

2006 Maui Organic Workshop

Organic Approaches to Plant Disease Management

By

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Outline

- Organic disease control practices before planting
- Organic disease control practices at planting
- Organic disease control practices after planting

I will give examples, but cannot cover all crops.
You can extend the principles to your own
crop/system.

Examples: Banana, kava, noni, coffee, papaya



Limitations of organic disease control

Reliance on organic pest control products probably won't save you. It is very difficult to control many plant diseases using sprays or applications of organically-approved products intended for pest control.

Brain and brawn are your best options. It is much better to take a systems approach to managing the crop to minimize plant diseases. This usually means the a lot more planning and human labor are required.

“BUILD THE SOIL”



Organic Practices – Before Planting

1. **Site Analysis** – data can save you
2. **Crop selection** – must be suited for the location
3. **Cropping method**
4. **Plant spacing** – can make or break an epidemic
5. **Site preparation**
6. **Composting** – building the soil is most important
7. **Planting material** – disease free, resistant or tolerant



Choice of Cropping System

- **Monocropping** favors the development of plant disease epidemics.
- **Multicropping, polycropping or agroforestry** systems can greatly reduce the impact of plant diseases.



Host: *Carica papaya*

Disease: Phytophthora blight

Pathogen: *Phytophthora palmivora*

- Proximity of adjacent plants increases the chance of infection from spores produced on neighboring plants, and increases the power of the pathogen population to adapt to the host and to the environment.



Left: Spraying of the fruit columns with fungicides is done 25 or more times per year.

Right: Symptoms of the disease on papaya fruits





Often times land is cleared of forest to plant papaya and after an epidemic occurs, the land is abandoned

Aerial view of a papaya monocrop papaya field that was devastated by *Phytophthora* blight in the Puna district on the island of Hawaii (The Big Island).



Polycropping methods - Micronesia

Agroforestry-type cultivation



Breadfruit, banana, taro, yam, papaya, cassava, noni, kava

Pest pressure: very low,
sustainable without much input

Intercropping-type cultivation



Banana, taro, cassava, sweet potato

Pest pressure: moderate

More intensive effort to control weeds
and pests, some clearing required

Yields: higher than agroforestry setting



Early shot hole epidemic on Big Island



First Kava monocrop on Molokai in 2001



Loss of kava crop due to shot hole



Kava dieback

Monocropping of kava in Hawaii led to the development of severe epidemics of kava dieback and shot hole than were unheard of before in Hawaii.

Site Preparation

- Careful site preparation can reduce disease problems associated with poor drainage.

Example: root crops such as kava can benefit greatly from thorough soil tillage (subsoil “ripping”) and hilling. This will reduce the incidence and severity of Pythium root rot (caused by *P. splendens*)



Site Preparation (continued)



Please don't scrape ... Incorporate!



Organic Practices – At Planting

- 1. Weed control**
- 2. Planting method and Fertilizer**
- 3. Irrigation**
- 4. Pest portfolio – understand life cycles and diseases**



Correct Problem Diagnosis

- Plant disease problems can be difficult to diagnose correctly.
- Correct diagnosis is necessary for best management of the crop.



Types of plant 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 (chemicals, drought, flooding, nutritional deficiency, physiological problems, etc.)

Develop a pest portfolio



Phytophthora diseases: root rot

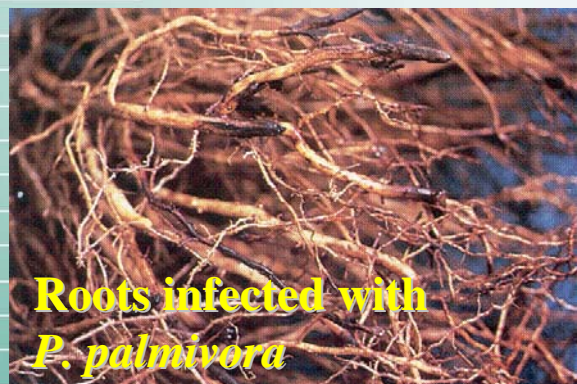


**Phytophthora root rot
on *Howea forsterana***

SYMPTOMS: plant stunting, chlorosis, wilting and death; black, soft and discolored roots; leaf scorch.

