FERTILIZATION PROGRAMS
FOR CONIFER PLANTS GROWN IN LANDSCAPE SETTINGS

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Conifer plants have nutrient requirements that are slightly different than turfgrasses, ornamental flowers or deciduous trees. Conifers have a higher demand for potassium, magnesium and sulphur, and will develop abnormal needle color when the supply is inadequate.

An unbalanced fertilization program can trigger the problem. For example, a high level of nitrogen fertilization can amplify a deficient potassium supply. Researchers in British Columbia have called this condition "nitrogen induced potassium deficiency" (1). Thus, a conifer tree grown in a nitrogen-fertilized lawn may require a corrective fertilization program.

I. TISSUE ANALYSIS RESULTS

A good method to pinpoint nutrient deficiencies is to compare tissue analysis of "good" needles with tissue analysis of "bad" needles.

In the B.C. Interior, a frequent problem of blue spruces is a purple coloration of needles inside the canopy. The affected needles eventually turn brown and fall. Tissue analysis comparing "normal" needles and "purple" needles indicates potassium is below "target" level.

Tissue analysis on Picea pungens with purple needles

Nutrient	"Target" (2)	Green Current growth	Purple 1-year old growth
Potassium	0.4 – 1.0 %	0.92	0.35
Magnesium	0.1 – 0.2 %	0.10	0.10
Sulphur	0.2 % and up	0.12	0.09

The condition is also found on white spruce, but the older needles are yellow rather than purple. Again, tissue analysis indicates deficient levels of potassium.

Tissue analysis on Picea glauca with yellow needles

Nutrient	"Target"	Green Current growth	Yellow 1-year old growth
Potassium	0.4 – 1.0 %	0.55	0.39
Magnesium	0.1 – 0.2 %	0.10	0.16
Sulphur	0.2 % and up	0.10	0.08

Tissue analysis on Lodgepole pine (*Pinus contorta*), yew (*Taxus*) and junipers (*Juniperus*) may reveal similar situations.

Above
Note the discoloration on the older needles of this blue spruce. Newer growth is good quality but older needles turn purple then brown, and eventually fall, leaving a bare appearance. Tissue analysis comparing "normal" and "purple" needles indicates potassium is below "target" level.

Below
Similar discoloration on white spruce, but the older needles turn yellow then brown rather than purple then brown. The nutrient deficiencies are the same, with potassium, magnesium and sulphur frequently deficient in tissue samples.

COMMON DEFICIENCY SYMPTOMS (3)

Nitrogen: the needles are yellowish, short and close together. Older plants have poor needle retention. The lower part of the crown may be yellow while the upper crown remains green.

Phosphorus: in young plants, the needles turn purple starting at the tips of lower needles, then progressing inward and upward. Older trees have a dull blue or gray-green colour.

Potassium: the older needles have a dark blue-green colour turning to yellow then reddish-brown. Needle retention is poor and needles are often stunted.

Sulphur: the symptoms are similar to those associated with nitrogen deficiency. The needle tips may be yellow or mottled. Needle retention is poor.

Magnesium: the needle tips are orange-yellow and sometimes red. In older plants, the older needles and the lower crown show symptom first.

II. CORRECTING THE SOIL CHEMISTRY

Sul-Po-Mag (also called K-Mag) 0-0-22-18Mg-11S: a granular product containing sulphur, potassium and magnesium, but no nitrogen. It can be mixed with urea (46-0-0) or ammonium sulphate (21-0-0) at standard nitrogen rates (2 to 3 pounds of actual nitrogen per 1,000 ft^2 per year). Sul-Po-Mag is acceptable for use under organic food production. Cost is approximately $20 for 25 kg.

PlantProd 20-8-20: this water-soluble product also contains boron, iron, manganese, zinc and copper. It was designed for use in forest seedling nurseries in British Columbia. When used in foliar fertilization, it provides rapid but non-lasting results. Cost is approximately $30 for 15 kg.

Muriate of potash 0-0-60: a basic potassium product that can be mixed with other products containing nitrogen, phosphorus, magnesium and sulphur. When applying nitrogen to conifers, the preference is to supply an equal amount of nitrogen and potassium.

III. FERTILIZATION AND PEST PROBLEMS

The impact of fertilization on plant pest problems is the subject of much debate. The interactions between plants and insects are affected by many factors beside nutrition. Also, different researchers use different measurements techniques, making it difficult to compare one study with another study.

In general, nitrogen applications tend to be followed by an *increase* in insect pest numbers. However, when forest trees are fertilized, nitrogen applications tend to be followed by a *decrease* in insect pest numbers. Apparently, fertilization to stimulate *more* growth will generate more insect pests, but fertilization of deficient trees to supply an *adequate,* balanced diet will improve plant health and reduce the risk of attack by opportunistic diseases and insect pests.

Research reports offer mixed conclusions when relating fertilization and conifer insect pests (4).

