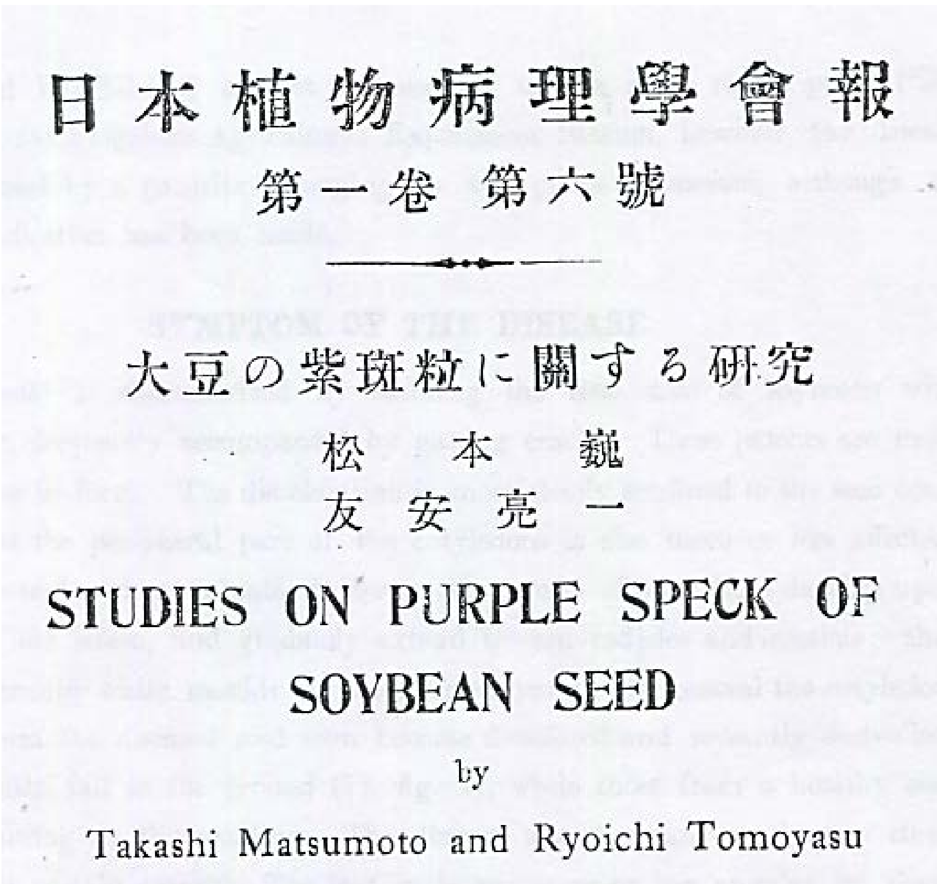
Understanding the origin and dispersal of the taproot decline and Cercospora leaf blight pathogens

Identifying sources of inoculum to determine effective management strategies for **Cercospora Leaf Blight** and **Purple Seed Stain**

