

MICRONUTRIENT DISORDERS IN BLUEBERRIES

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Ideal Blueberry Site

- Well-drained soil
- Low soil pH
- High organic matter
- Full sunlight
- Good air circulation
- Access to supplemental water

One Word: Complex

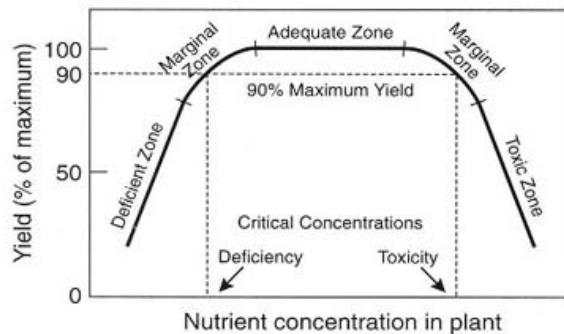
- Even though symptoms may indicate a single issue, the real problem is likely more complex
- The natural environment has many variables, all which interact with one another
- The soil may not release nutrients with 100% efficiency
- Plants may not utilize nutrients with 100% efficiency
- Lower efficiencies due to environment (i.e. soil pH)

Liebig's Law of the Minimum



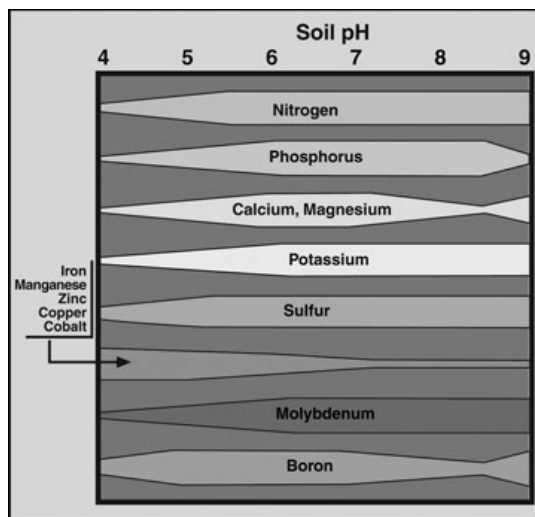
<http://corn.osu.edu/newsletters/2011/2011-04/adjusting-the-barrel-stave-concept>

Nutrient Concentration and Yield



<http://www.commodities.caes.uga.edu/turfgrass/georgiaturf/SoilTesting/analysis.html>

The Role of Soil pH



<http://extension.missouri.edu/p/MG4>

What are the Micronutrients?

- Boron (B)
- Copper (Cu)
- Iron (Fe)
- Manganese (Mn)
- Molybdenum (Mo)
- Zinc (Zn)

Some Known Interactions Involving Micronutrients

- Phosphorus ↑-- Zinc ↓, Copper ↓
- Calcium ↑-- Boron ↓
- Copper ↓-- Zinc ↑
- Manganese ↓-- Iron ↑
- Iron ↑-- Zinc ↓
- Some effect are still unknown in blueberries

What are the Functions of Boron?

- Boron
 - Maintains balance between sugar and starch
 - Translocation of sugar and carbs
 - Cell division, nitrogen metabolism, protein formation
 - Cell wall formation
 - Cell membrane function
 - Transport of Potassium to guard cells for control of internal water balance

Boron (B)

- Shoot die-back in deficient plants
- Terminal leaves small, misshapen, may appear “blue-ish”
- Yellowing or yellow spotting along leaf margins possible
- Can be toxic – difference between sufficient and toxic is small

B Deficiency



**Blueberry Tip Dieback
Due To B Deficiency**



Gary Pavlis, Rutgers

<http://www.spectrumanalytic.com/support/library/pdf/Fertilizing%20Blueberries.pdf>

B Symptoms

Blueberry B Symptoms Deficient Through Toxicity



0 0.2 0.4 0.8 1.6 3.2

**Soil B Levels
(ppm B by Hot Water Extraction)**

<http://www.spectrumanalytic.com/support/library/pdf/Fertilizing%20Blueberries.pdf>

B Toxicity



<http://westernfarmpress.com/orchard-crops/blueberry-iron-chlorosis-photo-gallery>

What are the Functions of Copper?

