

# **Diseases in the Vegetable Garden**

**How to recognize, understand, and control  
them.**

Jim Stark  
UMass Boston

Boston Natural Areas Fund  
Gardeners Gathering  
March 26, 2016

# What causes plant diseases?

- Bacteria
- Fungi
- Viruses

# How much do plant diseases affect crop and garden production?

Lots.

- ~14% of all global crop production lost to disease.
- Losses perhaps much greater under organic growing methods. (?)

# How much do plant diseases affect crop and garden production?

From personal, not-very-scientific experience:

**Early 1990s, Pre-Disease**



**About the  
same yield.**

**Now**



**= approximately 75% yield reduction!**

# A Rogues Gallery of Vegetable Diseases

- Mildews
  - Powdery Mildew
  - Downy Mildews
- Clubroot
- Vascular Wilts
  - Verticillium Wilt
  - Fusarium Wilt
- Foliar Diseases
  - Septoria Leaf Blight
  - Early Blight
  - Late Blight

**-Symptoms**

**-Biology/Life Cycle**

**-Control**

# Powdery Mildews

- Affect squash, pumpkin, cucumber, peas.
- Whitish “powdery” appearance on leaves.
- Weakens, can kill plant.
- Can produce overwintering spores.
- Main source of infection is probably airborne spores from southern states.



Powdery mildew on summer squash leaf

# Powdery Mildews



Powdery mildew on summer squash

# Powdery Mildews, Control

- Commercial products, various.
- Homemade sprays:
  - Milk?
  - Baking soda?
- Effectiveness? Unclear.

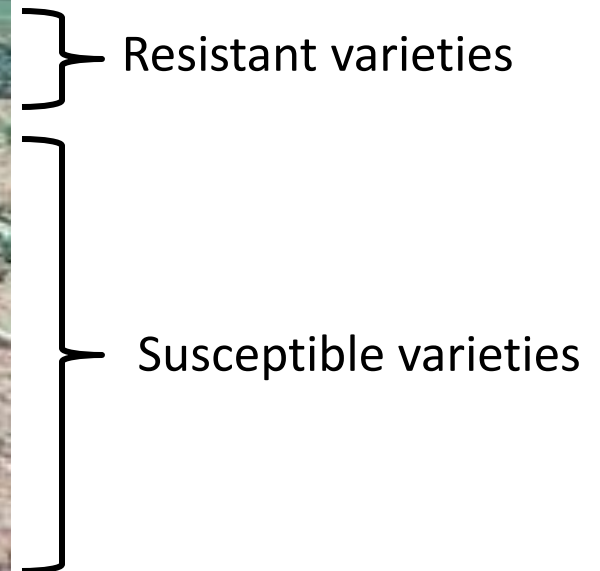


# Powdery Mildews, Control

- Plant resistant varieties. Very effective.  
Available for squash, pumpkin, cucumber, pea.



Pumpkin and winter  
squash field test



# Powdery Mildews, Control

- For lists of disease resistant vegetable varieties:  
<http://vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm>
- Many resistant varieties are available for squash, cucumber.



## **Golden Glory** (F1) Squash Seed

Product ID: 3837

### Spineless yellow zucchini.

High-yielding plants with an open growth habit making it easy to harvest blemish-free fruit. Excellent disease resistance keeps the plant productive over a long season. Medium dark yellow color. Intermediate resistance to powdery mildew, watermelon mosaic virus, and zucchini yellow mosaic virus. Avg. 3,500 seeds/lb. Packet: 30 seeds.

Johnny's Seeds



## **Metro PMR** (F1) Squash Seed

Product ID: 2867

Vegetables > Squash > Winter  
Squash > Butternut Squash

Smaller size with powdery mildew resistance.

[MORE DETAILS AND SIZES](#)

Johnny's Seeds

# Downy Mildew of Cucurbits

- Affects squash, pumpkin, gourds, cucumber, melons.
- Irregular yellow spots on leaves that don't cross veins.



Colucci and Holmes, American Phytopathological Society

Downy mildew on winter  
squash leaf



# Downy Mildew of Cucurbits

- In later stages, extensive browning of leaves. “Scorched” effect. →
- Weakens, can kill plant.



Colucci and Holmes, American Phytopathological Society

Downy mildew on  
winter squash

# Downy Mildew of Cucurbits

- Cannot survive NE winter.
- Source of infection is airborne spores from southern states.
- Commercial growers track the advance of spores each growing season.

