FERTILIZATION PRACTICES FOR CHRISTMAS TREES

ESSENTIAL NUTRIENTS FOR PLANT GROWTH

- C HOPKNS CaFe Mg B Mn CuZn MoCl
- Nutritional Levels: deficient (visible, hidden), optimum, luxury, toxic.
- Some important "laws".
  - Law of Minimum
  - Law of Diminishing Returns
- Essential Mineral Nutrients (Note, carbon, hydrogen, and oxygen not obtained from organic or mineral part of soil. Carbon obtained from carbon dioxide; hydrogen and oxygen obtained from water.

NUTRIENT	ABSORBED FORM	FUNCTION	DEFICIENCIES
Nitrogen	NH_4^+ & NO_3^-	Component of Chlorophyll, proteins, nucleic acids, enzymes, other org. cpds.	Yellowing of needles. Mobile, older needles first. Needles light green first, then yellow tips.
Phosphorus	$H_2PO_4^-$ HPO_4^{-2}	Component of number of cpds including nucleic acids. Impt. in energy transfer.	Stunted growth. Yellowing, bronzing, purpling. Mobile, older needles first. Often more pronounced if mycorrhizae absent.
Potassium	K^+	Only macronutrient not a constituent of org. molecule. Functions as enzyme. Involved with water balance and stomatal regulation.	Yellow tips and edges of needles. Mobile, older needles first.
Calcium	Ca^{+2}	Structural component of cell wall. Enzyme Involved with translocation of carbohydrates, protein synthesis, ion uptake, etc.	Lack of development, deformation, or death of terminal bud. Root tips also fail to dev. Often yellow as with nitrogen, but beginning with new needles. Not very mobile.
Magnesium	Mg^{+2}	Mineral constituent of chlorophyll. Enzyme.	Bright yellowing or oranging of needle tips progressing downward.
Sulfur	SO_4^{-2}	Constituent of proteins and enzymes.	Yellowing like nitrogen, but younger needles first.

Boron	BO_3^{-3}	Associated with various plant functions such as sugar translocation, respiration, reproduction, carbohydrate metabolism, and water relations.	In other plants deficiency causes variety of symptoms including cessation of growth of terminal bud, death of younger leaves, twisting of leaves, and breakdown of root tissue.
Copper	Cu^{+2}	Component of enzyme systems.	Probably not limiting in mineral soils. In other plants see poor development of newer leaves, poor color.
Iron	Fe^{+2}	Associated with chlorophyll formation. Enzyme function.	Yellowing to white of younger needles (chlorosis). Relatively immobile.
Manganese	Mn^{+2}	Associated with chlorophyll formation. Enzyme function.	Yellowing of younger leaves. Relatively immobile.
Molybdenum	MoO_4^{-2}	Enzyme associated with protein synthesis.	May include chlorosis.
Zinc	Zn^{+2}	Component of enzyme systems.	Relatively immobile.
Chlorine	Cl^-	Regulation of osmotic pressure and cation balance.	May include wilting, chlorosis, tissue death.

METHODS OF EVALUATING NUTRITIONAL/FERTILIZER NEEDS

A. Performance

B. Deficiency Symptoms

- Deficiency (visible, hidden), optimum, luxury, toxic).
- Visible symptoms (see nutrients above).
- Value - red flag of problem.

C. Soil Testing as Means of Determining Nutrient Content

1. Basics of soil sampling
   - Representative sample (about 1 pint) of uniform area (soil type, appearance, slope, drainage, past treatment, etc)
   - Obtain 15-20 samples of the surface 6-8 inches from throughout sample area (e.g. zig-zag pattern over entire area).
   - Thoroughly mix sample and subsample 1 pint for analysis.

2. Important considerations
   - Sample 6 months to year before planting.
   - Sample again at least once during rotation and 6 months to year prior to next planting (at least initially).

- Use same analytical lab for subsequent tests.
- Sample at same time of year.

3. Interpretation of results
   - Interpretation of soil tests for Christmas trees not easy - not great deal of research available.
   - Ultimately, each grower will need to become expert on their individual fields. Will take time and experience.
   - As place of departure often use agricultural crop recommendations modified by experience.
   - Some values for consideration.

