

Soybean Rust: Its history, biology, epidemiology and importance to crop production

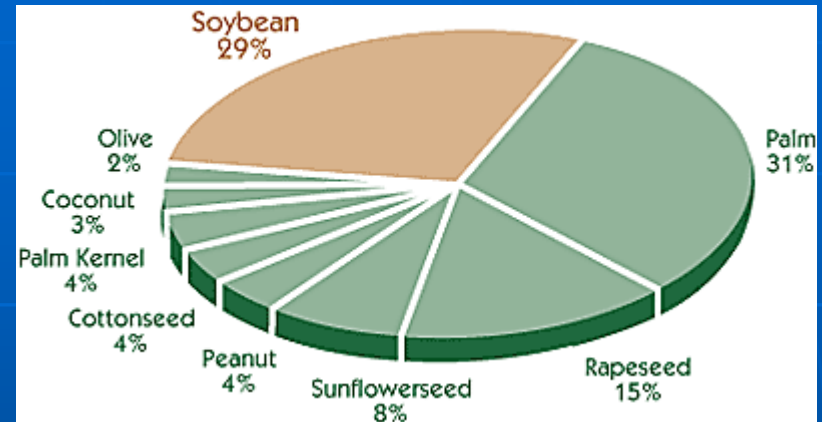
**James E. Kurle
Dean Malvick
Sagar Krupa
Crystal Floyd**

**Department of Plant Pathology
University of Minnesota**

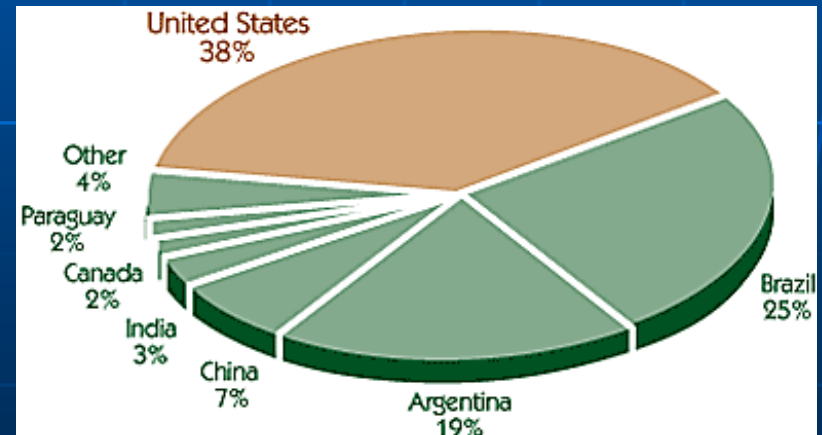
Overview

- The Host/The Pathogen
- History
- Biology
- Epidemiology in US
- Sentinel Plots
- Spore Detection

Processed soybeans are the world's second largest source of vegetable oil.

