

Common disease problems in Hawaii landscapes and gardens

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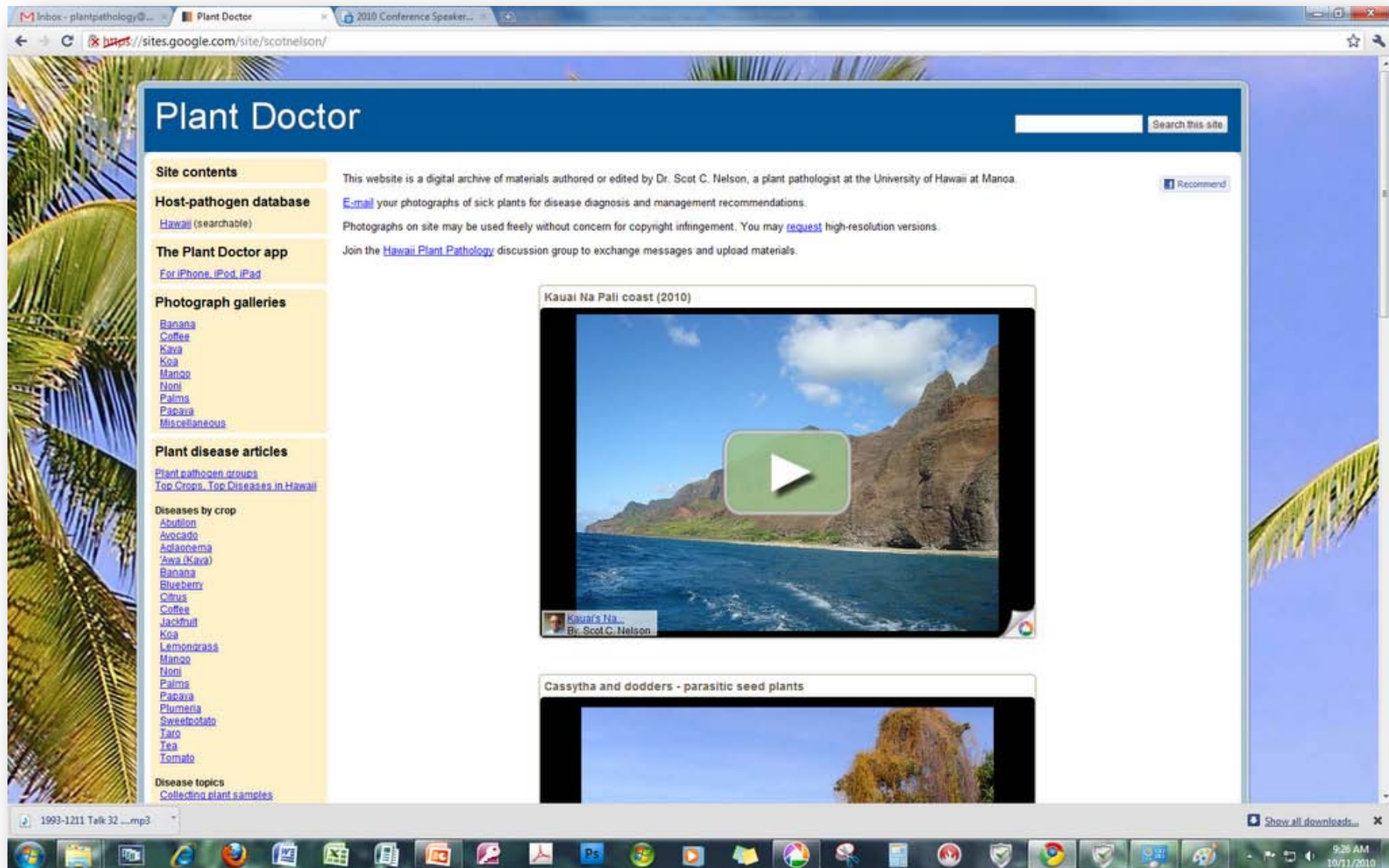
Correct Problem Diagnosis

- Plant disease problems can be difficult to diagnose accurately.
- Accurate problem diagnosis is necessary to realize the best management of an agroecosystem.

People want to know what is wrong and what they can do about it.

Resources

Plant Doctor – <http://www.plant-doctor.net>



This website is a useful resource

Plant Doctor website contents

- [Host-pathogen database](#)
- [“Plant Doctor” app](#) for iPhones
- Disease photograph galleries
- Articles by crops
- General plant pathology materials
- Crop profiles
- Research articles
- Books, Website links, Videos
- Presentations, Slide shows
- [Illustrated glossary](#) of tropical plant pests
- Field guides for diseases, Posters, Newsletters, Conference proceedings
- [User group](#), photograph sample submissions

Checklist of Plant Diseases in Hawaii

Comprehensive, yet needs to
be updated

CHECKLIST OF PLANT DISEASES IN HAWAII

including Records of Microorganisms, principally

Fungi, found in the State

by

Robert D. Raabe,

formerly Plant Pathologist, Department of Plant Pathology

University of Hawaii, Honolulu, HI

enlarged and revised

by

Ibra L. Conners (retired),

formerly Officer-in-Charge of the Canadian Plant

Disease Survey and Curator of the

National Mycological Herbarium of Canada

Agriculture Canada, Ottawa, Canada

and

Albert P. Martinez

Cooperative Extension Service

University of Hawaii at Manoa

1981

[digitized and revised by Scot C. Nelson - May 14, 2009]



Cooperative Extension Service
College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Soil and Crop Management
July 2006
SCM-14

Collecting Plant Disease and Insect Pest Samples for Problem Diagnosis

Scot C. Nelson¹ and Brian C. Bushe²

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²UH-CTAHR Agricultural Diagnostic Service Center

Most plants in Hawaii are prone to attack by various insect pest and plant disease organisms. Pest outbreaks and diseases must be identified accurately to enable their efficient management. In this article we describe the basic requirements for collecting, preserving and submitting plant insect and disease samples to the Agricultural Diagnostic Service Center (ADSC), a branch of the Cooperative Extension Service, College of Tropical Agriculture and Human Resources (CTAHR), University of Hawai'i at Mānoa. If you need to collect a soil sample to eliminate the possibility that the problem is due to physiological causes (nutrient deficiency or toxicity), see the CTAHR publication "Testing Your Soil: Why and How to Take a Soil-Test Sample," on the Web at <http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-9.pdf>.

Collecting plant samples

It is important to gather the best plant samples possible and to record all pertinent background information for the diagnostician. Following are general guidelines for collecting plant samples.

tombs of a particular disease will appear on any one plant within a diseased crop, and more than one plant organ may be affected by a given disease.

Examine all of the main plant organs for disease symptoms: roots, stems, leaves, and blossoms. Collect samples from various plant organs as needed. Plants may suffer from more than one disease simultaneously. Segregate different types of symptoms into different samples.

