Spore Deposition, Micrometerological Data, and the Spread of Soybean Rust

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Investigating Soybean Rust Epidemiology with a Team Approach

- **Penn State Plant Pathology**
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  - Erick De Wolf
  - Annalisa Ariatti
  - Nick Dufault
  - Jeremy Zidek
  - Maria Valez
  - Justin Dillon

- **Univ. Florida :NFREC**
  - **Jim Marios**
  - **David Wright**
  - **Dario Narvaez**

- **Funding organizations**
  - NRI-biosecurity program
  - USDA-Legume PIPE
  - Penn State University
  - Univ. Florida: NFREC

Soybean Rust Epidemiology Research 2006

- **Aerobiology**
  - Spore escape from soybean canopies
  - Spore deposition into soybean canopies
- **Pathogen Biology & Epidemiology**
  - Spore adhesion
  - **Within field spread of soybean rust**

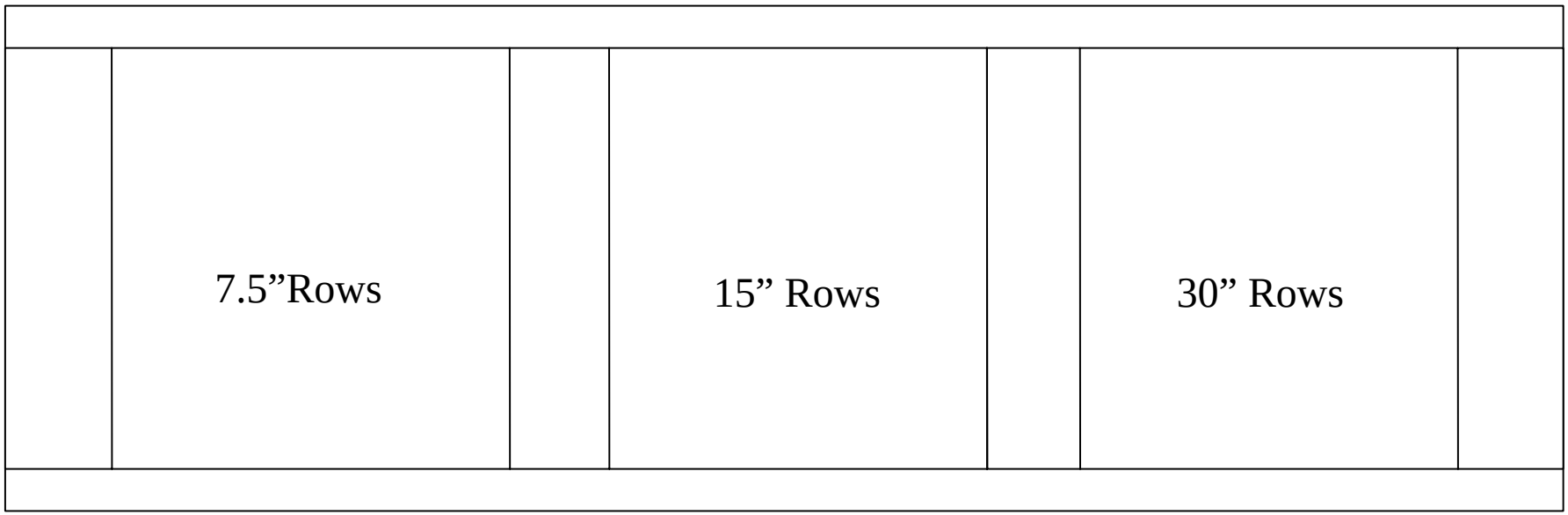
Evaluating the Within Field Spread of Soybean Rust

- Research motivated by the producers questions about changing crop production practices to address soybean rust
- Evaluate the influence of row spacing on the temporal increase and spatial spread of disease

Experimental Design

- Randomized Complete Block Design
- 2 Replications
- Treatments: Row spacing 7.5, 15 & 30 in
  - Maintaining planting density (173,000 pl/A)
- Monitor temp, RH and wind within the canopy for each treatment

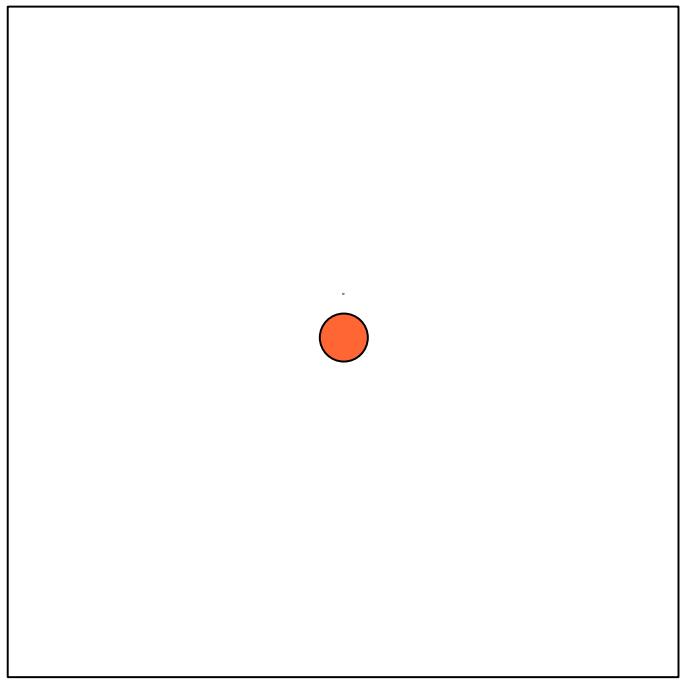
Plot Layout



- Plots 80x80 ft
- Border between plots - 30 ft fungicide treated soybeans planted in 7.5 inch rows
- Border surrounding plots 10 ft to reduce potential edge effect

