

Plant Pathology for Master Gardeners

Jeff Schalau, Agent ANR
University of Arizona Cooperative Extension, Yavapai County
and
Bob Gessner, Yavapai County Master Gardener, Professor Emeritus,
Western Illinois University

4/19/2023



1

Why Should We Worry?

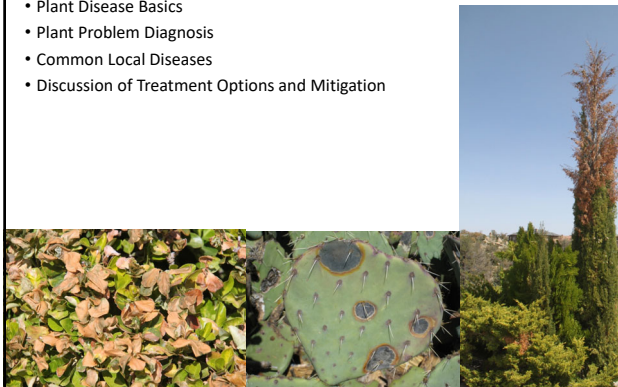
- Plant pathogens and pests are responsible for up to 40% of maize, potato, rice, soybean, and wheat crop yield losses worldwide.
- Plant diseases caused by bacteria, fungi, nematodes and viruses cost the global economy \$220 billion annually (USD).

From: Savary S., Willocquet L., Pethybridge S.J., Esker P., McRoberts N., Nelson A. The global burden of pathogens and pests on major food crops. Nat. Ecol. Evol. 2019;3:430–439.

2

Outline

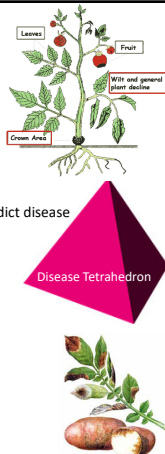
- Plant Disease Basics
- Plant Problem Diagnosis
- Common Local Diseases
- Discussion of Treatment Options and Mitigation



3

Plant Pathology

- Study of Plant Diseases
 - Host plants
 - Pathogens
 - Environmental factors
 - Interactions of host, pathogen, and environment
 - Management/control
 - Genetics, molecular biology, mathematical modeling to predict disease outbreaks



4

So You Want to be Master Gardener!

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



5

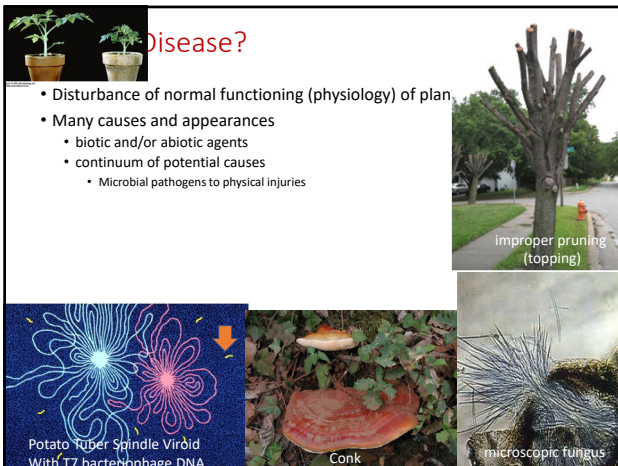
Normal or Abnormal?