- Spruce spider mites (*Olygonychus ununguis*): fertilization with nitrogen, phosphorus and potassium promoted an increase in the pest population.
- Spruce budworm (*Choristoneura occidentalis*): fir trees high in foliar nitrogen had female budworms weighing less than larvae on other fir trees.
- Spruce budworm (*Choristoneura occidentalis*): in another study with fir trees, the larvae developed slower, and died more rapidly, on trees with very low or very high nitrogen fertilization.
- European pine shoot moth (*Rhyacionia buoliana*): in one study, the population *increased* with nitrogen fertilization; in another study, the population *decreased* with nitrogen fertilization; in a third study, nitrogen had *no effect* on the population density.
- European pine shoot moth (*Rhyacionia buoliana*): in yet another study with this insect pest, but looking at potassium, the population *decreased* after fertilizer application.
- Balsam woolly aphid (*Adelges piceae*): population growth was *higher* on trees fertilized with urea, but *lower* on trees fertilized with ammonium nitrate, when compared to control trees.

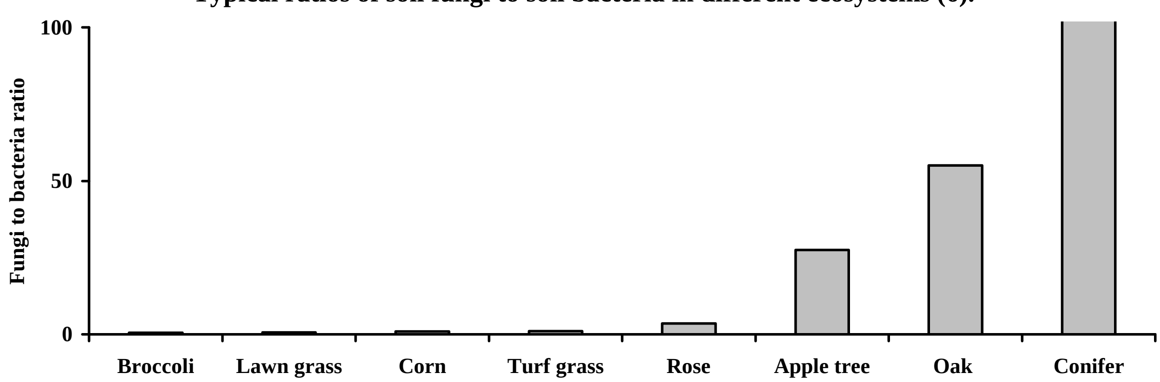
IV. THE SOIL BIOLOGY OF CONIFERS

The components of soil chemistry are fairly well understood. For example, we know that applying nitrogen will stimulate plant growth. The components of soil biology are much less understood. How many micrograms of fungal biomass per gram of soil are necessary for healthy spruce growth?

Across North America, researchers and private laboratories are currently attempting to quantify and characterize the soil microbes necessary for healthy plant growth (5). Although we lack a complete understanding for conifers, we already know of two important factors.

First factor, the ratio of fungi to bacteria is very different for conifer plants. Lawn and turf grasses prefer a root environment slightly dominated by bacteria. Quite the opposite, conifers have evolved in forests where the soils are highly dominated by fungi. The fungal biomass around conifer roots can be 100 to 1,000 times higher than the fungal biomass around turf grass roots.

Typical ratios of soil fungi to soil bacteria in different ecosystems (6).



Second factor, the type of fungi in the root environment is also very different between turf and conifers. Most turgrasses, vegetables, flowers, fruit trees and many ornamental shrubs and trees are associated with *endomycorrhizal fungi*. "Endo" refers to the fungi penetrating into the root.

On the other hand, most forest conifer trees and some hardwoods such as oak, beech and willow are associated with *ectomycorrhizal fungi*. "Ecto" refers to the fungal growth forming a thick sheath on the outside of feeder roots. Many ectomycorrhizal fungi produce mushrooms or puffballs, including the gourmet truffles.

BENEFITS OF MYCORRHIZAL FUNGI (7)

Mycorrhizae are specialized fungi that live on plant roots in a mutually beneficial relationship. The host plant supplies carbohydrates produced during photosynthesis. In return, the fungus grows an extensive hyphae network into the soil, transferring water and nutrients to the roots.

Researchers have documented many benefits when plants are inoculated with mycorrhizae.
Nutrient uptake: mycorrhizal roots usually grow faster and are much larger.
Stress tolerance: mycorrhizal plants show higher survival under drought conditions.
Disease resistance: mycorrhizal roots have an increased resistance to infection by soil diseases.

V. CORRECTING THE SOIL BIOLOGY

Mulches can be applied at the base of conifer plants to stimulate a fungal-dominated soil. Beneficial soil fungus prefer materials that are difficult to digest, high in cellulose and lignin, such as bark mulch, composts, dead leaves or newspaper. Avoid materials that decompose rapidly and stimulate bacteria, such as grass clippings and manures.

Commercial formulations of mycorrhizae products are sold in British Columbia for inoculation in special situations. Available products include the following:

- "Myke Pro", manufactured by Premier Tech Biotechnologies, www.premiertech.com. The ectomycorrhizal product, appropriate for most conifers, contains *Pisolithus tinctorius*, *Rhizopongon* sp., *Laccaria* sp., and *Scleroderma* sp.
- "mycorrhizaROOTS", manufactured by Roots Inc., www.rootsinc.com. This product contains species of ecto and endo mycorrhizae, plus humic acids.

VI. REFERENCES

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