NRCCA Basic Training

Management of Infectious Plant Diseases

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With content adapted from Dr. Gary Bergstrom, Cornell University

Objectives

- Intro to Plant Pathology terms and concepts
- Types of pathogens
- Specific disease examples
- Mycotoxins

General Plant Pathology 101: Terms and Concepts

- **Plant Disease**: a condition of a plant of abnormal growth or function caused by a living pathogen
- **Plant Pathogen**: a living organism that can incite a plant disease

- **Parasite**: requires a living host to feed and reproduce (pathogens)
- **Saprophyte**: a microorganism that feeds on a non-living host (usually secondary invaders)

General Plant Pathology 101: Terms and Concepts

- **Symptoms**: External and internal reactions or alterations of a plant as a result of a disease
  - Leaf spots, root rot, chlorosis, dead plants, lesions, galls

- **Signs**: The pathogen or its parts or products observed on an infected host plant
  - Sporulation, mycelium, bacterial oozing

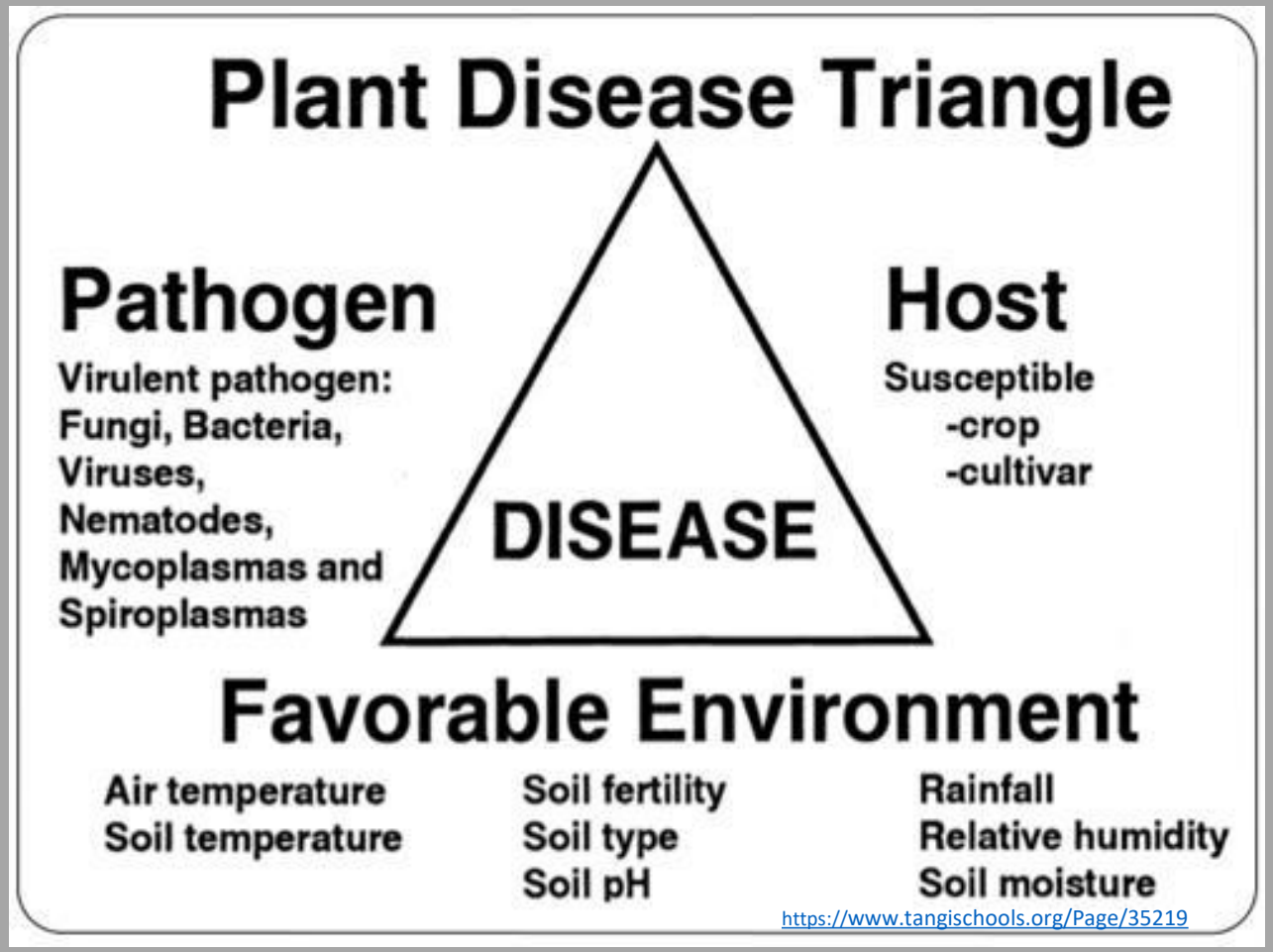
General Plant Pathology 101: Terms and Concepts

