
# USABlight: A tool to fight late blight: a re-emerging plant disease that threatens global food security

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# **Late blight re-emerging disease**:

## A constraint to production worldwide - food security

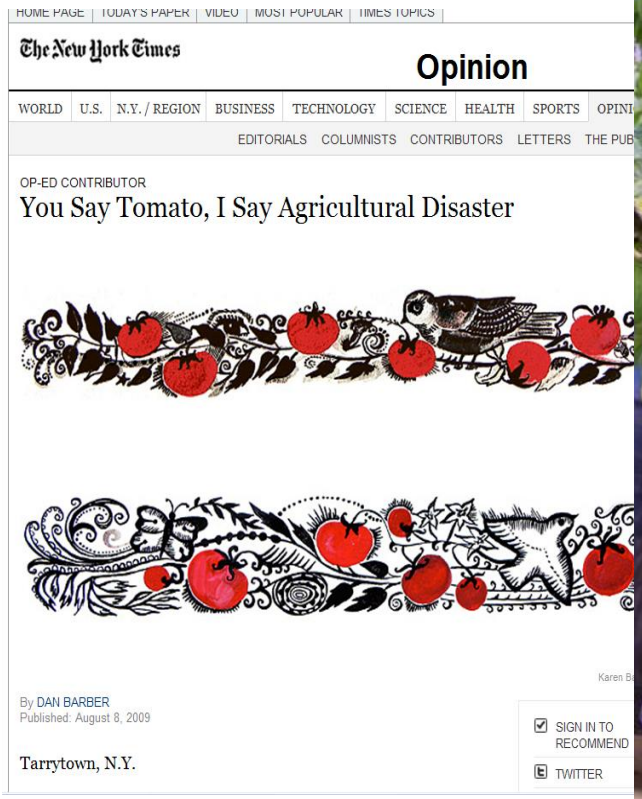
**Has increased in incidence, geographical and host range**

# Why is late blight a re-emerging plant disease ?

- Varied dispersal mechanism
  (airborne inoculum and in plant material)
- Polycyclic nature of disease cycle
- Fungicide resistance
- Ability to shift hosts ( potato, tomato, petunia, wild hosts) exploit new niches
- Genome plasticity – effector diversity overcomes host resistance
- Monoculture of susceptible hosts

# Late blight epidemics in the US in 2009
# Emergence of US-22 strain

- Climate change – rainy season
- Movement of infected tomato transplants
- Susceptible varieties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OP-ED CONTRIBUTOR

You Say Tomato, I Say Agricultural Disaster

By DAN BARBER
Published: August 8, 2009

Tarrytown, N.Y.

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Science News

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Late Blight -- Irish Potato Famine Fungus -- Attacks U.S. Northeast Gardens And Farms Hard

*ScienceDaily (July 5, 2009)* — Home gardeners beware: This year, late blight -- a destructive infectious disease that caused the Irish potato famine in the 1840s -- is killing tomato and potato s in gardens and on commercial farms in the rn United States. In addition, basil downy w is affecting plants in the Northeast.

"Late blight has never occurred this early and this widespread in the U.S," said Meg McGrath, associate professor of plant pathology and plant-microbe biology.

One of the most visible early symptoms of the disease is brown spots (lesions) on stems. They begin small and firm, then quickly enlarge, with white fungal growth developing under moist conditions that leads to a soft rot collapsing the stem.

Classic symptoms are large (at least nickel-sized) olive-green to brown spots on leaves with slightly fuzzy white fungal growth on the underside when conditions have been humid (early morning or after rain). Sometimes the of the spot is yellow or has a water-soaked appearance. begin tiny, irregularly shaped and brown. Firm, brown spots p on tomato fruit.

enlarge

*Leaf lesions due to late blight. (Credit: Copyright College of Agriculture and Life Sciences, Cornell University)*

