

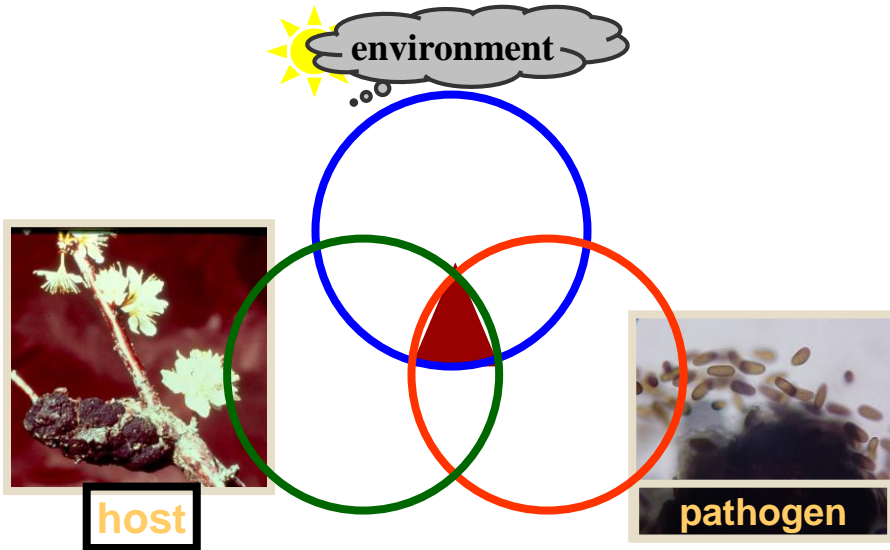


## What are plant diseases?

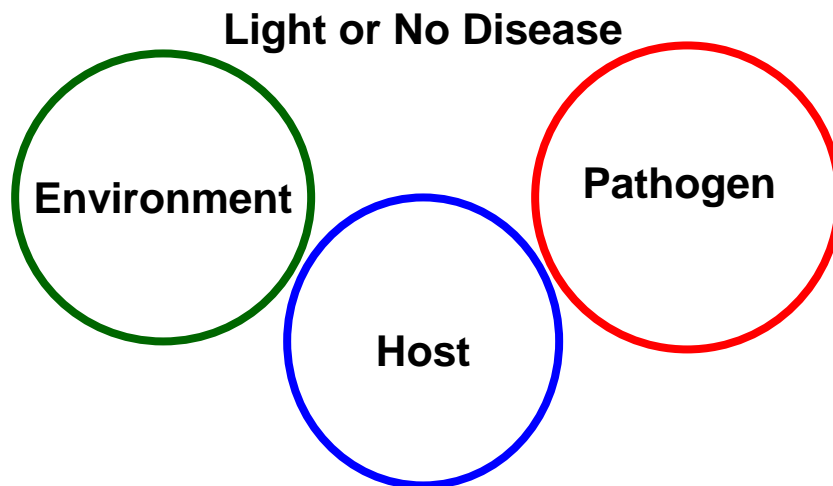
Anything that prevents a plant from performing to its maximum potential.



## Disease PathoSystem Components

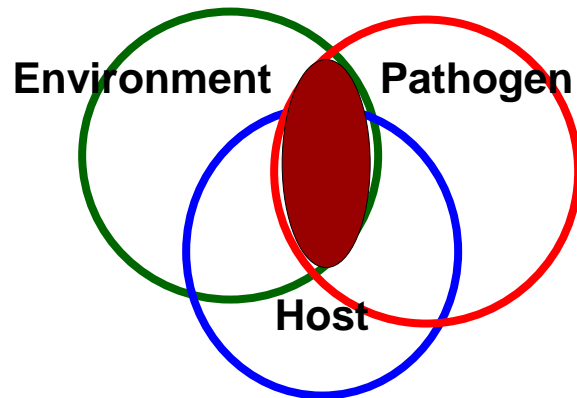


## Disease Development



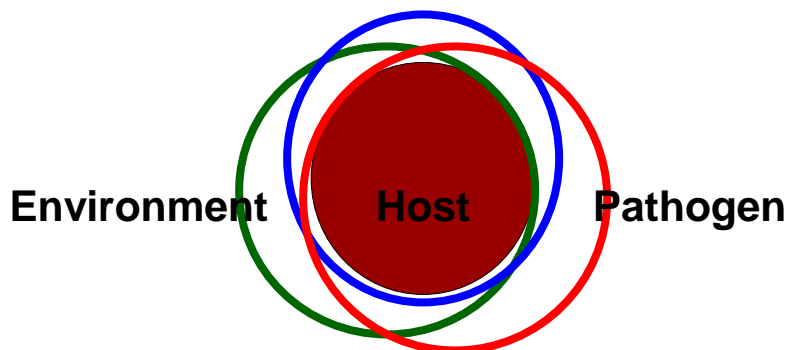
## Disease Development

### Moderate Disease

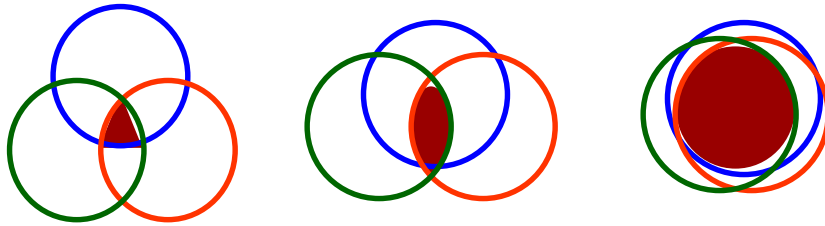


## Disease Development

### Severe Disease



## Disease Development



amount of disease = overlap of system components

impact on the host = timing of overlap

## Disease Development

With ornamental plant diseases **management** can be a significant factor in influencing disease development because it impacts all three factors; the **host**, the **pathogen** and the **environment**.