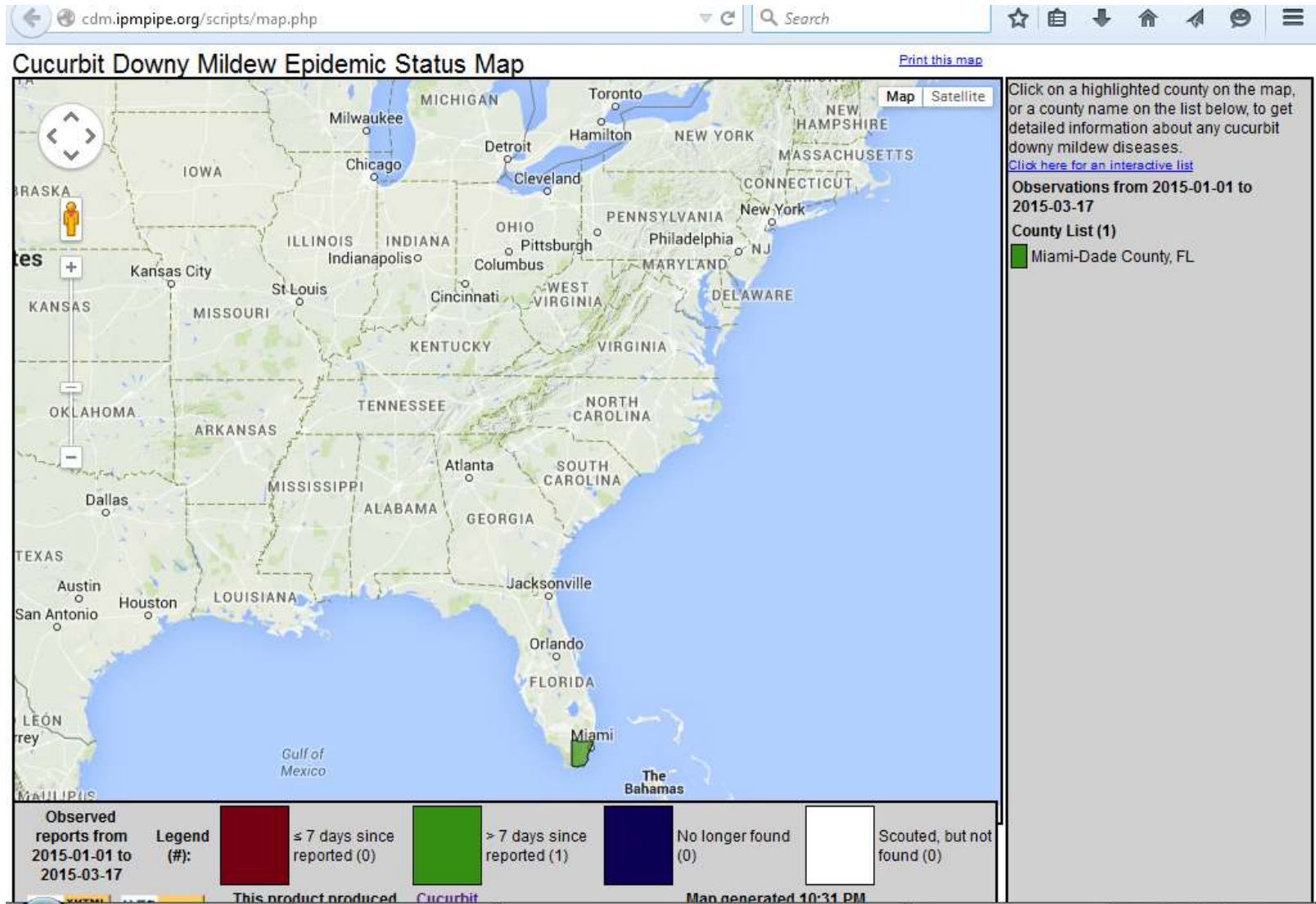


Colucci and Holmes, American Phytopathological Society

Dark spore-producing structures on  
underside of winter squash leaf

# Downy Mildew of Cucurbits

## North Carolina State U. Tracking Site



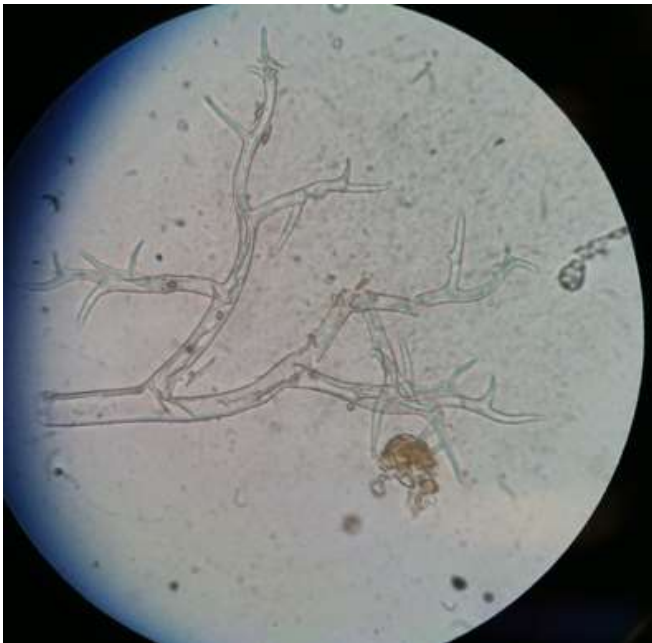
# Downy Mildew of Cucurbits, Control

- Resistant varieties
  - Many cucumber varieties are resistant to older strains of the disease.
  - But less so to a new strain of downy mildew that appeared in 2004.
  - Resistance is rarer in summer and winter squash.
- Fungicide applications. Copper somewhat effective.
- Early planting? Harvest some before the disease arrives.
- Build a greenhouse? Spores won't germinate on dry leaves.



# Downy Mildew of Basil

- Yellowing of leaves in sectors, resembles nutrient deficiency.
- Dark spore-producing structures on undersides of leaves.



Under the  
microscope.





# Downy Mildew of Basil

- Unknown in USA before 2007, but now established down south.
- Cannot survive NE winter.
- Source of infection is airborne spores from southern states, maybe infected transplants, maybe imported supermarket basil.