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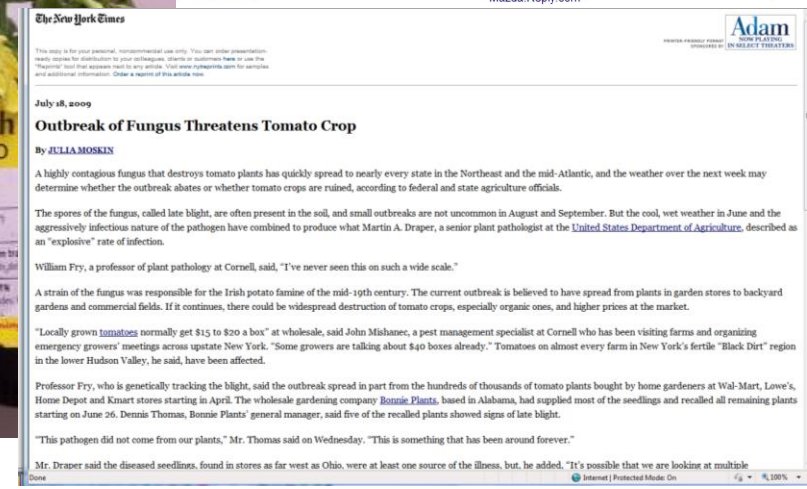

The New York Times

Adam

July 18, 2009

Outbreak of Fungus Threatens Tomato Crop

By JULIA MOSKIN

A highly contagious fungus that destroys tomato plants has quickly spread to nearly every state in the Northeast and the mid-Atlantic, and the weather over the next week may determine whether the outbreak abates or whether tomato crops are ruined, according to federal and state agriculture officials.

The spores of the fungus, called late blight, are often present in the soil, and small outbreaks are not uncommon in August and September. But the cool, wet weather in June and the aggressively infectious nature of the pathogen have combined to produce what Martin A. Draper, a senior plant pathologist at the United States Department of Agriculture, described as an "explosive" rate of infection.

William Fry, a professor of plant pathology at Cornell, said, "I've never seen this on such a wide scale."

A strain of the fungus was responsible for the Irish potato famine of the mid-19th century. The current outbreak is believed to have spread from plants in garden stores to backyard gardens and commercial fields. If it continues, there could be widespread destruction of tomato crops, especially organic ones, and higher prices at the market.

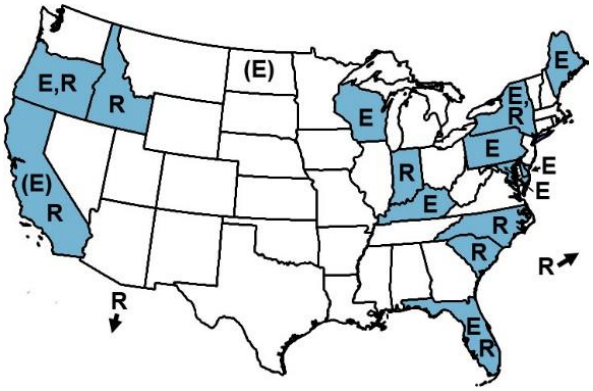
"Locally grown tomatoes normally get $15 to $20 a box" at wholesale, said John Mishanec, a pest management specialist at Cornell who has been visiting farms and organizing emergency growers' meetings across upstate New York. "Some growers are talking about $40 boxes already." Tomatoes on almost every farm in New York's fertile "Black Dirt" region in the lower Hudson Valley, he said, have been affected.

Professor Fry, who is genetically tracking the blight, said the outbreak spread in part from the hundreds of thousands of tomato plants bought by home gardeners at Wal-Mart, Lowe's, Home Depot and Kmart stores starting in April. The wholesale gardening company Bonnie Plants, based in Alabama, had supplied most of the seedlings and recalled all remaining plants starting on June 26. Dennis Thomas, Bonnie Plants' general manager, said five of the recalled plants showed signs of late blight.

"This pathogen did not come from our plants," Mr. Thomas said on Wednesday. "This is something that has been around forever."

