Growing Vegetables
Master Gardener Workshop
Kauai
April 10, 2014

Héctor Valenzuela
CTAHR, University of Hawaii at Manoa
hector@hawaii.edu
www.ctahr.hawaii.edu/organic
Join CTAHR Organic Listserv!!

'Science-based' gardening

- **Agriculture is both an ART and a Science**
- **Most of our production practices NOT based on local research (eg fertilizer rates for tomato, spacing for tomato).**

Food System in United States

- **16% of Gross Domestic Product (GDP)**
- **Employs 1 in 7 Americans (15%)**
- **Food & Fiber industry > $1.5tn**

Vegetable Industry World

- **1st. China**
- **2nd India**
- **3rd United States**

Vegetable Industry: United States

- **$ 20 billion**
- **> 7 mn Acres**
- **> 65 million tons**

Top Producing States

- **California**
- **Florida**
- **Texas**

Vegetable Industry

- per capita consumption, 422 lbs (2011) *(increase > 64 since 1970),*
- Imports- 23% of domestic consumption
- Food consumed away from home, 42% of all expenditures
- Processing- over 50% by volume
- Organic acreage, increased by 81% since 1977 (2% of total)

Industry Trend-- Consumers looking for:

- **local -** the 'hottest' segment of ag industry (USDA, 2010)
- organics
- grow your own
- Novelty
- Convenience (packaging)
- Taste
- Eye appeal
- Nutrition
- Health Benefits

Hawaii: Industries in Transition

Hawaii Vegetable Industry

- $80-90 million? (was $38 m in 1990)
- ca. 8,000 Acres
- ca. 800 farms
- 34% market share (66% imported)
- value of home-gardening??

High Volume Vegetables

Head cabbage,
head lettuce,
bulb onions, potatoes,
tomatoes,
watermelons

Specialties: Market Saturation

- Bittermelon
- Burdock (gobo)
- Cabbage
- Daikon (white radish)
- Green Onion
- Parsley
- Radish
- Watercress

Top Industry Priorities

- Pests and Diseases
- Marketing
- Resources (land, water, capital)
- Environmental Regulations

Energy
Pesticides
Fertilizers
Soil

Problems with Conventional Ag

- Soil Fertility decline
- Environmental damage
- Health hazards in food
- Reduced food quality
- Energy-intensive
- Costly to society (hidden-costs)

Solutions: sustainable agriculture, ecological agriculture, Integrated Pest Management

Overall goal of Cultural Management Program

To Establish Ecological Balance in the garden

- Internal Nutrient Cycles
- Natural Pest Control, biocontrol
- Water conservation

Key growing practices

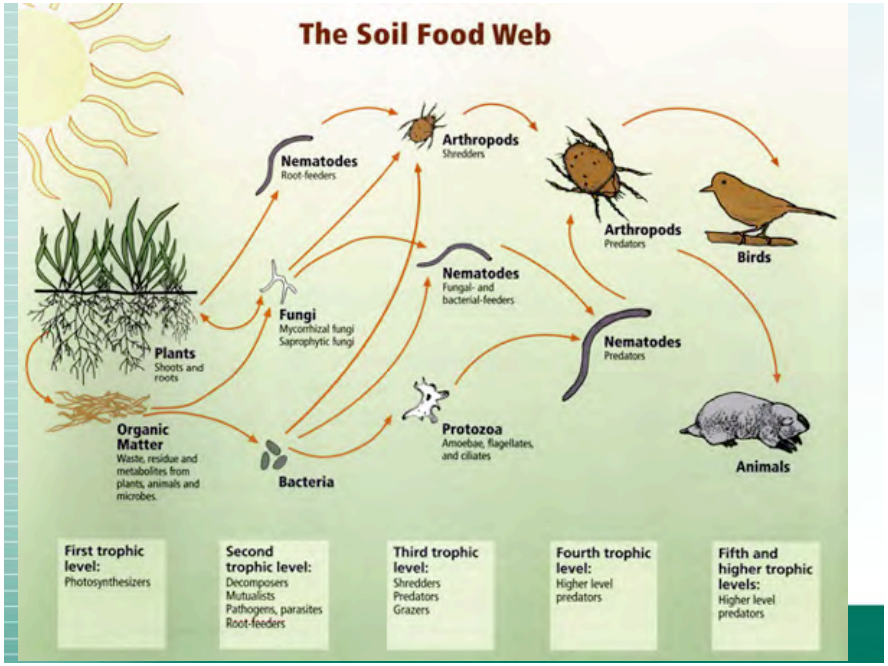
- Crop rotations
- Cover Crops, green manures
- Composts & organic mulches
- Crop and variety selection (adapted to the area)
- Saving Seed
- Crop diversity
- Goal: biocontrol, nutrient cycles, family balance

Organic or alternative agriculture

Prevention

Recycling

Know your soil

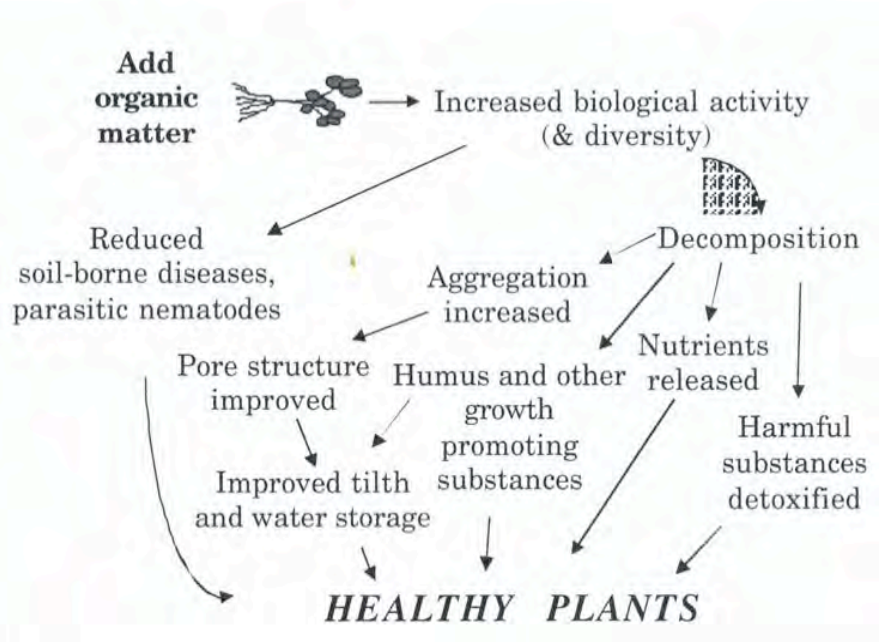


Microbial biomass in temperate grassland soils

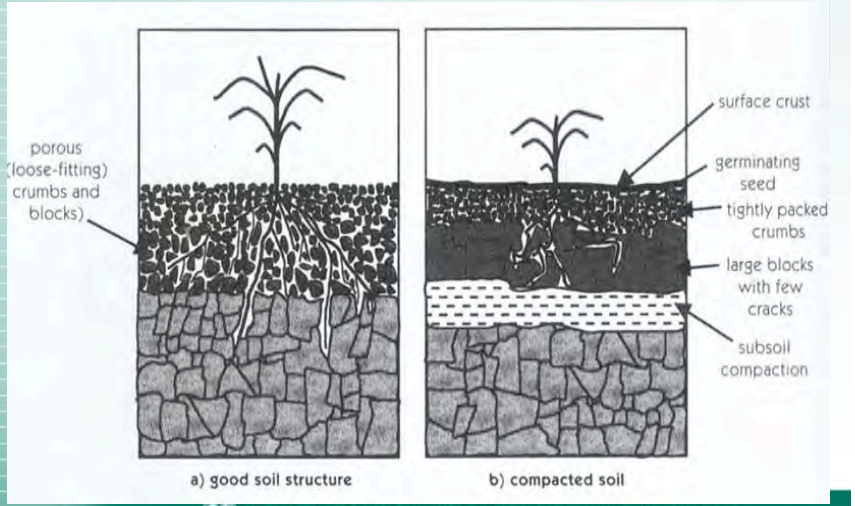
Component of soil biota	Biomass (t ha^{-1})
Plant roots	up to 90 but generally about 20
Bacteria	1–2
Actinomycetes	0–2
Fungi	2–5
Protozoa	0–0.5
Nematodes	0–0.2
Earthworms	0–2.5
Other soil animals	0–0.5
Viruses	negligible