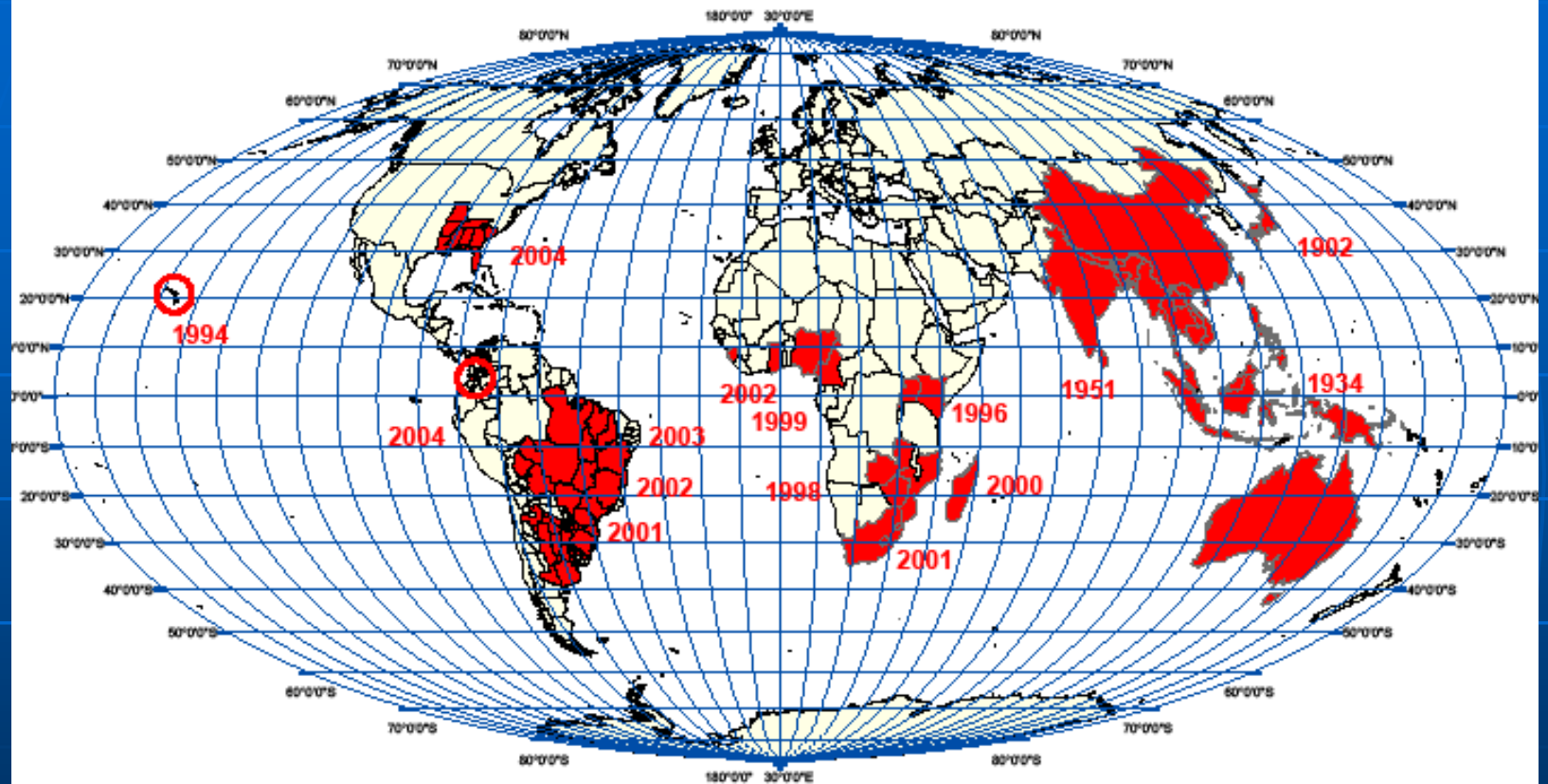


United States is world's largest producer of soybean – in 2006
3188 million bushels of
8391 million bushels



(<http://www.soystats.com>)

GLOBAL EXPANSION OF SOYBEAN RUST



2004

Projection: Mollweide
Central Meridian: 0.00



Source: Bromfield K.R., Frederick R.,
Godoy C.V., Hartman G.L., Levy C.,
Miles M.

Author: Annalisa Ariatti, Penn State University

The Rusts

- **Obligate Biotrophic Fungi**
- **Host Specific: Often Cycle between Two Specific Hosts**
- **Disseminated by Airborne Spores**
- **Major Pathogens of Agricultural Crops**
- **Numerous Examples of Transcontinental Dispersal**