CLB, PSS, and *C. kikuchii*



日本植物病理學會報

第一卷 第六號

大豆の紫斑粒に關する研究

松本 巍

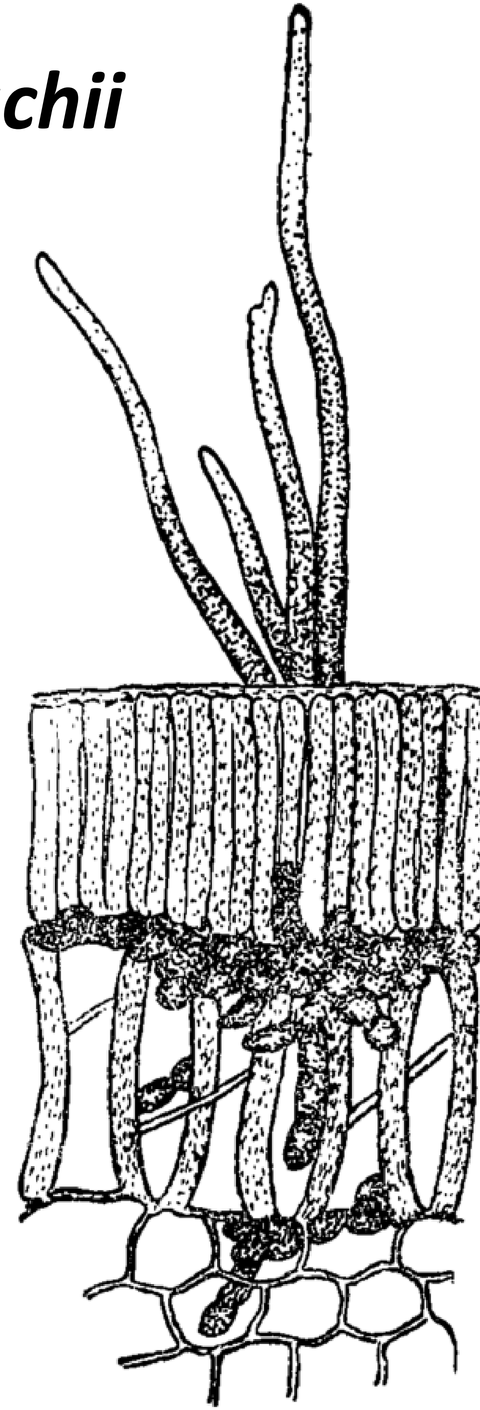
友安亮一

STUDIES ON PURPLE SPECK OF SOYBEAN SEED

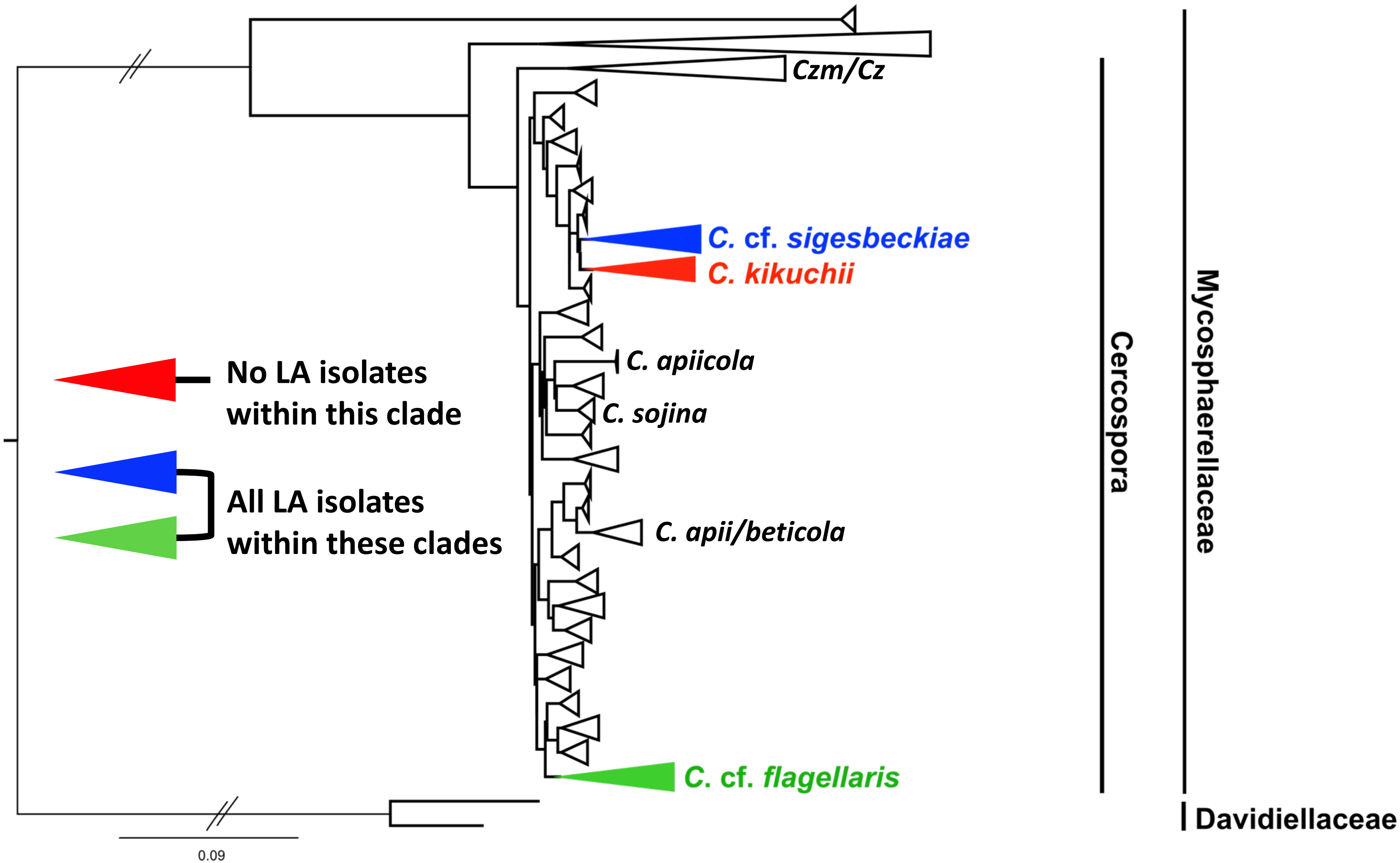
by

Takashi Matsumoto and Ryoichi Tomoyasu

1925



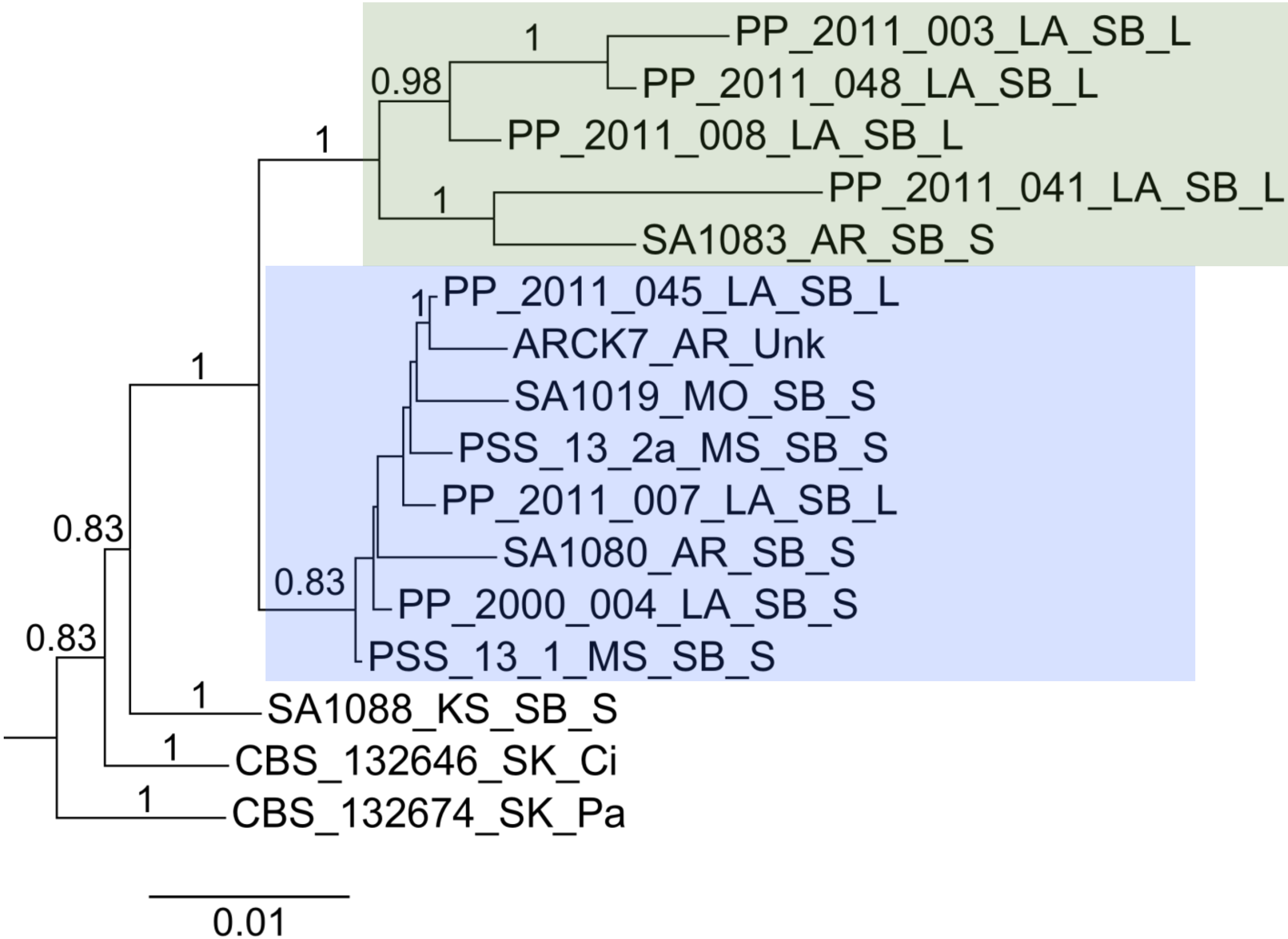
We found 2 *Cercospora* Lineages associated with CLB and PSS in Louisiana



ACT-CAL-EF1α-H3-ITS

Albu, Price, Schneider, Doyle, *Phytopathology* 2016

Cercospora flagellaris has a broad host range and high levels of genetic diversity.



Generalist

Louisiana*

Arkansas*

Missouri*

Mississippi*

Kansas*

Japan

Argentina

Developing effective management strategies

Do alternative hosts serve as a significant source of inoculum

or

is seed the primary source of inoculum for all manifestations of the disease (CLB, PSS)?

Identifying sources of inoculum to determine effective management strategies for **Cercospora Leaf Blight** and **Purple Seed Stain**

<u>Objectives:</u>

i) Evaluate strategies for seed disinfestation of soybean and determine if these approaches reduce the contribution of seed-borne inoculum to disease development (incidence and severity).

ii) Determine the relationship between seed-borne inoculum (PSS – seed lots) and pathogens isolated from blighted leaves (CLB) and harvested seed.

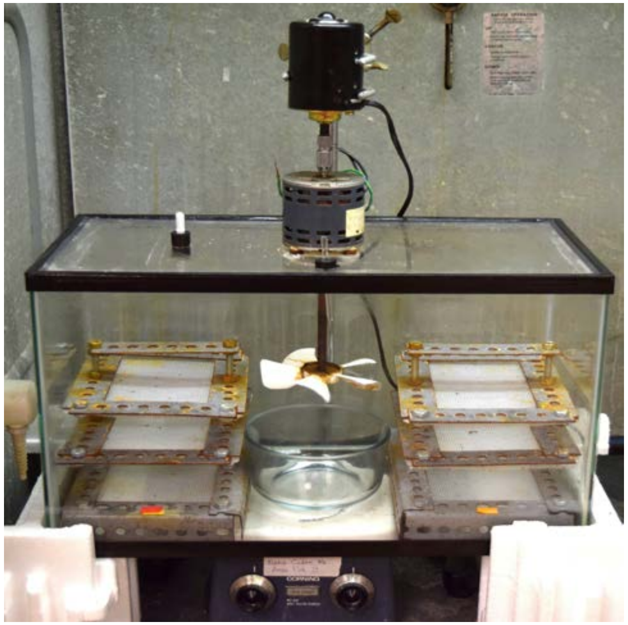
iii). Determine the potential of alternative host species to contribute to the pathogen population on soybean.

Is seed the primary source of inoculum?

Objective I

Determine whether seed disinfestation reduces disease incidence and disease severity.

