Introduction

- Bachelor of Science in Agronomy
- Research Associate at Monsanto for 13 years
- Research in soil carryover of herbicides, insecticide seed treatments and insect control
- Currently working in drought tolerant corn
- Previously worked in corn breeding program in Hawaii
Introduction

Planting on ground for the second season, began to notice problems with corn crop including:
- Curled ear tips
- Abortive kernels and incomplete ears
- Banded interveinal chlorosis
- Stunted growth

Normal fertilizer regime was not correcting problems

Meeting with agronomist confirmed micronutrient deficiencies
Introduction

Agronomy 512 – presentation on micronutrient issues in Maui

Difficulties finding consolidated and helpful information on micronutrients
The Module

- Objectives
- Introduction
- Micronutrients, each in five parts
  - Function
  - Availability
  - Deficiency symptoms
  - Toxicity symptoms
  - Sources
- Additional information
- Summary
- Quiz
The Objectives

- Define the function of each micronutrient within the plant
- Identify the availability and movement in soil and plants
- Identify deficiency and toxicity symptoms
- Suggested amendments for deficiencies
General Information

- Mass flow
- Diffusion
- Root interception
- Passive and active transport
General Information

- Cofactors and redox reactions
  - Photosynthesis
  - Respiration
- Chelation
General Information

🌟 Soil pH and availability
The Micronutrients

- Boron
- Chlorine
- Copper
- Iron
- Manganese
- Molybdenum
- Nickel
- Zinc
The Micronutrients: Boron

Function in the Plant

- Cell wall formation and integrity
- Protein synthesis
- Flower retention
- Pollen formation and germination
- Seed and grain production
The Micronutrients: Boron

Availability
- Anion that occurs as borate, B\textsubscript{O\textsubscript{3}}\textsuperscript{-}
- Decomposing organic matter is primary source
- Moves via mass flow and diffusion
- Most often lost through leaching
- Most available from pH 5.5-7.0
- Volcanic, organic, sandy and fine textured soils more susceptible to deficiencies
- Drought exaggerates deficiency symptoms
- Moderately mobile within the plant
The Micronutrients: Boron

Deficiency Symptoms

- Abnormal growth at meristems
- Brittle leaves and stems
- Decreased nitrate content
- Flowering and fruiting interruption
- Poor yield
- Discolored/deformed grain
- Beans can show interveinal chlorosis
- Causes hollow heart in beans
The Micronutrients: Boron

Toxicity Symptoms

- Yellow leaf tips
- Scorched leaf appearance
- Drop off of leaves
- Interveinal chlorosis
- Delayed pollination in corn
- Stunted soybean plants
- Crinkled leaves
The Micronutrients: Boron

Sources

- Not found as free element
- Manure/organic matter
- Borax (11% boron)
- Colemanite (10% boron)
- Solubor (20.5% boron)
Additional Information

- Several summary tables provided
- Helpful books and websites
- References

Summary

- Brief summary
Exam Questions

1. Identify the micronutrient deficiency causing interveinal chlorosis:
   a. Zinc
   b. Iron
   c. Manganese
   d. Boron

Correct: C, Manganese
distinct interveinal chlorosis caused by manganese deficiency
Exam Questions

19. Which micronutrient and enzyme are responsible for fixing nitrogen in legume crops?

a. Molybdenum and nitrogenase  
b. Nickel and urease  
c. Zinc and alcohol dehydrogenase  
d. Manganese and superoxide dimutase

Correct: A, Molybdenum and nitrogenase
Acknowledgements

- Dr. Allan Ciha
- Tom Schulz
- Jesse Drew
- Jill Litwiller
- Jaci Severson
- Dr. Ken Moore
- Dr. Tom Loynachan
- Maria Lux