

1

Outline

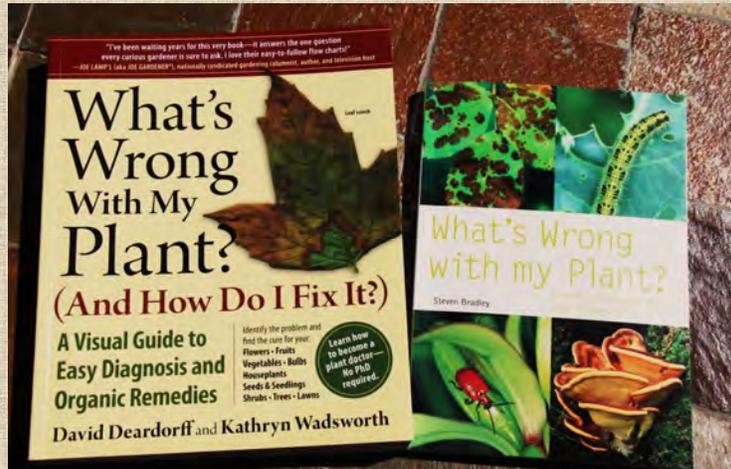
- Disease Basics
- Disease Diagnosis
- Causal Agents
- Fungal Symbioses
- Common Local Diseases
- Disease, Pest, and Problem Specimens



2

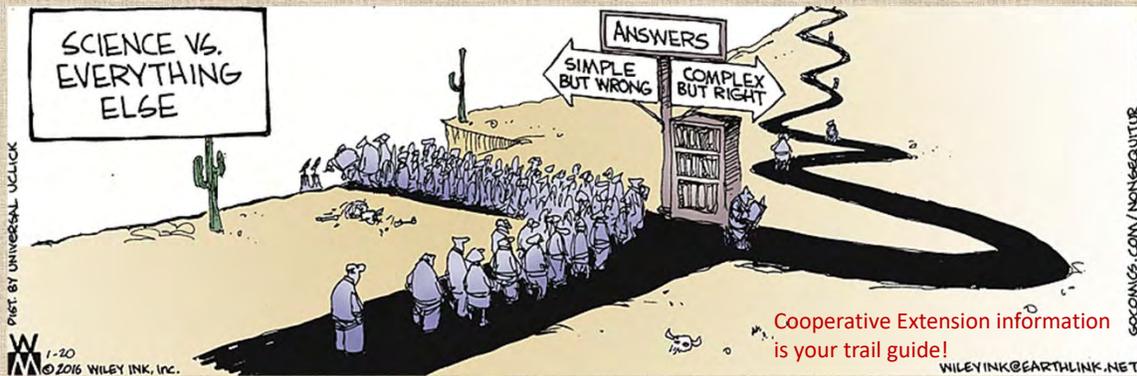
So, You Want to be a Master Gardener!

- Common Questions the public will ask you:
 - What's Wrong With My Plant?
 - How Do I Fix It?



3

“Scientific Based Horticultural Information”



4

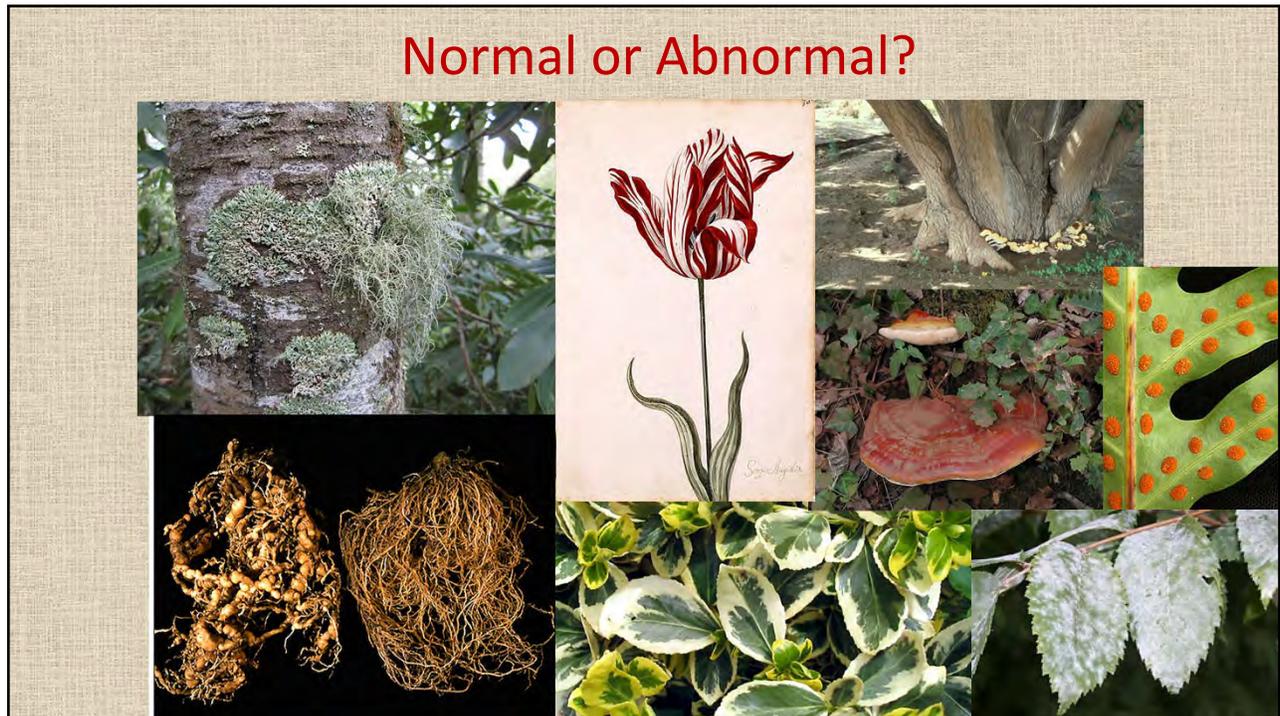
What is Plant Disease?

- Disturbance of normal functioning (physiology) of a plant
- Many causes and appearances
 - Biotic and/or abiotic agents
 - Continuum of potential causes
 - Microbial pathogens to physical injuries



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Normal or Abnormal?



6

Diseases vs. Non-Disease Problems

- Disease
 - Pathogenic organism, virus, or viroid
 - Environmental cause
 - Disorder or injury
- Non-disease problems (Pests)
 - Invertebrates - insects, mites, snails, slugs
 - Vertebrate pests including humans
 - Weed competition



improper pruning
(topping)



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What's Causing this?

- **What are the possibilities?**
- Abiotic problem
 - Hail damage
- Biotic disease
 - Caused leaves to drop
- Non-disease problem
 - Insect defoliation
 - Tomato horn worm, blister beetles
- Vertebrate animal grazing
 - Rabbits, pack rats, ground squirrels, javalina, deer, etc.



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Diseases?