How Plant Pathogens Spread:

- Rain
- Wind
- Irrigation and drainage water
- Soil movement
- Insects
- Crops debris movement
- Within seeds and other plant propagation materials
- Humans
- Machinery and tools

General Plant Pathology 101: Terms and Concepts

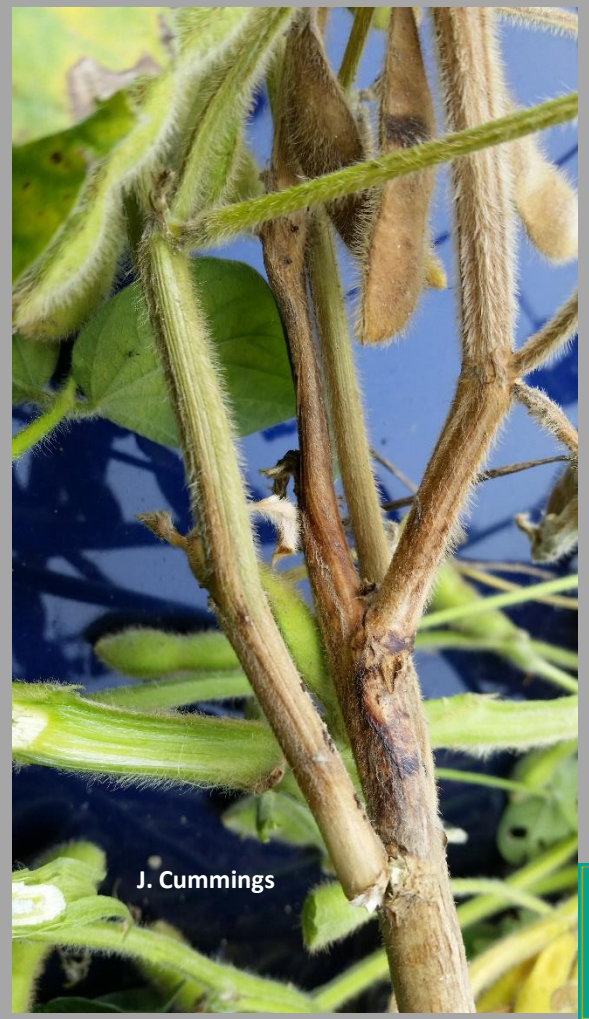
Disease Development in Plant Populations:



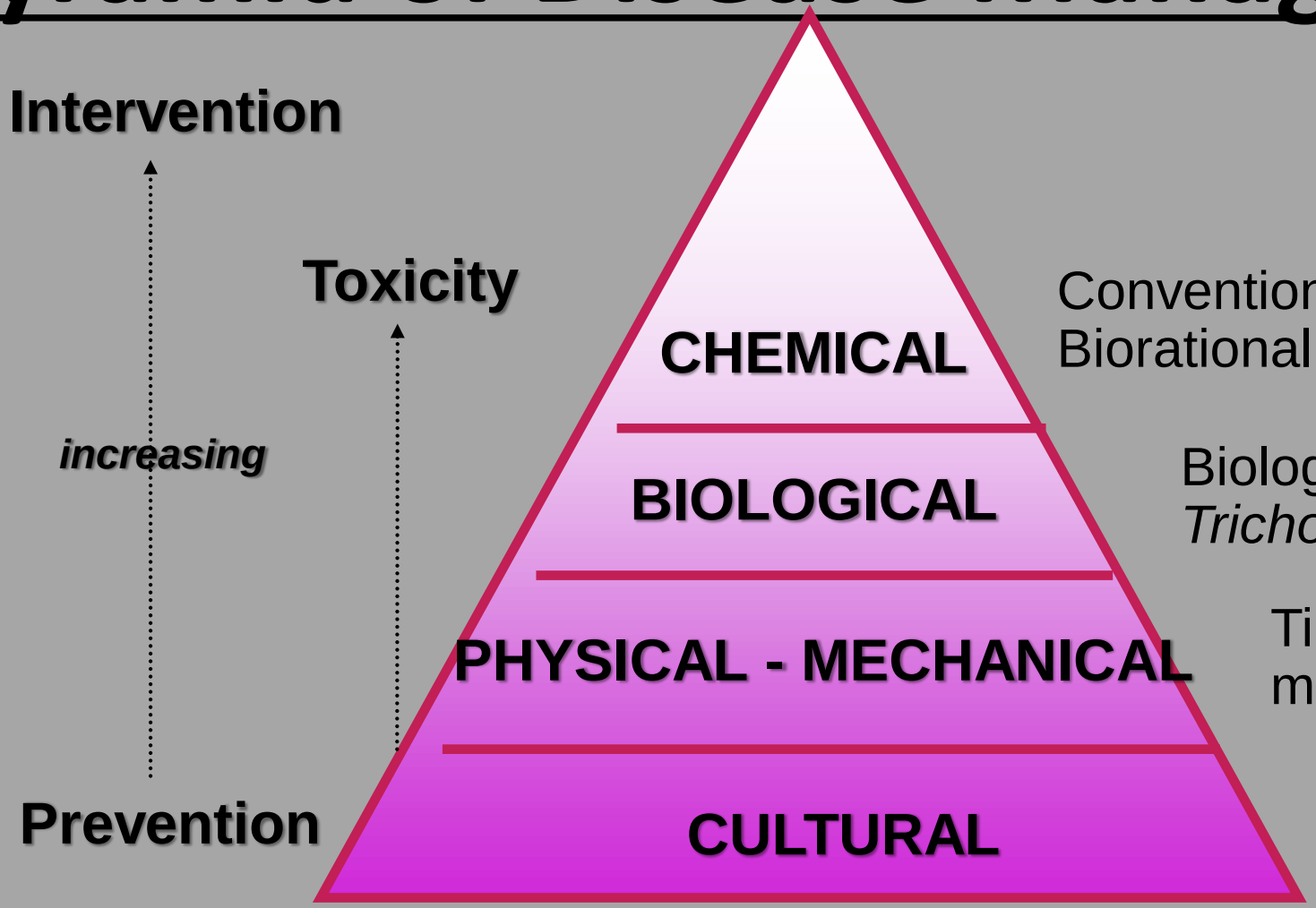
General Plant Pathology 101: Terms and Concepts

Factors Affecting Disease Epidemiology and Management:

- **Pathogen dissemination potential**
  - Long-distance, regional, local
- **Survival potential in debris or soil**
  - Overwintering capability, longevity of survival structures
- **Vector relationships**
  - Timing of arrival and abundance of vectors
- **Favorable environment**
  - Temperature, moisture



Pyramid of Disease Management Tactics



Conventional, Organic or Biorational pesticides, PGRs

Biological pesticides (*Bacillus*, *Trichoderma*, etc.)

Tillage for residue management, mulching

Varietal selection, seed certification, plant populations, crop rotation, planting date, fertility, pH, irrigation

Pyramid diagram modified from PSU IPM

General Plant Pathology 101: Terms and Concepts

Cultural Methods for Managing Plant Diseases:

- Select adapted cultivars with disease resistance
- Crop rotation and cropping sequence
- Tillage and residue management
- Site selection for drainage
- Balanced fertility and pH
- Adjusting planting and harvest dates
- Sanitation of equipment
- Weed and insect management

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General Plant Pathology 101: Terms and Concepts

Fungicides for Disease Management:

Contact Fungicides

- Protectant only, not curative
- Non-penetrant
- Broad spectrum
- Multi-site inhibitors
- Lower risk for resistance

Systemic Fungicides

- Protectant and some curative
- Penetrant and distributed throughout plant
- Specific-site inhibitors
- Selective, specific target
- Higher risk for resistance

General Plant Pathology 101: Terms and Concepts

Integrated Management of Plant Diseases:

- Understand **field history** of diseases
- **Varietal selection** and use of **certified, pathogen-free seed**
- **Crop management**: planting date, cropping sequence, tillage practices, plant populations, fertility, pH, weed and insect management, irrigation and drainage
- **Scouting**: monitor regularly for disease and economic thresholds for timely management decisions
- **Pesticides**: apply fungicides according to disease risk: crop susceptibility, growth stage, and environmental conditions for best return on investment
- Plan and execute a **timely harvest** strategy