- Copper
 - Catalyst in photosynthesis and respiration
 - Building and converting amino acids to proteins
 - Carbohydrate and protein metabolism
 - Formation of lignin in plant cell walls

Copper (Cu)

- Deficiency symptoms may include:
 - Mouse earring of leaves
 - Shoot dieback (also called Stem Blight)
- Can kill plant

Cu Deficiency



<http://www.growingproduce.com/article/13567/blueberry-report-managing-micronutrients>

What are the Functions of Iron?

- Iron
 - Chlorophyll development and function
 - Energy transfer
 - Plant respiration and metabolism
 - Nitrogen fixation

Iron (Fe)

- Deficiency symptoms first seen as interveinal chlorosis in young leaves
- Veins are green
- Can occur when:
 - Soil has pH >5.3-5.5
 - Excess lime or P
 - Waterlogged conditions
 - During drought when high pH water used for irrigation

Fe Deficiency Symptoms



John Hartman, University of Kentucky, Bugwood.org

What are the Functions of Manganese?

- Manganese
 - Assimilation of carbon dioxide in photosynthesis
 - Synthesis of chlorophyll and nitrate assimilation
 - Activates enzymes
 - Electron transport during photosynthesis

Manganese (Mn)

- Not usually an issue unless pH <4.0
- When pH this low, Mn becomes toxic to plant
- Reddening of leaves
- At high levels (toxicity) defoliation may occur

Mn Toxicity



**Mn Toxicity Symptoms
in Blueberry**

<http://www.spectrumanalytic.com/support/library/pdf/Fertilizing%20Blueberries.pdf>

What are the Functions of Molybdenum?

- Molybdenum
 - Converts nitrates into amino acids
 - Converts inorganic Phosphorus to organic forms

Molybdenum (Mo)

- Plant symptoms unclear
- Possible deficiency symptoms (based on other plant species)
 - Chlorosis
 - Leaf deformities
 - Poor fruit set

What are the Functions of Zinc?

- Zinc
 - Auxin production
 - Activates enzymes
 - Regulation and consumption of sugars
 - Starch formation
 - Root development
 - Formation of chlorophyll and carbs

Zinc (Zn)

- Deficiency shows interveinal yellowing of young leaves (like Fe)
- Leaves small, shortened internodes
- Mainly noticeable early in season



Similar to Fe symptoms shown here

Foliar Nutrient Levels (Highbush)

| Element | Deficient (ppm) | Sufficient (ppm) | Excess (ppm) |
|---------|-----------------|------------------|--------------|
| Mn | <23-25 | 50-350 | >350 |
| Fe | <60 | 60-200 | >200 |
| Zn | <8 | 8-30 | >30 |
| Cu | <5 | 5-20 | >20 |
| B | <20 | 30-70 | >70 |
| Cl | | | >350? |
| Mo | | >1? | |

Foliar Nutrient Levels (Rabbiteye)

| Element | Deficient (ppm) | Sufficient (ppm) | Excess (ppm) |
|---------|-----------------|------------------|--------------|
| Mn | <23-25 | 50-100 | >100-125 |
| Fe | <60? | 40-60? | >70 |
| Zn | <8 | 10-25 | >25 |
| Cu | <5 | 5-10 | >10 |
| B | <20 | 12-20? | >35 |
| Cl | | | >350? |
| Mo | | >1? | |

Rectifying Micronutrient Deficiencies

| Nutrient | Common Materials | Timing |
|----------|---|-----------------------------------|
| B | Boric acid/ Solubar | Leaves present |
| Fe | Ferrous sulfates/ Iron chelates | Symptoms appear |
| Mn | Manganese sulfate/ Manganese chelate | Leaves present |
| Zn | Zinc sulfates/ Zinc chelates | 1 to 3 times in growing season |
| Cu | Copper sulfates/ Copper chelates | Leaves present |
| Mo | Sodium molybdate | Leaves present |