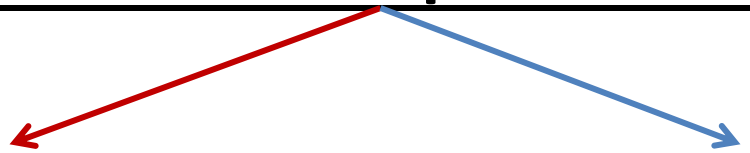
Infectious vs. Noninfectious Diseases

Hawaii Master Gardeners

Pearl City, February 2013

Fred Brooks

"What's the problem?"



An infectious disease caused by a living microorganism

Living: fungi, bacteria, viruses, nematodes

A noninfectious disease (disorder) due to other living or nonliving factors

Living: insects, mites, snails, rats, birds, weeds, etc.
Nonliving: temperature, moisture, sunlight, wind, nutrient deficiency or toxicity, mowers, chemicals, etc.

Infectious Disease	Noninfectious Disease
1. Symptoms appear progressively, in definite stages; may be fast or slow (leaf wilt followed by branch dieback due to root rot)	1. Symptoms appear suddenly, almost at once, to their full intensity; not progressive (leaf tip death from salinity or lack of water.)
2. Plants in an area vary in the level of disease, especially early in the disease (plants infected first show advanced symptoms the soonest)	2. All plants in an area may be affected to a similar extent or in a similar way (all plants wilt, leaves turn greenish-yellow from overwatering)
3. Symptoms are complex and may not point directly to their cause (wilt due to root rot, vascular plugging, under-watering, etc.)	3. Symptoms are simple, may be limited to one, often pointing at the cause (sunburn of plants that have suddenly lost their shade)
4. Lesion edges expand, with complex, graded or zonate centers or margins (leaf spots, blights)	4. Lesion edges sharp, do not expand; rapid change from healthy to diseased tissue (sunburn, pesticides)
5. Symptoms variable in type, pattern, and occurrence, but have a unique character (mosaic discoloration in virus diseases)	5. Symptoms very regular, uniform in nature or pattern (all veins green, with interveinal yellowing in iron chlorosis)
6. Symptoms may not be limited to tips, margins (interveinal or zonate leaf spots; blights)	6. Leaf tips and margins necrotic, or with typical stress-related patterns
7. Signs of the causal agent may be present	7. Signs not often present (except chemical residue)
8. Occurs over time, may be related to environmental conditions (fruit infection following rainfall)	8. Periodic occurrence can be related to a date and certain event (damage following herbicide drift)
9. Selective distortion (only leaves distorted, each leaf differing in symptom development)	9. Gross distortion (entire plant distorted from exposure to plant growth regulator)
10. Only certain species affected; host-specificity may be obvious	10. Fairly wide range of plant species affected
11. Distribution of affected plants fairly irregular or, if clustered, usually shows spotty spread to surrounding plants (infection centers with necrotic plants surrounded by plants in various stages of disease as in taro leaf blight)	11. Distribution of affected plants fairly regular in a field or tightly clustered in an area, with no apparent pattern of spread (plants on the edge of a field damaged by herbicide use on a nearby field)

Infectious

Symptoms appear progressively, in definite stages; may be fast or slow

Leaf spots caused by this fungus enlarge, turn brown, and form gray centers that sometimes fall out. Courtesy of D.B. Langston, Univ. Georgia, Bugwood.org

Noninfectious

Symptoms appear suddenly, almost at once, to their full intensity; usually not progressive

Dead, reddish-brown leaf margins that appear almost unnoticed. but do not expand are typical of salt burn. Courtesy of S.K. Hagle, USDA Forest Svc., Bugwood.org

Infectious

Plants in an area vary in the level of disease, especially in the early stages

Tomato blight is caused by a fungus that spreads through the soil from plant to plant. Courtesy of E. Sikora, Auburn Univ., Bugwood.org

Noninfectious

All plants in an area may be affected to a similar extent or in a similar way

Plants in an area of a field with a high salt content are stunted and chlorotic (yellow). Courtesy of H.F. Schwartz, Colorado State, Bugwood.org

