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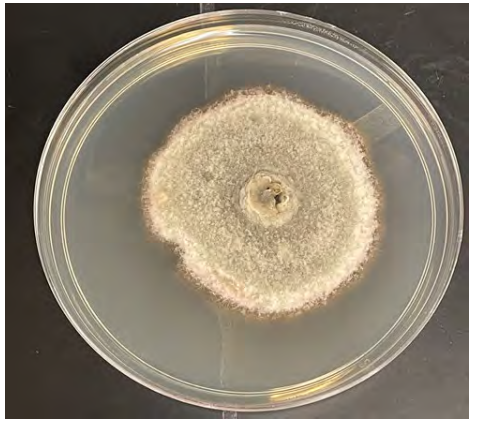
Ready, Set, Grow: 2026: Growing Challenges and Plant Diseases, a Plant Diagnostic Clinic Perspective



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General plant problems



- There are many different living (**biotic**) and non-living (**abiotic**) entities that can have a **negative** effect on plants



- Plants that are under **stress** are **more susceptible** to disease than plants that are growing strong and healthy



- Successful disease management depends on **accurate identification of the causal agent** and the integrated use of available control methods

Causal Agents

Biotic factor (living)

- Fungi
- Bacteria
- Viruses
- Nematodes
- Parasitic plants
- Insects
- Weeds



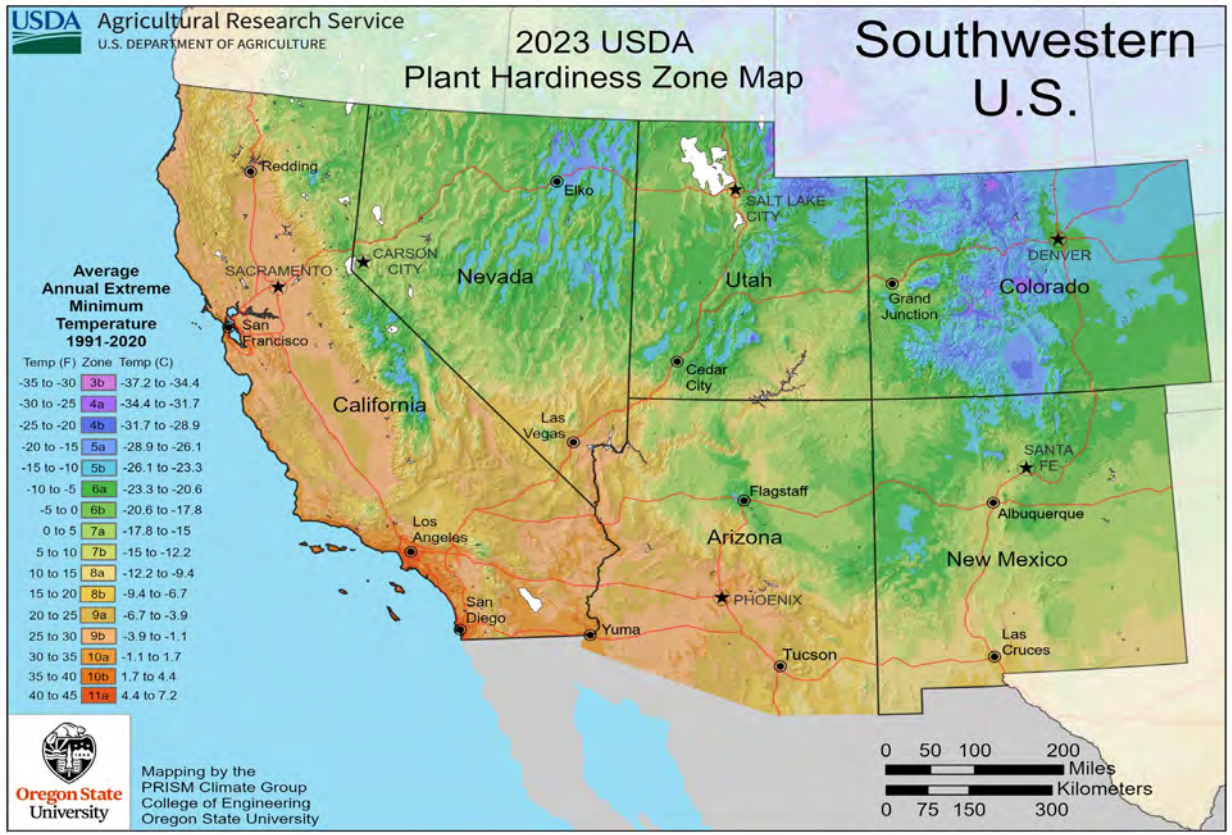


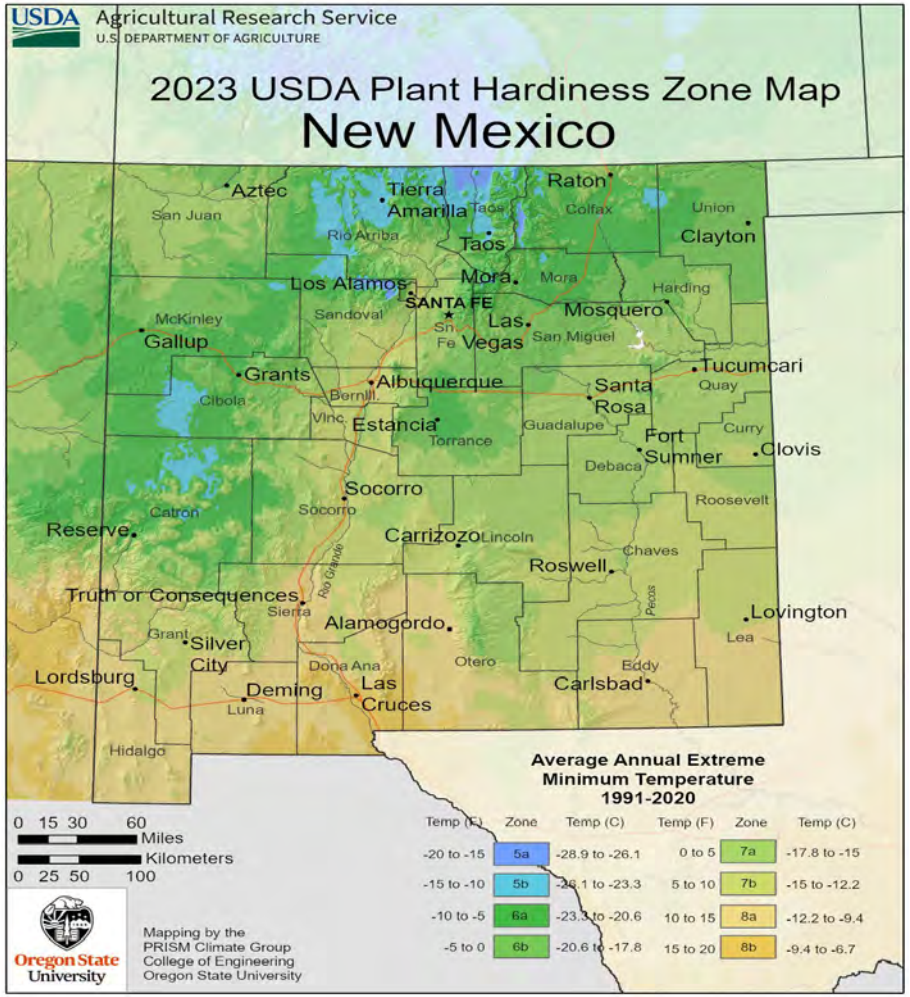
Abiotic factor (non-living)

- Temperature extremes
- Moisture extremes
- Soil problems
- Nutrient deficiency or toxicity
- Wind
- Pesticide toxicity
- Improper cultural practices



Minimize additional plant stress…select the right plant for the right growing zone and area!





