

# Vegetable Pests and Diseases

## BAMSI Pesticide Training

June 17-21, 2019

**Christian Miller**

**Fruit & Vegetable Extension Agent**

# Vegetable Pests and Disease

## -Part 1 Topics-

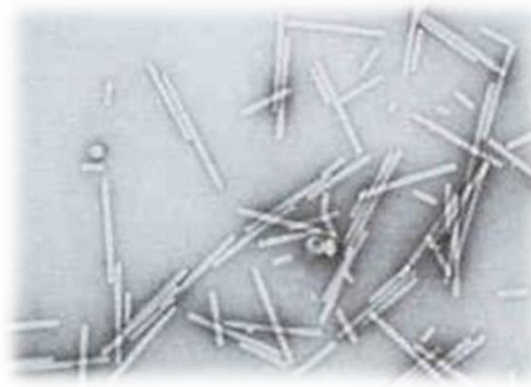
- General:
  - Disease symptoms and pathogens
  - Types of pests
  - Pesticide Information Resources
- Root & Stem Crops
  - Sweet potatoes, Irish Potato, Onions, Cassava
- Fruiting Crops
  - Solanaceous – Tomato, Pepper
  - Melons – Cantaloupe, Honeydew, Watermelon
  - Cucurbits – Cucumber, Zucchini, Squash
  - Okra, Green Beans

# Veg Diseases: Many Pathogens

- Fungi



- Viruses



- Nematodes



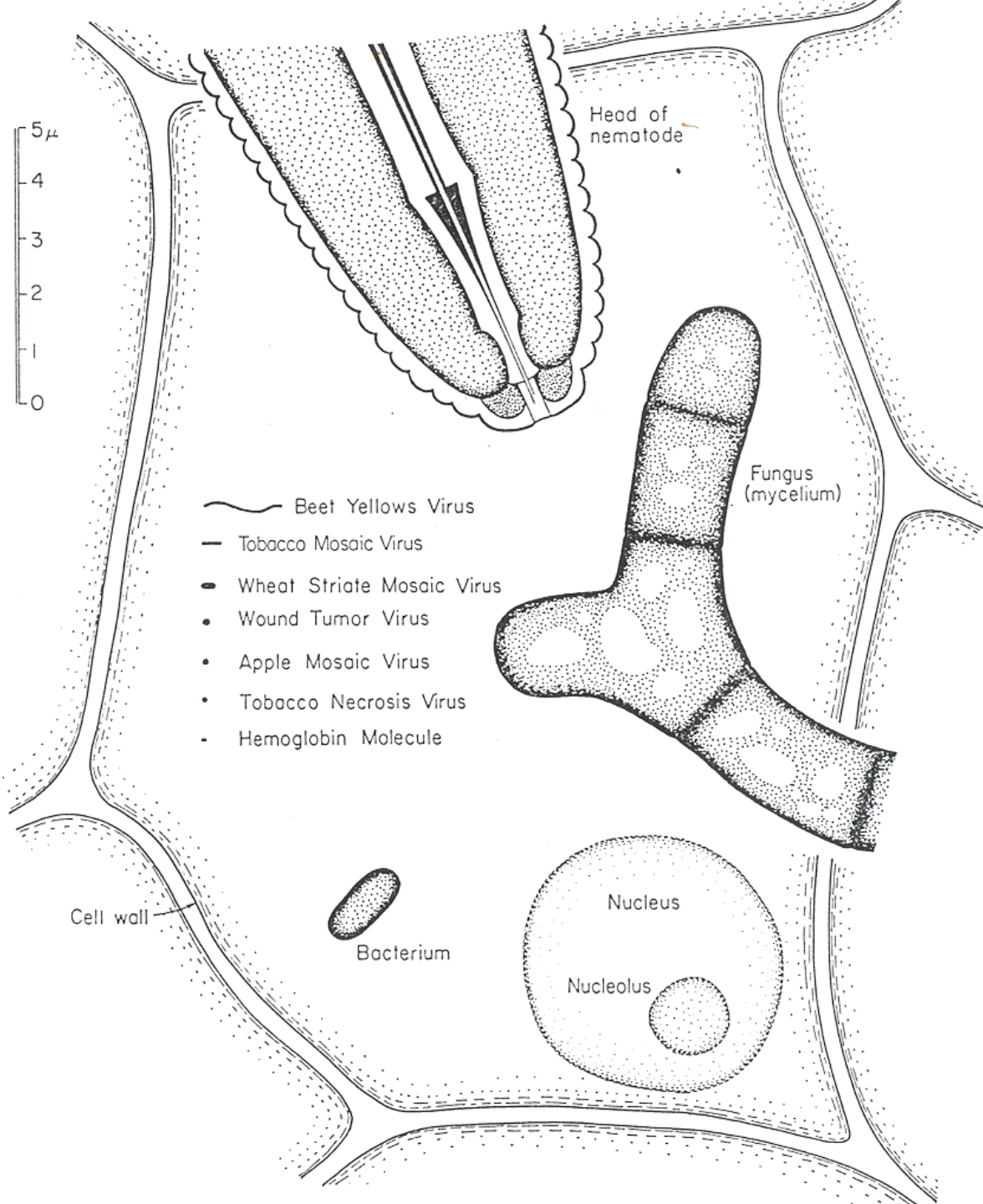
- Bacteria





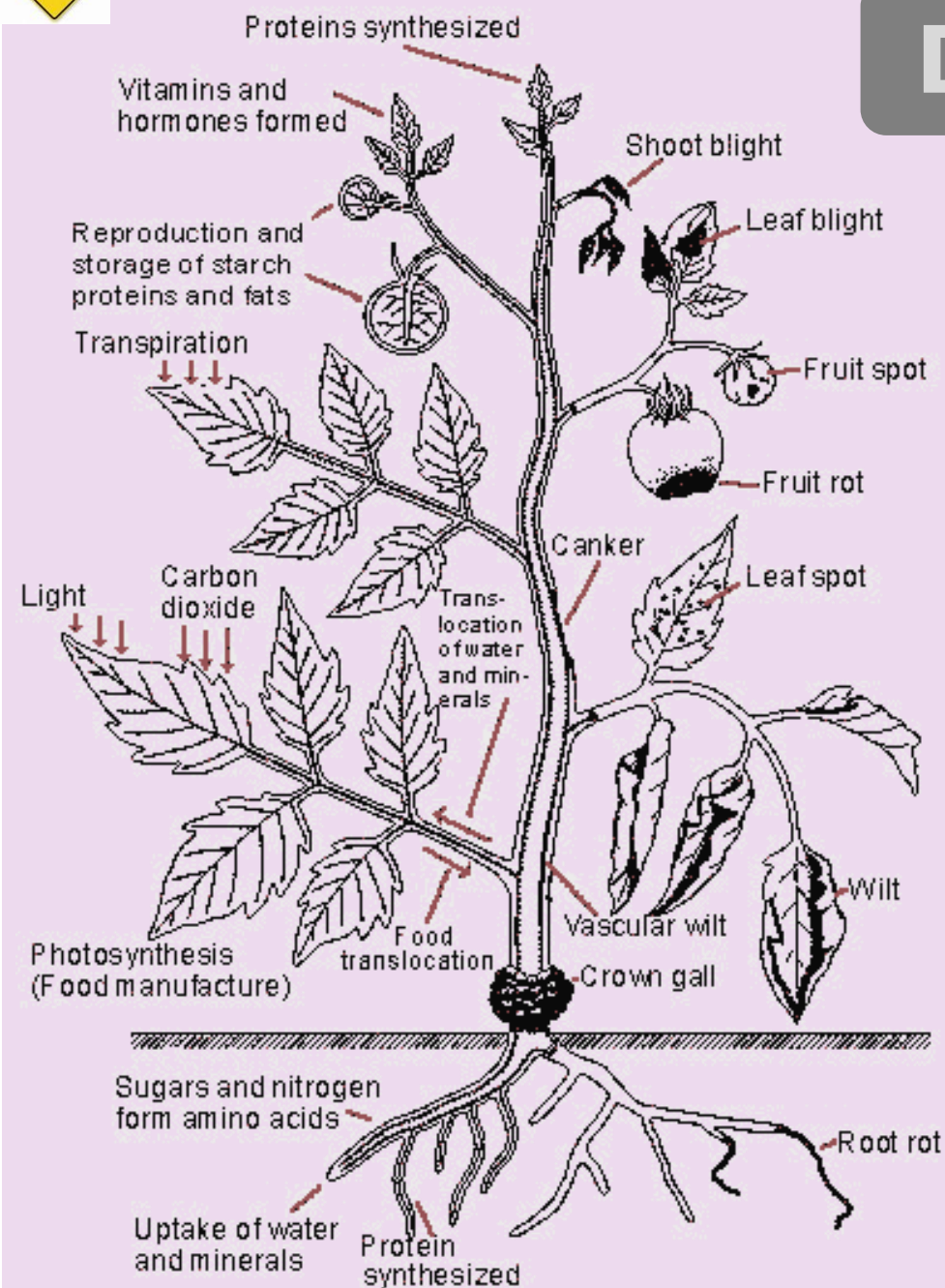
Showing the shapes and sizes of certain plant pathogens in relation to a plant cell.