Mr. Draper said the diseased seedlings, found in stores as far west as Ohio, were at least one source of the illness, but, he added, "It's possible that we are looking at multiple

# USDA NIFA grant: Goal to slow disease reemergence




- Grower Alert System –Link extension and research communities to implement novel disease control strategies
- Real time system to track genotypes and phenotypes USA blight developed
- Evaluate baseline fungicide sensitivity data
- Develop quick methods to detect pathogen and fungicide sensitivity
- Durable resistance on both tomato and potato

# Objective: improve management tools

*Public reports*

National reporting & alert website

*Co-PD labs*

*P. infestans* genotypes (SSRs) & phenotypes





*enhanced* Decision Support System

<u>Management recommendations</u> fungicide use, including solutions for organic growers

10% reduction in fungicide use = $20 million/year

Slide courtesy of H Judelson

# Objective: characterize *P. infestans* strains

**Past** → Five-year funding period → Future vision

- Methods for identifying genotypes developed.
- Phenotypes assigned to lineages.
- Data not available in time to aid disease management.
- Missed opportunities!

*(2009 epidemic US-22 was sensitive to mefenoxam)*

- Rapid genotyping, SSR (lineage) data to web site in 3 days.
- Decision Support System deployed, tailored to pathogen phenotypes.
- Rapid (DNA-based) trait-specific assays developed, deployed to extension.

- Real-time diagnosis of pathogen traits.
- Disease management more efficient.
- Economic and environmental benefits due to better control, reduced fungicide use.

Slide courtesy of H Judelson

# Developed a National Grower Alert System

## USAblight

A National Project on Late Blight of Tomatoes and Potato in the United States

About Late Blight | Occurrence Map | Reporting Outbreaks | Managing Late Blight | Decision Support | About Us | Admin Login

Personnel (Incomplete)