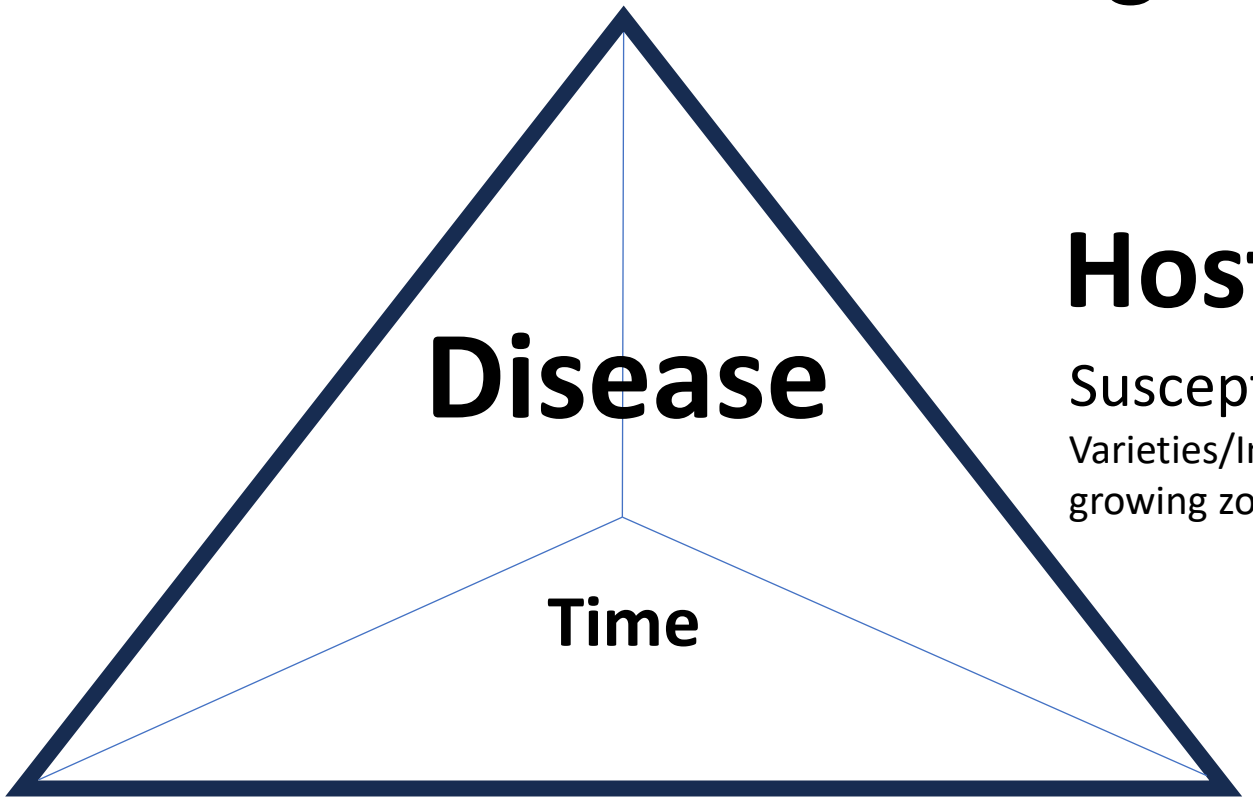
Identification of the causal agent

ENVIRONMENT VS. PATHOGEN

1. Typically more than one plant species affected.
2. Symptoms often develop suddenly.
3. Symptoms do not spread (localized).
4. Distribution is typically uniform.

1. Typically only one plant species affected.
2. Symptoms typically develop slowly.
3. Symptoms spread from plant to plant.
4. Distribution is typically scattered, clustered or sporadic.

The Plant Disease Triangle



Pathogen

Fungi
Bacteria
Viruses
Nematodes

Host

Susceptible:
Varieties/Inappropriate trees for the growing zone

Abiotic induced stress!

Favorable Environment

Air/soil temperature
Soil fertility
Soil type
Soil pH
Soil moisture
Rainfall/humidity

Definitions: Symptoms

- **Symptoms** are the **<u>responses</u>** of a plant:
  - to an attack by a pathogen
  - to adverse conditions caused by an abiotic factor

- Examples: Wilting, yellowing, **leaf spots**, dead/rotting parts, stunting, etc.

- ***<u>We can't identify the problem just by looking at symptoms!</u>***



Leaf spots

- **General symptoms** developed by host to “show” us there’s a problem



Fungal issue



Fungal issue



Bacterial issue



Viral issue

Definitions: Signs

- **Signs** are the **visual** presence of the pathogen on the plant
  - Examples: rust, pycnidia (fruiting bodies), ooze, powdery mildew









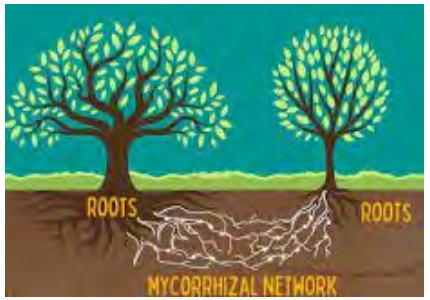
Disease Management

- The key to disease management is **PREVENTION!**
  - **Well managed plants = healthy plants**

- Most effective management programs incorporate all strategies known to reduce disease severity – **"Integrated Disease Management"**
  - **Physical (pruning, etc.), cultural (irrigation, etc.), biological and chemical**









- **<u>Accurate identification of the disease (pathogen) or disorder is essential for successful management</u>**

Integrated Disease Management

- Physical/mechanical management
  - Controlling pathogens with physical methods or mechanical devices
    - Examples:
      - Traps and barriers (insect vectors)
      - Mulches (weed vectors)
      - Pruning
      - Cultivating/hand removal
      - Soil solarization/heat treatments