# Downy Mildew of Basil, Control

- All sweet basil varieties (Italian, pesto-type) are susceptible.
- Some lemon basils may be more resistant.
- Breeders are working on the problem.



Johnny's Seeds

**Eleonora**

Basil Seed

Product ID: 3148

*Herbs > Basil*

New! Intermediate resistance to downy mildew.

[MORE DETAILS AND SIZES](#)

**Did *not* work well for me.**



# Cucumber Bacterial Wilt

- Caused by a bacterium.
- Spread by cucumber beetles.
- Individual leaves, then entire plant wilts.

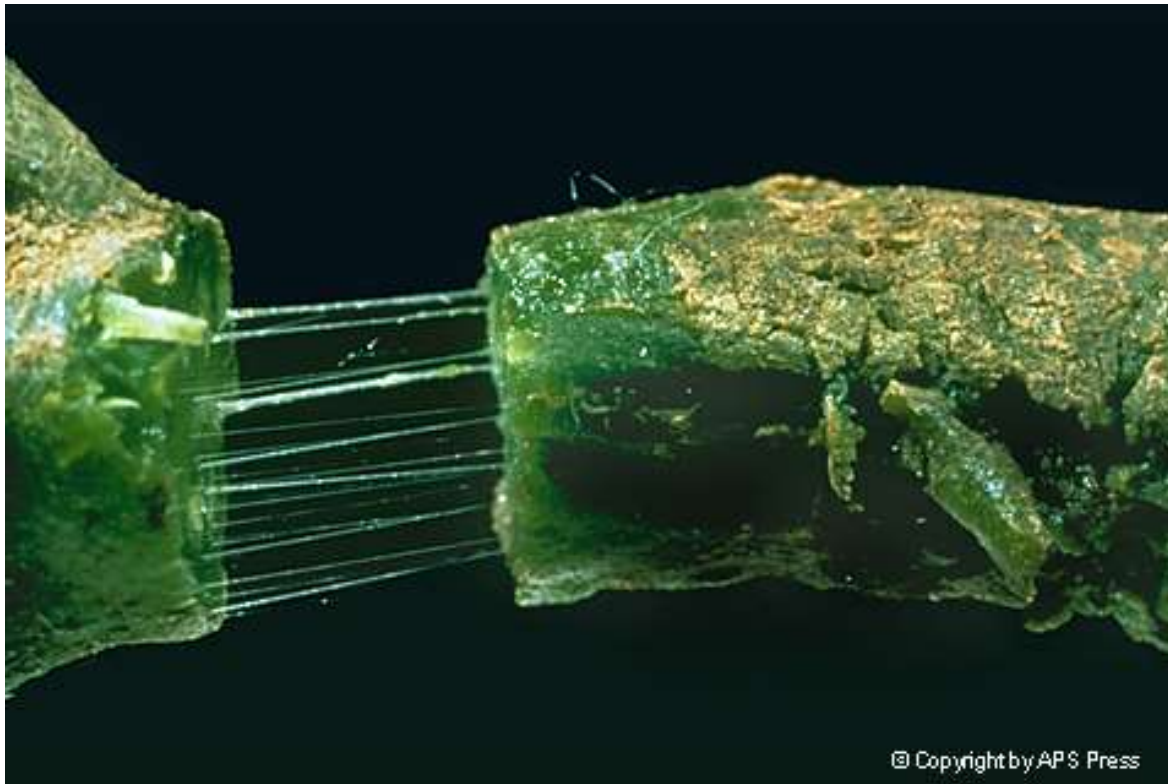


M.P. Hoffmann,  
Cornell University



# Diagnosing Cucumber Bacterial Wilt

- Cleanly cut stem, press back together, pull slowly apart.
- Look for strands of sticky bacterial ooze.




Photograph courtesy  
M. P. Hoffmann  
from the *Compendium  
of Cucurbit Diseases*

© Copyright by APS Press

# Cucumber Bacterial Wilt, Control

## Control the beetles!

- Kaolin clay?
  - Sprayed on plants.
  - Forms a barrier.
  - Must be frequently renewed.
  - Efficacy unclear.
  - Expensive.

8072	Surround at Home <sup>®</sup> Crop Protectant - 5 lbs (makes 10 gallons)
\$39.95	<input type="text" value="1"/>  <a href="#">Add to Cart</a>
8073	Surround at Home <sup>®</sup> Crop Protectant - 10 lbs (makes 20 gallons)
\$64.95	<input type="text" value="1"/>  <a href="#">Add to Cart</a>



# Cucumber Bacterial Wilt, Control

## Control the beetles!

- Row covers
  - Install at planting/transplanting time.
  - Remove 10 days after flowering begins to allow pollinator access.
  - (Or plant a parthenocarpic variety that doesn't need pollination.)



See: <http://www.ipm.iastate.edu/ipm/hortnews/2011/2-9/rowcover.html>

# Cucumber Bacterial Wilt, Control



# Cucumber Bacterial Wilt, Control

## Resistant varieties?

- Not many available.
- One gardener has had some luck (not 100%) with 'County Fair,' a pickling size cucumber.