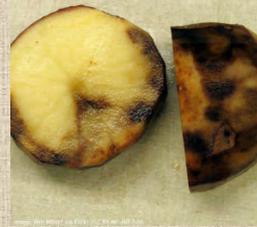
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Some Major Crop Losses from Diseases

- **Bible** – blasts, mildews, rusts
- **Romans** – rust god, animal sacrifice
- **Late Blight of Potato**
 - 1840s, Ireland, 2.5 mil. die or immigrate
- **Downey Mildew of Grape**
 - 1878-1885, devastated French wine industry, Bordeaux mixture
- **Stem Rust of Wheat**
 - 1916, 1935, 1953; losses in Great plains, >50%, plant breeding genetics
- **Panama (Fusarium Wilt) Disease of Bananas**
 - 1920s-1950s, Gros Michel, nearly wiped out; Cavendish, now susceptible new races of fungus; genetic studies on banana clones, also Black Sigatoka
- **Modern Devastating Diseases**
 - wheat blast, Xylella (olives), maize lethal necrosis, coffee rust, striped wheat rust, citrus greening, citrus canker, papaya ring spot virus, cacao witches' broom, s. corn leaf blight, rice bacterial leaf spot, rice brown disease, etc.



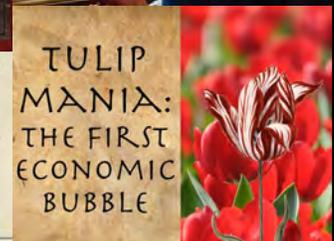
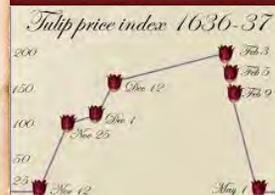
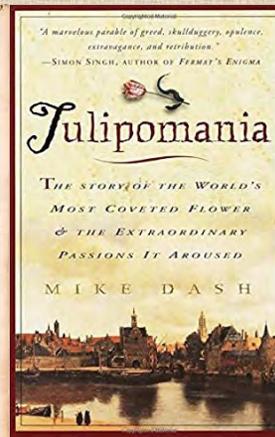
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Tulip Mania

Tulip-specific mosaic virus, known as the "Tulip breaking virus", because it "breaks" the one petal color into two or more

Semper Augustus, famous for being the most expensive tulip sold during Tulip Mania

1637 - one was advertised for 13,000 Florins (price of a nice house), market for tulips then crashed in Netherlands



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What about Home Gardens?

- Often use noncommercial cultivars (heirlooms, resistant hybrids)
- Disease tolerance (accept some level of disease or cut out)
- Low impact commercial pesticide alternatives
 - manual, hose off, soap, neem oil, etc.
- Follow disease prevention practices – sanitation, rotation, etc.
- Keep it simple!



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Diagnosing Plant Diseases

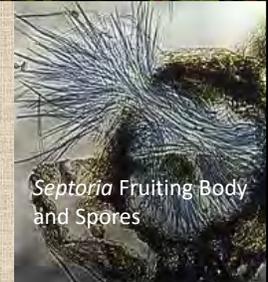
- Collect large enough sample so can identify:
 - Plant, symptoms, signs, history, etc.
- Take pictures
 - Appearance when fresh



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Diagnosing Plant Diseases

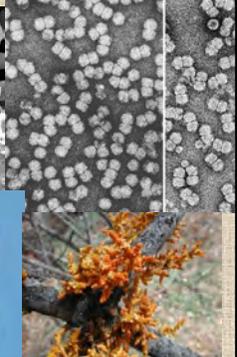
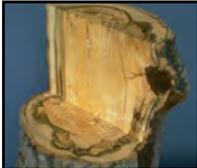
- Eliminate other possibilities
 - animal pests, weather, maintenance problems, etc.
- If a potential disease exists, you may need to know:
 - Plant species, maybe cultivar
 - Plant part affected
 - Foliar, stem, root, fruit problem
 - Type of abnormality
 - Symptoms
 - Changes seen in plant (yellowing, leaf spot, canker, etc.)
 - Type of pathogen
 - Signs (causal agent)
 - Environmental factor, structures of pathogen



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Symptoms and Signs

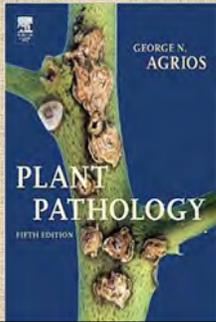
- Symptoms (host plant abnormality)
 - Expression of disease in host plant
 - Plant response, damage
- Signs (pathogen)
 - Organisms and their parts (fungi, bacteria, etc.)
 - Viruses, viroids



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How Can Master Gardeners Diagnose Plant Diseases?

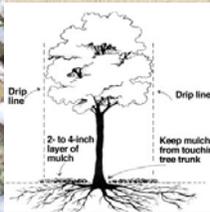
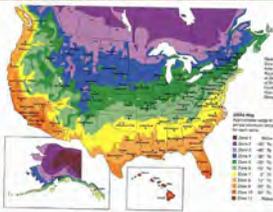
- Understand basic plant disease principles and concepts
 - http://ceventura.ucanr.edu/Environmental_Horticulture/Landscape/Problems/Pathology/
- Know where to look up detailed information
 - Arizona plant disease resources, other state extension web sites
- Learn from your experiences
 - Your gardening observations over time, classes, readings, knowledgeable people



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Other useful Information needed to Diagnose a Problem

- Where is plant located?
- Has the plant been exposed to any extreme or unusual environmental conditions?
- How has the plant been cared for or neglected?
- Be prepared to say:
 - “I don’t know but will research the available information”



VARIETY (genus and species, and/or common name of plant) _____

AGE OF THE PLANT: _____ PLANTING DATE: _____

SYMPTOMS (circle all that apply):
 Plant parts affected: roots, crown, stems, branches, leaves, fruit, whole plant.
 Symptoms: spots, galls, distortions, mites or mites, chlorosis (yellowing), necrosis, mildew, blights, defoliation, wilt, dieback, blight, staining, canker or galls.
 Description (be as specific as possible, describe the whole plant - remember the clinician is only seeing the specimen submitted): _____

When did symptoms first appear? _____
 Are the symptoms (circle one): spreading or localized? _____
 Symptom development (circle one): gradual or sudden? _____
 Distribution of diseased plants (circle): scattered, clustered, in a row or pattern? _____
 Number or percent of plants affected: _____

SOIL TYPE (circle all that apply): Sand, Silt, Clay, Well drained, Poorly drained, Heavy, Light.

GROWING CONDITIONS (circle all that apply): Indoors (home/greenhouse), Greenhouse, Home Garden, Lawn, Landscape, Organic Garden, Commercial Field, Other: _____

WEATHER CONDITIONS (immediately prior to and during development of symptoms):
 (Circle all that apply) Wet, Dry, Humid, Windy, Cloudy, Hail
 Temperature (°F) _____ Other Conditions: _____

IRRIGATION HISTORY (circle all that apply): Furrow, Flood, Drip, Sprinkler, Hand
 How often? _____ How much water is applied? _____

FERTILIZATION HISTORY (type, nutrient ratio, amount applied, and frequency of application) _____

CHEMICALS APPLIED (chemical name, method and frequency of application and amount applied) _____