General Plant Pathology 101: Terms and Concepts

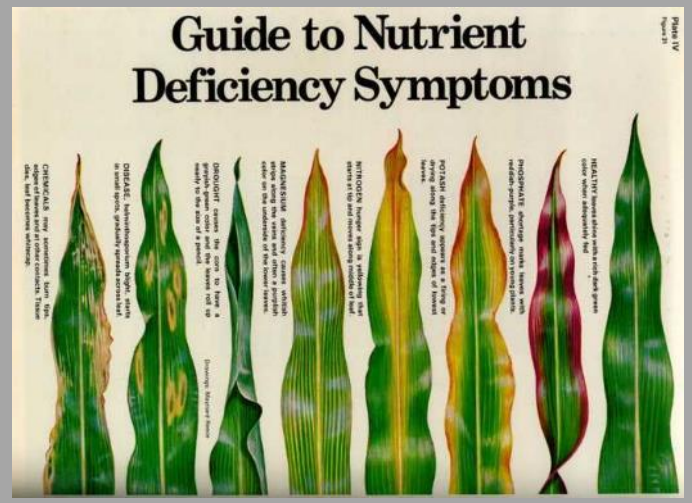
Abiotic Stresses are NOT Diseases:

Nutrient deficiencies or toxicities

Drought Stress or Flooding

Inadequate soil pH

Heat stress or frost injury

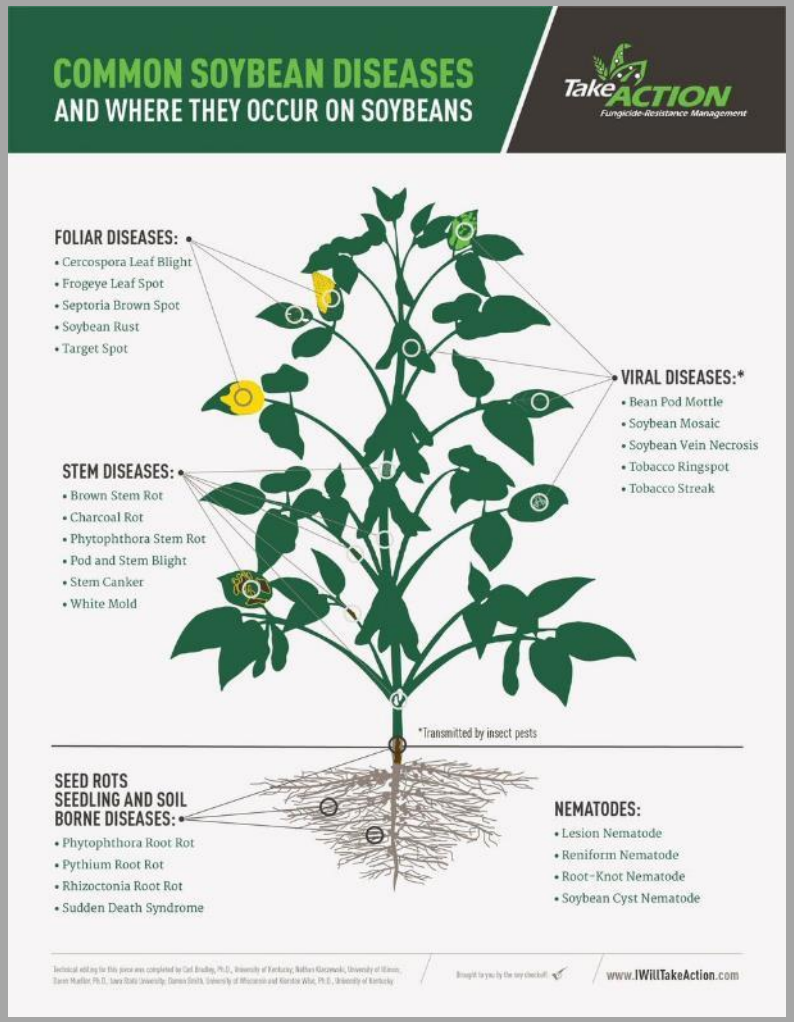


Hail or other mechanical damage

But they may leave plants more susceptible to diseases

General Plant Pathology 101: Types of Pathogens

- **Causal Agents of Infectious Diseases:**
  - Fungi
  - Oomycetes (aka: water molds)
  - Bacteria
  - Viruses
  - Nematodes
  - Spiroplasmas, Mycoplasmas