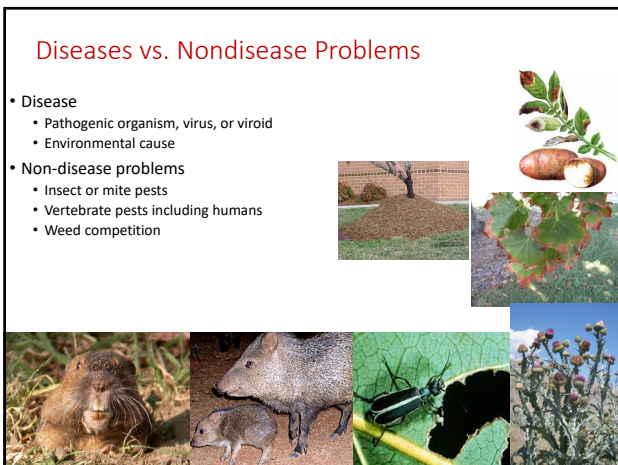
6



7




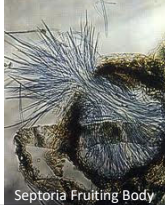
8



9

Diagnosing Plant Diseases



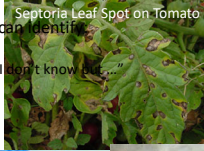


- If a problem exists, you may need to know:
- Plant species, maybe cultivar
- Plant part affected
 - Foliar, stem, root, fruit problem
- Type of abnormality
 - Symptoms
 - Changes seen in plant (leaf spot, canker, etc.)
- Type of pathogen
 - Signs (causal agent)
 - Environmental factor, structures of organism (fruiting body, spores, etc.)

10


Diagnosing Plant Diseases

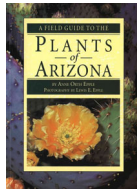
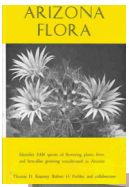
- Collect large enough sample so
 - Plant, symptoms, signs
 - Often the best answer is: "I don't know but..."

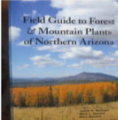






11

What is the plant?



12

Symptoms and Signs

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

13

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?

14

Types of Plant Diseases

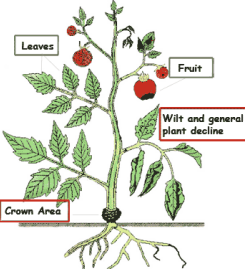
Based on General Type of Causal Agent

- 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 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"

15

Types of Plant Diseases Based on Plant Part

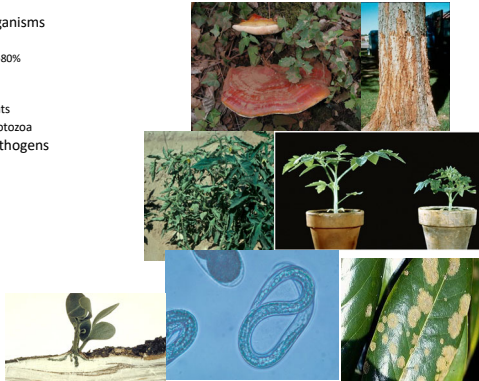
- Foliar
 - Spots, anthracnose, mildew, etc.
- Stem
 - Cankers, heart rot
- Root
 - Wilts, rots
- Fruit
 - Field, post harvest



16

Causal Agents of Plant Disease

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



17

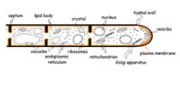
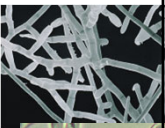
Come in Two Sizes

- Macroscopic
 - Mushrooms, bracket fungus
 - Fruiting body visible, spores microscopic
- Microscopic
 - Yeast, molds, zygote fungi, chytrids
 - Fruiting body details and spores microscopic


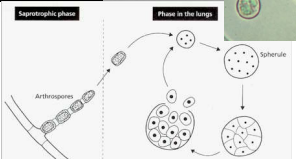


18

Somatic (Non-reproductive) Structures do

- **Molds**
 - Hypha (ae)
 - Mycelium
 - Septa
- **Yeast**
 - Single cells
 - Budding
 - Fission
 - Pseudohyphae
- **Dimorphic fungi**
 - Valley Fever

19

in our Gardens






- **Decomposers**
 - Organic debris
 - Soil fertility
 - Nutrient cycling
 - Compost making
- **Pathogens**
 - Plants
 - Insects, nematodes, weeds,
- **Symbionts**
 - Mycorrhizae
 - Lichens
 - Endophytes