Infectious

Symptoms are complex and may not point directly to their cause

Small, chlorotic, wilted leaves suggest a lack of water, but don't reveal whether the cause is dry soil, root damage, or another reason. Photo by Fred Brooks

Noninfectious

Symptoms are simple, may be limited to one and often points to the cause

Sunscald of tomatoes is caused by fruits being exposed to direct sunlight, such as by pruning. Courtesy of W.M. Brown, Bugwood.org

Infectious

Lesion edges expand, with complex, graded, or zonate centers

The taro leaf blight organism produces rings with indistinct edges as it grows. Photo by Fred Brooks

Noninfectious

Lesion edges sharp, do not expand; rapid change from healthy to diseased tissue

Chemical damage (ammonia) creates lesions with clean, sharp edges that do not expand. Courtesy of M. Williamson, U.S. Forest Svc., Bugwood.org

Infectious

Symptoms variable in type, pattern, and occurrence, but have a unique character

Lesions caused by this bacterium vary in shape and size, but are similar in character. Courtesy of S. Jensen, Cornell Univ., Bugwood.org

Noninfectious

Symptoms very regular, uniform in nature or pattern

Pale green to yellow or white between green leaf veins is a typical symptom of iron deficiency. Courtesy of W.M. Ciesla, Forest Health Mgmt. International, Bugwood.org

Infectious

Symptoms may not be limited to tips, margins

Taro leaf blight lesions are caused by spores in water from other leaves, or from spores produced on the same leaf (small spots).
Photo by Fred Brooks

Noninfectious

Leaf tips and margins necrotic, or with typical stress-related patterns

Air pollution causes damage to leaf margins similar to drought or salt stress. Courtesy of P. Capitola, Czechia, Bugwood.org

Infectious

Signs of the causal agent may be present

White mycelium and brown sclerotia are signs of this fungus disease. Courtesy of USDA Extension, Clemson Univ., Bugwood.org

Noninfectious

Signs of the cause not usually present

Chemical residue on this leaf is a rare example of the sign of a noninfectious agent. Courtesy of Dept. Plant Pathology, N. Carolina State Univ., Bugwood.org

Infectious

Occurs over time, may be related to environmental conditions

Slow, progressive, branch dieback of rhododendrons. Is especially severe in wet weather. Courtesy of E. Bush, Virginia Poly. Inst. Bugwood.org

Noninfectious

Periodic occurrence can be related to a date and certain event

A Christmas tree farm with widespread leaf death due to early frost. Courtesy of U.S. Forest Service., Bugwood.org

Infectious

Selective distortion

Distortion of the youngest leaves of this tomato plant is caused by a virus. Courtesy of W. M. Brown, Bugwood.org

Noninfectious

Gross distortion

Herbicide injury has caused severe distortion of stem and upper leaves. Courtesy of R. D. Wallace, Univ. of Georgia, Bugwood.org

Infectious

Only certain species affected; host-specificity may be obvious

Chestnut blight mainly affects American and European chestnut trees. Courtesy of J. Obrien, U.S. Forest Service, Bugwood.org

Noninfectious

Fairly wide range of plant species affected

Herbicide damage is not restricted to a single host, as shown by the yellowing of different tree and understory species. Courtesy of H. Williamson, U.S. Forest Service, Bugwood.org

Infectious

Distribution of affected plants fairly irregular or, if clustered, usually shows spotty spread to surrounding plants

The gray mold fungus has an uneven distribution and spread among these greenhouse-grown pine seedlings. Courtesy of A. Kunca, Nat. Forest Cntr., Slovakia, Bugwood.org

Noninfectious

Distribution of affected plants fairly regular in a field or tightly clustered in an area, with no apparent pattern of spread

Edge of a pine tree planting damaged by an upwind application of herbicide. Courtesy of U.S. Forest Service, Bugwood.org

DIAGNOSING INFECTIOUS AND NONINFECTIOUS PLANT DISEASES

Master Gardeners

February 2013

Identify the host plant
Scientific name, variety, cultivar
Living organisms have limited hosts

↓

How does a healthy plant look?
Size, color, characteristics
Compare "sick" with healthy plant

↓

Does the plant have an infectious or noninfectious disease?