Disease cycle

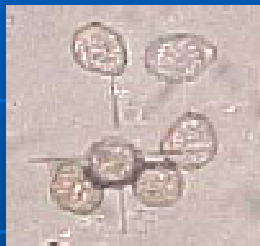


Infection

Germination

optimum 18°C - 26°C

Penetration



Dissemination: wind

Dissemination



Colonization

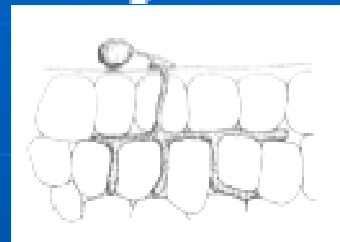
Free water on leaf surface

Minimum: 6 h

Optimum: 12 - 14 h

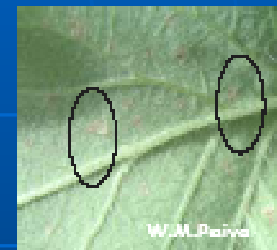


Direct penetration through stomata

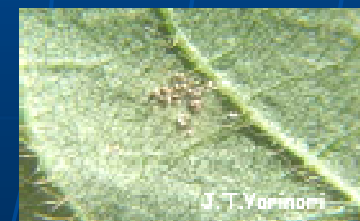


Symptoms start appearing 5 days after inoculation

Reproduction



6-7 days occurs spore liberation



One pustule releases spores along 3 weeks

Progression of Rust on Soybean

Day 1 – 0% symptoms



6 Days later



13 Days later

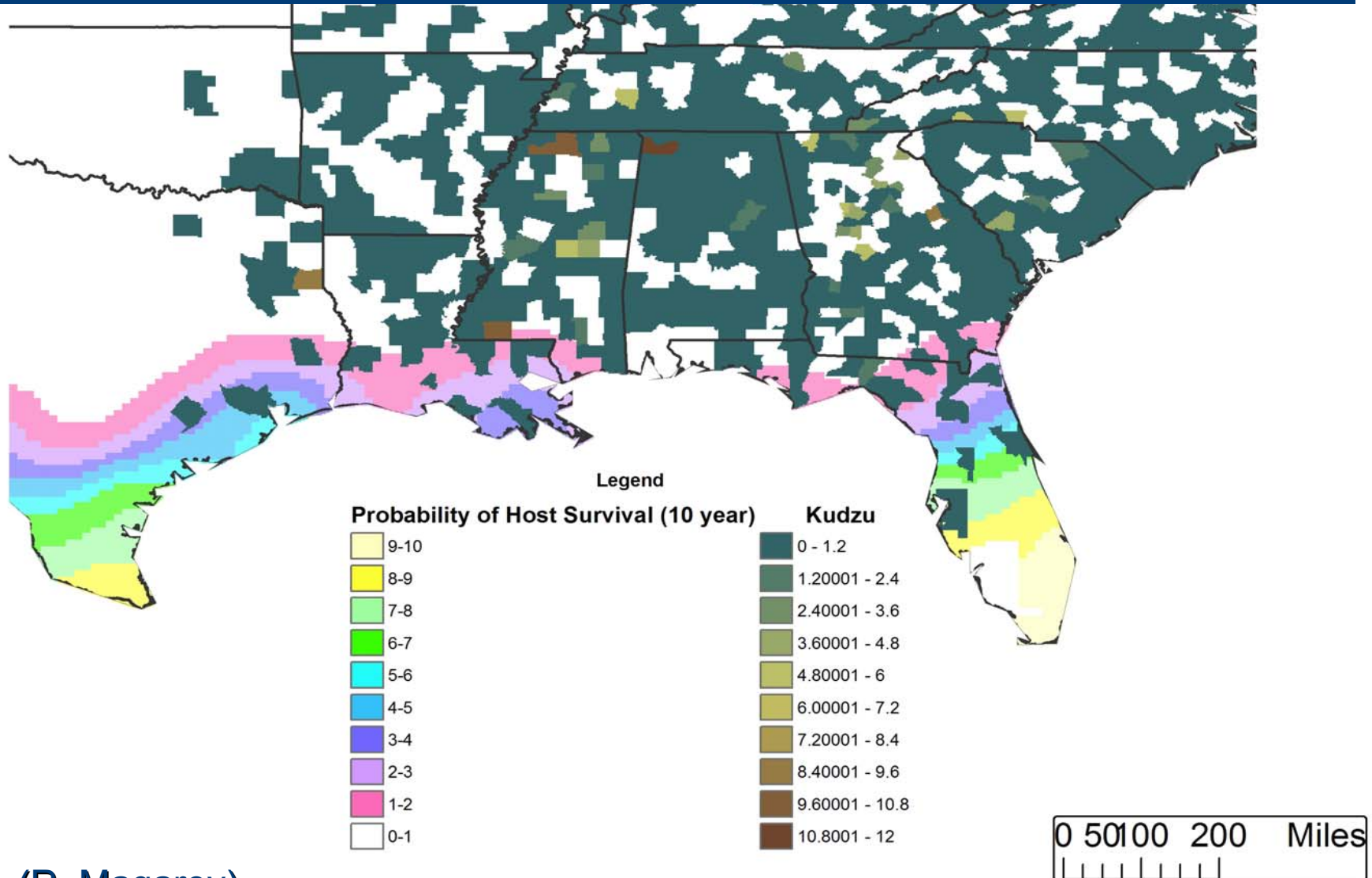


27 Days



(Courtesy X.B. Yang)

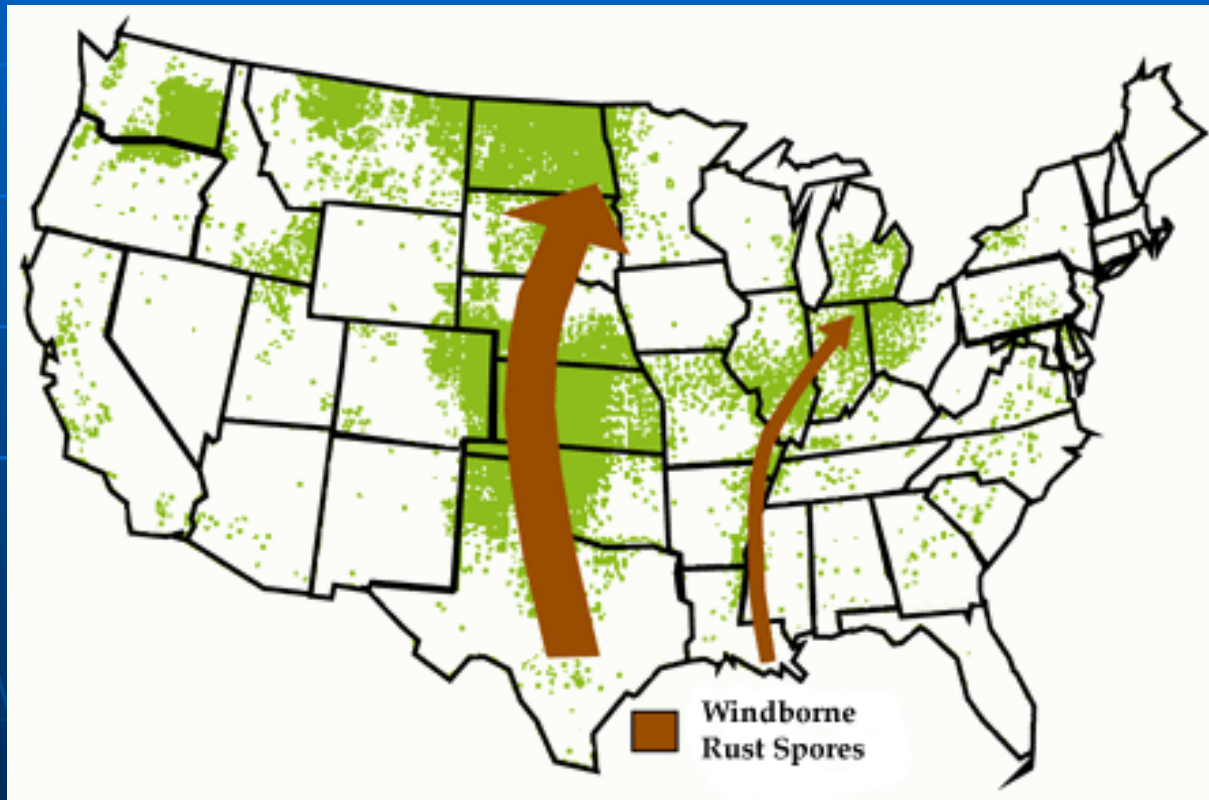
Probability for survival of overwintering hosts based on occurrence of temperatures greater than 28° F in a given year, overlaid with the estimated percentage of kudzu coverage by county.



