Pierce's Disease Update: Symptoms, Imposters, and Diagnostics

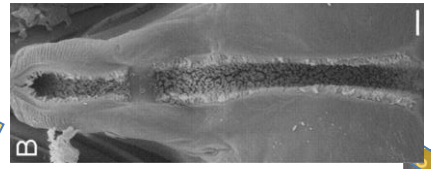
Sara Villani

Department of Entomology & Plant Pathology

North Carolina State University

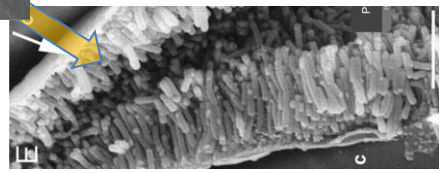
Pierce's Disease: Plugging of the Pipes

Acquisition



Newman et. al, 2004

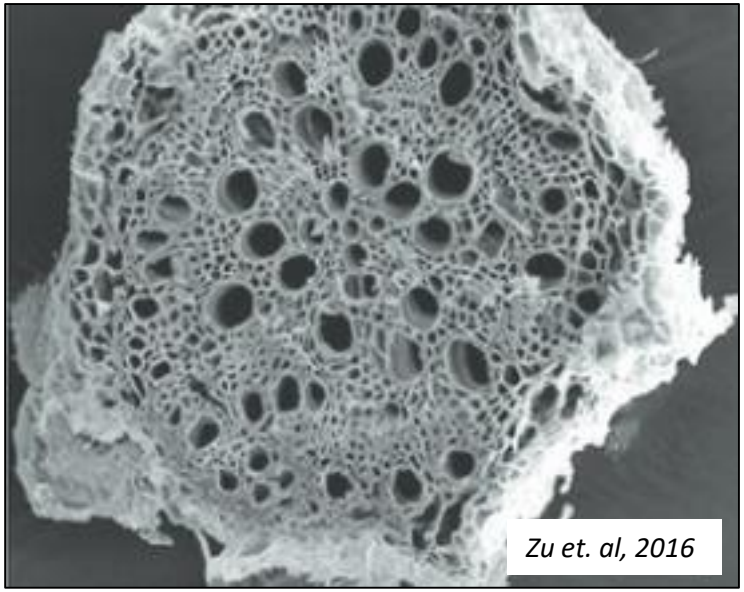
Retention

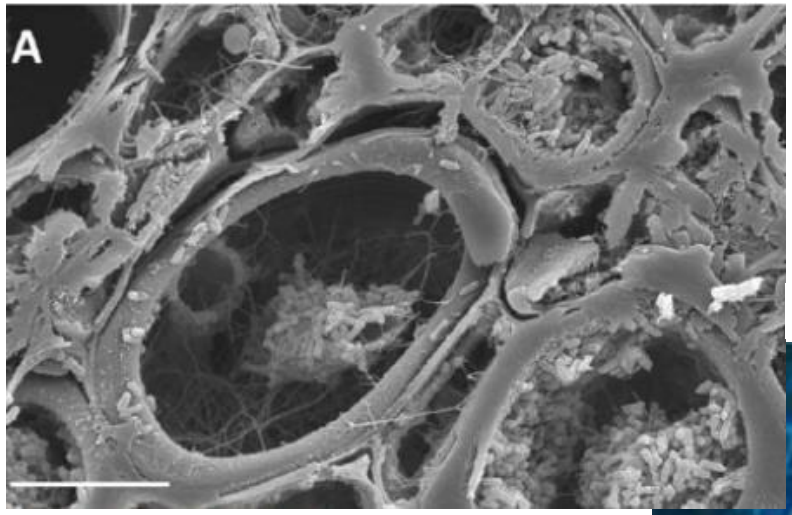


Hickey et. al, 2019

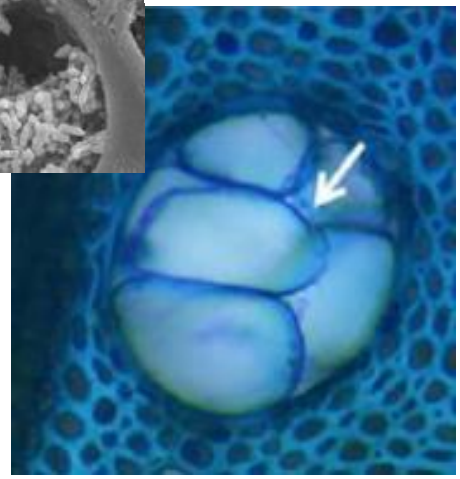
Transmission/Inoculation

Pierce's Disease: Plugging of the Pipes





Rapicavoli et. al, 2018



- Direct plugging of xylem tissue: bacteria cells and biofilms
- Indirect plugging of xylem tissue: Grapevine defense system-Barricade to stop/slow spread (tyloses)

Pierce's Disease: Systemic vs. Local Infections

- **Local Infections:** Occur near and around area in which the bacteria was introduced
  - Present for a single growing season

- **Systemic Infections:** Bacteria are moving and reproducing inside the vine
  - Infection present for multiple season and may likely persist forever

Symptoms of Pierce's Disease

- Depends on infection timing: Current year (**Local**) vs. previous year(s) (**systemic**)
- May resemble several other diseases or abiotic disorders
  - Don't zero in on a single symptom when diagnosing PD in the field
    - Complex of symptoms + cultivars + environment/timing
    - Late summer/autumn symptoms more dependable for diagnostics vs. early spring symptoms
- Appearance of symptoms dependent a # of factors including climate, cultivar (red v. white; susceptibility), timing of infection

Local Symptoms of Pierce's Disease: Year 1

- 1st Symptom = **Leaf Scorching**

White

Mid-Summer **Late-Summer** **Autumn**

Red

Photos: J.K. Clark in *Varela et al., Pub 21600*

Local Symptoms of Pierce's Disease: Year 1

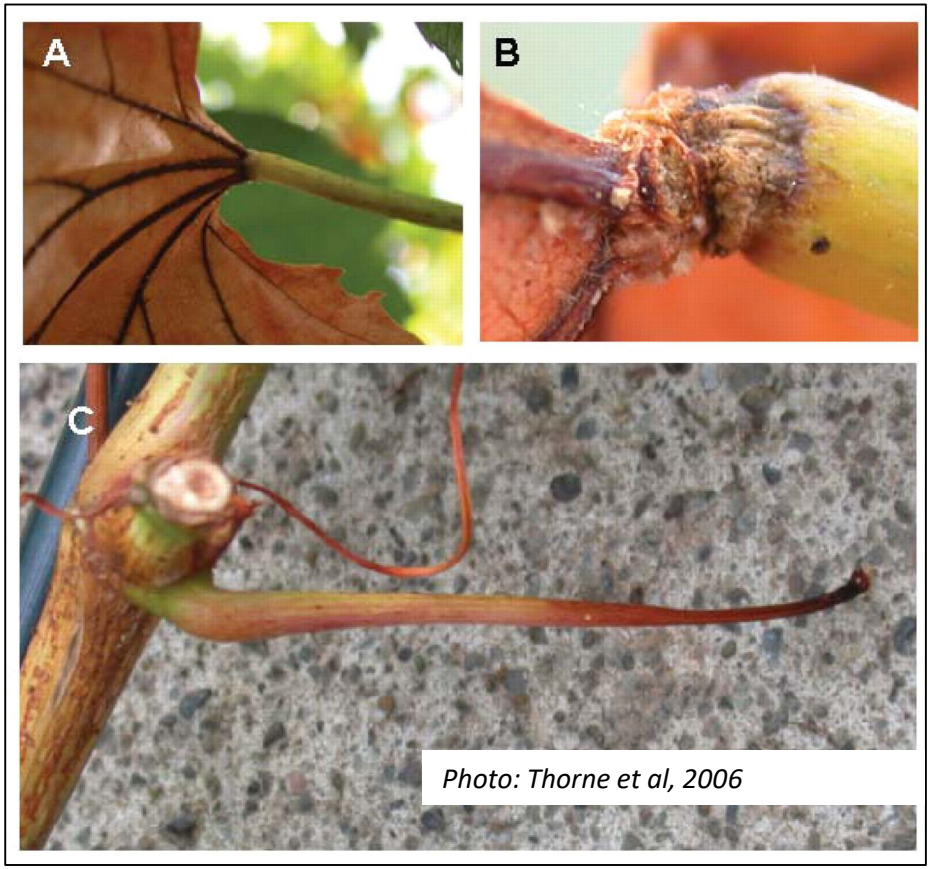
- 1st Symptom = **Leaf Scorching –** Sudden necrosis or irregular patterns