INFECTIOUS DISEASE SYMPTOMS:	**NONINFECTIOUS DISEASE SYMPTOMS:**
1. appear gradually, in definite stages. 2. on plants in an area may vary in extent of disease. 3. tend to be complex. 4. have lesion borders that expand, with complex, graded or zonate centers or margins. 5. are variable in type, pattern, occurrence, but all have a unique, common character. 6. are not limited to tips, margins. 7. may also include signs. 8. occur over time, related to environmental conditions. 9. may include selective distortion (e.g. leaves only affected). 10. may only affect certain plant species. 11. are usually on plants that are irregularly distributed.	1. usually appear suddenly, in their full intensity. 2. tend to affect all plants in area to a similar extent or way. 3. are not complex, often point to obvious causal agent. 4. have sharp, nonexpanding lesion borders with an abrupt change from healthy to diseased tissue. 5. are highly regular, uniform. 6. have necrotic leaf tips, margins, other stress-related patterns. 7. do not include signs. 8. intermittent, follow an event. 9. may include gross distortion and can affect the whole plant. 10. can affect many plant species. 11. are usually on plants that are fairly regularly distributed in field or clustered in an affected area with no apparent spread.

SIGN OF THE PROBLEM
Fungi (mycelium, fruiting bodies); Bacteria (ooze); Insects (eggs, larvae, molt, frass); Weeds, Rats, Snails, Birds; other visible plant pests.

FOR AN INFECTIOUS DISEASE:
identify the disease by its symptoms.
identify the organism by its sign.
determine if the organism is found in Hawaii.
link organism, host, symptoms, in references.

FOR A NONINFECTIOUS DISEASE:
identify the cause by its sign, if present.
identify conditions before and at onset.
are the environment/and symptoms related?
link symptoms and conditions in references.

Key to Infectious vs. Noninfectious Plant Diseases

Infectious Disease (biotic)	**Noninfectious Disease** (abiotic)
1. Symptoms appear progressively, in definite stages; may be fast or slow (leaf tip death followed by branch dieback due to root rot)	1. Symptoms appear suddenly, almost at once, to their full intensity; not progressive (leaf tip death from lack of water)
2. Plants in an area vary in the level of disease, especially early in the disease (plants infected first show advanced symptoms the soonest)	2. All plants in an area may be affected to a similar extent or in a similar way (all plants wilt, leaves turn greenish-yellow from overwatering)
3. Symptoms are complex and may not point directly to their cause (wilt can be due to root rot, vascular plugging, under-watering, etc.)	3. Symptoms are simple, may be limited to one, often pointing at the cause (sunburn of plants that have suddenly lost their shade)
4. Lesion edges expand, with complex, graded or zonate centers or margins (leaf spots, blights)	4. Lesion edges sharp, do not expand; rapid change from healthy to diseased tissue (sunburn, pesticides)
5. Symptoms variable in type, pattern, and occurrence, but have a unique character (mosaic discoloration in virus diseases)	5. Symptoms very regular, uniform in nature or pattern (all veins green, with interveinal yellowing in iron chlorosis)
6. Symptoms may not be limited to tips, margins (interveinal or zonate leaf spots; blights)	6. Leaf tips and margins necrotic, or with typical stress-related patterns
7. Signs of the causal agent may be present	7. Signs not often present (except chemical residue)
8. Occurs over time, may be related to environmental conditions (fruit infection following rainfall)	8. Periodic occurrence can be related to a date and certain event (damage following herbicide drift)
9. Selective distortion (only leaves distorted, each leaf differing in symptom development)	9. Gross distortion (entire plant distorted from exposure to plant growth regulator)
10. Only certain species affected; host-specificity may be obvious	10. Fairly wide range of plant species affected
11. Distribution of affected plants fairly irregular or, if clustered, usually shows spotty spread to surrounding plants (infection centers with necrotic plants surrounded by plants in various stages of disease as in taro leaf blight)	11. Distribution of affected plants fairly regular in a field or tightly clustered in an area, with no apparent pattern of spread (plants on the edge of a field damaged by herbicide use on a nearby field)

Based on Stoner, MF and McCain, JW. 1988. "Laboratory Exercises in Plant Pathology: An Instructional Kit," ABAM Baudoin, ed., APS Press

