

# Effects of Row Spacing and Canopy Height on Spatio-Temporal Development of Asian Soybean Rust

P. ESKER<sup>1,2,3</sup>, D. Narvaez<sup>4</sup>, J. Marois<sup>4</sup>, D. Wright<sup>4</sup>, E. De Wolf<sup>2</sup>, M. Nita<sup>2</sup>, E. Del Ponte<sup>3</sup>, and S. Isard<sup>5</sup>

<sup>1</sup>Dept. Plant Pathology, Iowa State University, Ames, IA 50011 USA; <sup>2</sup>Dept. Plant Pathology, Kansas State University, Manhattan, KS 66506; USA; <sup>3</sup>Departamento de Fitossanidade, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS 91540-000 Brasil; <sup>4</sup>North Florida Research and Education Center, Quincy, FL 32351 USA; <sup>5</sup>Dept. Plant Pathology, Penn State University, State College, PA 16802 USA

Corresponding Authors: P. Esker (Email: [pde@plantpath.wisc.edu](mailto:pde@plantpath.wisc.edu)) and S. Isard (Email: [sai10@psu.edu](mailto:sai10@psu.edu))



## Introduction

Asian soybean rust, caused by *Phakospora pachyrhizi*, is an economically important disease of soybean throughout the world. While much emphasis has been placed on the use of fungicides and resistance for reducing the effects of Asian soybean rust, little attention has been placed on increasing our understanding of cultural factors that may have reduce, or slow, an epidemic. For example, there has been much recent research into the use of narrower row spacing for soybean reduction. A natural question is whether reduced row spacing may change the microclimate of a soybean canopy, and thus, potentially decreasing the risk of Asian soybean rust in a soybean field, or at least slowing the rate of the epidemic down.

## Objective

To determine the effect of row spacing on the development of Asian soybean rust under inoculated field conditions.

## Field Experiment

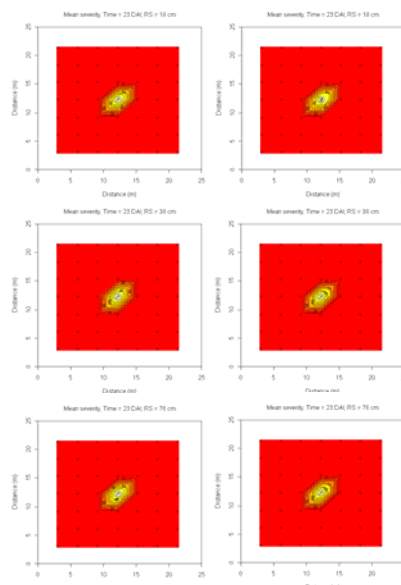
- Field study conducted at Quincy, FL, in 2006 (Fig. 1)
- Plot row spacing = 18, 36, and 76 cm
- Plant density = 427,000 plants per hectare
- Plots measured 24 by 24 m
- Experimental design was a randomized complete block

## Rust Inoculation and Data Collection

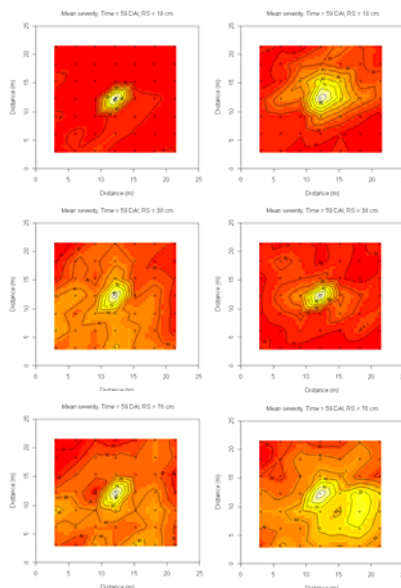
- Forty-nine quadrats were established within each plot (Fig. 2)
- Middle quadrat inoculated at approximately R1-R2 (Red dot in Fig. 2)
  - Single, heavily infected soybean plant used as source of inoculum
- Severity (% of leaf infected) assessed on five leaves
- Severity obtained at three canopy heights = lower, middle, and upper
- Disease assessments obtained at 23, 30, 40, 44, 51, and 59 days after inoculation

## Exploratory Analysis of Row Spacing

- Spatio-temporal development examined using a gridded bivariate interpolation
  - Accomplished for both severity data and the rate of disease change between two assessment periods (severity shown in Figs. 3 and 4)
- Correlation analysis used to examine association between lower canopy with middle and upper canopies



**Fig. 3.** Contour maps of Asian soybean rust (depicting all six replications – Rep 1 = Left column; Rep 2 = Right column) for different row spacings. Contour lines that are closer to one another suggest steeper gradients for the disease.