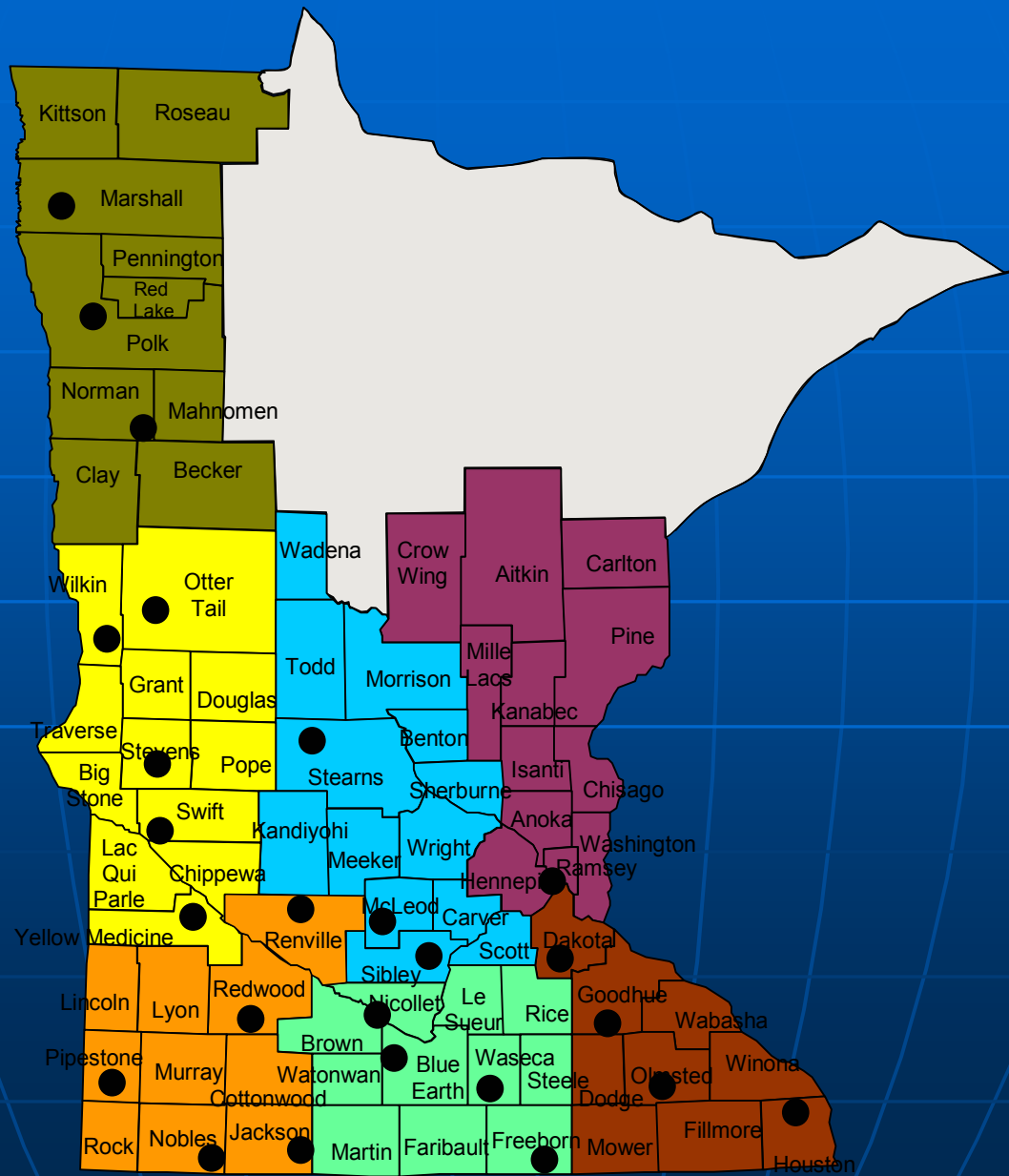
(R. Magarey)

Continental scale spore transport

- *The Puccinia pathway*



2007 sentinel plot and deposition collector locations



Monitoring in Minnesota - 2007

■ Sentinel Plots

- 25 Locations
- 100 Leaf Samples weekly
- Leaf Wetness Observation @ 4 locations