Pruning



Soil solarization



Mulches

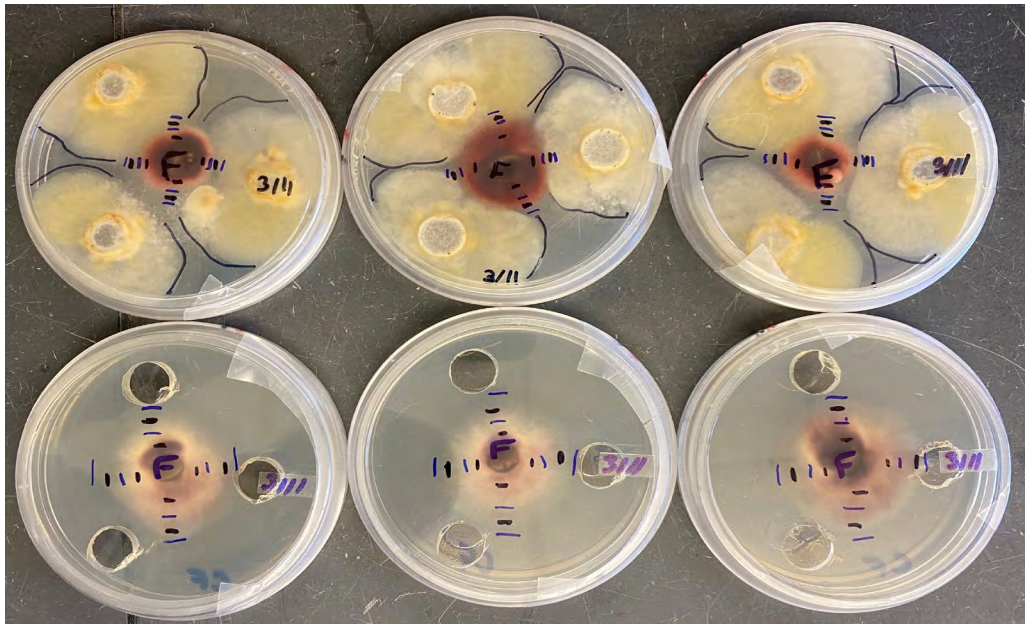
Integrated Disease Management

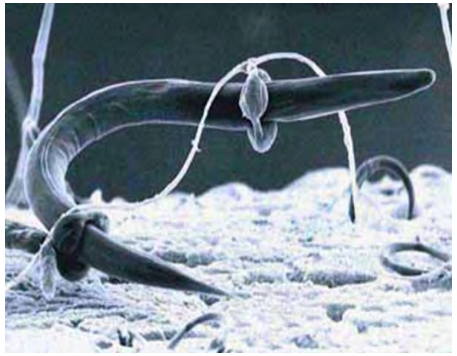
- Cultural management
  - The goal is to make the environment **less suitable** for the pathogens to survive and thrive
    - Examples:
      - Species and cultivar selection
      - Proper site selection and planting time
      - Proper watering and fertilizing
      - Insect and weed control
      - Sanitation! – remove debris, sterilize tools, wash hands, etc.



Integrated Disease Management

- Biological management
  - Management of pathogens by other beneficial microorganisms:
    - 1. Parasitism
    - 2. Antibiosis
    - 3. Induced host resistance (plant vaccine)
    - 4. Competition for resources or space
  - Examples:
    - Beneficial fungi: *Trichoderma*, *Aspergillus*, etc.
    - Beneficial bacteria: *Bacillus*, *Streptomyces*, etc.
    - Beneficial nematodes
    - Plant extracts: *Reynoutria* (giant knotweed), *Glycyrrhiza* (licorice), compost teas, etc.









Integrated Disease Management



- Chemical management
  - Used to prevent and protect plant hosts from pathogens using pesticides
  - IPM (IDM) – **only used when needed** and in combination with previously mentioned strategies
    - Examples: Fungicides, bactericide, nematicides
  - ***<u>***Read and follow the label! The label is the law!***</u>



Test… Don’t Guess!!! NMSU Plant Diagnostic Clinic

- Diagnosis is a **team** effort
  - Grower / Producer / “Boots on the ground” people
  - Submitting Agent (Extension Specialist / County Extension Agent / Company)
  - Diagnostic Lab






NPDN
National Plant Diagnostic Network
Advancing Diagnostics to Meet Plant Health Needs

NMSU Plant Diagnostic Clinic

- **Personnel:**
  - Co-Director/Weed Specialist: Dr. Leslie Beck
  - Co-Director/Plant Pathologist: Dr. Phillip Lujan
  - Plant Diagnostician: Dr. Srijana Dura
  - Associated personnel
    - Entomology: Dr. Joanie King, Dr. Jane Pierce
    - Horticulture: Dr. Marisa Thompson
    - Nematology: Coming soon…

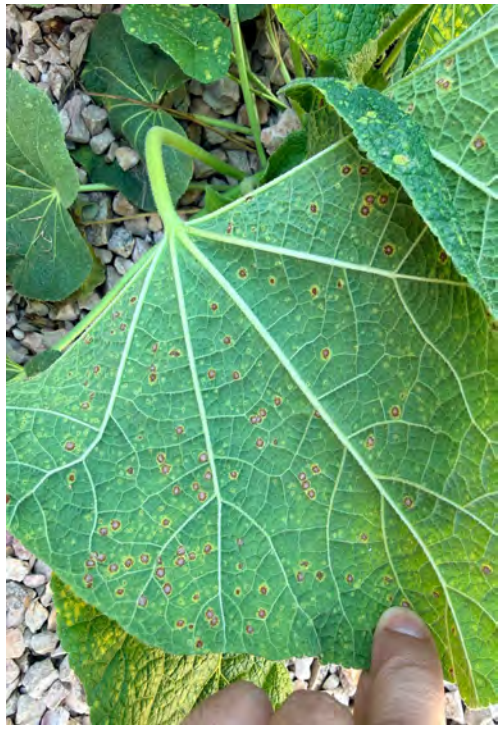







NMSU Plant Diagnostic Clinic

- Services provided:
  - **Integrated** plant diagnostic clinic
    - Diseases
    - Abiotic issues
    - Arthropod identification and damage
    - Plant and weed identification





  - Permitted to receive unknowns (diseases/abiotic/nematodes/insects) from within the contiguous 48 states

Bearer of Unfortunate News…

- Plant diseases are **very difficult** to **cure**
  - Especially diseases that are well established **within** and **throughout** the plant (vascular/root diseases)
  - When symptoms are clearly noticeable, it may be too late to treat effectively
- Management strategies are usually aimed at reducing stress and prolonging life, **not preventing death**



Top 10 Plants Submitted to the NMSU Plant Diagnostic Clinic (January – Present, n = 1,214)

Genus	Common name	% of Total Plant Samples Submitted
Solanum	Tomato	12
Pinus	Pine	10
Capsicum	Chile Pepper	9
Malus	Apple	8
Pyrus	Pear	6
Phaseolus	Bean	6
Prunus	Stone Fruits	5
Poa/Cynodon	Turfgrass	5
Vitis	Grape	5
Cucumis	Cucumber	3