General Plant Pathology 101: Types of Pathogens

- **Fungi:** non-photosynthetic eukaryotes in the kingdom Fungi that produce enzymes to break down matter to absorb food
  - Mushrooms, molds, mildews, yeasts, smuts, rusts
- Fungi typically produce a web-like network, called **mycelium** or **hyphae** and produces reproductive structures called **spores** or **conidia**
- Many foliar diseases are caused by infectious spores that germinate and invade leaf and stem tissues
- Many root diseases are caused by mycelium penetrating roots or germinating seeds
- Can be soilborne, airborne, seedborne, or within planting stocks

General Plant Pathology 101: Types of Pathogens

Common Examples of Fungal Diseases of Field Crops in the Northeast:

- **Anthracnose** and **Giberella stalk rot** of corn
- **Common smut** of corn
- **Northern corn leaf blight** and **Eyespot** of corn
- **Powdery mildew** and **rust** of wheat
- **Fusarium head blight** of wheat
- **Verticillium wilt** of alfalfa
- **Septoria brown spot** of soybean
- **White mold** of soybean

General Plant Pathology 101: Types of Pathogens

Management of Fungal Diseases:

- Resistant varieties (may be race-specific)
- Timely planting and harvest
- Crop rotation and residue management
- Improve drainage and compaction
- Fungicidal seed treatments
- Foliar fungicides

General Plant Pathology 101: Types of Pathogens

- **Oomycetes:** non-photosynthetic eukaryotes in the kingdom Chromista that produce enzymes to break down matter to absorb food
  - Downy mildew, Pythium, Phytophthora, = water molds
- Fungal-like organisms that produce a web-like network, called **mycelium** or **hyphae** and produces reproductive structures called **sporangia,** motile **zoospores** or **oospores**
- Can be soilborne, airborne, seedborne, or within planting stocks

Oomycetes	Fungi
Cellulose in cell walls	Chitin in cell walls
Hyphae are non-septate	Hyphae are septate
Can have motile spores	Non-motile spores

General Plant Pathology 101: Types of Pathogens

Common Examples of Oomycete Diseases of Field Crops in the Northeast:

- **Downy mildew** of soybean
- **Pythium damping-off** of several crops
- **Phytophthora root rot** of alfalfa
- **Phytophthora root and stem rot** of soybean

The most infamous Oomycete disease:

Late Blight of Potato - Irish Potato Famine in the 1840's

General Plant Pathology 101: Types of Pathogens

Management of Oomycete Diseases:

- Resistant varieties (may be race-specific)
- Planting when soils are adequately warm
- Crop rotation and residue management
- Improve drainage and compaction
- Seed treatments that target oomycetes/damping-off
- Foliar fungicides that target oomycetes (limited options)

General Plant Pathology 101: Types of Pathogens

- **Bacteria:** single-celled microorganisms which multiply by division
- Can cause stalk rots, foliar blights, seed rots, and vascular wilts
- Can be transmitted via insects, mechanical injury, splashing
- Can be soilborne, airborne, seedborne, or within planting stocks

General Plant Pathology 101: Types of Pathogens

Common Examples of Bacterial Diseases of Field Crops in the Northeast:

- **Bacterial Blight and Bacterial Pustule** of soybean
- **Bacterial leaf streak** of wheat and barley
- **Bacterial wilt** of alfalfa
- **Stewart's wilt** of corn (transmitted by corn flea beetle)
- **Holcus leaf spot** of corn

General Plant Pathology 101: Types of Pathogens

Management of Bacterial Diseases:

- Resistant varieties
- Crop rotation and residue management
- Manage insect vectors
- Purchase certified, pathogen-free seed

General Plant Pathology 101: Types of Pathogens

- **Viruses:** very small particles that consist of genetic material encased in a protein capsule which can only reproduce within a living organism
- Often cause distortion or discoloration of plant parts
  - Cupping or curling of leaves, mosaic or mottled discoloration
- Can be transmitted via insects, microorganisms or mechanical injury
- Can be soilborne, seedborne, or within planting stocks

General Plant Pathology 101: Types of Pathogens

Common Examples of Viral Diseases of Field Crops in the Northeast:

- **Barley yellow dwarf virus** of small grains (transmitted by aphids)
- **Soilborne wheat mosaic virus** of cereals (transmitted by protozoan)
- **Wheat spindle streak mosaic virus of wheat** (transmitted by protozoan)
- **Soybean mosaic virus** (transmitted by aphids)
- **Soybean vein necrosis virus** (transmitted by thrips)

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General Plant Pathology 101: Types of Pathogens

Management of Viral Diseases:

- Resistant varieties
- Manage insect vectors
- Purchase certified, pathogen-free seed


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General Plant Pathology 101: Types of Pathogens

- **Nematodes:** very small worm-like animals
- Often infect through the roots and plants more susceptible to other diseases
- Usually found in the soil, but there are foliar nematodes
- **Example:** soybean cyst nematode
- **Management:** resistant varieties, crop rotations, nematicidal seed treatments

Examples of Common Diseases of Field Crops in the Northeast

General Plant Pathology: Fungal Disease Examples

Powdery Mildew of Wheat

- *Blumeria graminis* f. sp. *tritici*
- Specific to wheat, no other host
- Infection on leaves and stems via spores
- Favored by high humidity and moderate temperatures with dense stands and high N
- Airborne, and survives on infected debris and stubble
- Management: resistant varieties, foliar fungicides

General Plant Pathology: Fungal Disease Examples

Northern Corn Leaf Blight

- *Exserohilum turcicum*
- 'canoe-shaped' lesions on leaves
- Infection via windblown spores that survive on crop residues
- Many races of the pathogen
- Favored by leaf wetness and moderate temperatures
- Management: resistant hybrids (race specific), residue management and crop rotation, foliar fungicides

General Plant Pathology: Fungal Disease Examples

White Mold of Soybean

- *Sclerotinia sclerotiorum*
- Very wide host range
- Infection on stems via spores
- Favored by high humidity and moderate temperatures with dense stands
- Soilborne, and very long-lived in the soil as sclerotia
- Management: foliar fungicides, crop rotation, tolerant or early maturing varieties

General Plant Pathology: Fungal Disease Examples

Fusarium Head Blight of Wheat

- *Fusarium graminearum*
- Can infect all grain crops – wide host range
- Infection of heads via spores during flowering
- Favored by high humidity during flowering
- Produces mycotoxins
- Local and regional inoculum overwinters on crop debris
- Management: resistant varieties, residue management, foliar fungicides

General Plant Pathology: Fungal Disease Examples

Common Smut of Corn

- *Ustilago maydis*
- Specific to corn
- Galls on ears, tassels, leaves
- Infection via spores that survive in the soil or crop residues
- Favored by heat and drought, and mechanical injury (deer feeding)
- Management: resistant hybrids, avoid mechanical injury and excess nitrogen

General Plant Pathology: Oomycete Disease Examples

Phytophthora Root and Stem Rot of Soybean

- *Phytophthora sojina*
- Infection through roots and crowns via spores
- Causes root and stem rot, seedling or plant death
- Favored by wet soil conditions
- Soilborne, with long-term survival within the soil
- Management: resistant varieties, improve drainage, crop rotation

General Plant Pathology: Oomycete Disease Examples

Downy Mildew of Soybeans

- *Peronospora manshurica*
- Specific to soybean – no other host
- Infection through leaves via spores
- Causes leaf spots
- Favored by high humidity and moderate temperatures
- Seedborne, and can overwinter on crop residues
- Management: resistant varieties, seed treatments, limited fungicides

General Plant Pathology: Oomycete Disease Examples

Phytophthora Root Rot of Alfalfa

- *Phytophthora medicaginis*
- infects alfalfa and other leguminous forages
- Infection through roots via spores
- Causes root rot, seedling or plant death
- Favored by wet soil conditions
- Soilborne, with long-term survival within the soil
- Management: resistant varieties, seed treatments, improve drainage, crop rotation

General Plant Pathology: Bacterial Disease Example

Bacterial Blight of Soybean

- *Pseudomonas syringae*
- Very common and widespread
- Foliar infection spread by rain or dew
- Favored by cool, wet weather
- Survives on crop debris
- Management: resistant varieties, crop rotation and residue management

General Plant Pathology: Viral Disease Example

Barley Yellow Dwarf Virus

- Very common and widespread among cereal crops
- Transmitted by aphids, especially in early planted fields during times of high aphid populations
- Survives in infected aphids and grasses
- Management: plant after Hessian fly-free date, systemic seed insecticides

General Plant Pathology: Nematode Example

Soybean Cyst Nematode

- *Heterodera glycines*
- Females infest roots
- Causes stunting and chlorosis
- Very long-lived in soil
- Management: crop rotation, resistant varieties (race specific), nematicidal seed treatments


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Mycotoxins

Mycotoxins

- Low molecular weight fungal by-products
- Predominantly secondary metabolites
- Toxic to vertebrates in very low concentrations
- Produced under favorable environmental conditions
- Only problematic when above levels of concern

Mycotoxin:	Level of concern:	Common effects on animals:
Deoxynivalenol (vomitoxin)	1-3 ppm	Feed refusal in monogastric animals; severity increases with level. Swine are the most sensitive species. Adult cattle and poultry tolerate > 10 ppm.
Zearalenone	1-5 ppm	Hyperestrogenism and infertility. Swine (gilts) are most sensitive. Adult cattle tolerate 50 ppm.
Fumonisins	5-10 ppm	Brain deterioration, death (horses); liver damage (horses, swine, cattle, poultry, others).