Chlorine gas eliminates pathogens from seed without phytotoxicity



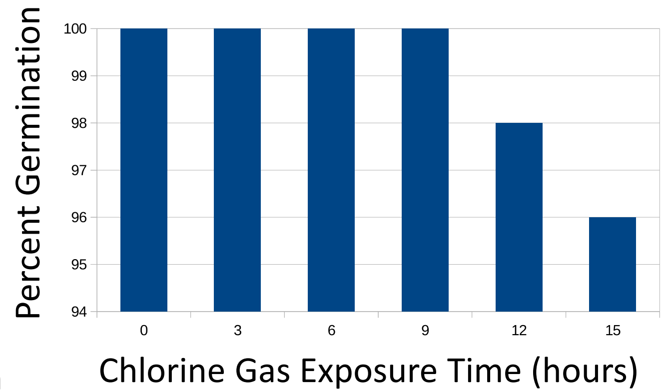
Variety
AG4632

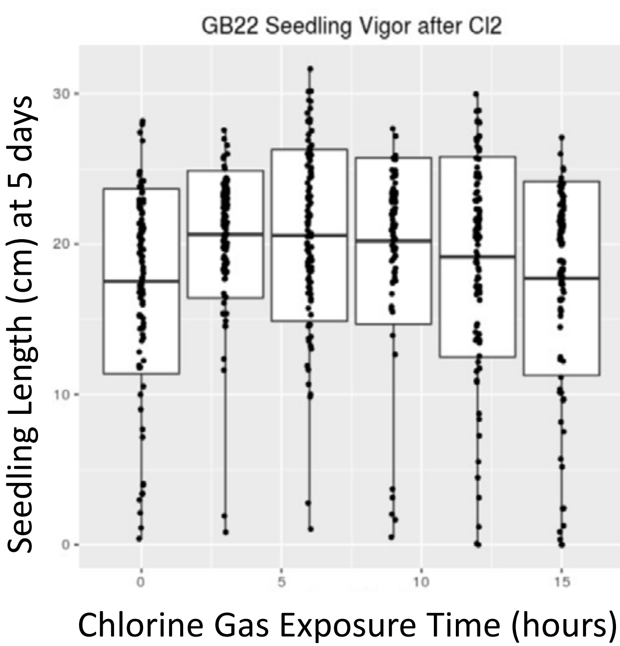
Lots
RH1B (TN)
GB22 (AR)

Treatment Times (hrs)
0,3,6,9,12,15

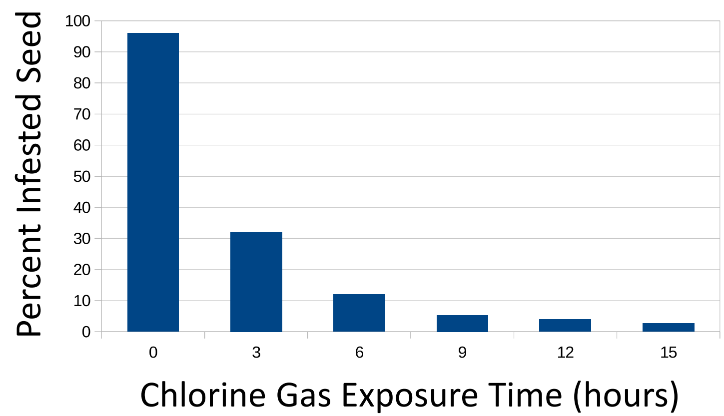
Chlorine Concentration
~200 ppm

Chlorine gas has minimal impact on germination rate

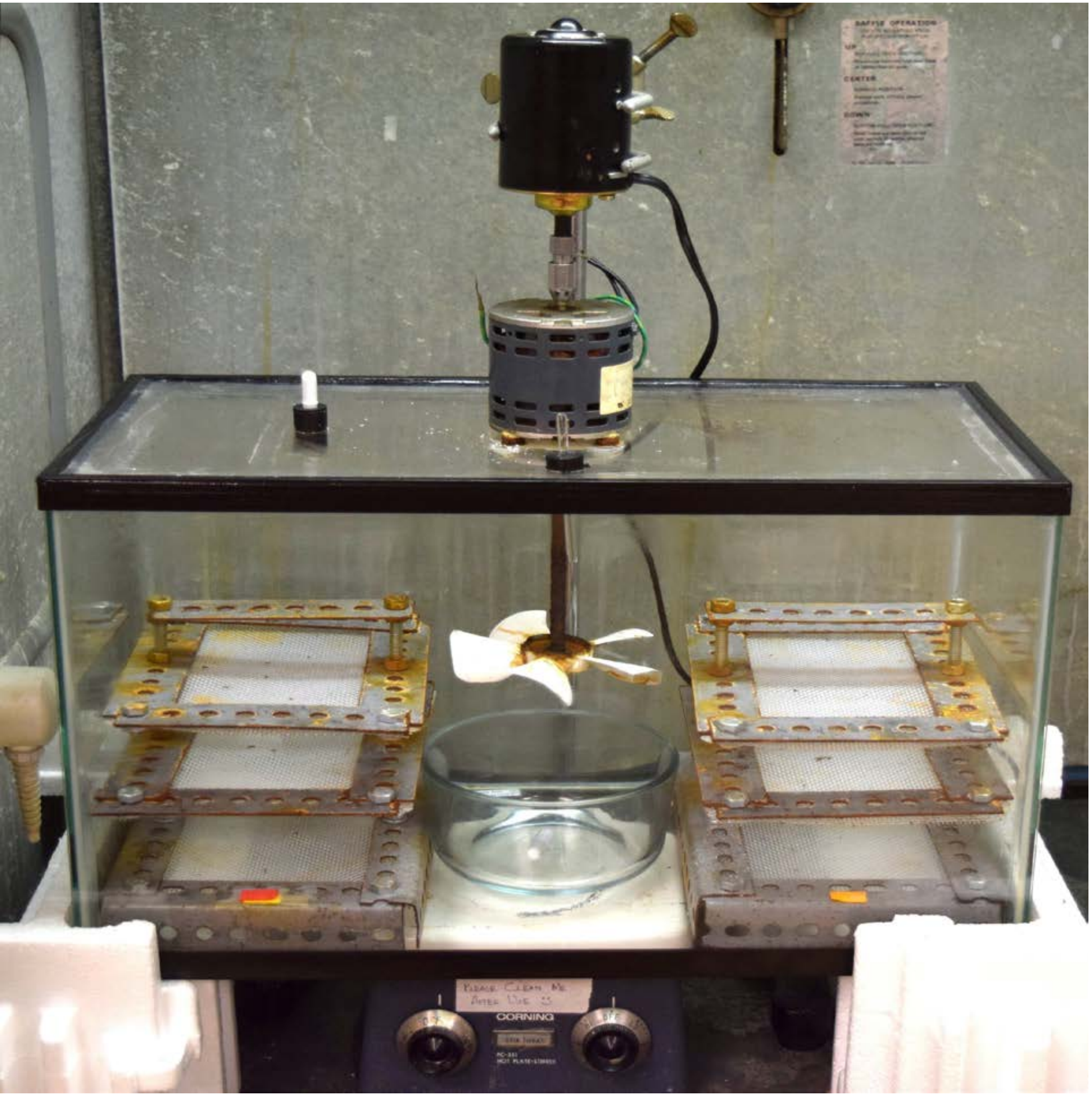




Chlorine gas eliminates microbes (including *Cercospora*)