■ Spore Deposition

- JB (Membrane Filter) Collectors

■ Filters tested for soybean rust using qPCR technique

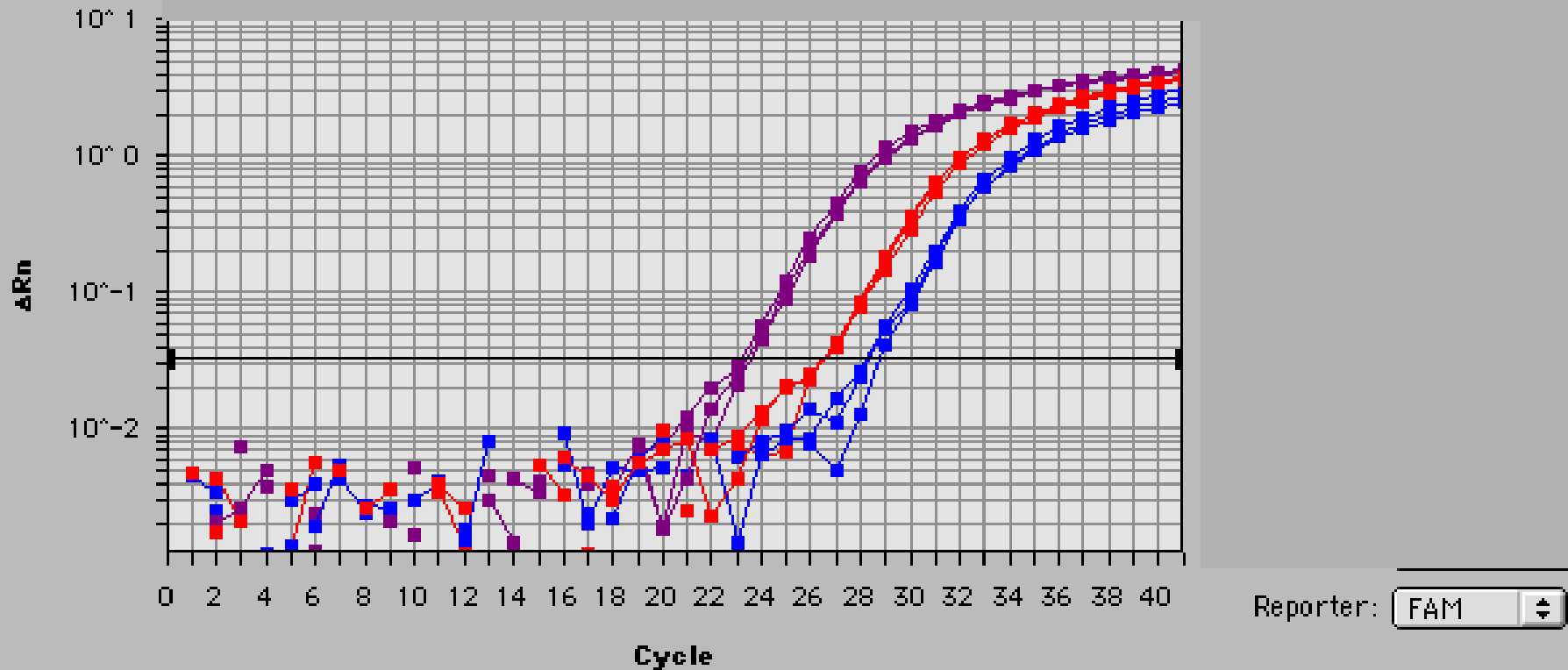
JB Collectors



DNA Analysis Techniques now available to Test Samples for Small Quantities of Fungal Spores

- **Real-time, quantitative PCR analysis (RT or qPCR)**
- **New technique - <10 years**
- **Advantages**
 - **Very sensitive – can detect <10 spores**
 - **Highly specific for certain fungi**
 - **Quantitative**
 - **High potential sample processing speed**
 - **No post amplification processing (no gels or photos)**