Organic Matter

- Soil Physical Condition
- Tilth- easy to work the soil
- Water infiltration
- Reduced Erosion
- Plant Nutrients

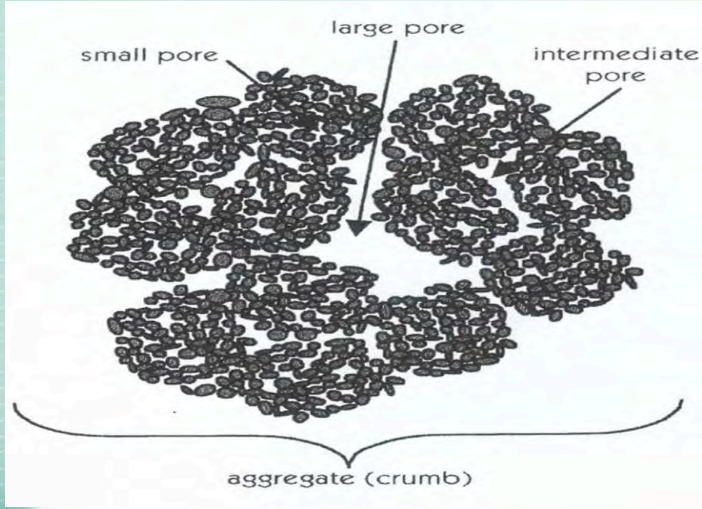


Soil Compaction limits root growth



Soil with ideal loamy texture but hard-pan below

Soil aggregate



Paddy Rice microbial activity

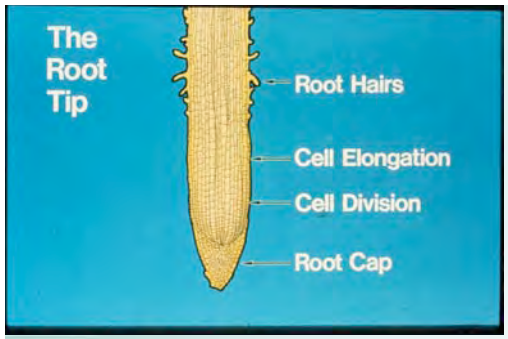
- Total microbial count was 2 bn cells g^{-1} soil (dry weight). (Bai et al., 2000).
- Another study bacteria count: 250 mn cells g^{-1} soil (dry weight) (Chin et al, 1999)

Paddy rice- Species recorded, 1-yr survey on one farm in Thailand

Sarcodina	31	Cyanobacteria	11
Ciliata	83	Algae	166
Rotifers	50	Pteridophyta	3
Platyhelminths	7	Monocotyledon	25
Nematoda	7	Dicotyledon	10
Annelida	11	Pisces	18
Mollusca	12	Amphibia	10
Arthropoda	146	Total	560

Biological Diversity on paddy rice

"The natural diversity of meso- and microbial populations has almost certainly contributed to the long-term sustainability of rice farming."



Rhizosphere Biodiversity
Ratio of numbers found in Rhizosphere vs Bulk Soil

Bacteria	23
Actinomycetes	7
Fungi	12
Protozoa	2
Algae	0.2
Ammonifiers	125
Denitrifiers	1260

(Osorio Vega, 2007)

Rhizosphere Biodiversity
Bacteria found in Rhizosphere vs Bulk Soil

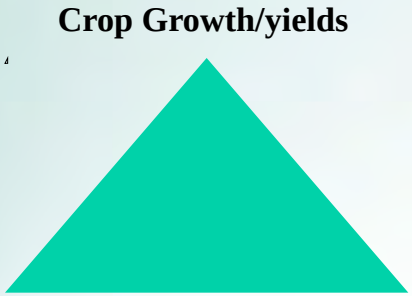
	Rhizoplane	R-sphere	Bulk
Red Clover	3844	3255	134
Oats	3588	1099	184
Flax	2450	1015	184
Wheat	4199	710	120
Corn	4500	614	184

(CFU x 10^6/g soil; Osorio Vega, 2007)

Nutrition

- Primary Nutrients
- Secondary Nutrients
- Micronutrients

Triangulation method to monitor fertility of your soil



Liming Acid Soils

- Lowers Al and Mn toxicity
- Increased Microbial Activity
- Prevents Ca and Mg Deficiencies
- Increased symbiotic Nitrogen fixation
- Increased Phosphorus/Molybdenum

Optimum soil pH

- Tomato- 6-6.5
- If pH below 5.8
  apply ag lime (5 lb 100 sq ft)

Calcium deficiencies

- Blossom end-rot
- Tip-burn

Calcium deficiency can result from:

- Excessive salts in the soil solution (such as from potassium, sodium, ammonium fertilizers)
- Excessive Nitrogen, foliage
- Uneven watering, growth

Boron Deficiency

Manure applications

- 20,000 lb/Acre
- 300 lb/100 ft (10 x 10 ft)
- 1 lb/hill chicken manure

Fertilizer Application Rates

- 1,500-2,000 lbs 10-20-20
  or 16-16-16
- = 25 lbs per 100 ft row
- = 2-3 lbs/10 ft row

If soil analysis shows high P and K

Then add fertilizers with no P and K, such as Ammonium Sulfate, or Calcium Nitrate

Timing of Applications

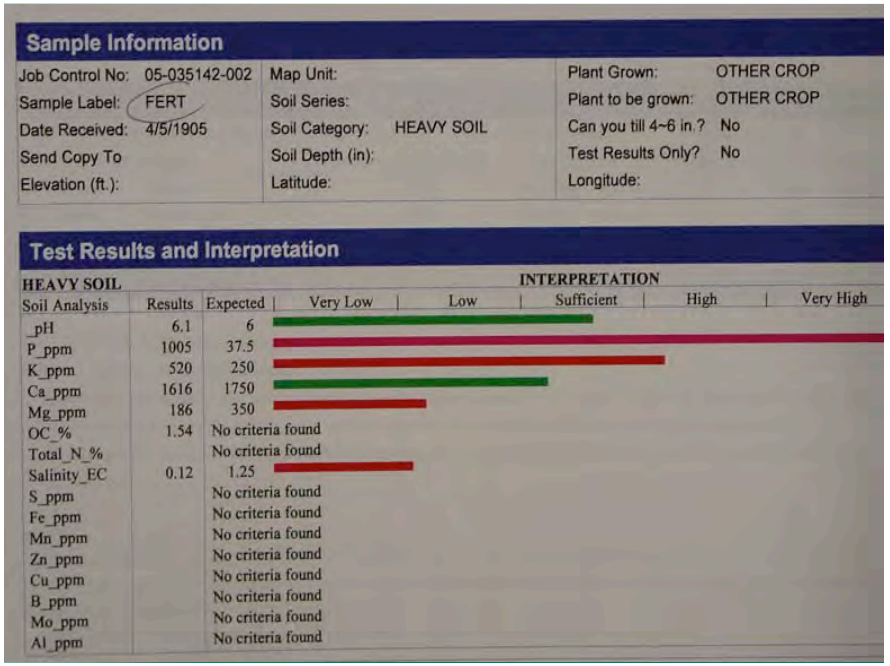
- 50% at planting (PK)
  50% 4 weeks later (NPK)
- 50% at planting
  25% 4-weeks later
  25% 4-6 weeks later

Tomato Fertility

- 10-20-20
  (ca 2-3 lb/10 ft)
- 100 lb/Acre Urea 3-4 weeks after 1st harvest
  (ca 0.15 lb
  or 2.5 oz/10 ft row)

Nitrogen sources

- N fixation
- OM amendments
- Dried blood (12-14%)
- Fish meal (8-10%)
- chicken manure (1.5-3%)
- Seabird guano, fish powder



Sample Information

Job Control No:	05-035142-002	Map Unit:		Plant Grown:	OTHER CROP
Sample Label:	FERT	Soil Series:		Plant to be grown:	OTHER CROP
Date Received:	4/5/1905	Soil Category:	HEAVY SOIL	Can you till 4~6 in.?	No
Send Copy To		Soil Depth (in):		Test Results Only?	No
Elevation (ft.):		Latitude:		Longitude:	