Agrios 1997





# Disease Symptoms



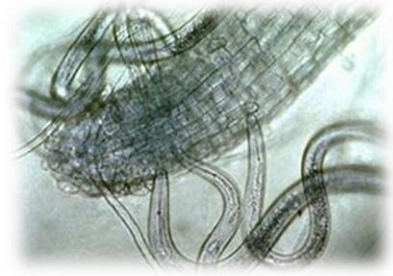
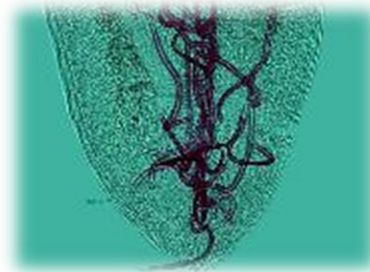
- **Chlorosis (chlorotic)** = yellowing
  - Seen in early stages of disease.
- **Necrosis (necrotic)** = brown-black
  - From cell death as disease develops.
- **Water-soaking** = green darkening
  - Associated with bacterial infections.
- **Spots** = relatively small
- **Blight** = rapid necrosis
- **Wilt** = collapse of the foliage
- **Canker** = elongate necrotic stem lesion
- **Dieback** = inward necrosis of branches
- **Rot** = disintegration of tissue
  - Soft (wet) rots
  - Dry rots
  - Post-harvest decay
- **Damping off** = death of seedlings
- **Galls** = swelling or outgrowth



# Pests of Vegetable Crops

## Underground Feeders

- grubs, rootworms, wireworms, nematodes





# Pests of Vegetable Crops

## Plant Sucking Pests

- aphids, mealybug, whitefly, stinkbugs, mites

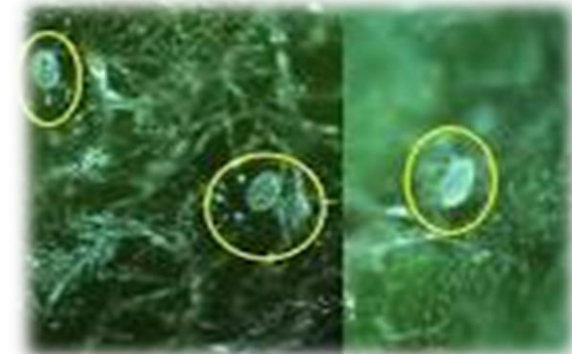




# Vegetable Pests: Mites



***Distorted Growth vs. Speckling***



***Broad Mites***



***Spider Mite  
& Egg***

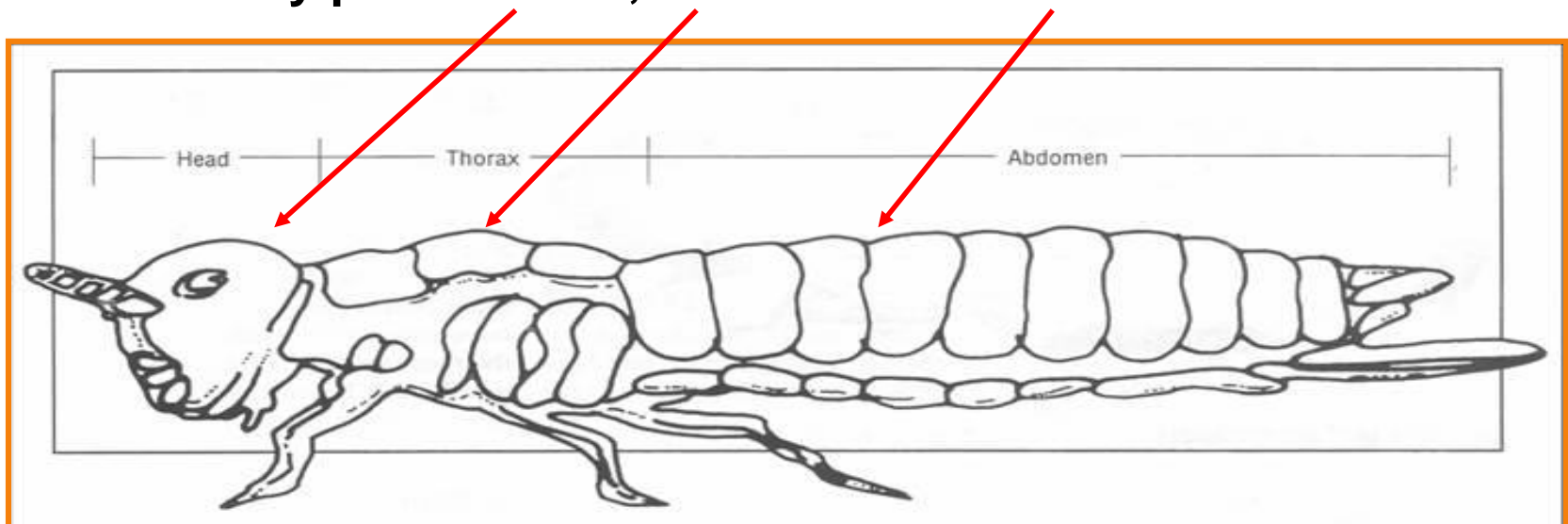
- Not all are pests.
  - Some are predators
- Actually not an “insect” rather an arachnid.
- Wide variety of colors.
- Difficult to see with unaided eye.
- Found on the underside of leaves and on developing buds.
- Spider mites associated with webbing.





# Insects

- Are arthropods like arachnids and crustaceans.
  - Exoskeleton + segmented body + paired jointed appendages.
- Insects differ from other arthropods by having:
  - **three pairs of jointed legs, compound eyes, one pair antennae and three body parts = head, thorax and abdomen.**



**\*\*\*ONLY INSECTS HAVE THESE CHARACTERISTICS\*\*\***

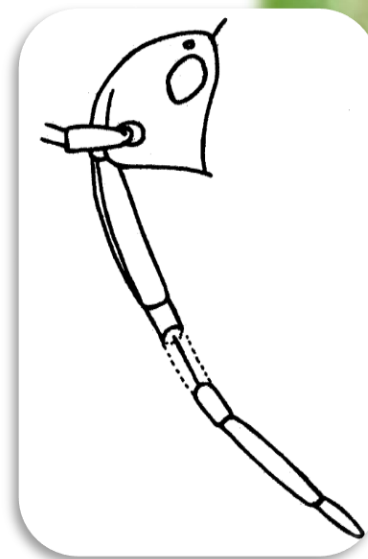


# Insect Mouthparts

## Chewing vs. Piercing-Sucking & Rasping



Mandibles rip, tear, & chew



Hollow  
needle-like  
straw

# Pests of Vegetable Crops

Internal Feeders

Ex. Pepper Weevil, and Leafminer & Fly maggots

Pepper Weevil  
adult & larva



Silk Fly &  
Larvae





# Pests of Vegetable Crops

## Cutworms

- Caterpillars that feed near soil line on stems



# Pesticide Information Resources

- **University of Florida = [edis.ifas.ufl.edu](http://edis.ifas.ufl.edu)**
- **Organic Products = [OMRI.org](http://OMRI.org)**



- **Agrian = [home.agrian.com](http://home.agrian.com)**
- **CDMS = [cdms.net](http://cdms.net)**

# Vegetable Pests and Disease

## -Part 1 Topics-

- General:
  - Disease symptoms and pathogens
  - Types of pests
- Root & Stem Crops
  - Sweet potatoes, Irish Potato, Onions, Cassava
- Fruiting Crops
  - Solanaceous – Tomato, Pepper
  - Melons – Cantaloupe, Honeydew, Watermelon
  - Cucurbits – Cucumber, Zucchini, Squash
  - Okra, Green Beans

# Sweet Potato

- *Ipomoea batatas*

**Traditional**



**Boniato = tropical**



# Traditional Sweet Potato

- Flesh can be yellow, orange or purple.
  - Originated in the Americas.
- Production
  - Plant in spring through June.
  - Rows spaced 48 to 54 inches apart.
  - Slips, transplants, or vine cuttings 12 to 14 inches apart.
  - Best with consistent irrigation to avoid cracking.
  - Sweet potato weevils and nematodes can be major pests.
  - Harvest at around 120 days after planting.
- Postharvest
  - Harvested sweet potato is sensitive to cold.
    - Store in a cool, dry pantry above 55 degrees.
      - Wait at least 2 weeks before consuming to increase sweetness.
        - Ideal conditions for curing is roughly 85 °F with 90% humidity.





# Boniato

- Tropical sweet potato, batatas, or camote.
  - Originated in Central America.
  - Pink to burgundy skin and creamy white flesh
- Production
  - Plant anytime of the year.
  - Plant in rows spaced 36 to 48 inches apart.
  - Slips, transplants, or vine cuttings 12 inches apart.
  - Sweet potato weevils and nematodes can be major pests.
  - Harvest between 120 and 180 days after planting.
- Postharvest
  - Root decay caused by *Rhizopus*, *Diplodia*, and *Fusarium* prevents long-time storage of the roots.
  - Harvested boniato is sensitive to cold.
    - Store in a cool, dry pantry above 55 degrees.