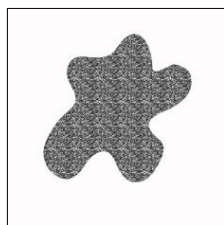
# Types of diseases

- **Abiotic**
  - Disease caused by a non-living agent
    - Sun scorch, nutrient deficiencies, chemical burn
  
- **Biotic**
  - Disease caused by a living agent.
    - Fungi, bacteria, nematodes, viruses (pathogens)

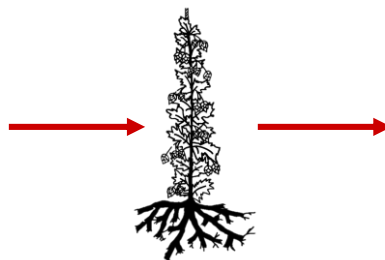


## Symptom Distribution

*By assessing symptom distribution at three scales, your diagnosis will come much easier.*



Landscape

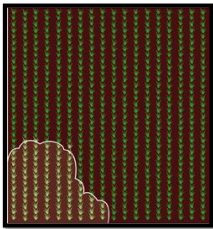


Plant

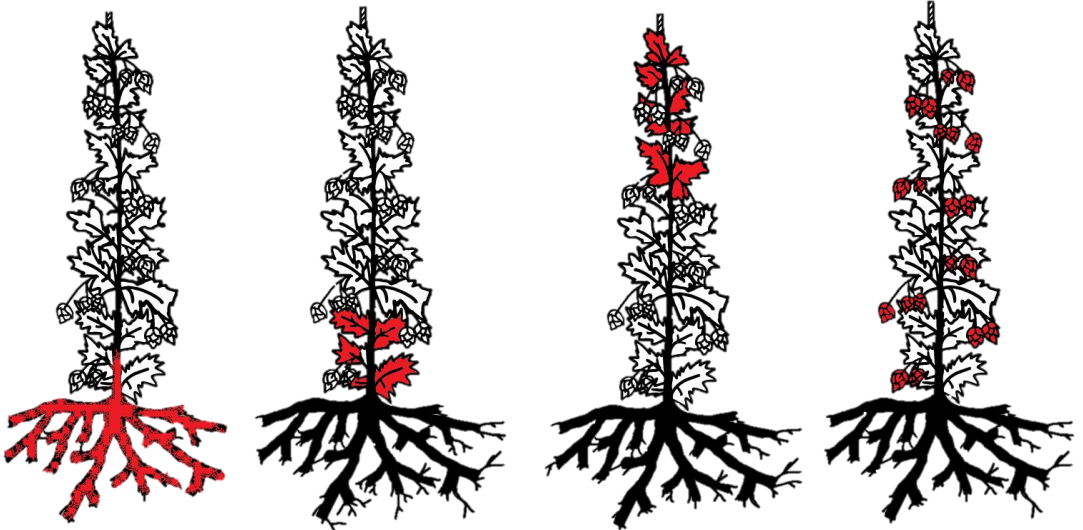


Plant  
Parts

## Symptom Distribution – Field



## Symptom Distribution – Plant

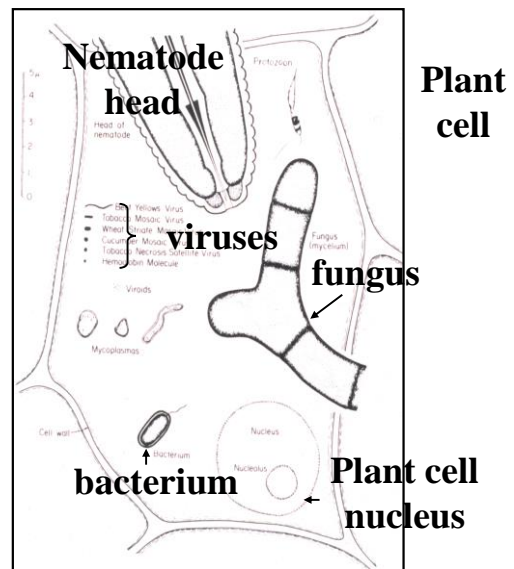


## Symptom Distribution – Leaf



## What size are plant pathogens?

**Common plant pathogens and their size relative to each other and to a plant cell**



## Cons

- Deceiver
- Goal is not to set off alarms
- Wants to continue to use you
- Primarily biotrophs
- Bacteria and viruses



## Thugs

- Break-and-enter
- Could care less about alarm system
- Gets what they want and gets out
- Primarily necrotrophs
- Fungi and nematodes



## Viruses

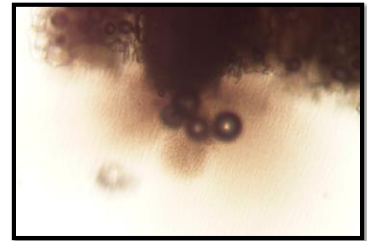
- Too small to be seen with light microscope
- Transmitted by aphids, mites, other insects, nematodes, and fungi
- Virus acquired by insects through feeding on infected plant tissue





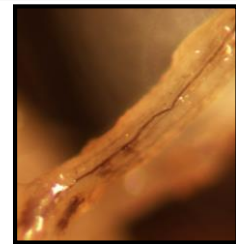
## Bacteria

- Single-celled organisms
- An opening is required for infection to occur.
- Favored by humid conditions.
- Can survive in soil and in/on plant debris.