Top 10 Plant Disease/Disorders Submitted to the NMSU Plant Diagnostic Clinic (January – Present, n = 1,214)

Disease/Disorder	% of samples	Common Hosts
1. Abiotic stress (cultural/environmental)	55	**Everything**
2. Beet Curly Top Virus	14	Wide host range… Tomato, Pepper, Bean
3. Phomopsis Blight / Canker	8	Pine, Juniper, Spruce, Mulberry, Poplar
4. Fire Blight	6	Apple, Pear, Cherry, Plum
5. Phytophthora Root and Crown Rot	6	Wide host range… Chile Pepper, Tomato, Fruit Trees
6. Iron Chlorosis	3	Pear, Fruit Trees, Cottonwood, Mulberry, Sycamore
7. Brown Patch	2	Turfgrass
8. Phymatotrichum Root Rot***	2	Pecan, Grape, Pine, Fruit Trees, Misc.
9. Powdery Mildew	2	Everything
10. Bacterial Leaf Spot	1	Cucumber, Chile Pepper, Tomato, Squash, Pumpkin, etc.

**** Pathogen restricted to Southern half of New Mexico*

1. Abiotic Stress (Cultural/Environmental)

- Cultural/Environmental stress examples:
  - Irrigation/drought
  - Planting area/depth
  - Inappropriate plants for your growing zone
  - Microclimates
- <u>Predispose plants to secondary pathogen infection</u>







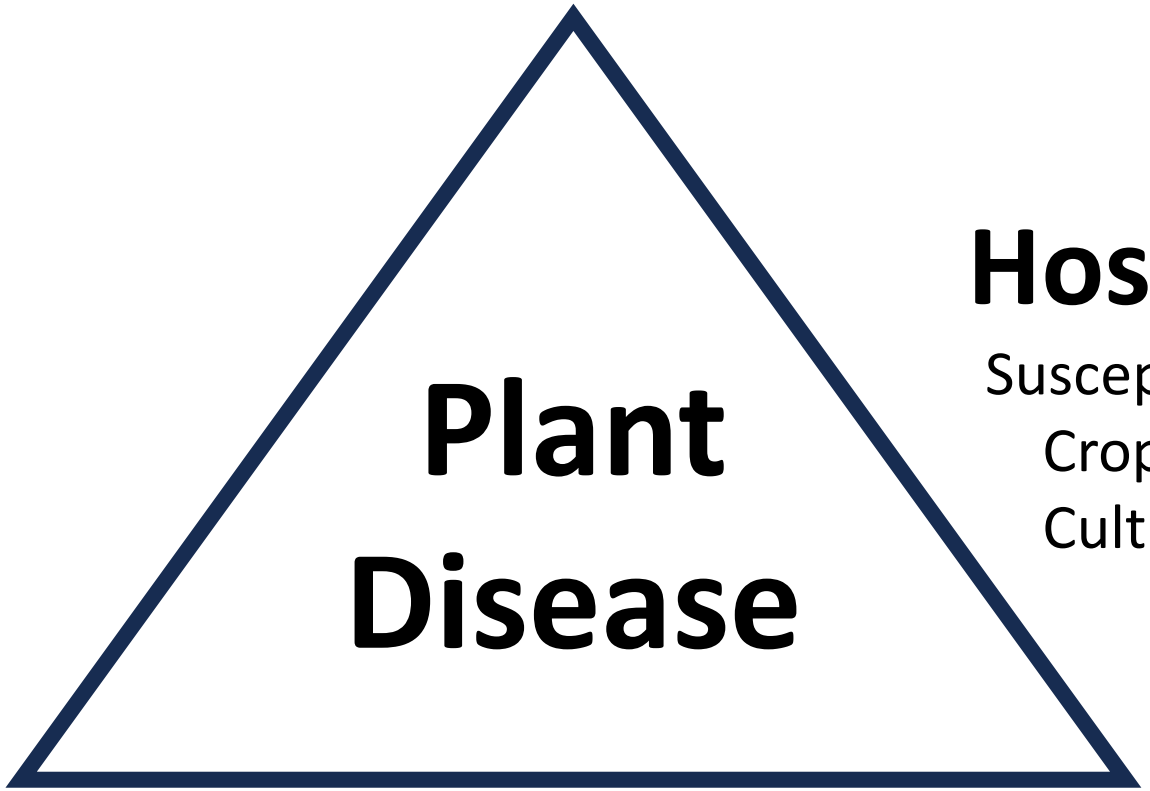
1. Abiotic Stress (Cultural/Environmental)







1. Abiotic Stress (Cultural/Environmental)



Host

Susceptible:
- Crop
- Cultivar

Favorable Environment

- Air/soil temperature
- Soil fertility
- Soil type
- Soil pH
- Soil moisture
- Rainfall/humidity

- Temperature extremes
- Moisture extremes
- Soil problems
- Nutrient deficiency or toxicity
- Wind
- Pesticide toxicity
- Improper cultural practices

- **Enormous amount of reference material found within our NMSU extension guides:** https://pubs.nmsu.edu/_h/index.html#hort

Viruses

- Do not carry out respiration, digestion or any other metabolic functions
- Virus are not given Latin names – they are named for the first economic host discovered, the primary symptom, and then virus is tacked on to the end



2. Beet Curly Top Virus

- Occurs in arid and semi-arid regions of the world
- Wide host range – peppers, tomatoes, melons, beans, spinach, beets, many ornamentals, and weeds
- Transmitted in a persistent manner by the beet leafhopper















Beet Curly Top Virus on Tomato









2. Beet Curly Top Virus

- Overwinters in winter annual weeds and in perennial hosts (ornamentals)
- Vectored by the beet leafhopper





Beet Leafhopper



London Rocket



Flixweed





Beet Leafhopper

London Rocket



Flixweed



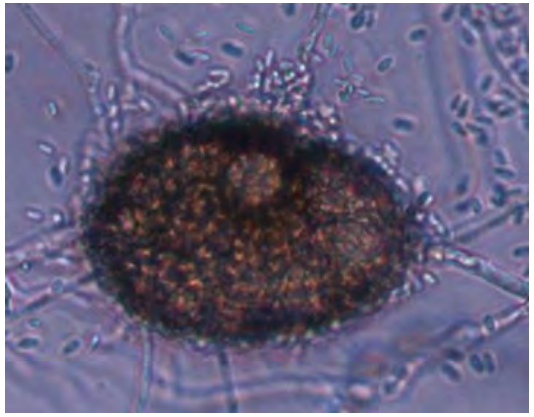
Management of Viral Diseases

- Once infected, there is no cure – destroy infected plants
- Plant in slightly shady location
- Use protective netting
- Weed control
- Resistance
- Chemicals – Not yet
- Insect control – No



