

# Lessons Learned over a Career about Vegetable Diseases, Management and Fungicide Resistance

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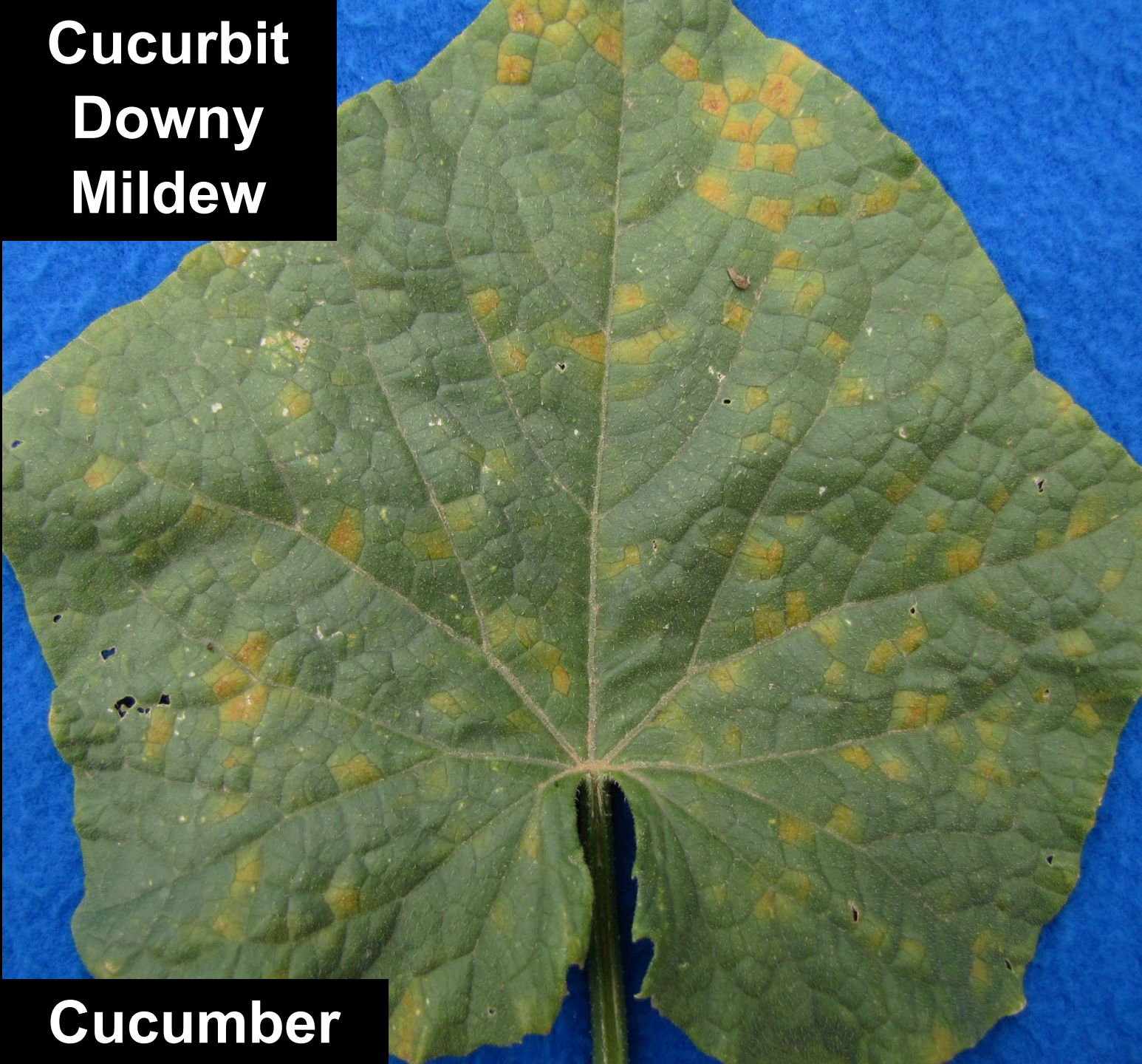
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**Overarching Theme of Lessons Learned:**

**Pathogens Change!**

**Cucurbit  
Downy  
Mildew**



**Cucumber**

**Re-emerged in 2004**

**Pathogen change:**

- Virulent on resistant cucumber varieties.

- Resistant to key fungicides: Ridomil and Quadris.

Continues to occur widely and affecting more than cucumber.





# Phytophthora Blight

cucurbits  
pepper, eggplant  
tomato  
NOT potato  
weeds (purslane)





## 2008 - Beans - *Phytophthora* blight







# Basil Downy Mildew

2007 – first seen in USA.

2001 – first seen in Europe.

1933 – reported in Uganda.

New disease – no labeled fungicides.  
IR-4 supported research + registration.

Now most important, common  
disease of basil worldwide.





# Late blight re-emerged in 2009

Pathogen change:

- More virulent on tomato.

Unique outbreak:

- Gardens source of pathogen for farms.

- Started very early (June).





# Late Blight Pandemic of 2009

Ability of this pathogen to:

- Spread
- Impact on plants and people

Importance of connected extension team in region to respond together:

- Determine what was happening
- Inform growers and gardeners



# Late Blight is Unlike Other Diseases

Can't live with it –

management required because  
of destructive potential.

Evokes extreme responses.



# Fungicide and Non-fungicide Treated Research Plots



cf. Bill Fry



# Challenges - 2009 Late Blight Epidemic

Informing and educating home gardeners.

Not knowing location of affected garden plants.

Onset very early in growing season.

Frequent rain favorable for disease, not for spraying.

Inadequate supply of key fungicides:

- Revus Top. Organic copper fungicide.

Common perennial, landscape weed susceptible.

Started in wet June.

Continued during warm, dry August.