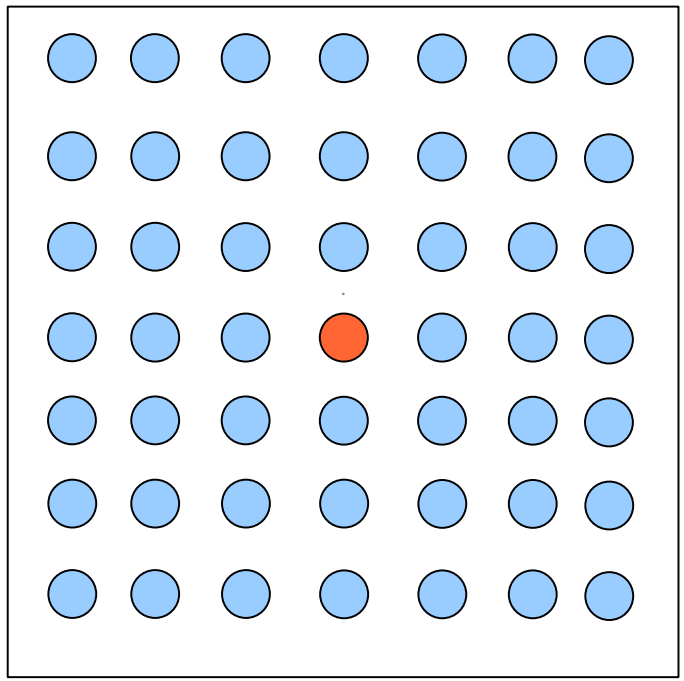
Establishing Disease

- Inoculate plots in early reproductive stages of growth (R1-R2)
- Single heavily infected plant placed into the center of each plot



Monitoring Disease

- Monitor disease on a 49 point sampling grid within each plot
- Evaluate the severity of 5 leaves in lower, middle and upper canopy (here we combine)
- Assessments made 23, 30, 40, 44, 51 & 59 days after inoculation



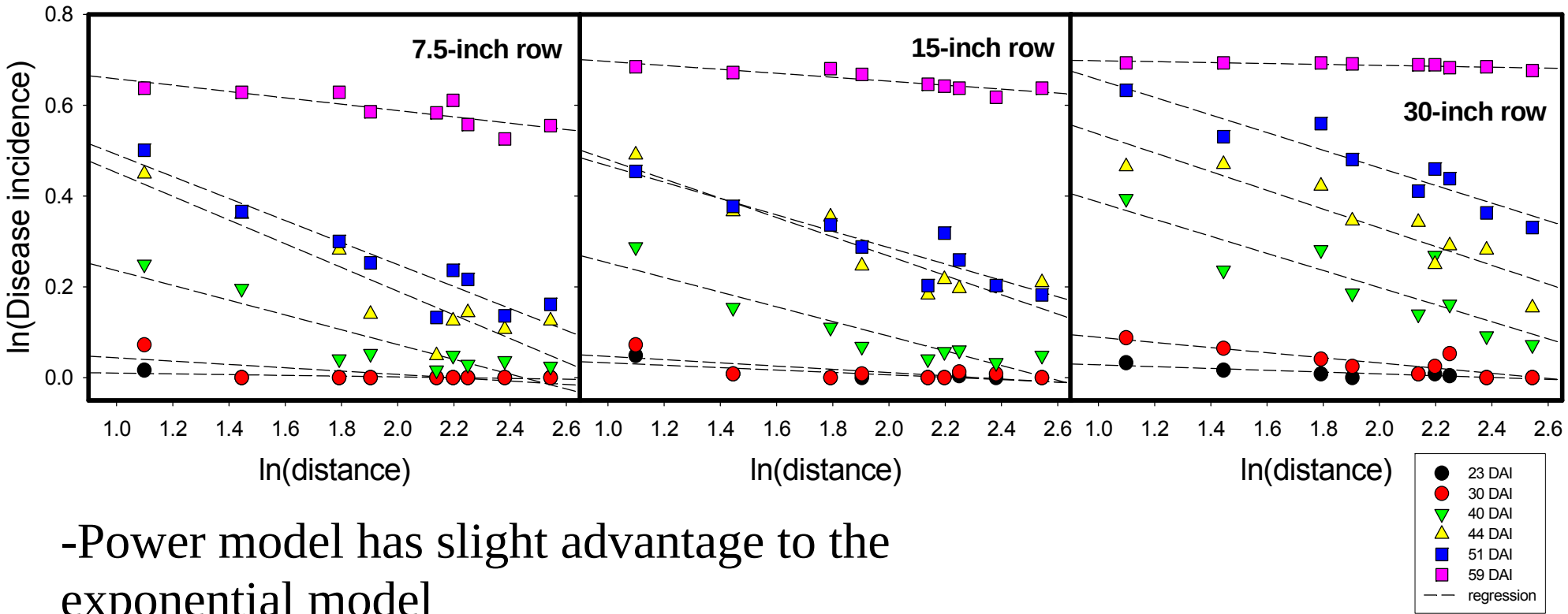
Spatial Analysis

- Distance calculated as Euclidian distance from point of inoculation, and observations in all directions (no directional component)
- Fitting the exponential and power models to the gradient of disease for each row spacing at each assessment date
- Identify the model with best overall fit to the data set
- Compare slopes of linearized form of the models describing each assessment date and row spacing

Temporal Analysis

- Evaluating the fit of exponential and logistic models to the increase of disease incidence and severity over time
- Identifying model with the best overall fit
- Comparing slopes of the linear form of the models for each row spacing
- ANOVA for comparison of discrete time periods

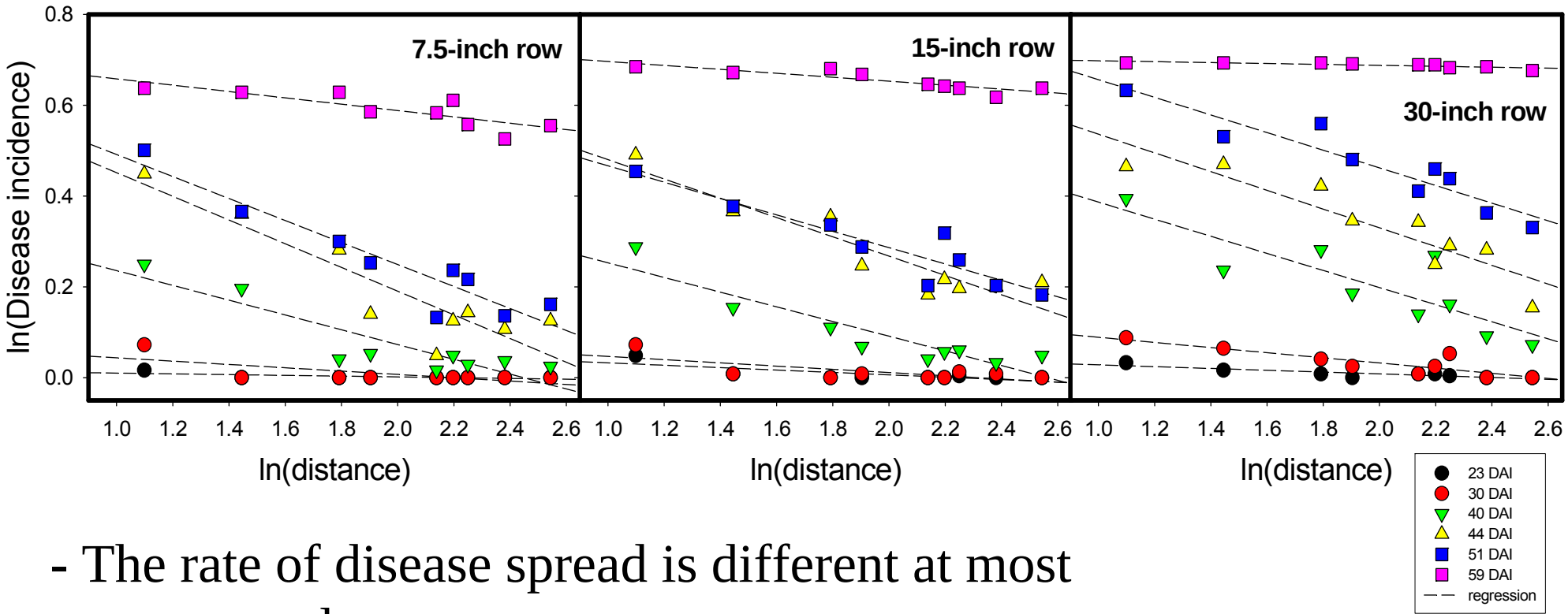
Rate of Disease Spread as Influenced by Row Spacing (Disease Incidence)