3. Phomopsis Blight and Canker

- Pathogen: *Phomopsis* spp. (species are pretty host specific)
- Hosts: Cottonwood, **juniper**, cedar, **pine** and **small fruits**
- Spores spread by wind, rain, insects, natural wounds and pruning
  - Moisture is required for spore release
- Optimum temperature for infection 75° F / disease development 90° F
- Serious problem in nurseries
  - Spread very easily by pruning/wounds
- **Landscape trees are rarely killed, but can become unsightly and unaesthetic with numerous dead branches**





3. Phomopsis Blight and Canker

- Symptoms
  - Dieback and blight
  - Cankers develop on larger stems
  - Small stems are girdled and killed

- Signs
  - Black fruiting bodies can sometimes be visible on infected shoots







3. Phomopsis Blight and Canker

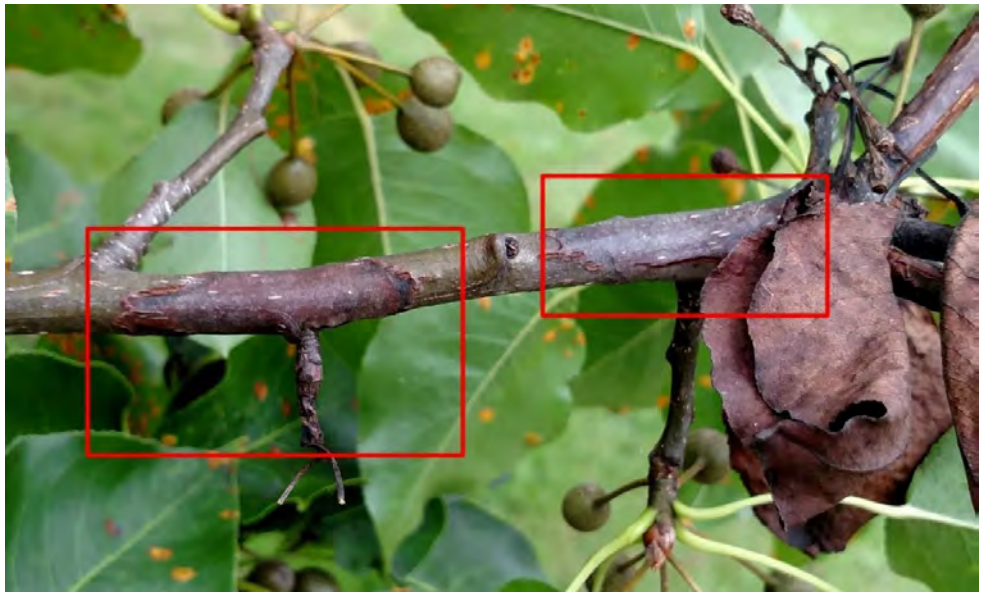
- Integrated disease management – cultural practices
  - Weak pathogen, so prevention is where to start!
    - Avoid unnecessary injuries
  - Reduce stress
    - Proper water and fertilizer (if needed) management
      - Avoid wetting foliage to prevent spore spread
      - Water early in day so foliage dries quickly
  - Prune out infected twigs and branches
    - Clean tools with alcohol, bleach or household cleaner
    - **Do not prune when branches are wet!**





4. Fire Blight

- Pathogen: *Erwinia amylovora*
- Hosts: Trees in Rosaceae family
  - Apples, Cherries, Peach, Plum, Quince, Crabapple, etc.
- Overwinters in previous years cankers and healthy buds
- Optimal conditions: 75-85° F day / > 55° F night + intermittent rain
- Spread by contaminated pruning tools, insects and bees
- Symptoms:
  - Infected twigs become water soaked, dark and sunken
  - Young twigs and branches die from terminal end and appear burned/bend







4. Fire Blight

- Integrated disease management
  - Start with disease free planting materials
    - Carefully inspect new material!
  - Prune out infected branches
    - At least **6 inches** below margin of disease/canker
    - Clean pruning tools afterward (70% alcohol, 10% bleach, household cleaners, etc.)
  - Protective sprays during flowering
    - Copper fungicides or antibiotics





5. Phytophthora Root and Crown Rot

- Several *Phytophthora* spp. cause root and crown rot
- Disease can occur on almost all fruit and nut trees, and ornamental trees and shrubs
  - **Tomatoes, peppers, eggplant and other vegetable crops can also be affected**
- Phytophthora infection on vegetables requires warm moist soils while tree diseases are favored by cooler moist conditions
- Wounds are **not required** for the pathogen to enter the plant/trees and cause infection



Lavender

5. Phytophthora Root and Crown Rot

- Leaves of plants affected with root rot appear drought stressed
- Plants wilt and die very rapidly with first warm weather spell
- Typically kills younger trees versus larger mature trees with a developed root system and crown











Phytophthora rot of boxwood and fir

5. Phytophthora Root and Crown Rot





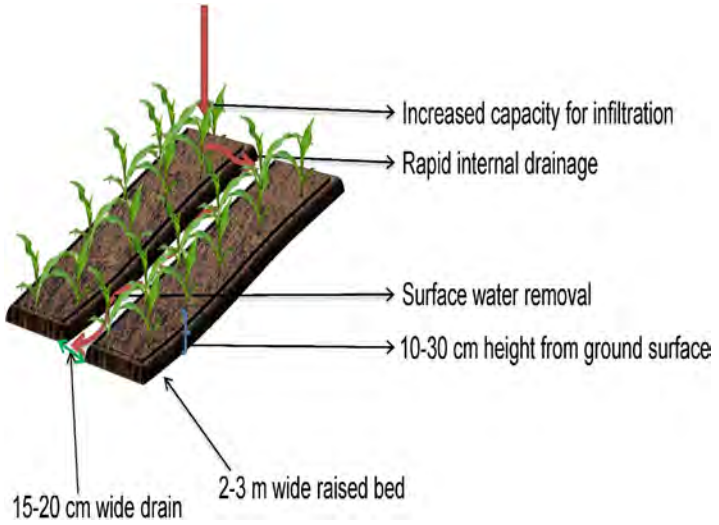
5. Phytophthora Root and Crown Rot

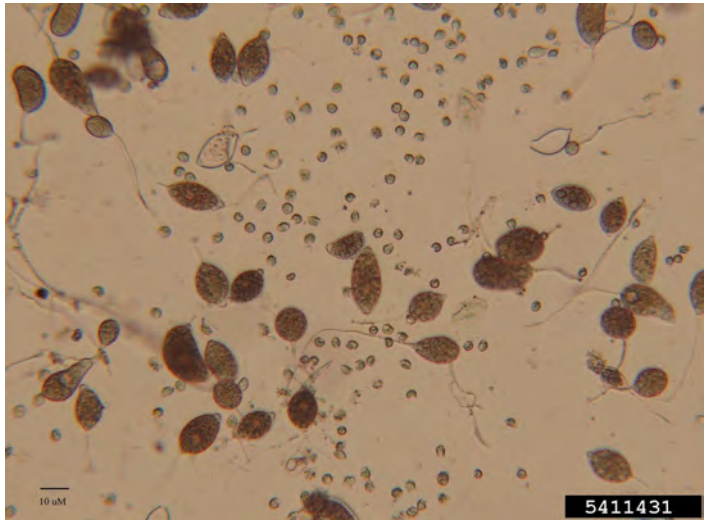




5. Management of Phytophthora root and crown rot

- Control is difficult, but soil management is where you start, keeping soil level and well-drained
- Plant vegetables on high, well-drained beds
- Don't overwater, as *Phytophthora* spreads through water
- Do not plant too deeply!
- Remove and destroy all infected plants and keep sanitation practices up
- Disease prevention is the primary goal since no chemicals cure *Phytophthora*-infected plants