### Current Disease Map

Click the map for more information


Reported | Within the past week | Over a week ago

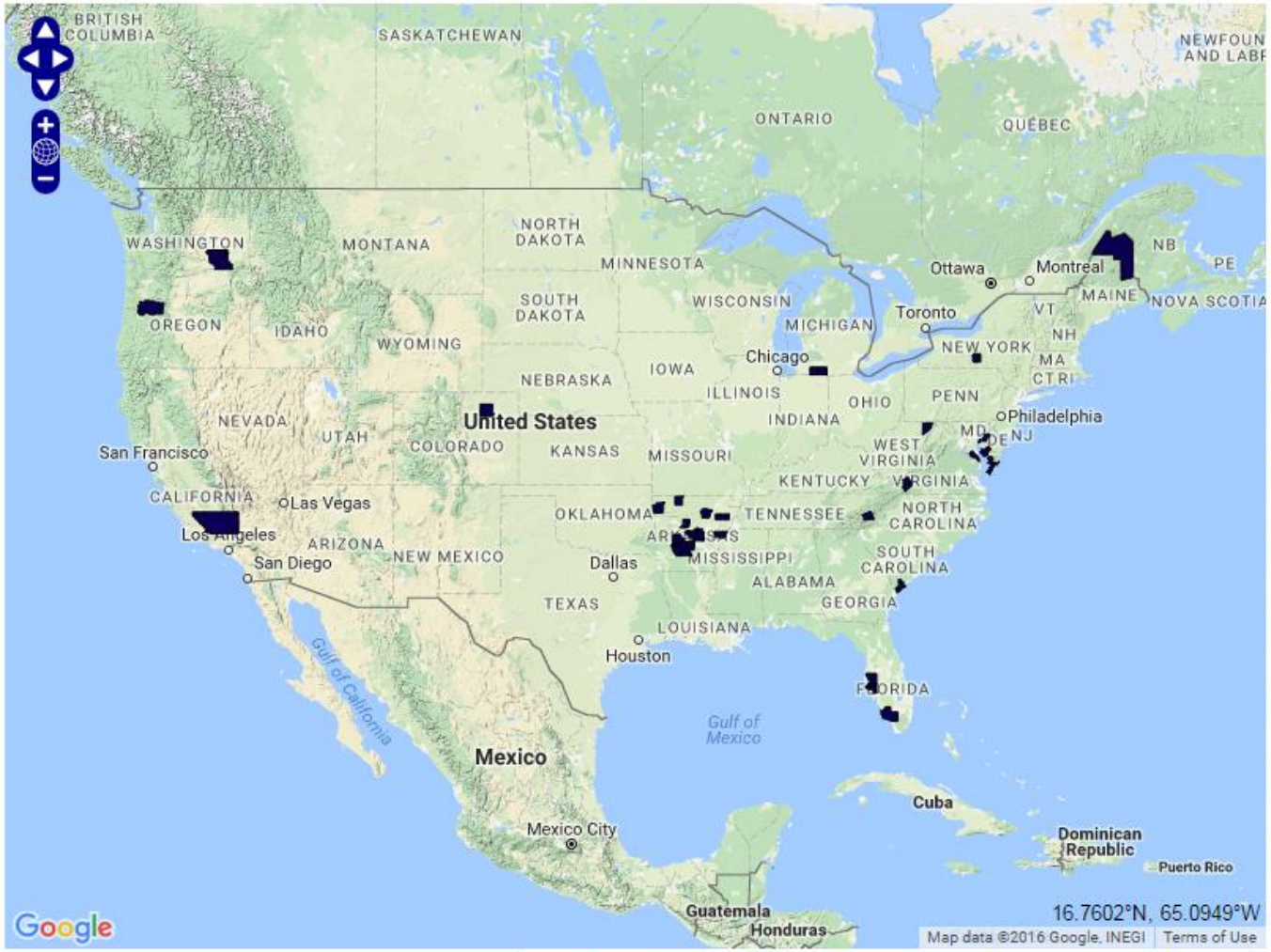
### Welcome to USAblight

Submitted by Anonymous on Mon, 05/09/2011 - 18:16

Potato late blight lesion. Image courtesy of Jean Ristaino, NC State University.

Welcome to USA blight, a new national website that will act as an information portal on late blight. You can report disease occurrences, submit a sample online, observe disease occurrence maps, and sign up for text disease alerts. There are also useful links to a decision support system, and information about identification and management of the disease.

# Reported Late blight Outbreaks on USAblight




Group by state

- 1 Boone County, AR
- 4 Clark County, AR
- 1 Conway County, AR
- 2 Dallas County, AR
- 2 Garland County, AR
- 1 Grant County, AR
- 4 Hot Spring County, AR
- 1 Independence County, AR
- 3 Lee County, AR
- 2 Lonoke County, AR
- 2 Poinsett County, AR
- 1 Pulaski County, AR
- 1 Washington County, AR
- 2 Kern County, CA
- 1 Morgan County, CO
- 1 Collier County, FL
- 1 Hillsborough County, FL
- 4 Manatee County, FL
- 1 Dorchester County, MD
- 2 Garrett County, MD
- 1 Queen Anne's County, MD
- 1 Somerset County, MD
- 2 St Mary's County, MD

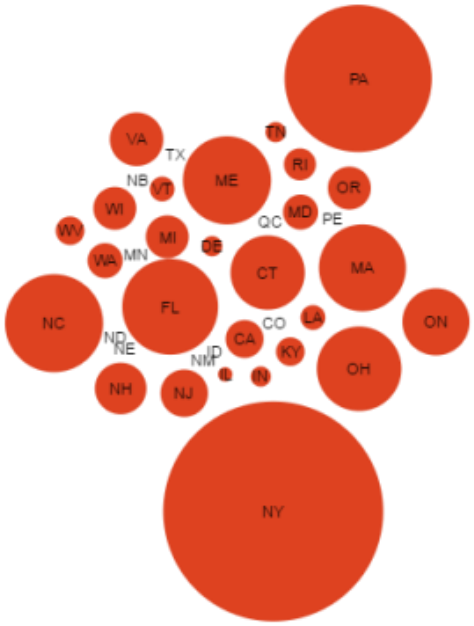
**Legend:** Observed in the last 7 days | Observed over 7 days ago