Mycotoxins

- The dose matters!
- Usually measured in ppm or ppb
- Approximate LD_{50} of some common chemicals:

• Ethyl alcohol	10 grams
• Saccharin	4
• Benzene	0.3
• Chloroform	0.2
• DDT	0.1
• Formaldehyde	0.008
• Sterigmatocystin	0.00009
• Aflatoxin	0.000005

Predominant Mycotoxins in the Northeast

- **Deoxynivalenol (DON):** *Fusarium graminearum* (and other species)
  - Common in wheat, barley, corn grain and silage
  - Feed refusal, vomiting, digestive issues
  - Worse in animals with simple stomachs (swine, dogs)
- **Zearalenone (ZON):** *Fusarium graminearum*
  - Common in corn grain and silage
  - Estrogenic compound that causes reproductive disorders (swine)
- **Fumonisins:** *Fusarium verticillioides* (and other species)
  - Uncommon in corn grain and silage in northeast
  - Fatal brain disease in horses, liver damage (horses, swine, cattle, poultry)

Other Mycotoxins in the Northeast

- **Aflatoxins:** *Aspergillus flavus*
  - Uncommon in corn grain and silage in northeast
  - Carcinogenic; liver damage (humans and livestock)
- **Ochratoxins:** *Penicillium* species
  - Common in corn grain and silage
  - Estrogenic compound that causes reproductive disorders (swine)

Risk Factors for Mycotoxins in Corn

- Susceptible hybrids
- High levels of local inoculum
- Moist weather at silking
- Insect or mechanical damage
- Delayed harvest
- Contaminated storage structures, inadequate moisture levels and poor ventilation in storage
- Failure to maintain anaerobic conditions in silage

Reducing the Risk to Mycotoxins

- Partially resistant varieties
- Avoid continuous corn
- Residue management
- Avoid excessive N
- Timely harvest
- Clean, aerated grain bins
- Well-packed silage

