high pH samples compared to Mitchell and Avery Counties both which had less than 5% of their samples with high pH. At high pH's, induced manganese deficiencies often stunt tree growth and turn foliage yellow. On the low side, Avery County had the highest percentage of samples (42%) with pH below 5.0. At these pH levels, calcium and magnesium could be deficient and a greater percentage of phosphorus fertilizer is tied up by iron and aluminum in the soil.

Distribution of Soil Reports by Ca %				
0-34.9	**35.0 -44.9**	**45.0 -54.9**	**55.0 - 64.9**	**65+**
16.8	23.5	37.2	20.0	2.5

The distribution of soil samples around the calcium level was skewed to the low side of the targeted 55 percent. Over all, 17% of samples were deficient in calcium, 24% were low, 37% were marginal, and 22% were high of which 3% were very high. Nearly eighty percent of these soil reports would justify lime and/or gypsum treatments to raise calcium levels. Alleghany County exhibited the largest number of high Ca soil reports; Avery and Watauga Counties the fewest. Distribution of low Ca soil reports was the inverse with Avery and Watauga leading. If calcium deficiency were limited to the small percentage of trees exhibiting symptoms in the field, it would be of little concern, however, calcium deficiency may be a factor in post harvest needle shedding – and therefore a threat to any grower's reputation for quality.

Soil samples keep fertilization on track

Calcium deficiency related needleshed

Overcome manganese deficiency by reducing pH

Distribution of Soil Reports by Mg %				
0-4.9	5.0 -9.9	10.0 -14.9	15.0 -19.9	20+
0.8	12.7	29.5	30.5	26.4

The distribution of magnesium (Mg) among 2006 soil report was much higher than that shown for calcium. Fifty-seven percent of the soil reports showed high Mg levels above the optimum range of 10 – 15 percent. Of these, 26% of reports were above a Mg level of 20%. Alleghany, Watauga, Ashe, and Mitchell Counties all had high numbers of reports in this category. At eleven percent, Avery County had the fewest 20%+ reports. These high levels of Mg can occur naturally in mountain soils, some of which include Mg-containing minerals such as Olivine.

Some of these high Mg soil reports may result from an over-reliance on dolomitic limestone used to raise the soil pH. Once Mg levels reach or exceed 15%, liming should be accomplished with materials that do not contain Mg – namely calcitic lime. Too much Mg will induce Manganese deficiencies just like Ca with typical "lime pile" symptoms. Too little Mg can result in foliage yellowing and generally poor growth. Magnesium is one nutrient deficiency that has shown a clear response to foliar treatments, in this case, Epsom Salts.

Distribution of Soil Reports by Mn Index				
0-10	11 -25	26 -50	51 -100	100+
0.1	0.5	3.1	16.2	80.1

One can not discuss pH, Ca, or Mg without alluding to manganese (Mn) deficiencies. One would expect a lot of soil reports with low Mn, particularly since it is seldom applied in fertilizers. However, the exact opposite is true. Eighty percent of all soil reports had Mn levels in excess of a 100 index! As the lowest entry, Jackson County still had 71% of reports in the 100+ category. Less than 5% of samples exhibited indices less than 50. Despite these high indices, Mn deficiency is common. The availability of this micronutrient is impeded by normal Fraser fir pH and by the recommended levels of Ca and Mg. Even when it is readily present in the ground, it may not be available to tree roots. To correct Mn deficiency, we usually lower the soil pH and foliar apply Manganese Sulfate rather than add Mn directly to the soil. Until the conditions that tie Mn up are altered, any addition of Mn to the soil would also be tied up.

The 2006 soil summary categories lose any detail above Mn levels of 100 +. Some individual soil report levels may far exceed an index of 100. I often see indices between 100 and 400 on North Carolina reports associated with good quality trees. Even fields with indices in the 700 range have grown good quality trees. The highest Mn levels I have seen – in the 1,500 to 3,000 range – were from Tennessee and Virginia farms. At these high levels of Mn, foliage was yellow and growth abnormal. Mn toxicity has only been expressed in the field at these very extreme levels. It may be that moderately high Mn can balance high pH better than normal Mn levels. A lot of successful Fraser fir ground exceeds the 100 point Mn index. However, any extreme Mn soil report numbers would certainly justify a current tissue analysis.