Field Trials conducted in 2016 and 2017



Variety
AG4632

Lots
Kentucky
Arkansas
Tennessee

Treatment Time (hrs)
9

Locations:
Winnsboro, LA
Macon Ridge Research Station
2016 & 2017

Alexandria, LA
Dean Lee Research Station
2017

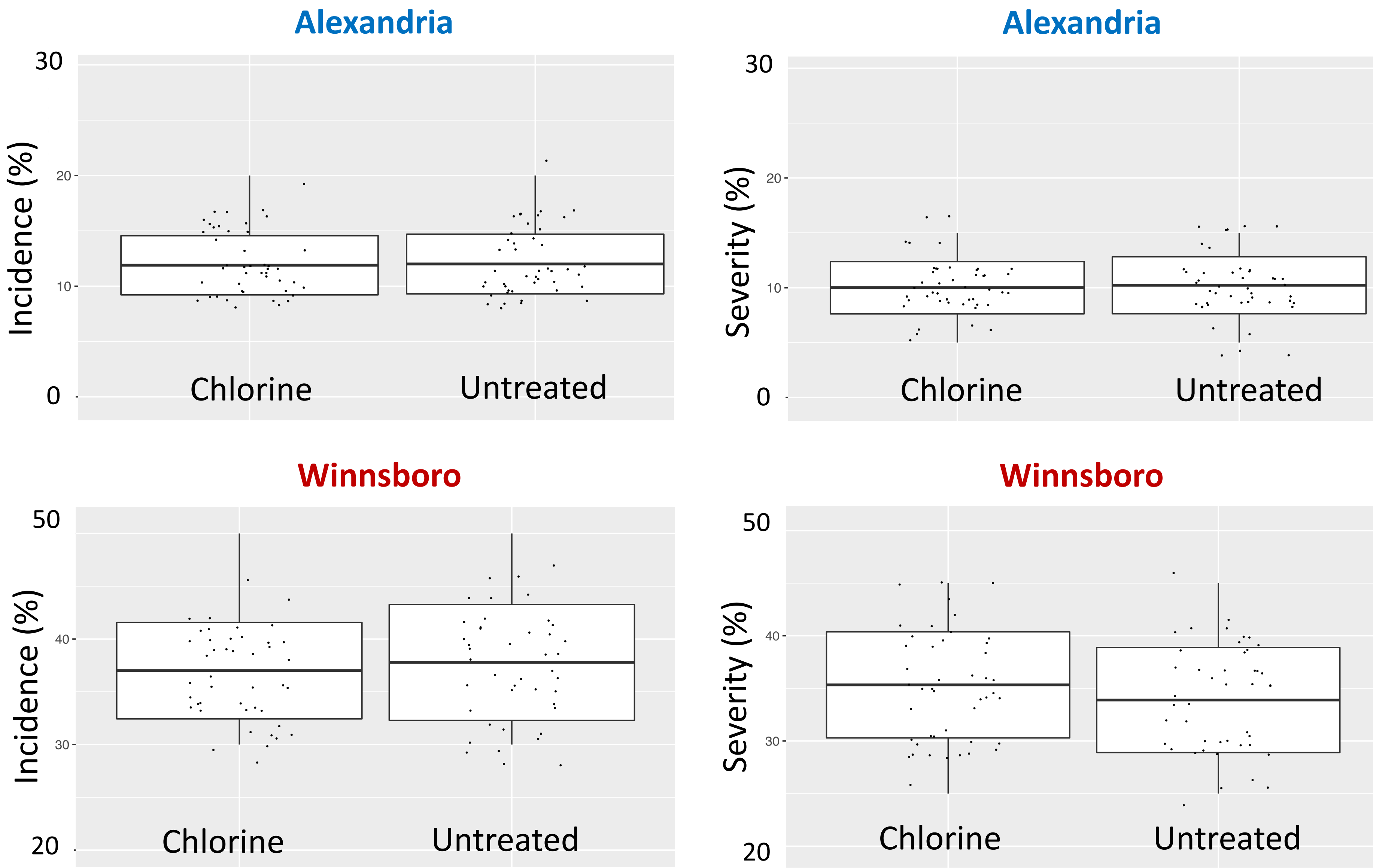
Planting Date:
mid-June 2017 and 2018

Randomized Complete Block Design
5 blocks
2 rows per treatment per lot

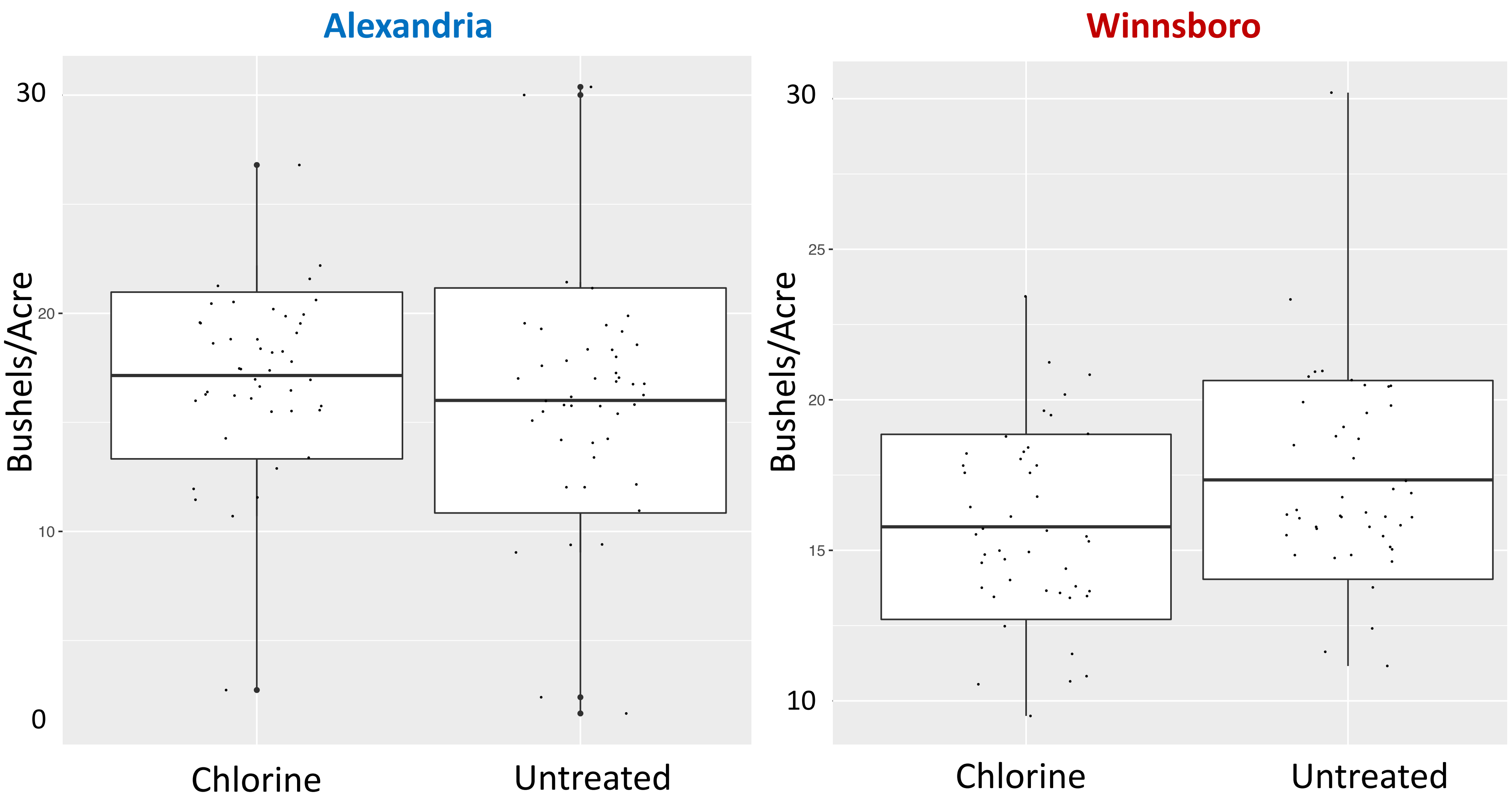
4320 seed treated per location

Chlorine treatment did not reduce incidence or severity in 2016

Chlorine treatment did not reduce incidence or severity in 2017



Chlorine treatment did not increase yield in 2017



Is seed the primary source of inoculum for all manifestations of the disease?