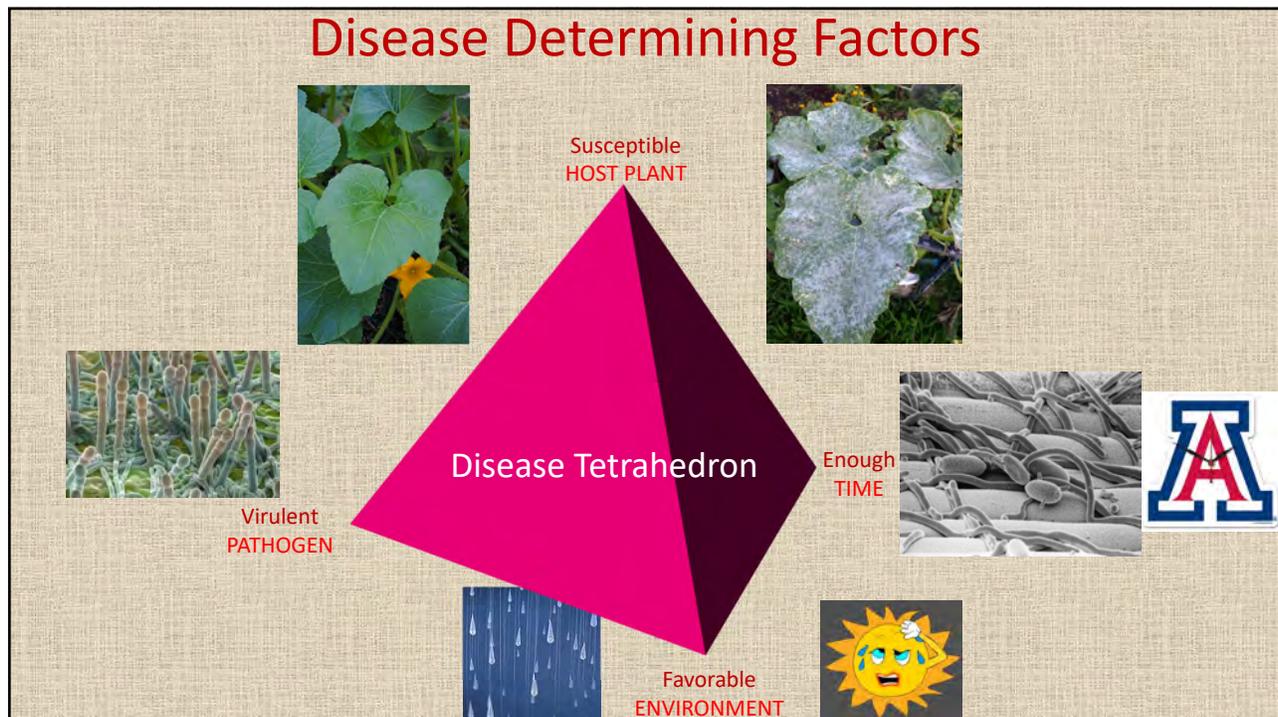
CROPPING HISTORY (for agricultural fields or home gardens)
 Rotation (previous 3 years) _____
 Past Problems (in field) _____

OTHER INFORMATION: _____

.....Diagnose Lab Use Only - Do Not Write In Box.....

Sample Conditions:	Information Requested:	Photo or digital image:
<input type="checkbox"/> Excellent / 1	<input type="checkbox"/> Complete / 1	Quality: _____
<input type="checkbox"/> Fair / 2	<input type="checkbox"/> Partial some useful information / 2	Time: _____
<input type="checkbox"/> Poor / 3	<input type="checkbox"/> Incomplete / 3	
<input type="checkbox"/> Unusable / 4	<input type="checkbox"/> None / 4	
Diagnosis: Complete / Non Complete	Explanation:	Task: _____

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Some Basic Plant Disease Principles

http://ceventura.ucanr.edu/Environmental_Horticulture/Landscape/Problems/Pathology/

- 1 - Disease is a malfunctioning of a plant
 - Results from a pathogenic agent
- 2 - Disease results from interaction of:
 - Virulent pathogen – Susceptible host - Favorable Environment – Enough Time
- 3 - Favorable conditions for plant growth and health
 - commonly favor disease
- 4 - Overwatering and underwatering plants
 - can increase disease, fertilizer also does
- 5 - Integrated Management - realistic way to manage disease
 - 1) cultural practices, 2) epidemiology, 3) resistant varieties, 4) chemical pesticides, and 5) biological control




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Basic Plant Pathology Principles

- **6 – Reducing inoculum**
 - can reduce disease, less pathogen present
- **7 - Wood decay organisms**
 - result in wind damage and breakage in trees
- **8 – Epidemics**
 - introduced (invasive) species cause more severe epidemics than endemic species
- **9 - Quarantine** - often the best method for combating disease
- **10 - Do no harm**

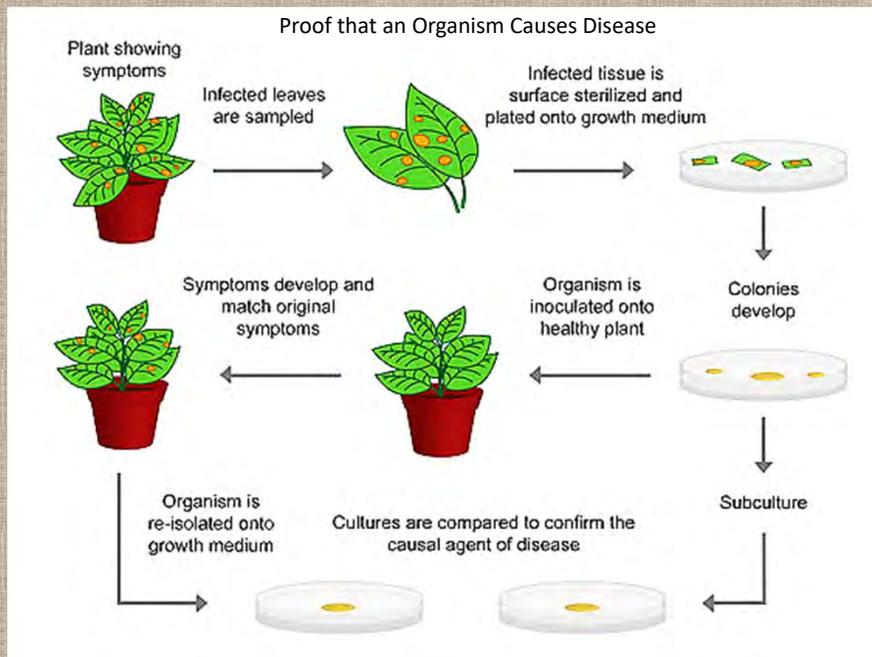
- John A. Menge and Elinor Pond
- Department of Plant Pathology
- University of California, Riverside
- http://ceventura.ucanr.edu/Environmental_Horticulture/Landscape/Problems/Pathology/



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Koch's Postulates

Proof that an Organism Causes Disease



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Types of Plant Diseases

Based on General Type of Causal Agent

- **Biotic Diseases** (Pathogens cause)
 - Symptoms: on specific plants or plant parts
 - Progression of symptoms
 - invasion of tissues (infectious)
- **Abiotic Diseases** (Environmental factors cause)
 - Symptoms: usually uniform on all plants
 - No progression of symptoms (noninfectious)
- **Declines** (Biotic and Abiotic factors cause)
 - Symptoms: usually from interchanging biotic and abiotic agents
 - Stress initiates (drought, cold, heat, etc.)
 - May not recognize original cause unless know history of problem
 - Environment, fungi and insects may be involved
 - “Disease complexes”



Late blight



Leaf scorch



Forest Decline

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Causal Agents of Plant Disease

- Pathogenic organisms
 - Fungi
 - Cause 70-80%
 - Bacteria
 - Nematodes
 - Parasitic plants
 - Algae and protozoa
- Noncellular Pathogens
 - Viruses
 - Viroids