6. Iron Chlorosis

- Most common nutrient disorder in all sorts of landscape plants/trees
  - Commonly submitted trees for diagnosis: willow, mulberry, maple, sycamore, aspen, apple, pear, stone fruit, and pecan
- Iron is an essential element for normal growth and green color
  - Can be plentiful in soil but often tightly bound to soil particles in high pH (alkaline/calcareous) soils
    - Iron is unavailable for tree use
- Symptoms typically begin in spring when trees are leafing out
  - During summer, trees exhibit severe symptoms and overall unhealthy appearance
  - Symptoms: interveinal chlorosis (yellow leaves and green veins), severe cases leaves turn white or develop necrotic spots, dieback
- Management
  - Applying the **correct type of chelated iron product at the correct time** for NM can help
    - **NMSU Extension guide: H-171 Iron Chlorosis**

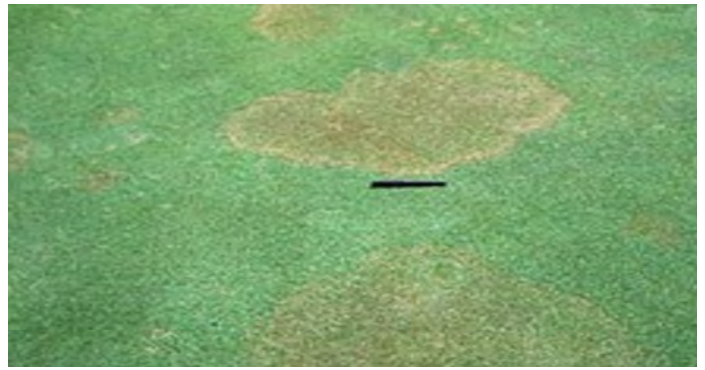




7. Brown Patch

- Caused by *Rhizoctonia solani*
- Worldwide; <u>all turf species</u> can be affected
- Most common and more severe in warm, humid weather; still can infect under a wide range of conditions
- **Highly variable symptoms**
- Excellent saprophyte









7. Brown Patch

- Conditions that favor disease development:
  - Excessive fertilizer (especially nitrogen)
  - Excessive moisture
    - Poor drainage
    - Leaf wetness
  - Excessive thatch

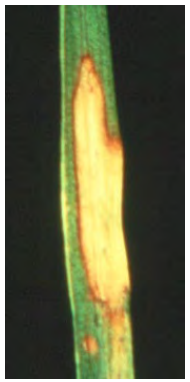




7. Brown Patch

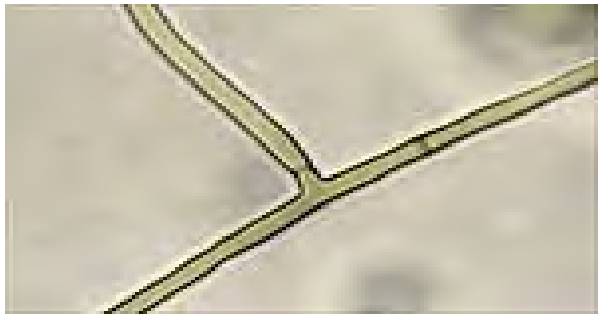
- Symptoms
  - Leaf spot / blight
  - Crown / root rot






- Signs






7. Brown Patch - Management

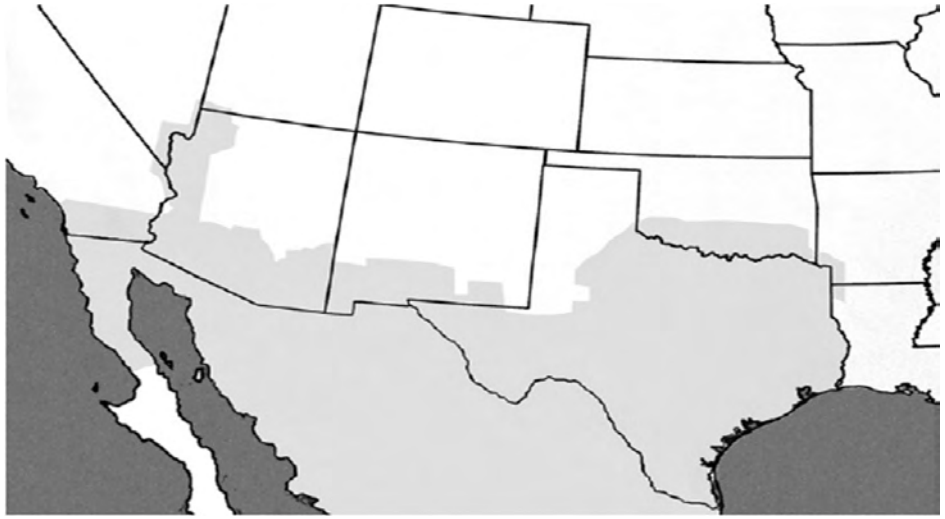
- Proper irrigation practices
  - Improve drainage, reduce leaf wetness, increase air circulation
- Avoid excessive nitrogen fertilization
- Reduce thatch
- Fungicides **(check labels before use!)**:
  - Chlorothalonil, fludioxonil, iprodione, pyraclostrobin, azoxystrobin, captan, mancozeb, others…