Collect several plant specimens

A single plant sample may not be enough to allow a correct diagnosis of the problem; several plant samples showing the range of symptoms may be needed. If possible, select samples with various stages of disease development (early and late stages). Samples should be as typical or representative of the overall problem as possible. The best plant tissues for diagnosis are the ones showing the symptoms in various stages of disease development, and adequate amounts of them are important, but submitting excessive amounts of leaves or soil should be avoided.

Examples of symptoms of disease infection and pest infestation

(see Worksheet, p. 7)

algal leaf spot
avocado



fruit rot
anthracnose fungus, cucurbit



fruit rot
anthracnose fungus, papaya



aphids
tended by ants, oleander



canker
fungus, shower tree



chlorosis (yellow leaves)
root-knot nematode, noni



chlorosis (interveinal)
citrus



dieback
koa



erino mite
lychee



fruit rot
Phytophthora, papaya



fruit spot
Asperisporium fungus, papaya



galls
erineum mites, hibiscus



gummosis
shower tree



leaf blight (black leaf streak)
Sigatoka fungus, banana



leaf spot
Cercospora fungus, coffee



leaf spot
Cercospora fungus, lettuce



leaf spot
Asperisporium fungus, papaya



mosaic
cucumber mosaic virus, 'awa



necrosis (internal stem)
Verticillium fungus, naupaka



postharvest rot
Rhizopus fungus, noni



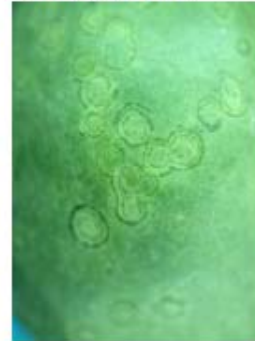
powdery mildew
fungus, papaya



powdery mildew
fungus, poinsettia



ringspot
papaya ringspot virus



root-knot
galls from nematodes, beans



root-knot
galls from nematodes, noni



root rot
Pythium, 'awa (kava)



rust
fungus, 'ohi'a



rust
fungus, heliotrope



rust
fungus, plumeria



scab (fungal scab)
Elsinoe fawcettii, citrus



scorch
abiotic symptom, avocado



soft rot
bacteria, orchid



sooty mold
fungus, noni



sooty mold
fungus, palm



whitefly
tomato

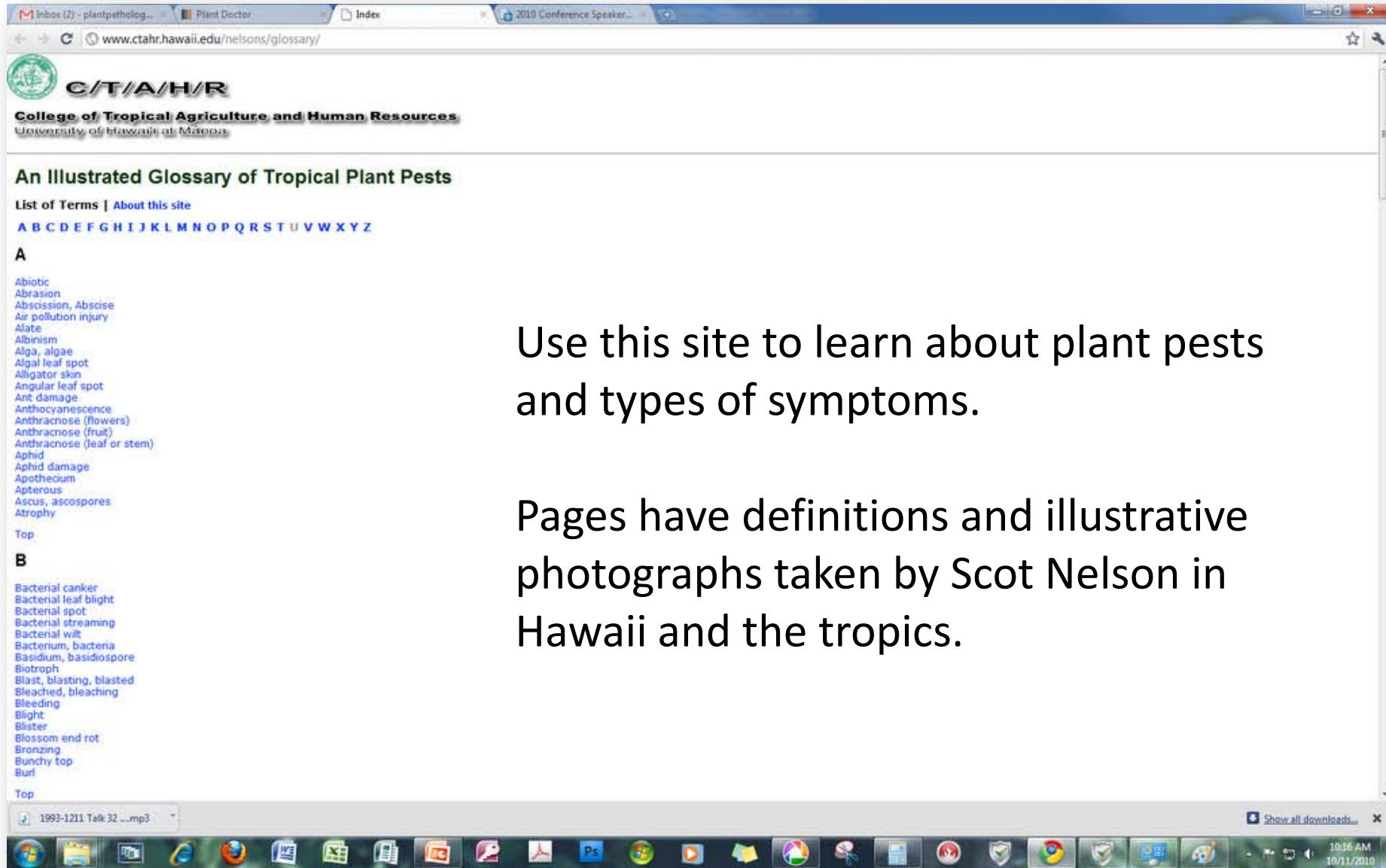


wilt and dieback
Verticillium fungus, naupaka



Illustrated Glossary of Tropical Plant Pests

<http://www.ctahr.hawaii.edu/nelsons/glossary/>



CTAHR
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

An Illustrated Glossary of Tropical Plant Pests

[List of Terms](#) | [About this site](#)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A

- Abiotic
- Abrasion
- Abscission, Abscise
- Air pollution injury
- Alate
- Albinism
- Alga, algae
- Algal leaf spot
- Alligator skin
- Angular leaf spot
- Ant damage
- Anthocyanescence
- Anthrachnose (flowers)
- Anthrachnose (fruit)
- Anthrachnose (leaf or stem)
- Aphid
- Aphid damage
- Apothecium
- Apterous
- Ascus, ascospores
- Atrophy

[Top](#)

B

- Bacterial canker
- Bacterial leaf blight
- Bacterial spot
- Bacterial streaming
- Bacterial wilt
- Bacterium, bacteria
- Basidium, basidiospore
- Biotroph
- Blast, blasting, blasted
- Bleached, bleaching
- Bleeding
- Blight
- Blisters
- Blossom end rot
- Bronzing
- Bunchy top
- Burl

[Top](#)

1993-1211 Talk 32 ...mp3

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Use this site to learn about plant pests and types of symptoms.

