The Role of Nutrients in Pest Management

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Overview

- Background
- Disease pyramid
- Definitions
- Effects of soil conditions on disease
- How elements affect diseases/pests
  - N, P, K, Ca, Mg, Mn, Zn, Si
- References
Background

“The primary reason to monitor is to improve your ability to make good pest management decisions.”

- IPM in Practice, 2001 ed.

Why bother plant nutrition testing?

“Soil tells you what happened. Plant tissue tells you what is happening. Water tells you what will happen.”

-E. Simonne

Determination of yield-limiting factor
Background (cont’d)

Integrated Plant Nutrition

- Soil texture
- pH
- Organic matter
- Leaching
- Erosion
- Nutrient availability

- Reduced erosion
- Balanced pH
- Reduced leaching
- Increased nutrient availability

- Expected yield
- Nutrient removal
- Variety selection
- Intercropping, planting method
- Water management
- Weeds, pests management

Nutrient Management

- FYM/Compost
- Green manures
- Organic matter
- Biological fixation
- Chemical fertilizers
- Residue management

Soil Management

Crop Management

Decision Environment

- Market access
- Labour availability
- Social equity
- Natural resources
- Food quality

FAO, 2005
Disease pyramid vs. IPM vs. Sufficiency Range

- Susceptible Host/Crop
- Sufficient Time
- Favorable Environment
- Pathogen!
- Pest!
- Deficiency!
- Toxicity!
Definition of an epidemic

“An epidemic occurs when there is a change in disease intensity in a host population over time and/or space.”

-Kranz, 1974

- Incidence: proportion of the plant population being affected (field)
- Severity: proportion of the plant being affected (individual)
Field signatures

- Random hotspots
- Diffuse edges: insects vs. soilborne pathogens
- Uniform: rusts, pollution, drift, nutrition

- Symptoms: damage to the host plant (e.g., yellowing, stunting)
- Signs: visual confirmation of the cause of the damage (e.g., insect, fungus)

L.L. Mount, 2012
The last few terms

- **Avirulence**: inability of a disease agent to infect a plant with genetic **resistance**
- **Virulence**: ability of a pathogen to cause disease
- **Resistance**: ability of a host plant to exclude/overcome a disease or other damaging factor
- **Tolerance**: ability of a host plant to endure damaging factor without debilitating injury or crop loss
Effects of soil pH & structure on disease, insects

- Increased incidence & severity of cotton root rot (*Phymatotrichopsis omnivora*) on peach in soils with high CaCO$_3$ content (SW US & northern Mexico) (Cribben, 2013)

- Increased virulence of downy mildews at acid pH
  - clubroot of crucifers (*Plasmodiophora brassicae*) highly virulent at pH 5.7, mildly at 6.2; gone by 7.8 (Webster and Dixon, 1991)
Nitrogen

- New growth, delayed maturity
- Under-fertilization of N can lead to increased early blight (*Alternaria solani*) on potato (MacKenzie, 1981); fusarium wilt (*Fusarium oxysporum*) on melons (Egel and Martyn, 2013)
- Over-fertilization can lead to increased disease susceptibility
  - Fire blight (*Erwinia amylovora*) on apple, pear (Johnson, 2015)
- Over-fertilization can lead to greater disease severity
  - *Rhizoctonia solani* on rice (Datnoff, 1994)
Nitrogen

- Form of nitrogen (ammonium, nitrate) effects severity of disease (Huber and Watson, 1974)
  - Acid-loving soil diseases are more severe when crop is fertilized with ammonium-N (fusarium root rot, clubroot)
  - Take-all of wheat (*Gaeumannomyces graminis*), potato scab prefer nitrate-N
Nitrogen

- Aphids and white flies are attracted to yellow, repulsed by dark green, blue (Smith, 1976; Cohen and Melamed-Madjar, 1978)
Phosphorus

- Reduces severity
  - Take-all (*G. graminis*) of wheat (Brennan, 1989)
  - Potato scab (*Streptomyces scabies*) (Davis et al., 1976)
Potassium

- Reduces drought stress, frost injury, may affect pathogen establishment (Wang et al., 2013)
- Delays maturity/senescence in some crops, increases vulnerability to facultative pathogens, parasites (Hendrix and Campbell, 1973)
- Decreases disease severity
  - Early blight of tomato (Blachinski et al., 1986))
  - Rice blast (*Magnaporthe grisea*) (Datnoff, 1994)
- High K levels increase severity
  - Southern root knot (*Meloidogyne incognita*) (Marks and Sayre, 1964)
  - White tip of rice (*Aphelenchoides oryzae*) (Datnoff, 1994)
Calcium

- Generally increases disease resistance through plant defense responses (Lecourieux et al., 2006)
  - *Ditylenchus dipsaci* (Sherwood and Husingh, 1970)
Magnesium

- Phytoplasmas & spiroplasmas inhibit Mg uptake (de Oliveiro et al., 2002)
- Decreases disease
  - Fusarium wilt (Huber and Jones, 2012)
Manganese

- Reduced disease
  - Take-all (Bockus and Tisserat, 2005)

- Increased disease
  - *Phytophthora cinnamomi* on avocado (Huber and Wilhelm, 1988)
Zinc

- Reduced disease in HLB-infected citrus (Iftikhar et al., 2016)
  - January pruning with vector control & fertilization
  - ZnSO4 + MnSO4 foliar application for under 2 months
Silicon

- Reduces disease (Datnoff, 1994)
  - Sheath blight (*R. solani*) of rice
  - Rice blast (*M. grisea*)
References


Thank you! Questions?

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