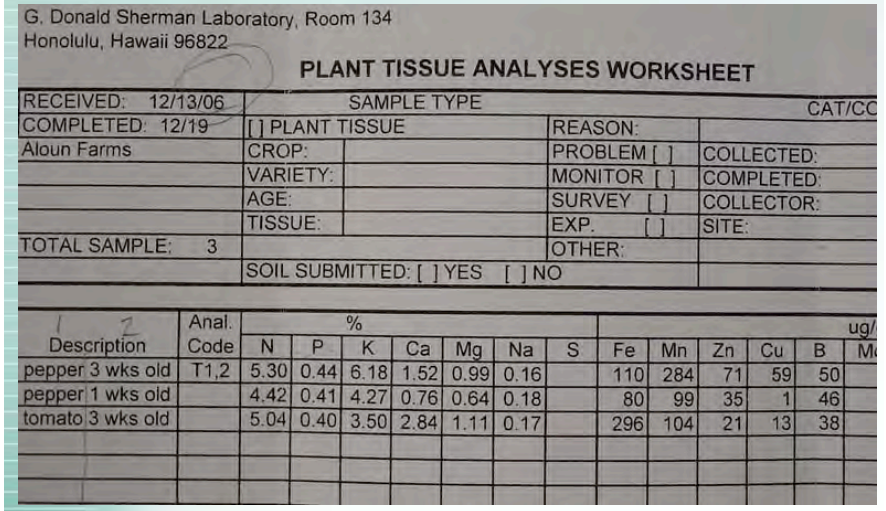
Test Results and Interpretation

HEAVY SOIL

Soil Analysis	Results	Expected	INTERPRETATION
			Very Low | Low | Sufficient | High | Very High
_pH	6.1	6	
P_ppm	1005	37.5	
K_ppm	520	250	
Ca_ppm	1616	1750	
Mg_ppm	186	350	
OC_%	1.54	No criteria found	
Total_N_%		No criteria found	
Salinity_EC	0.12	1.25	
S_ppm		No criteria found	
Fe_ppm		No criteria found	
Mn_ppm		No criteria found	
Zn_ppm		No criteria found	
Cu_ppm		No criteria found	
B_ppm		No criteria found	
Mo_ppm		No criteria found	
Al_ppm		No criteria found	

Adequate Soil Nutrient Levels

- P= 35-50 ppm
  >300 for veggies?
- K= 200-300
- Ca= 1500-2000



G. Donald Sherman Laboratory, Room 134
Honolulu, Hawaii 96822

PLANT TISSUE ANALYSES WORKSHEET

RECEIVED: 12/13/06	SAMPLE TYPE		CAT/CC
COMPLETED: 12/19	[ ] PLANT TISSUE	REASON:	
Aloun Farms	CROP:	PROBLEM [ ]	COLLECTED:
	VARIETY:	MONITOR [ ]	COMPLETED:
	AGE:	SURVEY [ ]	COLLECTOR:
	TISSUE:	EXP. [ ]	SITE:
TOTAL SAMPLE: 3		OTHER:	
	SOIL SUBMITTED: [ ] YES [ ] NO		

Description	Anal. Code	% N	P	K	Ca	Mg	Na	S	ug/ Fe	Mn	Zn	Cu	B	Mo
pepper 3 wks old	T1,2	5.30	0.44	6.18	1.52	0.99	0.16		110	284	71	59	50	
pepper 1 wks old		4.42	0.41	4.27	0.76	0.64	0.18		80	99	35	1	46	
tomato 3 wks old		5.04	0.40	3.50	2.84	1.11	0.17		296	104	21	13	38	

Tomato Tissue Levels

N= 4.5%
P= 0.7
K= 5%
Ca= 3%
Mg= 1.2%

Nutrient uptake rate patterns

Phosphorus

Heavy Users- cool season veggies
Moderate Users- warm season veggies

Potassium

Heavy Users- leafy crops,
root crops (carrots, celery)

Nitrogen

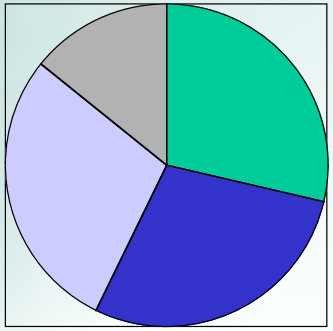
Heavy Users- cole crops,
carrots, onions, sweet corn

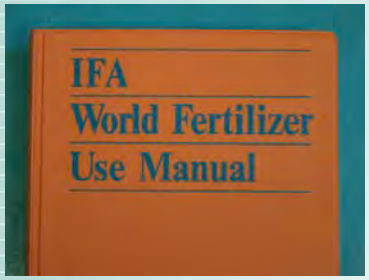
Moderate Users- fruit veggies,
smaller leafy crops

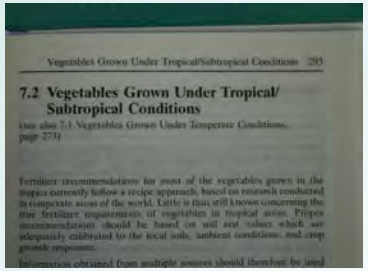
Nutrient budgets

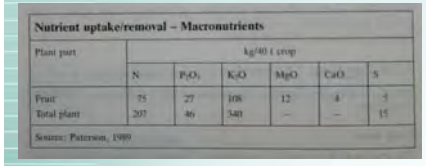
- Estimates of nutrients inputs and outputs on the farm
- Nutrient outputs- Harvested product, residues
- Inputs:
  * already present in the soil
  * organic amendments
  * legumes and cover crops
  * root exudates and depositions (20-40% of Pn)
  * high N side-dress applications

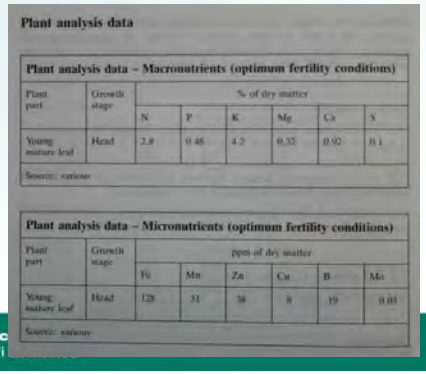
Example of N Inputs (120 lbs/Acre N)







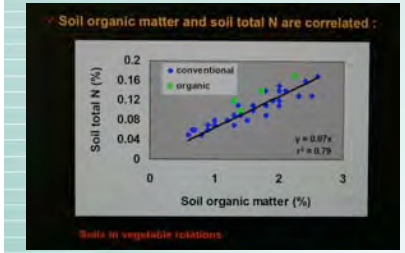




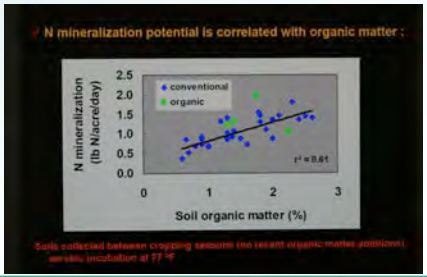
Organic Matter

- 30 to 50 pounds of N per acre for each 1% soil organic matter content (100 days)
- = about 0.3-0.5 lbs Nitrogen/Acre per day per foot of soil, 1%OM
- Also 4.5 to 6.5 lbs P205/Acre

Nutrient mineralization rates



Source: (T.K. Hartz, 2009)



Earthworm Casts

- Production rates of EW casts: ca 250 tons/Acre/year
- Nutrient composition of casts compared to untreated soil:
  - 5x Nitrogen
  - 7x Phosphorus
  - 11x Potassium
  - 2x Calcium

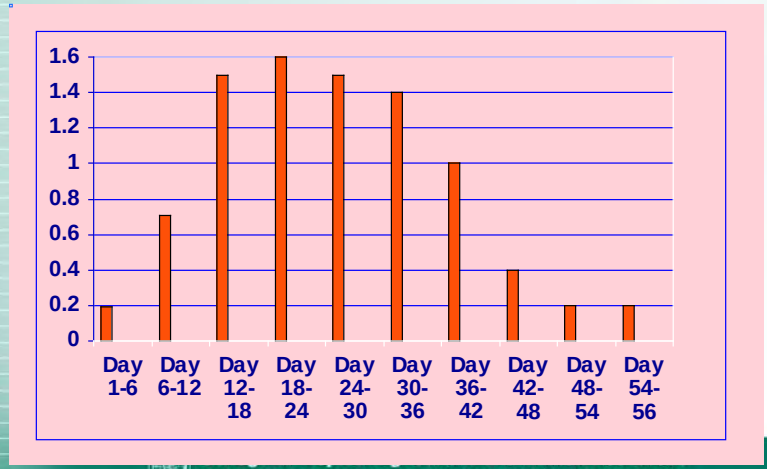
N Contribution by legumes/ cover crops

- Legumes 100-200 lbs/Acre N
- However, less than 50% may become available for the following crop