Kept going through October with outbreaks in tunnels.



# Late Blight – Impact on Growers

Panic. Stress. Anger.

Lost crops. Some lost food.

Controlled with preventive sprays. Sprayers not ready.

Increased production costs.

Frustration response not faster and not regulated pathogen.

Decreased production in 2010.

## Organic Growers:

Many not used to spraying. Lacked equipment.

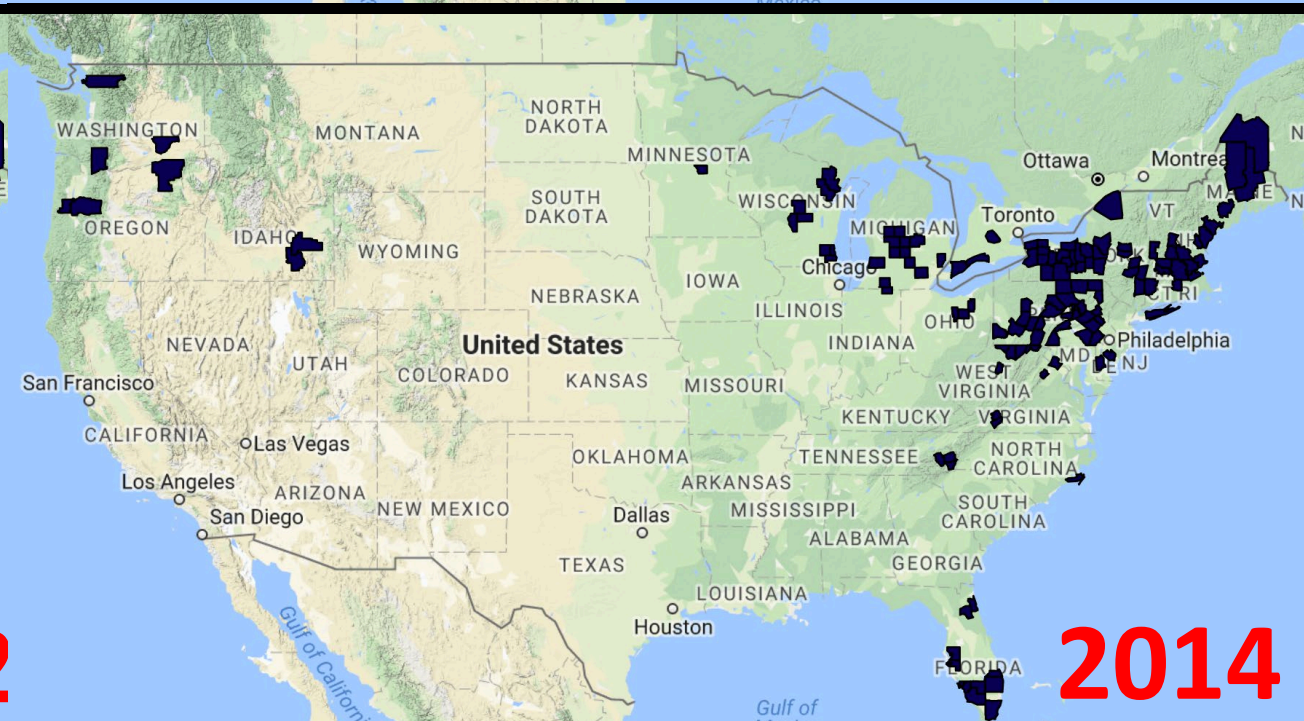
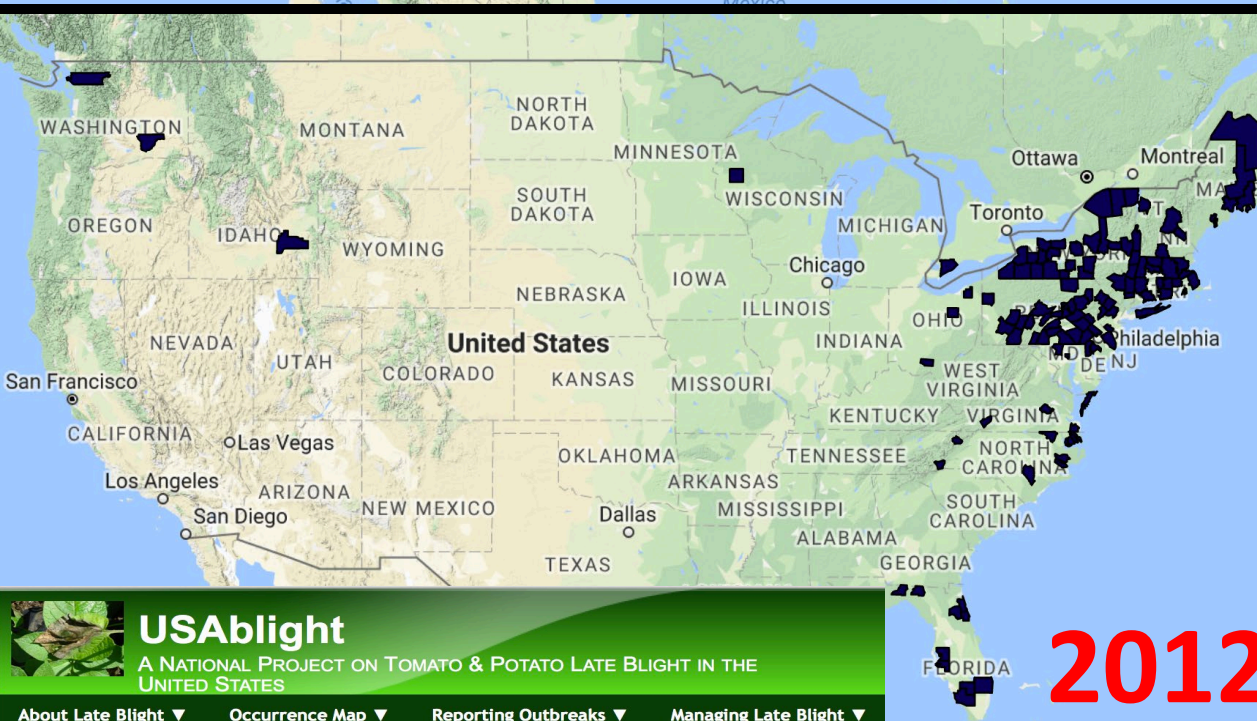
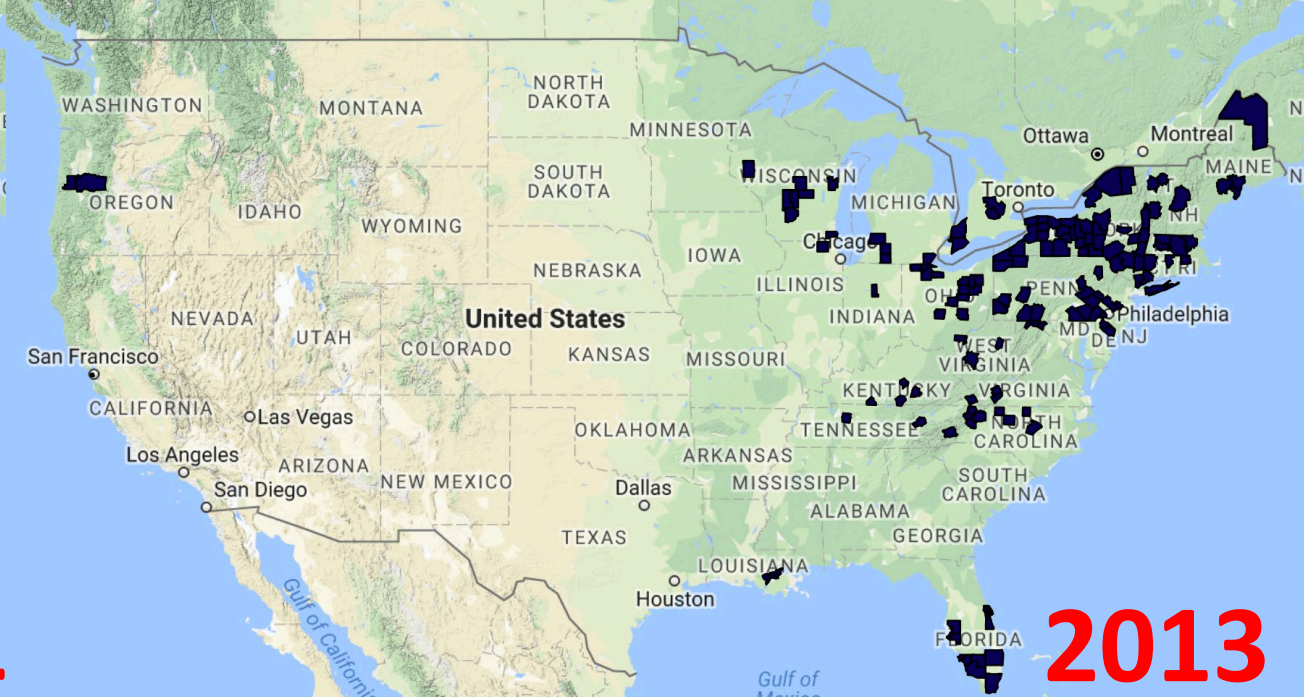
Approved copper not readily available.