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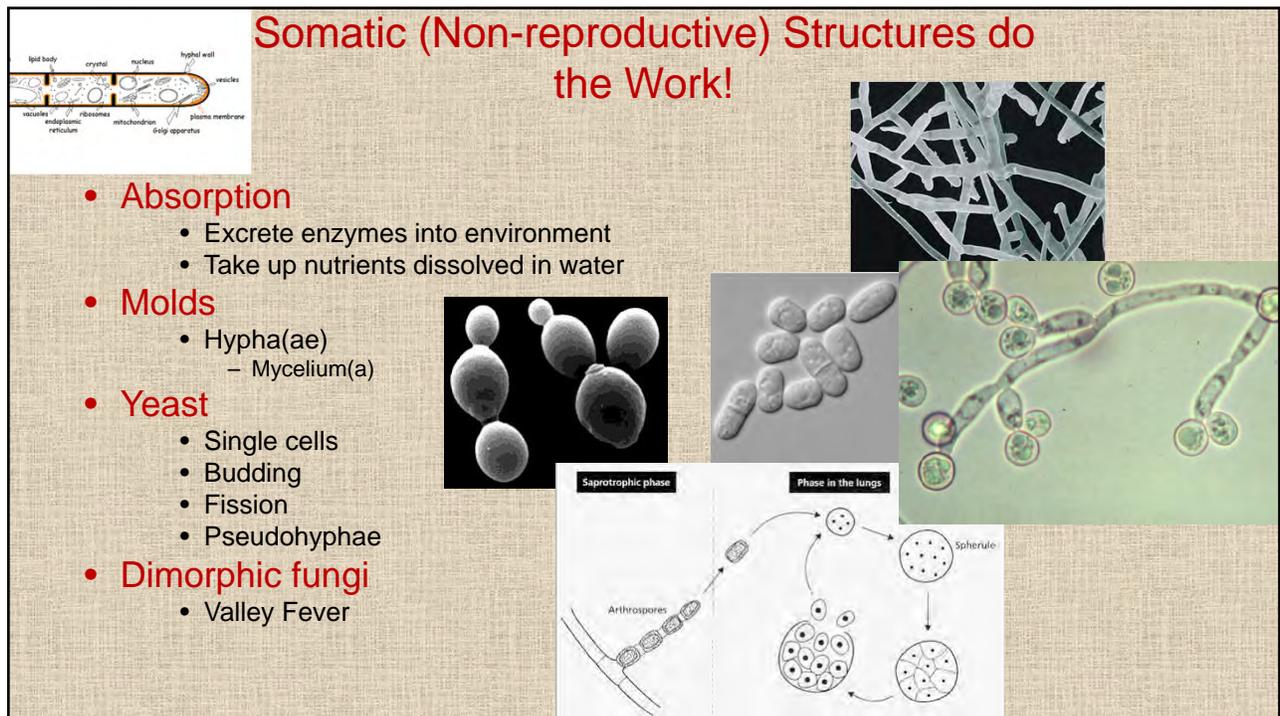
Fungi Come in Two Sizes



- **Macroscopic**
 - Mushrooms, bracket fungi, puffballs, etc.
 - Fruiting body visible, spores and mycelium are microscopic
- **Microscopic**
 - Yeast, molds, zygote fungi, chytrids

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Somatic (Non-reproductive) Structures do the Work!

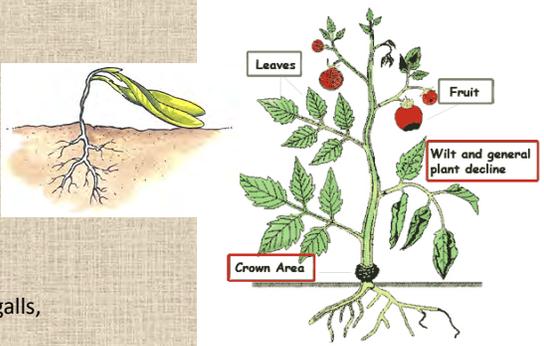


- **Absorption**
 - Excrete enzymes into environment
 - Take up nutrients dissolved in water
- **Molds**
 - Hypha(ae)
 - Mycelium(a)
- **Yeast**
 - Single cells
 - Budding
 - Fission
 - Pseudohyphae
- **Dimorphic fungi**
 - Valley Fever

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Fungi can Grow on all Plant Parts

- One or more species specific for ever plant
 - Over 100,000 species described, probably over 1 mil. Exist
- Leaves (Mildews, leaf spots, anthracnose, etc.)
- Branches and trunk
 - Cankers
 - Heart rot
 - Damping-off
- Roots
 - Rots
- Fruits and seeds
 - Rots, spots, etc.
- Rust diseases
 - Foliar
 - Stems - cankers, galls, brooms
- Smuts diseases
 - Reproductive parts





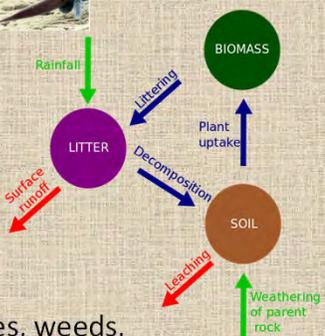


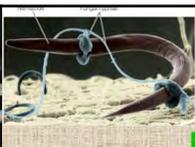



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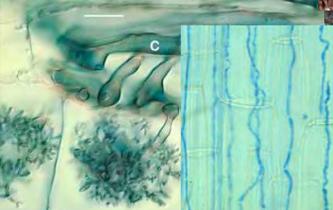
Roles of Fungi

- **Decomposers**
 - Organic debris
 - Nutrient cycling
 - Soil fertility
- **Pathogens**
 - Plants
 - Insects, nematodes, weeds, other fungi (**biocontrol**)
- **Symbionts**
 - Mycorrhizae
 - Lichens
 - Endophytes
- **Predators** – nematode trapping, etc.







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Fungi in our Gardens

- **Decomposers**
 - Organic debris
 - Soil fertility
 - Nutrient cycling
 - Compost making
- **Pathogens**
 - Plants
 - Biocontrol
- **Symbionts**
 - Mycorrhizae
 - Endophytes

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Mycorrhizae

- **Symbiotic associations**
 - Fungus and plant roots
 - Essential for one or both partners
 - Primarily function nutrient transfer
- **Most trees and agricultural crops**
 - Depend on or benefit substantially
- **How Plant Benefits**
 - Better growth in low nutrient soils
 - Soil-borne pathogen resistance
 - Drought resistance
 - Resistance to toxicity

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Types of Mycorrhiza

- **Ecto-**
 - Fungus outside the root and root cells
 - Pine family, oaks, over 20 other families of mostly woody plants
- **Endo-**
 - Fungus enters the cells of the root
 - Penetrate the cell wall and invaginate the cell membrane, nutrients transferred
 - Arbuscular (VA), arbutoid, monotropoid, ericoid, orchid
 - Estimated 80% of plant species