Compost teas

- low total nutrient contents
- at application of 30 gal/acre
- < 0.1 lbs/Acre of N, P, or K

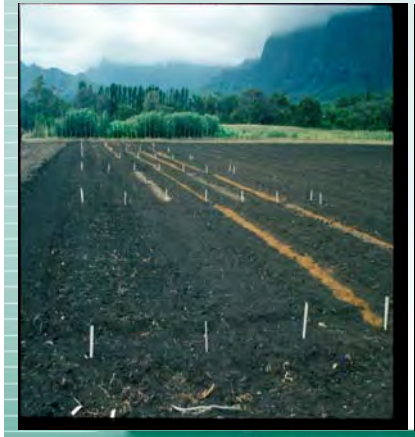
Water use in Squash (60 days)



Watering Schedule

- Irrigate-3x/ week.
- Irrigation schedule according to previous week's Evapotranspiration

Bone meal: Nitrogen, Phosphorus

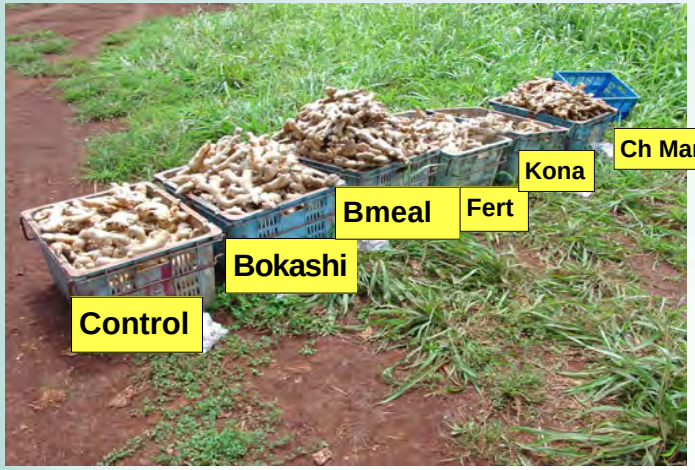


Conditions for composting

C:N Ratio	30:1
Moisture	50-60%
Oxygen []	> 5%
Particle size	1/8-1/2
pH	5.5-9
Temp (F)	130-140

Kona Magic (left)
And Bone meal (right)

Kona Magic (left)
And Bokashi (right)



Fertilizer 16-16-16

Control

Bonemeal

Nutrient analysis of raw materials

	N	P	K	Ca	Mg
Bokashi	3.76	1.03	0.77	2.25	0.24
Bone Meal	10.1	2.74	0.70		

It takes time to establish balance

- 1 acre soil 1 ft deep= 4 mn pounds
- adding 10 tn compost= .005% by wt
- adding 100 tn compost= 0.05% by wt

Bed preparation important for crop establishment




Good soil preparation IS important for root crops

Raised beds for improved drainage

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

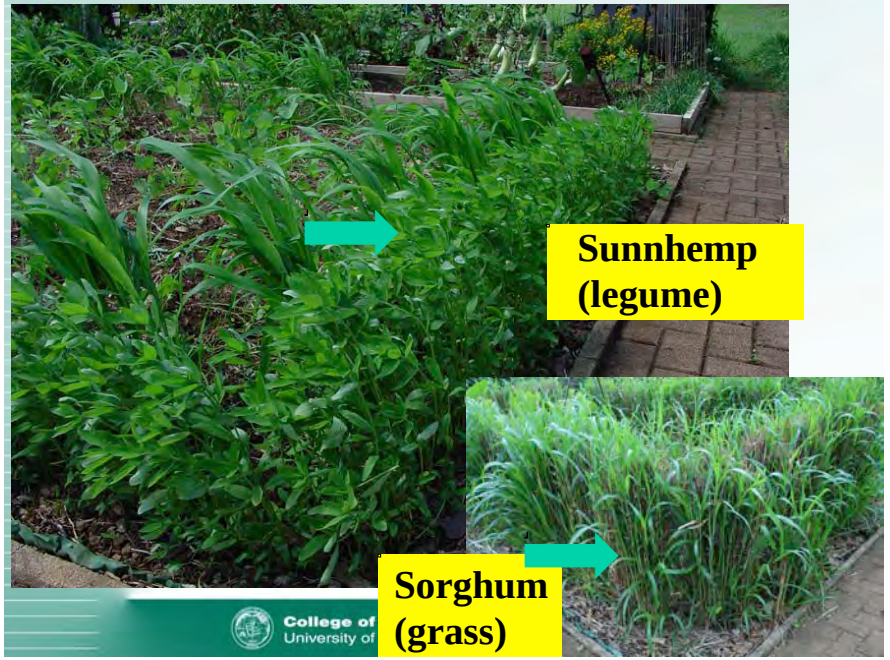
Hector's garden in Manoa

- Minimize soil disturbance
- Variety selection
- Diversify crops

College of Tropi
University of Hawai

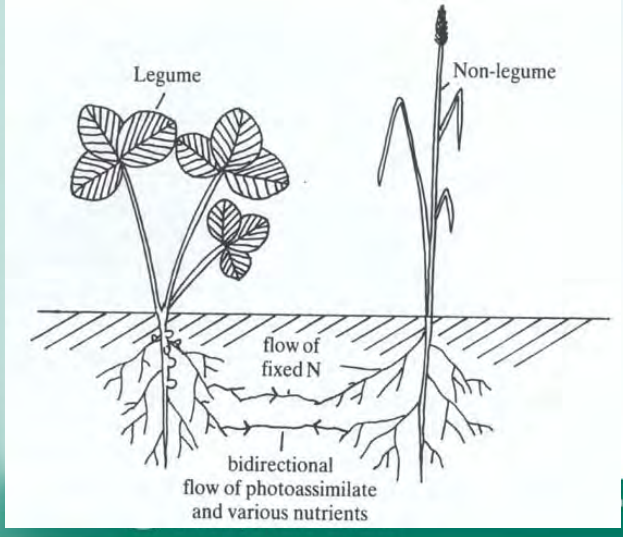
Hector's garden in Manoa

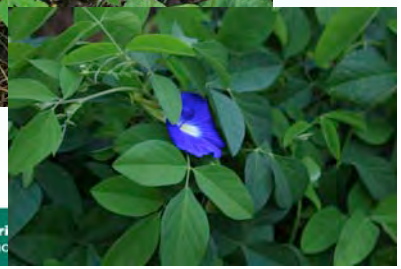
- Protect the Soil
- Grow your own 'fertilizer'
- Barriers against insects



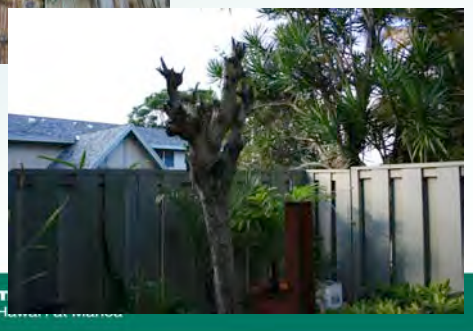
College of
University of

VAM mediated flow of Nitrogen from a legume To a non-legume via hyphal connection of roots



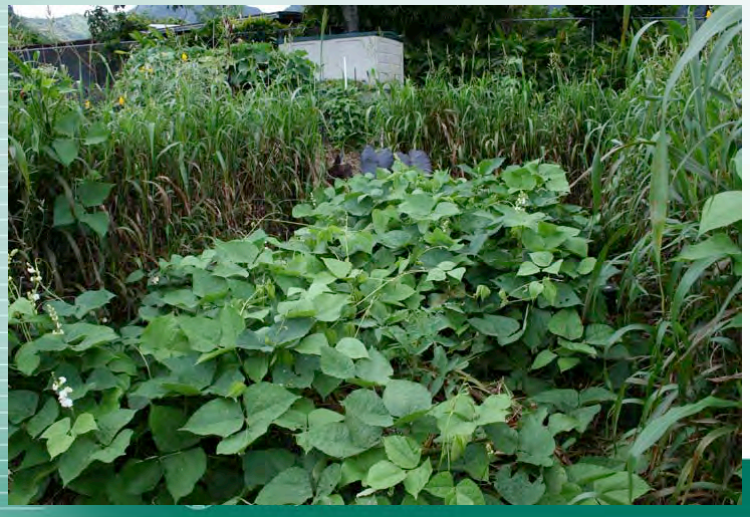


Tropical alfalfa, butterfly pea
Clitoria ternatea



Moringa Tree
malungay

Rotation with green manures
Lab lab bean, cowpea, and mucuna cover crops



Cover crops with cucurbits
Chayote and sweet potato

Cover crops with cucurbits
Chayote and sweet potato

Raised bed with organic mulch around bed

Raised bed with organic mulch around bed

Sugarcane, windbreak & mulch

Comfrey

Lemongrass

Crop Selection

- Crops adapted to your location
- Variety selection
- Select compatible intercrops
- Compatible rotations
- Semi-perennial production??
- Look at vegetable groups