Concern - increasing copper in soil.

Some certifiers limit copper use.

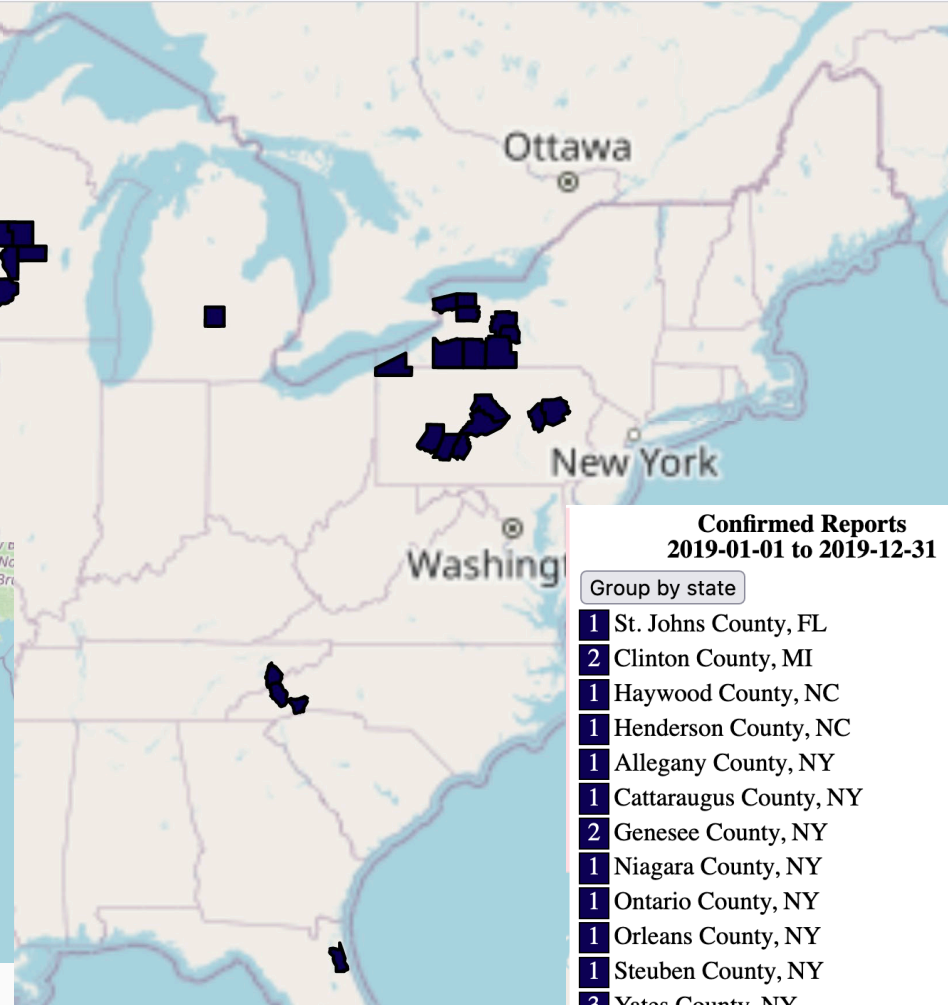
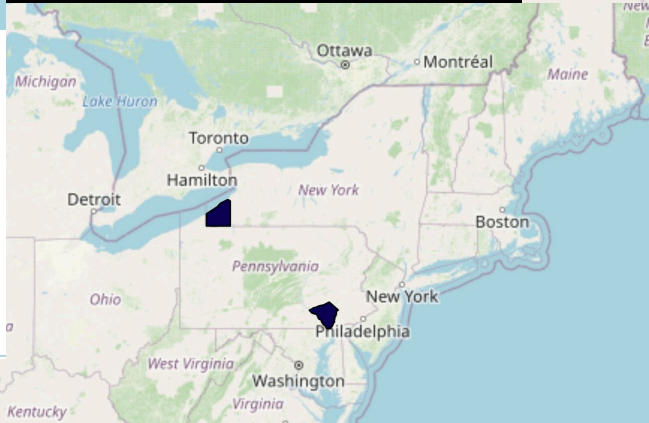
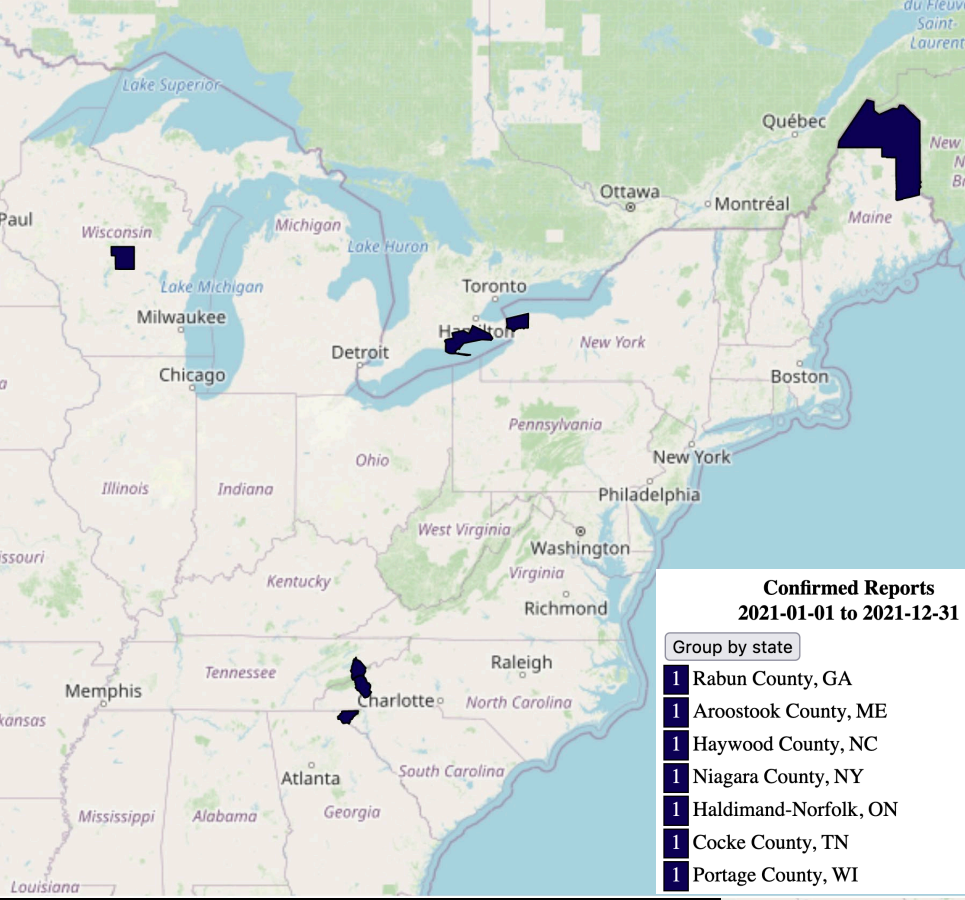
Some market pesticide-free. Dissention about fungicide use.







# Recent late blight occurrence



2021

2020

2019



# 2013-19 – Potato – *Dickeya*, *Plectosporium*



cf. Sandy Menasha



2 Seedlots

Dickeya

No  
Dickeya

14 June 2016







Impact

Politics



*Pectobacterium*  
*parmentieri*  
(*P. wasabiae*)

**Vivaldi**  
**2017**

**Stem-end rot**  
**at harvest**







# Some pathogens change A LOT!

## Spinach Downy Mildew

**Continually evolving to overcome  
race specific resistance.**

**1988 – 3 named races**

**2022 – 19 named races**

**Detected recently in northeast: 12, 14,  
15, novel. 13, 16, 17 suspected.**





# Factors Contributing to Ability of Some Pathogens to Change

- Reproduce asexually
- Short life cycle: about 1 week from infection to spore production
- Sexual reproduction important for some