## County Fair Improved Hybrid Cucumber

Gurney's

[Write a Review](#)

**FREE \$25 Off Any Order Of \$50 Or More!**

**Activate Offer**

**Nearly Seedless, Non-Bitter!**

High quality pickling type bears abundant yields of bitter-free fruit. Resistant to bacterial wilt and does not require a pollinator. Pick cukes at 2-4 inches for pickling; excellent for slicing at larger sizes. 52 DAYS.





# Brassica Clubroot

- Spores in soil infect roots of cabbage and relatives.
- Roots are deformed (clubbed).
- Plants are stunted.



Healthy



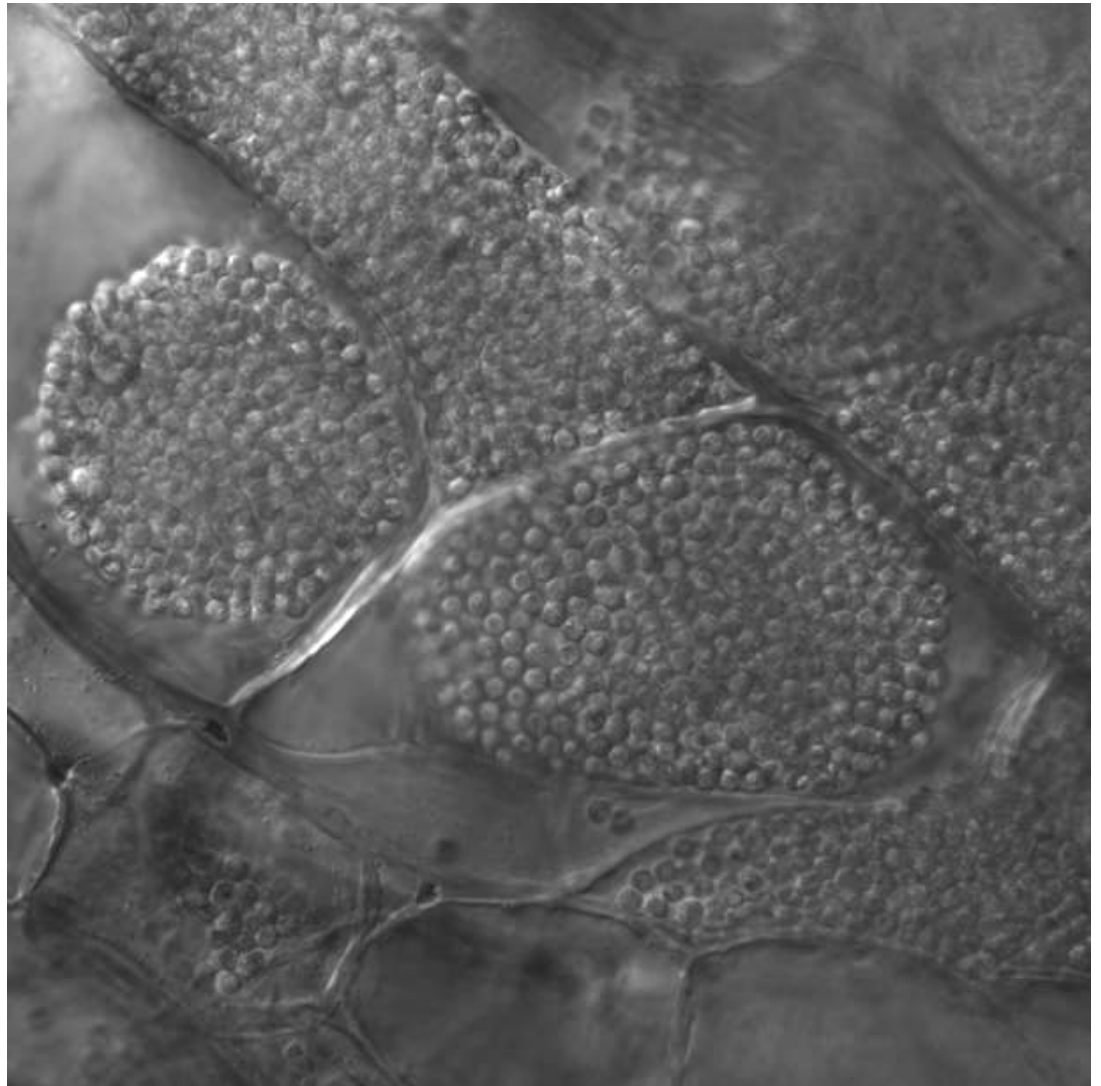
Healthy



Clubroot

# Brassica Clubroot

- Spores form inside infected plant cells.
- Spores survive winter, infect susceptible plants next season.
- Spores can stay viable for many years.



Clubroot spores forming inside collards cells.

# Brassica Clubroot, Control

- Plant resistant varieties.  
Some available.



**Bilko**  
Organic (F1) Chinese Cabbage  
Seed

Product ID: 2814G

**Full-size organic variety.**

Compared to Rubicon, Bilko is slightly bigger at 12", darker green, and a couple of days later. Wide adaptability. Slow-bolting heads have a good, mild, sweet flavor. High resistance to club root and fusarium yellows. Organically grown. Avg. 136,250 seeds/lb. Packet: 100 seeds.