- Distribution: Usually 1-2 canes, but more severe in young/susceptible vines

Local Symptoms of Pierce's Disease: Year 1

- **Late summer/autumn symptoms** of localized PD infection: Leaf abscission and matchsticks (petiole remains)

Photo: J.K. Clark in *Varela et al., Pub 21600*



Local Symptoms of Pierce's Disease: Year 1

- **Late summer/autumn symptoms** of localized PD infection: Irregular lignification (or maturation) of infected shoots producing "green islands"

Photo: J.K. Clark in *Varela et al., Pub 21600*

Photo: Hickey et al, 2019

Local Symptoms of Pierce's Disease: Year 1

- **Late summer/autumn symptoms** of localized PD infection: Shriveled/dry "raisin" berries

Photo: David Appel

Photo: Hickey et al, 2019

Systemic/Chronic Symptoms of PD: Yr 2 +

- **Early/mid spring**: Delayed shoot growth and stunting

- Usually infected vines are ~ 2 weeks behind non-PD infected vines/shoots
- Delayed or reduced bud break, shortened internodes

Systemic/Chronic Symptoms of PD: Yr 2 +

- **Mid-Spring**: Look at first 4-8 leaves towards base of shoot:
  - Interveinal chlorosis
  - Dimpling
  - Stunted/misshapen

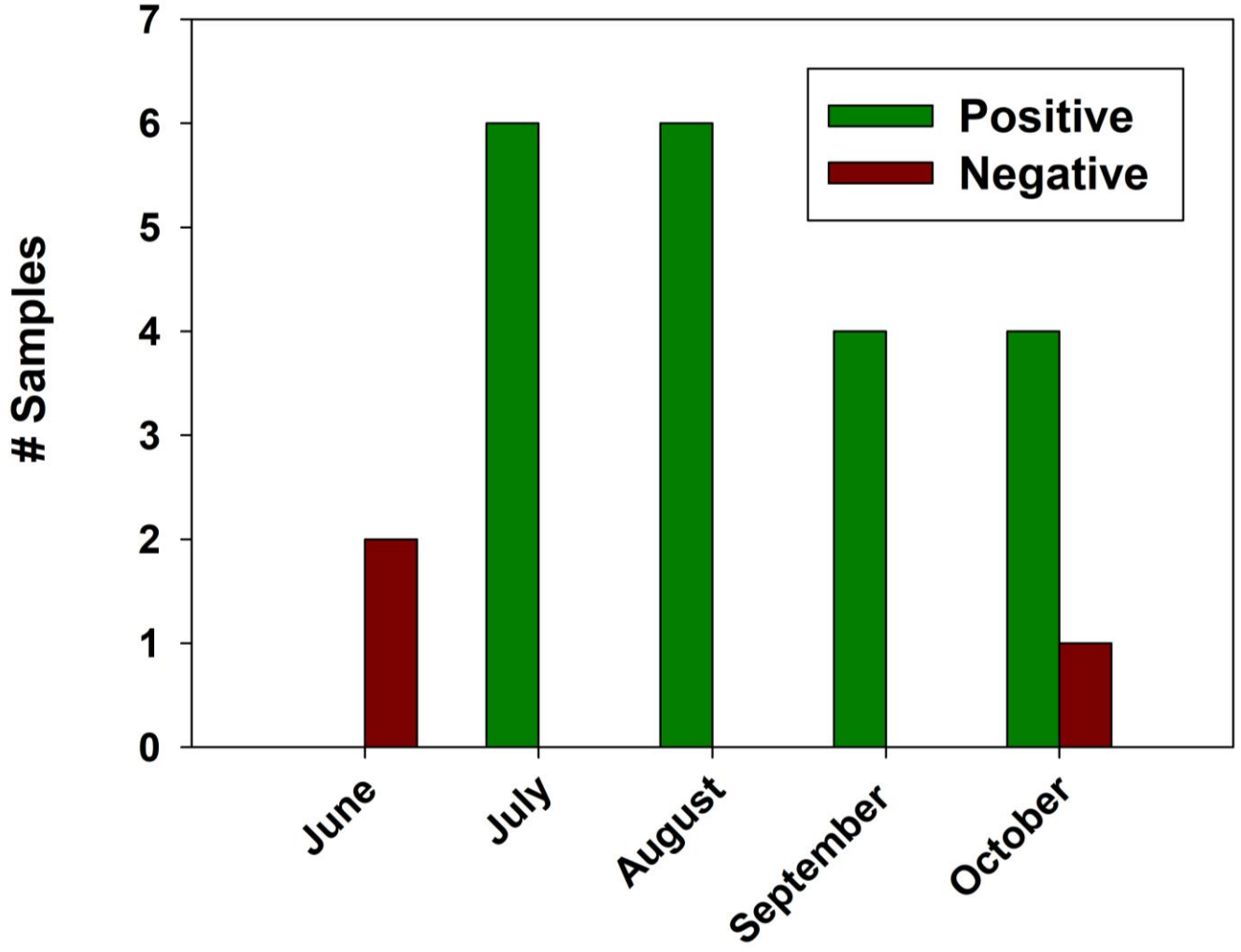
Systemic/Chronic Symptoms of PD: Yr 2 +

- **Late Spring to Mid-Summer**: Sparse canopy, leaf scorching in basal leaves that progresses towards tips