Spinach Stemphilium leaf spot



Pepper powdery mildew



Garlic Rust

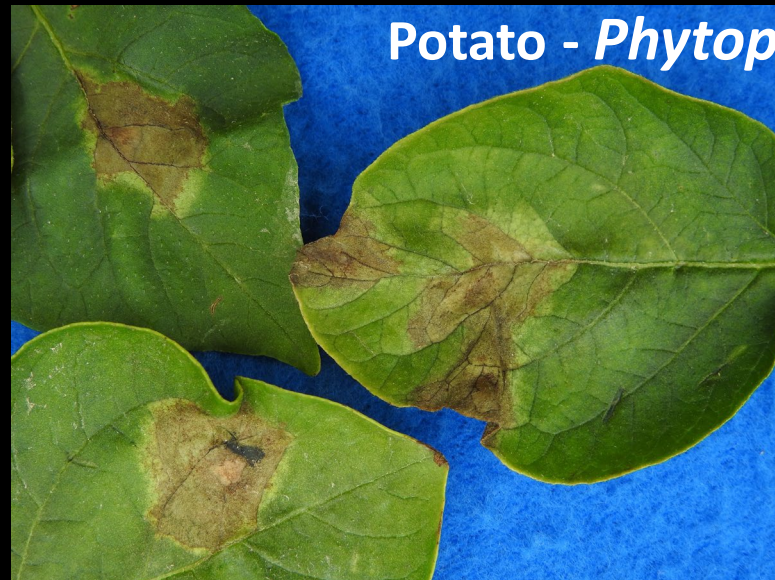


Basil downy mildew

**New diseases  
can appear!**



Potato - *Dickeya*



Potato - *Phytophthora nicotianae*





# Pepper - Powdery Mildew





# Stemphylium Leaf Spot Spinach - field



**Observed once on Long Island. 2019**

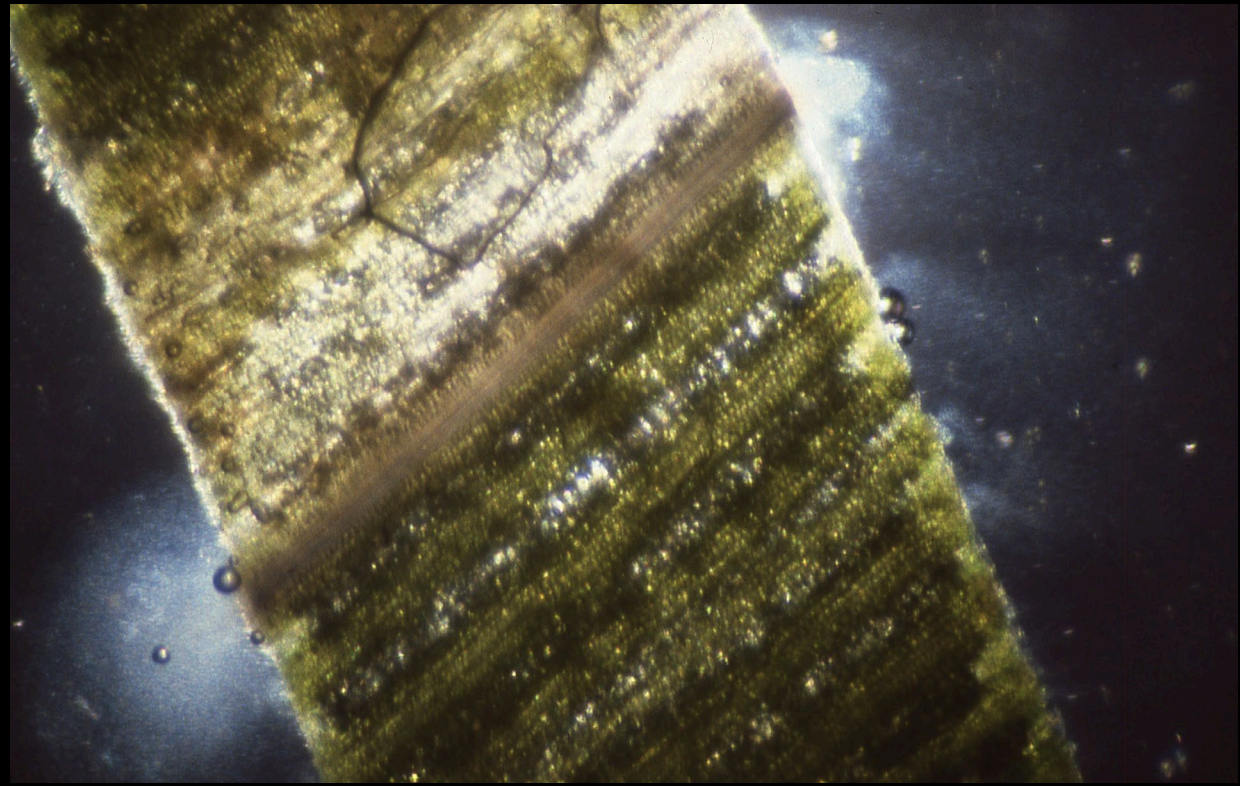
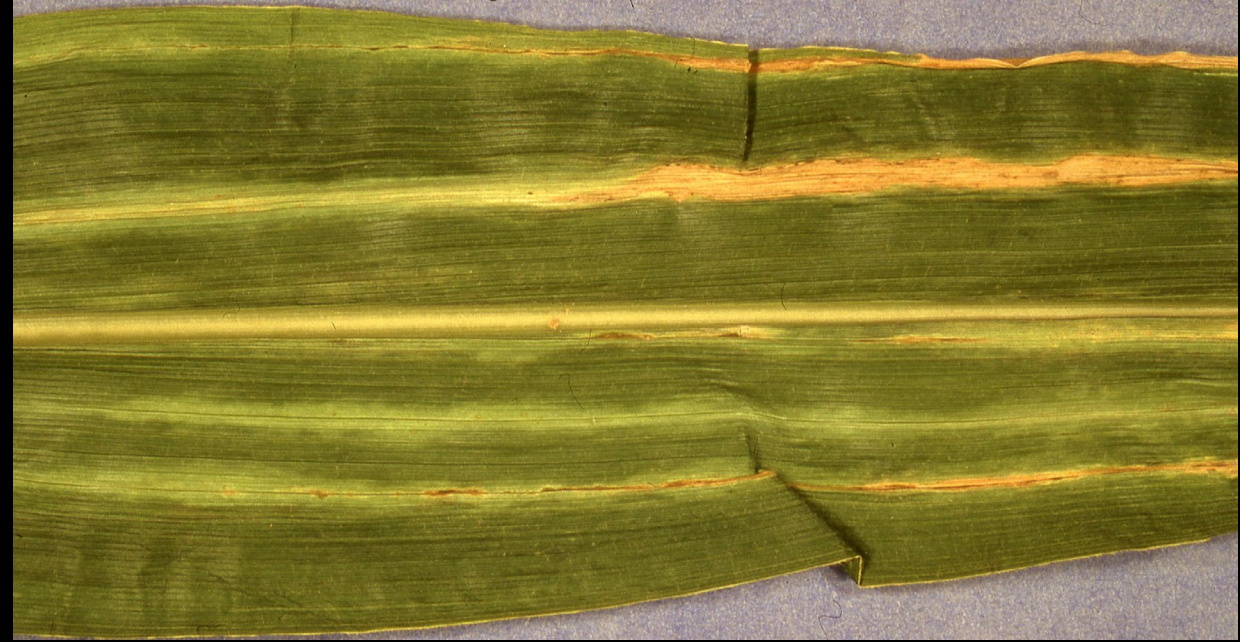
Sources: infested seed, wind-dispersed spores, crop debris.





