Nutrient Deficiencies

Nutrient deficiencies arise from environmental factors, soil characteristics and conditions, crop management or a combination of factors.

The purpose of this publication is to address the issue of nutrient deficiencies for broad regions and soil types, and to offer management options and solutions for organic farmers in British Columbia. As well as provide additional resources/links for nutrient deficiency problems.

NUTRIENT DEFICIENCIES IN BRITISH COLUMBIA

Nutrient deficiencies deter B.C. organic producers from performing optimally. British Columbia's soil landscapes and climate vary widely, thus different nutrient deficiencies are common to different regions.

Visual nutrient deficiency symptoms are one way to diagnose issues within the soil-plant-air-animal complex. Soil testing, plant tissue analysis and other procedures are also tools useful for preventing and managing nutrient deficiencies for farmers and gardeners alike. Characteristic plant deficiency systems often identify a limiting/deficient nutrient; however crop damage is often severe by this point[1]. As well, nutrients considered sufficient by soil and plant testing may show as visual deficiency symptoms, due to other factors effecting nutrient uptake.

REGIONAL PRODUCTION

For this publication, the province is split into three regions: Humid Coastal, Southern Interior, and Northern Interior/Peace, British Columbia, based upon general climatic and soil conditions. It is recognized that many areas of each designation vary widely.

Different production types require different nutrient requirements and management. If you suspect a nutrient deficiency or that your farm has the potential for deficiencies, the first step is to assess the factors affecting your production. Nutrient deficiencies can arise from environmental factors, soil characteristics or conditions, crop management or a combination of factors.

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Created in partnership amongst COABC (Certified Organic Association of BC), Kwantlen University College /Horticulture, UBC (University of BC/Agroecology) and UCFV (University College of the Fraser Valley/Agriculture). For more information on Organic Factsheets contact the COABC office c/o 3402 32nd Ave Vernon BC, Canada V1T 2N1. Phone 250.260.4429

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Images: www.canadaselect.com/.../maps/BC_map.gif; http://www.avocadosource.com/tools/FertCalc_files/pH_file/pH.jpg

FACTORS INFLUENCING NUTRIENT AVAILABILITY

Many factors affect the growth of crops in any agricultural system, particularly climatic conditions and soil characteristics. The climatic environmental factors include temperature, moisture, and light energy. Soil characteristics include soil structure and composition, pH, soil biology, nutrient availability and any processes affecting availability[2]. All of these factors are interrelated and manageable to some extent.

Temperature: Most agricultural plants grow between 15^0 and 40^0, each crop requiring a specific range for different growth processes. Soil temperature affects soil air composition and therefore soil moisture, which in turn alter soil biological processes affecting nutrient availability. Nutrient absorption and uptake are also affected. Soil pH may experience changes with temperature, which is thought to be relative to microorganism activity.[2]

Moisture: Movement of nutrients to roots and nutrient uptake are limited by inadequate water, as most soil nutrients are water-soluble. Too much water can result in nutrient loss by leaching. Micro-organism activity is subject to soil moisture levels, too high or too low results in decreased nutrient transformations that process nutrients into plant-available forms [2].

Soil Structure and Composition: *Soil texture* (determined by size of mineral and organic matter particles) and *soil structure* (how soil particles are aggregated) influence nutrient retention capacity by altering porosity, compaction, and the cation exchange capacity (CEC: the capacity of a soil for ion exchange of positively charged ions between the soil and the soil solution; most plant nutrients are cations).

pH: Plant nutrients are most available between pH of 6.2 to 6.8 [3, 4]. In acidic soils below pH 5.5, and in alkaline soils, most (cationic) nutrients change form and are unavailable to plants [4].