Objective II

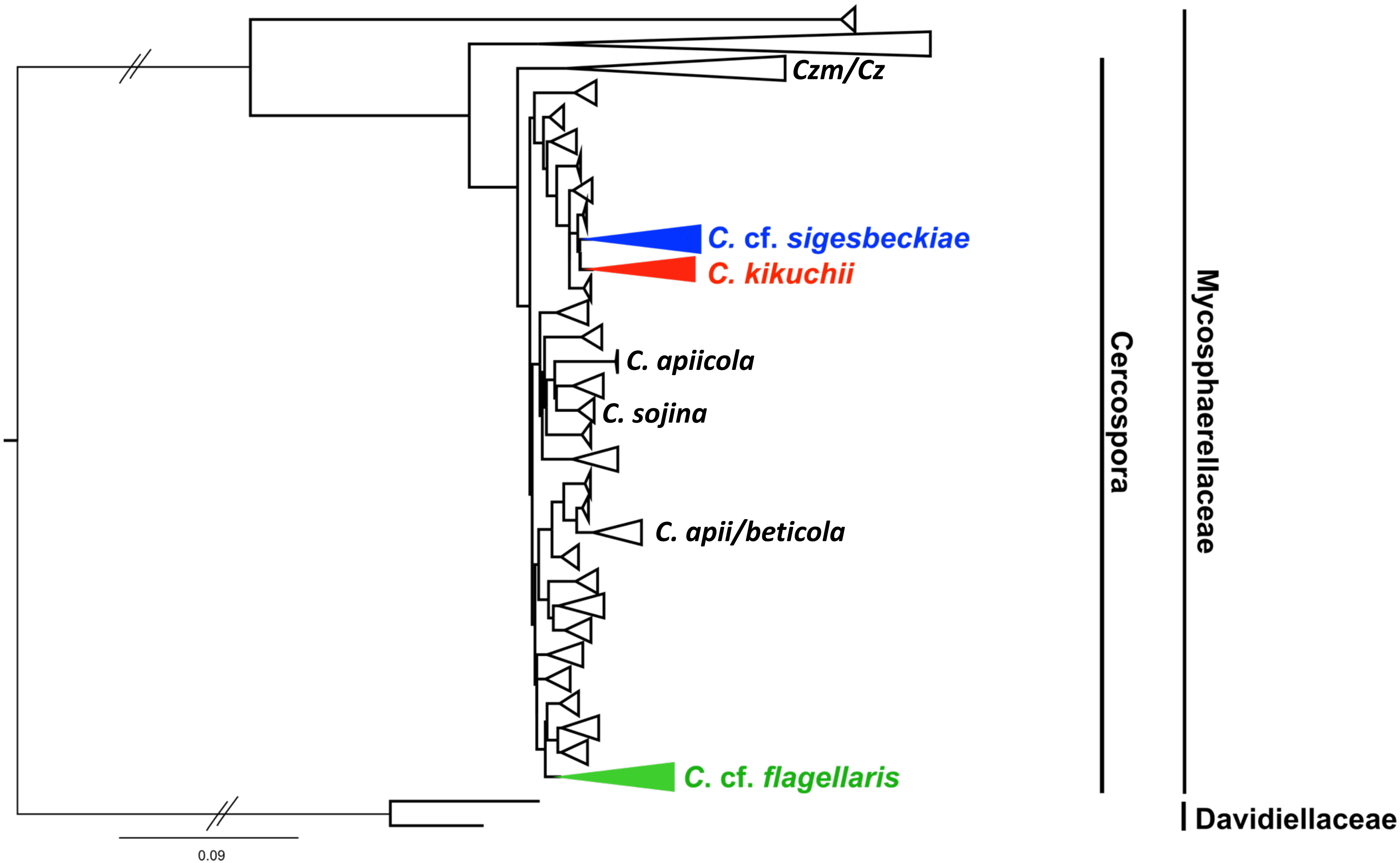
Determine the relationship between seed-borne inoculum (PSS – seed lots) and pathogens isolated from blighted leaves (CLB) and harvested seed

Sample from seed lots prior to planting

Sample from symptomatic leaves

Sample from harvested seed

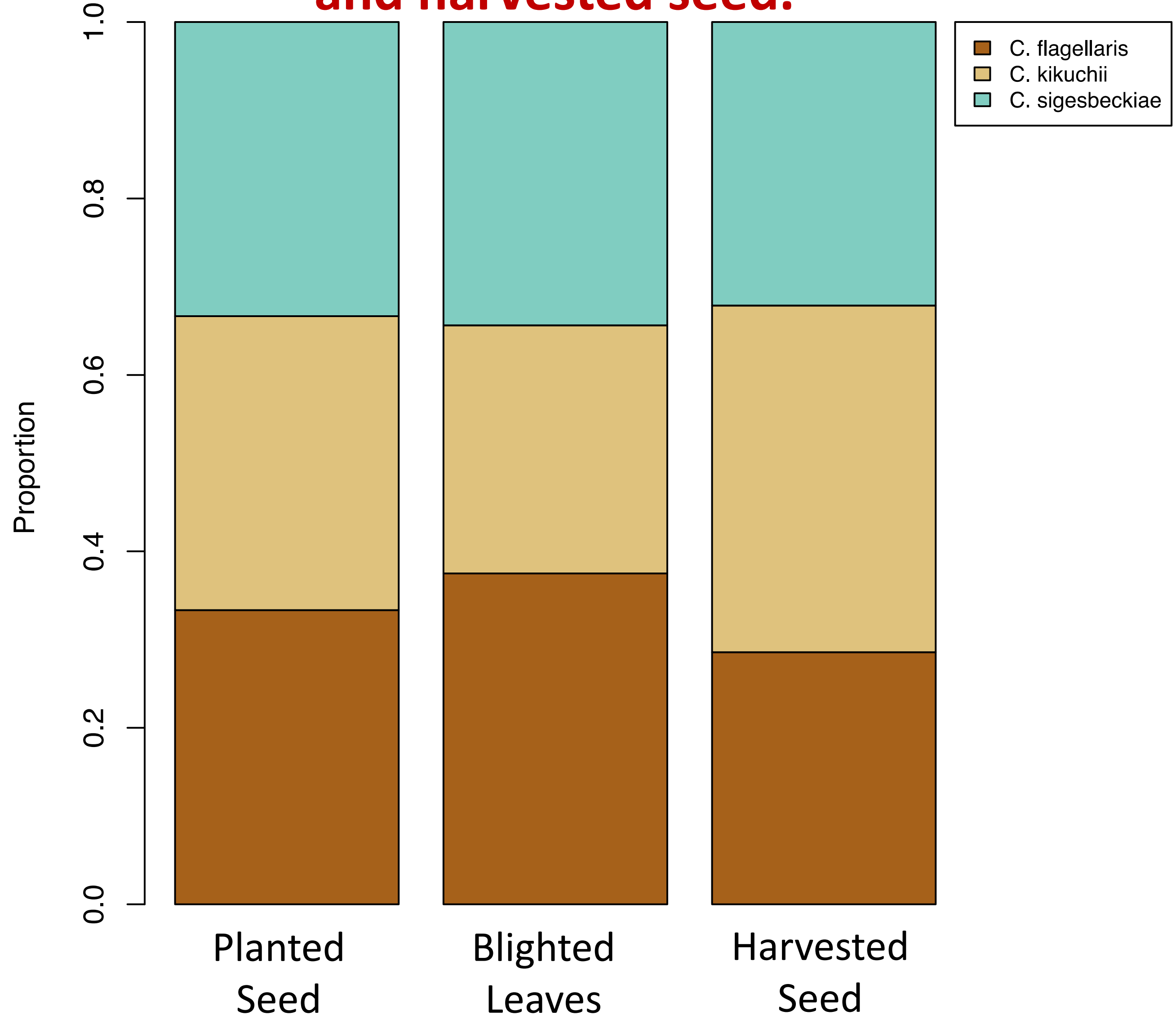
Seed from producers in Arkansas and Tennessee harbor multiple *Cercospora* species