Johnny's Seeds

# Brassica Clubroot, Control

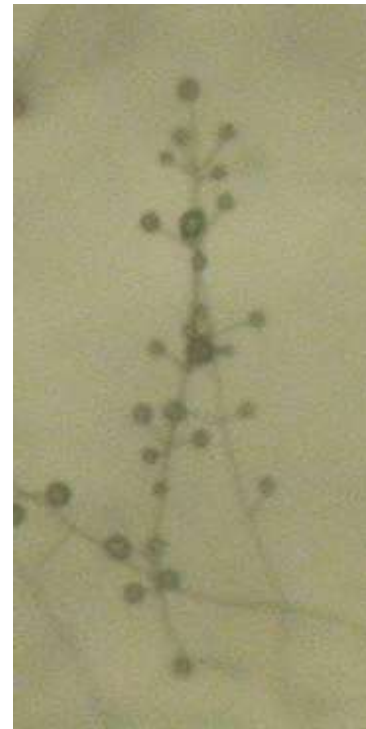
Lime soil to adjust pH to 7.2 or higher.

- Prevents spore germination.
- Hydrated lime (calcium hydroxide) thought to work better than regular garden lime (ground limestone). But is more dangerous—use gloves, eye protection.
- Have soil tested to determine the needed amount of lime.
- High pH may not benefit other crops grown in following years.

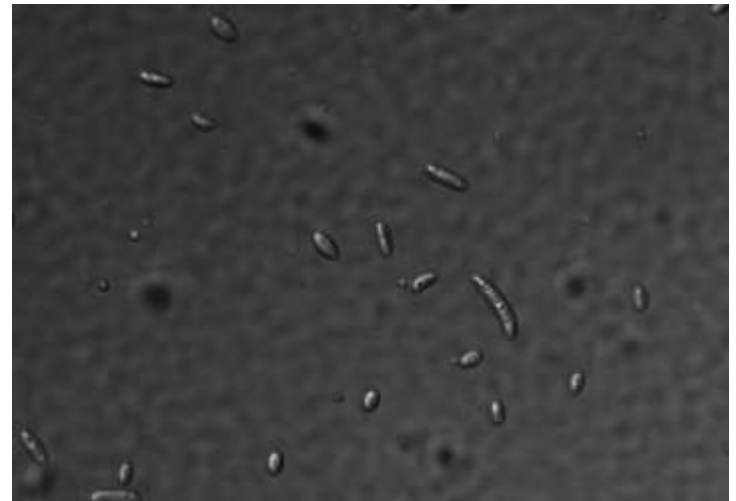


# Vascular Wilts

- ***Verticillium dahliae***: Affects tomato, eggplant, potato, many other plants.
- ***Fusarium oxysporum* f. sp *lycopersici***: Affects only tomato.
- Fungi enter plant roots, colonize and block water-conducting tissue.
- Yellowing, browning of leaf sectors.



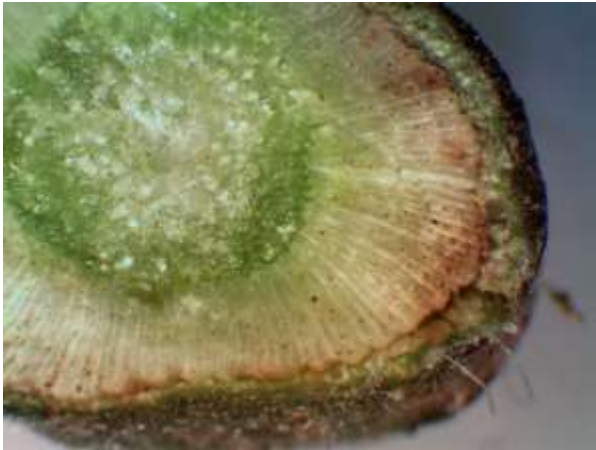
Verticillium  
sporulating  
structure



Fusarium spores

# Vascular Wilts

- Partial or total wilt of leaves.
- Brownish discoloration of conducting tissue in lower stem.



- Entire plant can wilt and be killed.





# Vascular Wilts

- Fungi make persistent resting structures that enter soil as host plant dies.
- Long rotations or soil fumigation needed to eliminate (or reduce) in soil.
- Fungi grow inside stems, so can't be reached by any sprays.



# Vascular Wilts—Which ones are present locally?

A 2015 survey of 13 community gardens and non-profit/educational farms in Greater Boston found:

- Tomato plants at all but one site exhibited vascular wilt symptoms.
- These specific pathogens were identified:
  - Verticillium Race 1
  - Verticillium Race 2
  - Fusarium Race 2



# Vascular Wilts, Control

- For tomato there are varieties resistant to Race 1 Verticillium (but not Race 2) and all 3 races of Fusarium.
- Many hybrids, or F1 hybrids are resistant (but check to be sure).



Johnny's Seeds

## Big Beef

### (F1) Tomato Seed

Product ID: 2063

Vegetables > Tomatoes >  
Indeterminate Tomatoes > Red

Nice combination of size, taste,  
and earliness.

[MORE DETAILS AND SIZES](#)

Disease Resistance Codes:

AS F2 L N TMV V



tomato flavor in every slice! Resistant to  
Verticillium Wilt, Root Knot Nematodes, Tobacco  
Mosaic Virus, and 2 strains of Fusarium Wilt.