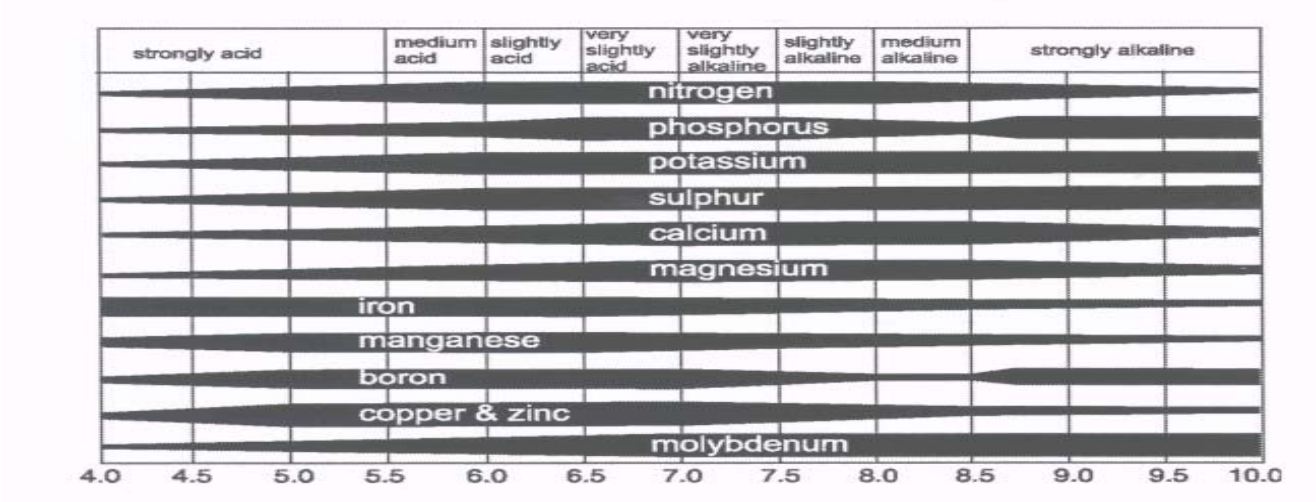
Factors Influencing Nutrients

FACTOR	INFLUENCE
Temperature	- Absorption - Uptake - Biological Processes
Moisture	- Uptake - Leaching - Transformations
Soil Structure/ Composition	- Retention Capacity
pH	- Availability - Biological Processes
Other Nutrients	- Balance Necessary

Biology: Biological activity responsible for nutrient transformations, making them more available for plant uptake, is most active in soil containing organic matter; soil that is warm and moist for some part of the year. pH between 6.2 and 6.8 is ideal for many beneficial organisms [3, 4.]

Other Nutrients: Some nutrients become less bioavailable when another nutrient is in excess. Please refer to the *Co-Dependent Nutrients* factsheet for further information.

Nutrient Deficiencies



pH and Nutrient Availability
(*http://www.avocadosource.com/tools/FertCalc_files/pH_file/pH.jpg*)

COMMON NUTRIENT DEFICIENCIES AND VISUAL SYMPTOMS

Nitrogen (N) is the most common limiting nutrient for western Canadian soils[1]. N fixation is most active between pH 6.2 and 6.8 [3], the production of nitrate stops at both high and low temperatures and in acidic soils[1].
Symptoms: Stunted crops and yellow lower leaves is common for deficient N [2, 4].
Management: Nitrogen is in adequate supply for organic systems that incorporate crop rotations with leguminous plants, utilize crop residues, and where necessary add manures[3].

Visual Symptoms

***See links to colour photos of deficiency symptoms at bottom of publication.*

Boron (B) Abnormal fruit growth and rotting[1]. leaf thickening, curling, and discoloration[2]. Additional symptoms for specific crops.

Calcium (C) Lack of growth and fast necrosis (brown, die-back) of stem, roots and leaf margins[5]. Abnormal fruit[1].

Copper (Cu) Lower leaves affected. For vegetables, dieback of leaves; for fruit trees, leaf chlorosis, stunted growth[1].

Magnesium (Mg) Interveinal yellowing (chlorosis) of older leaves[5]. Weak stems and curling of leaves[1].

Phosphorus (P) Retarded overall growth, especially of roots, and red or purpling of leaves[2, 5]. Dark green upper leaves[1].

Potassium (K) Chlorosis of outer leaf margins, beginning with lower leaves[2,4]. Weak stems and leaf mottling[1].

Sulfur (S) Difficult to assess deficiency through symptoms. Upper leaves may appear lighter green. Stunted growth[1].

Zinc (Z) Mottling of leaves, bud formation reduced. Blind buds. Small, thick leaves and interveinal yellowing[1].

HUMID COASTAL BC

The Coast Mountains and Islands experience wet winter soils with dry summer periods.

Iron (Fe) and aluminum (Al) oxides present under thick organic matter are prominent in coastal soils. Lower in the soil profile, hard, compacted layers are common.[6] Upland areas may have sandy soils susceptible to increased leaching.