Rooting patterns important to plan **rotations**

Medium rooted crops (20-40 inches)

- cabbage
- carrots
- sweet corn
- cucumber, squash
- eggplant, pepper

Deep rooted crops (>40 inches, 100 cm)

- melons
- okra
- tomato
- snap beans

Crops to get started with Organic Gardening

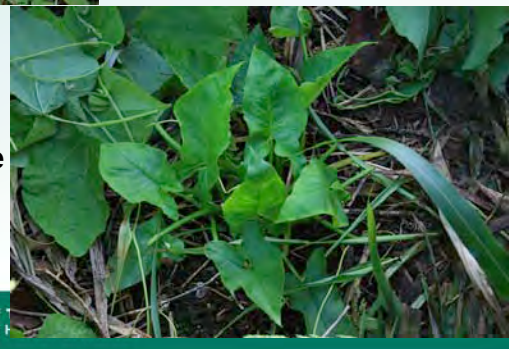
daikon, beets, carrots, eggplant, komatzuna, lettuce, mizuna, okra, gr. onion, soybean, choi sum, spinach, sw. potato, collards, beans, taro

Start with 'easy' crops

Instead of..	Grow---->
• tomatoes--------->	• cherry tomatoes
• bell pepper------>	• chili peppers
• head cabbage--->	• collards, kale
• cuc, zucchini---->	• hyotan, sequa
• potato---------->	• beets, taro, sw potato
• bush beans----->	cassava, yams, jicama
	• yard-long bean

Japanese Parsley
Cryptotaenia japonica

Tahitian taro
Xanthosoma brasiliense



Ung choy
Aquatic sweetpotato
Ipomoea aquatica

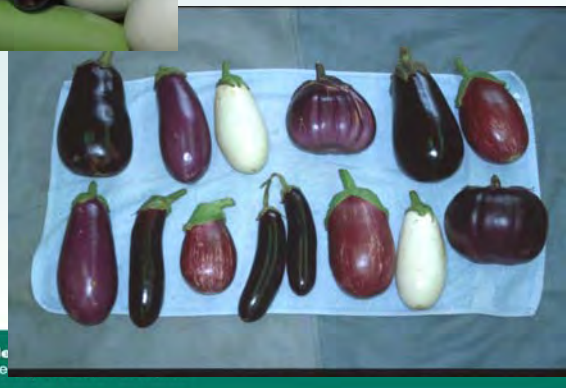
Basil, non-seeding

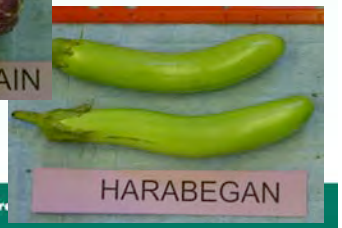
Sequa, hechima,
Chinese okra
Luffa acutangula

Lima beans, trellis
Prune the lower canopy

Taro,
root crops

Jicama, chop suey yam (Pachyrhizus erosus)





Rotate crops between different Groups (exclusion)

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

Slide from: Dr. Scot Nelson UHM

Stand Establishment

To obtain good stands in the field it is critical to start with healthy seedlings.

Stand Establishment

Clean and disease-free planting materials are key for succesful production

Growing Seedlings: Virus free

Starter Fertilizers

- For transplants, seedlings
- 8-24-8; 15-30-40
- use 3 pounds in 50 gallons of water

Kula cabbage seedling, nursery

Commercial Seedling house, Florida

Cuttings, seedlings, or seeds should be free of insects, nematodes, and diseases

Sweetpotato cuttings: clean and select from roots that have uniform shape

Good soil preparation important for root crops

Bed preparation important for crop establishment

Asparagus
10-20 year crop

Stand Establishment
- select male plants
- select healthy one-year old crowns
- proper field prep

Plants will remain in same spot for many years

Floating Cover and mats
Physical barriers to protect soybeans from birds

Trellis system for bell pepper

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University of Hawai'i at Mānoa

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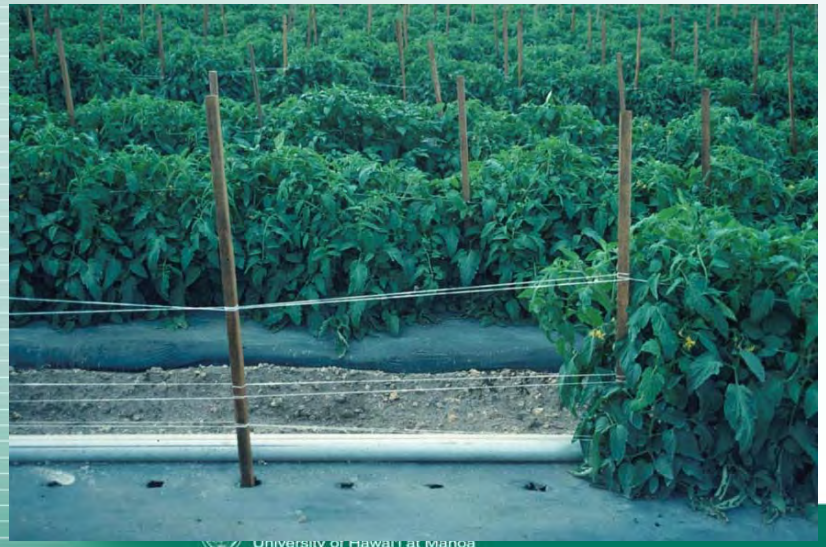
University of Hawai'i at Mānoa

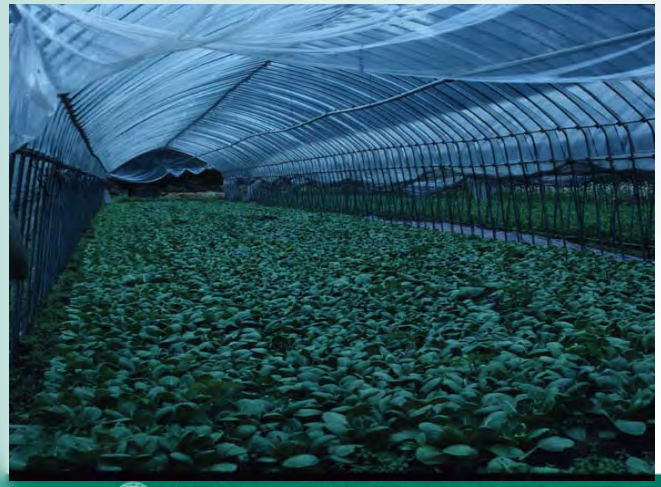
n Resources

Trellis for tomatoes



Greenhouses/rain shelters, Big Island

Rain-shelter for high-value vegetable production



Mini tunnels can also be made with bamboo shoots and covered with straw or other materials

Broccoli in tunnels

Floating Cover Zucchini in Waianae, living mulch experiment

Bees are important for pollination of cucurbit crops

Polycultures, multistory: watermelon/papaya

Polycultures, multistory: watermelon/papaya

Intercropping/diversity between planting beds

Intercropping in Mozambique

Beans- cool side of bed

Corn- full sunlight

Tomato- warm side of bed

Intercropping in American Samoa

Papaya-tomato

Bean-eggplant

Intercropping in American Samoa corn, taro, beans

Intercropping in American Samoa bean trellis, corn

Intercropping at home

Organic Mulches, weed control, water conservation, Cooler soil temperatures, less erosion

Coconut husk and leaf mulch in pineapple

Organic mulch / Plastic mulches

Vegetable Groups based on:

- Botany, taxonomy
- cool or warm season
- uses: leafy, fruit, root
- ethnic, Asia, Filipino, Pacific
- others?

