

Introduction to Plant Disease

Review of Principles

What is a disease?

Any abnormal condition that damages a plant and reduces its productivity or usefulness to man.

Two types of diseases.

1. **Non-infectious** (abiotic)

» Not caused by a living parasitic organism; usually an environmental factor

2. **Infectious** (biotic)

» Caused by a living parasitic organism

What is a non-infectious disease?

-- Diseases caused by some environmental factor that produces an abnormal plant, abnormal appearance.

Examples:

- **Nutrition.** Excess or deficiency
 - N deficiency, yellowing
- **Moisture.** Deficient or excessive water.
 - Deficiency, stunting
 - Excessive, lack of oxygen to roots.

What is a non-infectious disease?

More examples:

- **Temperature.** Cold or hot.
 - Frost damage; heat sterility in small grains.
- **Meteorological conditions.**
 - Sun, sunscald.
 - Heat canker caused by high temperature
- **Toxic chemicals.**
 - Ozone injury; Salt injury.

What is an infectious disease?

Infectious (biotic) diseases are caused by organisms that attack plants and get their nutrition from them.

- **Host** - the plant attacked by a parasite.
- **Pathogen** - the organism causing the disease.
 - **Fungi; Bacteria; Viruses; Mycoplasmas; Nematodes**

Terms

- **Parasite** - an organism living on or in another living organism and obtaining food from another organism.
- **Obligate parasite** - always a parasite; can only live on or in another organism.
 - ❖ Parasites causing leaf rust, stem rust of cereals.
- **Facultative parasite** - having the ability to be a parasite; can live on living or non-living host.
 - ❖ Parasites causing leaf spots of cereals.

Terms

- **Symptoms** - expressions of plant diseases; visible abnormalities; tissue death; stunting; abnormal color
 - **Necrotic** - dead and discolored.
 - **Chlorosis** - yellowing of normally green tissue
- **Signs** - presence of pathogen or its parts
 - fungal structures; bacterial ooze

Terms

- **Inoculum** - pathogen or its parts that can cause infection. That portion of the pathogen brought into contact with the host.
 - Spores; mycelial fragments or structures
- **Predispose** - weaken plants; increase effects of infectious diseases.
 - Temperature, moisture, wind, light, soil pH, nutrition, herbicides

Three factors needed to produce a disease:

Pathogen

Host

Environment



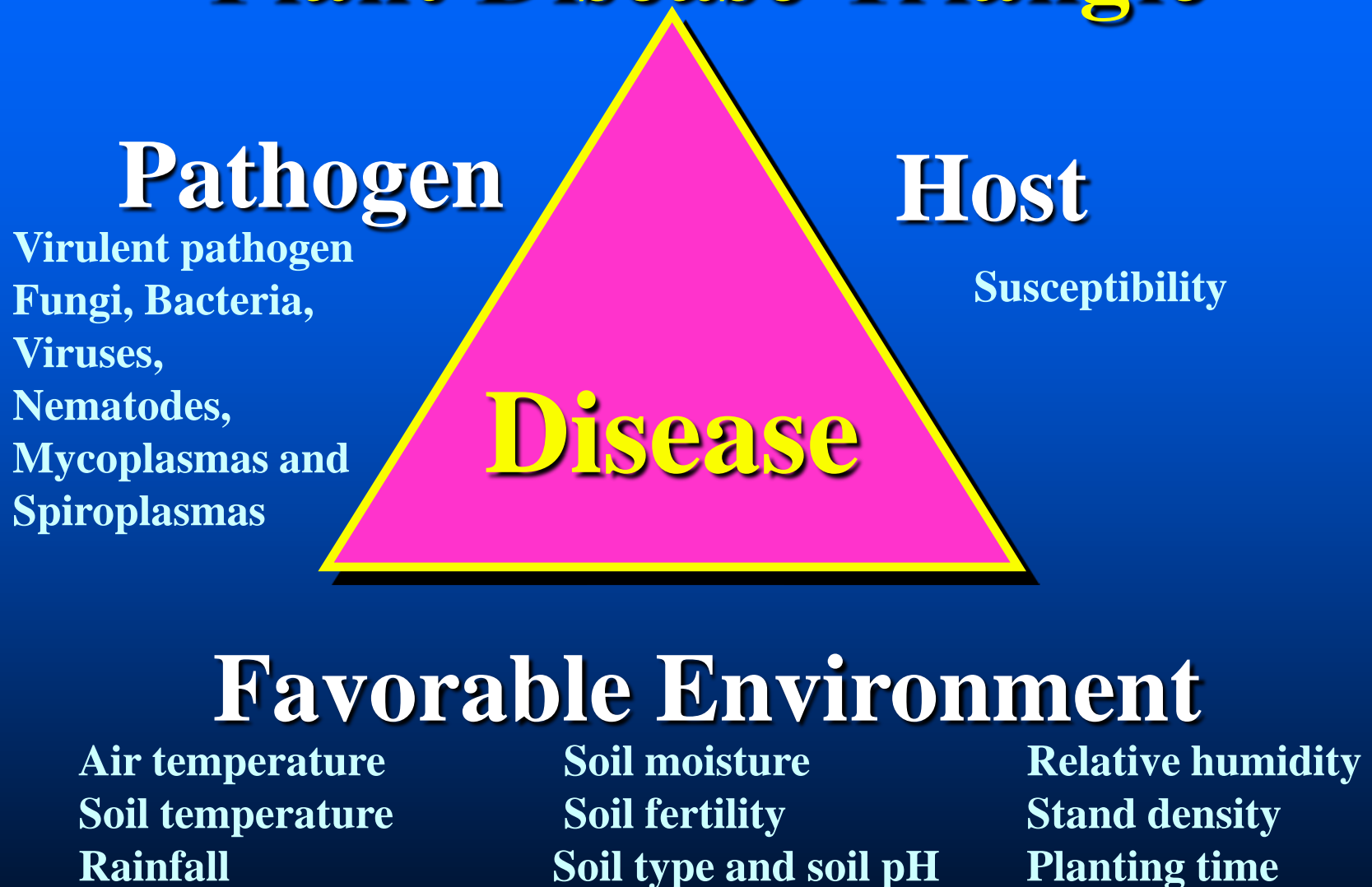
Pathogen

Host

Environment

If any of the 3 factors is missing disease will not develop.

Plant Disease Triangle



Pathogen

The organism causing the disease.

- **Fungus, fungi** - organisms which lack chlorophyll and range in form from a single cell to a body mass of branched filamentous hyphae. Includes the yeasts, molds, smuts, and mushrooms.
- Hyphae, **mycelium**, thread-like filaments.
- **Fruiting bodies**, structures containing spores; can be signs on the host.
- **Spores**, reproductive unit; seeds;
- E.g. Rusts, smuts, leafspots, powdery mildew

Pathogen

- **Bacterium, bacteria** - microscopic single-celled organisms; reproduction by division of body into two parts.
 - Bacterial blights, wilts, fireblight
- **Viruses** - submicroscopic particles of RNA with a protein coat; obligate parasite.
 - Wheat streak mosaic, cucumber mosaic, potato viruses

Pathogen

- **Nematodes** - generally microscopic eelworms or roundworms
 - ❖ Usually not a serious problem in North Dakota
 - ❖ Carriers or vectors of viruses, fungi, or bacteria.
- **Mycoplasmas** - microorganisms with no cell wall, no definite shape.
 - ❖ Aster yellows (purple top in potato and tomato).

Environmental Factors

- **Once disease established, local environment determines rate of disease development**
 - Disease severity can differ from site to site or be similar in region
 - **Rainfall**
 - Risk of disease greatest with highest rainfall levels
 - Dry conditions or intermittent wet/dry can limit disease development
 - **Temperature can influence disease**
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Plant Disease Triangle

A host, pathogen, and favorable environment are required for the development of a plant disease.

Pathogen

Virulent pathogen:
Fungi, Bacteria,
Viruses,
Nematodes,
Mycoplasmas and
Spiroplasmas

Host

Susceptible
-crop
-cultivar



Favorable Environment

Air temperature
Soil temperature

Soil fertility
Soil type
Soil pH

Rainfall
Relative humidity
Soil moisture

Knowledge of Crop Diseases

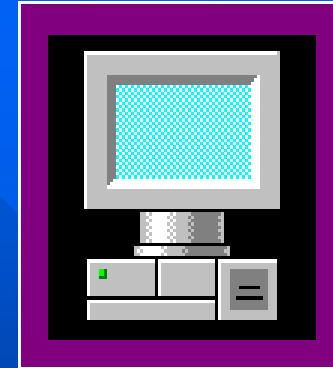
Important for developing management tactics

- **Major crop diseases on crop grown?**
- **Host range of major plant pathogens?**
- **Major crop diseases in your area?**

Records of Crop Diseases

Important for developing management tactics

- **Local farm and field history?**
 - Disease problems in past?
- **Crop sequence in fields?**
 - No. of years since last host crop?
 - Disease impact in last host crop?
- **Field scouting/In-crop inspections**
 - Diseases present; disease impact



Measurement of Disease

- **Incidence of disease** - proportion of host units that show symptoms.
- **Severity of disease** - proportion of area or amount of plant tissue that is diseased; percentage of plant destroyed by disease.
- **Yield loss** - proportion of yield that grower will not harvest because of disease.