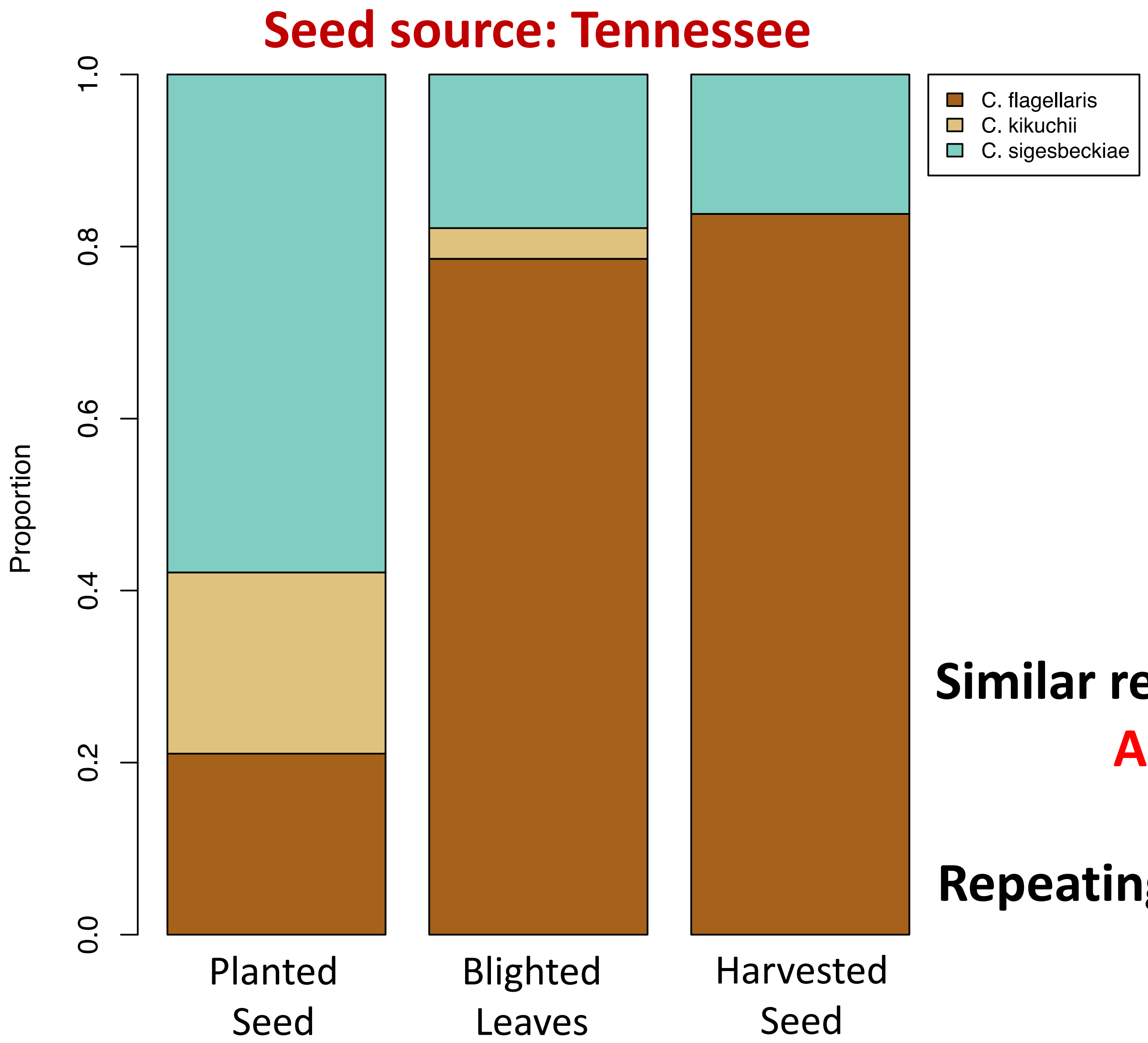
What do we expect if seed is the primary source of inoculum?

Expectations:

Similar proportions of each species in planted seed, blighted leaves, and harvested seed.



The proportion of each species in blighted leaves and harvested seed is significantly different from planted seed



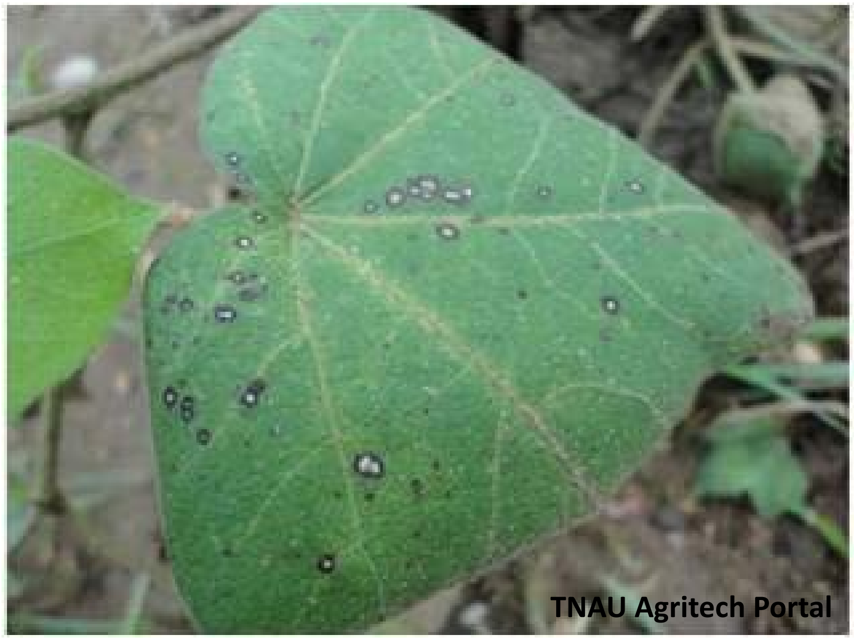
Similar results for AR

Repeating in 2017

Objective III

Identify potential alternative host species for the CLB and PSS pathogen

Pokeweed
Phytolacca



Cotton
Gossypium

Several plant species are potential sources of inoculum

Cotton – *Gossypium*
Jungle Rice – *Echinochloa colona*
Pokeweed – *Phytolacca americana*
Mulberry – *Morus sp.*
Giant Ragweed – *Ambrosia trifida*
Clasping Venus' Looking Glass - *Triodanis perfoliata*
Palmer amaranth – *Amaranthus palmeri*

Giant Ragweed

Pokeweed

Triodanis

Jungle Rice

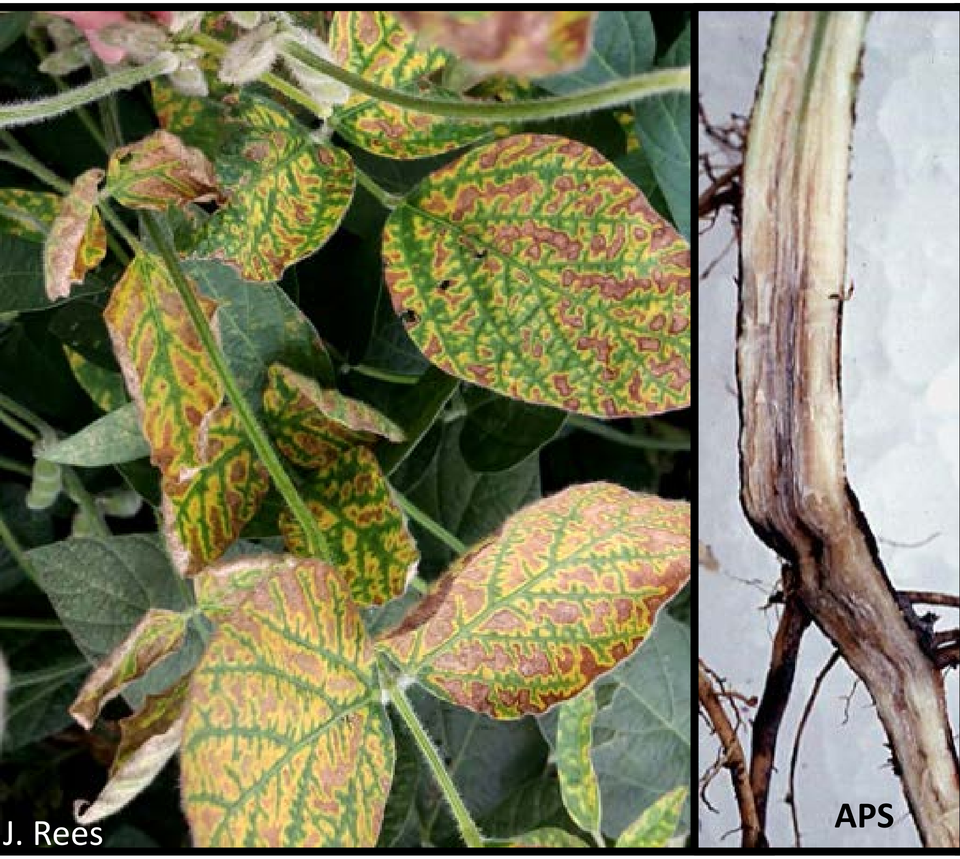
Giant Ragweed is abundant along roadsides, field margins, and disturbed areas in Louisiana

Conclusions

- Disinfesting seed prior to planting does not reduce disease incidence or severity.
- There is a significant change in the community of *Cercospora* species between planting and the appearance of blighted leaves.
- The dominant species associated with CLB and PSS, *C. flagellaris*, can be found on multiple host species that may serve as a source of inoculum.
- Seed does not appear to be the primary source of inoculum.

Building the framework to develop integrated management strategies for taproot decline


Foliar symptoms of taproot decline are similar to many other soilborne diseases and nutritional deficiencies.



Sudden Death Syndrome
Fusarium virguliforme

Taproot Decline
Xylaria sp.