Main Production: mixed farm, mainly mixed vegetable, with small livestock and some fruit; berries.

Unique Factors Influencing Nutrient Availability

Heavy rainfall 'accelerates soil acidification'[1]. Nutrient availability is greatly affected by low pH, where leaching is typical. While soil testing may show adequate amounts, problems may remain with limited nutrient availability and uptake by plants.

Common Deficiencies

Base Cations (Ca^+, Mg^+, and K^+):[1,4] limited by leaching and low pH. All may be unavailable in coarse textured soils[1].

Phosphorus (P): In coastal and acidic soils, P is naturally unavailable as it is retained in Al and Fe complexes[1], P is most available to plants between 5 and 6.5 pH. Many of these soils are high in P due to past management.

Management

Improving and maintaining soil structure will aid in nutrient retention and soil biological health.

Liming where applicable to raise soil pH and add Ca/Mg where deficient.

SOUTHERN INTERIOR BC

Moisture is the most limiting factor for the southern interior. Frost is also an important issue, particularly in valleys[1]. Many of the regions soils are fine textured and high in plant nutrients[7].

Main Production: tree fruit and wine grapes.

Unique Factors Influencing Nutrient Availability

Soils of arid regions are usually rich in minerals, particularly base cations (Ca^+, Mg^+, K^+, etc) and are productive when irrigated [4]. Low moisture conditions may restrict nutrient uptake. Excessive runoff or infiltration from irrigation may leach nutrients and acidify soils. Low organic matter is common of this region's soils.

Common Deficiencies

Boron: soils are often sufficient in boron, though its availability is diminished with a pH increase (from 5 to 7), and reduced with low soil moisture[1].

Zinc (Zn), Copper (Cu), Phosphorus (P) and Iron (Fe): nutrients may be unavailable in alkaline soils (of high pH)[1]. Availability decreases with pH increase (5 to 7).

Management

Monitoring pH is important to the availability of common limiting nutrients in the Southern Okanagan *(P, Zn, Cu, Fe, B)*.

NORTHERN INTERIOR/PEACE

This region is characterized by low to moderate precipitation, cooler temperatures and a short intense growing season with long days[7]. Soils vary widely in texture, from clays to sandy, and vary greatly in their ability to provide base cation nutrients such as Ca^+, K^+ and Mg^+. Higher moisture retention is standard further north and east[7].

Main Production: vegetables, grains and forage crops

Unique Factors Influencing Nutrient Availability

Short periods of warm weather and cool soil temperatures influence the rate of organic matter decay and other biological functioning. Such a reduction in the transformation of nutrients into plant available forms differentiates this region from other areas of the province.

Common Deficiencies

Boron (B): an issue for the interior northern region as well as the southern [see *B* section above].

Sulfur (S): may be a problem for alfalfa and other crops. Sulfur acidifies soil and can be easily leached from the soil profile[1].

Management

Improving growing conditions in cool weather, via a hoop- house or other climatic alteration, may be a better solution than adding temporary, soluble, nutrients for intensive production[3]. Building higher levels of nutrients in open field production may be necessary to compensate for cool soils.

Organic matter recycling supplies soil with sulphur[1], however in cold regions the temperature may not be sufficient for O.M. breakdown.

OPTIONS AND SOLUTIONS

Organic farm management relies on long-term integrated approaches rather than short-term fertility solutions suggested by conventional agriculture[8]. Elliot Coleman[3] differentiates two ways of fertilizing a plant; the first is feeding the plant directly, a temporary management strategy (if soil processes are deemed inadequate). The second is to feed the soil, and by enhancing soil health and natural processes, allowing the soil to provide for the plants[3].

LINKS

***Crop Nutrient Deficiency Symptoms Pictures*

-Colour images of mineral nutrient deficiencies. http://www.enst.umd.edu/enst411/index.htm

-Images arranged by crop type. http://www.hbci.com/~wenonah/min-def/list.htm

Soil Survey and Regional Landscape Info.

-Soil survey information with descriptions of soil properties, land use options, and mapping. http://nlwis-snite1.agr.gc.ca/slc-ppc30/index.phtml?lang=en-CA#

-Major characteristics of soil and land for Northern and Southern B.C. Link to colour pictures and soil profiles at bottom of page. http://sis.agr.gc.ca/cansis/nsdb/slc/intro.html