-Power model has slight advantage to the exponential model

-Amount of disease is not considered at this stage in analysis

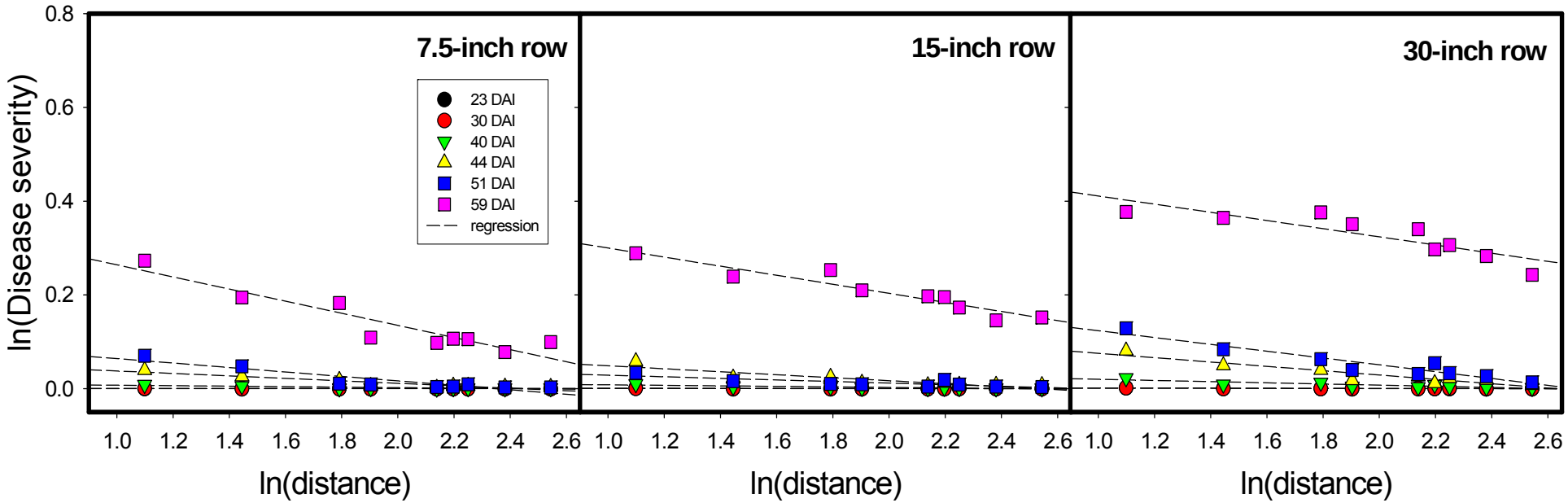
Rate of Disease Spread as Influenced by Row Spacing (Disease Incidence)



- The rate of disease spread is different at most assessment dates

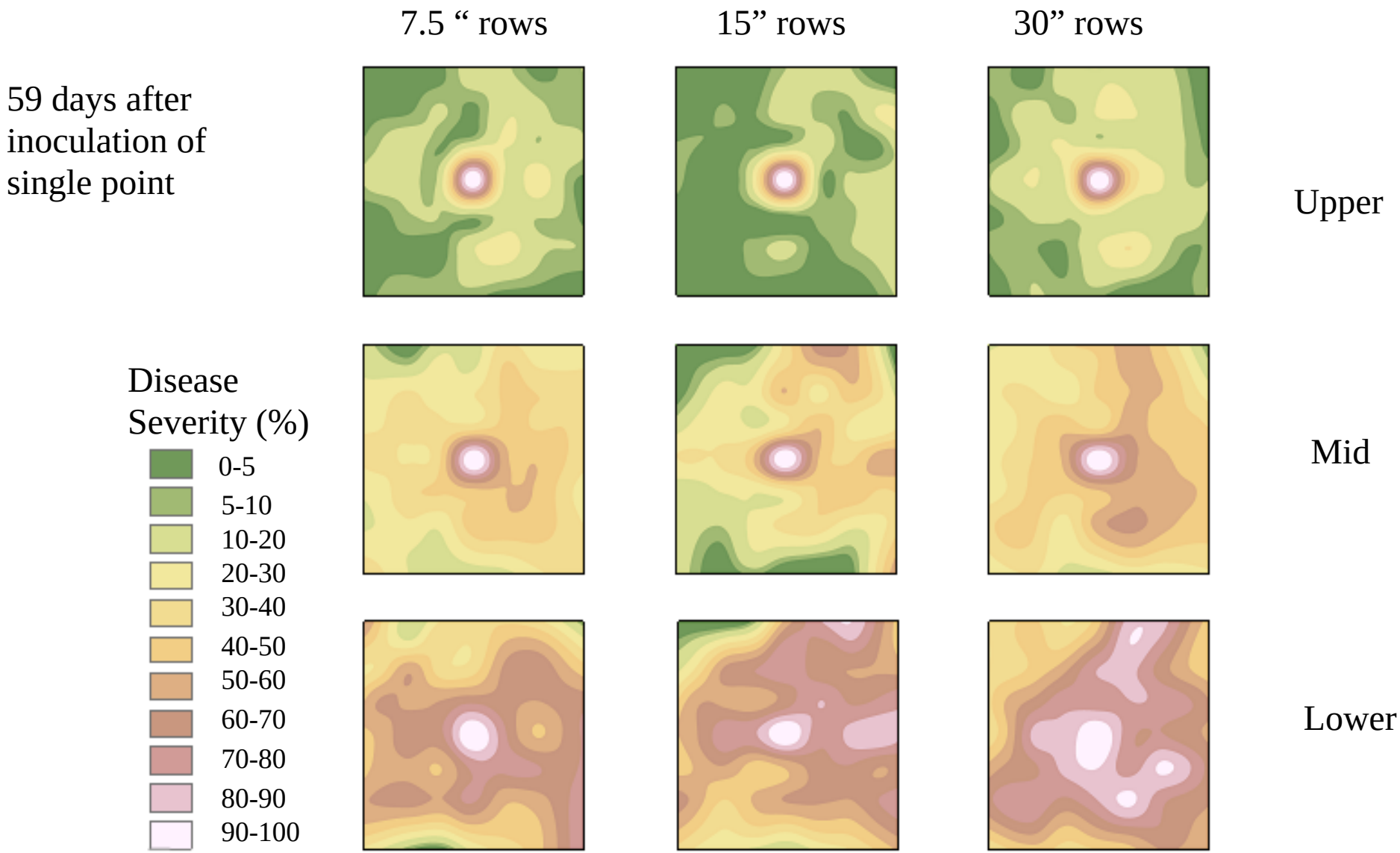
- The rate of disease spread does not differ with row spacing for most assessment dates