Pages have definitions and illustrative photographs taken by Scot Nelson in Hawaii and the tropics.

Sample page from the Glossary

Inbox (2) - plantpatholog... Plant Doctor Factsheet - Aphid 2010 Conference Speaker...
www.ctahr.hawaii.edu/nelsons/glossary/Aphid.htm

Aphid

[List of Terms](#) | [About this site](#)
[A](#) [B](#) [C](#) [D](#) [E](#) [F](#) [G](#) [H](#) [I](#) [J](#) [K](#) [L](#) [M](#) [N](#) [O](#) [P](#) [Q](#) [R](#) [S](#) [T](#) [U](#) [V](#) [W](#) [X](#) [Y](#) [Z](#)



Close-up of adult melon aphids (*Aphis gossypii*) feeding on a plant leaf.

A colony of black citrus aphids (*Toxoptera citricola*) on a noni (*Morinda citrifolia*) plant.

A colony of black citrus aphids (*Toxoptera citricola*) on a noni (*Morinda citrifolia*) plant.

A colony of melon aphids (*Aphis gossypii*) on a noni (*Morinda citrifolia*) leaf.

A colony of aphids being tended by ants on a taro (*Colocasia esculenta*) leaf.

A colony of oleander aphids (*Aphis nerii*) being tended by ants on an oleander (*Nerium oleander*) plant.

Definition

An **aphid** is any of various small, soft-bodied insects of the family Aphididae that have mouthparts specially adapted for piercing and feed by sucking.

Etymology. 1884, Anglicized from Mod.L. *aphides*, pl. of *aphis*, coined by Linnaeus, though where he got it and why he applied it to the plant louse are mysteries. The theory favored by OED as "least improbable" is that it derives from the pl. of Gk. *apheides* "unsparing, lavishly bestowed," in ref. either to the "prodigious rate of production" of the insects or their voracity. They also are known as ant-cows.

For images and discussion of winged versus wingless aphids, see: [alate](#), [apterous](#)

Discussion

Aphids are important vectors of many plant diseases caused by viruses, such as papaya [ringspot](#).

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The focus of the Glossary is plant diseases and pathogen vectors.

Hawaii host-pathogen database (searchable)

Instructions: Enter any consecutive letters of a plant's common or scientific name or a plant pathogen name. Search results will be displayed in a new window. If you do not find the common name for your plant, search for the scientific name. Key: sp. = species; prob. = probably; poss. = possibly; X = hybrid or cross

Source of data: The data derive solely from records (1995-2008) for plant disease samples submitted by the public to the University of Hawaii at Manoa, Agricultural Diagnostic Service Center in Hilo, Hawaii. There are many common host-pathogen combinations in Hawaii that are not represented by this database. The database will be revised and updated periodically, and yearly to provide new records. For more information contact snelson@hawaii.edu.

Host common name	Host scientific name		Pathogen name		
A'alii	Dodonaea viscosa		Phytophthora	sp.	
A'alii	Dodonaea viscosa		Pythium	sp.	
Aechmea	Aechmea fasciata		Alternaria	sp.	
Aechmea	Aechmea fasciata		Colletotrichum	sp.	
African daisy	Arctotis	sp.	Pythium	sp.	
African daisy	Arctotis	sp.	Rhizoctonia		solani
African daisy	Gerbera jamesonii		Botrytis	prob.	cinerea
African daisy	Gerbera jamesonii		Oldium	sp.	
African daisy	Gerbera jamesonii		Rhizopus		stolonifer
African lily	Agapanthus africanus		Colletotrichum	sp.	
African lily	Agapanthus africanus		Phoma	sp.	
African mash	Alocasia parasol		Cylindrocarpum	sp.	
African violet	Saintpaulia ionantha		Botrytis cinerea		
African violet	Saintpaulia ionantha		Corynespora		cassicola
African violet	Saintpaulia ionantha		Corynespora	prob.	cassicola
Agave	Agave	X	Erwinia	sp.	
Agave	Agave	X	Fusarium	sp.	
Agave	Agave victoria		Colletotrichum	sp.	
Agave	Agave victoria		Pseudomonas	sp.	
Aglaonema	Aglaonema	X	Erwinia	prob.	chrysanthemi
Aglaonema	Aglaonema	X	Pythium	sp.	
Aglaonema	Aglaonema commutatum		Colletotrichum	sp.	
Aglaonema	Aglaonema commutatum		Erwinia		chrysanthemi
Aglaonema	Aglaonema commutatum		Fusarium	prob.	subglutinans
Aglaonema 'Emerald Beauty'	Aglaonema commutatum		Colletotrichum	sp.	
Aglaonema 'Emerald Beauty'	Aglaonema commutatum		Fusarium	prob.	subglutinans
Aglaonema 'Maria'	Aglaonema	X	Fusarium	prob.	subglutinans
		X	Colletotrichum	sp.	

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Use this site to search for know host-pathogen combinations in Hawaii (Big Island database)

Hawaii's top crops and top diseases [.PDF]

68 crops, 248 diseases

Hawaii: Top Crops, Top Diseases (draft Dec. 2008) - by Scot C. Nelson and Brian C. Bushe					
Crops	Disease name	Pathogen(s)	Site(s) of Infection	Symptoms	Management*
Anthurium	Anthurium blight	<i>Xanthomonas campestris</i> (bacterium)	Root, Leaf, Petiole	Foliar chlorosis and necrosis, wilting, leaf and plant decline and death	Sanitation, rogue diseased plants, use sterilant to disinfect shears between cuts
	Anthrachnose (blacknose)	<i>Colletotrichum gloeosporioides</i> (fungus)	Spadix	Necrotic spots on spadix (actual flowers)	Sanitation, harvest early, fungicidal sprays
	Radopholus root rot	<i>Radopholus similis</i> (nematode)	Root	Root necrosis, plant chlorosis, plant stunting and decline	Avoidance, sanitation, crop rotation
	Root knot	<i>Meloidogyne</i> spp. (nematodes)	Roots	Above ground- chlorosis, stunting; below ground- stubby roots	Preplant fumigation, avoidance, crop rotation, composting
	Root rots	<i>Phytophthora</i> , <i>Pythium</i> , and <i>Rhizoctonia</i> spp. (fungi and fungus-like organisms)	Roots	Root necrosis, plant chlorosis, plant stunting and decline	Ensure good drainage of soil or media, crop rotation, do not over-irrigate
Aglaonema	Algal leaf spot	<i>Cephaleuros virescens</i> (alga)	Leaves	Leaf spots on both leaf surfaces	Increase plant vigor; open canopy
	Bacterial Leaf Spot	<i>Pseudomonas cichorii</i> ; <i>Erwinia</i> spp.; <i>Xanthomonas</i> sp. (bacteria)	Leaves	Water-soaked, dark brown to black leaf spots with chlorotic halo.	Sanitation, rogue diseased plants, use sterilant to disinfect shears between cuts
	Foliar Blight/Crown Rot	<i>Fusarium subglutinans</i> (fungus)	Leaf, stem spots; stem/collar rots	Large leaf spots with extensive yellowing; stems rot completely	Sanitation, Increase plant aeration, fungicides
	Magnesium deficiency	none	Foliage	Yellow-orange color appears	Fertilize plants, choice of