CAUSE: *Phytophthora* spp.; *Pythium* spp.

CONTROL: water management; good drainage; rogue diseased plants; clean plants and seed source; clean nursery sanitation.



**Roots infected with
*P. palmivora***



**Root cortex strips off
easily**

Collecting Plant Disease and Insect Pest Samples for Problem Diagnosis

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<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-14.pdf>



Examine the entire plant for symptoms

- *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 itself in the roots, but especially in the foliage (wilting, yellowing, etc.).

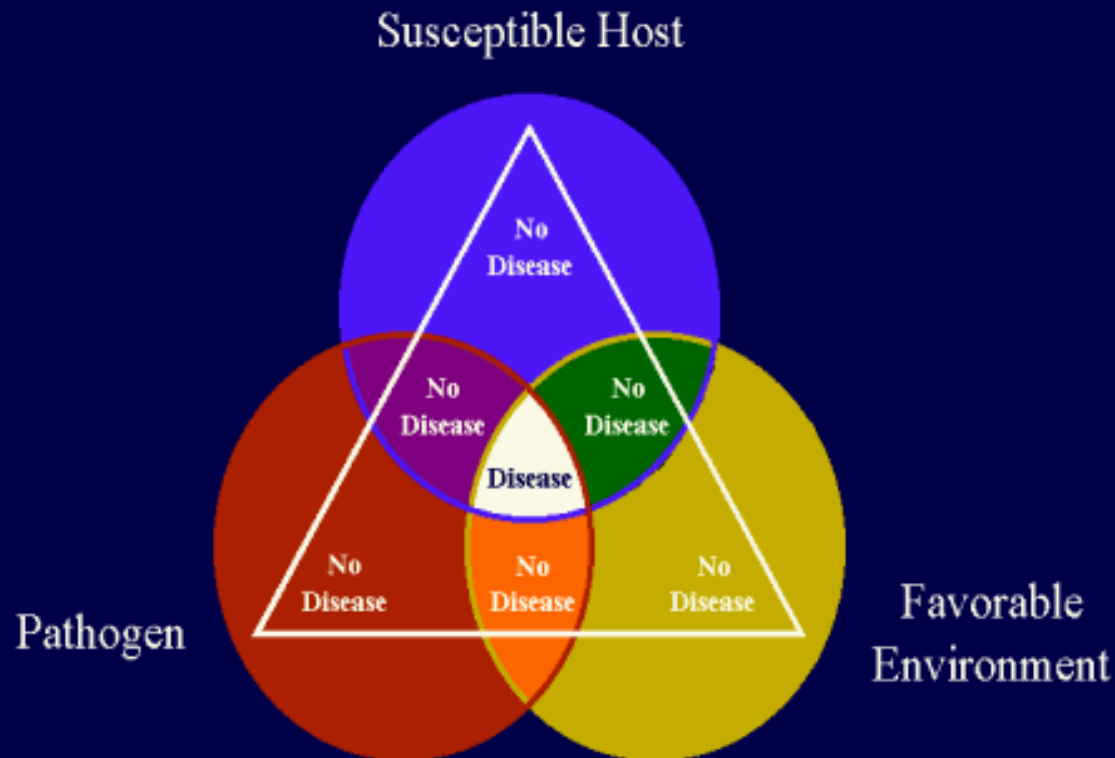
I generally consider root health first.



Plant Diseases

The Disease Triangle

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Organic Practices – After Planting

1. Scouting & record keeping
2. Cultural practices
3. Sanitation
4. IPM
5. Use of approved pest control products
6. Fertility and Irrigation management
7. Beneficials
8. Breaking disease cycles
9. Crop rotation, fallow



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



Fallowing example: banana



Toppling of banana plants is associated with high populations of **root-knot nematodes**. Fallowing of the field every 5 years or so can reduce the problem.