Fred Brooks, 14 January 2013

Integrated Pest Management
Oahu Master Gardener Training
15 February 2013

A. What is IPM
1. Protecting plants
2. Keeping pest populations low
3. Minimizing environmental damage
4. Efficient and cost-effective

Integrated: uses a variety of methods, science-based
Pest: living organism that cause injury, are unwanted, a nuisance, etc.
Management: planned, systematic, acceptable pest levels

B. History

C. Pesticide Misuse
1. Environmental contamination
2. Pesticide resistance
3. Secondary pests
4. Natural enemies killed, pest resurgence
5. Pesticide treadmill

D. Economic (Action) Threshold, Economic Injury Level

E. Management Methods
1. Exclusion
    a. Quarantine: international, national (government)
    b. Quarantine: local (personal actions)
    c. Limits of quarantine
2. Eradication
    a. Difficult to achieve
    b. Pesticides, physical destruction (burning, burying, etc.)
3. Avoidance
    a. Don't plant where the pest is
    b. Plant resistant or non-host plants
    c. Alter planting/harvest times
4. Protection
    a. Cultural/Physical/Mechanical Control
        1) Barriers and mulches
        2) Traps, trap crops, attractants
        3) Plant nutrition, modify soil pH
        4) Heat, water management, flooding
        5) Rouging, hoeing, plowing
        6) (Rotation, fallow)
    b. Biological Control
        1) Parasites, hyperparasites, predators
        2) Altering flora and fauna
            a) Crop rotation, fallow, suppressive soils
            b) Green manure, compost, teas, soil pH
        3) Resistant hybrids
            a) Traditional plant breeding
            b) Genetic engineering
    c. Chemical control

F. Key Concepts

Science-based, **correct pest identification**, **planned**, **monitored**, **Action Threshold**, **practical**, **various approaches**, **chemicals used appropriately**

Fred Brooks, 14 January 2013

Integrated Pest Management

Oahu Master Gardener Training

15 February 2013

Fred Brooks

Integrated Pest Management

- Some history
- What is IPM?
- When do we use it?
- How do we use it?
  - Exclusion
  - Avoidance
  - Eradication
  - Protection
- Summary

Non-target species

Applying DDT in the 1950s

History of Pest Control

- 2500 BC: 1st insecticide (sulfur) by Sumerians
- 950 BC: Burning to control plant diseases
- 750 BC: Greeks spread wood ash on soil
- 300: 1st biocontrol, ants/caterpillars, citrus
- 1732: crops grown in rows for weed control
- 1901: 1st success. weed biocontrol, lantana, HI

Integrated Pest Management is:

1. Protecting plants from pest damage
2. Keeping pest populations at or below an acceptable level
3. Minimizing danger to people and the environment
4. Efficient (includes cost-effectiveness)

Mediterranean fruit flies

What Does IPM Mean?

Integrated: combining a variety of science-based methods to protect plants from pests

Pest: insects, mites, nematodes, pathogens, weeds, rodents, etc. that cause injury or are unwanted

Management: a planned, systematic way to control pest populations by keeping their numbers and damage at or below acceptable levels

IPM: A Fruit Fly Example

"Using a combination of techniques ranging from heightened field sanitation through lures and poison to eradicate fertile male flies, UH researchers were able to drastically reduce fly populations on local farms.

What they have come up with is not a "magic bullet", but rather a mix of techniques that change according to crop, terrain, and type of fly being targeted."

Honolulu Advertiser, 31 August 2004

How Did IPM Come About?