Root Crops

(both cool and warm season)

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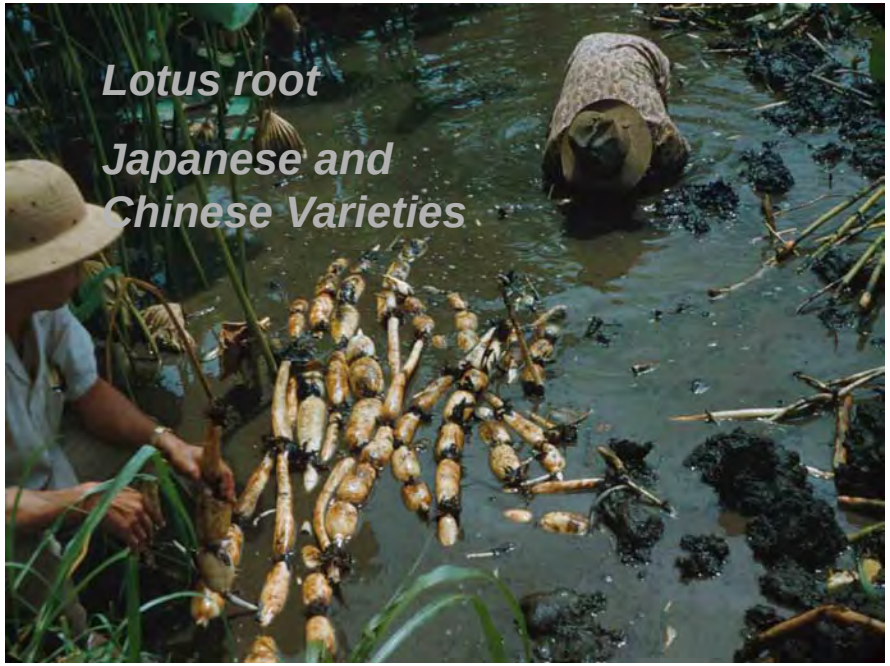
Carrots, Imperial Valley, Calif.

50-95 days

Daikon Korean

40-70 days

Daikon or white radish



Jicama, chop suey yam, potential specialty crop
Pachyrhizus erosus, 3-8 months

Ginger 9-14 months
Chinese and Japanese (smaller, more pungent) varieties

Year 1 low elevation

Year 1 high elevation

Year 2

Year 3

- Planted on March, bottom of furrow
- Hilled 3-4 times
- Harvested Feb. to March of following year
- can harvest young ginger (5-6 months)

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Beets 55-70 d, yams 6-10 mo, potato 90-120 days

Jerusalem Artichoke
Helianthus tuberosus


Cole Crops or Brassica
(cool season)


Pak choi, mustard cabbage
35-45 days


Choi sum
30-50 days


50-125 days
Cool season
CAULIFLOWER
Vacuum-Cooled
ZELLWIN FARMS, CO.
ZELLWOOD, FLORIDA 32798
PRODUCE OF U.S.A.


Mustard cabbage, mizuna
35-50 days

Leafy Crops

(cool and warm season)

70-75 days

Watercress

45 days

Opal basil

30-35 days

Saluyut, Filipino spinach

35-50 days

Leafy Lettuce (40-50 days)

Leafy lettuce cv Magenta

Romaine Top varieties

(65-75 days)

Winter (Poamoho)	Spring (Molokai)	Summer (Poamoho)	Summer (Poamoho)
Ceasar	41-64RZ (2)	Tall Guzmaine (2)	Concept
Jericho (2)	Heavy Hrt	Barracuda	Jericho
41-40RZ	Brave Hrt	Triple Play	Fresh Ht
Lital	Tall Guzmaine	41-64RZ	Green Towers

Romaine cv 41-40RZ (Rijk Zwan)

cv Concept (Johnny's)
(Summer Poamoho)

cv Bamby (Johnny's)
(baby, specialty, cooler?, Waimea)

cv Jericho (Johnny's)

High yields in Spring
High yield but bolting in the summer

Ung choy

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Cucurbits *(warm season)*

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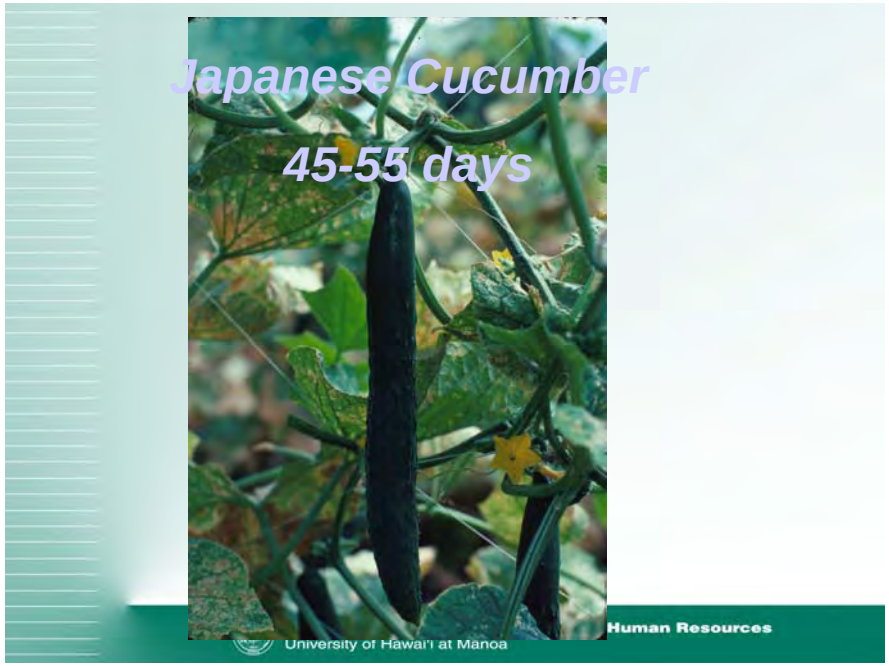
Japanese Cucumber
45-55 days
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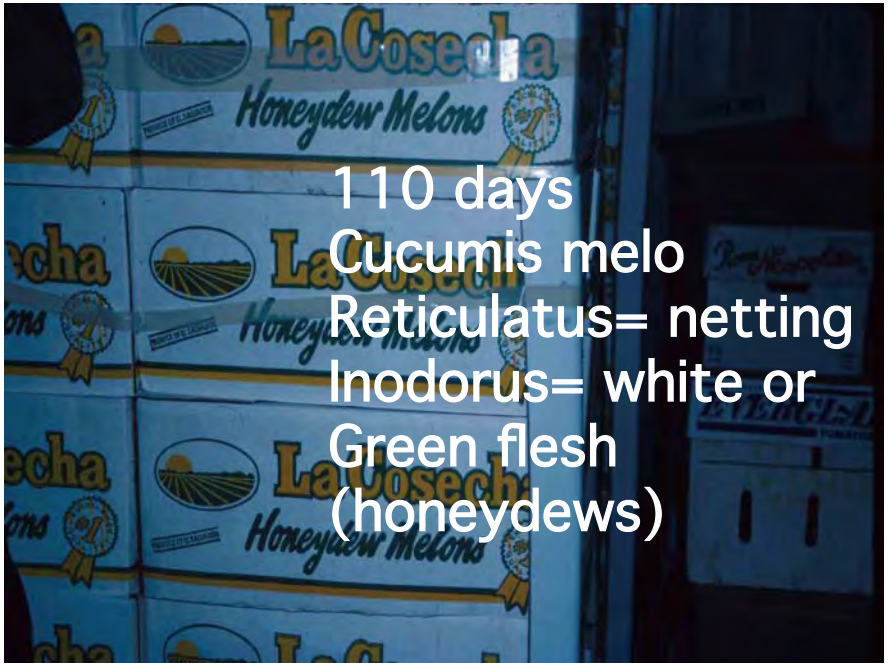
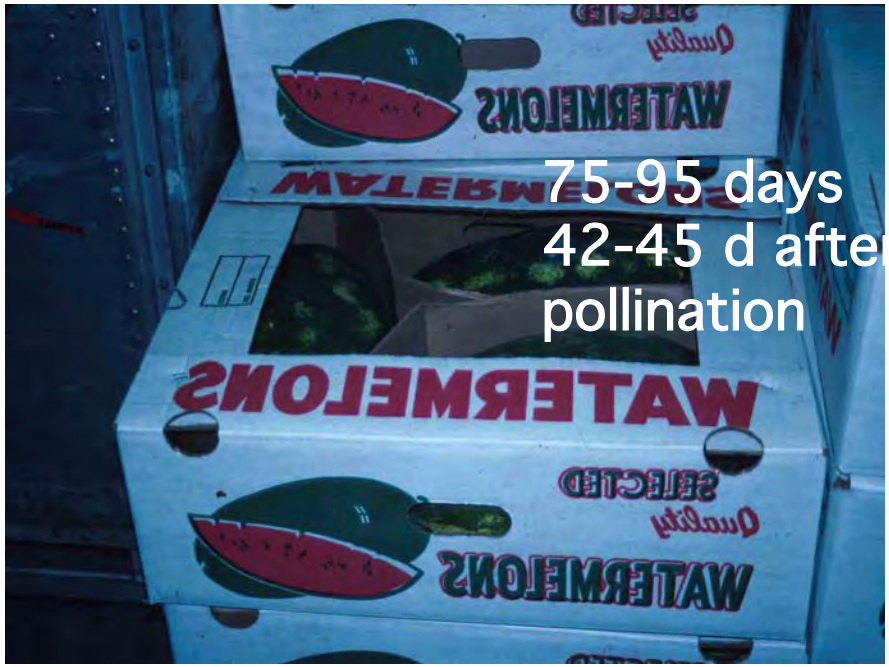