Pathogen Inoculum Levels Can Be Measured with qPCR

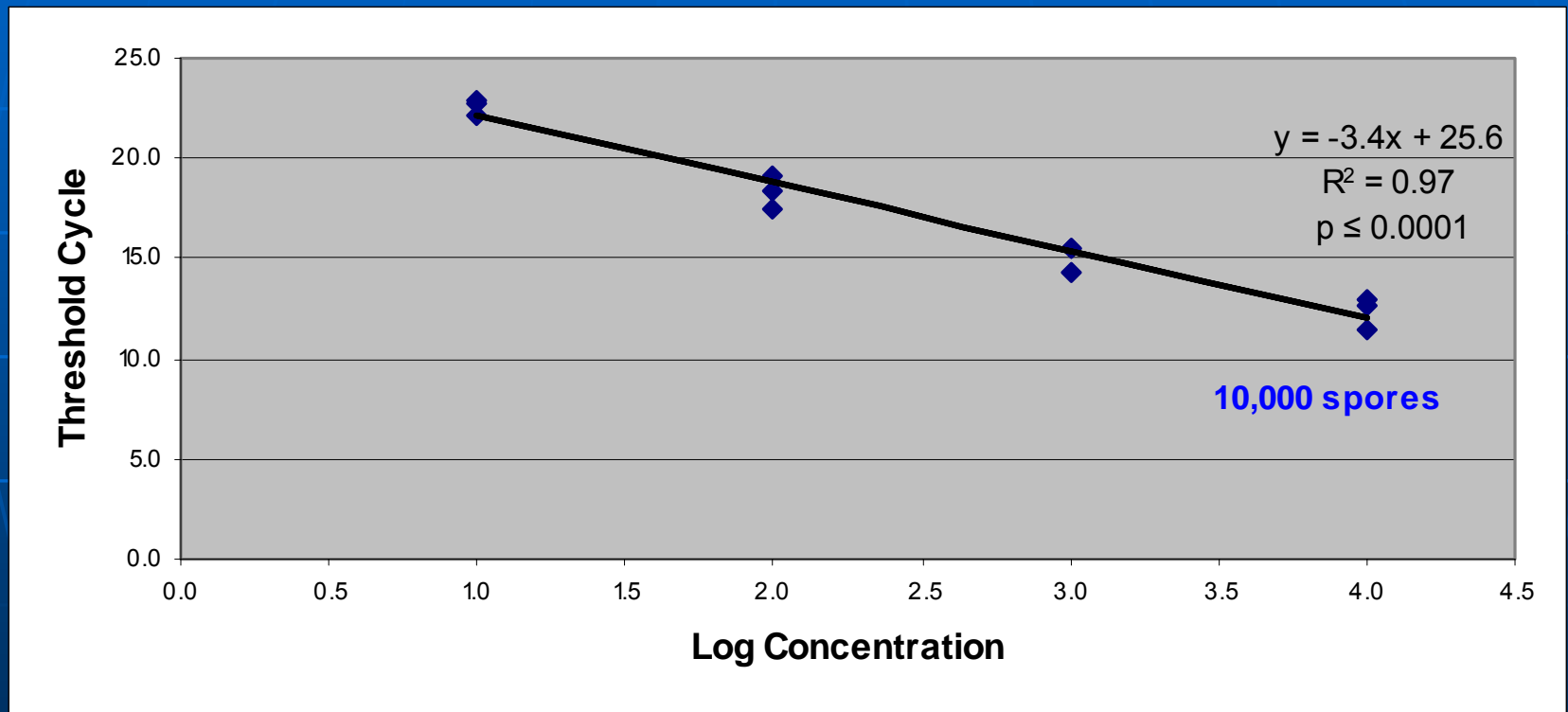


Violet = 3,500 spores

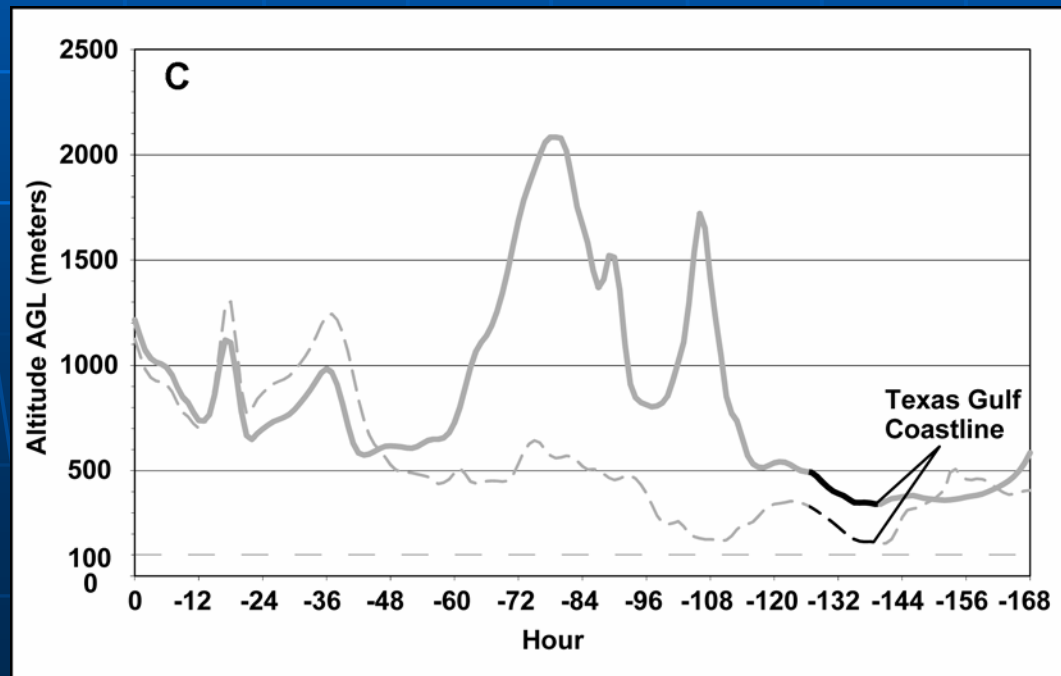
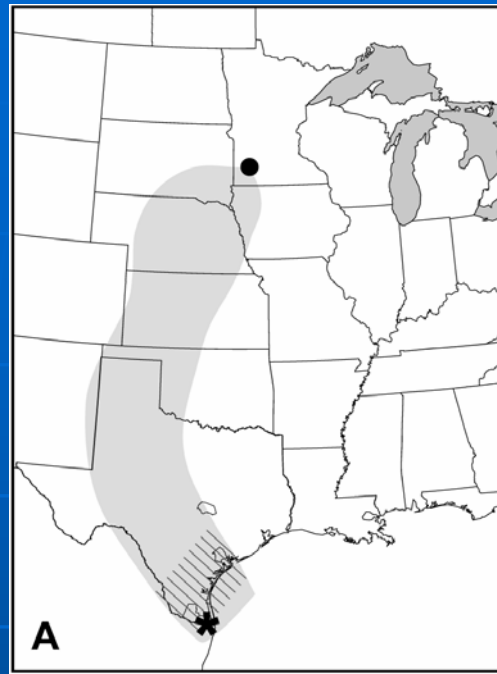
Red = 200 spores