# Sweet Potatoes

## Foliar pests:

- Aphids
- Caterpillars
- Leafminers
- Whitefly
  - Sweet potato = Silverleaf

## Root feeding pests:

- Many are immature stages

- ⚡ ▫ Sweet potato weevil
- ⚡ ▫ Wireworms
- ⚡ ▫ Beetles
- ⚡ ▫ Nematodes



Sweet potato weevil

- Weevil larvae feeding causes a bitter taste.
  - Regal = some resistance.
  - Beauregard = susceptible.
  - Jewel = some resistance
- Few soil insecticides
- Chlorpyrifos, 125 day PHI
    - Not on early-mature varieties.
  - Foliar insecticides aimed at adults can help control

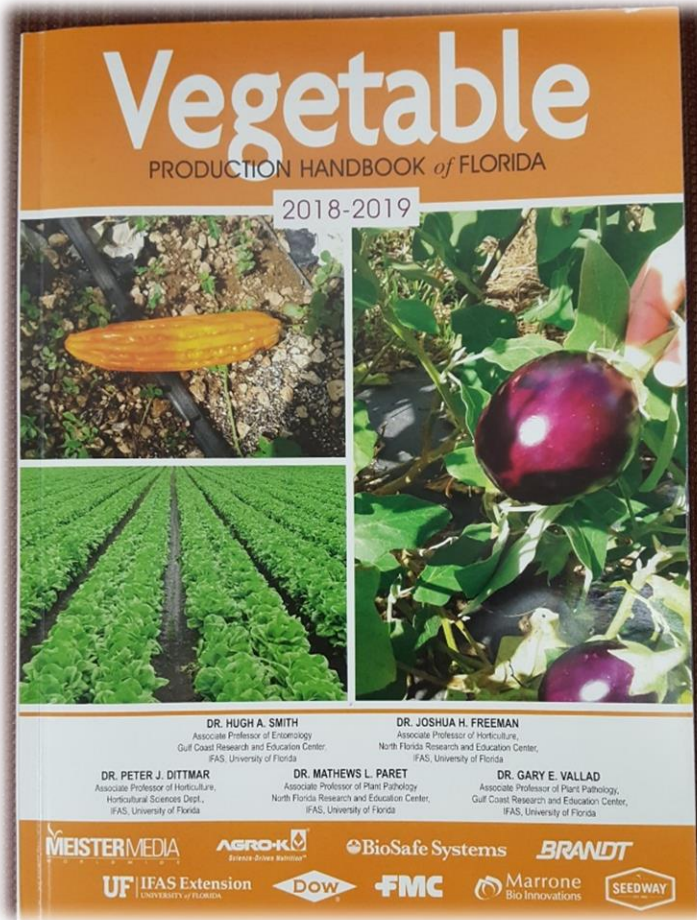


# Vegetable Production Handbook

## Specifically for Florida

-Local issues, products may differ-

- General Fertilizer Use
- General Irrigation
- General Pest Management
- Crops listed on page “iii”
  - Crop Culture
  - Registered Pesticides per Crop
    - Herbicides, Insecticides, Fungicides, Bactericides, Nematicides



***“The label  
is the law.”***

# Vegetable Production Handbook

## Crop Index

Crop	Pages	Crop	Pages	Crop	Pages	Crop	Pages	Crop	Pages
Bean	175-197	Tropical root crops	276	Kale	33-53	Parsley	141-174	Squash	55-82
Beet	275-309	Chive	199-217	Kohlrabi	33-53	Pepper	219-251	Strawberry	311-331
Broccoli	33-53	Collards	33-53	Leek	199-217	Potato	253-273	Sweet corn	333-338
Cabbage	33-53	Cucumber	55-82	Lettuce	111-139	Pumpkin	55-82	<u>Sweet potato</u>	<u>275-309</u>
Cantaloupe	55-82	Edamame	175-197	Lima bean	175-197	Radish	275-309	Tomato	349-393
Carrot	275-309	Eggplant	83-109	Mustard	33-53	Snowpea	175-197	Turnip	33-53
Cauliflower	33-53	Endive, Escarole	111-139	Okra	141-174	Southernpea	175-197	Watermelon	55-82
Celery	141-174	Ethnic Vegetables	31	Onion	199-217	Spinach	111-139		

2018 Vegetable Production Handbook for Florida

iii

Table 1. Insecticides approved for managing insect pests of sweet potato.

Labels change frequently. Be sure to read a current product label before applying any chemical.

Also refer to Table 18.2 for biopesticide and other alternative products labeled for disease management.

Insects	MOA Code <sup>1</sup>	Trade Name Active Ingredient *Restricted	Rate Product/acre	REI hours	Days to Harvest	Notes <sup>2</sup>
Aphids	3A	*Mustang (zeta-cypermethrin)	1.4-4.3 oz	12	1	A maximum of 0.3 lb ai/acre per season may be applied. Leaves cannot be used for food or feed.
	3A, 28	*Besiege (lambda-cyhalothrin and chlorantraniliprole)	5-9 oz	24	14	Do not apply more than 27.0 fl. oz of product per acre per season. Supplemental label.

# Sweet Potatoes

## Diseases

- Alternaria
- Early blight
- Botrytis
- Damping off
- Phytopthera
- Powdery mildew
- Rhizoctonia
- Rust
- Sclerotinia
- ⚡ Scurf
- Septoria leaf spot



**Dark spots from Scurf, a fungal disease  
-which does not affect eating quality-**

- **Plant disease-free slips.**
- **Persist for several years in soils.**

# Irish Potato

## *Solanum tuberosum*

- Cool-season crop
- Red or brown skin, white flesh



## **Production:**

- Plant starting in October through January in south Florida.
- Allow seed potatoes to dry for a few days before planting.
- Grocery store bought potatoes are treated to prevent sprouting.
- Plant 6 inches deep.
- Water and fertilize regularly to prevent splitting.
- 3-4 weeks after planting, fertilize with 0.75 lb N and 0.5 lb K per 100 ft of row in a 4-6 inch band 2 inches deep.
- Mound soil around the base of the plants as they grown.
- Harvest about 90 days after planting.



# Irish Potato

## Major insect pests:

- ⚡ Wireworms
- Others:
  - ⚡ □ Caterpillars, aphids, beetles, whiteflies, leafhoppers
  - Diaprepes root weevil
    - Fields near field nurseries.
- ⚡ Nematodes



## Diseases

- ⚡ Early blight
  - *Alternaria solani*
- ⚡ Late blight
  - *Phytophthora infestans*
- ⚡ Rhizoctonia
- Leaf roll and mosaic viruses
  - Stunting, curling, chlorosis
    - Remove suspect plants
- Tobacco rattle virus
  - Corky ringspots
  - Lesions in tubers
    - Transmitted by nematodes

# Potato: Late Blight



5365781



4866935



5457057



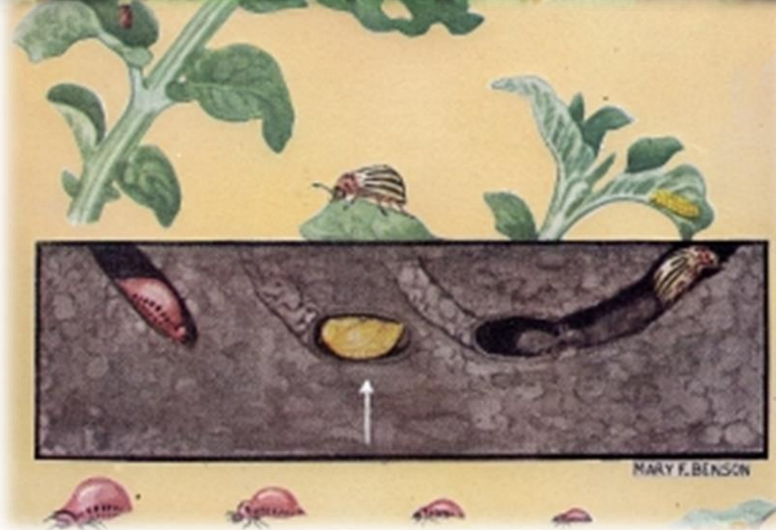


# Beetles on Potato

Colorado Potato Beetle



Flea Beetles & Damage



# Colorado Potato Beetle Management

- **Cultural control** = crop rotation or crop destruct.
  - Because the initially walk - at least 0.5 km
  - Trenching can significantly reduce infestations
- **Chemical control:**
  - Resistance to insecticides develops rapidly.
    - Pyrethroids, Carbamates, Imidacloprid and others
      - Some applied at-plant and other foliar
  - Some strains of *Bacillus thuringiensis* are effective.
    - Must be applied to the first two instars to be effective.
    - *Bacillus thuringiensis* var. *kurstaki*, var. *tenebrionis*

# Onion

## *Allium sp.*

- Cool-season crop
- Information also applies to shallots



## **Production:**

- Start in September through December in south Florida.
- Can grow from seed but transplants will be ready sooner.
- Water regularly to prevent splitting.
- Fertilize monthly with nitrogen.
- For larger bulbs, move soil away from the bulb as it grows.
- Harvest about 150 days after planting.
  - **Taste varies with soil type and fertilizer practices.**



# Onion

*Allium sp.*

## Insect pests:

- Wireworms, thrips, caterpillars, aphids, leaf miners, leafhoppers, beetles and the ⚡ onion maggot pictured here:



## Nematodes

## Diseases

- ⚡ Bacteria
  - Black Mold
- ⚡ Botrytis leaf blight & Neck rot
  - Cercospora leaf spot
  - Cladosporium leaf blotch
  - Damping off
  - Downy mildew
  - Iris Yellow Spot Virus
  - Purple blotch
  - Rhizoctonia
  - Rust
  - White rot
- Stemphyllium Blight

# Onion: Major Diseases

**Bacterial Sour Scale**



**Botrytis Neck Rot**



# Cassava

## *Manihot esulenta*

- Many common names:
  - Manioc, Yucca, Tapioca

## **Production:**

- Plant any time of the year.
- Same soil and fertilizer needs as for sweet potatoes.
  - 40 to 60 pounds N per acre applied 28 days after planting
  - 60 pounds per acre P at or shortly after planting
  - 150 to 200 pounds of K
    - 50 pounds at planting + 150 pounds at about 28 days later.
- Plant 10-inch sections of stem 4-6 inches deep.
  - Take stem pieces from at least 12 inches above the soil.
- Space stems 20-30 inches apart on 48-inch wide rows.
- Water regularly to prevent splitting.
- Harvested roots do not store well.
- Harvest about 250-300 days after planting.