Impacts can be seen from seedling to full seed (R6)

Allen, …, **Doyle**, **Price**, **Singh**, et al. 2017. Plant Health Progress

Signs of the pathogen occur on and in the tap and lateral roots

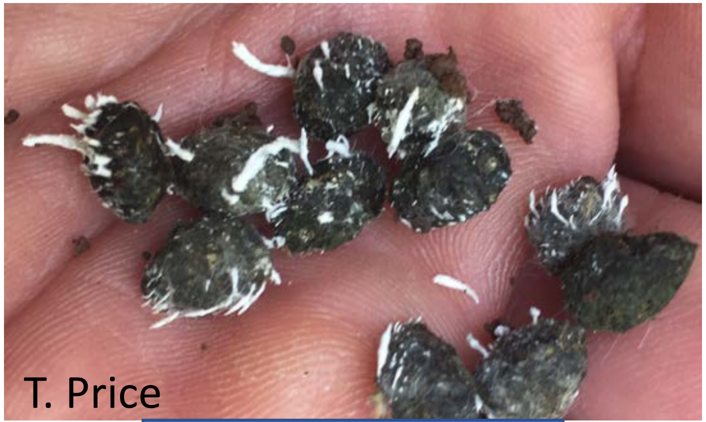
Allen, …, **Doyle**, **Price**, **Singh**, et al. 2017. Plant Health Progress

Likely overwinters on crop debris

Corn debris

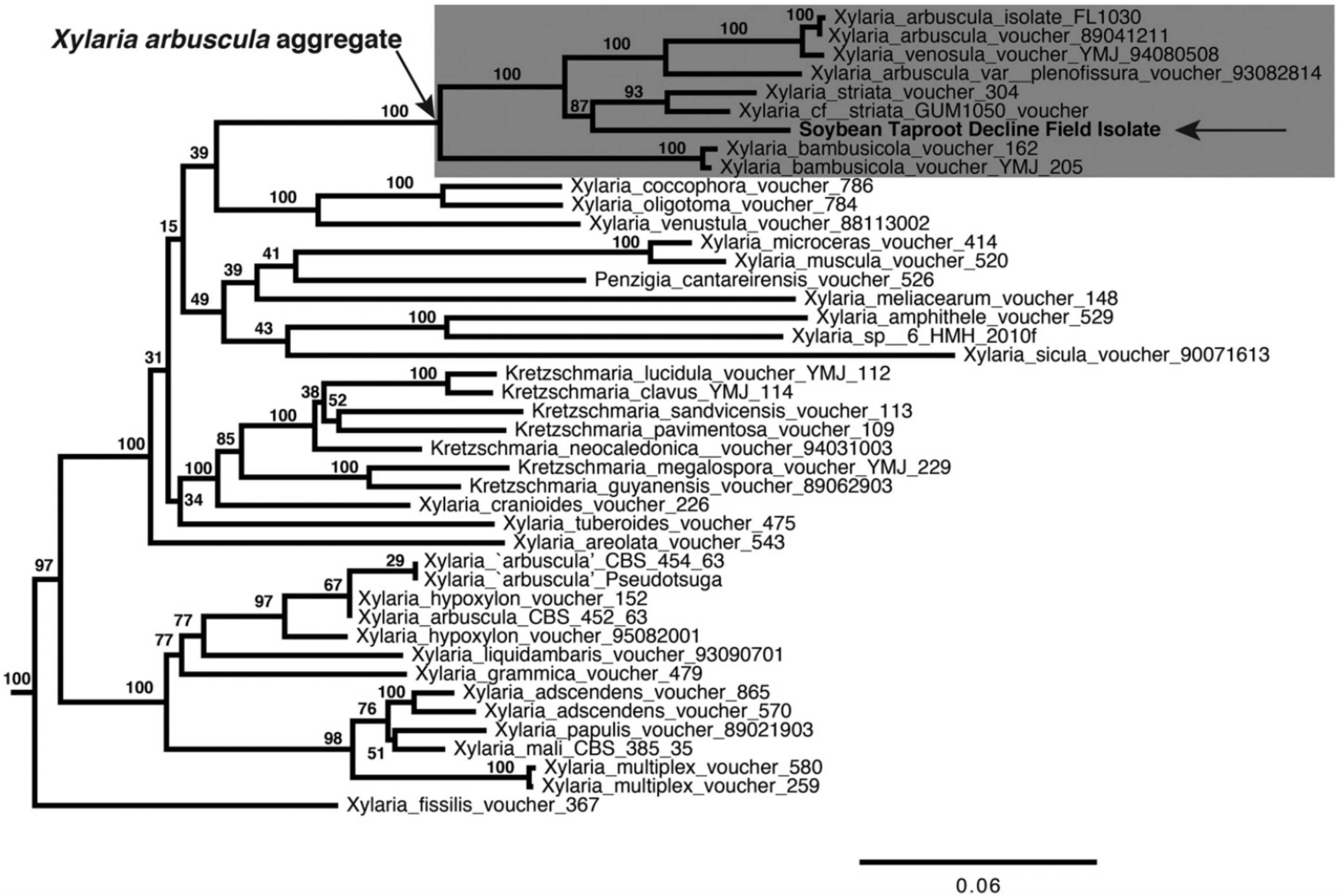
Soybean debris

Corn after soybean



Soybean seed

The taproot decline pathogen is likely an undescribed species of *Xylaria*.



Allen, …, **Doyle**, **Price**, **Singh**, et al. 2017. Plant Health Progress

More information is needed to develop management approaches

What isolates should we select to represent the pathogen population for cultivar screening and breeding?

- Genetic diversity of TRD
- Maintenance of culture collection

What is the potential for this pathogen to adapt to changing management regimes and cultivars?

- Genetic diversity of TRD
- Sexual reproduction

Was this pathogen introduced or did it emerge due to a change in the genetic base of the cultivars being used today?