SPECIES	pH (IDEAL)	AVAILABLE P #/A	AVAILABLE K #/A	AVAILABLE Ca #/A	AVAILABLE Mg #/A
Scotch Pine	5.0-5.5	15#/A	100-150#/A	800+#/A	100+#/A
White Pine	5.0-6.0	15-20#/A	100-150#/A	800+#/A	100+#/A
Spruces	5.5-6.0	25-30#/A	150-170#/A	800+#/A	100+#/A
Firs	5.5-6.0	30#/A	170+#/A	800+#/A	100+#/A
Douglas-fir	5.5-6.0	30#/A	170#/A	800+#/A	100+#/A

- CEC: about 70+ base saturation
  Calcium:Magnesium at least 1:1
  Magnesium:Potassium at least 1.5:1

D. Foliar Analysis As Means of Evaluating Plant Nutritional Status

1. Very poorly developed diagnostic tool for Christmas tree growers. Little data.
2. Basics of foliar sampling
   - Sample whole, undamaged first year needles.
   - A composite sample from several trees - sample about 2 ounces.
   - Always sample at same time of year - fall recommended.
   - Always use same lab.
   - Refrigerate samples if not immediately sent to lab.
3. Some foliar analyses - see attached sheet.

CONIFER FOLIAR NUTRIENT LEVELS FROM SELECTED REFERENCES[1]

NUTRIENT	N. CAROLINA SP & WP	N.CAROLINA F,S,D-F	McEVOY NS	McEVOY WS	McEVOY RP	McEVOY SP	McEVOY BF	McEVOY D-F	H & F & V SP
Nitrogen	1.5-2.0%	1.5-2.0%	1.8 (1.3)%	1.5(1.3)%	1.8(1.3)%	1.5(1.0)%	1.8(1.3)%	1.8(1.2)%	
Phosphorus	0.2-0.6%	0.2-0.6%	0.2(0.15)%	0.18(0.14)%	0.15(0.12)%	0.17(0.14)%	0.18(0.11)%	0.22(0.14)%	0.48%
Potassium	0.5-0.75%	0.6-0.8%	0.45(0.30)%	0.44(0.24)%	0.45(--)%	0.60(0.45)%	0.65(0.26)%	0.80(0.40)%	2.14%
Calcium	0.45-0.75%	0.6-0.8%	0.12(0.10)%	0.15(0.10)%	0.04(0.03)%			0.20(--)%	0.47%
Magnesium	0.1-0.15%	0.1-0.15%	0.12(0.10)%	0.10(0.06)%	0.07(0.05)%		0.11(0.05)%	0.12(--)%	0.17%
Sulfur	0.08-0.2%	0.08-0.2%							
Iron	40-300ppm	40-300ppm							3000ppm
Manganese	30-300ppm	30-300ppm							75ppm
Zinc	20-75ppm	20-75ppm							73ppm
Copper	5-10ppm	5-10ppm							22ppm
Boron	18-30ppm	18-30ppm							40ppm
Molybdenum	.04-1.0ppm	.04-1.0ppm							5ppm

[1] Species abreviations as follows: SP=Scotch pine, WP=white pine, F=fir, S=spruce, NS=Norway spruce, WS=white spruce, RP=red pine, BF=balsam fir, D-F=Douglas-fir

N.Carolina reference from: Huxster, William T., Jr. 1992. *ITQ Through Foliar Feeding Of Minor And Trace Elements.* Paper presented at National Christmas Tree Association Convention, Spokane, Washington.

McEVOY reference from: McEvoy, Thom J. 1992. *Using Fertilizers In The Culture Of Christmas Trees.* Paragon Books. 148 pp.

H & F & V reference from: Hacskaylo, John, R. F. Finn, and J. P. Vimmerstedt. 1969. *Deficiency Symptoms Of Some Forest Trees.* OARDC Res. Bul. 1015 Wooster, Ohio. 68 pp.

Numbers listed under McEvoy references are adequate amount (deficiency amount).