Rate of Disease Spread as Influenced by Row Spacing (Disease Severity)

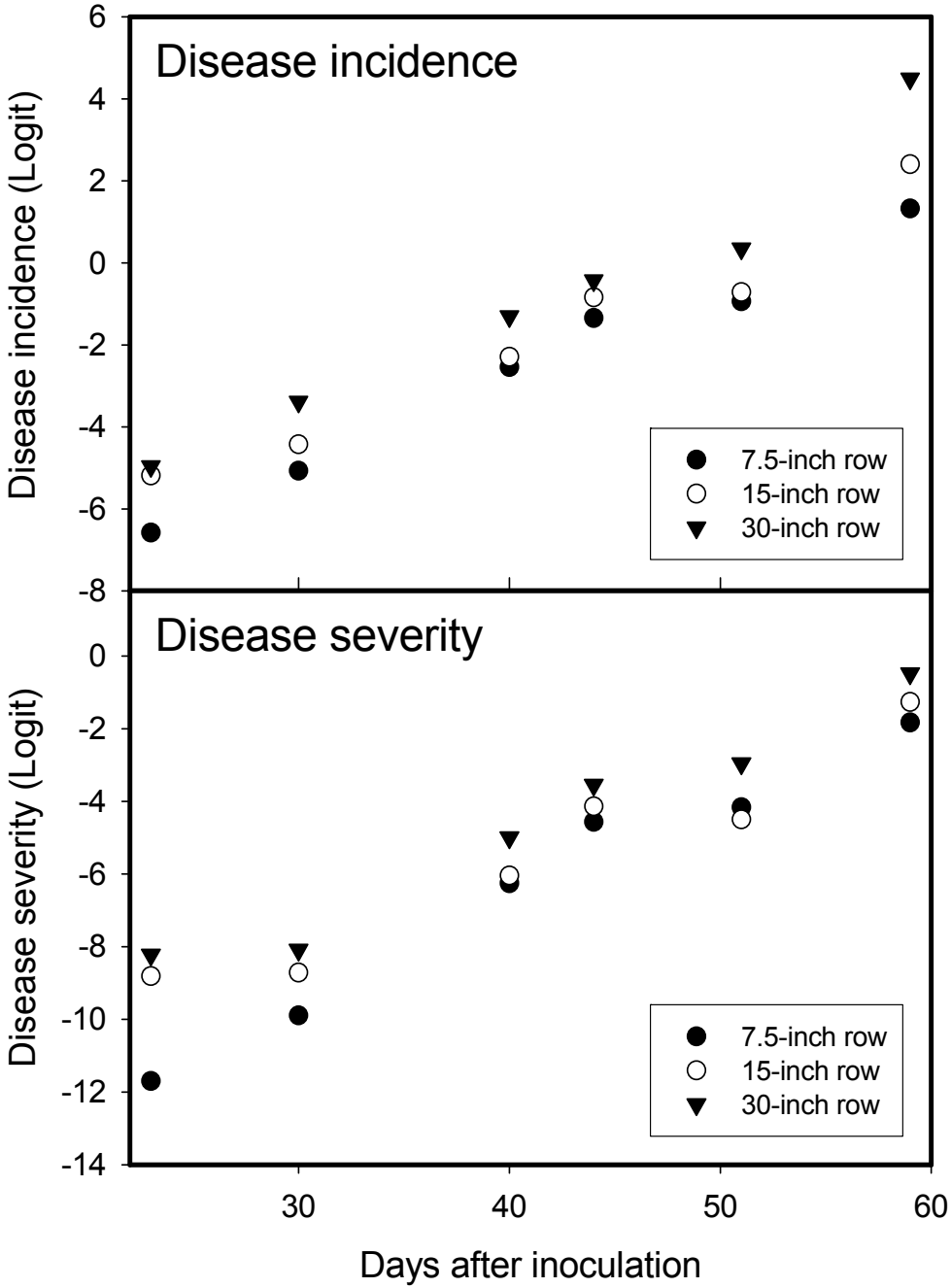


-Similar patterns in rate of disease spread observed with disease severity