Best bunch 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

Banana Bunch management in the FIELD:

- ✓ Leaf removal: minimizes fruit injury
Remove leaves that rub against bunches
Remove severely diseased leaves (de-trashing)
- ✓ Deflowering: reduces incidence of fungus and insect attack; reduces abrasion injury on fruit skin.
- ✓ Bunch spray (insecticidal soap, BT, etc.) reduces pest and disease damage (moth, thrips, sooty mold, etc.)
- ✓ Field sanitation: reduces insect and pathogen populations
- ✓ Bagging and Tagging: protects bunch; ensures on-time harvest of cohorts
- ✓ Good cultural practices (weed, pest, disease management, drainage, fertility, pruning, plant spacing, etc): ensures healthy, consistent fruit
- ✓ Careful harvesting, handling & transport to packing house: minimizes fruit injury and bruising.



De-flowering

Female flowers are plucked twice per week
Each bunch is plucked 1-2 times

Flowers are plucked soon after they open up,
while they are still fresh.

Tools: ladder, gloves

After plucking is complete, male flower is cut
off & bunch is sprayed and bagged & tagged
with colored ribbons.

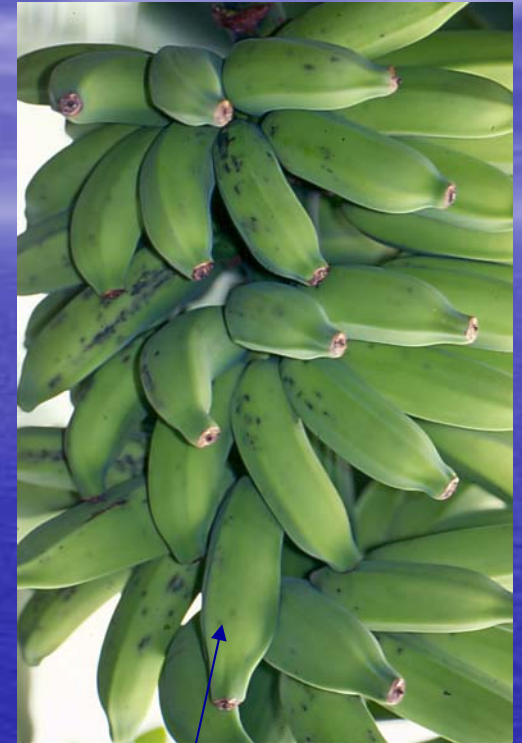
Bagging and Tagging

Bagging is done once per week

Perforated polyethylene sleeves

Tied at top and bottom

Tagged with bi-colored ribbon



Bagging minimizes sooty mold, insect damage and abrasion injury to fruits.

**Identify plants at critical stage of development
and mark the pseudostem with the date**



A simple alternative to Bagging and Tagging

Good cultural practices



Pruning on a regular basis removes unwanted or suckers, keeps production mats in optimum condition, saves fertilizer, reduces pest and disease



Pruned field



Banana Black Leaf Streak: caused by the fungus
Mycosphaerella fijiensis

- Ensure good drainage, air circulation
- Pruning and detrashing (weekly removal of leaves having > 50% disease)
- Maintain good plant nutrition – strive for at least 10 green leaves at flowering



Bunch management in the PACKING HOUSE:

- ✓ **House hygiene:** minimizes pest and disease; keep packing area clean and free of trash and banana debris
- ✓ **Hang bunches overnight:** allows fruit to cool, reach uniform temperature before dehanding, grading, washing & packing.
- ✓ **Careful de-handing:** minimizes rot of cut ends; use sharp, clean knife and make even (not ragged) cuts.
- ✓ **Washing:** removes sap stains and superficial insects and fungi (water, soap, 0.5 to 1% bleach).
- ✓ **Drying:** air-drying after wash allows dry fruits to be packed (less chance of fungal rots or diseases).
- ✓ **Packing:** sturdy, well-ventilated boxes; careful placement of bunches; use of plastic liner.
- ✓ **Storage, shipping:** depends on market and ripening process.

Cigar-end rot



SYMPTOMS: Dark brown to black tip rot; pulp characteristically dry and fibrous; gray and powdery spore masses occur on lesions.

CAUSE: The fungus *Verticillium theobromae*.

CONTROL: Frequent removal of dead flowers followed by bagging of bunches with perforated polyethylene sleeves; remove bracts and dead flower parts that accumulate in bags a few weeks after bagging; field sanitation for fruit spot control; packinghouse sanitation; cull infected fruits before placing them in the washing tank; fungicide sprays may be necessary during severe epidemics.