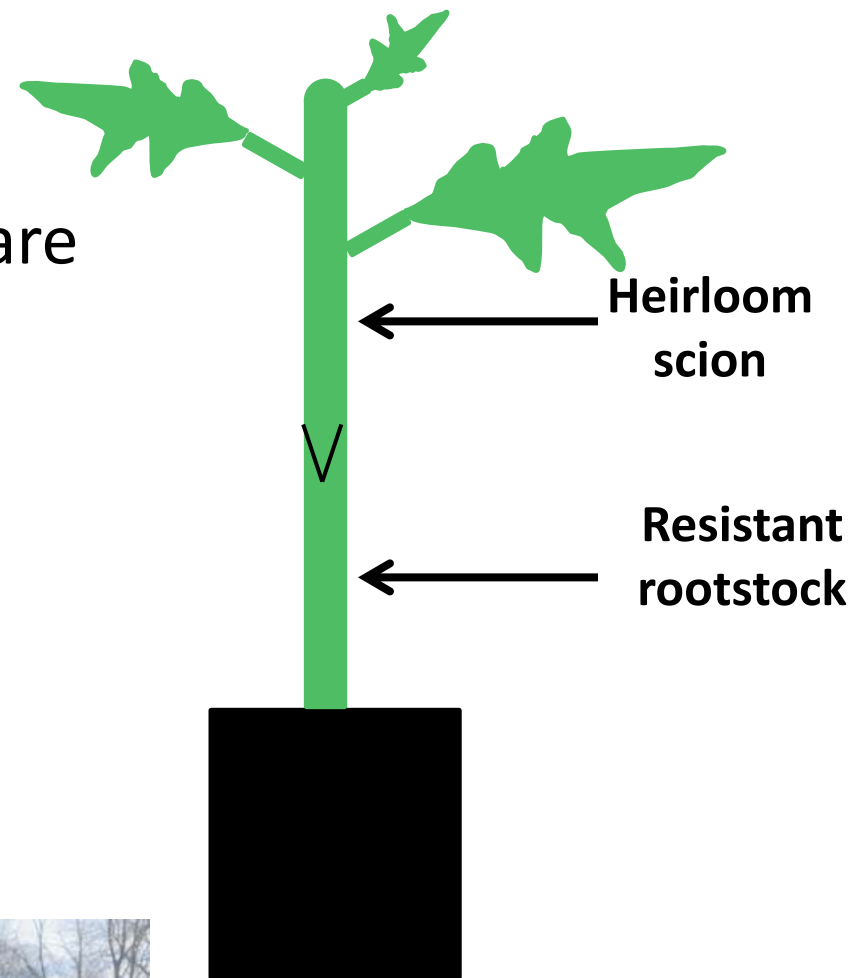


Park's Whopper CR Improved  
Tomato Seeds

Park Seed

# Vascular Wilts, Control

- No heirloom tomato varieties are resistant.
- But they can be grafted on resistant rootstock.
- Be sure to transplant with the graft union well above ground.



# Vascular Wilts, Control

- Grafted tomatoes are becoming more common.
- Expensive!

First, a word or two about grafting. Here's how it works: the top part of the tomato variety you want (in the case of this collection, either Mortgage Lifter, Cherokee Purple, or Pineapple) is attached to the root system of another, more vigorous variety. We have chosen a variety that is resistant to a wide range of tomato diseases, including Fusarium Wilt races 1 and 2, Nematodes, Fusarium Crown Root Rot, Corky Root Rot, Tobacco Mosaic Virus, and Verticillium Wilt. Unbeatable protection!