# Landscape level view of late blight
# ArcMap Project - Late blight outbreaks 2011-15

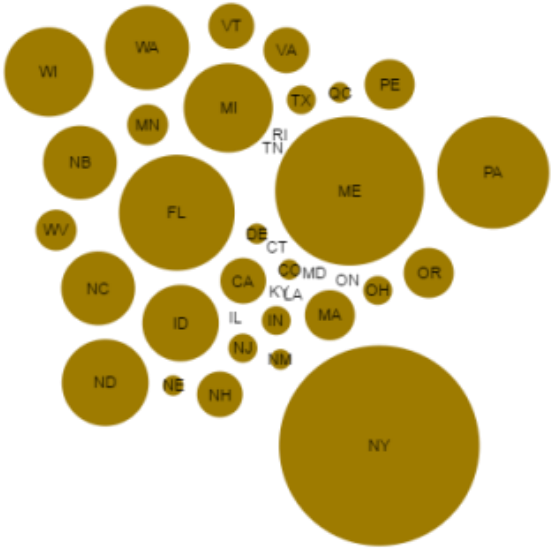
# 5 Years of Data

Number of records: 1094
Number of states/provinces: 37
~ 64% tomato reports
~ 82% US-23 reports (within genotyped samples)
~ 59% reports from conventional production systems

Tomato outbreaks




Potato outbreaks



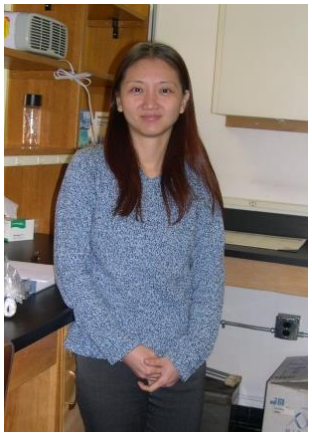
# Genotyped and named US lineages

## Recent Genotypes of *Phytophthora infestans* in the Eastern United States Reveal Clonal Populations and Reappearance of Mefenoxam Sensitivity

**Chia-Hui Hu,** Department of Plant Pathology, North Carolina State University, Raleigh, 27695; **Frances G. Perez,** United States Department of Agriculture–Agricultural Research Service (USDA-ARS) PSI-GIFVL, BARC-West, Beltsville, MD, 20705; **Ryan Donahoo,** University of Florida, Florida IFAS-SWFREC, Immokalee, 34142; **Adele McLeod,** Department of Plant Pathology, University of Stellenbosch, Stellenbosch, South Africa; **Kevin Myers,** Department of Plant Pathology, Cornell University, Ithaca, NY; **Kelly Ivors,** Department of Plant Pathology, North Carolina State University; **Gary Secor,** Department of Plant Pathology, North Dakota State University, Fargo, 58108-6050; **Pamela D. Roberts,** University of Florida, Florida IFAS-SWFREC; **Kenneth L. Deahl,** USDA-ARS PSI-GIFVL, BARC-West; **William E. Fry,** Department of Plant Pathology, Cornell University; and **Jean B. Ristaino,** Department of Plant Pathology, North Carolina State University

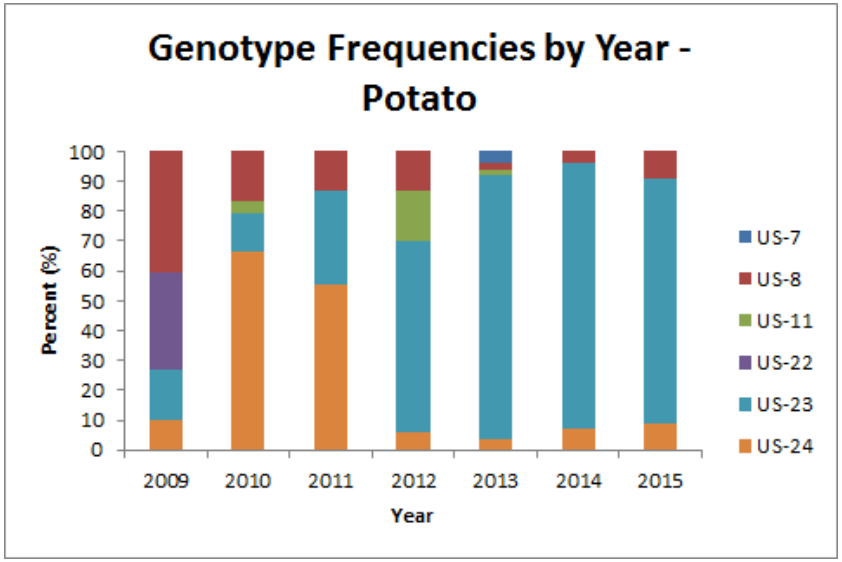
**Table 3.** Summary of multilocus genotypes of *Phytophthora infestans* collected in the United States and Canada, 2002 to 2009