# Cassava

*Manihot esulenta*

## Insect pests:

- ⚡ Spider mites
- ⚡ Root weevils
  - Flies
- ⚡ Mealybugs
- ⚡ White fly
  - Caterpillars
- ⚡ Viruses

***Insects  
transmit  
many viruses***



## Diseases

- ⚡ Bacterial blight
- ⚡ Super-elongation of stems
  - - caused by a fungus
- ⚡ Rhizoctonia root rot





## Brown Streak Virus Symptoms



## Ants tending mealybugs



## Cassava Mosaic Disease



## Whitefly vectors CMD



# Cassava: Major Issues





# Tomato

*Solanum lycopersicum*

-Fruit comes in many shapes, sizes and colors-

Evening temperatures over 80 °F cause these types to stop setting fruit.

Round



Roma



Heirloom





# Tomato

**These typically perform well when evening temperatures over 80 °F.**

**Grape**



**Cherry**



# Tomato

- Indeterminate varieties are large and sprawling vines.
  - Produce fruit over a period of several months.
  - Require removal of suckers = first few side branches
    - Leave two to three main stems.
- Determinate varieties are more compact and bushy.
  - Produce just a single crop of tomatoes.
- Need ties, stakes or trellising to keep fruit off ground.
- Plant transplants slightly deeper than in original pots.
- Water 1-2 inches weekly with heavy soakings.
- General NPK fertilizer: **6-6-6** or **15-15-15**
  - 3-4 lbs 6-6-6 per 100 square feet.
  - 5-6 ounces per 10 feet of row.








# Tomato

## Insect pests:

- Aphids
- Beetles
-  Caterpillars
- Grasshoppers
- Lace Bugs
- Leafhoppers
-  Leafminers (*Liriomyza* sp.)
- Mites
- Mole Crickets
- Plant Bugs
- Planthoppers
- Psyllids
- Stinkbugs
- Thrips
- Vegetable Weevil
-  Whitefly
- Wireworms

## Nematodes

## Diseases

- Anthracnose 
- Bacterial canker, spot, speck
- Black Mold
- Botrytis (grey mold)
-  Early blight
- Late blight
- Leaf mold
- Grey leaf spot
- Phytophthora fruit, root, crown rot
-  Fusarium wilt
- Powdery mildew
- Pythium (damping off)
- Rhizoctonia
- Septoria leaf spot
- Southern blight
-  Target spot
- White mold
-  Viruses



# Caterpillars on Tomato

**Pinworm**



**Hornworm**



**Corn Earworm**



**Armyworm**





# Tomato: Virus symptoms & vectors



Thrips vector TomNSV



Whitefly  
vector  
TYLCV

TomNSV



TYLCV

# Tomato: Major Issues

**Early Blight**



**Target Spot**





Vascular wilt



# Tomato Major Issues

**Blossom  
End Rot**

(Ca deficiency)

**Bacterial spot**



**(#1) Bacterial leaf spot**





# Pepper

*Capsicum annum*

Peppers start as green and turn yellow -> orange -> red as they mature.

Sweet



Hot



# Pepper

- Spicy flavor from a compound known as capsaicin.
- Scoville unit scale measures the heat (spiciness).
  - Mild peppers like jalapenos are 1,000 to 10,000.
  - Cayenne and habanero can be 50,000 to 250,000.
    - Trinidad Moruga scorpion is 1.2 million Scoville units.
    - Carolina Reaper measures 2.2 million Scoville units!
- Spacing depends on variety
- May require staking as fruits get larger and heavier.
- Water regularly to keep plants producing fruits.
- Prefer moist but not wet soils.
- Green harvest usually 60-80 days after transplanting.
  - 80-100 days after planting by seed.

# Pepper

## *Capsicum annuum*

### Insect pests:

- Aphids
- Beetles
- Caterpillars
- Grasshoppers
- Lace Bugs
- Leafhoppers
- Leafminers (*Liriomyza* sp.)
- ⚡ Broad Mites
- Mole Crickets
- Plant Bugs
- Planthoppers
- Psyllids
- Stinkbugs
- ⚡ Thrips
- ⚡ Weevils
- ⚡ Whitefly
- Wireworms

### Diseases

- Anthracnose
- ⚡ Bacterial spot
- Botrytis (grey mold)
- Cercospora leaf spot
- Grey leaf spot
- Phytophthora blight, root/crown rot
- Powdery mildew
- Pythium (damping off)
- Rhizoctonia
- Southern blight
- ⚡ Viruses



# Pepper Issues: Diseases




**Bacterial Leaf Spot**



**TSWV**



# Pepper in Florida

PESTS		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May		
Western flower thrips			[Yellow bar]							[Yellow bar]			
Melon thrips			[Yellow bar]						[Yellow bar]				
Broad mite			[Yellow bar]										
Pepper weevil					[Yellow bar]				[Yellow bar]				
Silverleaf whitefly			[Yellow bar]					[Yellow bar]					
Phenology			[Flower]			[Peppers]			[Flower]			[Peppers]	

Planting

Planting

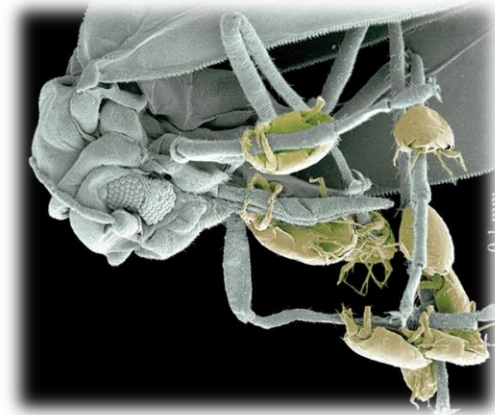


# Pepper Issues: Broad Mite

**Broad Mite Damage**



**Broad Mites  
-alone & on a whitefly-**





# Pepper Issues: Thrips, Damage & *Orius predator*



Florida flower thrips

Western flower thrips

Melon thrips

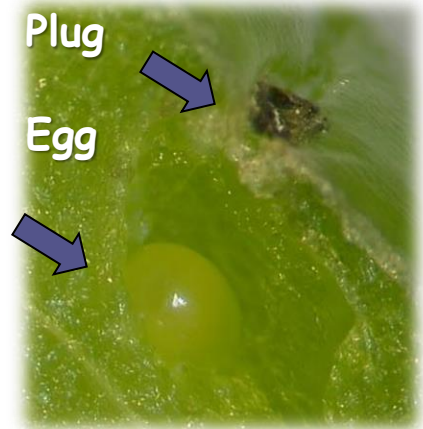
Chilli thrips





# Pepper Weevil

Prefers laying eggs near calyx of young fruit



Egg laid in small cell sculpted by mandibles and covered by a plug



Adult Prefers feeding on flower buds



Infested fruit often fall to the ground where adult emerges



Photos by E. Rodriguez



Larvae burrow into fruit, feed on placenta and seeds





# Scouting Pepper Weevil



## Adults:

### Concentrate on

- Field margins
- Upper 1/3 of plant
- Leaf axils and blooms
- Pheromone traps
- Look for-
  - punctured fruit
  - fallen fruit
  - Bloom drop

## Cultural Control:

- Control nightshade weeds.
- 3 months fallow.
- Isolate plantings.
- Rotate crops.
- Shorten crop cycles
- Remove and destroy infested fruit.
- Plow down and incorporate old crops.

# Melons

- Grow on vines, need room to spread.
  - 18 to 24 square feet *per plant*
- Thrive in full sun and rich, well-drained soil.
- Seed or transplants if in peat pots & planted directly.
- Space 36 inches apart, in rows 7 to 8 feet apart.
- Grow best when day temperatures are 70-85 °F.
  - Can handle daytime temperatures up to 90 °F.
- Require bees to pollinate
- Harvest in 80-100 days depending on variety.
  - Bottom of melon should be cream-colored or bright yellow.
  - White or pale green spot on bottom = not yet ripe.
  - The curled tendril closest to the melon on the vine turns brown and shrivels when the melon is ripe.
- Last about a week at room temperature; 2 weeks if cooled.