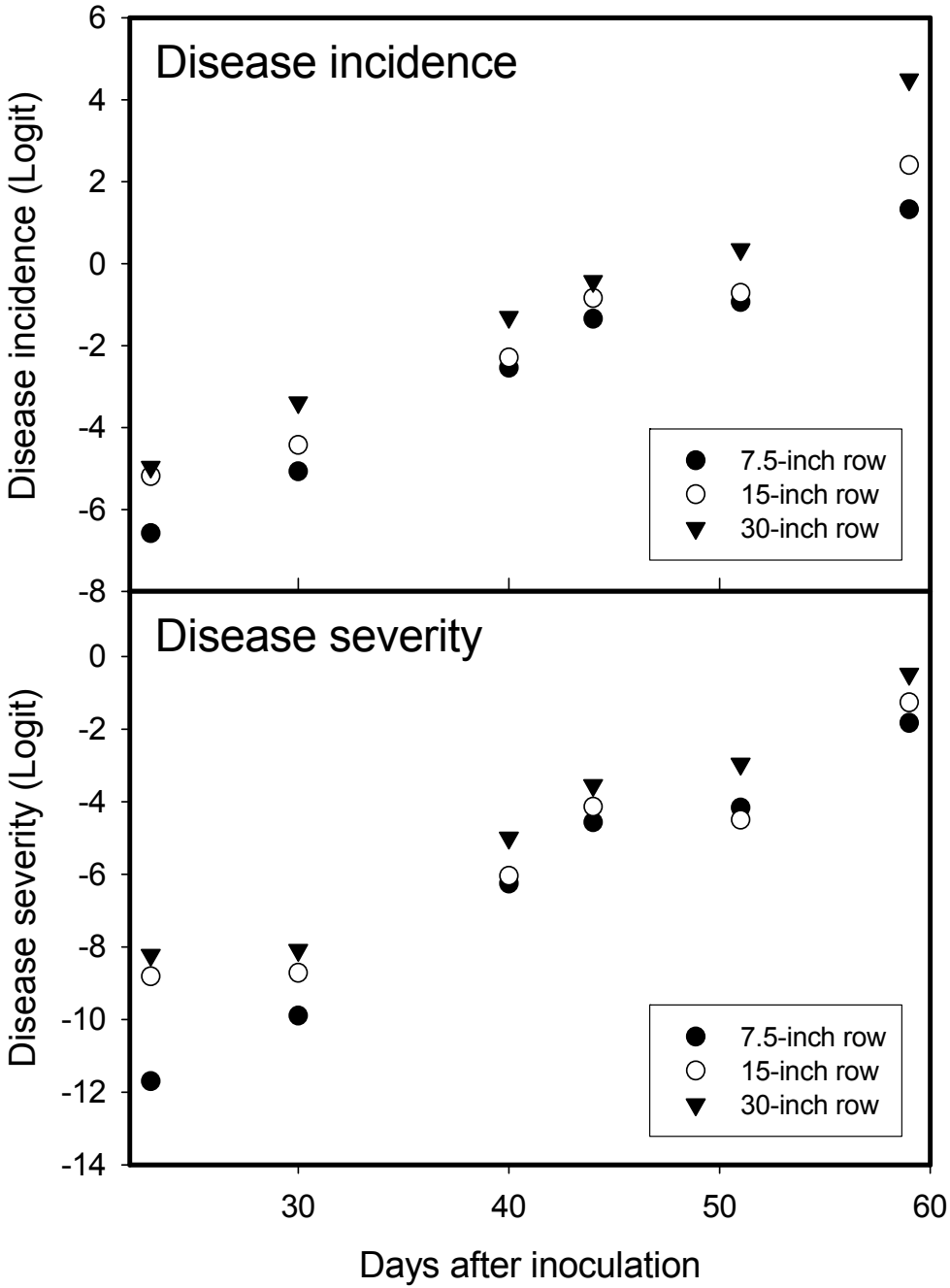
Spatial Distribution of Soybean Rust



Annalisa Ariatti, Penn State



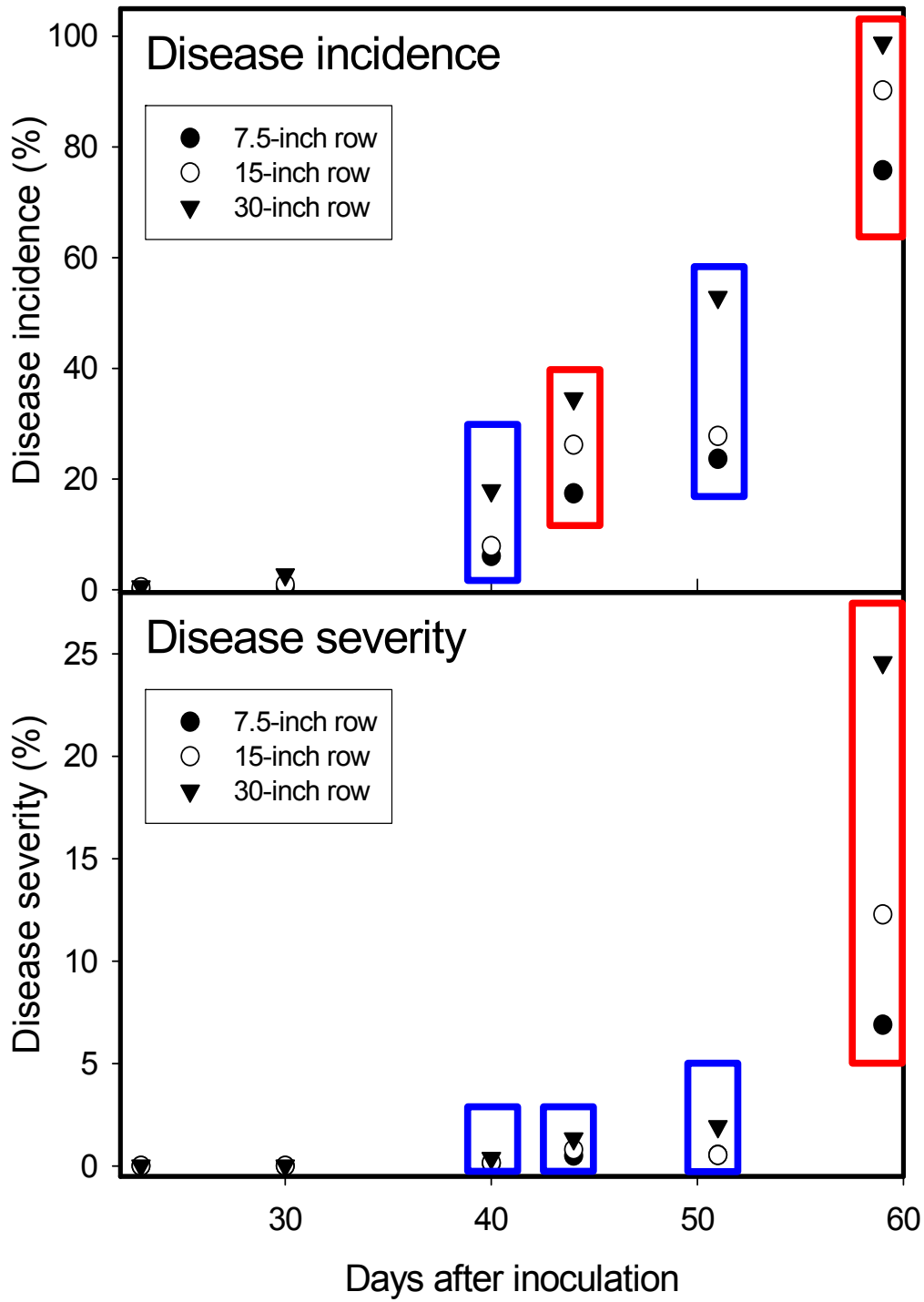
Disease progress over time with different row spacing