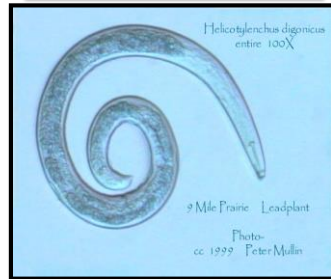


## Fungi

- Hyphae – small thread-like filaments
- Mycelium – mass of hyphae
- Spores – reproductive structures
- Most fungi require free moisture to cause infection of plants
- Can survive in soil or on plant debris



# Nematodes



- Microscopic worm-like animals
- Feed on roots and above ground plant parts.
- Roots become distorted or galled after feeding occurs.
- Some are vectored by insects.
- Can survive in soil, in plants, and in insect vectors.



# Phytoplasmas

- Similar to viral infections
- Stunting
- Chlorosis
- Epinasty (abnormal growth)



## Terms: Pathogen vs. Disease

**Disease:** Any malfunctioning of host cells and tissues that results from continuous irritation by a pathogenic agent or environmental factor and leads to the development of symptoms

**Pathogen:** An entity, usually a microorganism, that can incite disease

- The Disease Pine Wilt is caused by the Pathogen *Bursaphelenchus xylophilus*.



## Terms: Sign vs. Symptom

- **Sign**

- Visible evidence of the presence of the pathogen.

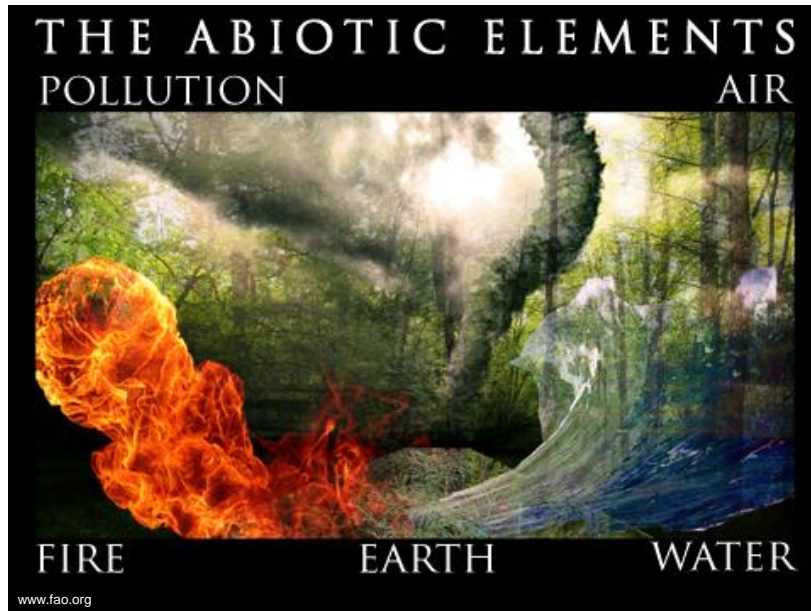


- **Symptom**

- Various changes in function and appearance of the infected plant.



## Abiotic Diseases



## Abiotic Disease Symptomology

- More uniform than biotic diseases
- Often non-specific symptoms
- May be associated with a specific environmental event
- May become more pronounced with additional stresses

## Frost Crack

- Maple



## Root Girdling



[hort.ufl.edu](http://hort.ufl.edu)

# Salt Damage



# Salt damage



## Salt Damage

- Slow and spotty germination
  - Restricted root development
  - Wilting and leaf yellowing
  - Marginal burn on leaves (especially lower leaves)
- 
- Leaching excess soil salts can help plants recover
    - 3 – 4” of overhead irrigation

## Winter Injury



## Lawn Mower Blight



## Herbicide Drift





# Sunscald



# Fruit cracking



# Blossom End Rot



Colorado State University William Brown Jr.



<http://timberglade.typepad.com>



Watermelon: Blossom end rot. Photo by Tom Isakeit, TAEX,



E. Maynard, Purdue University

# Catface



<http://www.omafra.gov.on.ca>



## Physiological leaf roll



## Yellow shoulders disorder



## Management of abiotic diseases

- Good fertilizer program
- Proper staking to reduce exposure to excessive sunlight
- Control diseases that increase loss of leaves
- Soil cover – mulching
- Proper water management
- Leaching – 3-4” of overhead irrigation
- Avoid wet feet – put pieces of wood at the bottom of the pot – do not let plant sit in the water

## Crown, Root and Stem Rots



- Most landscape perennials/annuals susceptible



[aggie-horticulture.tamu.edu](http://aggie-horticulture.tamu.edu)

## Crown, Root and Stem Rots

- Many plants susceptible to crown, root and stem rots
- Caused by many different types of soil microbes
  - Oomycetes: *Pythium*, *Phytophthora*,
  - Fungi: *Fusarium*, *Rhizoctonia*
  - Bacteria: *Erwinia*, *Pseudomonas*



[franoiswirthensohn.girlshopes.com](http://franoiswirthensohn.girlshopes.com)