General disease cycle

- **Monocyclic or single cycle pathogens** - one disease cycle in one year. e.g. Smuts
- **Polycyclic or multi-cycle pathogens** - more than one cycle per year; secondary inoculum, secondary infection. e.g. Downy mildews, powdery mildews, grain rusts, leaf spots

Pathogen Factor

- **How are pathogens transmitted?**
 - Air-borne, long distance (rusts)
 - Air-borne, short distance
 - Seed-borne (smuts)
 - Insect transmitted (WSMV)
 - **How do pathogens survive?**
 - Stubble or residue borne
 - Seed-borne
 - Soil-borne
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Dissemination (spread) of pathogens

- **Wind** - Air-borne fungal spores
 - Wheat leaf rust, stem rust
- **Insects** - Carriers of viruses
 - Aphids - barley yellow dwarf
- **Water** - Carry or splash spores
- **People** - Carry over long distances
 - e.g. contaminated farm equipment
- **Animals and birds**

Survival of pathogens

- **Soil**
 - Resistant structures of pathogens, e.g. sclerotia
- **Seed and plant parts**
 - Pathogens survive in infected seed and plant parts
- **Insects**
 - e.g. Bacterial wilt pathogen in cucumber beetles
- **Mild climates**

Basic methods of plant disease management.

- **Exclusion** of pathogens.
- **Eradication** or elimination of pathogens.
- **Host Resistance.**
- **Protection.**

Protect plants from infection.

Basic methods of plant disease management.

- **Exclusion** of pathogens.
 - Quarantine.
 - Seed certification for low levels of pathogens.
 - Indexing, testing for pathogens, e.g.. viruses
- **Eradication** or elimination of pathogens.
 - **Crop rotations** keep populations low.
 - Eradication of alternative hosts.
 - Sanitation, removal of inoculum

Crop Rotation a key factor



- **Similar crops usually have similar diseases.**
- **Disease severity and yield losses are higher with crop monoculture.**

Basic methods of plant disease management.

- **Host Resistance.** Two types
 - **General resistance.** Horizontal resistance.
 - Slows down disease development.
 - Stable against all races of pathogen.
 - **Specific resistance.** Race specific.
 - High level; may fail with new race.
- **Tolerance.** Ability of plant to sustain disease without dying or suffering loss

Resistant Host – No Disease

“Plant Disease Triangle”