20

Fungi Grow on all Plant Parts

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



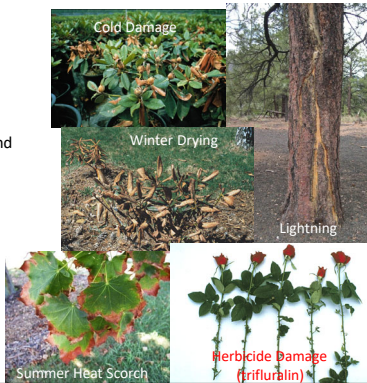




21

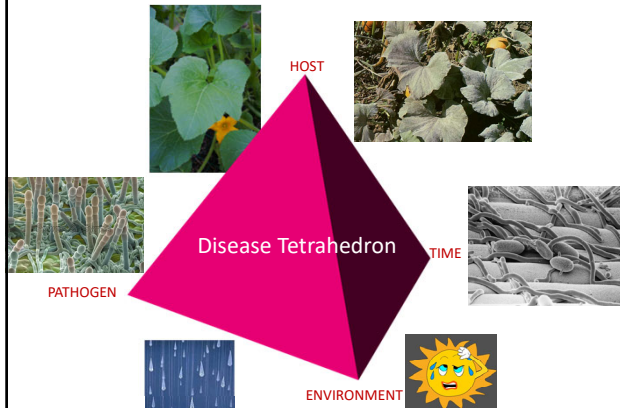
Abiotic (Environmental) Factors

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



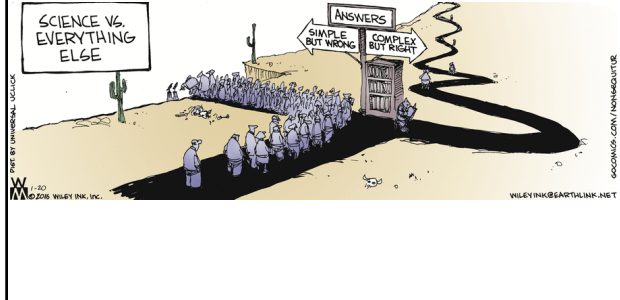
25

Disease Determining Factors



26

"Scientific Based Horticultural Information"



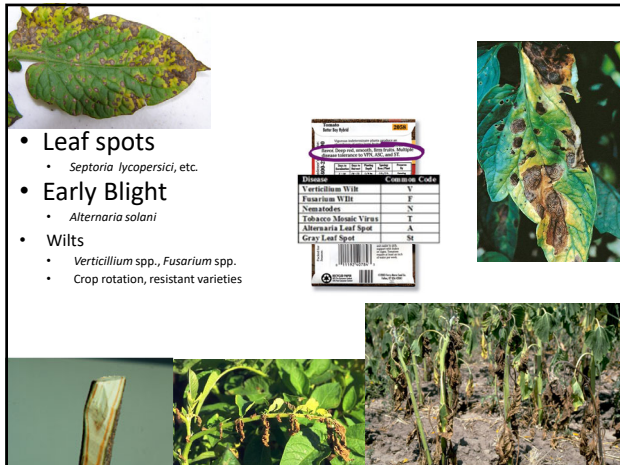
27

Common Local Diseases and 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



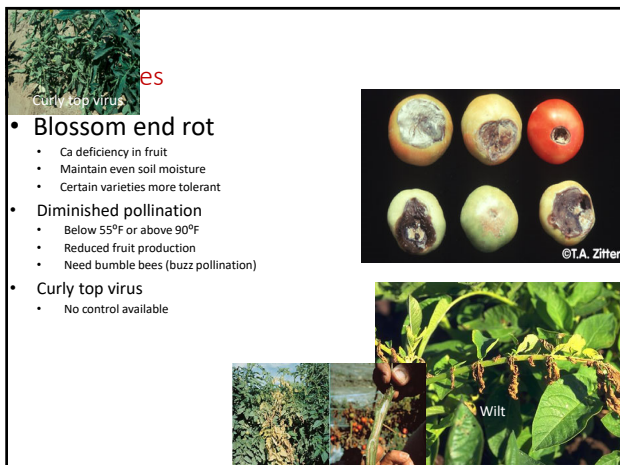
28



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

Disease	Control Code
Verticillium Wilt	V
Fusarium Wilt	F
Nematodes	N
Tobacco Mosaic Virus	T
Alternaria Leaf Spot	A
Gray Leaf Spot	S