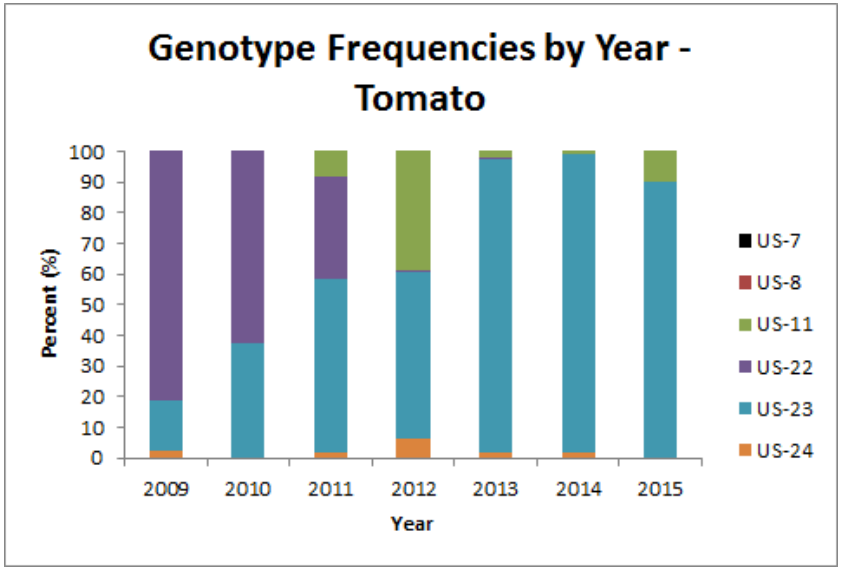
| Genotype[b] | Host | MT[c] | Allozyme genotype[a] | | Mefenoxam sensitivity[d] | mtDNA[e] | RG57 RFLP[f] |
|---|---|---|---|---|---|---|---|
| | | | *Gpi* | *Pep* | | | |
| US-8[g] | Potato | A2 | 100/111/122 | 100/100 | R/I | Ia | 1,5,10,13,14,16,20,21,23,24,25 |
| US-20 | Tomato | A2 | 100/100 | 100/100 | R/I | Ia | 1,3,5,7,10,13,14,16,18,20,21,24,25 |
| US-21 | Tomato | A2 | 100/122 | 100/100 | R/I/S | Ia | 1,5,10,13,14,18,20,21,24,25 |
| US-22[h] | Potato and tomato | A2 | 100/122 | 100/100 | S/I | Ia | 1,5,13,14,16,20,21,24,25 |
| US-23 | Potato and tomato | A1 | 100/100 | 100/100 | S/I | Ia | 1,2,5,6,10,13,14,17,20,21,24,24a,25 |
| US-24 | Potato | A1 | 100/100/111 | 100/100 | I | Ia | 1,3,5,7,10,13,14,16,20,21,23,24,25 |



Hu et al. 2012. Plant Dis. 96: 1323-1330.

