Diagnosing Plant Problems: Diseases
What is plant disease?

- Abnormal growth and/or function of a plant caused by living organisms (pathogens) or non living factors.

Diagram courtesy of L. M. Rodriguez Salamanca, ISU Plant and Insect Diagnostic Clinic
Causes of plant problems

• Disease, Biotic (living)
  Plant pathogens: Fungi, bacteria, nematodes, viruses, parasitic plants, etc.

• Disorder, Abiotic (non-living)
  Chemical damage, weather conditions, mechanical injury, genetic disorders, lightning, water, nutrient deficiencies, nutrient toxicity, improper application of toxic agrichemicals, etc.
Disorder / abiotic problems

- Diseases caused by non-living factors
- Cannot be spread from plant to plant
- Examples: Temperature extremes, too much or too little moisture, air pollution, nutrient imbalances

Bean leaves showing chlorosis due to a deficiency of iron

Photo credit: Howard F. Schwartz, Colorado State University, Bugwood.org #5364031
Causes of plant disease: disorder/abiotic

- Genetic disorders
- Soil nutrient deficiencies
- Transplant shock/stress
- Improper light exposure
- Improper temperatures
- Agrichemical damage
- Air pollutants
- Heavy soil
- Mechanical injury

Tree death due to calcium chloride dust abatement applied to road

Dry bean plants showing symptoms of moisture stress

Plant diseases

- Can be caused by living organisms = biotic
- Bio: from *bios*, meaning living or alive

Stripe rust of wheat

Photo credit: Ron French, Texas A &M
Plant disease triangle

Favorable Environment

Susceptible Host

Virulent Pathogen

Tar spot of maple caused by the fungal pathogen (*Rhytisma acerinum*) (Pers.) Fr.
Causes of plant diseases (Biotic)

- Fungi
- Water molds
- Bacteria
- Viruses
- Nematodes
- Phytoplasmas

Bacterial spot of pepper

Wheat stem rust

Photo credits: Left – Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org, # 5368905; Right – Ron French, Texas A & M
Causes of plant diseases: endemic or exotic pathogens

- Endemic pathogens are commonly found in a geographic area. They are also called “native pathogens.”
- Exotic pathogens have been brought in from another place. Exotic pathogens can be very damaging when local crops are not resistant to them. They are also called “introduced pathogens.” Often times they become invasive.

Photo credit: Linda Haugen, USDA Forest Service, www.bugwood.org, #1400112
How plant disease is diagnosed: role of First Detectors
First steps in diagnosing plant diseases

• Ask questions
  – What does a healthy plant look like? What is normal?
  – What are the symptoms?
  – Is there a pattern observed?
  – When was the problem first noticed?
  – What percentage of plants are affected?

• Proper sample collection
  – Several different specimens at varying stages of disease
  – Provide adequate information
Questions to ask: What does a healthy plant look like? What is normal?

Healthy pumpkin plants

Diseased pumpkin plants with powdery mildew

Photo credit: Left - Howard F. Schwartz, Colorado State University, www.bugwood.org, #5362950; Right – Howard F. Schwartz, Colorado State University, www.bugwood.org, #5393115
Questions to ask: Is there a pattern observed?

Soybean field with a small area of stunted plants due to infestation of soybean cyst nematodes, *Heterodera glycines*.

<table>
<thead>
<tr>
<th>Disorders</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern present</td>
<td>Hot spots, start in one area and move to others</td>
</tr>
<tr>
<td>Static (NO progression space)</td>
<td>Progress in time and space</td>
</tr>
<tr>
<td>Broad occurrence</td>
<td>Narrow host range* (some exceptions)</td>
</tr>
</tbody>
</table>

Slide courtesy of L. M. Rodriguez Salamanca, ISU Plant and Insect Diagnostic Clinic
Photo credit: Paul Bach, University of Kentucky Research and Education Center, Bugwood.org, # 5430023
Questions to ask: How was the plant grown and harvested?

Ridge-tillage in a soybean field to control weeds

Furrow irrigation in a potato field

Questions to ask: Were agrichemicals used?

- Any chemical used to protect and improve crop production
- Questions to ask about agrochemicals:
  - What was applied?
  - Application rates?
  - Targeted organism(s)?
Symptoms of agrichemical injury

Cupping of bean leaves due to chemical injury

Winter wheat herbicide injury

Signs vs. symptoms

- **Sign**: includes any part of the pathogen itself or its products
- **Symptom**: visible abnormality (physiological effect) on a plant

**SIGN**
- Powdery mildew on hops

**SYMPTOM**
- White powder is the pathogen itself (fungal growth)
- Mosaic on common bean leaf

What to look for: symptoms of diseases

Diseases can be recognized as growth irregularities in plant parts (leaves, stalks, fruits, etc), including:

- Galls
- Cankers
- Rots
- Scabs
- Wilt
- Necrosis (tissue death)

Photo credit: Clemson University, USDA Cooperative Extension Slide Series, www.bugwood.org, #1436170
Symptoms of plant diseases

Chlorotic or necrotic rings are a symptom of *Tobacco ringspot virus* (a viral pathogen)

Tissue death is a symptom of common bacterial blight of bean (caused by a bacterial pathogen)

Categories of symptoms

- Overdevelopment of tissue
  - Galls, profuse flowering

- Underdevelopment of tissue
  - Stunting, shortened internodes, failure of fruits and flowers to develop

Photo credit: American Phytopathological Society Archive, American Phytopathological Society, www.bugwood.org, #0162085

Underdevelopment (stunting) caused by *Potato yellow dwarf virus*
Categories of symptoms

• Death of tissues (necrosis)
  – Blights, leaf spots, fruit rots.

• Alteration of normal appearance
  – Mosaics, altered coloration in leaves and flowers.

Apple bitter rot caused by the fungal pathogen *Colletotrichum gloeosporioides*
Categories of symptoms

Overdevelopment:
- Oak leaf blister. Note thickening and distortion.

Underdevelopment:
- Healthy plant in middle. Underdevelopment in side plants caused by Chrysanthemum stunt viroid.

Death of tissue:
- Necrotic leaf spot typical of early blight on potato.

Altered appearance:
- Mosaic virus on melon.
Symptoms and disease terms

- **GALLS**
  - Bullet galls on white oak

- **WILT**
  - Southern bacterial wilt on flue-cured tobacco

- **SCAB**
  - Pecan scab

Systemic plant diseases

Goss's wilt of corn showing vascular plugging by the bacterium *Clavibacter michiganensis subsp. nebraskensis*

Verticillium wilt of tomato, caused by fungal pathogens in the genus *Verticillium*

Photo credits: Left-Howard F. Schwartz, Colorado State University, Bugwood.org, # 5361257, Right – Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org, # 1573860
Symptoms and disease terms

**ROT**

Black rot on sweet potatoes

**CANKER**

Canker caused by *Geosmithia morbida*, the causal agent of thousand cankers disease on walnut

Photo credits: Left - Charles Averre, North Carolina State University, www.bugwood.org, #1563470; Right - Curtis Utley, CSUE, www.bugwood.org, #5406079
Symptoms and disease terms

**NECROSIS**

Necrotic leaf spots caused by *Impatiens necrotic spot virus*. Host plant: Coleus 'Freckles'

**BLIGHT**

Bean plants showing common bacterial blight

**CHLOROSIS**

Downy mildew on squash
Symptoms and disease terms

**LEAF SPOT**

Leaf spots caused by *Cercospora arachidicola* on peanut

**ROOT KNOT**

Damage caused by a root-knot nematode on burley tobacco (*Nicotiana tabacum* (burley type) L.)
Signs of plant disease

Hollyhock rust pustules on the underside of the leaf

Powdery mildew on pecan

Photo credits: Left – Tom Creswell, Organization: Purdue University www.bugwood.org, #5483031; Right – Clemson University, USDA Cooperative Slide Series, www.bugwood.org, #1235030
Signs of plant diseases

Fungal spores - microscope

Bacterial streaming - microscope

Photo credits: Left-Jason Brock, University of Georgia, Bugwood.org, Bugwood.org # 5453983, Right-Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org # 5368282
Laboratory examination and testing

May involve:

– Dissecting microscope
– Compound microscope
– Electron microscope
– Moist chamber incubation
– Culturing
– Tests for biotic agents
– Tests for abiotic agents
Questions?

• To find your local NPDN lab or for more information on the NPDN
  – [www.npdsn.org](http://www.npdsn.org)
  – See scripted presentation “Introduction to NPDN”

• Regional Training & Education Contacts
  [http://www.npdsn.org/first_detector](http://www.npdsn.org/first_detector)

• NPDN First Detector Training Website
  – [www.firstdetector.org](http://www.firstdetector.org)
Helpful Resources

- Illustrated Glossary of Plant Pathology
  [http://www.apsnet.org/edcenter/illglossary/Pages/default.aspx](http://www.apsnet.org/edcenter/illglossary/Pages/default.aspx)
  ✓ Provides an on-line glossary of plant pathology

- Introductory Plant Pathology Resources
  [http://www.apsnet.org/EDCENTER/INTROPP/Pages/default.aspx](http://www.apsnet.org/EDCENTER/INTROPP/Pages/default.aspx)

- Visit your state/local plant diagnostic clinic website
  ✓ Most offer online factsheets for local common plant diseases in and provides affordable diagnosis of diseased plant samples
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- Extension Disaster Education Network (EDEN)
- Center for Invasive Species and Ecosystem Health (Bugwood)
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