29



- 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

30

Hosts **Curly Top Virus**

- Tomatoes, beans, pepper, spinach, beets, and cucurbits
- Many plant species, weeds

Symptoms

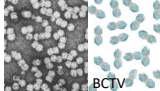
- Plants stunted, roots stunted, phloem purple leaf veins
- Chlorotic leaves curl up, leaf outgrowths

Vector


- Beet leafhopper (*Circulifer tenellus*)
 - wild mustard, Russian thistle

Prevention


- attention to planting date
- breeding resistance mostly unsuccessful
- weed and insect management
- destroy infected plants



BCTV




beet leafhopper



31

Blossom end rot



Pollination problems

- Separate female and male flowers

Mildews

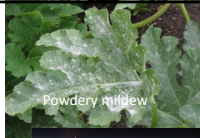
- Powdery, downy

Insects


- Squash bugs
- Vine borers

Wildlife


- Lesser goldfinch
 - Squash, rhubarb and




Powdery mildew



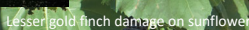
Moth



Squash bug



Vine borers






Lesser gold finch damage on sunflower

32

Powdery Mildew

- Foliar diseases of many different plants
 - Fungal species usually very specific to a plant group
- Prevention
 - Resistant cultivars
 - Early applications of specific fungicides

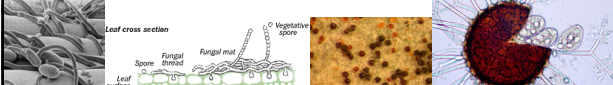




33

Powdery Mildew of Cucurbits

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

- **Hosts**
 - Cucumbers, melons, pumpkins, squash
 - most susceptible
 - 16-23 days after leaves unfold, after fruit initiated, dense growth, low light
 - susceptible cultivars (lack wild cucurbit resistance genes)
- **Pathogens**
 - Powdery mildew fungi, airborne conidia (spores)
 - *Podosphaera xanthii*, *Erysiphe cichoracearum* (most common)
 - Host specific, survive winter on plant debris
- **Environmental conditions**
 - 69-80°F most favorable, 50-90°F infection range, stops at ≥100°F, 50% RH or higher, dry leaf surface favorable, wet unfavorable
- **Time**
 - Symptoms 3-7 days after infection



34

Fruit Tree Diseases caused by Bacteria

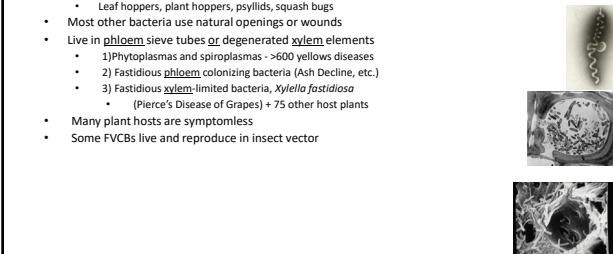
- **Fireblight**
 - Pears and apples other rose family
 - Twig blight
 - Cankers may develop in limbs and trunks
- **Crown gall**
 - Fruit trees, also grapes, roses, most plants
 - Woody galls on the upper roots and crown
 - Usually comes with the plant from nursery



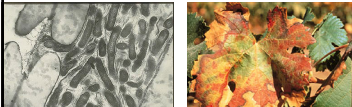
35

Fastidious Vascular-Colonizing Bacteria

- Introduced by vascular-feeding insect vectors
 - Leaf hoppers, plant hoppers, psyllids, squash bugs
- Most other bacteria use natural openings or wounds
- Live in **phloem** sieve tubes or degenerated **xylem** elements
 - 1) Phytoplasmas and spiroplasmas - >600 yellows diseases
 - 2) Fastidious **phloem** colonizing bacteria (Ash Decline, etc.)
 - 3) Fastidious **xylem**-limited bacteria, *Xylella fastidiosa*
 - (Pierce's Disease of Grapes) + 75 other host plants
- Many plant hosts are symptomless
- Some FVCBs live and reproduce in insect vector