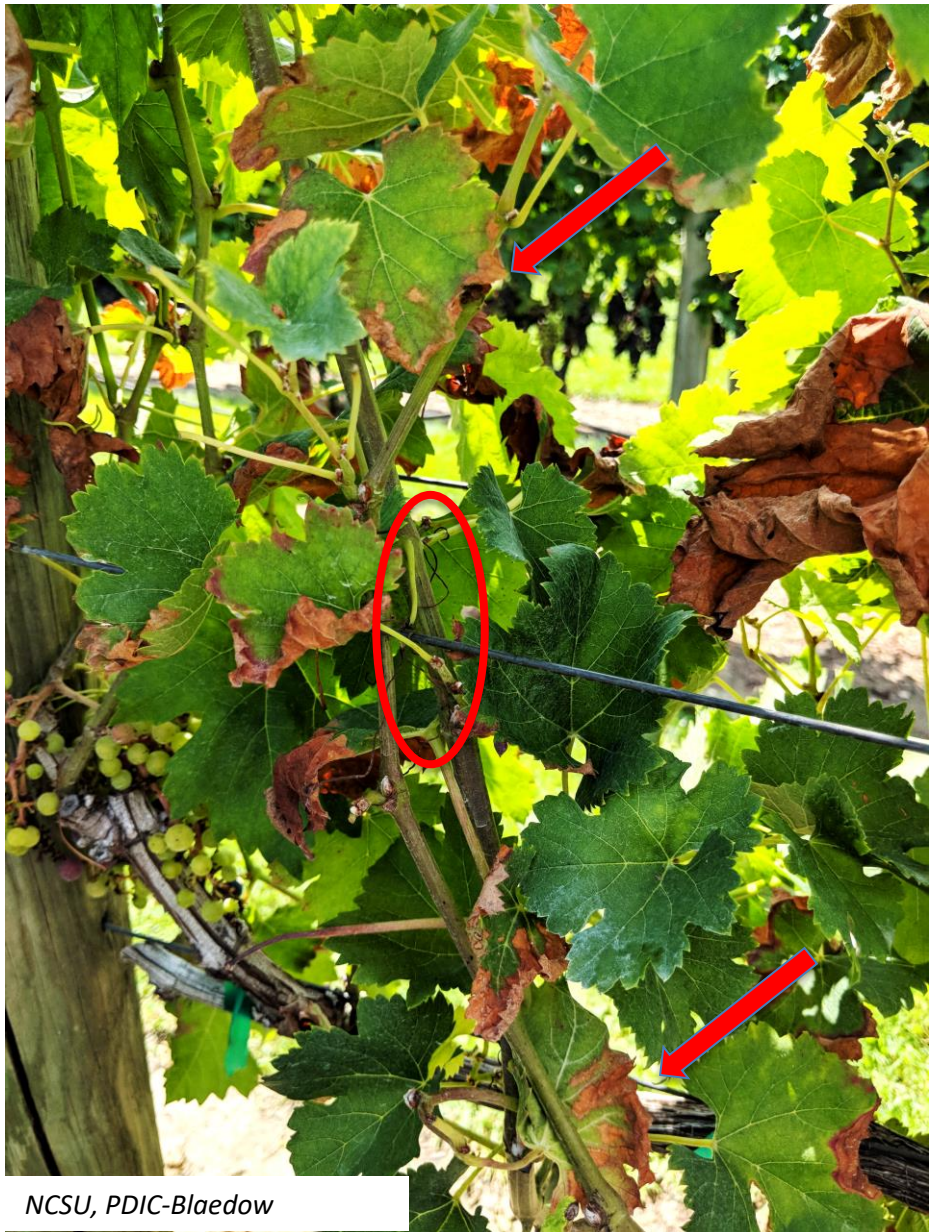
Photos: J.K. Clark in *Varela et al., Pub 21600*

Pierce's Disease in NC: PDIC Records

- 23 submissions from 2017-2020



Let's Take a Look at Some NC PDIC Submissions

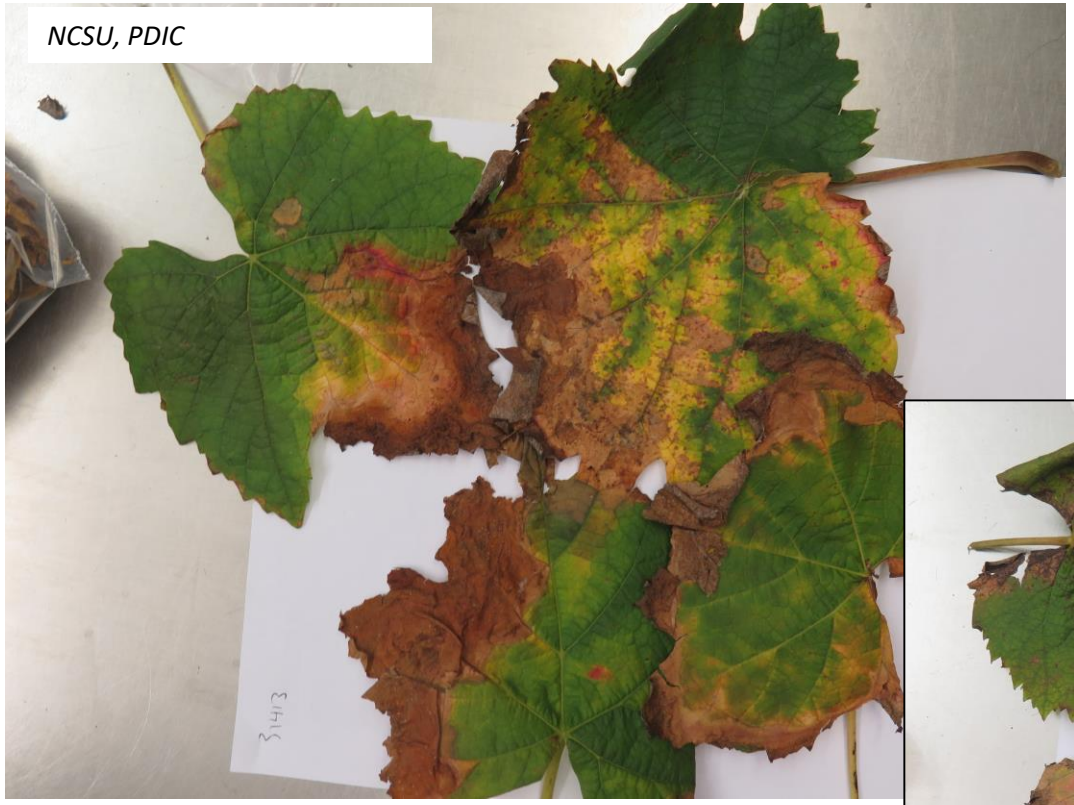


NCSU, PDIC-Blaedow

- Leaf Scorching
- Petiole "matchsticks"