La Cosecha
Honeydew Melons
110 days
Cucumis melo
Reticulatus= netting
Inodorus= white or
Green flesh
(honeydews)


WATERMELONS
75-95 days
42-45 d after
pollination


Seedless/baby Watermelon Cultivar Trial
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100-120 days

Sequa (Hechima)
Luffa acutangula

Onion Family
(cool season)

Sweet onion variety from Israel
150-180 days

Sweet Onion Cultivars

- Mercedes
- Linda Vista
- Chula Vista
- Rio Bravo
- Sweet Dixie

Green onions, 45-60 days,

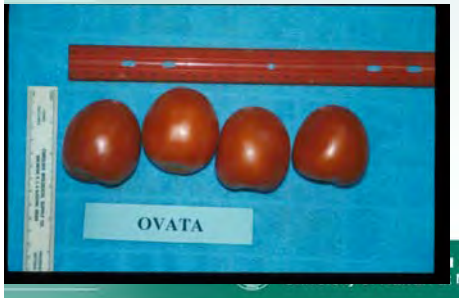
futo-negi (large leaved) 160-200 days, Allium fistulosum

8-10 months
Plant Nov-Feb
Harv. Aug-Sep
Allium chinense
(For pickling)

Shallots, plant Sept. to May, harvest on late summer, Allium ascalonicum
can use immature stage or dry bulb, 75-120

Solanaceous Family

(warm season,
potato= cool season)



Eggplant
50-80 DAT

Bell pepper
65-80 DAT

Jupiter, and open-pollinated variety

65-80
DAT

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Legumes
(cool and warm season)

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Yard long beans
Vigna uncuiculata

40-80 days

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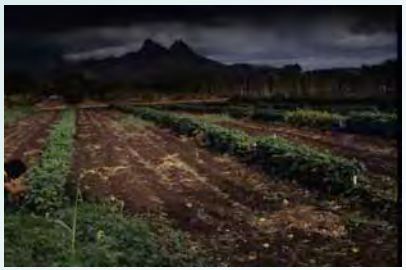
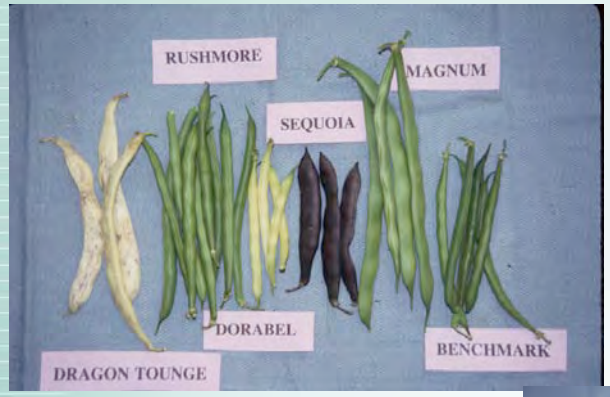
Lima beans, 78-88 days (pole); 65-78 (bush)

Pole beans, Manoa Wonder (60-70 days)

Bush beans (65-75 days)

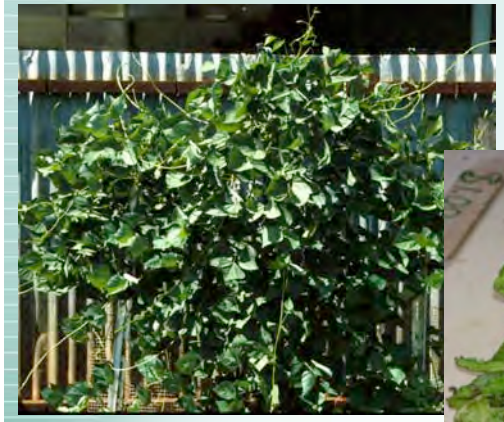




Chinese peas (5-7 days after flowering, 56-75 days)

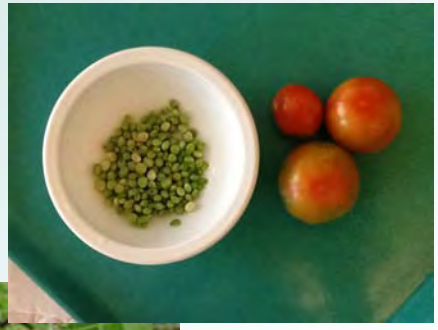
Winged beans, 90 d, pods 14-20 d after flowering, tubers 4 mo

Psophocarpus tetragonolobus



Pigeon peas, 3-14 months, 25-30 d after flowering

Cajanus cajan



Sword beans

Canavalia ensiformis DC

Specialties other

Sweet corn, 70-85 days

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Pest Management Guides

- Sanitation
- Variety Selection
- Soil Preparation
- Seedling growth
- Trellis/Pruning
- Break pest life cycle (disease triangle)

Some pests spend part of their life cycle in soil

Soil diseases
Leafminers
Thrips (pupal stages)
Chinese Rose Beetles
tomato pinworm

Cultural Practices for disease control

- seed treatment
- scout weekly
- raised beds (winter months)- field drainage
- disinfect transplant trays
- sanitation, people, shoes, tools
- always work on diseased fields last

Hot Water Seed Treatments

- Cabbage, brassicas 122 F for 20 minutes
- Eggplant, 122 F for 30 minutes
- Tomato, pepper 122F for 25 minutes

Establishment of insectary ‘patches’ to attract the ‘good guys’

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Establishment of insectaries at home

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Chose a variety that is tasty, easy to grow and adapted to your garden

Keys to a healthy growing

- **Rotations**
- **Green manures**
- **Composts & mulches**
- **Crop diversity & Seed**

Rotate crops between different Groups

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

Slide from: Dr. Scot Nelson UHM

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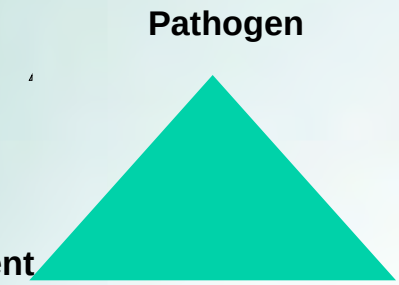
Disease triangle (Koch's postulates)



Interfere with the weakest link (i.e. alternate hosts, moisture)

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Disease diagnosis, other possible problems may include:

- **Nutrient deficiency/toxicity**
- **Soil problems, compaction, drainage**
- **Pesticide injury, look for a uniform pattern**
- **Environmental conditions, hot weather, wind, high humidity**

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Cucurbit Pests

- Aphids (virus)
- Whitefly, Thrips
- Leafminers
- Melon flies
- Pickleworm

Caterpillars

Cabbage looper

Fruit worm

Tomato Pinworm, Keifera lycopersicella

Tomato Pinworm

Pickleworm of cucurbits, Diaphania nitidalis

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Pickleworm of cucurbits

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University of Hav

Pickleworm of cucurbits

Pepper weevil Anthonomus eugenii

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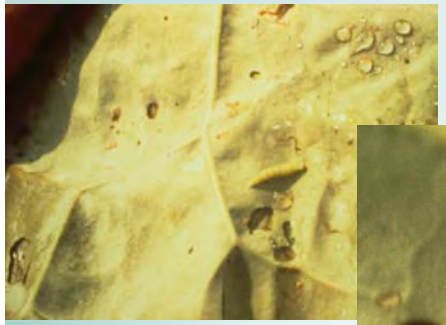
Diamondback moth, Plutella xylostella