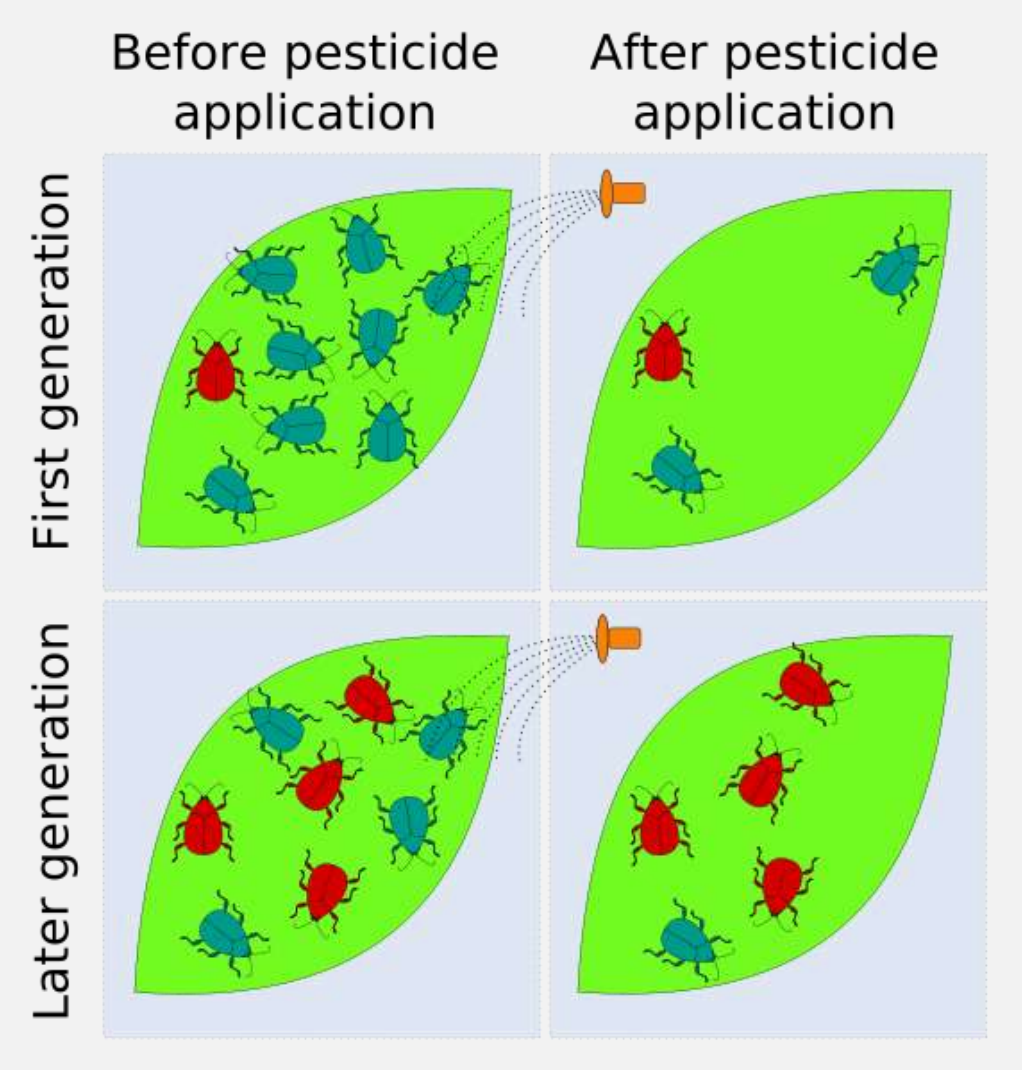
- WW II and organic pesticides (OPs, DDT, etc.)
- Early pesticides broad spectrum, long-lasting
- New technologies made application fast, easy, efficient
- Entomologists in the late 1950s were concerned about misuse of pesticides
- Rachel Carson's *Silent Spring* (1962)


Rachel Carson

Misuse of Pesticides Leads to:

- Contamination of water, soil, air
- Bioconcentration, biomagnification
  - (WHO and the flying cats)
- Pesticide resistance (next slide ⇨)
- Secondary pests may become a problem
- Natural enemies killed ⇨ biological vacuum ⇨ pest resurgence
- Pesticide treadmill