# Summer Squash

- Harvested before rind hardens and the fruit matures.
- Grows on bush-type plants; not spreading vines.
- Roots are shallow.
- Summer squash fruit have diverse shapes and colors:
  - **Scallop or Patty Pan** = round & flattened, scalloped edge
    - Usually white but can be yellow or green.
  - **Crookneck** = stem end bent & thinner than blossom end.
  - **Straightneck** = stem end straight & thinner.
    - Crookneck & Straightneck squash are usually yellow.
  - **Zucchini** is usually green.

# Summer Squash

## Production

- Seeds 24 to 36 inches apart & 1 inch deep.

## Harvest

- Ready to pick within 4 to 8 days after flowering.
- When small and tender and every 1-2 days :
  - Elongated - 2 inches or less in diameter, 6-8 inches long.
  - Patty Pan types - when 3 to 4 inches in diameter.



# Melons & other Cucurbits

**Cantaloupe** = *Cucumis melo*



**Cucumber** = *Cucumis sativus*



# Melons & other Cucurbits

**Squash (Zucchini) = *Cucurbita pepo***



**Watermelon = *Citrullus lanatus***



# Winter Squash

**-have hard rinds and can be stored for up to six months-**

**Butter Nut = *Cucurbita moschata***



**Seminole Pumpkin = *C. moschata***



# Melons & other Cucurbits

## Insect Pests

- ⚡ Aphids
  - Beetles
- ⚡ Caterpillars
  - Leafminers (*Liriomyza* sp.)
  - Mites
- ⚡ Squash & leaf-footed bugs
  - Thrips
- ⚡ Whitefly
  - Wireworms



**Rindworm**

## Diseases

- Alternaria leaf spot/blight
- Angular leaf spot
- ⚡ Anthracnose
- ⚡ Bacterial fruit blotch
  - Belly rot
  - Cercospora leaf spot
  - Downy Mildew
- ⚡ Gummy stem blight
  - Phytophthora root rot & blight
- ⚡ Powdery Mildew
- ⚡ Damping-off
  - Target spot
  - Scab
  - Fusarium wilt/rot
  - Viruses



# Melon: More Caterpillars

Pickleworm



Melonworm





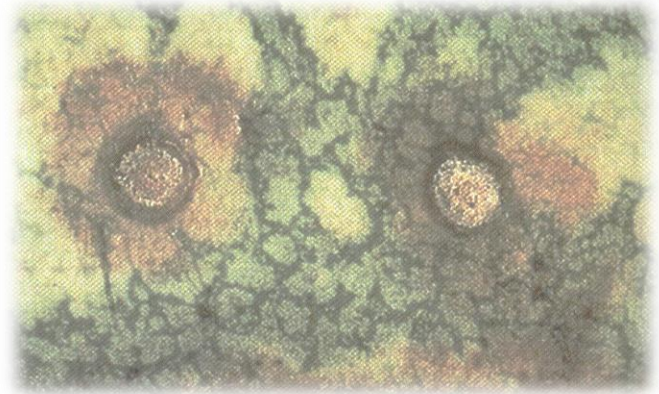
# Squash Bug: Eggs, Nymph, Adult



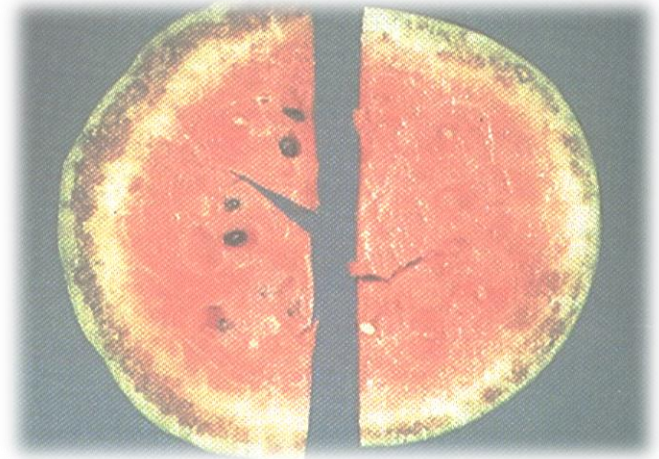
# Melon Diseases



Bacterial fruit blotch



Anthracnose



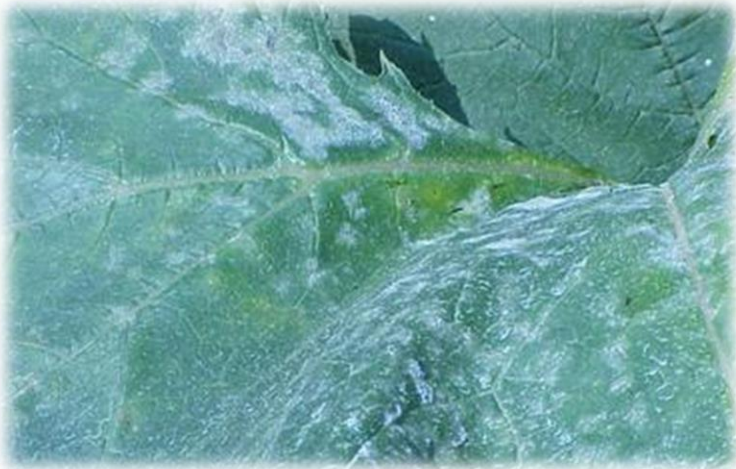
Bacterial rind  
necrosis

# Melon: Gummy Stem Blight



# Melon: Other Foliar Diseases

**Powdery Mildew**



**Anthracnose**

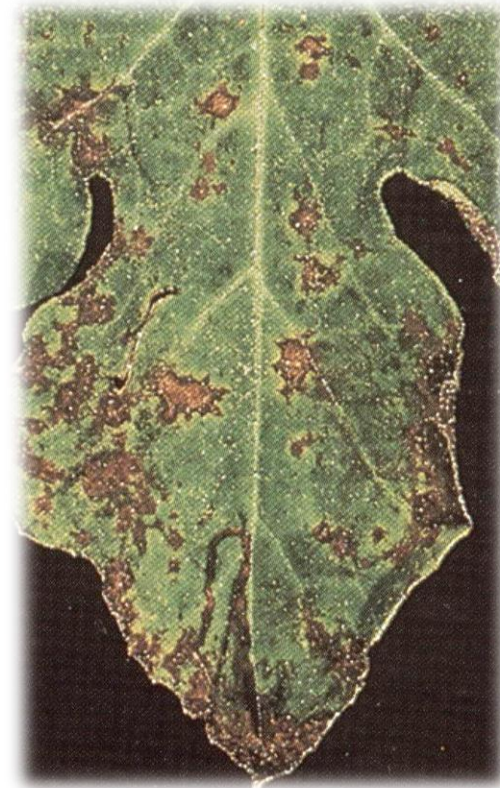


# Melon: Other Foliar Diseases

**Anthracnose**



**Cercospora**





# Legumes: Green Bean, Pigeon pea

- Legumes need less Nitrogen vs. other veggies because they make their own-
- This makes legumes a good covercrop to enhance soil-

**Green bean** = *Phaseolus vulgaris*  
(also known as snap bean)



**Pigeon pea** = *Cajanus cajan*



# Green Beans

- Some varieties are bushy and others are vines.
- Start with seeds - transplants do not do well.
- Plant 1–2 inches deep in rows 18–30 inches apart.
- Space seeds 2–3 inches apart.
- Keep soil moist until seeds sprout.
  - Then water when the soil surface has dried out.
- Caution when weeding; bean plants have weak roots.
- Fertilize at half the rate used for other vegetables.

## Harvest

- When pods are still tender & about 5-6 inches long
- Ready about 50–60 days after planting.
  - Harvesting regularly keeps plants producing.





# Pigeon Pea

- Perennial bush or small tree 3–12 feet tall.
- Deeply rooted tap root– suited for semiarid land.
  - Do not tolerate waterlogged ground
- Grow in soil containing a pH 4.5 to 8.4
- Seed 8–10 pounds per acre in rows 3–4 feet apart.
- Plant seed 1.5 inches deep – 2 weeks to germinate.
- Thin to 12–18 inches between plants.
- Plant in late spring (May) and harvest Oct–Nov.
- Harvest when seeds reach their maximum size within the pod chamber & while the pod still green.
  - During this period, the seed has a sweet flavor.

# Legumes: Green Bean, Pigeon pea

**Green bean** = *Phaseolus vulgaris*  
(also known as snap bean)

## Insect Pests

-  Aphids
  - Beetles
-  Caterpillars
  - Grasshoppers
  - Leafhoppers
  - Leafminers (*Liriomyza* sp.)
-  Mites
  - Stinkbugs
-  Thrips
  - Whitefly
  - Wireworms

**Pigeon pea** = *Cajanus cajan*

## Diseases

- Ascochyta blight
-  Bacterial spot/blight
- Botrytis (Grey mold)
- Cercospora leaf spot
- Downy Mildew
- Fusarium root rot/blight
- Phytophthora root rot & blight
-  Powdery Mildew
-  Damping-off
-  Rhizoctonia root rot
-  Rust
  - White mold
-  Viruses



# Thrips & Damage to Bean



# Bean Leaf Roller & Damage





# Bean: Rhizoctonia & Pythium



04/20/2015

5361373

# Tobacco Streak (Red Node) Virus



# Bean: Major Issues

**Rust**



**Powdery Mildew**



**Bacterial Halo Blight**



# Okra

## *Abelmoschus esculentus*



- Originated in Africa.
- Tall upright bush.