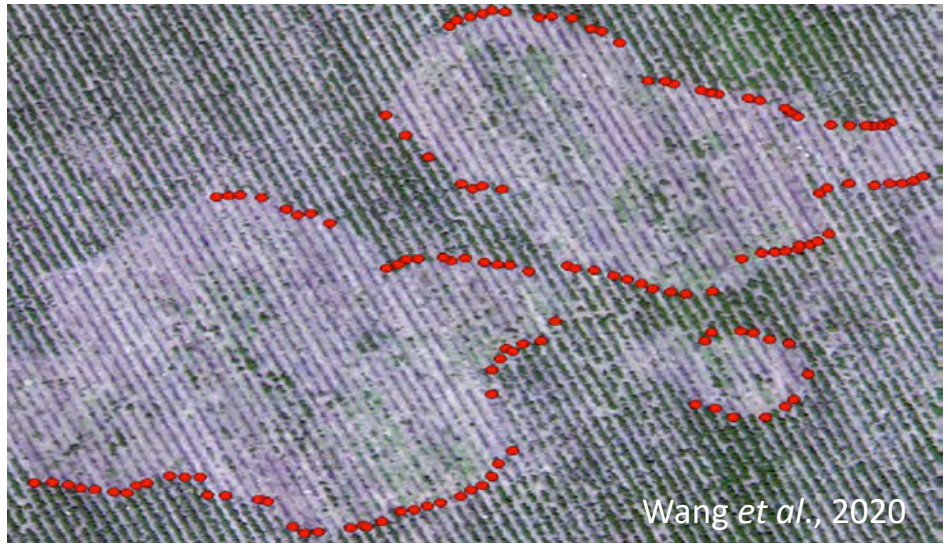




8. Phymatotrichum Root Rot

- Also known as cotton root rot or Texas root rot
- Pathogen: *Phymatotrichopsis omnivora* (means “eats everything”)
- Hosts: Extremely wide host range (2,300 plant species); pine, fruit trees, ash, cottonwood, willow, grape, sycamore, and pecan
- Fungus is geographically limited – part of Arizona, Southern New Mexico, Oklahoma, Texas, and Mexico
  - Only found at elevations below 5,000 feet
  - Even with its geographical boundaries, the fungus is spotty in occurrence

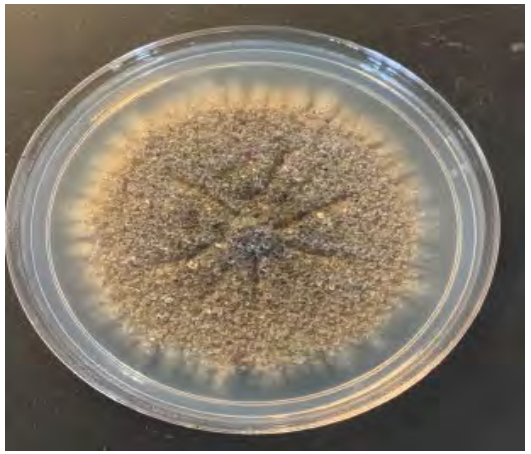




8. Phymatotrichum Root Rot

- Found in soils that are low in organic matter and high in alkalinity (pH 7.0 - 8.2)
  - Fungus is endemic to desert areas
    - Old riverbeds or arroyos
- Spread of the fungus is very limited – no viable spores and only spreads by root graphs
  - Survives deep (over 12 feet!) in soil as fungus and sclerotia
  - It may take many years for trees to develop a root system deep enough to encounter the fungus
- Disease typically appears in summer or fall
  - Temperature above 85° F + some moisture





8. Phymatotrichum Root Rot

- Symptoms:
  - Slight yellowing of leaves → bronze
  - Wilt
    - Plants can die very rapidly – **as little as two weeks!**
  - Lesions may develop on roots





- Signs:
  - Whitish-tan spore mats (during wet conditions)
  - Fungal strands on roots (visible with a hand lens)
    - Unique cruciform/acicular hyphae visible with microscope





8. Phymatotrichum Root Rot

- Integrated disease management
  - Management is extremely difficult, if not impossible
  - Changing the soil environment is an attempt – short term management (difficult in NM with buffered soils)
    - Loosen the soil just beyond the drip line
    - Addition of organic matter (manure)
    - Addition of ammonium sulfate and sulfur to reduce pH (1 lb. / 10 sq. ft.)
    - Flood with water to a depth of 3 feet (maintain for a couple of weeks)
  - Green manure cover crop
    - Stimulate vigorous rooting of trees; better withstand disease pressure
    - Incorporating into soil may help stimulate soil microflora





9. Powdery Mildew

- One of the **most common** plant diseases
- Common name for diseases that produce whitish, powdery growth on the surface of the plant
- Only the above-ground parts are affected
- Almost all plants can be infected by powdery mildew
- Most powdery mildew fungi have a relatively limited host range (squash mildew won't infect roses and vice versa)