Banana (*Musa sp.*) Pest and Disease Image Gallery

Online *quick* reference for Hawaii's banana growers

Scott C. Nelson <snelson@hawaii.edu>, University of Hawaii at Manoa ([UHM](#)), College of Tropical Agriculture and Human Resources ([CTAHR](#)), Department of Plant and Environmental Protection Sciences ([PEPS](#))

Over 200 digital photos of more than 30 pest and disease problems of bananas in Hawaii and the Pacific are provided here to help banana growers diagnose their problems. For most images, the resolution and size is set at 150 DPI and (500 x 375) pixels to provide sufficient clarity and size to enable the recognition of the more subtle disease characteristics with confidence when printed. Users of this site may [request](#) or [submit](#) high-resolution images of banana problems by e-mail. Images here are copyright-free.

How to use this site: Pests and banana health problems are listed in **brown font** below in alphabetical order, with different symptoms or other important aspects listed below each entry. Browse and click on an image associated with a particular problem. View, save or print the image. *Click on your browser's "back arrow" to return to this page.* If you would like more information, please contact the University of Hawaii at Manoa Cooperative Extension Service.

1) Free banana pest & disease publications and links from the University of Hawaii:

1. [Species Profile \(*Musa sp.*\)](#). [PDF] (Permanent Agriculture Resources, August 2006, by S. C. Nelson, R. Ploetz and A. Kepler)
2. [Banana and Plantain – an Overview With an Emphasis on Pacific Island Cultivars](#) [PDF] (Permanent Agriculture Resources, Jan. 2007, R. C. Ploetz, A. K. Kepler, J. Daniells and S. C. Nelson)
3. [Banana Bunchy Top Virus](#). [PDF] (University of Hawaii extension publication, 1997, by S. Ferreira, E. Trujillo and D. Ogata)
4. [Banana Rust Thrips Damage to Banana and Ornamentals in Hawaii](#). [PDF] (University of Hawaii, extension publication, 2002, by A. Hara, R. Mau, R. Heu, C. Jacobsen and R. Niino-DuPonte)
5. [Banana Bunchy Top Brochure: Symptoms and Management](#). [PDF] (University of Hawaii, extension publication, 2005, by the Banana Action Group)
6. [Banana Bunchy Top in Hawaii: Online Video](#). (University of Hawaii, extension product, Requires one of three media players, 14.5 minutes in duration, full color, by S. C. Nelson and L. Richardson)
7. [Banana Bunchy Top Website](#). (University of Hawaii, extension product, by S. C. Nelson).
8. [Banana Ripening and Bunch Management](#). [PDF, from a Powerpoint slide show, 8.8 MB], 79 slides, University of Hawaii extension product, 2004, by S. C. Nelson, not copyrighted)
9. [Banana Bunchy Top Poster](#) (PowerPoint, 11.5 mb)
10. [Banana Pest Management Strategic Plan](#) (Hawaii) [PDF]
11. [Cost of banana production in Hawaii](#) (Excel spreadsheet, by Kent Fleming)
12. [Banana cultivar synonyms in Hawaii](#) (Drs. Angela Kay Kepler and Frank Rust, 2007) [PDF, 150 KB]
13. [Growing Bananas: Online Video](#). (University of Hawaii, YouTube.com format, extension product, 2009, banana cultivation in Hawaii, 36 minutes, by S. C. Nelson and Lynn Richardson)
14. [Postharvest rots of banana](#) [PDF] (University of Hawaii, extension publication, 2008, by S. Nelson)
15. [Black leaf streak of banana](#) [PDF] (University of Hawaii, extension publication, 2008, by S. Nelson)

2) The Pest & Disease Image Gallery

Abrasion injury: | [text](#) |

- Bruised, abraded, scarred banana fingers from rubbing against each other [1](#) |
- Alligator skin: light abrasions on fruit peel caused by leaves or bracts [1 2](#) |

(Giant) African snail (*Achatina fulica*):

- Snails feeding on banana pseudostems and petioles [1 2 3](#) | on banana leaves and damage (holes) caused [1 2](#) |

Ant damage (long-legged ant, *Anoplolepis longipes*): | [text](#) | [text](#) at [Crop Knowledge Master](#) |

Plant pest and
disease image
galleries

Example: banana

<http://www.ctahr.hawaii.edu/nelsons/banana/index.htm>

Websites with information about plant pests in Hawaii:

- [Crop Knowledge Master](#)
- [Farmer's Bookshelf](#)
- [University of Hawaii Agricultural Diagnostic Service Center](#)
- [Hawaii Department of Agriculture](#)
- [University of Hawaii at Manoa, CTAHR](#)
- [PEPS \(Dept. of Plant and Environmental Protection Sciences\)](#)
- [Free Pest and Disease Publications](#) (University of Hawaii at Manoa)
- [UH-CTAHR Office of Communication Services for-sale publications](#)
- [Pesticide Labels and MSDS Sheets](#)
- [HPIRS \(Hawaii Pesticide Information Retrieval System\)](#)

USA and international

- [American Phytopathological Society](#) (APS)
- [The Plant Pathology Internet Guide Book](#)
- [International Society of Plant Pathology](#)
- Google (also Google Scholar) [http://www.google.com/](http://www.google.com/type: \)
type: "plant pathology resources"

Problem diagnosis

Types of plant health problems

- **Parasites**
 - Insects
 - Pathogens (viruses, bacteria, fungi, nematodes, phytoplasmas, algae, viroids)
 - Parasitic seed plants
- **Infectious diseases** – caused by plant pathogens
- **Non-infectious diseases** – disorders caused by environmental factors (agrichemicals, drought, flooding, nutritional deficiency, physiological problems, sunburn, [lightning strike](#), [air pollution](#) (volcano), etc.)