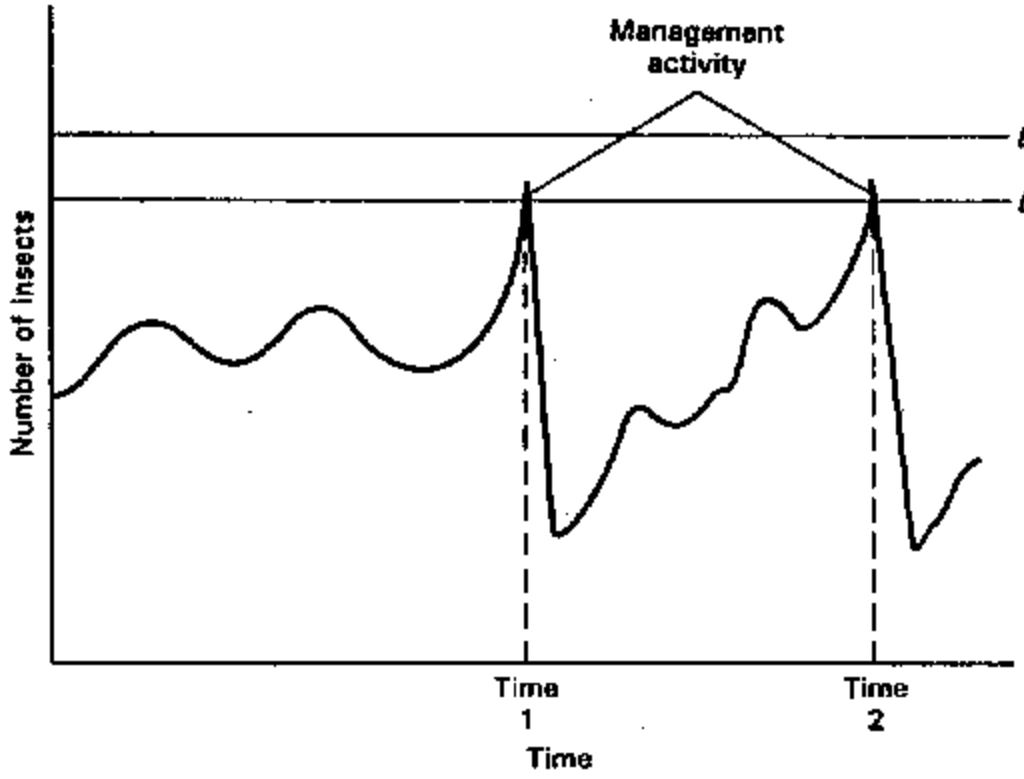
“Selecting” for Pesticide Resistance



When Do I Use a Pesticide in IPM?

When pest levels reach an Economic (Action) Threshold

SCOUTING



(Econ. Injury Level)

(Econ. Threshold)

ET: # pests that trigger a control measure(s) to prevent reaching EIL

EIL: losses caused by pest ≥ cost of control measures

Integrated Pest Management

Maintains pests at "acceptable" levels by:

Exclusion

Eradication

Avoidance

Protection

Exclusion

- Exclusion: manage disease by preventing pest introductions into the landscape
- Quarantines
  - 1) International, national, state regulated (government)
  - 2) Regulate local movement (individuals, nurseries, etc)

Exclusion

Quarantine limitations

- Natural dispersal of the pest (wind, water, vectors)
- Cannot see pathogens, early infections, pest eggs, etc.
- Insufficient resources or technical training of inspectors

Pests in or on seeds (fungi)

Small pests (aphids)

Hidden pests (hornworm)

Eradication

- Difficult – pest outbreak must be **located** and **contained** quickly
- **Destroy** all infested/infected plants
- **Disinfest** all containers, tools, soil, etc.
- **Monitor** surrounding area for reoccurrence (usually 2 years)

Eradication

Soil fumigation

- Chemicals
  - Disinfestants
  - Herbicides
  - Insecticides
  - Nematicides
  - Soil fumigants
  - Seed treatments

Disinfection rollers

Treat soybean seeds

Avoidance

- Do not plant in an area known to harbor disease
- Select best plants and planting sites
- Choosing planting/harvest time
- Resistant varieties, non-host
- Usually cannot completely exclude, eradicate, or avoid pests, so must protect plants by managing pest populations