Sample submitted: 08/28/2019; Henderson Cty, NC

Let's Take a Look at Some NC PDIC Submissions

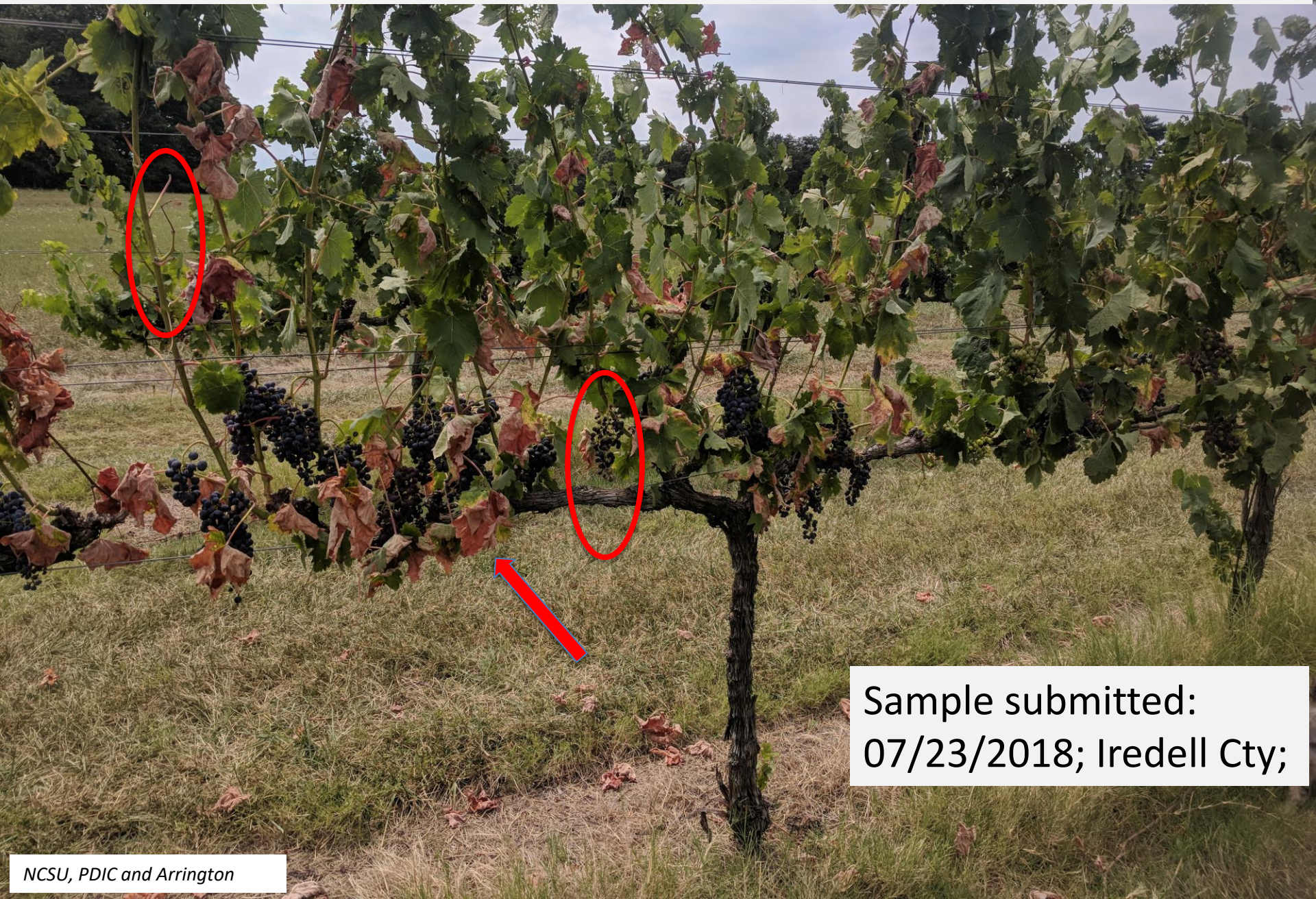


Sample submitted:
10/25/2018; Surry Cty;
'Petit Verdot', 'Malbec'

Let's Take a Look at Some NC PDIC Submissions

Sample submitted:
07/31/2018; Wilkes Cty;
'Petit Verdot',
'Sagrantino'

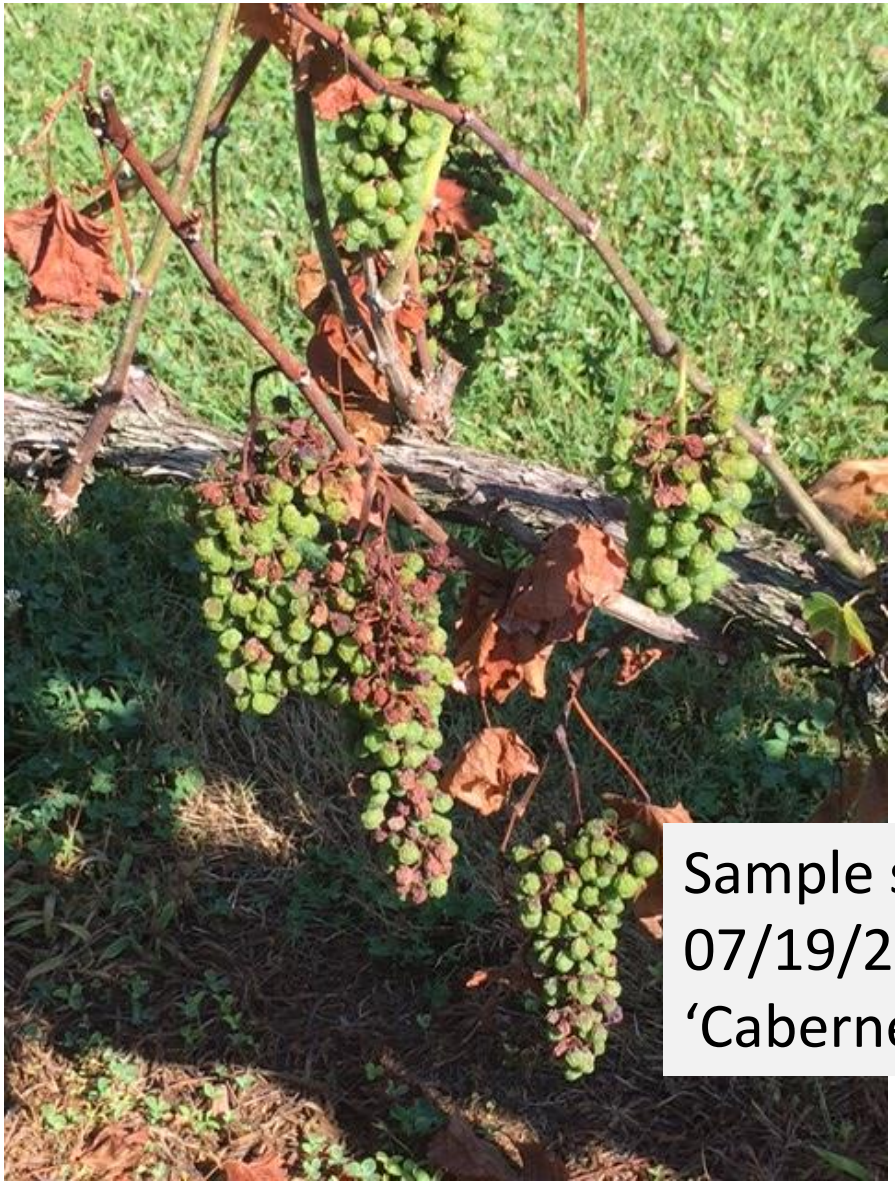
Let's Take a Look at Some NC PDIC Submissions