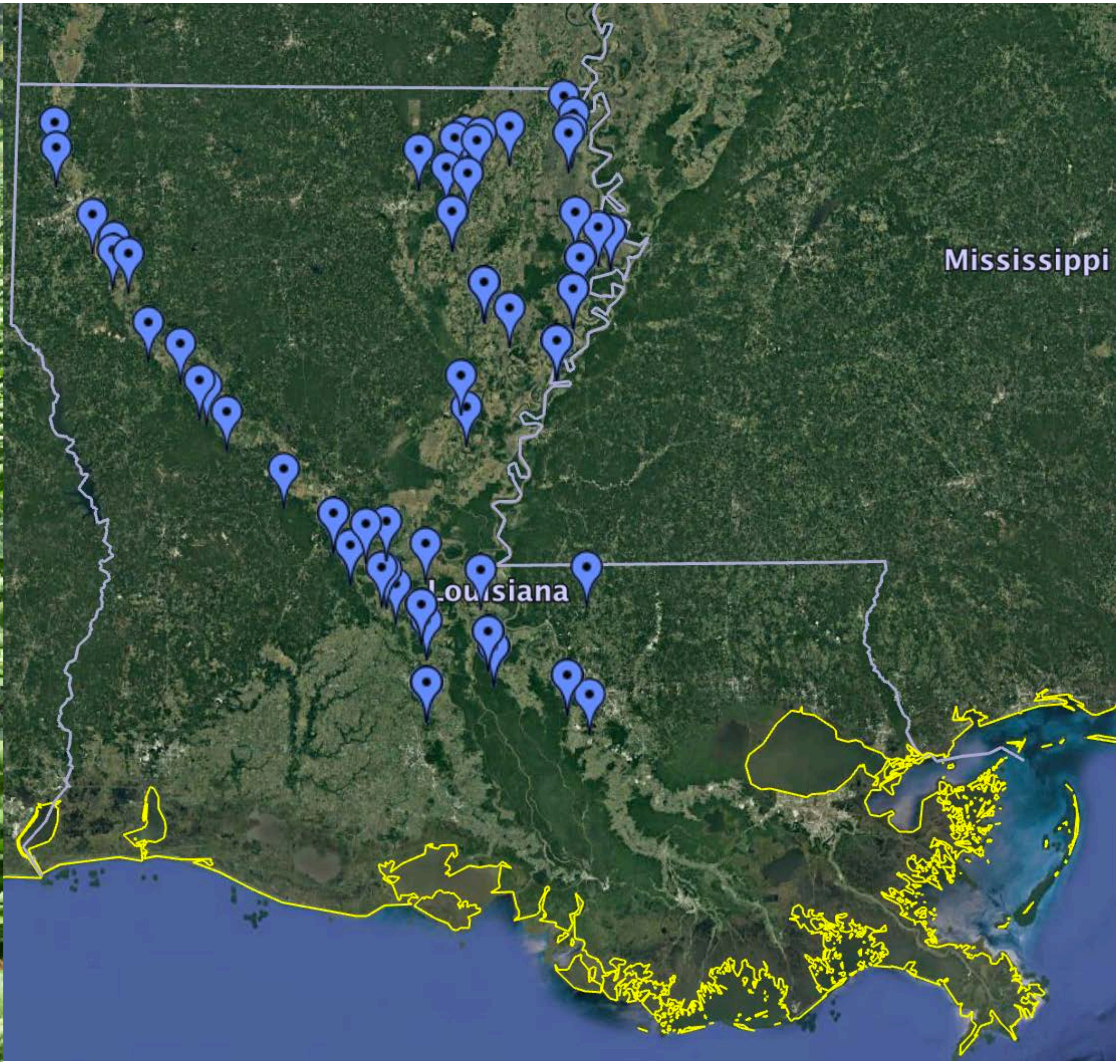
Historical specimens of *Xylaria*

Broader sampling

Does this pathogen produce mycotoxins that cause foliar symptoms like those of SDS (*Fusarium*)?

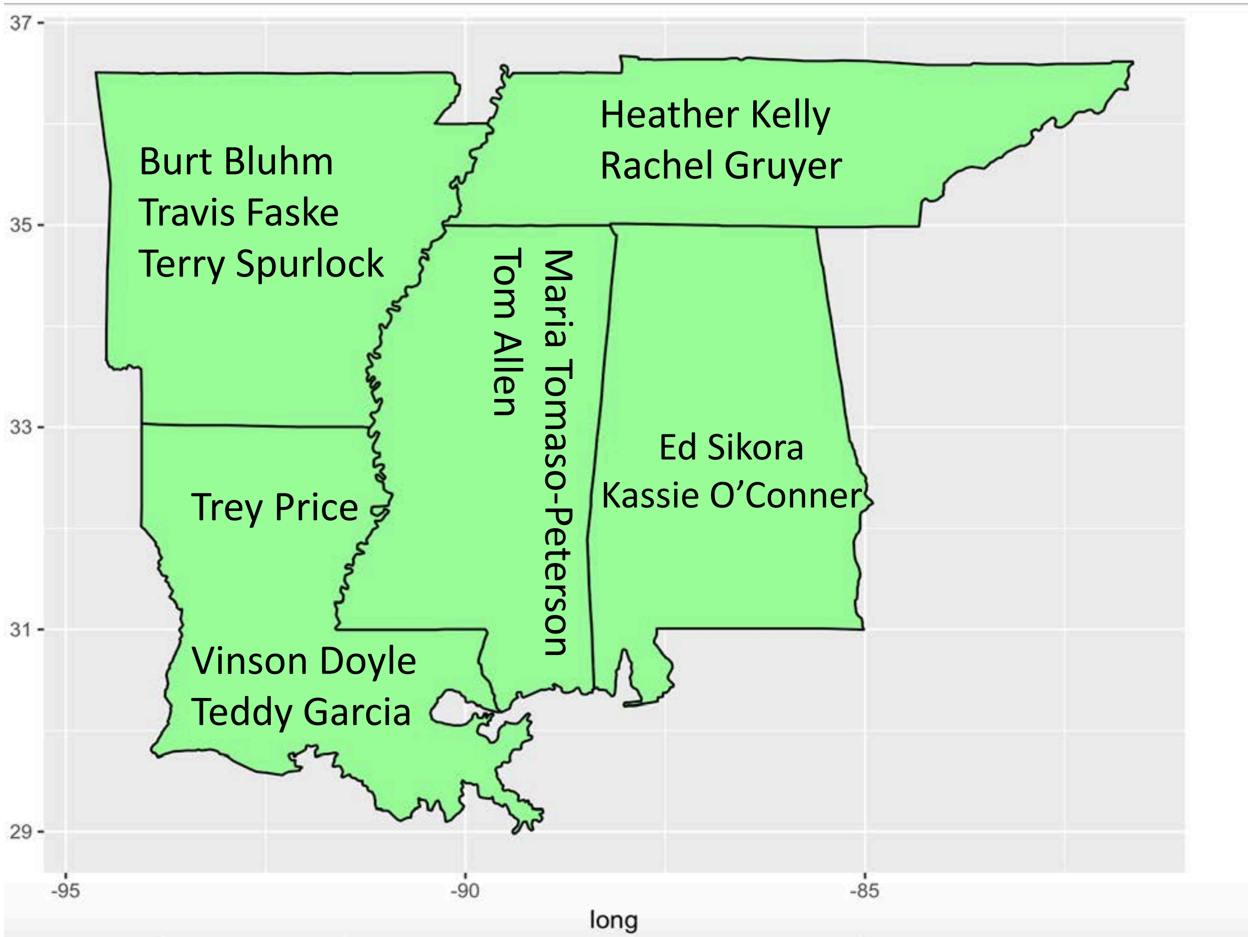
Preliminary Work

Teddy Garcia



Sampling of taproot decline in 2017

Taproot Decline Regional Collaborators



Acknowledgements

Doyle Lab

Teddy Garcia

Zachary Carver

Elaisa Tubana

Hannah Tonry

Jacob Searight

Veronica Bras

Jose Solarzano

Sara Berrezueta

Emily Rolfes

Dan Cooke

Price Lab

Trey Price

Myra Purvis

Hunter Pruitt

Schneider Lab

Ray Schneider

Clark Robertson

Eduardo Chagas

Brian Ward

Other Collaborators

Marc Cohn

Soybean & Grain

RESEARCH & PROMOTION BOARD REPORT

LSU AgCenter

Research & Extension

More information is needed to develop management approaches

What isolates should we select to represent the pathogen population for cultivar screening and breeding?

- Genetic diversity of TRD
- Maintenance of culture collection

What is the potential for this pathogen to adapt to changing management regimes and cultivars?

- Genetic diversity of TRD
- Sexual reproduction

Was this pathogen introduced or did it emerge due to a change in the genetic base of the cultivars being used today?

Historical specimens of *Xylaria*

Broader sampling

Does this pathogen produce mycotoxins that cause foliar symptoms like those of SDS (*Fusarium*)?

Research Plans for 2018

i) Determine the contribution of alternative host species to the pathogen population on soybean

- Continue survey for alternative hosts of *Cercospora* near soybean fields
- Genotype *Cercospora flagellaris* from alternative hosts to determine contribution to soybean disease

ii) Develop protocols to re-infest disinfested seed with *Cercospora* and generate inoculum in the lab.

- Utilize seed disinfestation protocol to rid seed of pathogens and re-infect with selected isolates of *Cercospora* as a means to determine the role of each of these species in disease development (host-fungal interactions, plant breeding)
- Develop protocols to induce sporulation of *Cercospora* on artificial media for inoculation studies.

iii). Determine the potential for crop debris to serve as a source of inoculum for CLB and PSS.

Survey soybean fields monthly from February – June for soybean and other crop debris and assess as a source of inoculum (morphological and molecular).

Objectives

I. Identify the principal lineages of the TRD pathogen in Louisiana and maintain isolates for future cultivar screening and breeding work.

II. Determine whether the TRD pathogen is sexually reproducing in Louisiana to make predictions about the long-term stability of cultivar resistance.

III. Determine the TRD pathogens dispersal modes and center of origin to design the most impactful and relevant mitigation strategies.

IV. Determine whether the symptoms produced by the TRD pathogen is the result of the production and translocation of phytotoxic compounds.

Projected Outcomes

I. Characterization of the genetic diversity of TRD in Louisiana and a culture collection to be used for cultivar screening.

II. An assessment of the long-term potential for TRD to adapt to management regimes.

III. A determination of whether management practices can be implemented to limit pathogen dispersal.

IV. A potential rapid cultivar screening method using fungal extracts.