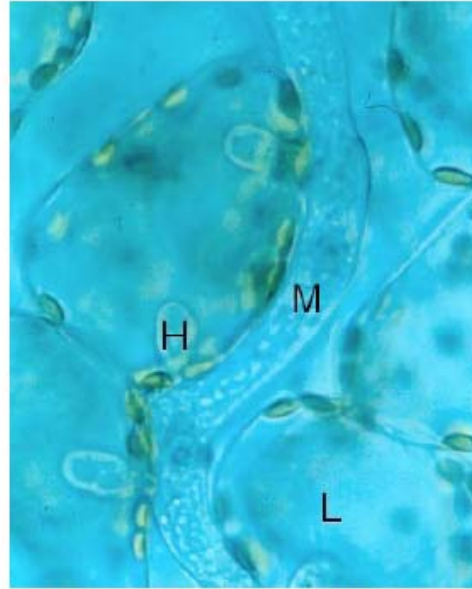
Major pathogen groups

- [Fungi](#)
- [Bacteria](#)
- [Viruses](#)
- Viroids
- [Nematodes](#)
- Phytoplasmas
- [Algae](#)
- [Parasitic seed plants](#)



Cassytha filiformis on noni
Cassytha and dodders are parasitic seed plants

Note: example .pdf files provided at links above



Haustoria. Some plant parasitic plants and plant pathogenic fungi have evolved the same mode of parasitism (haustoria), as demonstrated in this plant-fungus comparison. *Left:* A stem of the plant parasitic phanerogam, *C. filiformis*, spiraling around a woody stem in Hawai'i. The small rectangle and black arrow in the photograph indicate one of many haustoria occurring at intervals along the stem) (Photo: Wayne Nishijima). *Right:* Haustoria of the lettuce downy mildew pathogen, *B. lactucae*, penetrating and invaginating cells of lettuce (*Lactuca sativa*) within a lettuce leaf (highly magnified.). Key: H = a bulbous haustorium, one of five or six that are visible here along the strand of fungal mycelium growing between the lettuce cells, extending from the intercellular fungal mycelium and penetrating a lettuce cell; M = intercellular fungal mycelium of the plant pathogen, *B. lactucae*; L = a lettuce cell with numerous olivine chloroplasts visible.



Left: *Caseytha filiformis* stems and haustoria on *Metrosideros polymorpha*. *Right:* An inflorescence of *C. filiformis* and haustorial attachments of stems of *C. filiformis* to other stems, demonstrating the autoparasitic nature of this plant. (Photos: J. B. Friday)

Some pathogens use subtle infection structures known as haustoria (Greek for “drinker”)

These “obligate” pathogens must have a living host in order to survive.

Other pathogens can obtain food saprophytically from dead material.

Korthalsella species – [Hawaiian mistletoes](#), parasitic seed plants

UH-CTAHR

Hawaiian Mistletoes (*Korthalsella* Species)

PD-62 — Jan. 2009



Korthalsella complanata infecting *Metrosideros polymorpha*
(Photo: J.K. Obata, permission granted by G.D. Carr)



A vigorous *Korthalsella complanata* plant infecting *Acacia koa* near Keanakolu on the island of Hawai'i (Photo: J.B. Friday)



Korthalsella complanata
Viscaceae
© C. H. Lamoureux

A stem of *K. complanata*; members of this species are somewhat variable in morphology, in this case the flattened stem tends to narrow appreciably at the nodes.

(Photo: C.H. Lamoureux, permission granted by G.D. Carr)



A *Korthalsella complanata* plant infecting *Acacia koa* near Keanakolu on the island of Hawai'i (Photo: J.B. Friday)



A large *Korthalsella complanata* plant infecting a young *Acacia koa* tree near Keanakolu on the island of Hawai'i (Photo: J.B. Friday)

UH-CTAHR

Hawaiian Mistletoes (*Korthalsella* Species)

PD-62 — Jan. 2009



Close-up of a branch of *Korthalsella complanata*
(Photo: J.B. Friday)



Korthalsella complanata plants dominating the canopy of an old, declining *Acacia koa* tree near Keanakolu on the island of Hawai'i (Photo: J.B. Friday)



A population of *Korthalsella complanata* infecting a young stand of *Acacia koa* near Umikoa, on the island of Hawai'i (Photo: J.B. Friday)



Korthalsella cylindrica
Viscaceae
G. K. Linney

Seeds of Korthal mistletoes are ejected explosively into the environment. (Photo by J.K. Obata, G.D. Carr, and G.K. Linney, used with permission)

Important disease-inducing genera of parasitic seed plants and their hosts.

Genus of Parasitic Seed Plant	Example of Host Plant Attacked
I. ROOT PARASITES	
A. Broomrapes (Orobanchaceae)	
1. <i>Aeginetia</i>	maize, rice, sugarcane
2. <i>Christisonia</i>	Sugarcane
3. <i>Orobanche</i>	legumes, tobacco, tomato, cabbage, flax, hemp, grapes, watermelon, cucurbits, mint, sunflower, clover, eggplant
B. Figworts (Scrophulariaceae)	
1. <i>Alectra</i> (<i>Melamsa</i>)	cowpeas, soybeans, peanuts, legumes, sugarcane
2. <i>Rhamphicarpa</i>	maize, cowpeas, rice, sorghum
3. <i>Striga</i> (witchweed)	maize, sorghum, sugarcane, tobacco, grasses
II. STEM OR LEAF PARASITES	
A. Cuscutaceae	
1. <i>Cuscuta</i>	alfalfa, clover, sunflower, potato, sugar beets, tobacco, bamboo, asters
B. Lauraceae	
1. <i>Cassytha</i>	evergreen shrubs and ornamentals, orange trees
C. Viscaceae	
1. <i>Arceuthobium</i>	Conifers
2. <i>Dendrophthora</i>	rubber, mango, avocado, cacao
3. <i>Korthalsella</i>	acacia, eucalyptus
4. <i>Notothixos</i>	eucalyptus
5. <i>Phoradendron</i>	coffee, avocado, teak, various forest trees
6. <i>Viscum</i>	rubber, conifers, fruit trees, deciduous trees
D. Loranthaceae	
1. <i>Amyema</i>	eucalyptus
2. <i>Elytranthe</i>	rubber, cashew
3. <i>Phthirusa</i>	rubber
4. <i>Psittacanthus</i>	citrus trees

Source: Donald M. Knutson (1979). How Parasitic Seed Plants Induce Disease in Other Plants. pp. 293-309 In: *Plant Disease, an Advanced Treatise* (Vol. IV, How Pathogens Induce Disease). (Horsfall and Cowling, eds.) Academic Press, NY

Plant diseases in Hawaii

Which diseases can we expect to encounter?

→ Knowing what to expect can assist diagnosis.

→ Know and use your available resources.

The correct answers are there, we just have to find them.

The problem is that each plant can suffer from dozens of diseases, and that there are thousands of diseases to consider.

The good news is that by using information and analysis of symptoms, we can narrow down the number of possibilities.

Examine entire plant for symptoms

People often submit the wrong plant organ

- *Roots*
- *Stems*
- *Leaves*
- *Flowers, fruits*

A plant may have more than one disease or express disease symptoms on different plant organs.

Plants often display a range of symptoms as disease progresses.

Root disease expresses in roots *and* foliage (wilting, yellowing).