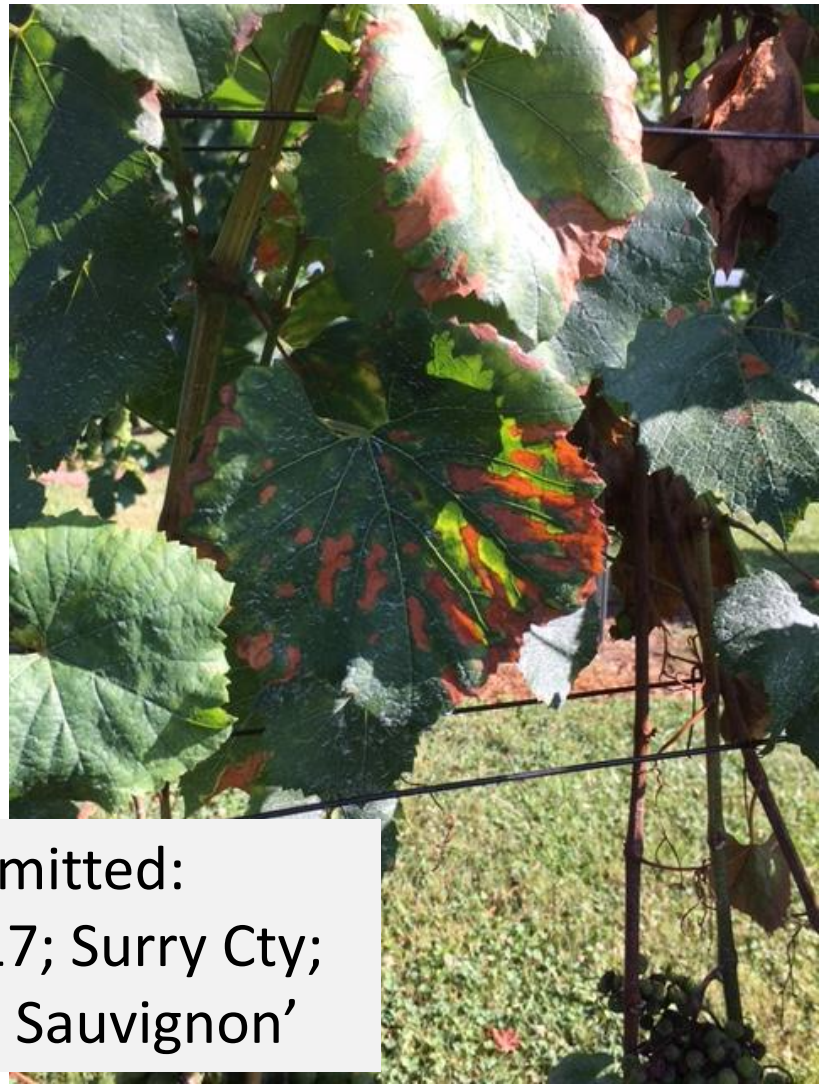


Sample submitted:
07/23/2018; Iredell Cty;

NCSU, PDIC and Arrington

Let's Take a Look at Some NC PDIC Submissions





Sample sumitted:
07/19/2017; Surry Cty;
'Cabernet Sauvignon'

Photos: NCSU PDIC and J. Radford, NC Co-op Ext.

BOLO for Imposters! *Viruses*

Photo: Libby Cieniewicz

BOLO for Imposters! *Grapevine Trunk Diseases*

Photo: Mark Hoffmann, NCSU

Photo: P. Larigno
P. Dis. 2018

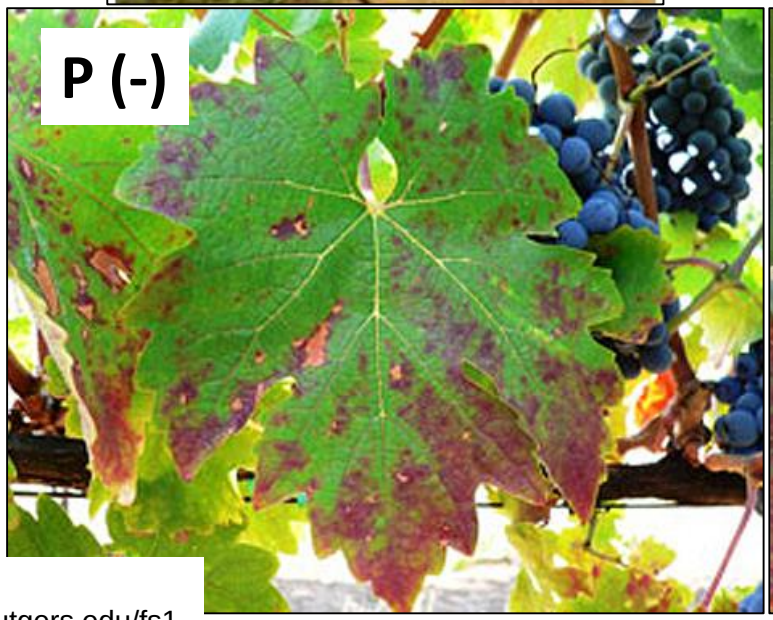
- Similar Symptoms: Stunted shoots, leaf chlorosis and scorch, shriveled berries
- Differential Symptoms: No green islands, “v” shaped wedge through woody tissue is absent

BOLO for Imposters! Abiotic

drought stress

salt toxicity

Photos: A.N. Kasimatis, Grape Compendium



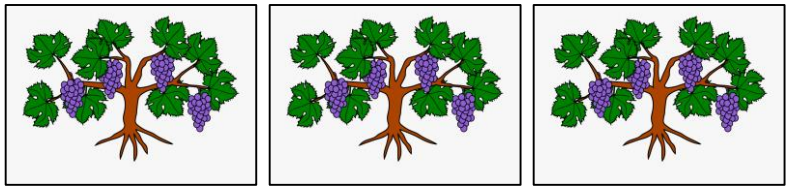
Photos:
https://njaes.rutgers.edu/fs1260/

“acidic soil sickness”

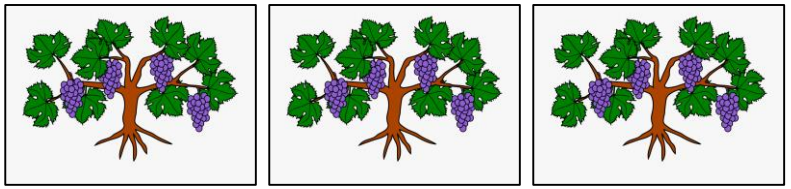
Pierce's Disease Imposters: Drought Stress

***Thorne et. al 2006*:**

1. ***Water deficit vs PD symptoms?***
2. ***Relationship of vine H2O status on PD symptom development?***



600 ml 3x/day | 335 ml 3x/day | 200 ml 3x/day



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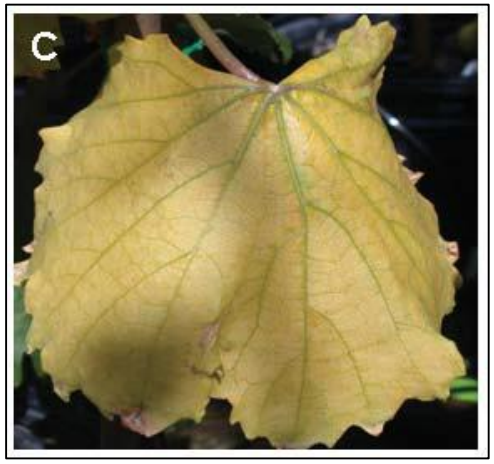
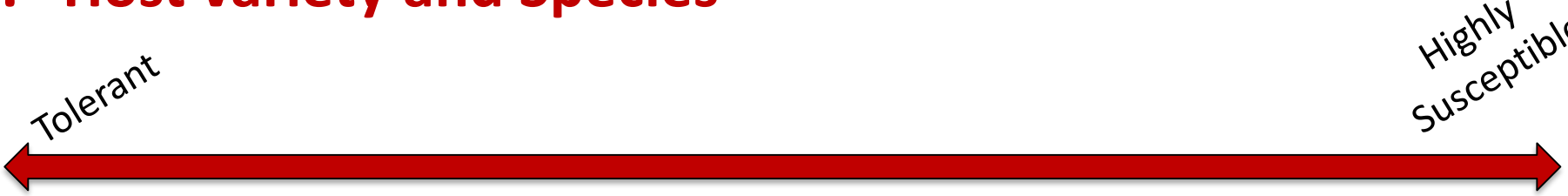