Larvae

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Diamondback moth

pupae

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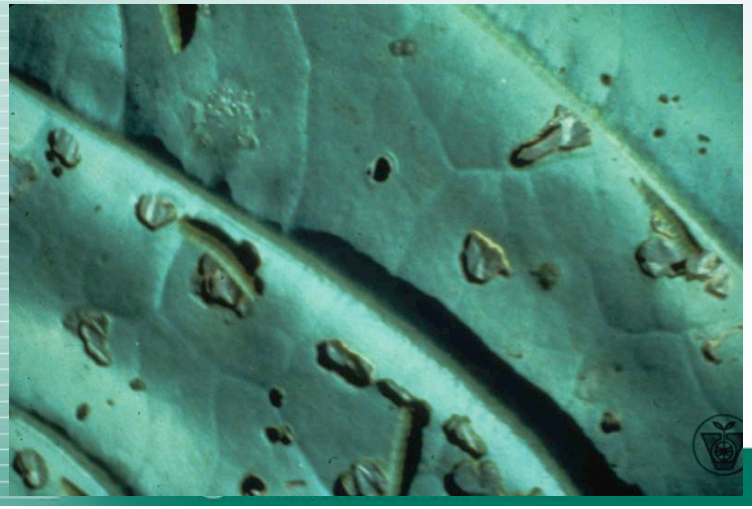
Diamondback moth

adult

man Resources

Diamondback moth
damage from larvae feeding



Diamondback moth spiders as natural controls

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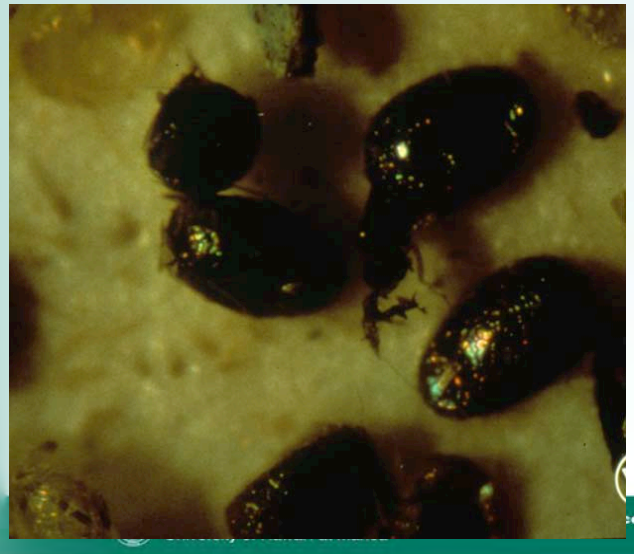
Diamondback moth parasitized eggs



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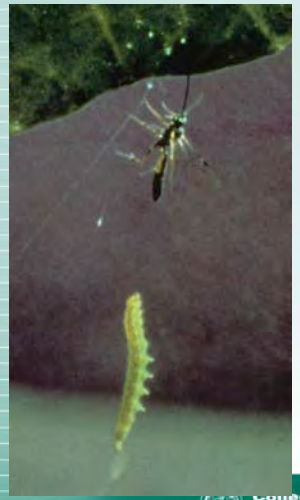
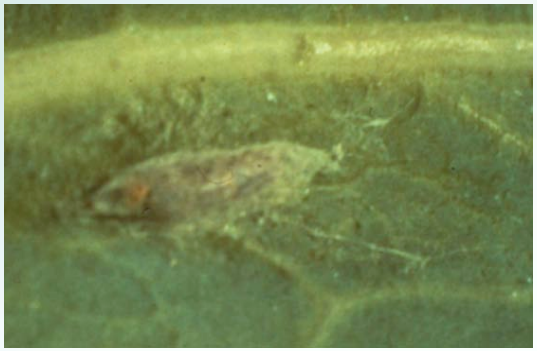
Diamondback moth parasitized larvae





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Diamondback moth diseases: bacteria, fungi, viruses

sources

Diamondback moth
clean field after harvest!!

Diamondback moth
keep seedlings clean in nursery

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Diamondback moth
pheromones may monitor pest levels

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Some major pests in HI

- Lots of sap-suckers – aphids, scale insects, mealy bugs;
- Virus vectors, energy drain on plants, cause sooty molds

Slide from: Dr. Mark Wright UHM

Whiteflies – huge numbers, vector some viruses; sooty molds

Slide from: Dr. Mark Wright UHM

Thrips

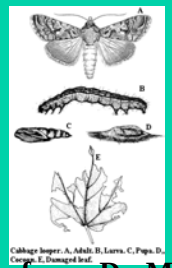
- Thrips (Thysanoptera) – on tomatoes, bananas, many vegetables, ornamentals. Physical damage and virus vectors (e.g. TSWV)

Slide from: Dr. Mark Wright UHM

Caterpillars (Lepidoptera)

Diamond back moth

Cabbage looper



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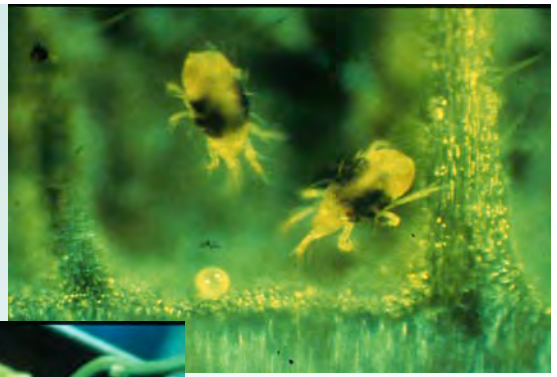
Spider mites



Pests, thrips damage

Pests, mites damage

Leaf miners

Root-knot nematodes

Cucumber Diseases

- Viruses
- Anthracnose
- Powdery Mildew
- Fruit rots (Pythium, Rhizoctonia, Botrytis)

Soil Rots (Rhizoctonia solani)

Fusarium, watermelon

Pythium, soil rot

Sclerotinia, fungus

Bacterial spot, Xanthomonas

Bacterial speck, Pseudomonas syringae

Speck (l), spot (r)

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Bacterial speck

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Bacterial spot, Xanthomonas

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Bacterial wilt, Ralstonia

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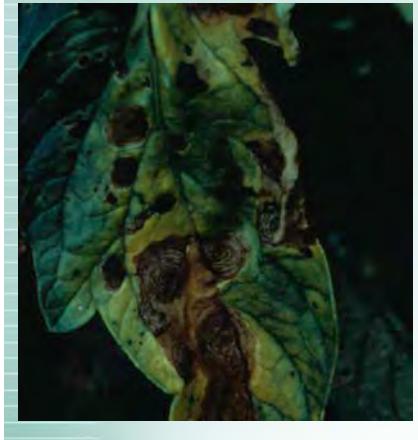
Early Blight, Alternaria solani (rotations)

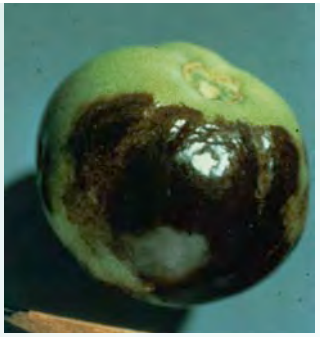


Fusarium Wilt (soil-borne) (resistant varieties)

Fusarium Wilt

Gray leaf spot, Stemphylium (use resistant varieties)

Late blight, Phytophthora



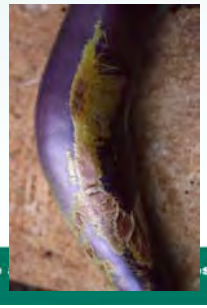
Leaf Mold, Cladosporium

(resistant varieties)

Diseases, TSWV

Wind damage

Nematode damage



Tomato Yellow Leaf Curl Virus (TYLCV)

Iris Yellow Spot Virus in Onion (2010)

Variety or Cultivar Selection possible resistance to:

- Nematodes
- Fusarium Wilt
- Verticillium Wilt
- Tobacco Mosaic Virus
- Bacterial Wilt
- Stemphylium
- Heat

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Disease control products

- Sulfur, Thiolux, powdery mildew, others
- Insecticidal soap, powdery mildew
- compost teas
- copper, fungi, bacteria
- baking soda, foliar diseases

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Insect control products

- Sulfur dust, mites
- soaps, aphids, whiteflies
- Bts (caterpillars)
- Neem sprays
- mineral oils
- beneficial organisms

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Factors that reduce quality

- Harvest at incorrect maturity
- Careless Handling
- Lack of Sanitation
- Delays in cooling