Blue = 20 spores

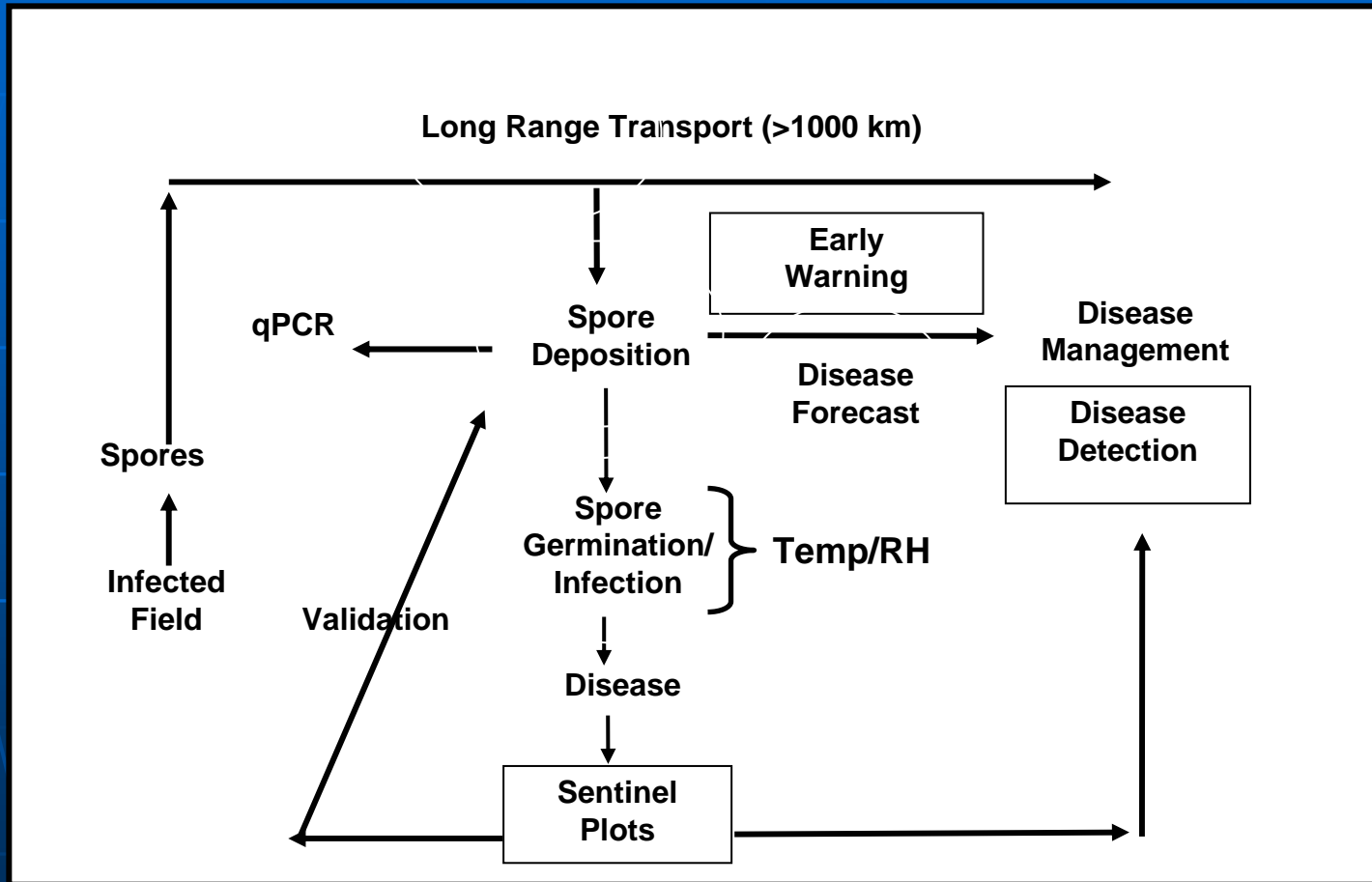
Quantitative real time PCR enables precise measure of number of *Phakopsora pachyrhiza* spores present in sample



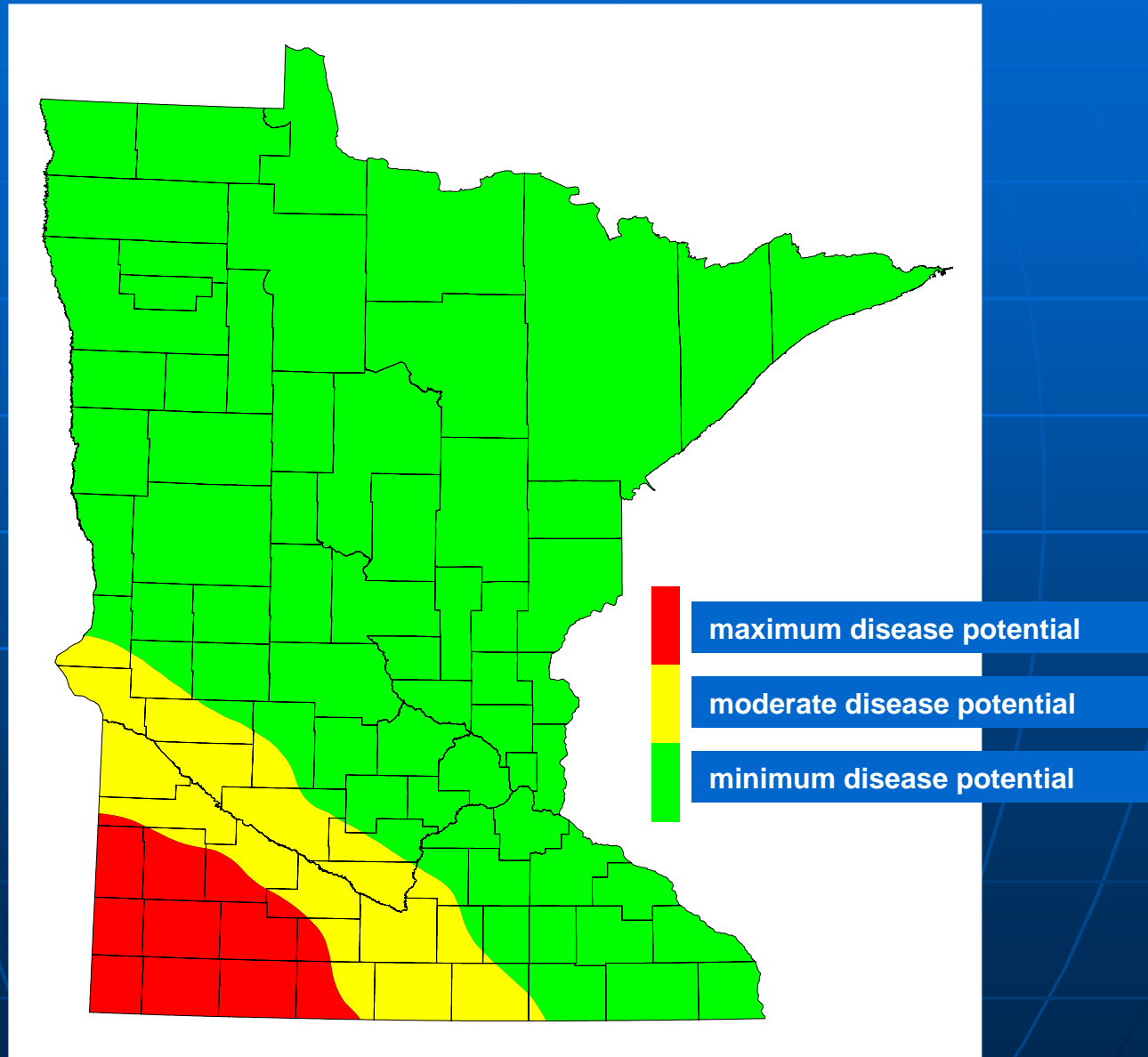
HYSPLIT trajectories for positive sample collected following 7 August 2007 rain Event at Freeborn MN