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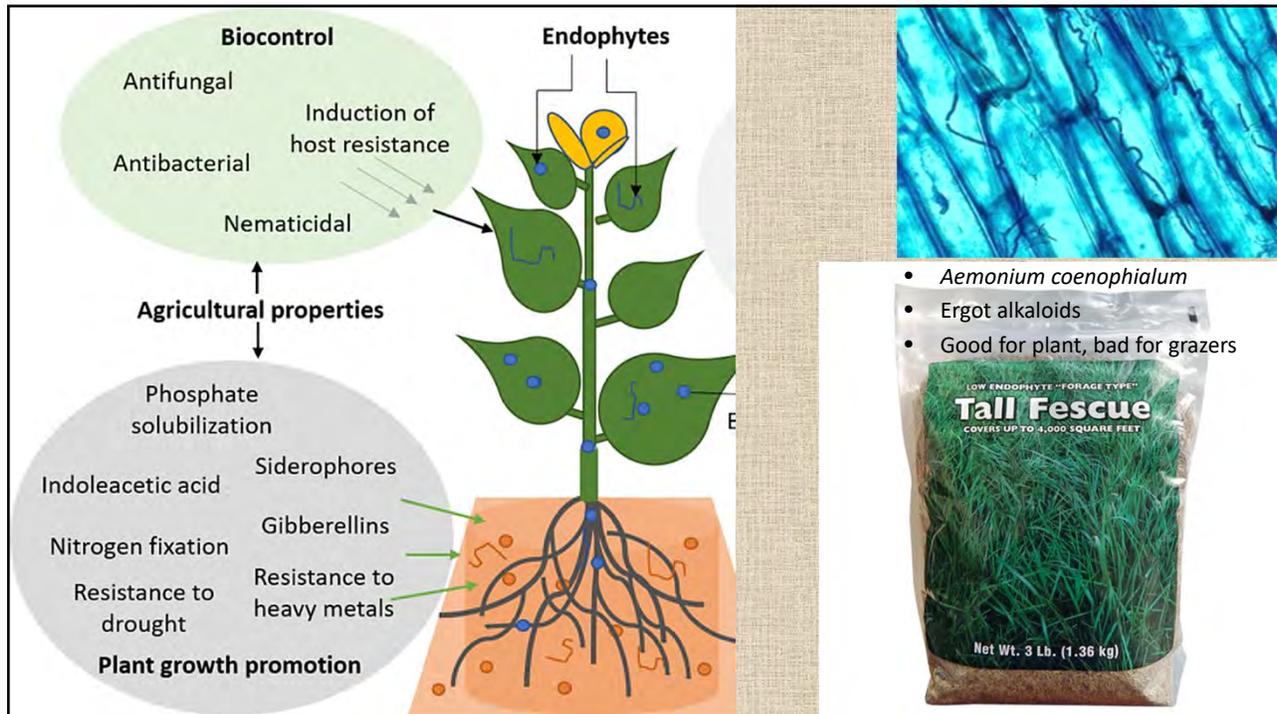
Mycorrhizae are Present in most Garden Soils

- **Enhance by improving your soil**
 - Increase aeration
 - Increase beneficial bacteria
 - By applying organic matter
 - Mulch, compost, cover crops
 - Reducing tillage
- **Don't like:**
 - Fungicides or fumigation
 - Soil Compaction
 - High NPK fertilizers, hydrogen peroxide, Epsom salt
 - Rapid changes to the soil nutrient levels or pH
 - Excessive phosphorus, prefer levels below 70 ppm
- **Mycorrhizal products available for sale**
 - Usually not needed if care for soil

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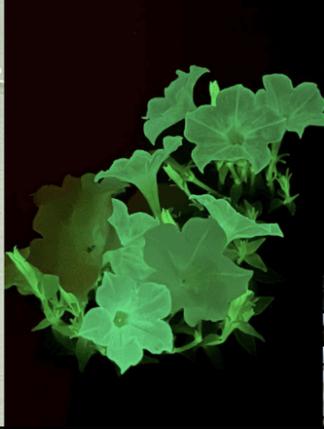
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Firefly Petunia

- Glows brightly
- Genes from the bioluminescent mushroom
 - *Neonothopanus nambi*
- <https://light.bio/> \$29



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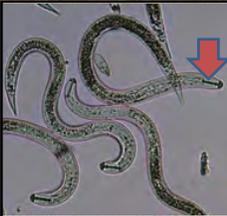
Bacteria

- ~100 species cause plant diseases
 - Pathovars (strains) specific for host cultivars
- Most bacterial plant pathogens
 - Rod-shaped cells
 - All lack nuclear membrane (Prokaryotes)
 - Order of magnitude smaller than our cells
- Many symptoms
 - Galls, blights, cankers, leaf spots, etc.
- Xylem and phloem invading bacteria
 - Infect vascular system
 - Leaf scorch, plant decline, etc.



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Other Biotic Agents

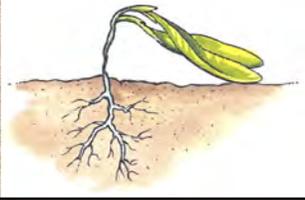




- Nematodes
 - Small round worms related to pin worms
 - Root knot, cyst, dagger, etc.
 - Stylet pierces plant cells
- Parasitic plants
 - Mistletoe, dodder
 - Dodder can transmit viruses
- Algae and protozoa
 - Once only tropical
 - Can cause
 - Root rot
 - Damping off
 - Zoospores infect





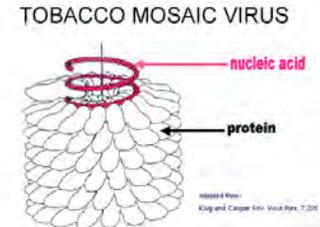


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Viruses and Viroids



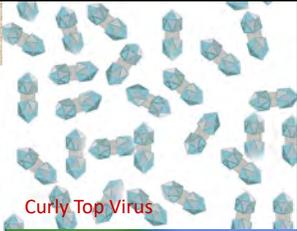
Potato Tuber Spindle Viroid
With T7 bacteriophage DNA



TOBACCO MOSAIC VIRUS

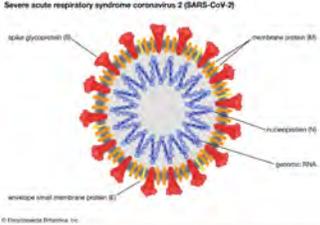
nucleic acid

protein



Curly Top Virus

- Viruses
 - DNA or RNA surrounded by protein
 - most plant viruses are RNA viruses
 - Vectors
 - Insects
 - » aphids, white flies, hoppers, thrips, beetles
 - Mites, nematodes, plasmodiophorids
 - Disease Symptoms
 - Leaf yellowing (whole leaf, or stripes or blotches)
 - Leaf distortion (e.g., curling), other growth distortions
 - » stunting of the whole plant, abnormalities in flower or fruit formation
- Viroids
 - Infectious single stranded RNA
 - Inhibit plant manufacturing of proteins
 - » Causes stunting and distortion
 - Potato tuber spindle viroid
 - » Potatoes (main host), tomatoes, solanaceous plants
- Prions
 - misfolded proteins induce misfolding of normal variants protein and trigger cellular death, not in plants



Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)

spike glycoprotein (S)

membrane protein (M)

nucleocapsid protein (N)

envelope small membrane protein (E)



PTSVd



beet leafhopper



CTV

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Common Local Diseases and a few Pests

- **Abiotic Diseases**
 - Can affect all types of plants
- **Biotic Diseases and Pests**
 - Vegetables
 - Fruit Trees
 - Succulent perennials
 - Trees and Shrubs
- **Verde Valley Diseases**
 - Texas (Cotton) Root Rot
 - Curley Top Virus



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Abiotic (Environmental) Factors