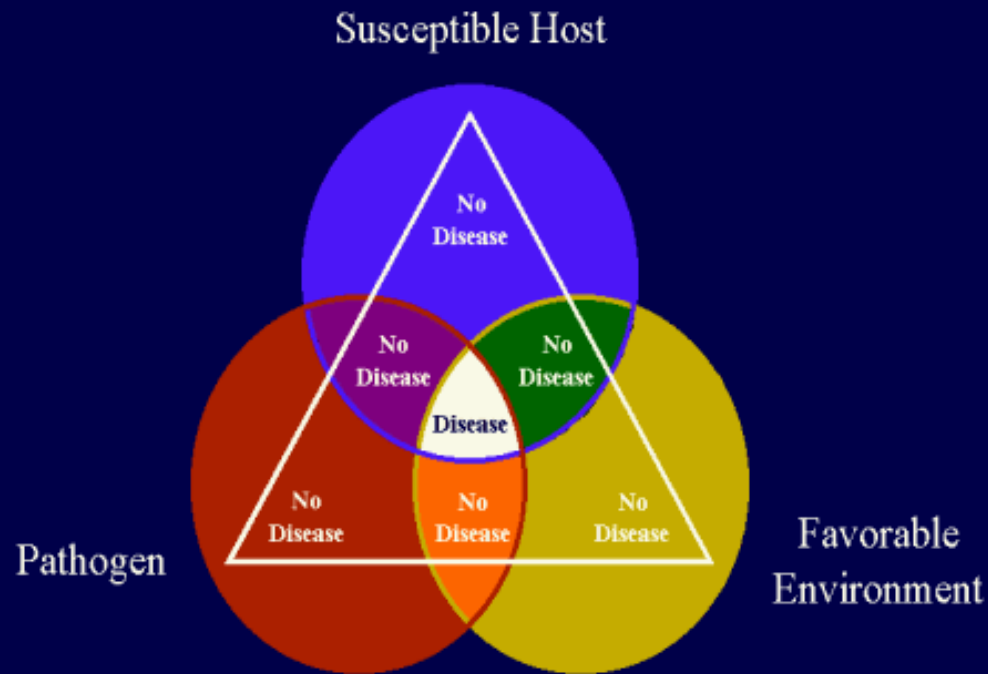
Consider root health first: can the symptoms derive from root disease?

The plant disease triangle:

a disease diagnosis and management aid

Plant Diseases The Disease Triangle

2



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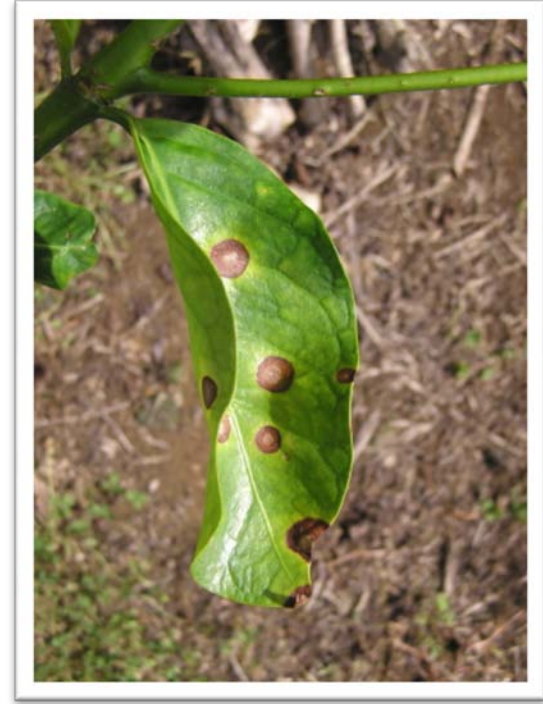
Pathogen

Environment

Symptoms: (sample .pdf files linked below)

- [Leaf spot](#)
- [Leaf blight](#)
- Root rot
- Wilt
- Chlorosis (e.g., [mosaic](#), yellows)
- [Rot](#), blotch
- [Dieback](#)
- [Galls](#)
- Necrosis
- [Gummosis](#) (bleeding)
- Scorch
- Stunting
- Hydrosis
- [Rust](#)
- [Malformation](#)
- [Blight](#)

Cercospora leaf spot of coffee



Cercospora berry blotch, coffee



Root rot



Wilting



Malformation

Coffee



Necrosis

Symptomatology is complex

- Many diseases express a variety of symptoms
 - Symptoms may depend on plant variety
 - Symptoms may depend upon environment
 - Symptoms may depend upon stage of disease cycle
 - Symptoms may vary with pathogen race
 - Symptoms of different diseases may occur together
 - Symptoms may depend on [plant nutrition](#)
 - Symptoms of different diseases may resemble each other
-
- Try to examine and consider a set of symptoms
 - Do not rush to judgment

Recognize, however, that some symptoms are *diagnostic* for a disease.



‘AWA DIEBACK SYMPTOMS (CMV)



Leaf rugosity



Stem necrosis



***A. gossypii* colonizing 'awa leaf**



'AWA DIEBACK SYMPTOMS (CMV)



Witling, yellowing

***Aphis gossypii*,
vector of CMV**





'Awa field



Rapid wilt of young plants

CMV-infected

CMV-free



'Awa stump: complex tissue



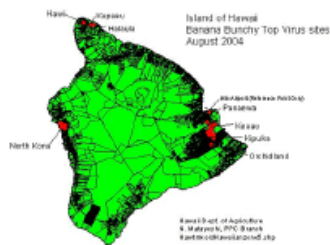
honohono grass w/ CMV



Wilted plant

Integrated Management

- Disease-free planting material
- Eradicate alternate hosts
- Protect young plants
- Monitor ants/aphid populations
- Intercropping
- Host resistance
- Good nursery practices
- Windbreaks
- Rogue infected plants when young
- Rogue diseased stems when > 9 mo. old
- Minimize plant stresses
- Aphid control



Banana Bunchy Top Disease in Hawaii

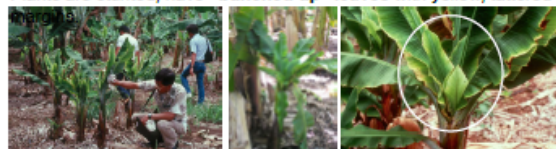
College of Tropical Agriculture and Human Resources University of Hawai'i at Mānoa

Poster design: Dr. Scott C. Nelson

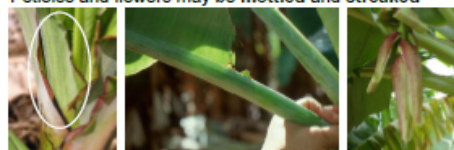
Banana bunchy top virus (BBTV) is a threat to Hawaii bananas. BBTV is diagnosed by identifying symptoms of diseased plants or by submitting a banana leaf sample to test for the banana bunchy top virus. Diseased plants should be destroyed properly.

Disease Symptoms

Plants are stunted, have "bunched up" leaves with yellow, tattered



Petioles and flowers may be mottled and streaked



Leaf veins "green J-hooks" near the midrib and "Morse code" dots-and-dashes.



Diseased



Compare diseased versus healthy older plants



Diseased

Leaves bunchy, erect, narrow, yellow, stunted.

Healthy

Leaves open, wide, not stunted or yellow



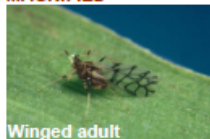
Diseased older plant

Leaves fan-like, resembles traveler's palm.