Distribution of Soil Reports by Zn & Cu Indices					
Index	0-10	11 -25	26 -50	51 -100	100+
Zn	0.2	4.9	26.4	35.4	33.1
Cu	0.6	5.9	27.0	44.9	21.5

Both copper (Cu) and zinc (Zn) summaries were skewed with almost two-thirds of soil reports falling in high soil test indices (above 50). A third of the Zn reports had 100+ indices. Eighty-two percent of the Alleghany County samples were in this category (almost twice the number of Ashe, the next closest county). These high numbers likely result from zinc in the parent material of the soil and/or Virginia sources of limestone that contain more Zn. These high Zn reports could reflect induced deficiencies if other micronutrients were marginal, but in most cases, simply reflect abundant levels of Zn for good growth.

While two-thirds of the soil samples exhibited copper indices over 50, only twenty-two percent of them were over 100. This is a good thing, since most plants cannot tolerate excess copper. Years ago, Dr. Jim Shelton induced copper toxicity in containerized Fraser fir, but it has only been visible in the field under unusual conditions such as excessive loading with poultry litter. Deficiencies can occasionally be observed with marginal yellowing and even tip dieback on needles. Watauga County had the highest number of low Cu indices and fewest high Cu indices – probably an indication of the mineral content of the parent material of county soils. Again, these county trends simply serve as a flag to pay attention to what may be more likely to occur to you and your neighbors.

Conclusion

Sorting through tables of annual summaries has been a lot like sorting through pages of your own soil reports – it's hard work but worth the investment. The more you know about your soil, the better prepared you can be. There were some real differences among the county surveys. These patterns have existed to some extent as long as Christmas trees have been grown on unique mountain soils. Some soils are simply richer in nutrients than others. Yet, imbalances raise questions about practice as well. Are growers keeping up with soil fertility management issues on their farm?

Ultimately, the important question for you is not why one county had higher nutrient levels than another, but what you can do about similar issues on your own farm. Where do your soils fall on each scale? How different is the fertility of new or established fields you use? How far from optimum are your nutrient levels? Are you willing to address individual field problems separately to bring your numbers closer to the ideal? What is the impact of CEC on your different fields? Hopefully, this summary has provided a context in which the soil reports for your own fields fit into the larger pattern for Fraser fir production.

As long as we are asking some final questions, when was the last time you collected soil and tissue samples? Are you guessing in the dark or basing your fertilizer decisions on current information? These summaries of soil reports point toward varied soils with differing response to fertilizer. Make sure you are working from a position of knowledge – keep up with your soil and tissue sampling!

Association News

The Ashe County Christmas Tree Association encompasses 121 active members and represents the largest volume of quality Fraser fir Christmas trees of any county association in the Eastern United States. In 2006 the Ashe County Christmas Tree Association worked closely with the North Carolina Cooperative Extension Ashe County Center to support its growing membership and community through many educational programs and sponsorships.

In 2006 the Ashe County Christmas Tree Association's 15 member board held monthly meetings to address issues from the Christmas tree industry as well as our community.

The ACCTA 2006 Annual Winter Meeting offered growers insight into the immigration issue, pesticide education, post harvest freshness issues, groundcover management and updates from the NCCTA and the NCTA. The meeting was concluded as news officers were elected and 4 board members were re-elected to the 15 member board.

In the spring of 2006 the Ashe County Christmas Tree Association gave our first annual $1000 scholarship to a graduating senior from Ashe County High School.

The Ashe County Christmas Tree Association also helped arrange, sponsor and actively participate in the regional 2006 Hispanic Farm Safety Day held at Hudler Carolina Tree Farms, Inc. in West Jefferson. The six-hour training workshop was an ideal educational program with hands on training, lecture, and discussion style programming - all taught in Spanish. Nineteen educators, 16 volunteers (including translators), and 175 farm owners, contractors, and migrant workers were in attendance to make the Hispanic Farm Safety Day a huge success.

A special thank you to Ashe County Christmas Tree Association Members Cline and Ellen Church for opening their farm as a loading area for the National Trees for Troops program. 21 growers from Ashe County donated trees. Volunteers loaded 800 trees from the Church's farm from Ashe, Alleghany and Watauga Counties. The Ashe County Christmas Tree Association would also like to extend a special thank you to the Ashe County High School JROTC for all their help with loading the trees. They are a great group to work with and worked very hard to help.

The Ashe County Christmas Tree Association is proud to be a member of the North Carolina Christmas Tree Association and we appreciate all of the hard work of the NCCTA for marketing and promoting the Christmas Tree Industry in North Carolina.

The Ashe County Christmas Tree Association would also like to thank Wiley Gimlin, President, Nolan Walters, Vice President, Rusty Barr, Treasurer, and Michelle Ham, Secretary, for all their hard work in 2006.