## Crown, Root and Stem Rots

- Symptoms:
  - Discoloration of stem, crown, roots
  - Plants are wilted, flaccid
  - Dark brown/black water soaked tissues
  - Foul odor
    - Fishy smell? – *Pythium* spp.
    - Overly sweet? – soft rot



[franoiswirthensohn.girlshopes.com](http://franoiswirthensohn.girlshopes.com)

## Crown, Root and Stem Rots

- Management:
  - Plant resistant varieties
  - Rotation
  - Improve soil drainage
  - Remove infected plants
  - Chemical treatments involve soil drenches which are costly and need repeat applications
- Transplanting to a new area risky due to movement of soil



## Powdery Mildew



[www.missouribotanicalgarden.org](http://www.missouribotanicalgarden.org)

- Superficial white or gray growth over the surface of leaves, stems, fruits & flowers
- Host specific fungi
- Favored by
  - Moderate temperatures
  - High humidity
  - Poor air circulation

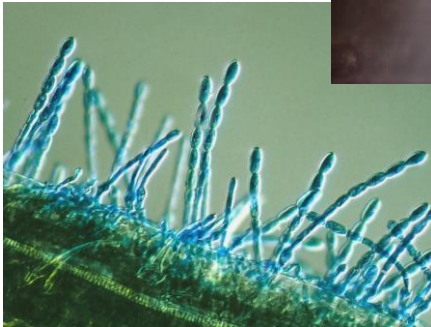
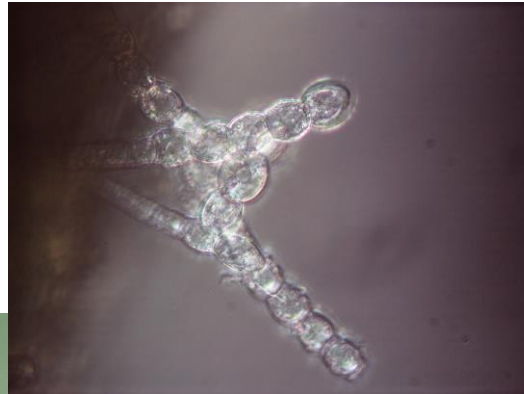
## Powdery Mildew

- *Sphaerotheca pannosa* var. *rosae* fungi develop wind-borne spores
- Low rainfall plus 70°–80°
- Low daytime humidity, high nighttime humidity
- Depletes nutrients



## Powdery Mildew

- Host(s): Kentucky bluegrass
- Pathogen(s): *Erysiphe graminis*





## Powdery Mildew Control



- Plant resistant varieties
- Rake & remove infected leaves
- Improve air circulation
- Increase sun exposure
- Avoid overcrowding plants
- Improve soil drainage
- Protective fungicide sprays

## Anthracnose



## Anthracnose - Management

- ▶ Planting pathogen-free seed/transplant
- ▶ Sanitation – remove infected fruit
- ▶ Pick fruit frequently
- ▶ Water early in the day

## Anthracnose



## Anthracnose - Management

- Plant disease-free plants
- Don't let fruit over-ripen
- Minimize overhead irrigation
- Mulching with straw instead of plastic
- Remove infected plant parts
- Fungicide use



## Anthracnose on Deciduous Trees

- Sycamore, ash, oak, maple, walnut
- Also poplar
- Host specific fungi
- Causes leaf spot or leaf blight (typically along leaf veins)
- Twig and shoot dieback



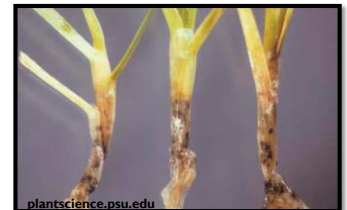
## Anthracnose



- Fungi overwinter on infected twigs or small branches
- Symptoms appear following cool, wet weather in spring
- Leaf or shoot blight may appear suddenly after a rain

## Anthracnose of Turf

- Host(s): Annual bluegrass, creeping bentgrass, most warm and cool season grasses
- Pathogen(s): *Colletotrichum cereale*



[www.msuturfdiseases.net](http://www.msuturfdiseases.net)



[extension.umass.edu](http://extension.umass.edu)

## Anthracnose Control



- Plant resistant species
- Rake & destroy fallen leaves
- Prune out dead or infected branches
- Mulch & water during dry periods
- Protective fungicide spray

## Mushroom ID: Terms

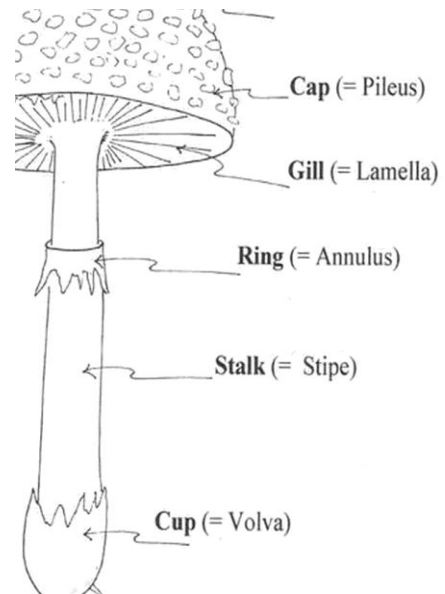
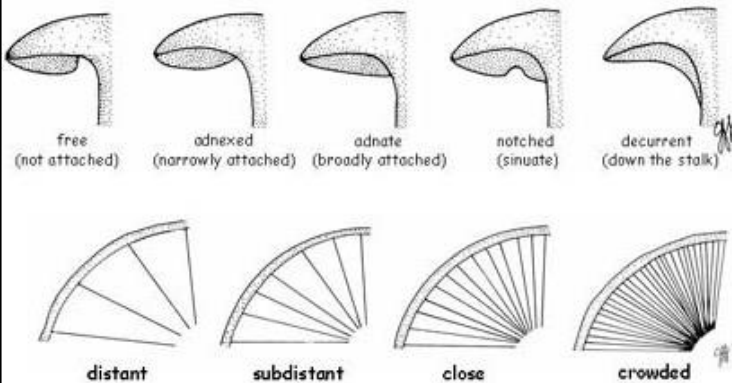


Fig. 3. Gill attachment and arrangement.