Factors Determining Transition from Local to Systemic Infection

1. **Infection Timing:** Spring infections more likely to become systemic compared to later season infections
2. **Winter Temperatures:** Lower temperatures in the winter aid in vine recovery from PD
3. **Host variety and Species**

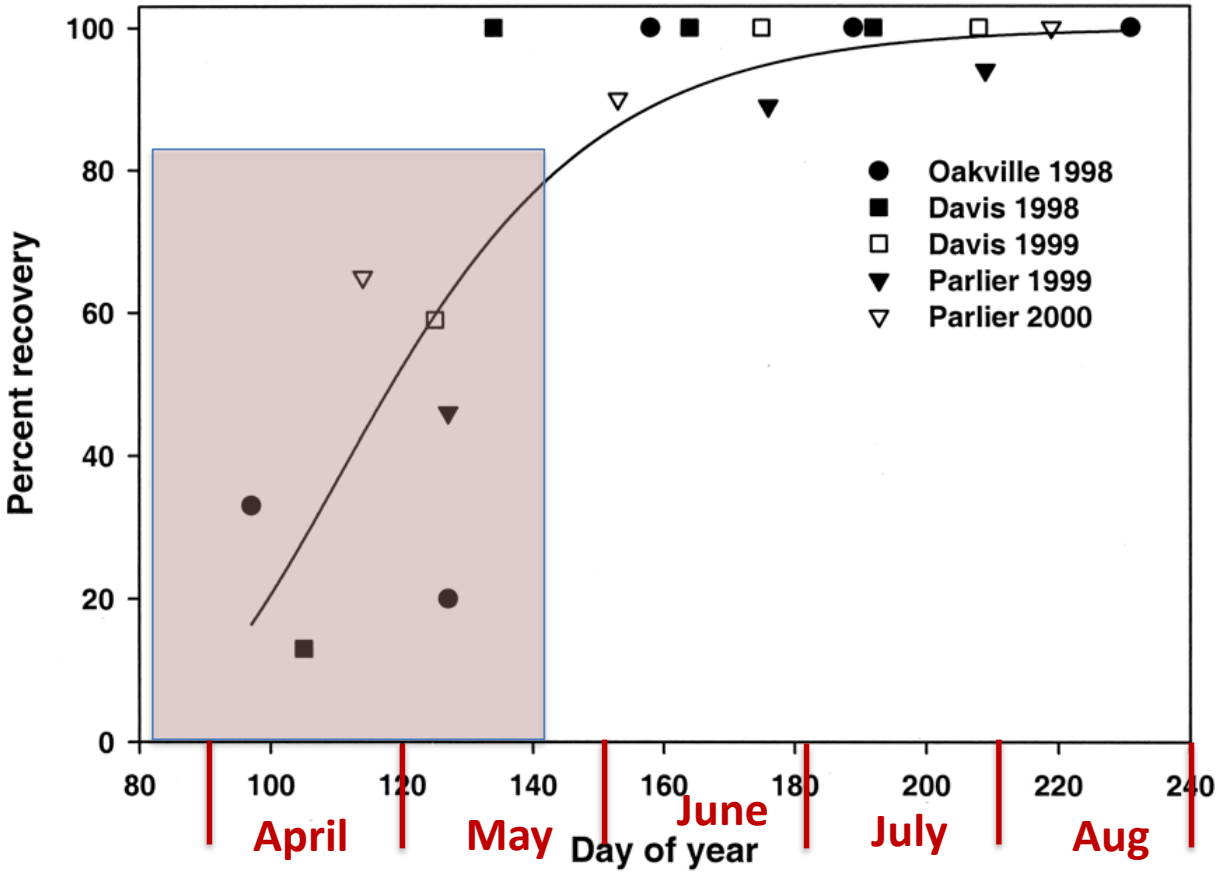


Most muscadines
Villard blanc
Lenoir
Norton
Crimson Cabernet
Lomanto

Cab. Sauv.
Merlot
Petite Sirah
Sauv. Blanc
White Riesling?

Chardonnay
Mission
Pinot Noir
Barbera

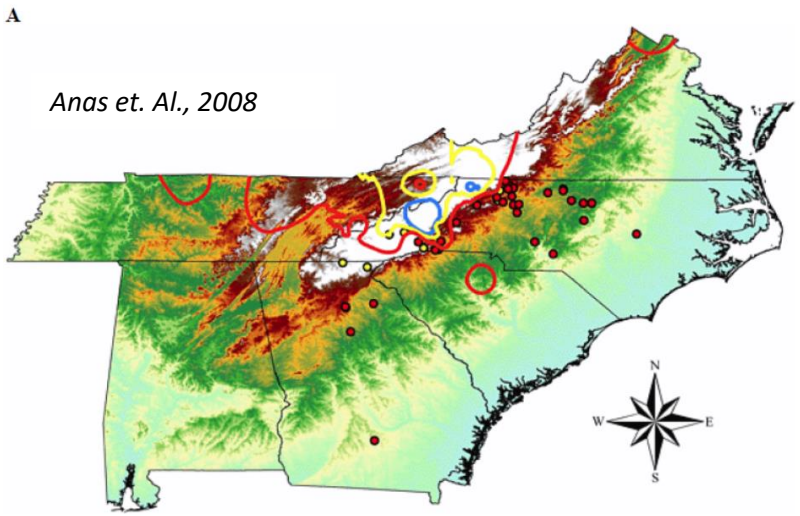
Pierce's Disease: Importance of Infection Timing

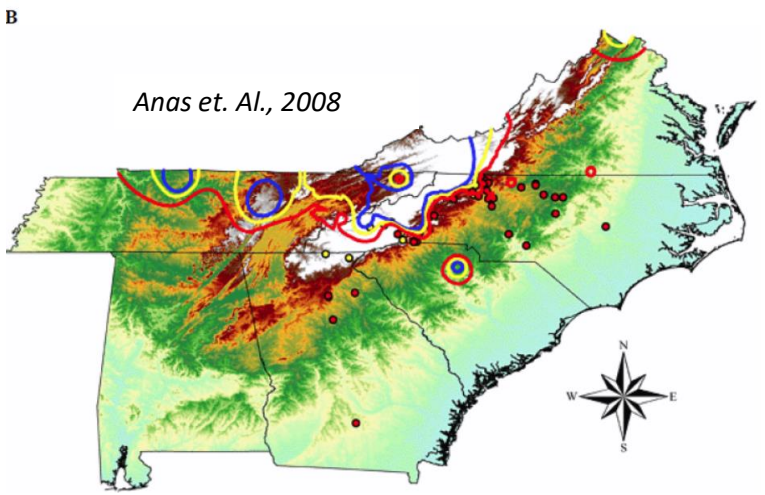


In high risk areas, infection early in season = less chance of recovery during winter = more systemic disease

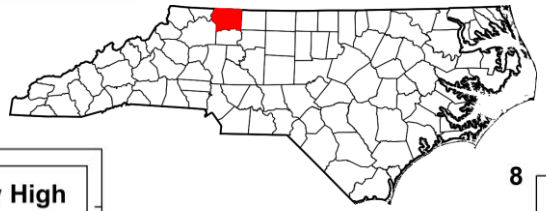
Feil, et al. 2003. Phytopathology.