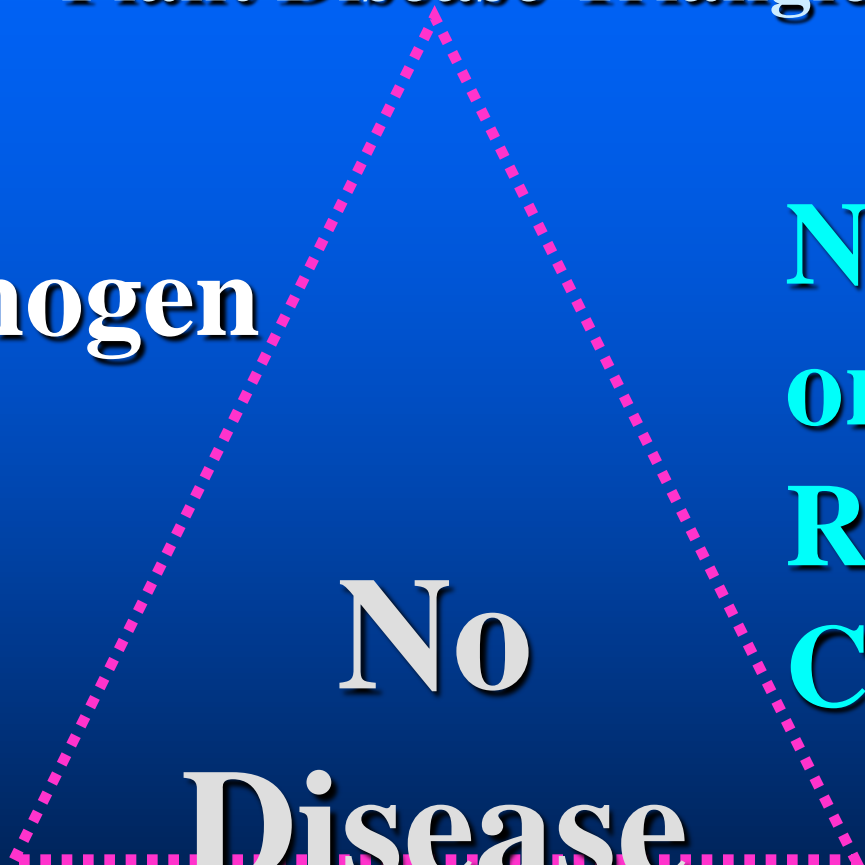
Pathogen

**Non-Host
or
Resistant
Crop**

No

Disease

Favorable Environment



Basic methods of plant disease management.

- **Protection.** Protect plants from infection.
 - Cultural practices.
 - » Time of planting; Destruction of volunteers
 - Handling practices.
 - » Mature potato tubers less prone to infection by late blight fungus.
 - Managing insect vectors.
 - » Weed management
 - Fungicides.

Fungicides

-- Protectant fungicides --

Protect plants from infection.

- **Act on plant surface to protect against infection.**
- **Timely application is critical.**
- **Cannot stop development of a pathogen once the infection occurs.**

Fungicides

-- Systemic fungicides --

- **Taken up (absorbed) by plant tissues and then function to prevent infection.**
- **Protect both sides of leaf; Not washed off; Not decomposed by sunlight.**

Seed Treatments

- **Control soil-borne pathogens**
 - Root rots, damping-off, seedling blights
- **Control surface-borne pathogens**
 - Safflower rust
- **Control internally-borne pathogens**
 - Loose smut fungi of cereals.

Smut Stopped with Seed Treatment

“Plant Disease Triangle”

Pathogen
Eliminated
with
Fungicide

Host

No

Disease

Favorable Environment



Consider before fungicide use.

- **Field disease history - past diseases**
- **Disease severity - amount of damage**
- **Growth stage - efficacy of fungicide**
- **Weather/disease interaction**
 - **disease potential**
- **Fungicide selection**
- **Application method**
- **Potential economic return**

Fungicides.

Always follow label directions.

- ❖ **Your intended use must be consistent with the label.**
- ❖ **Check instructions on how and when to apply.**
- ❖ **Check waiting periods before harvest.**
- ❖ **Check important safety precautions.**

Principles of Integrated Pest Management (IPM).

- **Whenever possible, eradication, exclusion, host resistance, and protection should be practiced.**
- **The use of these combined practices usually produce the most reliable and stable plant disease management.**
- **Growers need to integrate as many different management tools as possible for long term success.**

Factors to recognize in disease management programs.

- **Field history - past diseases**
- **Crop sequence - non-host crop**
- **Variety selection - resistance**
- **Seed/plant source - inoculum free**
- **Site preparation - improve plant growth**
- **Planting date - avoid certain weather patterns; vary planting time**

Factors to recognize in disease management programs.

- **Plant density – microenvironment**
- **Nutrients - balanced, reduce stress**
- **Water management - irrigation**
- **Weed control - sources of inoculum**
- **Timeliness of harvest - avoid inoculum on seed**
- **Sanitation - reduce inoculum, clean equipment.**

Review

- 1. What are the three factors necessary for the development of a disease?**
- 2. Difference between the severity and incidence of a disease?**
- 3. A process by which a pathogen establishes a parasitic relationship? a. dissemination, b. inoculation, c. infection**
- 4. What does IPM stand for?**

Review

5. Two types of host resistance?
6. What are the four main components of integrated pest management?
7. What is inoculum?
8. What are the three most important types of pathogens in ND? a. Fungi, b. Bacteria, Nematodes, c. Mycoplasmas, d. Viruses
9. What is a monocyclic or single cycle pathogen?

Review

10. Would it be easier to control a monocyclic or polycyclic pathogen?
11. Difference between systemic and non-systemic fungicide?
12. Why is crop rotation important for managing diseases?

**Additional information is available on
internet links, check out
“Internet Resources for Information
on Plant Diseases”**