## Mushroom Answers:

### • Unknown Mushroom #1

#### ◦ *Armillariella tabescens*

- No volva
- No ring around stem
- Does not exude milk when damaged
- Cap not brittle or crumbly
- Not growing on remains of other mushrooms
- Large caps
- Non-decurrent gills
- No tap root
- Non-cartilaginous stem
- Growing in clumps

### • Unknown Mushroom #2

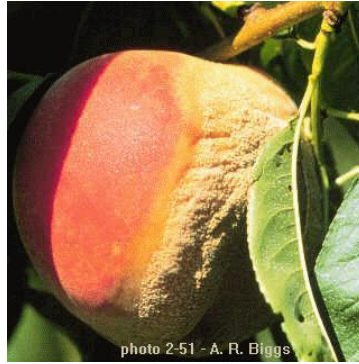
#### ◦ *Marasmius* a.k.a. Fairy Ring

- No volva
- No ring around stem
- Does not exude milk when damaged
- Cap not brittle or crumbly
- Not growing on remains of other mushrooms
- Small caps
- Tough, cartilaginous stems

break



# Brown Rot of Stone Fruits



## Brown Rot - Management

- Sanitation
  - Remove all rotted fruit and mummies
- Prune out twig cankers
- Remove wild plum thickets that are adjacent to orchards
- Several fungicide applications
  - Flower infections – apply at pink, bloom and petal fall
  - Fruit – start about 1 month before harvest



## Gray Mold - Berries





## Gray Mold - Management

- Select a site with good air circulation
- Canopy pruning to increase air movement (raspberry)
- Avoid crowding plants
- Straw mulch to form barrier between fruit and soil (strawberry)
- Remove infected plant material
- Fungicide applications at 7 - 10 day intervals during bloom



## Bacterial Wilt



## Bacterial Wilt - Management

- Insect management
- Remove and discard infected plants in the garden
- Resistant varieties
- Cover soil with reflective mulching



aggie-horticulture.tamu.edu

## Virus Infected Tomato Fruit

Several different viruses can result in this appearance:



Tomato Bushy Stunt

Tomato Mosaic

Tomato Spotted Wilt

Eggplant Mosaic

## Virus Infected Tomato

Tomato Bushy Stunt Virus



Tomato Spotted Wilt Virus

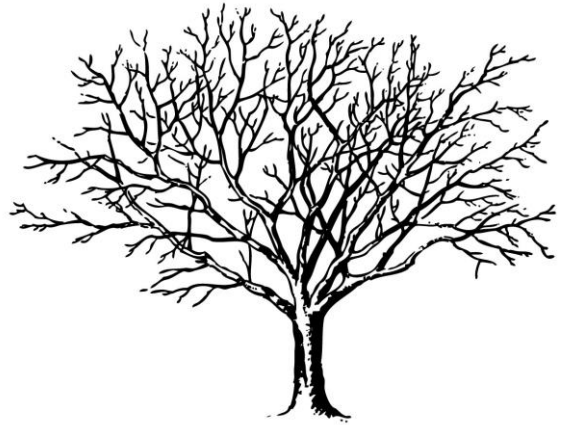


## Management of viruses on Tomatoes

- Control weeds especially those in the same family
- Separation of vegetable garden from flower bed
- Remove infected plants
- Select vigorous and healthy looking plants
- Control insects



## Diseases of Trees



## Diplodia / Sphaeropsis Tip Blight



## Sphaeropsis Tip Blight (Diplodia)

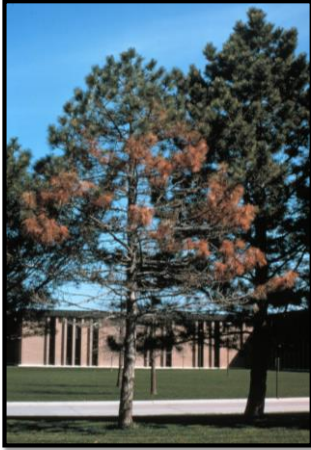


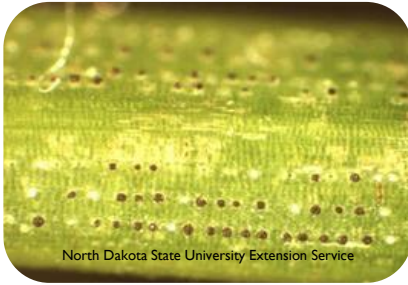
Image courtesy of University of Nebraska

- Favored by rain and high humidity
- Spores overwinter on infected needles and cones
- Avoid overcrowding
- Protective fungicide sprays
  - Two applications
  - Third week of April - first week of May
  - Bordeaux mixture