### **Production**

- Plant in rows 3-6 feet apart.
- Seed 9-12 inches apart & 3/4 inch deep.
- Soil pH 5.8 and 6.5
- 6-12-12 at planting and later sidedress.
  - Responds to a high phosphate fertilizer.
  - Sensitive to N – avoid excess till fruiting.
    - Then sidedress with nitrogen.
    - Apply N again late season when blooms are concentrated in the top of the plant.

### **Harvest**

- 60-70 days after planting.
- Pods about 2-3 inches long.
- Harvest early and often – every 2 days.
  - Pods too tough to eat when old.
- Wear gloves for protection.





# Okra

## Insect pests:

- Aphids
- Beetles
- Caterpillars
- Leafminers (*Liriomyza* sp.)
- Mites
- ⚡ Stinkbugs
- Thrips
- Whitefly
- Wireworms

## ⚡ Nematodes

## Diseases:

- Anthracnose
- Bacterial leaf spot
- Cercospora leaf spot
- Pod spot
- Powdery Mildew
- Phythophthora
- Damping off



Stink bug  
& eggs.  
Feeding  
causes  
pods to  
twist.

(Barbara H.  
Smith, ©2018  
HGIC, Clemson  
Extension)

# Vegetable Pests and Diseases

## BAMSI Pesticide Training

June 17-21, 2019

**Christian Miller**

**Fruit & Vegetable Extension Agent**





# Cole Crops

## Crucifers:

- Broccoli
- Cauliflower
- Cabbage
- Kale

## Insect pests:

- ⚡ Aphids
- Beetles
- ⚡ Caterpillars
- Grasshoppers
- Leafminers
- Mites
- ⚡ Whitefly
- Wireworms

(like this looper below)



## Diseases

- ⚡ • Alternaria leaf spot, blight
- Anthracnose
- Black leg
- Black rot
- Cecospora leaf spot
- Club root
- ⚡ Downy Mildew
- Fusarium
- Grey mold
- Powdery mildew
- Phytophthora root/crown rot
- ⚡ Pythium (damping off)
- Rhizoctonia
- Ring spot
- Sclerotinia
- White rust
- White leaf spot



# Cole Crop: Issues

**Turnip Aphid and leaf distortion**



**Thrips & their damage**



**Green Peach  
Aphid**





# Cole Crop: Issues

Cabbage White Adult, Larva & damage

Cabbage White Larvae



Chrysalis





# Cole Crop: Issues

## Diamondback Moth



DBM resistant to 93 different pesticides (2016)  
Some R to *B.t. kurstaki*, *B.t. aizawai*

Chlorantraniliprole (Voliam Flexi) is “new” and can be effective.

## Diamondback Larvae



# (FL) Diamondback Moth Management

- 1) Avoid cabbage production during the warmest months
  - *B.t.* insecticides are least effective, insect problems are highest
- 2) Destroy crop residues
- 3) Use pest-free transplants
- 4) Scout frequently, beginning at the seedling stage
- 5) Use action thresholds to limit # insecticide applications
- 6) Use *B.t. kurstaki* and *B.t. aizawai* as main insecticides
- 7) Rotate the two *B.t.* strains to reduce resistance selection
- 8) Avoid using carbamates and pyrethroids
  - These are broad-spectrum and harm beneficial insects



# Cole Crop: Issues

## Flea Beetles & damage



## Cucumber Beetle



## Tarnished Plant Bug



## Harlequin Bug



# Cole Crop: Issues

**Downy Mildew**



**Bacterial Soft Rot**



**Bacterial Blight**



# Cole Crop: Issues

## Powdery Mildew



## Alternaria



1576647



# Cole Crop: Issues

## White Rust



## Sclerotinia White Mold



## Sclerotia



# Broccoli

## *Brassica oleracea* var. *italica*



- Brassica (Cole) crop
- Originated in Mediterranean region.
- Best in cool weather.
  - Warm weather => bolting (flowering)

### **Production**

- Start with seed or transplants.
- Plant in rows 2 feet apart.
- Seed 12-18 inches apart & 1/4 inch deep.
- Soil pH 6.2 and 6.5
- 10-10-10 at planting and later.

### **Harvest**

- 50-90 days after transplanting.
- When central head is still compact.
- Cut at least 5 inches below head.
  - This will encourage side shoots.
  - Small but harvestable for 40-80 days.

# Cauliflower

*Brassica oleracea* var. *botrytis*



**Pests & diseases are very similar to that of broccoli.**

- Brassica (Cole) crop
- Originated in Mediterranean region.
- Best in cool weather.
  - Warm weather => bolting (flowering)

## **Production**

- Start with seed or transplants.
- Plant in rows 2 feet apart.
- Seed 12-18 inches apart & 1/4 inch deep.
- Soil pH 6.2 and 6.5
- 10-10-10 at planting and later.

## **Harvest**

- 50-100 days after transplanting.
- When central head is still compact.
- Cut at least 5 inches below head.
  - This will encourage side shoots.
    - Small but harvestable for 40-80 days.

# Cabbage

*Brassica oleracea* var. *capita*



- Brassica (Cole) crop
- Originated in Mediterranean region.
- Best in cool weather.
  - Warm weather => bolting (flowering)

## Production

- Start with seed or transplants.
- Plant in rows 24 inches apart.
- Seed 9-16 inches apart & 1/4 inch deep.
- Soil pH 6.2 and 6.5
- 10-10-10 at planting and later.

## Harvest

- 70-110 days after transplanting.
- When central head is still compact.
- Cut at least 5 inches below head.
  - This will encourage side shoots.
  - Small but harvestable for 40-80 days.

**Traditional also in red or purple.**

- Chinese cabbage is related:
  - Bok Choy = open-leaf type
  - Napa = tighter heads



# Chinese Cabbage

## *Brassica oleracea* var. *capita*

- Brassica (Cole) crop
- Originated in Mediterranean region.
- Best in cool weather.
  - Warm weather => bolting

### Production

- Start with seed or transplants.
- Napa
  - Rows 24 inches apart.
  - Seed 14-18 inch apart, 1/4 inch deep.
- Bok Choy
  - Seed 8-12 inch apart & 1/4 inch deep.
- Soil pH 6.2 and 6.5
- 10-10-10 at planting and later.

### Harvest

- 60-90 days.
- Before head starts to open.
- Crops mature at different rates.

Bok Choy



Napa Cabbage





# Kale

## *Brassica oleracea* var. *acephala*



- Brassica (Cole) crop
- Originated in Mediterranean region.
- Best in cool weather.
  - Warm weather => bolting (flowering)

### **Production**

- Start with seed or transplants.
- Plant in rows 18 inches apart.
- Seed 8-12 inches apart & 1/4 inch deep.
- Soil pH 6.2 and 6.5
- 10-10-10 at planting and later.

### **Harvest**

- 55-80 days after planting.
- Harvest the lower leaves
  - No more than one-third of the plant

# POPEYE<sup>®</sup>



# Spinach

*Spinacia oleracea*



- Originated in Asia.
- Best in cool weather.

## Production

- Start with seed.
- Plant in rows 12 inches apart.
- Seed 2-6 inches apart & 1/2 inch deep.
- Soil pH slightly acidic.
- 10-10-10 at planting and later.

## Harvest

- 45-60 days after planting.
  - 21-30 days for baby leaf.
- When central head is still compact.



# Spinach

## Insect pests:

- ⚡ Aphids
- ⚡ Beetles
- ⚡ Caterpillars
  - Grasshoppers
  - Leafhoppers
- ⚡ Leafminers
  - Mites
  - Mole Crickets
  - Plant Bugs
  - Stinkbugs
  - Thrips

## Diseases:

- ⚡ Cladosporium leaf spot
- ⚡ Powdery mildew
- ⚡ Pythium (damping off)
- ⚡ Stemphylium leaf spot

### 3 Leafminer Stages



### Downy Mildew



### Root-Knot Nematode





# Spinach: Issues

**Stemphylium**



**Cladosporium**



**Damping Off  
(Pythium)**



# Lettuce

*Lactuca sativa*

-Many shapes, sizes and colors-



**Red Leaf**



**Iceberg**



**Butter  
(Bibb)**



**Romaine**

# Lettuce



- Best in cool weather.
  - Warm weather => bolting (flowering)

## Production

- Start with seed or transplants.
- Plant in rows 18 inches apart.
- Seed 8-12 inches apart & 1/4 inch deep.
- Soil pH slightly acidic.
- 10-10-10 at planting and later.


## Harvest

- 60-80 days after planting.
- Harvest leaves and/or heads.







# Lettuce

## Insect pests:

-  Aphids
  - Beetles
-  Caterpillars
  - Grasshoppers
  - Leafhoppers
-  Leafminers (*Liriomyza* sp.)
  - Mites
  - Mole Crickets
  - Plant Bugs
  - Planthoppers
-  Thrips
  - Wireworms

## Diseases

- Alternaria leaf spot
- Bacterial leaf spot
- Basal rot
- Botrytis rot
-  Cercospora leaf spot
-  Downy mildew
  - Grey mold
  - Powdery mildew
  - Pythium (damping off)
-  Rhizoctonia bottom rot
-  Sclerotinia drop
  - Septoria leaf spot
  - Viruses





# Lettuce Issues:

## Thrips & Damage



## Fusarium Wilt





# Lettuce Issues:

**Downy Mildew**



**Bacterial Soft Rot**



# Lettuce Issue?

**Bottom Drop  
(Rhizoctonia)**



**Sclerotinia White Mold**



# Swiss Chard

*Beta vulgaris*



- Related to beets
- Consume leaves and stems
- Heat tolerant

## Production

- Start with seed or transplants.
- Plant in rows 18 inches apart.
- Seed 6-12 inches apart & 1/4 inch deep.
- Soil pH slightly acidic.
- 10-10-10 at planting and later.