Principles of Plant Disease Management

- **Exclusion** – prevent entry and establishment
- **Elimination** – removal or reduction of pathogen
- **Avoidance** – alter time and place of cultivation
- **Protection** – treat the plant to prevent infection
- **Resistance** – use plants genetics to limit infection and disease development
- **Therapy** – curative measures to limit pathogen



Disease Prevention

- Prevention is the best approach to plant disease control when using organic cultivation methods.
- Prevention may involve suppressing the disease agent or avoiding the disease.
- Utilizing as many disease-prevention practices as possible will ensure the best possible control.



Suppressing the Disease Agent

- Rotation

Vegetables from different family groups should be rotated because they are usually not susceptible to the same disease organisms.



The groups listed below should be rotated so a selection from one group is not planted in the same location more than once every 2 to 3 years or production cycles.

GROUP A	GROUP B	GROUP C	GROUP D	GROUP E	GROUP F
Cantaloupe	Brussels	Eggplant	Beet	Sweet	Bean
Cucumber	Sprouts	Irish	Carrot	Corn	Cowpea
Honeydew	Cabbage	Potato	Garlic		Pea
Melon	Cauliflower	Okra	Onion		
Pumpkin	Collards	Pepper	Shallot		
Squash	Lettuce	Tomato	Sweet		
Watermelon	Mustard		Potato		
	Radish				
	Rutabaga				
	Spinach				
	Swiss Chard				
	Turnip				



Suppressing the Disease Agent

- Organic Matter increases the number and kind of microorganisms in the soil.
- Many of these microorganisms compete with disease agents for nourishment.
- In most cases, the best organic matter is obtained by turning under a green cover crop, such as a small grain (wheat, oats, barley, cereal rye) or a legume.



Suppressing the Disease Agent

- Resistant or tolerant varieties

Sometimes the use of a resistant or tolerant variety is the only way a farmer can grow a crop successfully in a given environment.

Example: banana bunchy top disease and the cultivation of “Dwarf Apple” (tolerant) versus Cavendish varieties (intolerant).



Suppressing the Disease Agent

- **Sanitation:** Any crop residue destruction practice that reduces the disease agent's ability to reproduce or overseason could be included under sanitation.

Example: Banana cultivation

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



Suppressing the Disease Agent

- Fallowing: Leaving land idle and clean for a period of time. This can be especially important to reduce numbers of soilborne parasites such as root-knot nematodes.

Example: Root-knot nematodes on vegetables, coffee, banana, taro.



Example: Control of Plant Parasitic Nematodes

- **Prevention**

Prevent the spread: Sanitation, clean equipment, discard infected plants or propagules, hot water dips,

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

- Biological control
- Plant resistance
- Plant tolerance

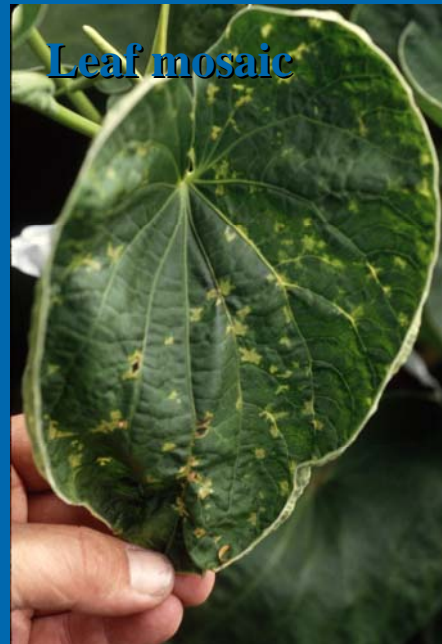


Suppressing the Disease Agent

- Weed control: Weeds harbor insects and serve as hosts for many virus diseases.

Example: Kava dieback caused by cucumber mosaic virus (CMV) and *Commelina diffusa* (honohono grass).





'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



IPM for 'Awa Dieback

- 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

Mahalo!

a copy of this presentation will be available at

- <http://www.ctahr.hawaii.edu/nelsons/MauiOrganic.pdf>