Disease progress over time with different row spacing

-Logistic model has slightly better fit than exponential

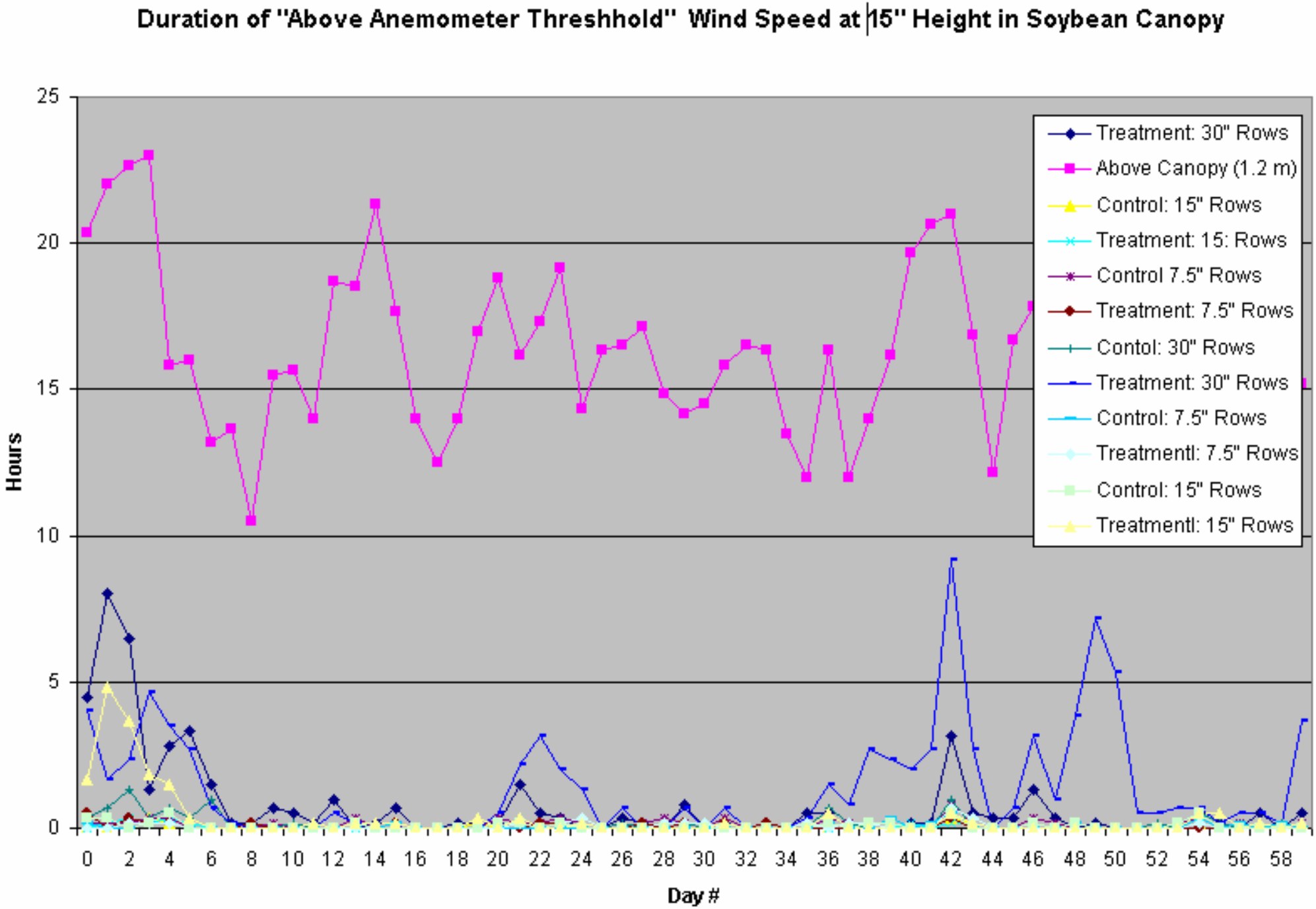
-Rate of disease progress does not vary with the row spacings considered