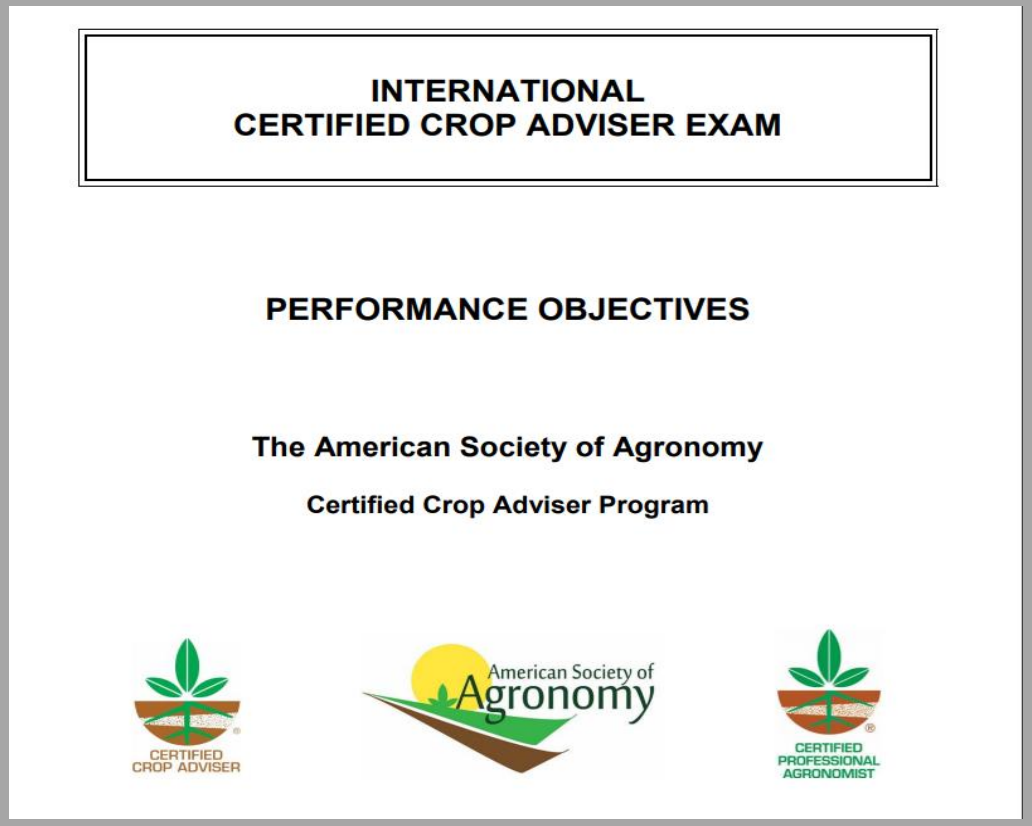
Testing for Mycotoxins

- On-site test kits: test strips/Lateral Flow Devices
  - Most useful on dry grain
- Lab submission: ELISA, HPLC, GC-MS
  - Very accurate and thorough
  - More expensive
  - Good for wet or dry samples

Samples collection must be representative of the grain bin or silo/bunker!

Study Resources for CCA Exam

- NRCCA Pest Management Study Guide
- ICCA Performance Objectives Study Guide
- Cornell Guide for Integrated Field Crop Management



INTERNATIONAL
CERTIFIED CROP ADVISER EXAM

PERFORMANCE OBJECTIVES

The American Society of Agronomy

Certified Crop Adviser Program

CERTIFIED CROP ADVISER

American Society of Agronomy

CERTIFIED PROFESSIONAL AGRONOMIST

Nutrient Management
Pest Management
Crop Management
Soil and Water Management

Northeast Region Certified Crop Adviser (NRCCA) Study Resources

Search: go

ANNOUNCEMENTS

The next Northeast Region Certified Crop Adviser exam will be held February 2, 2018.
Exam information.

WHAT IS CCA?

The Certified Crop Adviser (CCA) Program is a voluntary professional certification program offered by the American Society of Agronomy (ASA). It is the largest certification program in agriculture with over 12,000 certified throughout the USA and Canada.

CCA RESOURCES

- ICCA website
- NRCCA website
- ASA website
- How to become a CCA
- ICCA performance objectives
- NRCCA performance objectives
- NRCCA manual
  - Nutrient management (pdf)
  - Soil+water management (pdf)
  - Pest management (pdf)
  - Crop management (pdf)
- Additional resources

The learning modules and materials available through this course website prepare prospective Certified Crop Advisers (CCAs) for the Northeast Region CCA exam. The exam covers four major areas of expertise: nutrient management, pest management, crop management, and soil and water management. Each area of expertise is divided into competency areas (CAs) composed of performance objectives (POs). Click on the links below to access the various sections of the course.

NUTRIENT MANAGEMENT COMPETENCY AREAS

- CA1: Basic concepts of plant nutrition
- CA2: Basic concepts of soil fertility
- CA3: Soil testing and plant issue analysis
- CA4: Nutrient sources and application methods
- CA5: Soil pH and liming
- CA6: Nutrient management planning

PEST MANAGEMENT COMPETENCY AREAS

- CA1: Integrated pest management
- CA2: Weed management
- CA3: Management of infectious plant diseases
- CA4: Management of arthropods
- CA5: Pesticide formulations and labels
- CA6: Management of pesticide resistance
- CA7: Using pesticides in an environmentally sound manner
- CA8: Protecting humans from pesticide exposure

CROP MANAGEMENT COMPETENCY AREAS

- CA1: Crop adaptation
- CA2: Crop staging, growth and development
- CA3: Tillage systems
- CA4: Seeding factors
- CA5: Seeding rates and row spacing
- CA6: Considerations in replanting decisions
- CA7: Forage harvesting factors
- CA8: Cropping systems

SOIL AND WATER MANAGEMENT COMPETENCY AREAS

- CA1: Basic soil properties
- CA2: Soil hydrology AEM
- CA3: Drainage and irrigation AEM
- CA4: Soil health and compaction
- CA5: Soil conservation AEM
- CA6: Watershed hydrology AEM
- CA7: Non-point source pollution A
- CA8: Concentrated source pollutio
- CA9: Conservation planning AEM

IPM

KEEP
CALM
AND
GOOD LUCK
WITH THE EXAM!

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STUDY HARD!