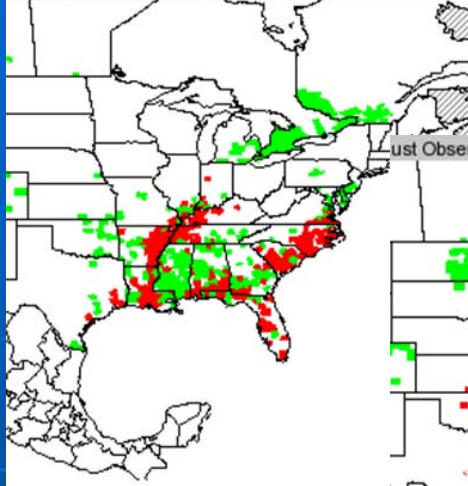
Flow diagram of the Minnesota Soybean Rust Forecast Model



Asian Soybean Rust Disease Potential

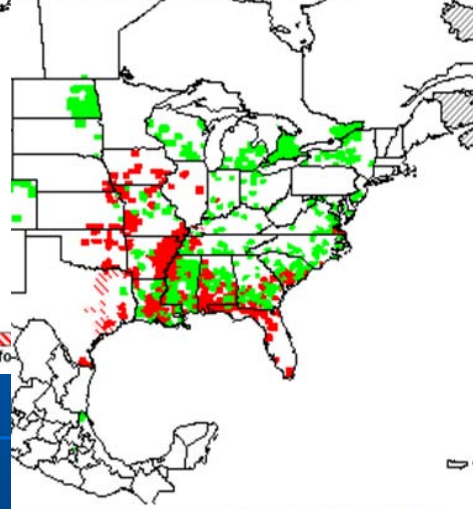


1st Observation - 2006-10-31 | Last Update: 10/31/06



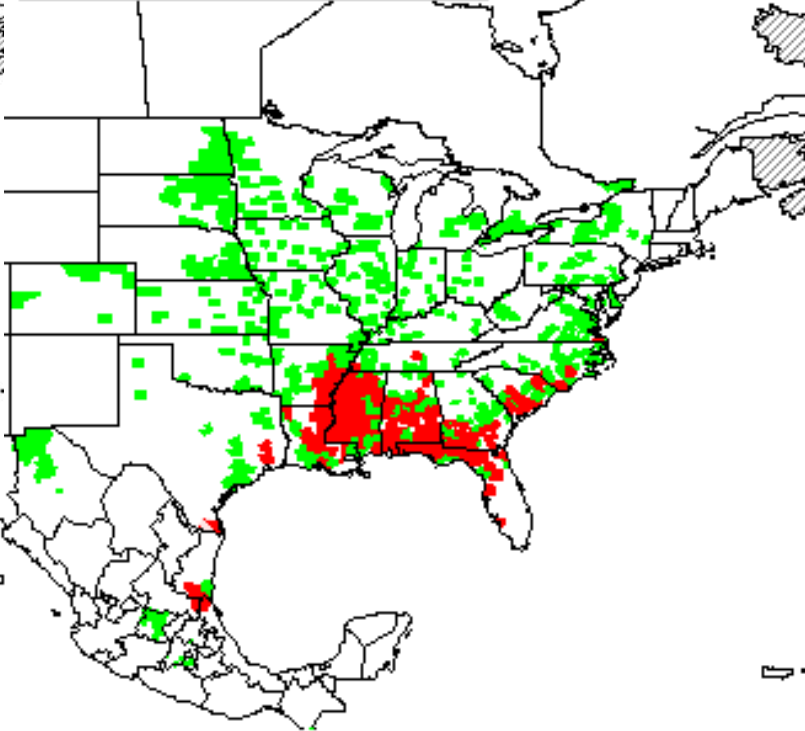
Scouted, confirmed Confirmed, no longer found

1st Observation - 2007-10-31 | Last Update: 10/31/07



Scouted, confirmed Confirmed, no longer found

SB Rust Observation - 2008-10-13 | Last Update: 10/13/08



Recently scouted, not found Scouted, confirmed Confirmed, no longer found

No Soybean Rust – Why?

- Unfavorable weather conditions
Infection interval
- Deposition of non-viable spores
Effect of UV radiation
Effect of age
- Failure to detect SR symptoms
Limited