## Needle Cast Diseases

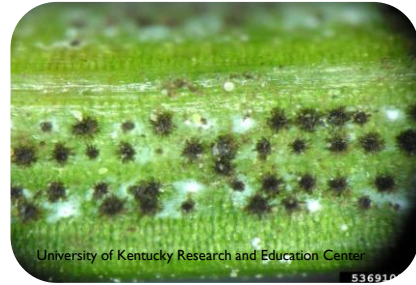


## Needle Cast Diseases: *Rhizosphaera* vs. *Stigmina*



### Rhizosphaera

- Black, spherical protrusions from fruiting bodies under 20x magnification.
- Infect 2-3 year old needles
- Fruiting bodies appear as the needles begin to turn brown



### Stigmina Needle Cast

- Finger or spider-like protrusions from fruiting bodies under 20x magnification.
- Infect 2-3 year old needles
- Needles tend to look more 'dirty' than *Rhizosphaera* infection

## Needle Cast Diseases: *Management*

### General Cultural Practices:

- Removal of all fallen needles to reduce inoculum level.
- Prune back declining and infected limbs
- Keep grasses cleared from base of the trunk to reduce humidity levels

### Rhizosphaera Management

- Requires a 2 – 3 year treatment plan
- 2 applications per year; one in the spring and another 3 – 4 weeks later.
- Application should begin once the needles/shoots are elongated 50% of the previous year's growth.

### Stigmina Management

- Indefinite treatment plan
- At least 2 applications per year; one in the spring and another 3 – 4 weeks later.
- Application should begin once the needles/shoots are elongated 50% of the previous year's growth.
- Chlorothanlonil and mancozeb fungicides are effective

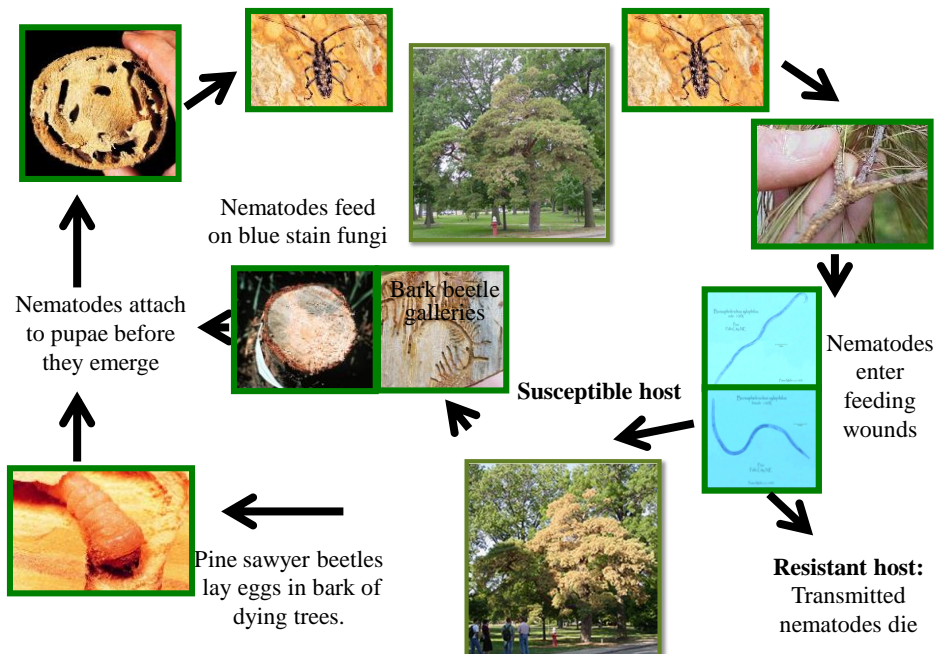
## Pine Wilt Disease



nfs.unl.edu

- Scotch pine
- Also Austrian and sometimes white pine
- Older tree, at least 10 yrs
- Rapid decline of tree
- Causal organism
  - Pinewood nematode
- Vector
  - Pine Sawyer beetle

### Pine Wilt Disease Cycle



## Pine Wilt Management and ID



- Chemical controls have mixed efficacy and can be very expensive due to repeat applications
- Diseased trees should be removed by end of April, which is before the beetles become active and could move the nematode from infested to non-infested trees
- Trees should be burned or buried

### Sampling

- Collect sections of wood either from the main trunk or branches that are at least 1.5 inches in diameter.
- Collect several sections of wood if possible.
- Collect wood from dead branches.

## Fire Blight



Courtesy Iowa State University

- Apple, crabapple, pear, cotoneaster, hawthorn, firethorn, mountain ash, rose, quince, spirea, viburnum (limited)
- Bacterial disease
  - *Erwinia amylovora*
- Bacteria overwinters at edge of canker
- Spread to flowers via rain, wind, and insects



## Fire Blight Control



Courtesy University of Nebraska

- Plant resistant varieties
- Prune and discard infected branches
- Prune only during the dormant season
  - Cut 6-12 inches below the visible canker
- Apply fertilizers sparingly in spring
- Protective sprays
  - Streptomycin or copper-based beginning at pink stage

## Apple Scab

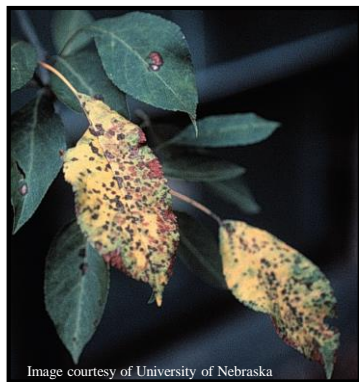


Image courtesy of University of Nebraska



- Favored by wet, humid weather
- Olive to greenish-black lesions on leaves, petioles and fruits
- Fruit lesions enlarge and become cracked & scabby