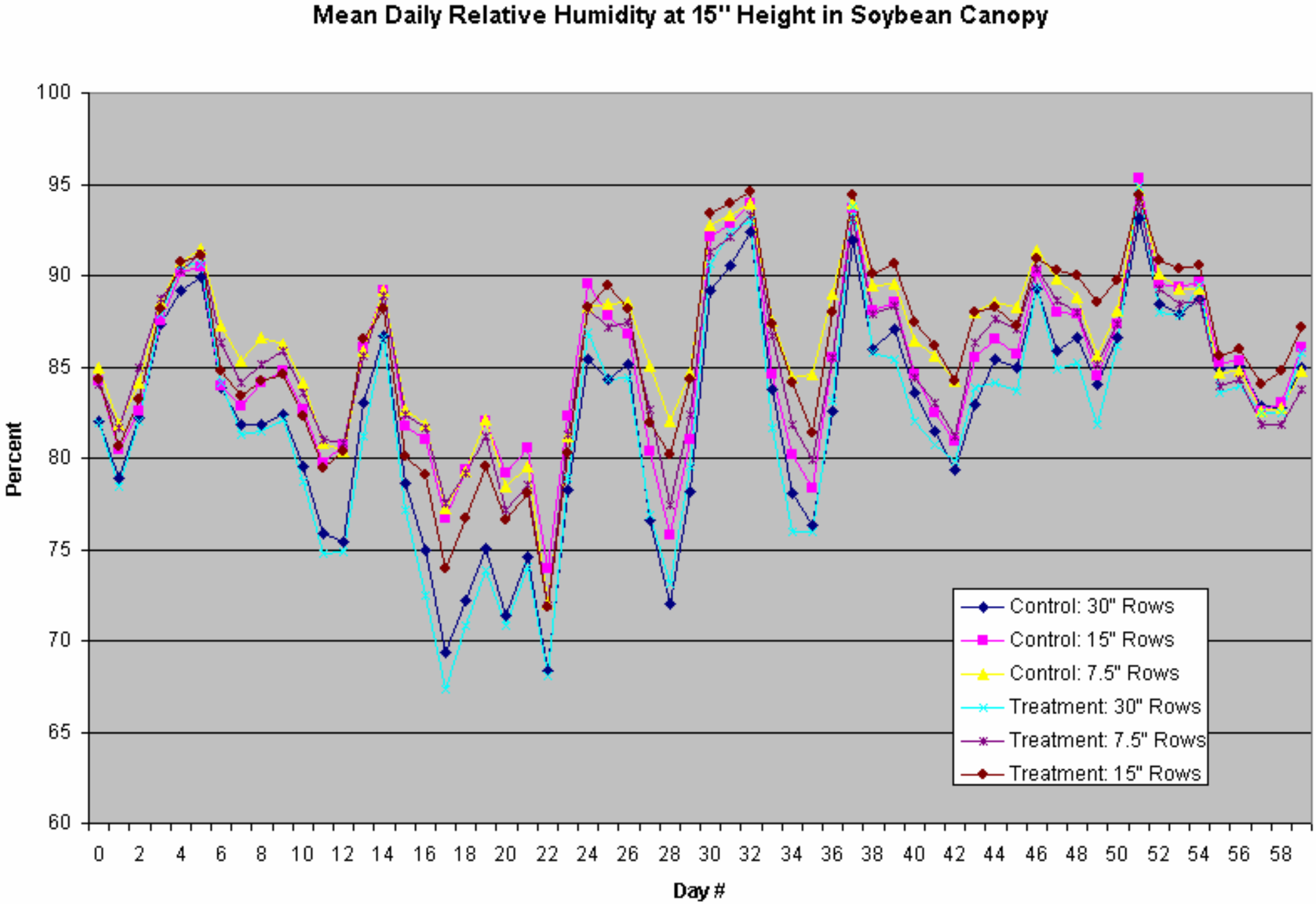


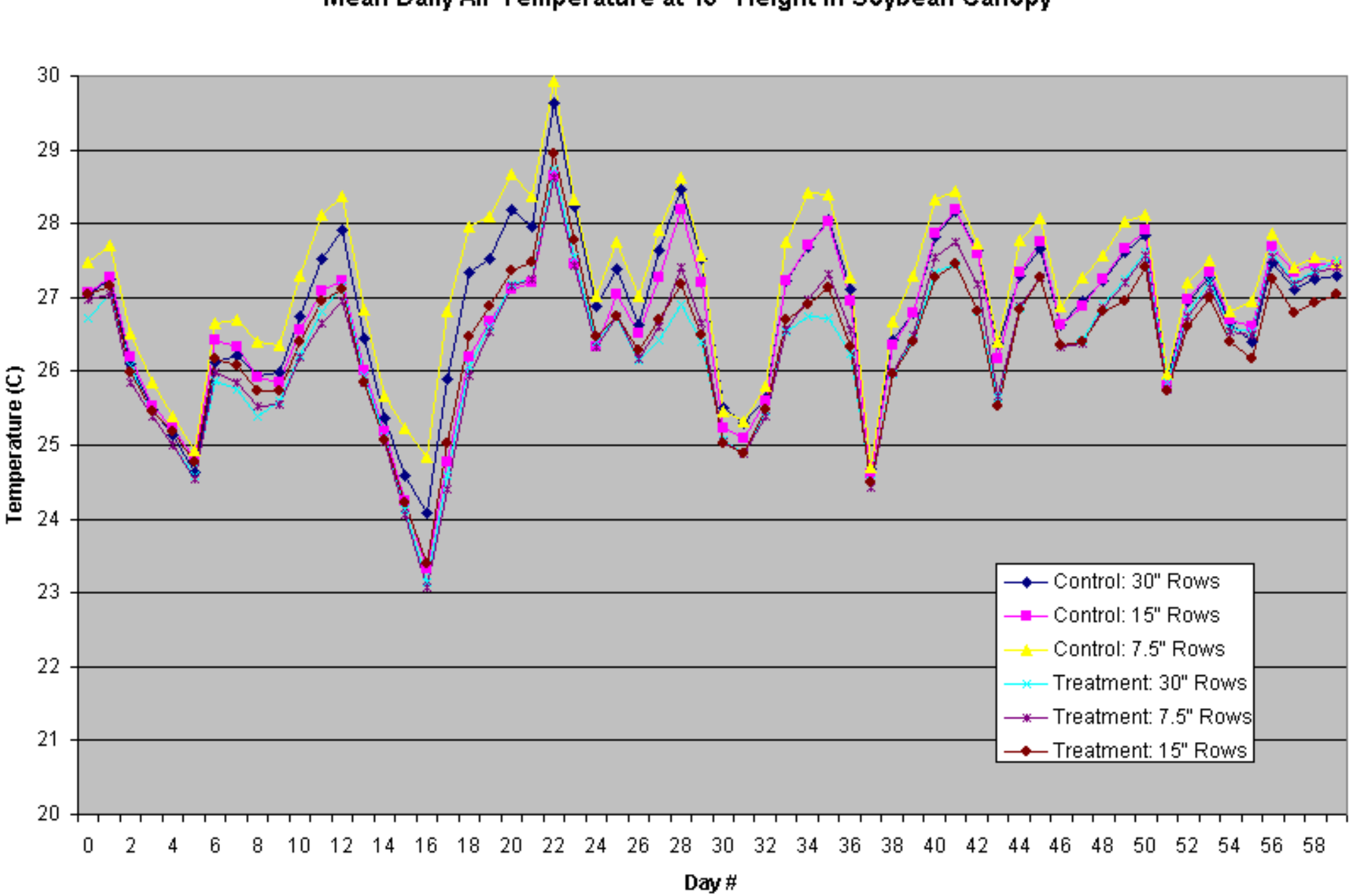
Comparison of disease at discrete time periods