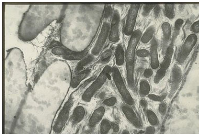

PLANT	DISEASE
Grapevine	Pierce's disease
Citrus	Citrus variegated chlorosis
Oleander	Oleander leaf scorch
Almond	Almond leaf scorch
Oak	Oak leaf scorch
Sycamore	Sycamore leaf scorch
Alfalfa	Alfalfa dwarf
Peach	Phony peach



36

Ash Decline (Ash Yellows)

- Symptoms
 - dead and dying branches
 - new tufts of foliage ("witches brooms") reduced in size
 - previous two or three year's growth greatly reduced
 - 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
Decline in Yavapai County"








37

Succulent Perennials

- Diseases
 - Agave anthracnose
 - Phyllosticta pad spot






- Pests
 - Agave and yucca weevils
 - Cochineal scale

38

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

39

Bacterial Wetwood and Slime Flux

- **Hosts**
 - Elms, mulberry, and other wounded trees
- **Cause**
 - Bacteria grow in the bark and sapwood
 - Smelly discolored liquid flows down branch
 - 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



40

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
 - Verde Valley but not Prescott



41

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



42

Cotton Root Rot


- **Signs**
- Dense web of hyphae covers the root
 - root penetrated and decays
 - strands grow through soil, infects healthy roots nearby
- Survives for long periods in soil
 - resistant hyphal structures (sclerotia)
- **No** airborne spores or other reproductive structures
 - spreads only by growth of the strands in soil




43

Cotton Root Rot

Infected root




Strands growing on the surface of an infected root

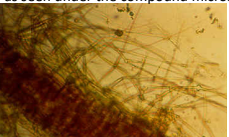


Root Rot

Hyphal mat



Strand as seen under the compound microscope



44


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>

Dead peach tree with leaves attached



45

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*

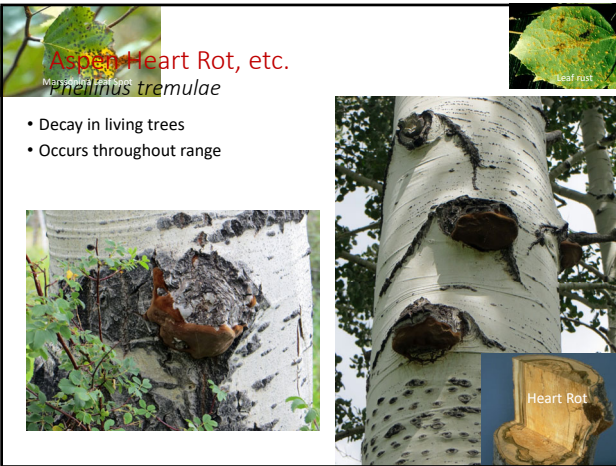


46

Aspen Heart Rot, etc.

Hellinus tremulae

- Decay in living trees
- Occurs throughout range



47

Seiridium Canker

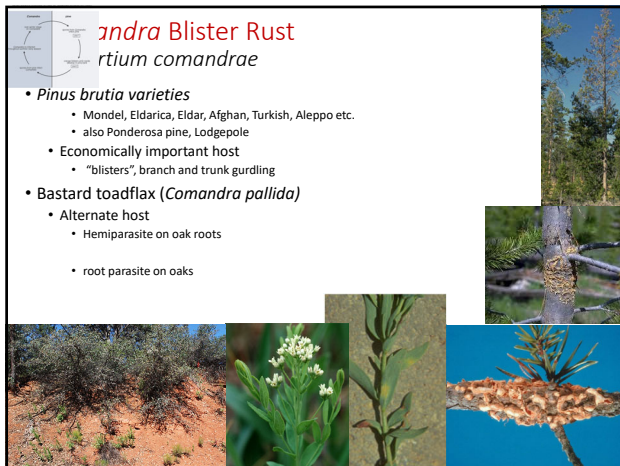
- Hosts
 - Leyland, Italian, and Monterey cypress
- Fungal Pathogen
 - *Seiridium cardinale*
 - Girdles - twigs, branches, and trunk
 - Foliage - dies
 - Cankers
 - Multiple vertical cracks
 - Resin flows
 - Black spots (fruiting bodies) at edge
 - Diagnose from characteristic spores in resin
 - (Backyard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