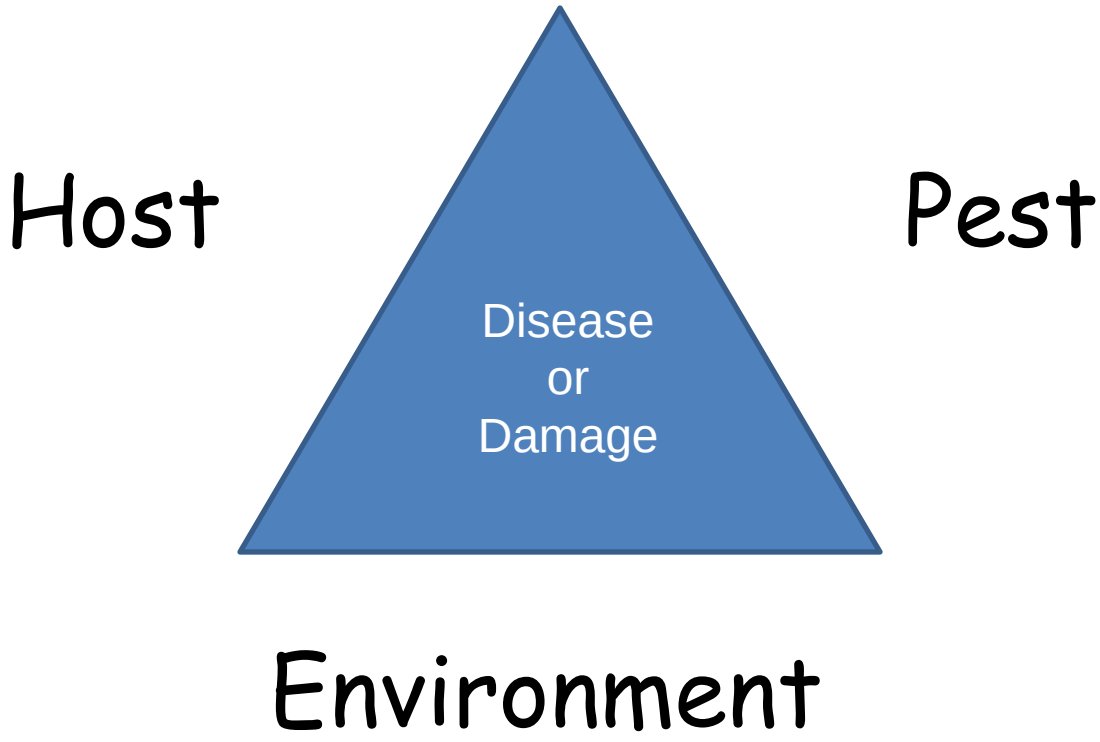
Phytophthora in berm soil

Area with previous disease problems

Protection

- Physical and Cultural protection
- Biological control
- Genetic resistance
- Chemicals

"Plant Disease Triangle"



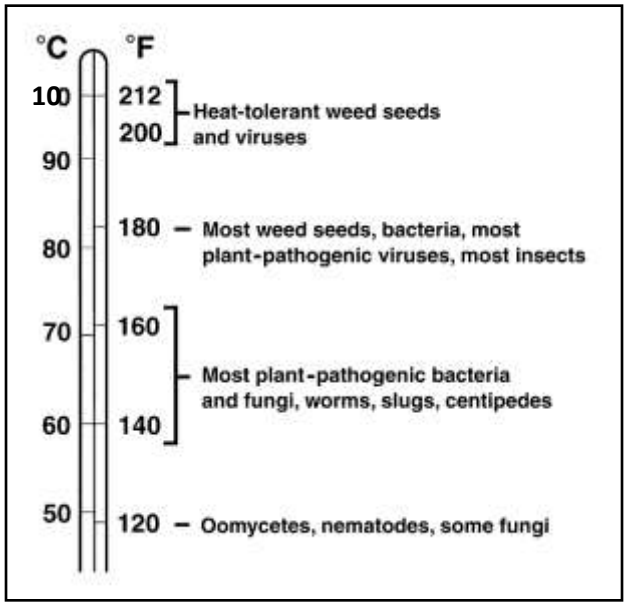
Protection

- Physical and cultural practices
  - Temperature ⇨
  - Water mgmt. ⇨
  - Plant nutrition, soil pH
  - Barriers and mulches
  - Traps, attractants

protecting beans from web blight fungus with an organic mulch

Protection

- Physical, cultural (temp.)
  - Burning stubble, debris
  - Steam heat
  - Composting
  - Solarization (clear)
  - Greenhouse temp., vent.