**Some diseases disappear  
with effective management**

## **Stewart's Wilt – Sweet Corn**





**Fungicide Resistance**

**is result of**

**Pathogen Change**



# Fungicide Resistance – Lessons Learned

- Resistance often is result of a simple genetic change in pathogen.
- Resistant pathogens usually are not less fit than susceptible ones.
- Resistance potential of fungicide can be hard to predict. Ex. Qols.
- Resistance potential of pathogen can be hard to predict.  
Ex. Cucurbit gummy stem blight/black rot pathogen.
- Goal of resistance management is delaying its development.
- Resistance can still develop despite label use restrictions and good resistance management program. Ex. Torino.



# Fungicide Resistance – TORINO – Cucurbit Powdery Mildew

2012. Registered for this use in USA.

Label restrictions stronger than any other at-risk fungicide:  
no consecutive applications allowed; maximum 2 applications.

Other at-risk fungicides not yet impacted by resistance available  
to use in a sound resistance management program:  
Quintec and DMIs plus Vivando 2 years later.

2017. Fully resistant isolates detected.

Resistance detected to Qols after 3 yrs, Endura after 6 yrs, and  
Quintec after 8 yrs.



# Fungicide Resistance – Cucurbit Powdery Mildew

Pathogen has developed resistance to:

Fungicides in FRAC groups: 1, 3, 7, 11, 13, and U6.

Cross resistance is typical.

Resistance is partial among fungicides for some chemistries:

DMIs (FRAC 3). Most newer products still highly effective (ex. Proline, Procure). Some differences in inherent activity.

SDHIs (FRAC 7). Endura, Pristine, Fontelis, and Merivon are cross resistant. Luna fungicides, Aprovia Top, and Miravis Prime bind differently from others (different active ingredient).



# Fungicide Resistance – Lessons Learned

- Occurrence of resistance in a commercial crop can change substantially with fungicide use during a growing season.
- Resistance can be hard to detect in a crop based on control impact.
- Pathogen isolates can develop resistance to multiple unrelated fungicides. Ex. cucurbit powdery mildew pathogen – 5 chemistries.
- Resistance usually remains in pathogen population.