- **Temperature**
 - Extremes
- Soil pH
- **Light**
- Moisture
 - Excessive, insufficient
 - Drought, flooding, wind, humidity
- **Nutrition**
 - Deficiencies, excess
- Herbicide Damage
- **Lightning Damage**
- Air Pollution Damage
- **Salt damage**
- others



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Precipitation in Arizona

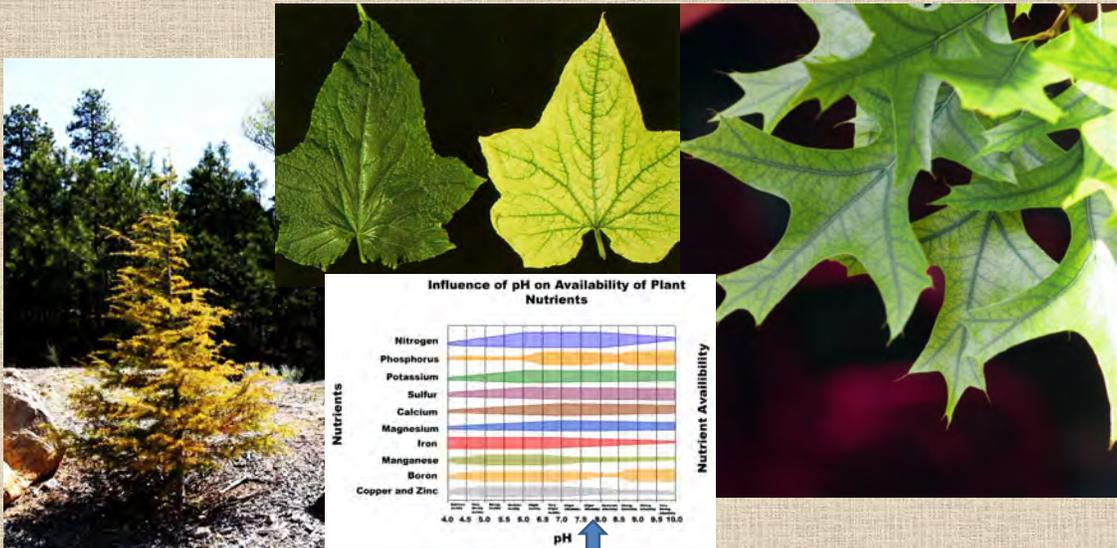


Environmental conditions may not be uniform in an area!

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Iron Deficiency Chlorosis

– High soil pH, iron less available for some plants



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Colorado Blue Spruce

- Yellow needles, needle drop
- High elevation tree grown on warmer and drier sites
- Stress from less moisture and higher temperatures





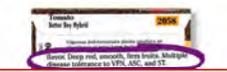

Cytospora Canker
Morton Arboretum

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Tomatoes




- Leaf spots
 - *Septoria lycopersici*, etc.
- Early Blight
 - *Alternaria solani*
- Wilts
 - *Verticillium* spp., *Fusarium* spp.
 - Crop rotation, resistant varieties



Tomato Disease Resistance Codes

V - Verticillium Wilt
 F - Fusarium Wilt (FF - Races 1 & 2; FFF - Races 1, 2, & 3)
 N - Nematodes
 T - Tobacco Mosaic Virus
 A - Alternaria Stem Canker
 St - Stemphylium Gray Leaf Spot
 TSWV - Tomato Spotted Wilt Virus







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Tomatoes

- Blossom end rot
 - Ca deficiency in fruit
 - Maintain even soil moisture
 - Certain varieties more tolerant
- Diminished pollination
 - Below 55°F or above 90°F
 - Reduced fruit production
 - Need bumble bees (buzz pollination)
- Curly top virus
 - No control available



Curly top virus

©T.A. Zitter

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Beet Curly Top Virus

- Hosts
 - » Tomatoes, beans, pepper, spinach, beets, and cucurbits
 - » Many plant species, weeds
- Symptoms
 - » Plants stunted, roots stunted, phloem necrosis, purple leaf veins
 - » Chlorotic leaves curl up, leaf outgrowths
- Vector
 - » Beet leafhopper (*Circulifer tenellus*)
 - wild mustard, Russian thistle
- Prevention
 - attention to planting date
 - breeding resistance mostly unsuccessful
 - weed and insect management, netting
 - destroy infected plants



BCTV

beet leafhopper

DGA0454052

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Squash








- Blossom end rot
- Pollination problems
 - Separate female and male flowers
- Mildews
 - Powdery, downy
- Insects
 - Squash bugs
 - Vine borers
- Wildlife
 - Lesser goldfinch
 - Squash, rhubarb and sunflower leaf eating

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Powdery Mildew

- Foliar diseases of many different plants
 - Fungal species usually very specific to a plant species or group
 - Prevention
 - Resistant cultivars
 - Early applications of specific fungicides
 - Tolerated – usually not controlled



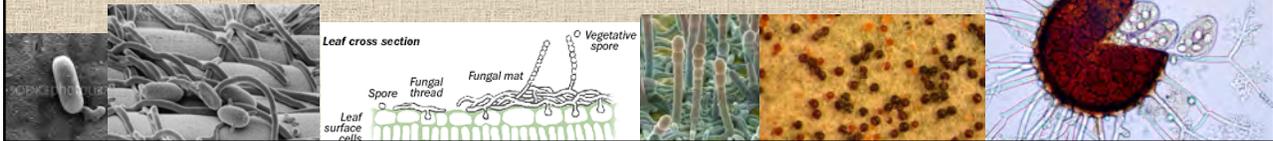



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Powdery Mildew of Cucurbits

Vegetablemdonline.ppath.cornell.edu/factsheets/Cucurbits_PM.htm

- Hosts
 - Cucumbers, melons, pumpkins, squash
 - most susceptible
- Pathogens
 - Powdery mildew fungi, airborne spores
- Environmental conditions
 - 69-80°F most favorable, 50-90°F infection range, stops at $\geq 100^\circ\text{F}$,
 - 50% RH or higher, dry leaf surface favorable, wet unfavorable
- Time
 - Symptoms 3-7 days after infection



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Fruit Tree Diseases caused by Bacteria

- Fireblight
 - Pears, apples, other members of rose family
 - Leaf blight extends to branches and trunk
 - Cankers may girdle branches and trunk
- Crown gall
 - Fruit trees, grapes, roses, most plants
 - Woody galls on the upper roots, crown, branches
 - Usually comes with the plant from nursery



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Fastidious Vascular-Colonizing Bacteria

- Vascular-feeding insect vectors introduce bacteria
 - Leaf hoppers, plant hoppers, psyllids, squash bugs
 - Most other bacteria use natural openings or wounds
- Live in phloem sieve tubes or degenerated xylem elements
- Many plant hosts are symptomless
- Some FVCBs live and reproduce in insect vector
- Stress may make plants more susceptible



PLANT	DISEASE
Grapevine	Pierce's disease
Citrus	Citrus variegated chlorosis
Oleander	Oleander leaf scorch
Almond	Almond leaf scorch
Oak	Oak leaf scorch
Sycamore	Sycamore leaf scorch
Alfalfa	Alfalfa dwarf
Peach	Phony peach

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Ash Decline (Ash Yellows)

- Symptoms
 - dead and dying branches
 - new tufts of foliage ("witches' brooms") reduced in size emerges from lower branches
 - trees may die
- Host trees in Arizona
 - Arizona ash (*Fraxinus velutina*) - native
 - Modesto ash (*F. velutina* 'Modesto')
 - Raywood ash (*F. oxycarpa*) - possibly
- Pathogen
 - bacterium (*Candidatus fraxinii*) invades phloem
 - insects possibly may transmit
- Reference
 - Backyard Gardener - Jun 27, 2012
 - "Ash Decline in Yavapai County"