**Fig. 4.** Contour maps of Asian soybean rust (depicting all six replications – Rep 1 = Left column; Rep 2 = Right column) for different row spacings. Contour lines that are closer to one another suggest steeper gradients for the disease.

**Table 1.** Correlation of lower canopy Asian soybean rust measurements with middle and upper canopy measurements made on: (i) same day (+0), (ii) one assessment time ahead (+1), and (iii) two assessment times ahead (+2)

Row Spacing (cm)	DAI (Lower)	Middle+0	Upper+0	Middle+1	Upper+1	Middle+2	Upper+2
18	23	NA <sup>a</sup>	NA	NA	NA	0.315** <sup>b</sup>	0.439**
	30	NA	NA	0.610**	0.805**	0.592**	0.918**
	40	0.456**	0.466**	0.249*	0.01**	0.473**	0.408**
	44	0.493**	0.577**	0.509**	0.508**	0.561**	0.549**
	51	0.922**	0.918**	0.643**	0.720**	NA	NA
	59	0.771**	0.755**	NA	NA	NA	NA
36	23	NA	NA	NA	NA	0.008NS	0.195NS
	30	NA	NA	0.165NS	0.129NS	0.169NS	0.207*
	40	0.303**	0.246*	0.536**	0.089NS	0.374**	0.407**
	44	0.680**	0.111NS	0.527**	0.338**	0.579**	0.500**
	51	0.888**	0.317**	0.608**	0.485**	NA	NA
	59	0.697**	0.630**	NA	NA	NA	NA
76	23	NA	NA	0.289**	-0.011NS	0.339**	-0.043NS
	30	0.316**	0.043NS	0.332**	-0.017NS	0.401**	0.096NS
	40	0.792**	0.283**	0.715**	0.440**	0.543**	0.507**
	44	0.811**	0.251*	0.447**	0.251*	0.304**	0.268**
	51	0.899**	0.685**	0.624**	0.475**	NA	NA
	59	0.708**	0.288**	NA	NA	NA	NA

<sup>a</sup> NA = not available and this represents either situations where there was no data to estimate a correlation coefficient, or situations where there were no assessments made for later time periods.

<sup>b</sup> \* indicates correlation coefficients significant at  $P < 0.05$  and \*\* represents significances at  $P < 0.01$ .

## Results and Discussion

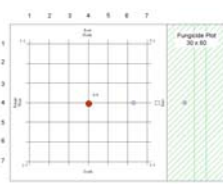
- Significant linear correlations were observed measurements made at the lower canopy with measurements obtained at the middle and upper canopies out to two assessment times later (Table 1)
  - Correlation coefficients were as high as 0.922 for middle+0, 0.918 for upper+0, 0.715 for middle+1, 0.805 for upper+1, 0.579 for middle+2, and 0.918 for upper+2
  - Using graphical methods, no consistent pattern was observed (*data not shown*) between different canopy assessments
- At 23 DAI, minimal differences were observed between Asian soybean rust assessments within different row spacing distances (Fig. 1)
- By 59 DAI, it appears that Asian soybean rust had spread the furthest in the 76 cm row spacing (Fig. 2)
- This is further observed when examining the spatio-temporal changes in estimates of the rate of change between two assessments (using lower canopy):
  - Rates first show increase between 40-44 DAI
  - Highest rates observed between 51 and 59 DAI
  - For example:
    - 18 cm, typically < 1% day<sup>-1</sup> (40 – 44 DAI), increasing to as high as 5% at 51 – 59 DAI
    - 36 cm, approximately 3.5% (40 – 44 DAI), increasing to as high as 8% at 51 – 59 DAI
    - 76 cm, approximately 6% (40 – 44 DAI), increasing to as high as 10% at 51 – 59 DAI

## Current Research Effort

- Disease gradients assessments at angles from 0-315° from the source to understand the directionality for spread of *Phakospora pachyrhizi* and subsequent occurrence of Asian soybean rust
- How does the direction of pathogen spread link with microclimatic conditions obtained within the canopy?
- What is the relationship between Asian soybean rust at the lower canopy and the subsequent occurrence of Asian soybean rust at middle and upper canopy heights?



**Fig. 1.** Quincy, FL field location



**Fig. 2.** Schematic of experimental plot to study the effect of row spacing on Asian soybean rust development