= 7.5, 15 & 30 inch rows spacing all significantly different

= 7.5 & 15 inch rows similar, but 30 inch rows significantly different

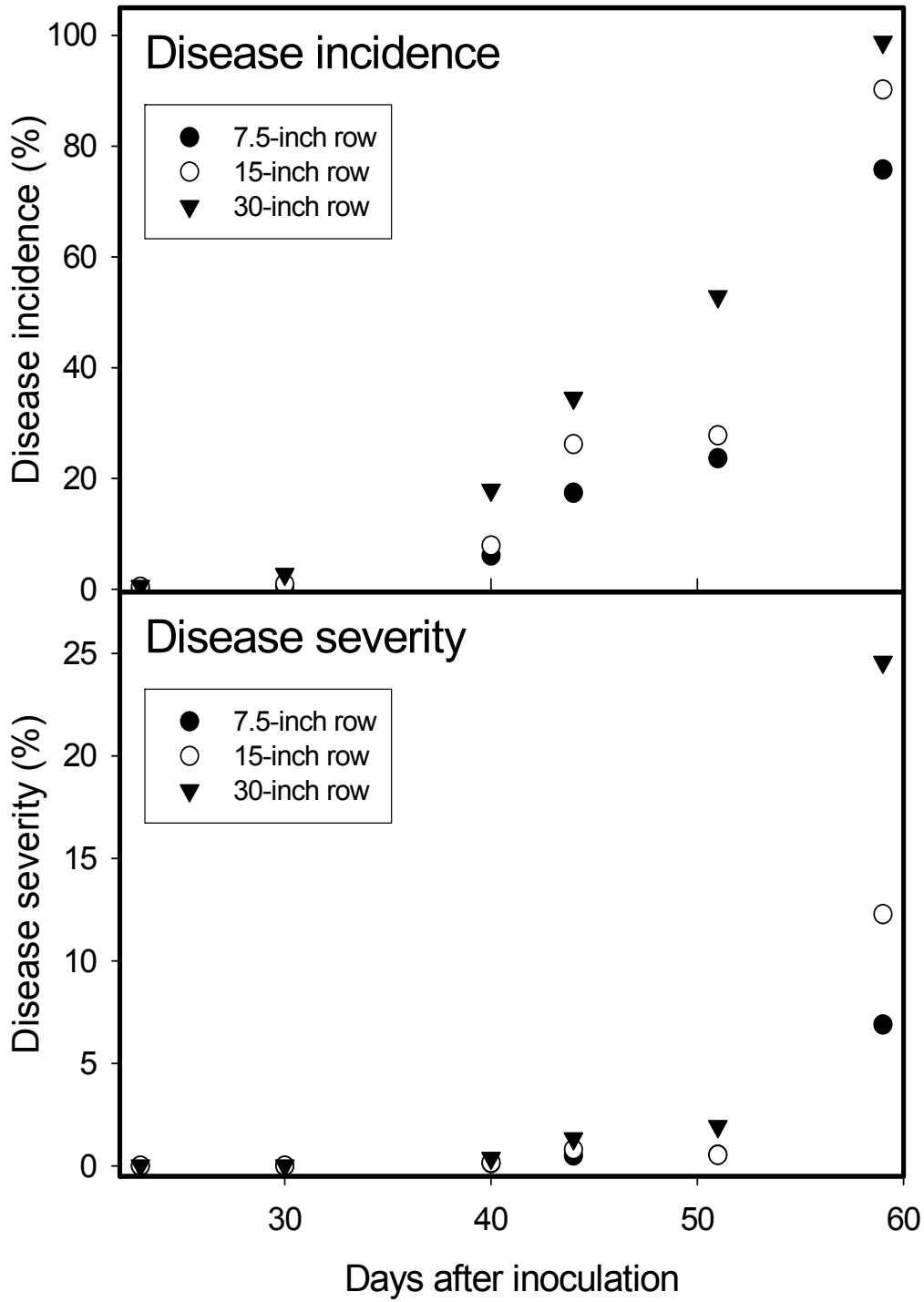

Duration of "Above Anemometer Threshhold" Wind Speed at 15" Height in Soybean Canopy
Hours
Day #
0
5
10
15
20
25
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58
Treatment: 30" Rows
Above Canopy (1.2 m)
Control: 15" Rows
Treatment: 15: Rows
Control 7.5" Rows
Treatment: 7.5" Rows
Contol: 30" Rows
Treatment: 30" Rows
Control: 7.5" Rows
Treatmentl: 7.5" Rows
Control: 15" Rows
Treatmentl: 15" Rows


Mean Daily Relative Humidity at 15'' Height in Soybean Canopy
Percent
100
95
90
85
80
75
70
65
60
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58
Day #
Control: 30" Rows
Control: 15" Rows
Control: 7.5" Rows
Treatment: 30" Rows
Treatment: 7.5" Rows
Treatment: 15" Rows


Mean Daily Air Temperature at 15" Height in Soybean Canopy
Temperature (C)
30
29
28
27
26
25
24
23
22
21
20
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58
Day #
Control: 30" Rows
Control: 15" Rows
Control: 7.5" Rows
Treatment: 30" Rows
Treatment: 7.5" Rows
Treatment: 15" Rows

Reality Check!

- Row spacing did not affect rate of disease spread or rate of disease increase
- Any difference at a given point in time will be quickly eliminated by rapid increase of disease (less than 5 days)
- Treatments could easily reverse order when experiment is repeated
- **DO NOT CHANGE MANAGEMENT OF YOUR SOYBEANS!**



Comparison of disease at discrete time periods

- Rapid rate of disease increase will make scouting for soybean rust a challenge

- If scouting is possible disease incidence would be a better target

Preliminary Conclusions

- Growing soybeans in 7.5, 15 or 30 inch rows did not significantly alter the rate of disease spread or disease increase over time
- Significant differences of disease at discrete time periods will likely not translate into meaningful management
- Explosive rate of progress will make scouting for disease difficult but our best chance is with disease incidence

Escape of soybean rust spores from a soybean canopy

Jeremy Zydek

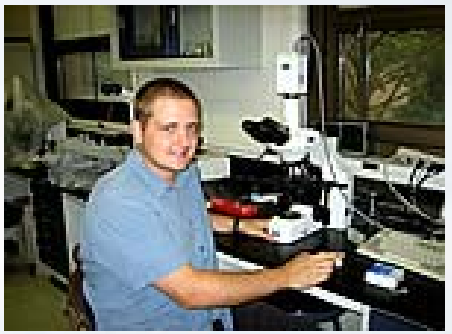
Research Objective: to quantify the proportion of released SBR spores that escape from a soybean field and relate this proportion to atmospheric turbulence and changes in canopy structure.

Microclimate and rate of within field soybean rust spread

Evaluate the effect of row spacing on the spatial distribution and rate of spread of an induced soybean rust epidemic.

Justin Dillon

Wet and dry deposition of soybean rust urediniospores



Nick Dufault

Adhesion of *Phakopsora pachyrhizi* urediniospores to soybean

No germ tube (N)

Short germ tube (G/S)

Long germ tube (G/S)

Small Appressorium (A/S)

Large Appressorium (A/L)

Maria Valez

Determine the timeline of *Phakopsora pachyrhizi* urediniospore adhesion to soybean leaves and the chemical components of the process.

Results of Spatial Analysis

- Power model had slightly better fit than the exponential model
- Comparison of slopes for incidence & Disease severity
  - Rate of disease spread is different at most assessment dates within given row spacing
  - Rate of disease spread is **not** different among the different row spacings at most assessment dates

Results of Temporal Analysis

- Logistic model of disease increase had a better fit than the exponential model
- Comparison of slopes
  - Rate of disease increase does **not** vary among 7.5, 15 and 30 inch row spacings