52

Succulent Perennials

- Diseases

- Agave anthracnose
 - *Colletotrichum*
- *Phyllosticta* pad spot

- Pests

- Agave and yucca weevils
- Cochineal scale



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Trees and Shrubs

- Leaves
 - Mildews, leaf spots, anthracnose, etc.
 - Aphids, scale, spider mites, etc.
- Branches and trunk
 - Cankers
 - Heart rot
 - Borers
 - Crown gall
- Roots
 - Rots
 - Root knot nematode



Root Rot



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Bacterial Wet Wood (Slime Flux)

- Hosts
 - Elms, mulberry, cottonwood, and other wounded trees
- Cause
 - Bacteria grow in the bark and sapwood
 - Smelly discolored liquid flows down branch or trunk
 - Bacterial fermentation products
 - Soil bacteria enter injury above or below soil line
 - » Natural cracks, pruning cuts, etc.
 - Will not kill the tree, more a nuisance
- Treatment
 - Usually no treatment, wait for wound healing
 - Pruning and drainage tubes not recommended



55

Cotton (Texas) Root Rot

- Hosts
 - Many different trees, shrubs, vines and perennials (over 2,300 host plants)
- Pathogen
 - Fungus - *Phymatotrichopsis omnivorum*
- Distribution
 - Southwest USA and Mexico
 - Low desert areas and elevations up to 5000 ft
 - Verde Valley but not Prescott



Dead peach tree with leaves attached

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Cotton Root Rot

- Symptoms and Signs
 - Sudden wilting
 - during the summer when temperatures are high
 - Dead or dying foliage remain attached to plant
 - Roots rotted and brown in color
 - Strands of fungus grow on root
 - Fungal mats found on soil surface



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Cotton Root Rot

- Treatment
 - rarely successful
 - therefore, not recommended
 - plant immune or highly resistant species in infested areas

– Replanting

- monocots are immune
 - use yuccas, grasses
 - hardy palms in mild locations
 - pines are very tolerant
- <http://ag.arizona.edu/pubs/diseases/az1124/#pr>
- <http://ag.arizona.edu/pubs/diseases/az1150.html>



58

Cytospora Canker

- Hosts
 - Aspen, cottonwood, other stressed deciduous trees
 - Orange spore masses develop in moist conditions
 - Branches and trunk girdled
 - Do not plant riparian or high elevation trees in dry habitats
- Pathogen
 - Fungus - *Cytospora chrysosperma*



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Aspen Diseases and Problems



Marssonina Leaf Spot

Marssonina Leaf Spot



Melampsora leaf rust

- Environmental stress problems
- Foliar Diseases, Cytospora canker
- Heart Rot (*Phellinus tremulae*)
- Deer rubbing bark



Heart Rot



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Artist Conk etc.

- *Ganoderma appanatum*
 - bases of hardwood stumps or logs, white rot
 - unvarnished, furrowed and lumpy, dull brown cap
 - woody, brownish or cinnamon flesh, perennial
- 5 other species in AZ
 - *G. lucidum* (Lingzhi or Reishi)



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Seiridium Canker

- Hosts
 - Leyland, Italian, and Monterey cypress
- Fungal Pathogen
 - *Seiridium cardinale*
 - Girdles - twigs, branches, and trunk
 - Foliage - dies
 - Cankers
 - Multiple vertical cracks
 - » Resin flows
 - » Black spots (fruiting bodies) at edge
 - Diagnose from characteristic spores in resin
 - (Backyard Gardener - Aug 10, 2011)



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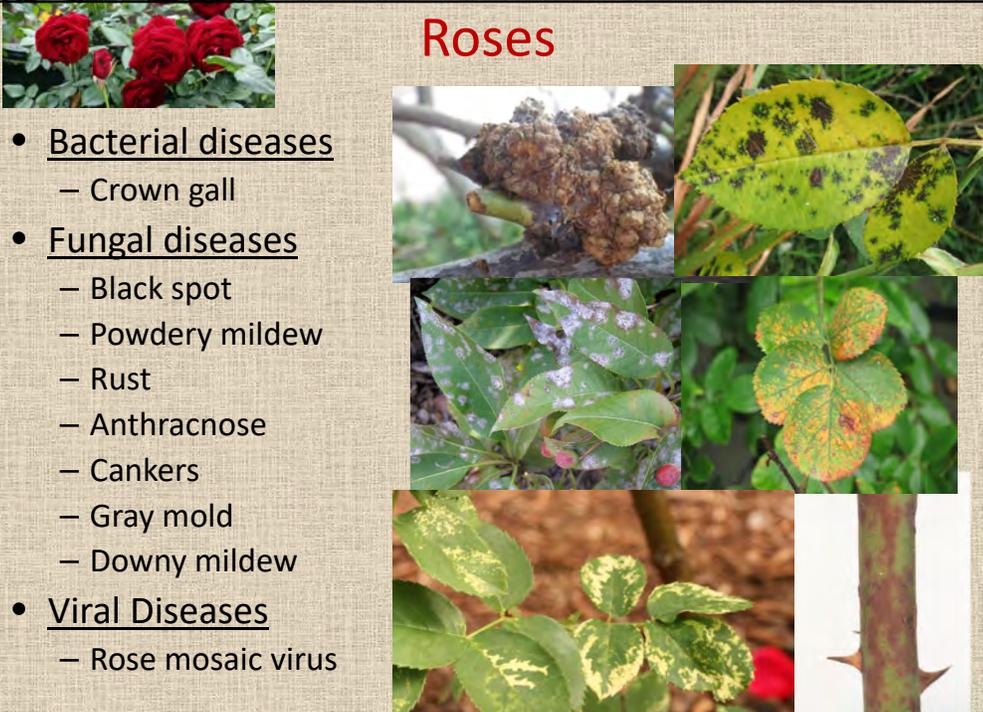
Corn Smut

- German for dirt “schmutz”
- Economically Important Host plants
 - Maize, barley, wheat, oats, sugar cane, forage grasses
- Hijack the plant’s reproductive systems forming galls
 - dark, thick-walled, and dust-like teliospores
- Sweet corn more susceptible