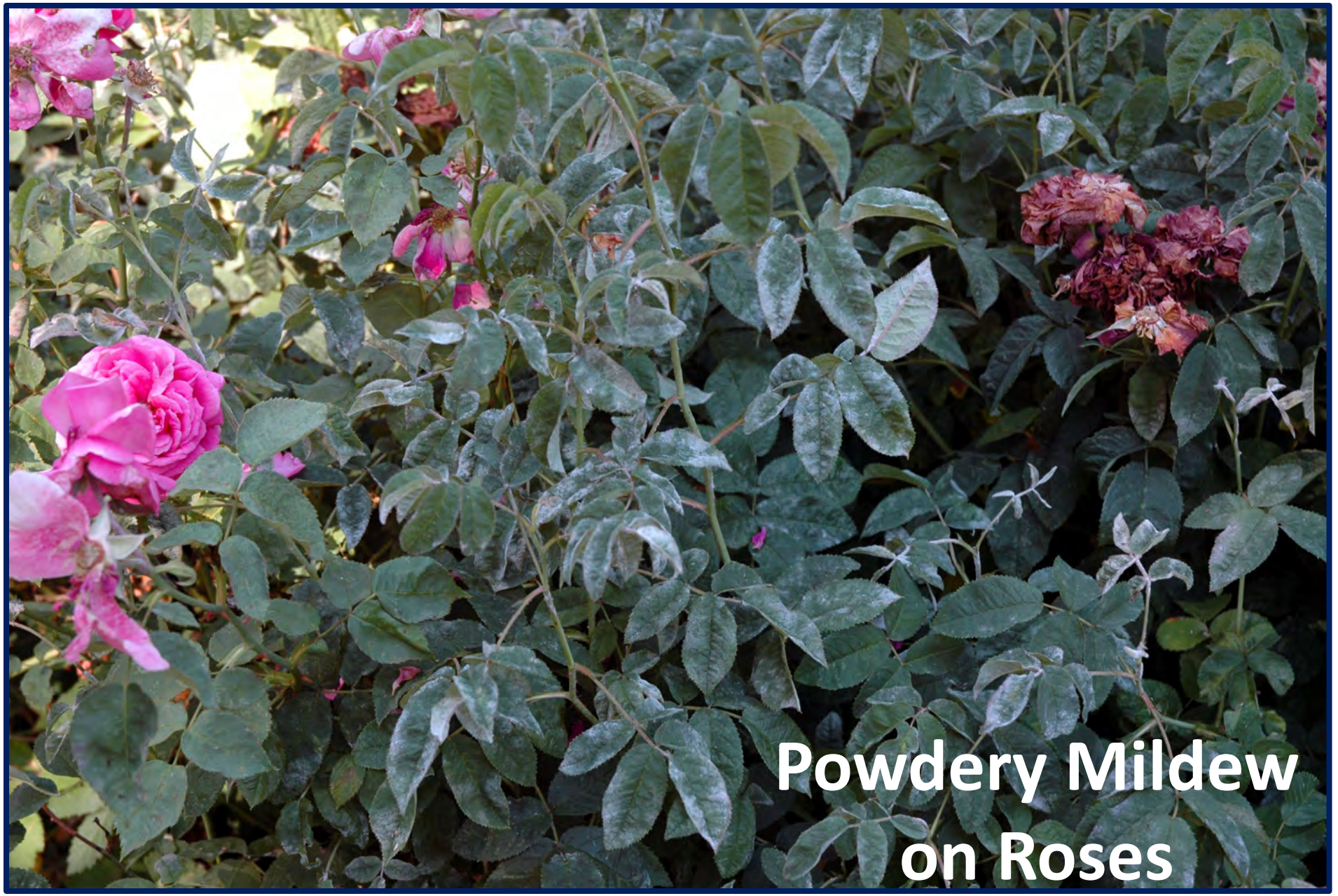
9. Powdery Mildew

- Powdery mildew do not typically kill their host
- Interfere with normal plant growth
  - Utilize plant nutrients and decreasing photosynthesis
- **Signs:** fungal mats appear white, grayish white or tan colored patches on leaves, buds, stems or young fruit; fruiting bodies can appear as small black specks
- **Symptoms:** infected leaves appear chlorotic, leaf curl/drop








Powdery Mildew
on Roses

9. Powdery Mildew Management

- Start with disease-free planting material
- Good sanitation practices: prune out infected canes, remove fallen leaves, and destroy all infected plant material
- Use of protective fungicides – timing is critical (before moist, warm days 80-86˚ F)
- Use of systemic fungicides for severe outbreaks



10. Bacterial leaf spot

- Most commonly caused by *Pseudomonas* or *Xanthamonas* spp.
- Bacterial pathogens live on plant surfaces in low numbers without causing disease
- However, when weather conditions are favorable (moist and humid), pathogen populations grow exponentially and cause disease



Violet



Geranium

10. Bacterial leaf spot

- Leaf spot diseases start as small dark brown to black spots with a halo of yellow tissue around each spot

- Center will dry up and sometimes fall out, giving it a “shot hole” appearance

- Leaf spots can grow together creating large blotches on leaves or turn leaves, shoots, buds or flowers completely black



Pepper



Tomato





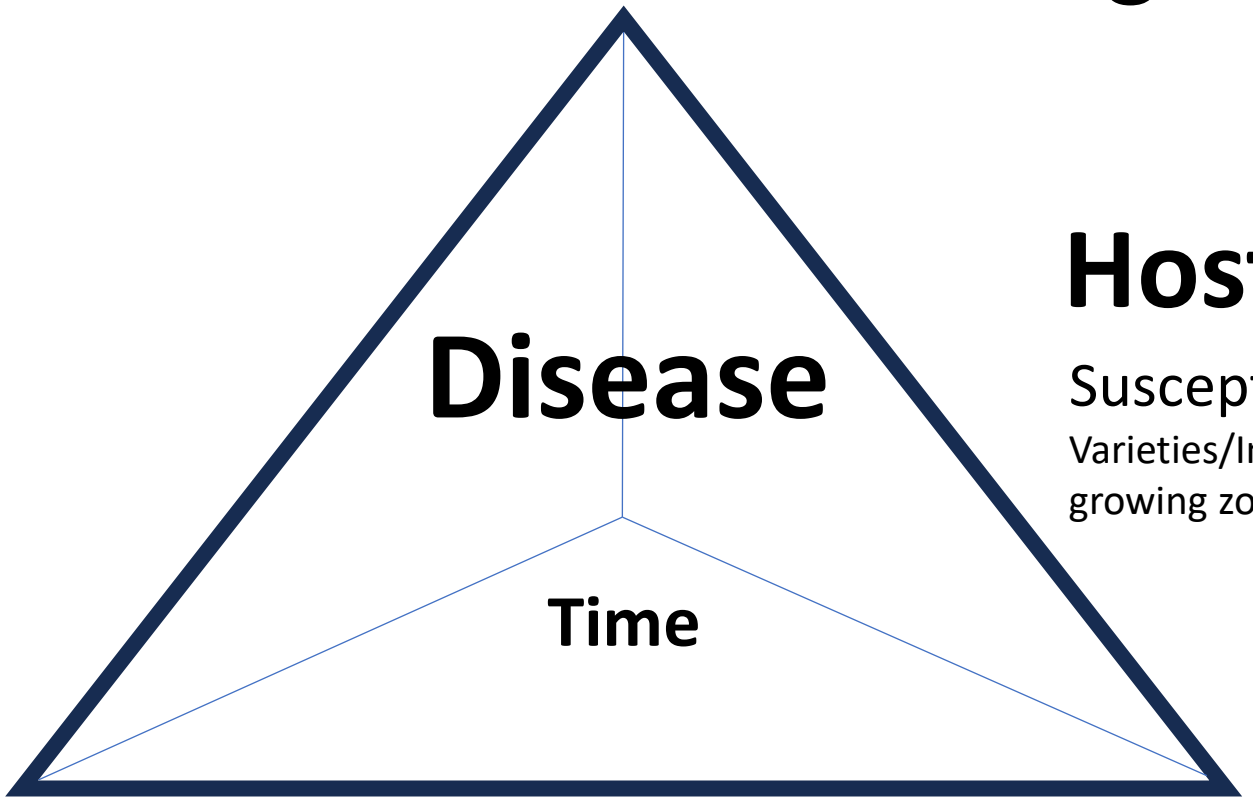
Bacterial leaf spot of tomato

10. Management of Bacterial leaf spot

- Use pathogen-free seed/stock
- Avoid sprinkler irrigation if possible
- Seed treat in hot water (122˚ F for 20 minutes with agitation) prior to planting
- Protective sprays (copper fungicides, antibiotics) are available



The Plant Disease Triangle



Pathogen

Fungi
Bacteria
Viruses
Nematodes

Host

Susceptible:
Varieties/Inappropriate trees for the growing zone

Abiotic induced stress!

Favorable Environment

Air/soil temperature
Soil fertility
Soil type
Soil pH
Soil moisture
Rainfall/humidity

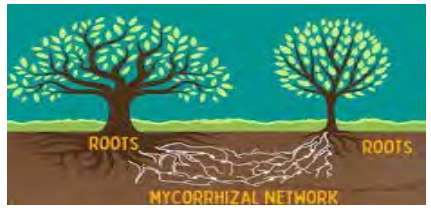
Disease Management

- The key to disease management is **PREVENTION!**
  - **Well managed plants = healthy plants**

- Most effective management programs incorporate **all strategies** known to reduce disease severity – **"Integrated Disease Management"**
  - **Physical (pruning, etc.), cultural (irrigation, planting area, etc.), biological and chemical**









- **<u>But first! Accurate identification of the disease (pathogen) or disorder is essential for successful management</u>**

Questions about the presentation or plant problems/sampling suggestions?

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