Pierce's Disease in NC: An Increasing Threat?

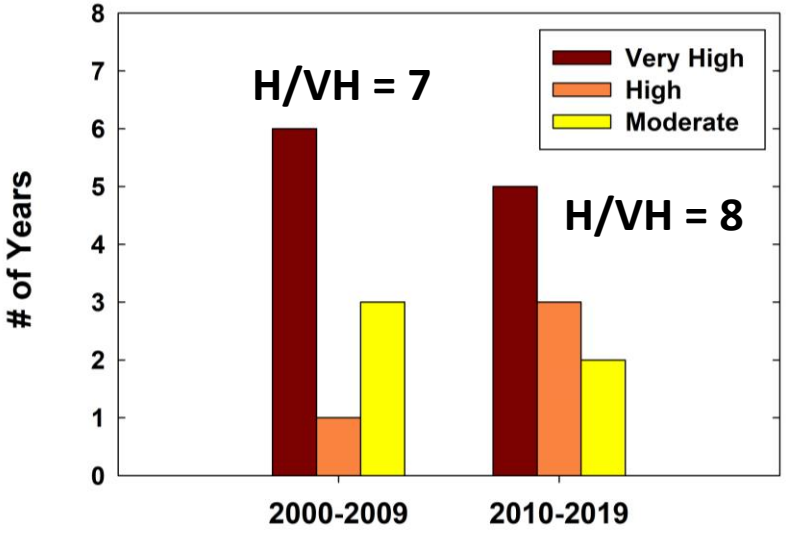


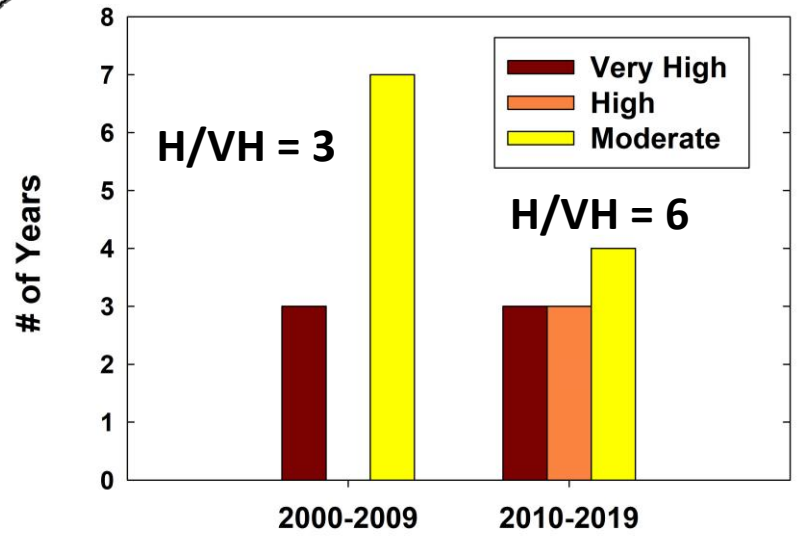


T(min) = 10 F



T(min) = 15.1 F





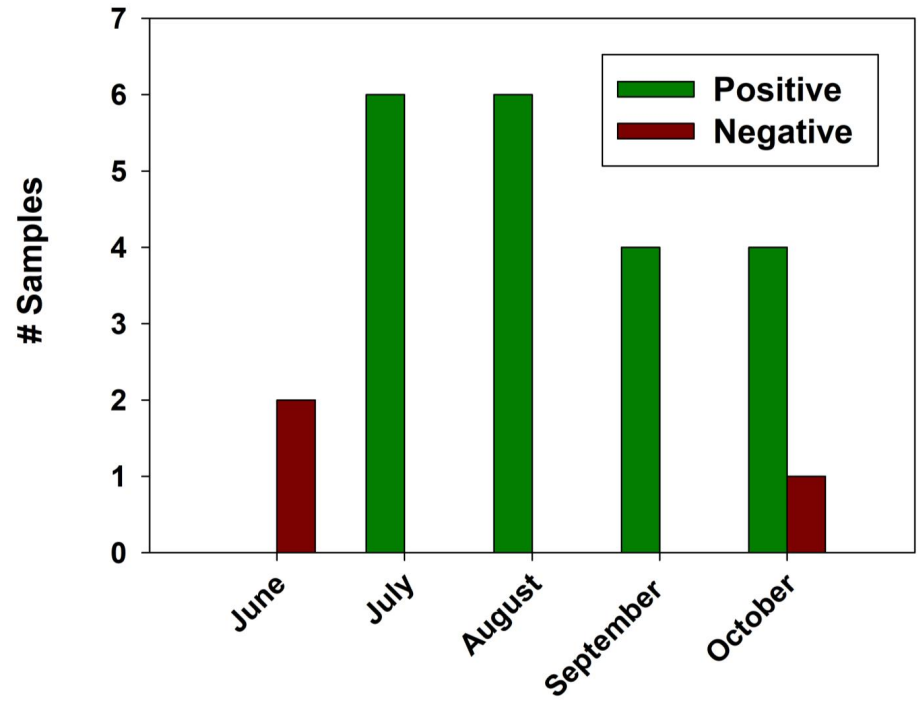
Testing for Pierce's Disease

***3 Options*:**

- Isolation of pathogen in culture
  - (+): No false positives; (-): very difficult and takes awhile
- Molecular (gene level) ID using PCR
  - (+): Highly sensitive, accurate; (-): Expensive(ish), cannot distinguish between live and dead bacteria
- ELISA-Serological assay
  - (+): Inexpensive, fast turn-around; (-): greater risk of false positives and negatives
  - Default option for NCSU-PDIC

When Should I Sample for PD?