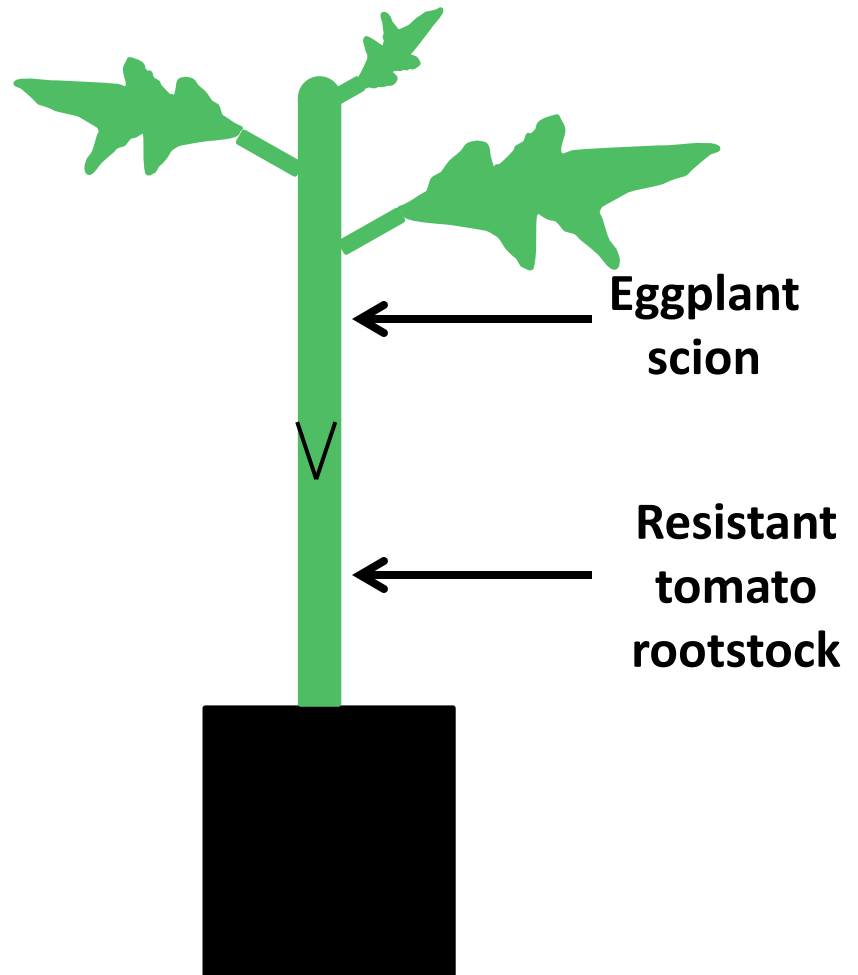


Heirloom Grafted Tomato Trio  
Annual Plant Collection

As low as: **\$24.95** Park Seed

# Vascular Wilts, Control

- For eggplant, no varieties are resistant to Verticillium.
- But they can be grafted on Verticillium-resistant tomato rootstock.
- This works for Verticillium Race 1 only. Not Race 2.



# Control Options for Verticillium Race 2

## Rotation with broccoli?

- Chop and immediately dig in residues after broccoli harvest.
- Reduces population of live Verticillium (but not to zero).
- Worked in trials in California and Japan.
- Will it work here?





# Control Options for Verticillium Race 2

## Solarization

- Cover soil with clear plastic for several weeks in midsummer.
- High heat kills many Verticillium (but not all).
- Effect is not permanent.
- Loss of most of a season's production.
- Environmental cost of all that plastic.



# Control Options for Verticillium Race 2

## Fertilization

- Well nourished plants are better able to tolerate vascular wilts.



# Tomato Foliar Diseases

- Spread via airborne spores.
  - Three important ones in New England:
    - Septoria Leaf Spot
    - Early Blight
- Can survive our winters.  
Will occur every year.  
Damaging, but not usually lethal.
- Late Blight
- Less likely to survive our winters.  
Appears occasionally.  
Rapidly lethal.



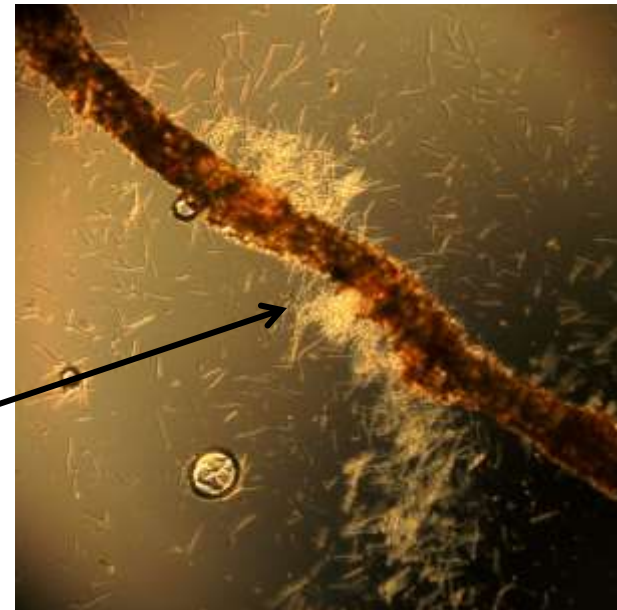
# Septoria Leaf Spot

- Affects tomato.
- Overwintering spores in soil splash onto lower leaves, fungus invades leaf tissue.
- Brown circular spots form, studded with tiny spore-producing structures.



Spore-  
producing  
structures

Spores



# Septoria Leaf Spot

- New spores are produced, infect upper leaves.
- Leaves drop, plant weakens.
- Spores can survive over winter, at least one season.

Upper leaf surface



Lower leaf surface





# Early Blight (Alternaria Blight)

- Affects tomato, potato.
- Overwintering spores in soil splash onto lower leaves, fungus invades leaf tissue.
- Brown “bullseye” circular spots enlarge.



**“Bullseye”,  
target-like  
spots with  
concentric  
rings**

# Early Blight (Alternaria Blight)

- Lower leaves are affected first.
- New spores are produced, infect upper leaves.
- Leaves wither and drop, plant weakens.





# Septoria and Early Blight, Control

- Garden sanitation.  
Remove and destroy infected plant matter to reduce the number of overwintering spores.
- Fertilize regularly. Well-fed plants “keep ahead” of the blights.
- Avoid wetting foliage.  
Spores can’t germinate on dry leaves.



?

# Septoria and Early Blight, Control

- Plant resistant varieties.

Several available with some resistance to early blight.



Johnny's Seeds

## Juliet

### (F1) Tomato Seed

Product ID: 707

Vegetables > Tomatoes > Saladette and Sauce Tomatoes

Small mini-roma flavor fresh or cooked.

[MORE DETAILS AND SIZES](#)

Intermediate resistance to early blight.



Johnny's Seeds

## Mountain Magic (F1) Tomato Seed

Product ID: 2513

Excellent flavor and late blight resistant.

Mountain Magic produces high yields of 2 oz., bright red, round salad tomatoes with very sweet flavor. The uniform, crack-resistant fruits may be truss harvested. Great in salads or right off the vine. Intermediate resistance to early blight. Indeterminate. Avg. 150,000 seeds/lb. Packet: 1! seeds.