The Banana Aphid

The banana aphid (*Pentalonia nigronervosa*) is a small sap-feeding insect that can transmit the banana bunchy top virus, causing infection of bananas and bunchy top disease development.

MAGNIFIED



Winged adult



Wingless adult



Aphid colony

NOT MAGNIFIED



Aphid colony



Aphid colony



Aphid colony

LEFT: Banana aphids prefer to feed on young leaves and under leaf sheaths. These insects must be controlled in order to successfully manage banana bunchy top disease



Aphid colony

LEFT: Pull down leaf sheath to reveal Aphid colony. The aphids are often tended by ants (see dead ant at left). The ants feed on the sweet honeydew excreted by the feeding aphids.

BBTV Management

- Disease Identification and Routine Monitoring.** Scout your plants weekly for symptoms. Submit banana leaf tissue samples for virus testing. Early identification of diseased plants is critical to controlling the spread of BBTV.
- Insect Control.** Controlling aphids with sprays of the appropriate insecticides is essential to reducing the spread of BBTV. Control aphid populations on alternate hosts such as ginger if necessary.
- Disease Prevention and Diseased Plant Eradication.** Avoid planting diseased keikis. Destroy all infected plants and their mats by either digging them out (labor-intensive) or by injecting the plants with Roundup Ultra Max herbicide. Before destroying plants, spray to kill the aphids first. Homeowners can use a soap-oil mixture.
- Restrict Banana Plant Movement.** Avoid moving banana planting material around the islands; do not move diseased plants anywhere until they are completely dead.

Symptoms of [Banana Bunchy Top Disease](#) (video link)

Leaves are bunchy, narrow, stiff, upright.
Plant is stunted.



Williams Hybrid (Cavendish)



The youngest, central leaves are bunched up and upright,
and the plant is stunted

Symptoms of [Banana Bunchy Top Disease](#) (website link)

Leaves are bunchy, upright



Diseased (with bunchy leaves)

Healthy

Symptoms of Banana Bunchy Top Disease

Leaves have yellow, wavy and/or tattered brown margins



Tall apple banana



Symptoms of Banana Bunchy Top Disease

Leaves and stems have “Morse code”, green dots & dashes or streaking along veins.



Symptoms of Banana Bunchy Top Disease

Leaves have green J-hooks along midrib



Diseased: green J-hooks at leaf midrib



Healthy

Plant disease symptoms occur at different levels of resolution:
cell, tissue, organ, and plant

Advanced symptoms of bunchy top disease



In advanced stages, outer edges of the leaves are light yellow in color and the margins are tattered or uneven (left).

The center, developing leaves are all deformed: stunted, short, narrow and erect (right).

What is the etiology/cause of a problem?

1. Biotic vs. abiotic (is this an injury or is it infectious)?
2. Insect vs. plant pathogen?
3. Root vs. shoot?
4. Single versus multiple etiology?

Ask a series of questions to resolve these dichotomies.

Question (example)

1. Is this an [injury or an infectious disease](#)?
 - Examine the static versus dynamic appearance or progression of symptoms
 - Examine the simple vs. complex array of symptoms presented

Collecting information about the cropping system will help with problem diagnosis

Pesticide history

List pesticides used

Rates of application (concentration)

Frequency or number of applications

Fertilizer history

List fertilizers used

Amount of fertilizers used

Frequency of fertilizer applications

Plants or area affected

No. of acres

No. plants

% of plants

Spatial pattern of damaged plants (check one)

- ☐ Uniform; widespread
- ☐ Random distribution
- ☐ Clustered

Rooting environment

- ☐ Commercial potting medium (identify)
- ☐ Hydroponics

If rooted in soil, specify type

- ☐ Lava
- ☐ Red or brown, deep soil
- ☐ Rocky
- ☐ Other

Plant parts affected (check all that apply)

- | | |
|-----------------------------------|--|
| ☐ Buds | ☐ Rootlets |
| ☐ Seeds | ☐ Large rots |
| ☐ Stem | ☐ Growing tips |
| ☐ Trunk | ☐ Fruits or nuts |
| ☐ Bark | ☐ Bulbs or corms |
| ☐ Tubers | ☐ Branches, large |
| ☐ Blossoms | ☐ Branches, terminal |
| ☐ Petioles | ☐ Leaves, upper surface |
| | ☐ Leaves, lower surface |

History of problem (check one):

- ☐ First time
- ☐ Recurrent

Symptom appearance (check one)

- ☐ Rapid
- ☐ Gradual

Know where to submit questions and samples

Contact information

ADSC Web page

<http://www.ctahr.hawaii.edu/adsc>

ADSC at UH-Manoa

1910 East-West Rd.
Sherman Laboratory Rm 134
Honolulu, HI 96822
956-6706 (fax 956-2592)
adsc@ctahr.hawaii.edu

ADSC at CES-Hilo

Komohana Research and Extension Center
875 Komohana St.
Hilo, HI 96720-2757
981-5191 (fax 981-5211)
bushe@hawaii.edu

CES offices

Hawai'i	Hilo (Komohana)	875 Komohana St, Hilo 96720-2757	808-981-5199
	Kamuela	67-5189 Kamamalu Rd, Kamuela 96743-8439	887-6183
	Kona	79-7381 Mamalahoa Hwy, Kealahou 96750-7911	322-4892
Kaua'i	Lihue	State Office Bldg, 3060 Ewa St, Ste 210, Lihue 96766-1881	274-3471
Maui	Kahului	310 W Kaahumanu Ave, Bldg 214, Kahului 96732-1617	244-3242
Moloka'i, Lāna'i	Hoolehua (Molokai)	P.O. Box 394, Hoolehua 96729-0394	567-6933
O'ahu	Honolulu	1955 East-West Rd, Rm 217, Honolulu 96822	956-7138
	Kaneohe	45-260 Waikalua Rd, Ste 101, Kaneohe 96744-3134	247-0421
	Urban Garden Center (UGC)	955 Kamehameha Hwy, Pearl City 96782-2501	453-6050
	Wahiawa	910 California Ave, Wahiawa 96786-2124	622-4185

To contact an office by e-mail, use the location name (or the one given above in parentheses);
e.g., komohana@ctahr.hawaii.edu, lihue@ctahr.hawaii.edu, etc.

You may always contact Dr. Scot Nelson snelson@hawaii.edu

Physiological functions of plants

affected by disease (examples)

- Uptake/translocation of water and nutrients
- Photosynthesis
- Reproduction
- Respiration
- Transpiration

Affected functions create abnormal plant growth and disease symptoms.

Note: Symptoms caused by different pathogens can be similar, because the pathogens affect the same physiological functions.