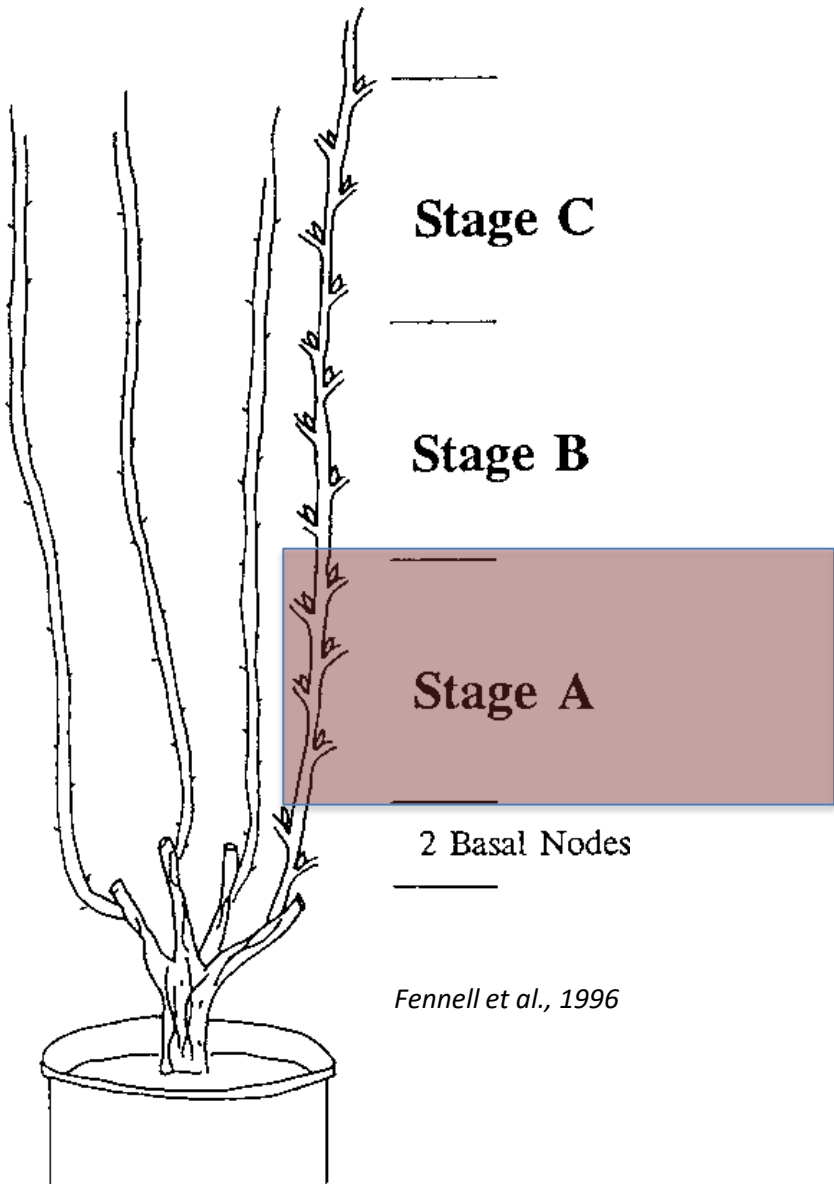
- ELISA Assay: Result depends on bacterial population ("titer") in provided sample



- In systemically infected vines bacteria does not move into new growth until mid-summer
- Time sample collection between last 1/3 July to mid-October
- Just because test is (-) doesn't mean vine isn't infected….

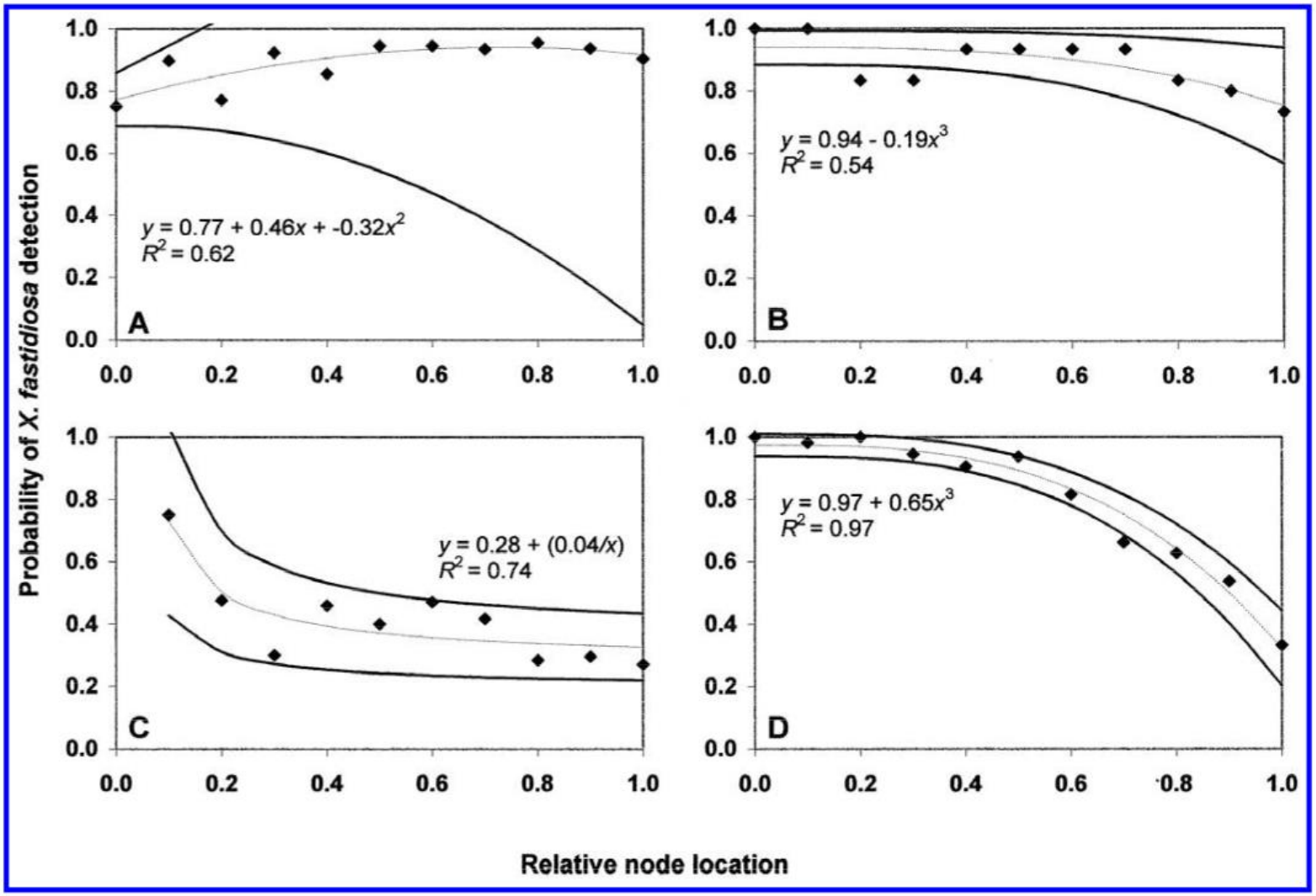
Where Should I Sample?

- Petioles of infected leaves have the greatest titer
- Try to collect symptomatic leaves + petiole
  - Basal nodes = best
- Minimum sample should consist of 3-5 leaves + petioles



Fennell et al., 1996

Where Should I Sample?



Krell, R. K., Perring, T. M., Farrar, C. A., Park, Y.-L., and Gispert, C. 2006. Intraplant sampling of grapevines for Pierce's disease diagnosis. Plant Dis. 90:351-357.

What Should I Do With Collected Samples?

- If you have a suspected case of PD contact your county extension agent or NCSU grape specialist (Hoffmann or Villani)
  - Discount on diagnostic test ($20/sample/test)

- In field, place samples on cooler w/ ice pack in Ziplock bag w/ paper towel (no need to moisten)

- Place samples in fridge prior to shipping

- Fill out PDIC submission form online (agent should do if sending) and mail same or next day to NCSU PDIC:

https://projects.ncsu.edu/cals/plantpath/extension/clinic/

References

Newman et. al, 2004. Cell-cell signaling controls *Xylella fastidiosa* interactions with both insects and plants. PNAS. 101(6): 1737-1742.

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Fennell et al., 1996. Use of 1-H NMR to determine grape bud water state during the photoperiodic induction of dormancy. Journal of the American Society for Horticulture Science

Krell et al., 2006. Intraplant sampling of grapevines for Pierce's Disease diagnosis. Plant Dis.