**Quintec**

**Sensitive  
Isolate**

**Luna Privilege**

**Torino**

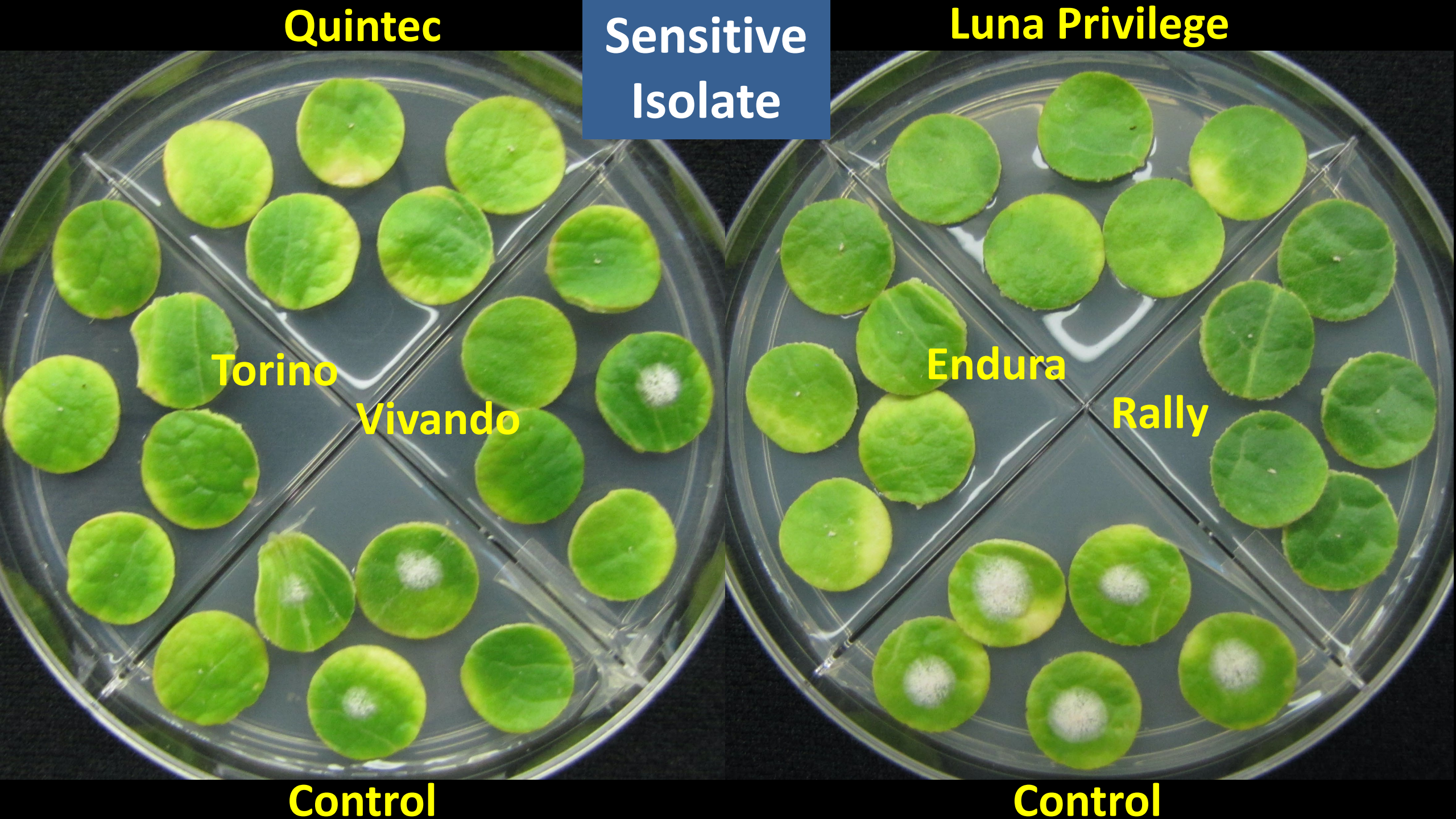
**Vivando**

**Endura**

**Rally**

**Control**

**Control**





**Quintec**

**Resistant  
Isolate**

**Luna Privilege**

**Torino**

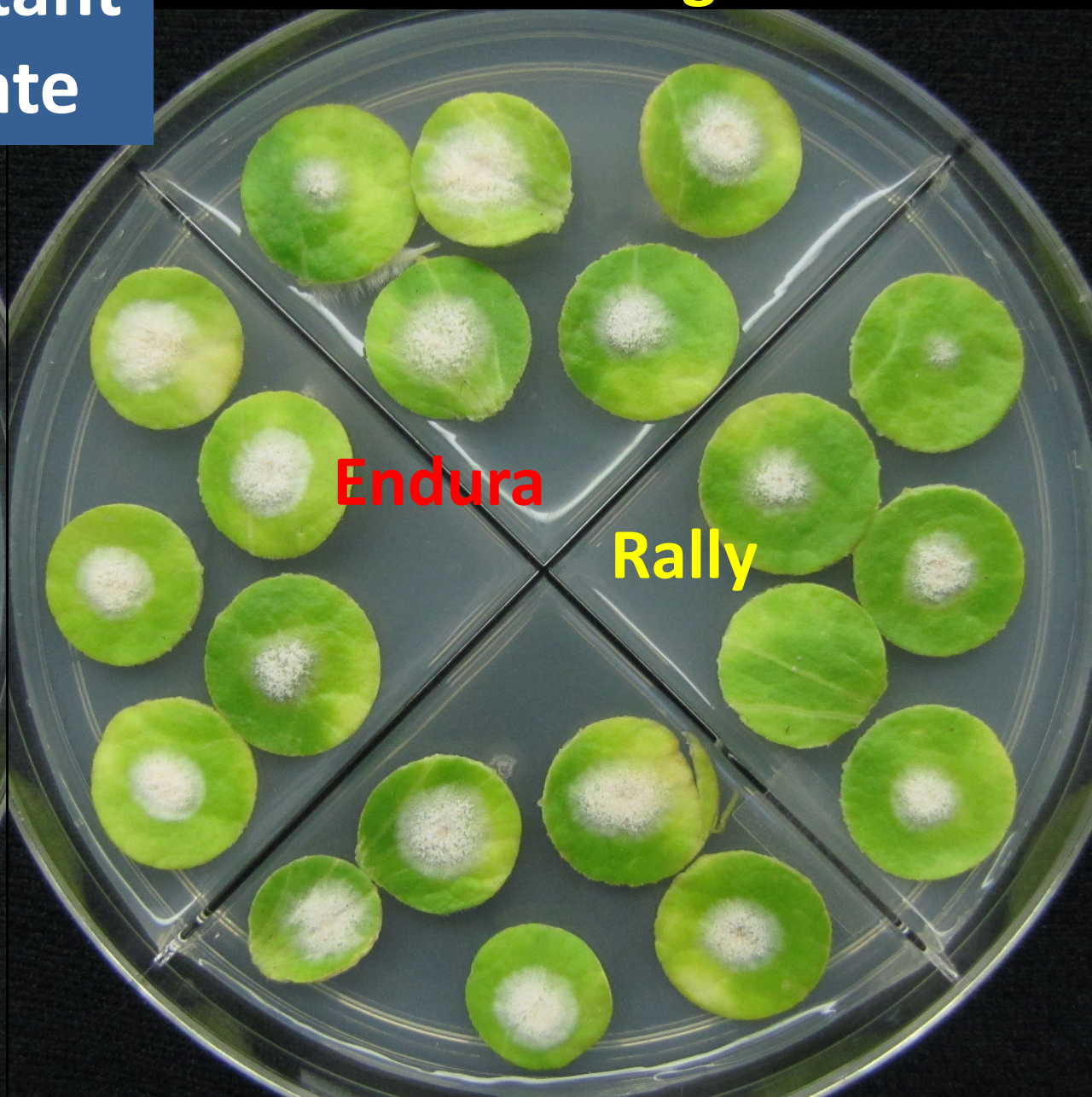
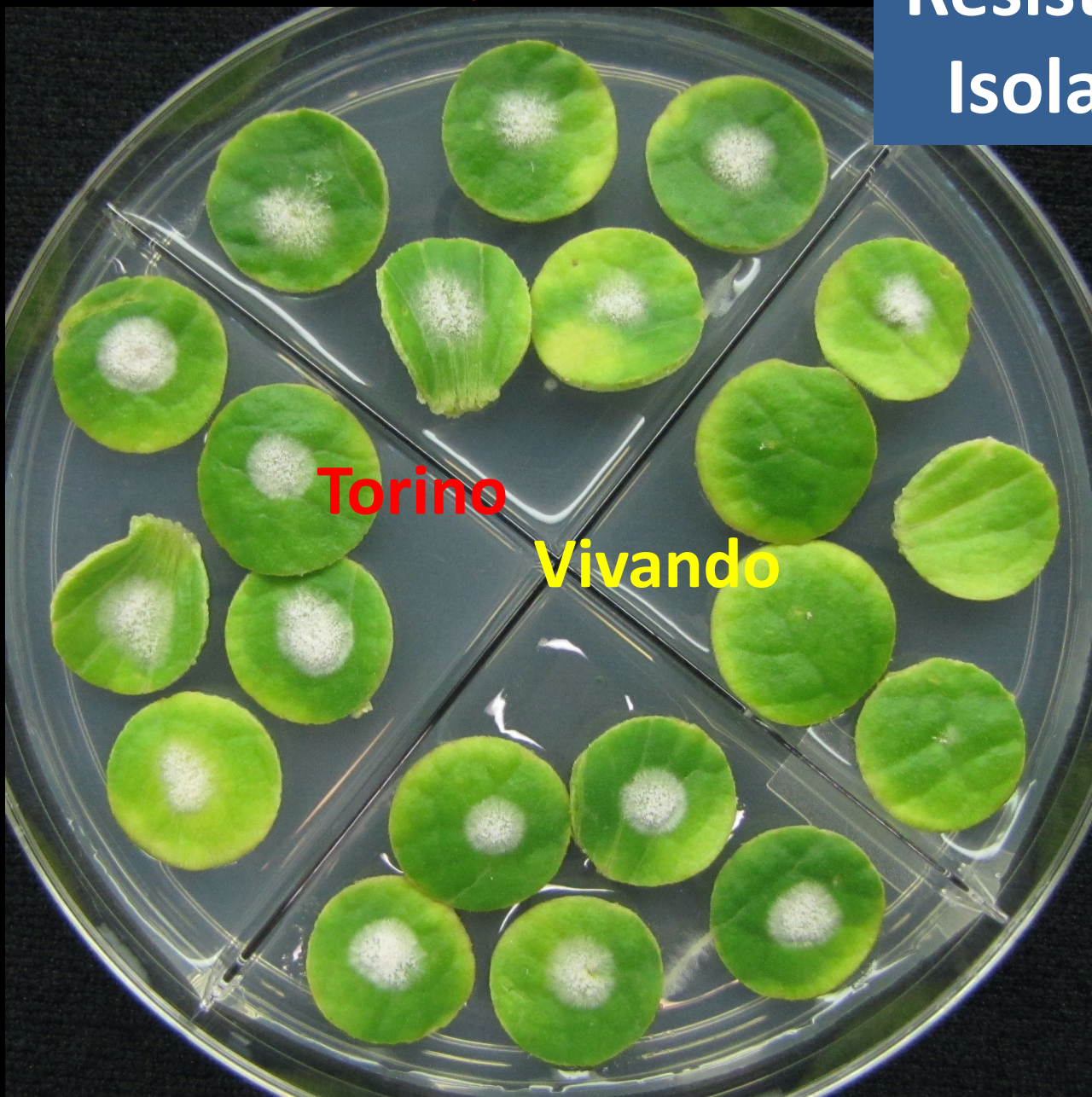
**Vivando**

**Endura**

**Rally**

**Control**

**Control**







# Late blight – Potato and Tomato

1980s re-emerged when pathogen developed resistance to Ridomil (metalaxyl).

Recent genotypes are sensitive.

Pathogen is uniquely clonal.

MAJOR potential future pathogen change:

Both mating types occurring together and reproducing sexually.

Outcome: Oospores and consequent increased pathogen variation and ability to survive in absence of living plant tissue.



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- Pathogen isolates can develop resistance to multiple unrelated fungicides. Ex. cucurbit powdery mildew pathogen – 5 chemistries.
- Resistance usually remains in pathogen population.
- Sound fungicide recommendations require knowledge of resistance.
- Knowledge of resistance requires testing pathogen isolates.
- Label uses are not changed when resistance becomes common.



# **Novel Disease Management Practices**



**Reduced  
Tillage  
for  
Managing  
Phytophthora  
Blight**



**Unverferth  
Zone-builder**





# Mustard Biofumigation for Managing Phytophthora Blight





# 34-year career as a Vegetable Pathologist





# **Pathogens Change!**

**and we need to expect this  
will continue to occur.....**

**contact extension specialist if  
you see something unusual**