Huitlacoche

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Roses

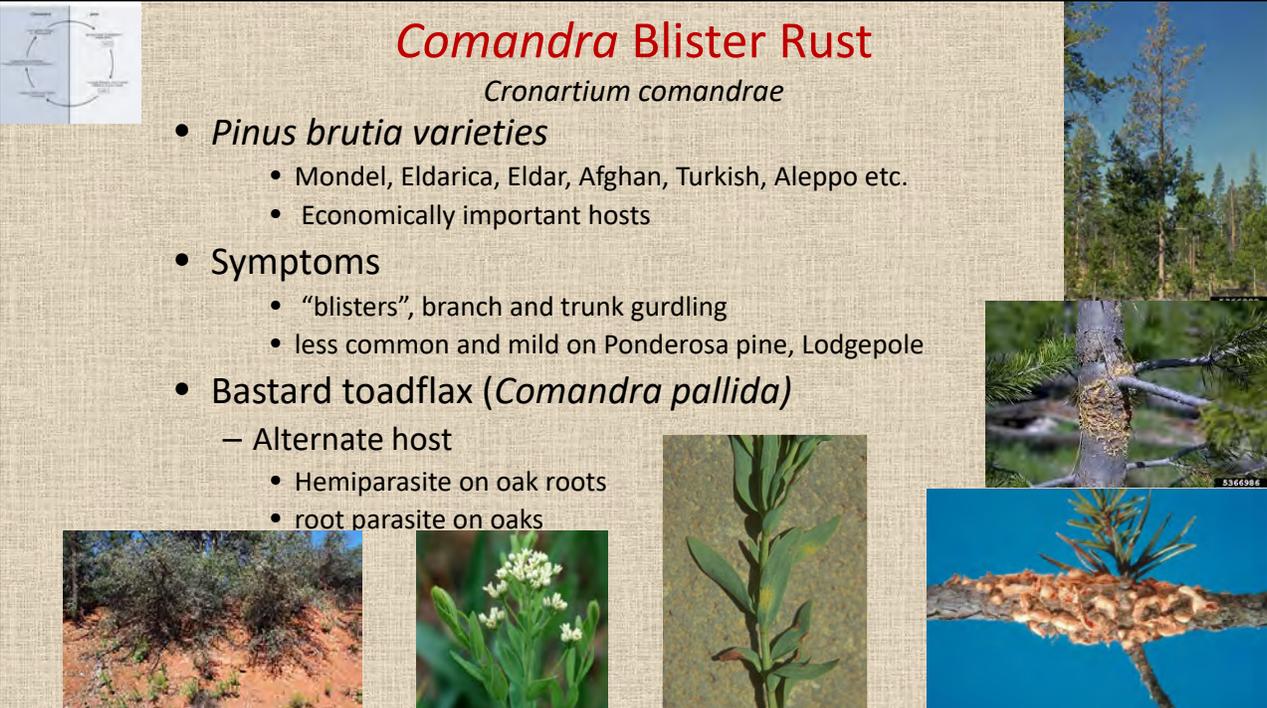


- Bacterial diseases
 - Crown gall
- Fungal diseases
 - Black spot
 - Powdery mildew
 - Rust
 - Anthracnose
 - Cankers
 - Gray mold
 - Downy mildew
- Viral Diseases
 - Rose mosaic virus

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Comandra Blister Rust

Cronartium comandrae



- *Pinus brutia* varieties
 - Mondel, Eldarica, Eldar, Afghan, Turkish, Aleppo etc.
 - Economically important hosts
- Symptoms
 - “blisters”, branch and trunk girdling
 - less common and mild on Ponderosa pine, Lodgepole
- Bastard toadflax (*Comandra pallida*)
 - Alternate host
 - Hemiparasite on oak roots
 - root parasite on oaks

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Verticillium Wilt



Potato

- Hosts
 - 300 species of dicot plants
 - Tomatoes, potatoes, maple, etc.
 - Soil fungi
 - *Verticillium dahliae*, *V. albo-trum* and *V. longisporum*




Tomatoes






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Plant Parasitic Nematodes

- Root-knot nematode
 - swellings in the roots
 - interfere with the flow of nutrients and water
 - Feed with stylet
 - most vegetables, bedding plants, many trees and shrubs
 - impossible to eradicate
 - introduced with plants and soil








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Parasitic Flowering Plants

True Mistletoes

- *Phoradendron* spp.
 - Common on hardwoods: oaks, sycamores, cottonwood, mesquite, *Acacia* spp., palo verde; also juniper, cypress, white fir
 - Lower to mid elevations
 - Limited damage to host
 - Birds distribute seed



Dwarf Mistletoes

- *Arceuthobium* spp.
 - Common on pines, cypress
 - Higher elevations
 - Can severely debilitate or kill host
 - Forcibly discharge seeds (52ft)



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Dodder



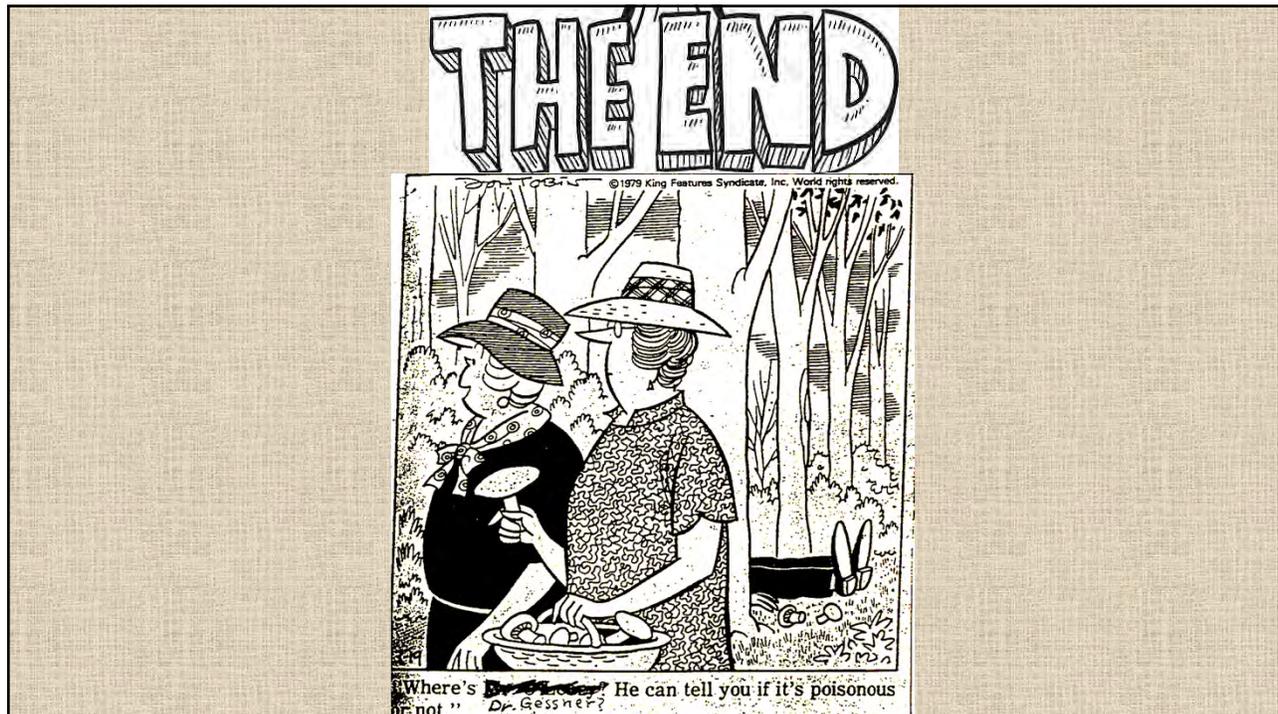
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Plant Selection in Yavapai County

- Be cautious using plants from:
 - Riparian areas in hot dry landscapes
 - Cottonwood, Sycamores, Willows, Aspen, etc.
 - High elevations - cooler and moister environments
 - Colorado Spruce, Douglas Fir, Aspen, etc.
- Do not plant:
 - Invasive plants
 - Siberian Elm, Tree of Heaven, *Vinca major*, etc.
 - Leland Cypress
 - Dies from Seiridium canker
- Plants that may have problems in certain areas
 - Eldarica Pine group (Commandra rust), Ponderosa Pine (road salt), Pinyon Pine (scale, dwarf mistletoe), etc.



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