# Documented Displacement of US-22 by US-23

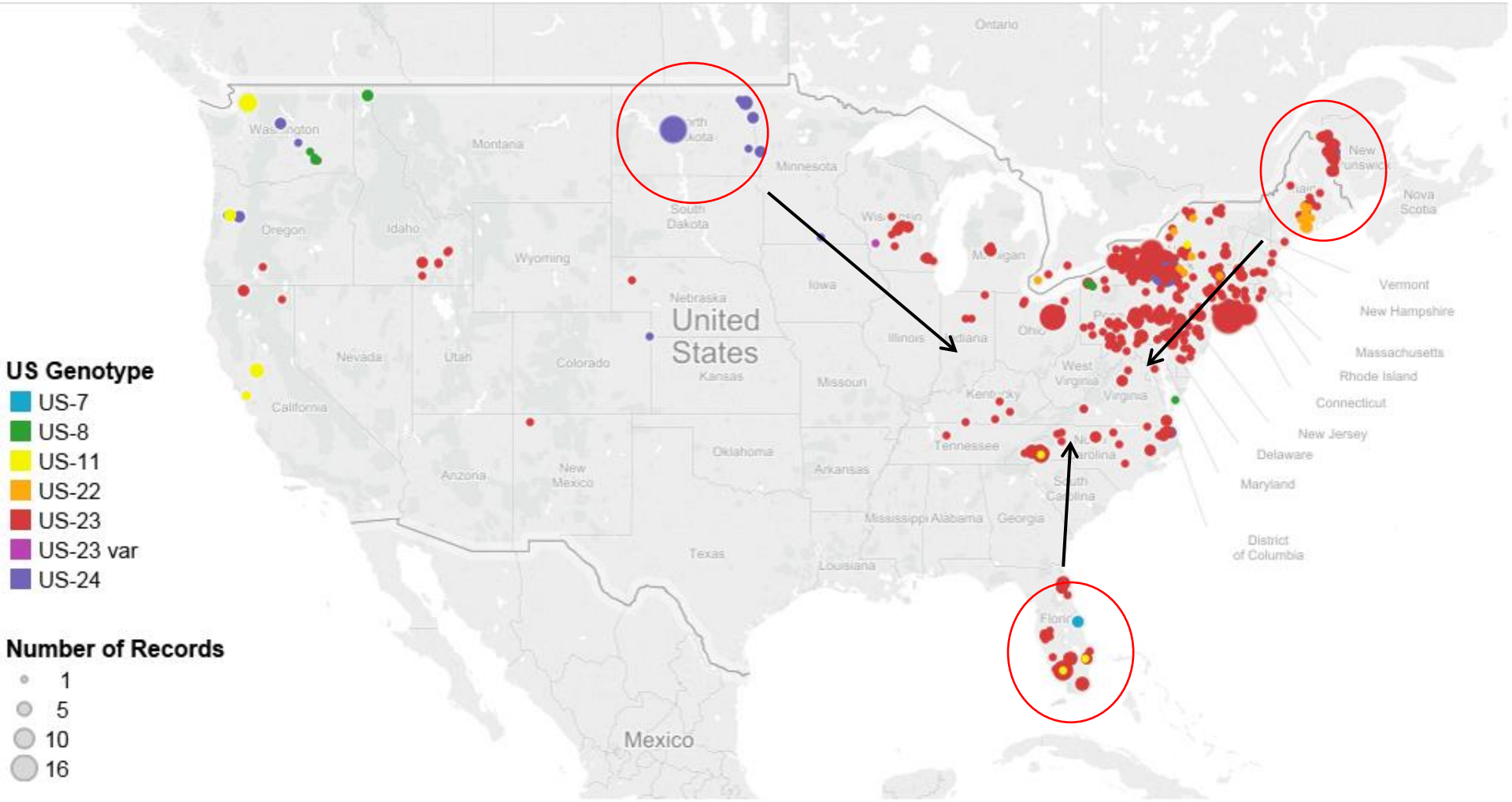




- Fry, W. E, et al. 2015. Re-emerging *Phytophthora infestans*. Phytopathology
- Fry, W. E., et al. 2013. The 2009 Late Blight Pandemic in Eastern USA- causes and results. Plant Dis. 96: 296-306.
- Fry, W. E. et al. The 2009 Late Blight Pandemic in Eastern USA. APSNet Feature August, 2012.