# Septoria and Early Blight, Control

- Plant resistant varieties
  - Resistance to Septoria is rarer, but there are some varieties.



## Jasper

### Organic (F1) Tomato Seed

Product ID: 3812G

Small, deep red cherry resists late blight.

Round, 7-10 gm. fruits are crack resistant, borne on small trusses, and store on the plant well, resisting cracking and rot. The texture is pleasantly chewy, and the flavor is sweet and rich. Plants are extra vigorous and tall, staying healthy for a long picking period. Intermediate resistance to early blight, Septoria Leaf Spot, fusarium races 1 & 2, and late blight. Indeterminate. AAS winner. Organically grown. Avg. 300,000 seeds/lb. Packet: 15 seeds.

Johnny's Seeds



# Septoria and Early Blight, Control

- Plant resistant varieties
  - ‘Iron Lady.’ New variety with resistance to both Septoria *and* Early Blight.
  - (Also resists vascular wilts and late blight!)
- Flavor?



Organic Non-GMO Iron Lady F1 Tomato - HYBRID

High Mowing Seeds

Fight the blight with this disease resistant red slicer! Impressive disease resistance including Early and Late Blights. Fine textured fruit is both dense and juicy with good tomato flavor. Plant away from susceptible varieties for best results. From our collaboration with Cornell University and North Carolina State University. Determinate • 5 oz. (*Lycopersicon esculentum*)

Days to maturity: 75 days



Disease Resistance: Late Blight, Early Blight, Fusarium Wilt (races 1,2), Verticillium Wilt, Septoria Leaf Spot



# Late Blight (Phytophthora Blight)

- Affects tomato, potato.
- Occasional, sporadic outbreaks in NE.
- Airborne spores grow to produce “water-soaked” darkened regions on leaves and stems.



# Late Blight (Phytophthora Blight)

- White, fuzzy spore-producing structures form.





# Late Blight (Phytophthora Blight)

- Infected area enlarges quickly, can cause rapid wilting, death.
- This is the disease that caused the Irish Potato Famine.
- Once infected, plants usually can't be saved. Rapid action is needed to contain the outbreak.



# Late Blight (Phytophthora Blight)

- Causal organism can only survive our winters in living host plant tissue (not as dormant spores).
- Can live overwinter underground in infected potato tubers. When these sprout in spring they can spread the disease.
- Can arrive in NE on infected transplants.

**Infected potato tuber.**



American Phytopathological Society



# Late Blight (Phytophthora Blight), Control

- Garden sanitation. Destroy or dispose of infected plants. (Do this immediately upon diagnosis.) Do not compost.
- Don't leave potato tubers in the ground over winter. Eliminate any sprouts from overlooked tubers.

**Infected sprout growing from an infected tuber.**



American Phytopathological Society

# Late Blight (Phytophthora Blight), Control

- Plant resistant varieties. Several are available for tomato.



## Mountain Magic (F1) Tomato Seed

Product ID: 2513

Excellent flavor and late blight resistant.

Mountain Magic produces high yields of 2 oz., bright red, round salad tomatoes with very sweet flavor. The uniform, crack-resistant fruits may be truss harvested. Great in salads or right off the vine. Intermediate resistance to early blight. Indeterminate. Avg. 150,000 seeds/lb. Packet: 1! seeds.

Johnny's Seeds

## Organic Iron Lady F1 Hybrid Tomato



### 'Iron Lady'

Resistant to:  
-Late Blight  
-Early Blight  
-Septoria  
-Verticillium  
-and Fusarium!

High Mowing Seeds



## Jasper

### Organic (F1) Tomato Seed

Product ID: 3812G

Vegetables > Tomatoes > Cherry Tomatoes > Indeterminate; Red

Small, deep red cherry resists late blight.

[MORE DETAILS AND SIZES](#)

Johnny's Seeds

# Conclusions

- Plant resistant varieties for powdery mildews.
- Keep beetles away from cucumber vines to reduce bacterial wilt.
- Combat cabbage clubroot with resistant varieties and/or soil pH adjustment.
- Resistant varieties or grafting may help combat vascular wilts of tomato, eggplant.
- For leaf diseases of tomato, garden sanitation may reduce spore counts. Resistant varieties are available. Some even resist multiple leaf diseases.
- Late Blight endangers others' gardens as well as yours. Timely action may prevent a wider outbreak.

# Useful Links

For more information on the biology, life cycles and control of plant pathogens:

- Vegetable MD Online, Cornell University  
<http://vegetablemdonline.ppath.cornell.edu/>
- The American Phytopathological Society, Plant Disease Lessons  
<http://www.apsnet.org/edcenter/intropp/lessons/Pages/default.aspx>

For seeds of varieties mentioned in this presentation:

- Johnny's Seeds  
<http://www.johnnyseeds.com/>
- Gurney's  
<http://www.gurneys.com/>
- Park Seed  
<http://parkseed.com/>
- High Mowing Seeds  
<http://www.highmowingseeds.com/>



**Please sign the sheet if you would like a copy of this presentation.**

**Please contact me with any questions, or to participate in a summer 2016 survey of plant diseases in greater Boston vegetable gardens.**

**james.stark@umb.edu**