## Apple Scab Control



Image courtesy of University of Nebraska

- Plant resistant varieties
- Rake & remove infected leaves
- Protective fungicide spray

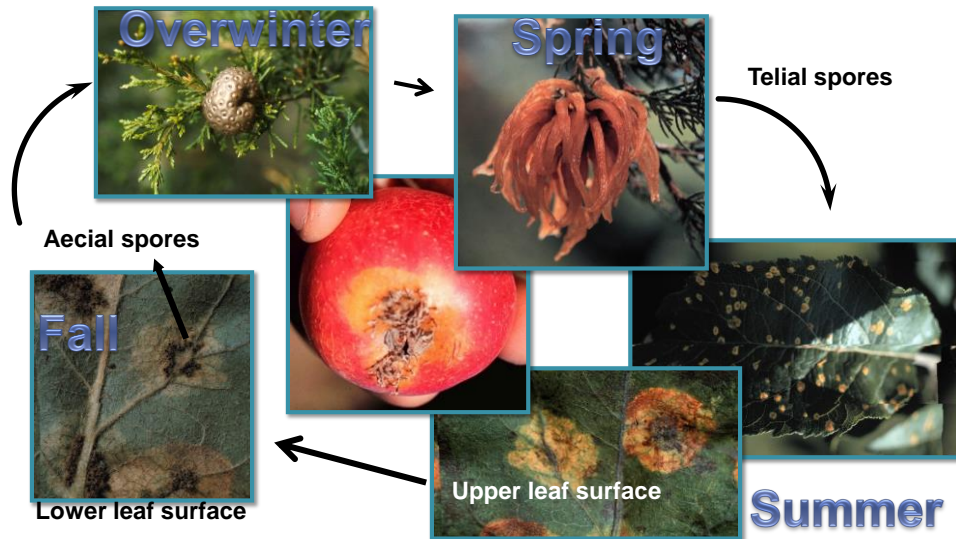
## Cedar-Apple Rust



flickrhivemind.net

- Apple, crabapple, hawthorn
- Spore production & release favored by wet weather
- Spores blown from juniper host to apple host
- Fruit infected at blossom end
  - Premature fruit drop
  - Distorted fruit with decreased size

## Cedar-apple rust



## Dutch Elm Disease



- Fungal disease transmitted by elm bark beetles
- May also spread through infected root grafts
- Management
  - Remove dead trees
  - Prevent root grafts
  - Plant resistant elms
  - Injection of chemical fungicides to protect high value trees
- Streaked vascular tissue is diagnostic

ISU Plant Disease Clinic

## Oak Wilt



- Fungal vascular disease
- Causes wilting and browning of leaves
- Brown discoloration or streaking in sapwood
- Management
  - Remove dead trees
  - Prevent root grafts
  - Injection of chemical fungicides to protect high value trees
  - Sample from partially wilted branches that have discolored sapwood to confirm disease

## Verticillium Wilt



- Affects over 300 kinds of plants
  - Annuals & perennials
  - Trees & shrubs
  - Food & fiber plants
- Caused by a soil-borne fungus
- Attacks the plants vascular system
- Microsclerotia cause vascular streaking
  - Resting structure
  - Survives in soil for several years

Image courtesy Ned Tisserat, Kansas State University Research & Extension

## Verticillium Wilt Control



Image courtesy Ned Tisserat, Kansas State University Research & Extension

- Favored by cool temperatures
- Avoid planting susceptible plants in locations with a history of verticillium wilt
- Remove infected branches
  - Sanitize equipment!
- Avoid wounds in wet conditions
- Burn infected wood debris
- Avoid environmental stresses

## Canker



- A localized diseased area or lesion in the bark of a woody plant which often results in an open wound

## Cytospora Canker of Spruce



## Conditions Favoring Cankers



Thyonectria Canker of Honeylocust  
Image courtesy of Michigan State University  
Extension

- Environmental stresses favor the development of most canker diseases.
  - Some favored by drought, others by excess moisture
- Mechanical wounding provides entry sites for canker-causing pathogens.
- Moisture after wounding (within one week) creates an environment favorable for infection.

## Canker Management



Cytospora Canker of Douglas Fir

Image courtesy of Sarah Browning, University of Nebraska Cooperative Extension

- ID not typically necessary for cankers
- Chemicals not effective
- Wound dressings are not recommended.
- Select the planting site carefully, avoiding drought prone sites. (Anticipate the future needs of the mature tree)
- Remove dead trees and prune diseased branches. Disinfect tools after each cut.
  - Cut at least 5 inches below canker
- Prune in late winter or during dry periods to reduce the potential spread of the pathogen.



## Turf grass Diseases

## Brown Patch

- Host(s): Ryegrasses, tall fescue, creeping bentgrass, Kentucky bluegrass
- Pathogen(s): *Rhizoctonia solani*
- July – August
- Hot, humid weather and lush growth

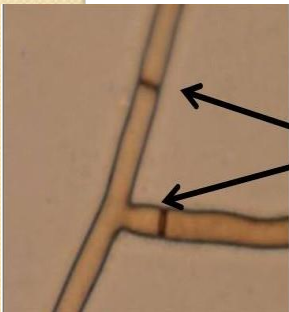


plantscience.psu.edu



## Brown Patch Management

- Don't over fertilize in early summer.
- Over seed with resistant varieties.
- Don't water in late evening.
- Apply a fungicide at first signs of disease.