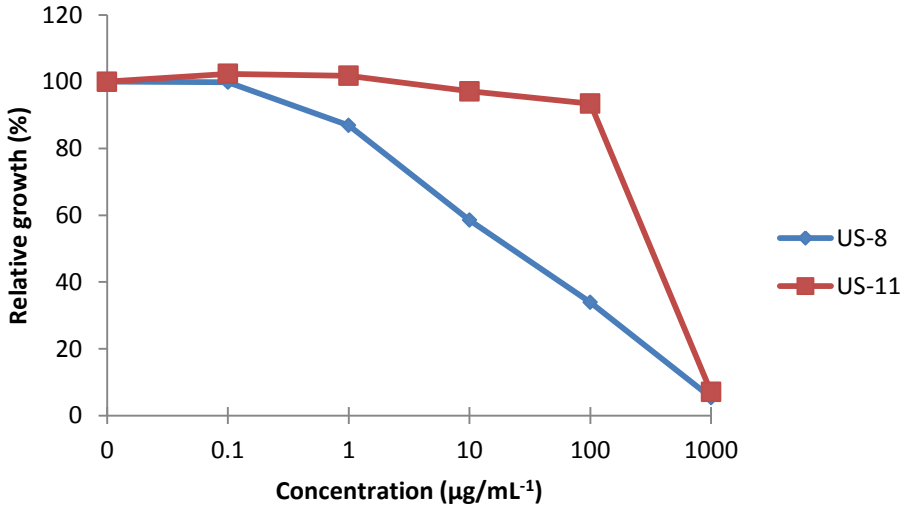
# US genotype frequency

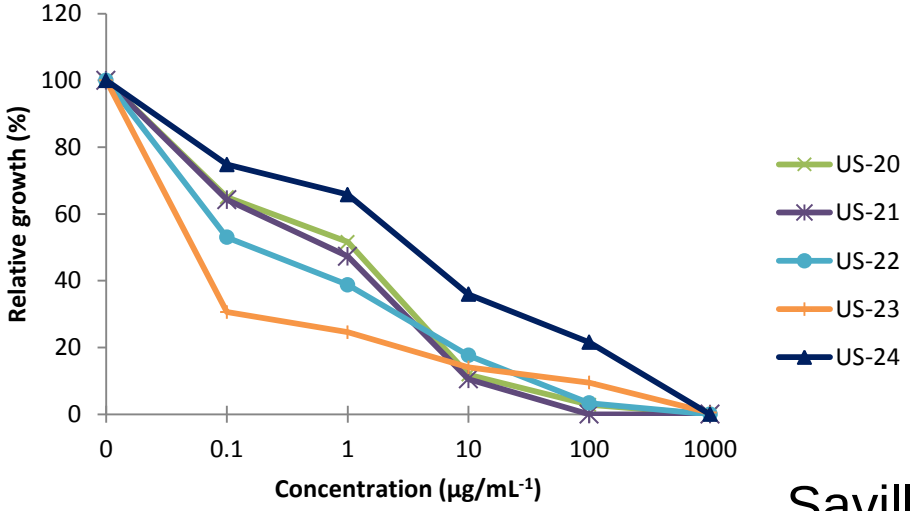


# Fungicides used for control

Over 2500 tons active ingredient/year in USA: $200 million

# How do the recent US lineages respond to Oomycete target fungicides?




- US-8 and US-11 highly resistant to mefenoxam
- All lineages sensitive to azoxystrobin, cyazofamid, cymoxanil, fluopicolide, mandipropamid,

Saville et al, 2015 Plant Dis 99:659-666

# Summary

- USAblight disease alert system developed
- Rapid genotyping with 12-plex SSRs – Fry lab and team
- Shift in genotypes with time
- US-22 dominant in 2009 – displaced by US-23
- US-8 and US-11 are mefenoxam resistant. Other lineages are sensitive to most Oomycete targeted compounds
- FL tomatoes source of novel lineages in western NC and US

# Thank you Late blight team and USDA NIFA for funding us

United States Department of Agriculture
National Institute of Food and Agriculture


Judelson


Smart


Fry


Grünwald


Ristaino


Gloy


Gay


McComas


Klessig

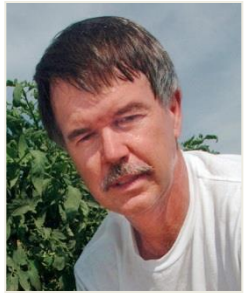

Xiao


Girke


Birch


Boyles


Hein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Johnson


Besley


Seebold


Lozoya


Gugino


Everts


Gevens


McGrath


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J. Ristaino's laboratory website

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