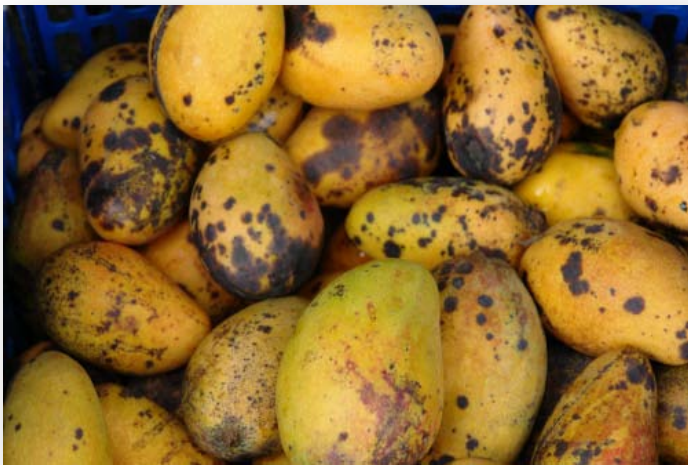
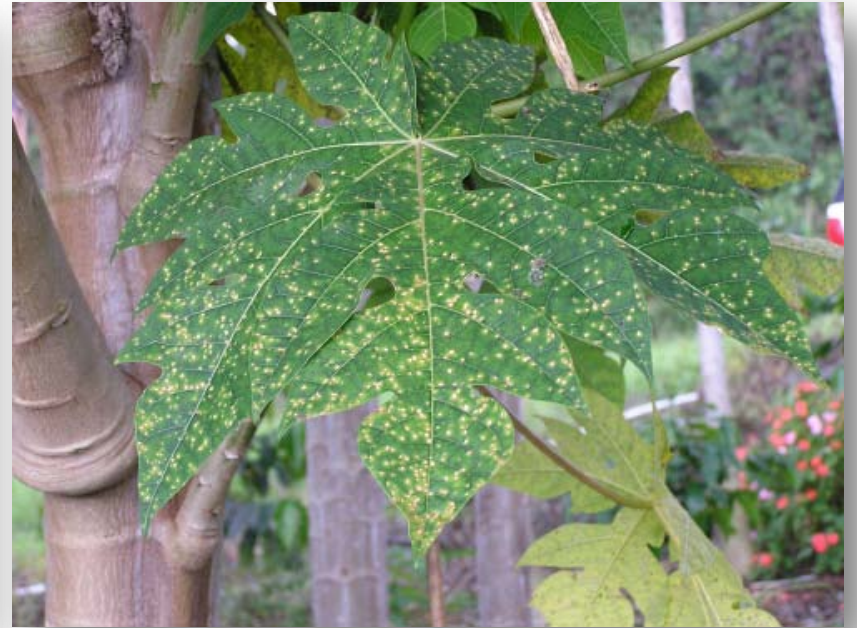
Spatial pattern suggests etiology

Random - suggests biotic pathogen, early in disease cycle

Aggregated - clustered, suggests contagious agent affecting proximal plants or plant parts

Uniform - suggests abiotic factor such as drought or pesticide injury

However, these are just guidelines, as some pathogens can cause uniform symptoms, especially late in the disease cycle: examples include RUST FUNGI, POWDERY MILDEWS, and BLIGHTS





Time required for symptom development suggests a causation

Rapid development - suggests abiotic cause, such as pesticide injury

Gradual, dynamic development - suggests a biotic plant pathogen

Symptoms develop after implementation of cropping practice – suggests abiotic factor associated with irrigation, fertilizer, or pesticide application

However, these are just guidelines, as some pathogens can cause very rapid and severe plant symptoms: examples include *Phytophthora* (blight, rot) and *Pythium* (root rot, wilt, damping off)

Pest and disease symptoms slideshow

(random pests in Hawaii)

Pathogen signs

We can use pathogen signs to help us make a diagnosis. Sometimes a microscope and training are needed.

- Fungal spores/mycelium on leaves (rusts, mildews)
- Nematode bodies (root knot diseases)
- *Pythium* oospores within roots (root rot)
- *Rhizoctonia* mycelium on roots
- Sclerotia on plant tissues
- Bacterial streaming from stem tissue

Evidence of pathogens suggests etiology

Remember

It is better to give no diagnosis than to give a wrong diagnosis. Be certain of what you provide.

A wrong diagnosis creates a cascade of misinformation within the user population.

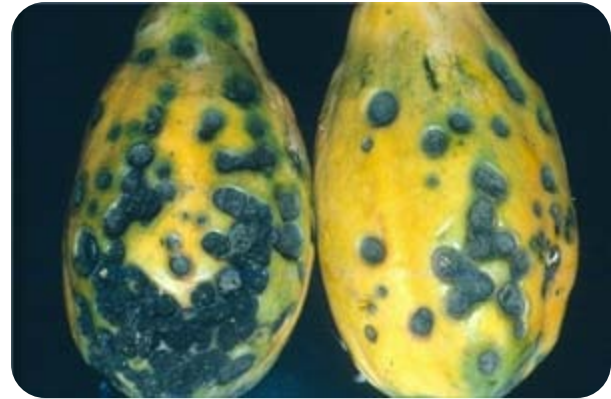
A wrong diagnosis results in potentially incorrect management practices and wasted money and effort, and can result in lost plants and confidence in CTAHR.

Do not think that any diagnosis is a good diagnosis. Swallow your pride and say “I don’t know.”

Disease management

Disease management: principles/tactics

- Avoidance
- Protection
- Resistance
- Therapy
- Chemical methods
- Physical methods
- Cultural practices
- Modifying the environment
- Exclusion (quarantine)
- Eradication
- Sanitation



Knowing the disease can help you manage it

Breaking Plant Disease Cycles

- Pathogen dispersal (liberation, flight, landing)
- Inoculation and penetration
- Disease and symptom development
- Pathogen reproduction
- Pathogen survival

A plant disease cycle can be broken at any step

Integrated management practices

“quality control from the field to the shelf”

Field practices:

- Leaf removal (diseased leaves, sanitation)
- Deflowering (of individual fingers)
- Bunch spray (to reduce insect and mold)
- Bagging and Tagging
- On-time harvest
- Careful handling & transport to packing house

Packing house practices:

- Good packing house hygiene
- Hang bunches in shade over night to cool
- Careful de-handing (clean cuts)
- Washing
- Drying
- Packing
- Storage (refrigerated), shipping (prompt)



Bunch of bananas

Suppressing the disease agent

- Sanitation: A crop residue destruction practice that reduces the pathogen's ability to reproduce or to survive.

Example: Banana cultivation practices for disease control

- a) “De-trashing” to control black leaf streak disease
- b) Rouging infected plants to control banana bunchy top disease
- c) Culling diseased fruits after harvest

Management of plant-parasitic nematodes

Prevention: Sanitation, clean equipment, discard infected plants or propagules, hot water dips, nematode-free potting media

Land management and cultural practices: fallow, cover crops, crop rotation, manuring, removal and destruction of infected plants, use of trap crops, use of antagonistic crops, use of plant nutrition.

Biological control

Host plant resistance

Host plant tolerance

HPIRS:

Hawaii Pesticide Information Retrieval System

We can teach clients how to use this site for them to search for pesticides which are labeled for use on their crop, as Master Gardeners are discouraged from dispensing pesticide recommendations.

For assistance or information,
please contact:

Scot C. Nelson
snelson@hawaii.edu
(808) 969-8265

Thank you!