## Harvest

- 45-60 days after planting.
- Harvest leaves and petioles.





# Swiss Chard & Beets

## Insect pests:

-  Aphids
-  Beetles
-  Caterpillars
- Grasshoppers
- Leafhoppers
- Leafminers (*Liriomyza* sp.)
- Mole Crickets
- Plant Bugs
- Stinkbugs
- Weevils
- Wireworms

## Diseases:

- Alternaria leaf spot
-  Cercospora leaf spot
-  Downy mildew
- Powdery mildew
- Pythium (damping off)

### Leafminer Damage



### Cercospora Leaf Spot



# HERBS



**Basil**



**Parsley**



**Dill**



**Cilantro**

# Herbs: Culture

<b>Herb</b>	<b>Growth Cycle</b>	<b>Propagation</b>	<b>Spacing</b>	<b>Part Used</b>	<b>Harvest</b>
Basil	annual	seed or transplants	4-12"	leaves	as needed
Cilantro	annual	seed or transplants	6-12"	leaves	as needed
Dill	annual	seed or transplants	4-12"	seedheads	as needed
Parsley	biennial	seed or transplants	6-12"	leaves	as needed

# Herbs

## Basil Downy Mildew

### Insect pests:

- Aphids
- Beetles
- Caterpillars
- Grasshoppers
- Leafhoppers
- ⚡ Leafminers
- Mites
- Plant Bugs
- Planthoppers

### Diseases

- Alternaria leaf spot
- Bacterial leaf spot
- Cercospora leaf spot
- Powdery mildew
- Damping off
- ⚡ Downy mildew (Basil)



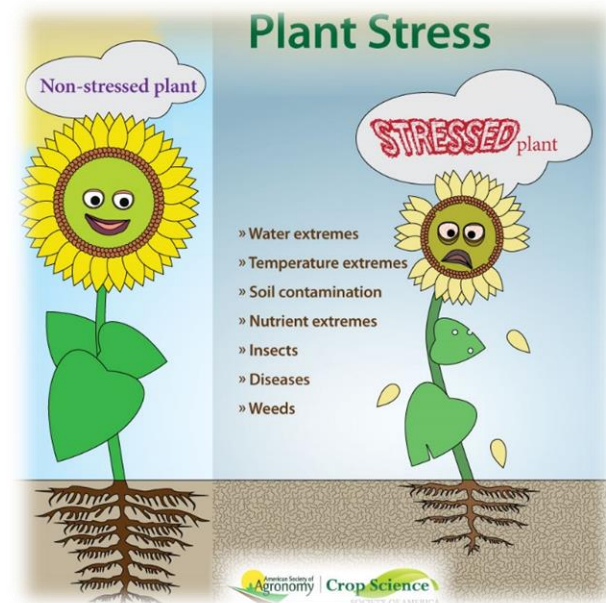


# Getting a Good Start

- Implement an IPM strategy
- Testing
  - Soil & Nematode
- Aerate the soil
  - Hand or machine
- Incorporate soil amendments
  - Slow-release fertilizer
  - pH adjusters
  - Organic matter
- Form beds if prone to flooding.
  - 6-8 inch high & 12-48 inch wide.
- Plant extra seed & thin later.
  - Not all will germinate.
  - Pests may damage others.
  - Or start with transplants.

## The 6 Principles of IPM

- Prevention
- Scouting
- Management Guidelines
- Numerous tools & tactics
- Evaluation
- Record keeping





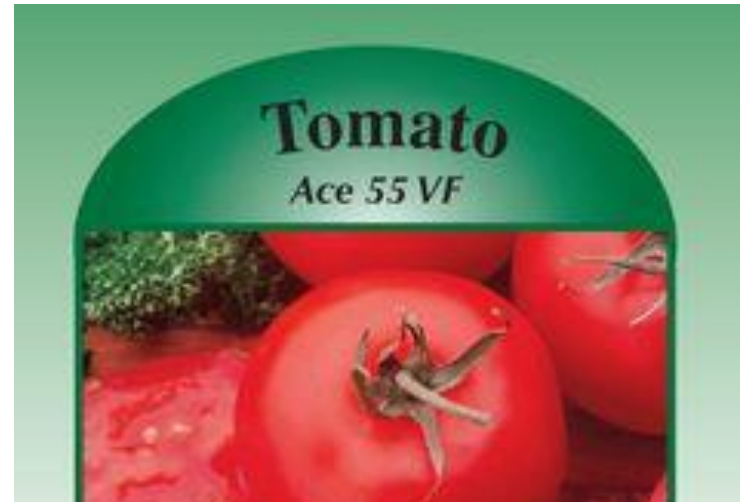
# Planning is a Critical Step to Success

## Variety Selection

- Time of year
- Local pests & diseases
  - Resistance
  - Tolerant
  - Fungicide treated seed
  - Grafted
    - Heirloom varieties have less pest resistance



## Plant Resistance



- A = Alternaria Stem Canker
- T = Tobacco Mosaic Virus
- TSWV = Tomato Spotted Wilt
- V = Verticillium Wilt
- F = Fusarium Wilt
- N = Nematodes
- S = Grey Leaf Spot



# Limiting Disease and Pesticide Use

## What can be done?

- Scout early & often.
- Remove pests by hand.
- Proper ID & pesticide choice.
- Spot-treat problems.
- Utilize beneficials:
  - Properly ID.
  - Use softer pesticides.
    - Not broad spectrum.
    - Short REI.
  - Use selective pesticides.
  - Keep or plant refugia.
  - Have a no-spray zone.
  - Purchase & release.

## What else can be done?

- Start with clean seed.
- Start with health plants.
- Good cultural practices.
  - Right plant, place, time.
  - Irrigation & nutritional BMPs.
- Good sanitation habits
  - Clean hand-tools after use.
  - Work young to old plants & clean to dirty areas.
  - Use mature compost.
  - Remove diseased plants.
  - Kill weeds before they seed.

# Weed Management Strategies

- Early-season competition critical
- Integrate mechanical, cultural and chemicals:
  - Cultivation
  - Herbicides
    - Preemergent &/or Postemergence
  - Row spacing
  - Seed spacing
- Herbicide performance depends on:
  - Weather
  - Irrigation
  - Soil type
  - Proper weed identification
  - Accurate application
  - Timing

## Cultural Practices:

- Start with weed-free seed.
- Help crop get good start.
- Kill weeds before they go to seed.
- Minimize soil disturbance.
- Use physical means to remove.
- Mulch.
- Solarization.
- Chemical herbicides as last resort.
  - Small weeds easier to kill.

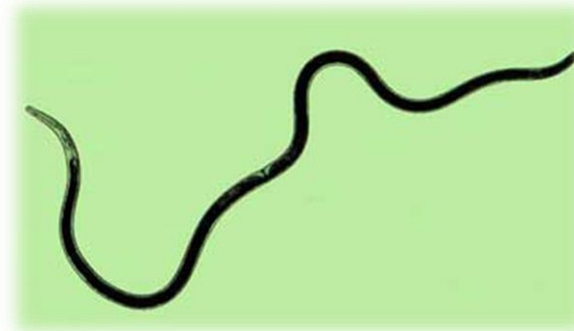


# Nematode Management

- Microscopic Worms
  - Thrive in sandy soil.
  - Root feeders
    - Stunted roots
    - Root distortion (galls)
    - Root lesions & necrosis
  - Prevention
    - Plant in clean soil
    - Avoid already damaged plants
  - Crop rotation
  - Root destruction
  - Flood
  - Fallow period
  - Summer solarization
  - Nematicides – Not all are fumigants (oxamyl, fluensulfone).
- **Resistant varieties**
    - Tomato
    - Bean
    - Sweet potato
    - Bell Pepper
    - Cucumber
    - + others



*Spurge is a good indicator of nematode activity*





# Nematode Management

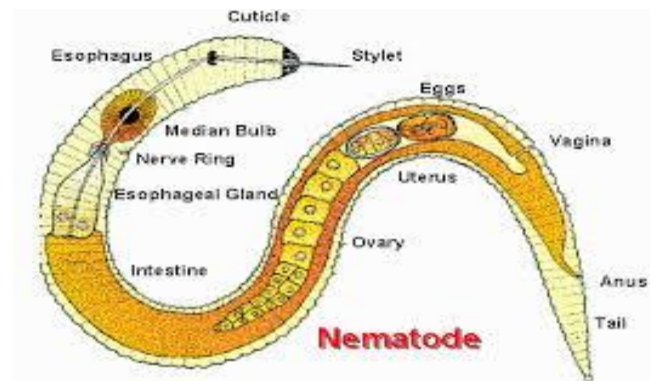
## Summer Solarization

- kills seed in top 4" of soil
- will not kill all nematodes
- takes 3-4 months to work



## Manure & Compost

- usually good source of N & K.
- usually low in P.
- also contain micronutrients.
- nutrients are more slowly available than commercial fertilizers.
- great source of organic matter.
- deters nematodes by reducing the air space between soil particles thus reducing their mobility.