Solarization: raise soil temp. 2-15°C x 4-8 weeks

Composting

Protection

Physical, Cultural: Water Management

poor drainage

trees modify air circulation

removing dew from greens

overhead irrigation

Protection

- Physical, cultural practices
  - Fallowing
  - Crop rotation
  - Flooding
  - Roguing (weeding)

Field in fallow

Hand weeding

Flooding

Protection

- Biological control
  - Parasitism*
  - Predation*
  - Resistant varieties
  - Crop rotation
  - Green manure
  - Composts, teas
  - Suppressive soils

*Classic biocontrol is using a natural enemy to control a pest (see next two slides).

Predatory lady bug and aphid prey

Green manure: plowing under living plants

Mechanisms of Biological Control

Competition

Antibiosis


Parasite/Predator

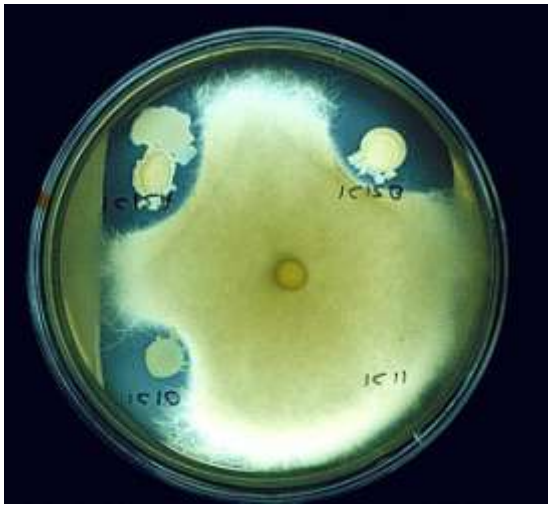

Resistance


Tectococcus ovatus

Biocontrol of Strawberry Guava

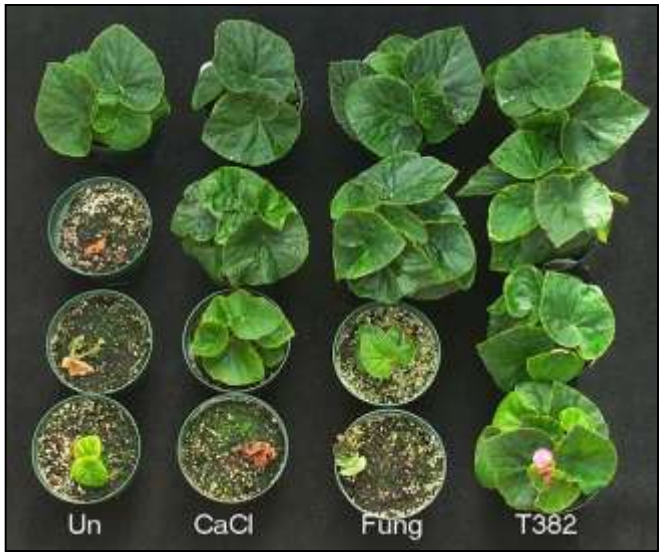
Protection

- Biological control (cont.)
  - Antibiosis
  - Resistant hybrids (see last slide)
  - Genetic engineering (see last slide)



Antibiosis: Take-all fungus

- Biocontrol of Botrytis
  - Un: untreated control
  - CaCl: calcium chloride
  - Fung: chlorothalonil
  - T382: Trichoderma hamatum T382
  - Top row: healthy plants



Protection

Genetic Resistance

- Uses inherited mechanisms
  - DNA ⇨ genes ⇨ proteins ⇨
- Traditional breeding
  - Exchanging genes of like organisms
- Genetic engineering
  - Can use genes from any living organism

Specific resistance (PRSV)

General resistance vs. susceptible

Protection

- Chemicals
  - Right pest
  - Right stage of pest
  - Right pesticide
  - Correct dosage
  - Effective application
  - Protectants
  - Systemics
  - Pesticide resistance

IPM, in summary . . .

- *Planned, science-based* pest control
- Correctly identifies and monitors pests
- Sets a *personalized* economic threshold
- Considers best *practical* options to:
  - Exclude, Eradicate, Avoid, or Protect

Thank You
and
Good Luck