Cross walls





# Dollar Spot

- Host(s): All cool-season turf. Most common on bentgrass and bluegrass
- Pathogen(s): *Sclerotinia homoeocarpa*



www.rhebo.com



www.apsnet.org

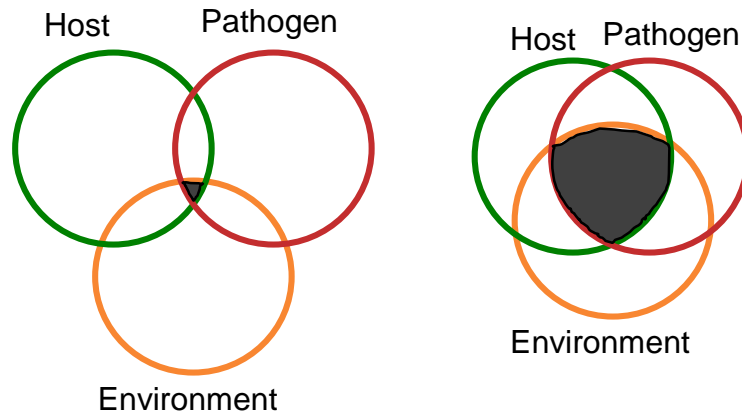


www.turfdiseases.org

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Typhula</i> spp. gray snow mold	■											■
<i>Microdochium nivale</i> pink snow mold (microdochium patch)	■			■								■
<i>Rhizoctonia cereale</i> yellow patch			■		■					■		
<i>Drechslera</i> and <i>Bipolaris</i> spp. melting out			■		■				■			
<i>Laetisaria fuciformis</i> red thread				■		■			■			
<i>Rhizoctonia solani</i> large patch				■		■			■			
<i>Limonomyces roseipellis</i> pink patch					■				■			
<i>Sclerotinia homoeocarpa</i> dollar spot				■		■		■		■		
<i>Gaeumannomyces graminis</i> take all patch				■					■			
<i>Colletotrichum cereale</i> anthracnose					■		■		■			
<i>Drechslera erythrospila</i> red leaf spot					■				■			
<i>Waitea circinata</i> brown ring patch (waitea patch)					■				■			
<i>Ophiosphaerella</i> spp. necrotic ring spot					■		■					
<i>Drechslera</i> and <i>Bipolaris</i> spp. leaf spot					■		■					
<i>Rhizoctonia solani</i> brown patch					■		■					
<i>Pythium</i> spp. Pythium blight					■		■					
<i>Magnaporthe poae</i> summer patch					■		■					
<i>Pyricularia grisea</i> gray leaf spot							■		■			
<i>Puccinia</i> spp. rust diseases				■				■		■		
<i>Ustilago</i> spp. smut diseases				■					■			
<i>Blumeria graminis</i> powdery mildew				■					■			

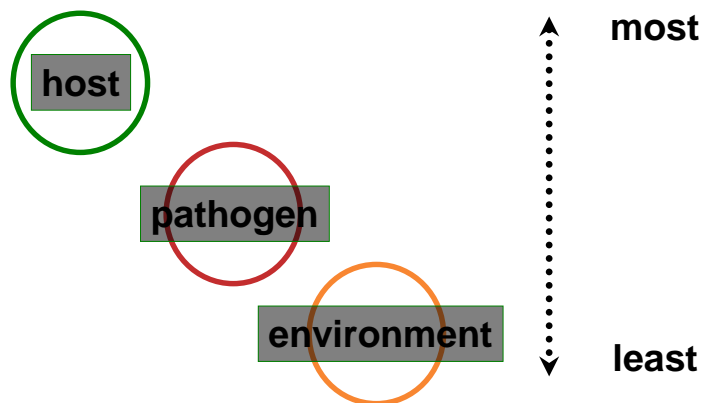
Disease calendar from University of Purdue Extension **Turfgrass Disease Profiles: BP-125-W**

## The Disease Triangle



## Disease Management Strategy

- Ability to influence or manipulate



## Environmental Manipulation



- Space landscape to allow adequate airflow
- Avoid localized monocultures
- Mulch and other landscaping to influence water run-off and retention
- Pre-plant soil amendments

## Plant Health Management

- Choose right, place right
  - Environment and spacing
  - Diversity
- Be observant
  - Do you look or do you see?
  - Catch problems early
- Minimize stress to maximize health
- Sanitization – removal of infected tissue

## Diseased Tissue Disposal

- **PROPER** composting will kill most plant pathogens
  - Pathogens killed 140 – 160°F
  - Turned regularly to get all parts up to temp
- Most home compost bins don't reach temp!
- Tissue with low levels of disease may be composted



## Burying Diseased Tissue

- Effective for destroying leaves with foliar diseases
- Do NOT bury soil-borne infections
  - Crown/root rots
  - Nematode issues
- Bury at least 1 ft deep so it won't be unearthed
- Bury away from similar plants



## General Disease Management

- Trees and Shrubs
  - Wait until leaf drop and mow leaf spots with mulching mower
- Perennial Garden
  - Cut stems at soil line to remove infected material
- Vegetable Garden
  - Rotate crops
  - Bury plant debris
- Improve air flow to decrease leaf wetness

## Questions?