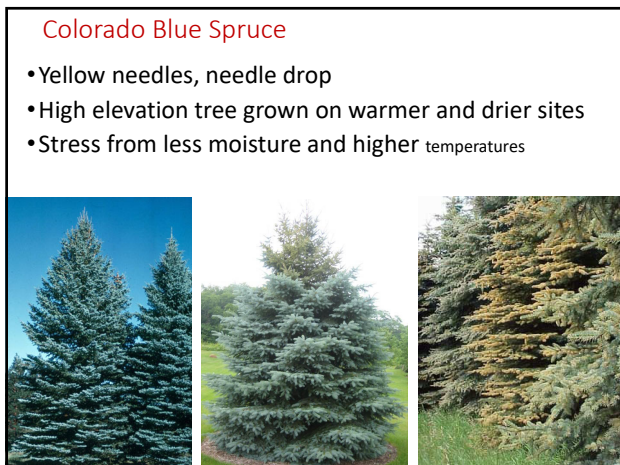
48



49



50



51

Galls on Manzanita

Leaf Gall Aphid (*Tamalia coweni*)

Fungal Leaf gall (*Exobasidium vaccinii*)

52

Verticillium Wilt

Potato

Hosts

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

53

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 shrubs
 - impossible to eradicate
 - introduced with plants and soil

54

Parasitic Flowering Plants

- *Phoradendron* spp.
- Common on hardwoods, also juniper, cypress, white fir
- Lower elevations
- Limited damage to host
- Birds distribute seed

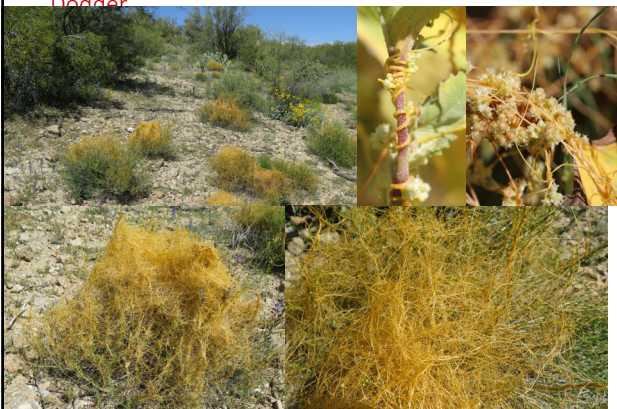
Dwarf Mistletoes

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



55

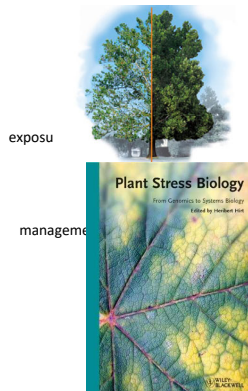
Dodder



56

Preventing Plant Diseases

- Plant
 - Disease resistant species/cultivars
- Location
 - Hardiness zone, sun/shade, moisture,
- Proper planting
 - Hole shape/size, depth, staking, pruning
- Maintenance
 - Water, fertilizer, pruning, pest
 - Reduce stress
 - Prevent damage



57



Identifying Diseased Plants

- Identify cause
 - Symptoms, signs, etc.
- Learn about pathogen/pest's
 - Bulletins, etc.
 - Online information
- Integrated Pest Management
 - Prevent and manage disease with
 - Start with lowest impact treatment
- May be too late or no control

lif
holisti
ma

WHAT IS IPM?

Farmers use **Integrated Pest Management (IPM)** strategies to prevent crop damage from insect, weed, and disease pests.

IPM PRACTICES INCLUDE:

WHY SHOULD YOU CARE?

Because IPM practices help farmers:

- conserve our environment
- produce quality crops
- maintain farm profitability

UNIVERSITY OF CALIFORNIA EXTENSION