*“The label is the law.”*

- **Pesticide labels must be followed by all.**
  - For personal and environmental safety.
  - Even by dooryard & backyard growers.
  - Includes – reentry (REI) & preharvest (PHI) intervals.
    - REI = Restricted Re-entry Interval.
      - Required wait time after application until allowed to enter treated area.
- **Crop & application site must be on label.**
  - Turf vs. Ornamentals vs. Edible Crops
  - Specific fruits and vegetables.



***“The label is the law.”***

**PHI = required wait time after application until harvest.**

**Harvesting a crop before the PHI expires is illegal.**

- Will be stated on product label.
- Following the PHI reduces risk from pesticides on food.
- Time listed tested to minimize pesticide residues.
- Wait times differ between products and crops.
- For products that can be applied up to the day of harvest, label may list '0' (zero) days or there may be no time listed.



# Fertilizing

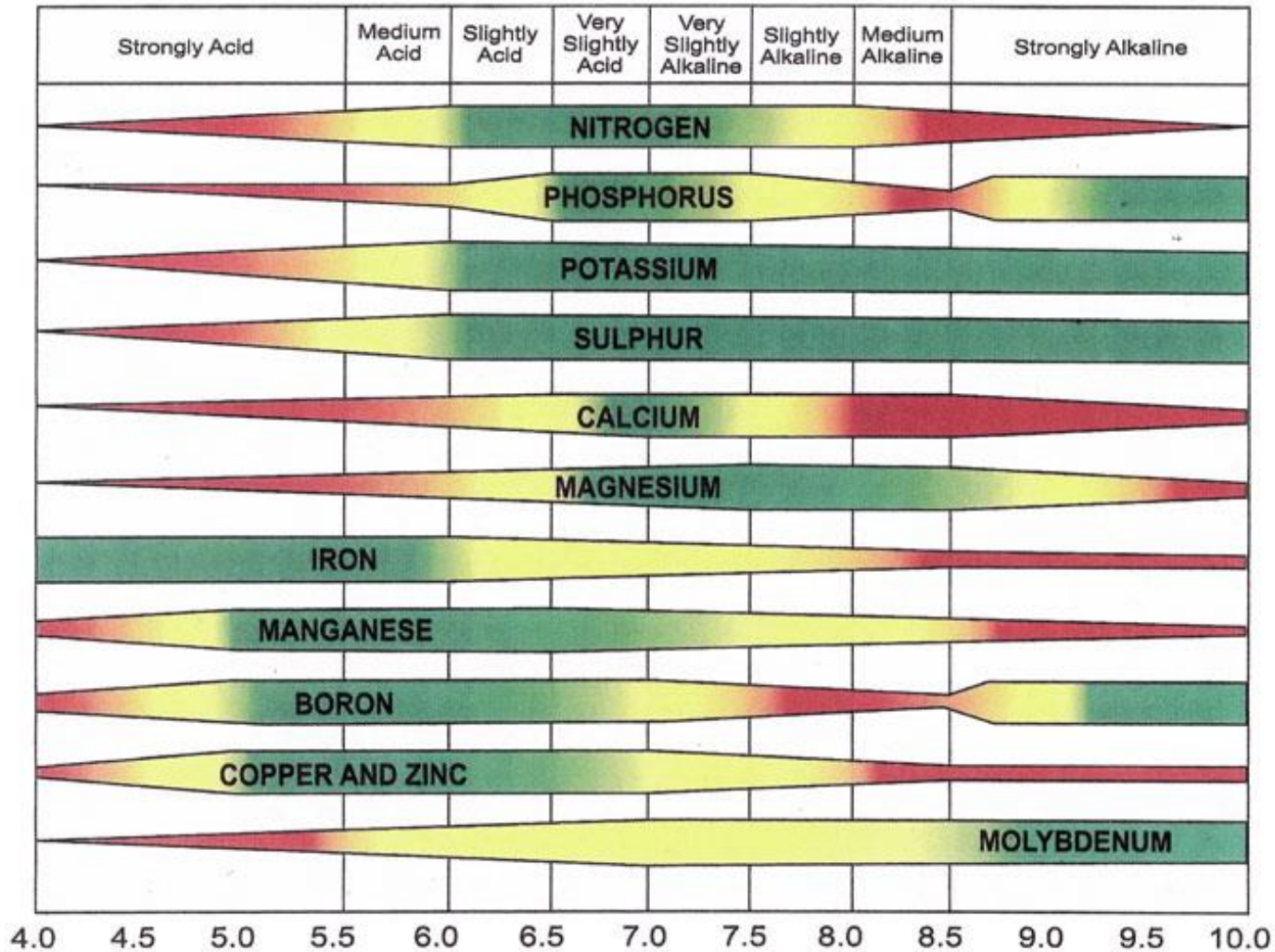
- Follow label instructions & test recommendations.
- Too much fertilizer:
  - Burns plants
  - Reduced yields
  - Encourages pests
  - Leaches into our waters
- 100sq.ft
  - 1lb 6-0-6
  - 1/3lb 15-0-15
- Sandy soils: 4-2-4
  - 2-3wks
  - Less often for organic & slow release fertilizers.
- Water the roots
  - Keep foliage dry for less disease.
- Water early morning to reduce disease development.
- Veggies need about 1-inch per week.



# General Fertilizer Management

- It is always best to have soil tested for pH and nutrient recommendations.
  - Split applications of recommended rate throughout season via sidedress.
- Common fertilizer (N-P-K) grades: 6-6-6, 6-8-6, 10-10-10, 20-20-20.
  - 6-8-6 = 6% nitrogen (N); 8% phosphorus (P) and 6% potassium/potash (K).
  - The higher the number in the grade, the more nutrient there is.
    - 10-10-10 is half as concentrated as 20-20-20.
- Leafy crops (cabbage, kale, collards, lettuce, spinach) need extra N.
  - Additional N via 2-3 applications of soluble 1/4-1/2 pounds per 100 sq. ft.
  - Avoid extra nitrogen on muck and peat soils.
- Soils near limestone, shell-rock, near concrete may have Phosphorus.
  - Additional P is a pollutant to surface water such as lakes and rivers.
- Tuber and root crops need a higher percentage of potash (K).
  - Sweet potatoes, potatoes, beets, carrots and turnips,
  - Additional potash via 1/4 pound of muriate of potash per 100 square feet.
- Other elements are needed by plants, but these are usually present in the soil or are needed only in relatively minute quantities
  - Micronutrients: S, Ca, Mg, Fe, Mn, Cu, B, Zn, and Mo.

## How soil pH affects availability of plant nutrients.



# Soil pH

- Most fruit and vegetable crops prefer slightly acidic soil (less than 7.0).
  - pH = 6.8 - 5.0
    - Potato, tomato, sweet potato, watermelon, blue berry, strawberry
  - pH = 6.8 - 5.5
    - Bean, pea, carrot, corn, kale, parsley, pepper, radish, squash, turnip
  - pH = 6.8 - 6.0
    - Beets, broccoli, cauliflower, Chinese cabbage, lettuce, spinach, okra, onion
- Soil may be alkaline (above 7.0) due to limestone, shell-rock, concrete.
  - Alkaline water from wells used for irrigation is also a factor.
  - Alkaline soil conditions can make minor elements unavailable to the crop.
    - Particularly manganese and boron.
- Acidic soils may make certain nutritional elements unavailable too.
  - Particularly calcium and magnesium
- Soil pH can be adjusted:
  - These adjustments are temporary and require extensive amounts of materials.
    - Upward for acidic soils with lime, egg shells
    - Downward for alkaline soils with sulfur, pine needles/bark, coffee grounds

# Vegetable Pests and Disease

## -Part 2 Topics-

- Specialty Winter Crops
  - Crucifers: Broccoli, Cauliflower, Cabbage, Kale
  - Spinach
  - Lettuce
  - Swiss Chard
- Herbs
  - Parsley, Cilantro, Dill, Basil
- Getting a Good Start
  - Planning ahead
  - Limiting Disease & Pesticide Use
  - Weed Management Strategies
  - Nematode Management Strategies
  - REI – Restricted Entry Interval
  - PHI – Preharvest Interval
  - Fertilizer Management



# Acknowledgments

**Special thanks to the colleagues sharing information from which this presentation drew as resources.**

- IPM Florida (<http://ipm.ifas.ufl.edu/>)
- UF/IFAS Palm Beach County Extension
  - <http://discover.pbcgov.org/coextension/Pages/default.aspx>
- UF/IFAS – Small Farms (<https://smallfarm.ifas.ufl.edu/>)
- University of Georgia Extension (<https://extension.uga.edu/>)
- <https://www.ipmimages.org/>
- <https://www.slideshare.net/>
- <http://edis.ifas.ufl.edu/>
- <https://www.bugwood.org/>

# Thank You

# Any ?'s



- Christian Miller
  - [cfmiller@ufl.edu](mailto:cfmiller@ufl.edu)
  - 561-233-1718
  - UF/IFAS Palm Beach County Extension
    - <http://www.pbcgov.com/coextension/>
    - 559 N. Military Trail,  
West Palm Beach, FL 33415