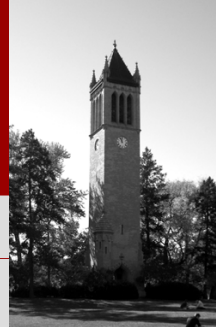


Assessing the rainfall suitability for Asian Soybean rust epidemics in the US soybean production regions

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INTRODUCTION

The US soybean regions seem to have suitable temperature and dew conditions for infection of the crop by *Phakopsora pachyrhizi*. However, temperature and dew duration may not be the only factors limiting the occurrence of epidemics in the field. The importance of rainfall has been suggested by early work in China (Tan et al, 1996) where rainfall-based variables were good predictors for soybean rust epidemics in an over 10-years dataset. An empirical rainfall model has also been developed for Brazilian conditions with a large epidemic dataset collected in a range of climatic conditions in that country (Del Ponte et al., unpublished). The biological effects of rainfall on the occurrence of epidemics of soybean rust should be different from those of temperatures and wetness duration.

RESULTS AND DISCUSSION

✓ There is an increasing in disease severity estimations from high to lower latitudes for both July and August, especially for locations below Kentucky (Figure 1). July seems to be more conducive for the disease than August for most of the locations (Figure 2).

✓ The rainfall in most locations in the country seem suitable (index >50%) for light to moderate disease severity to develop in most years if inoculum was available late in June in these regions, being less suitable if disease onset is in late July. For locations south of Tennessee, the suitability index for a severe epidemic ranges from 18 to 43% if disease onset had occurred before late June or 10-31% if disease onset had occurred before late July (Figure 3).

✓ The rainfall conditions in the central to northern regions do not seem conducive for severe epidemics if the disease establishes in those regions. There was a 10-20% probability of severe epidemics to develop in the northern soybean regions if disease was detected in late June there. The suitability index decreases (4 -16%) if the disease is detected later in the season as late July.

✓ Since the disease reaches southern region earlier than northern regions, the chance for the disease to develop into severe levels in the northern soybean production regions is low for a particular year, especially if the disease establish late in the season. Exceptions for years exceptionally wet with sufficient early build-up of inoculum in the soybean production region.

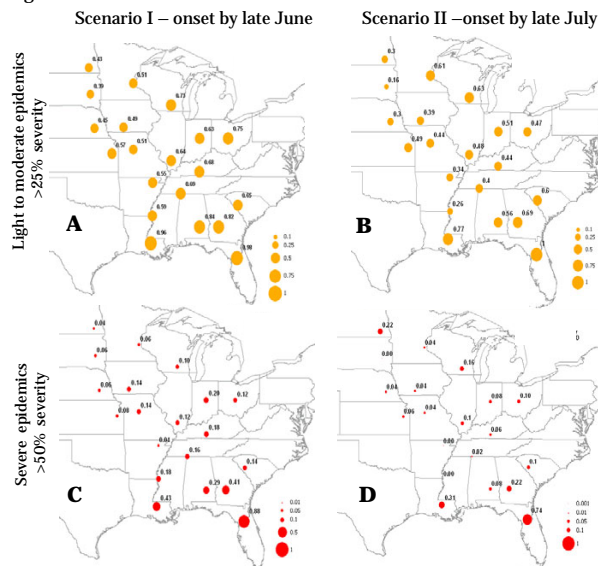


Figure 3. A and B - Suitability index for an epidemic of severity >25% if disease is detected in late June or late July, respectively. C and D - Suitability index for an epidemic of severity >50% if disease is detected in late June or late July, respectively. Suitability index is based on the frequency of epidemics above the thresholds, estimated by a rainfall model, in 50 years of rainfall data for the locations.

OBJECTIVE

To assess the rainfall suitability in different soybean production regions in the United States for soybean rust epidemics by using a rainfall model developed with Brazilian conditions to estimate disease severity

MATERIAL AND METHODS

The assessment was made for 20-US locations arbitrarily selected across the soybean producing areas in the country. Series of monthly rainfall data from 1951 to 2001 was used from NOAA website. The Brazilian model uses rainfall amount (mm) and rainy days for the monthly period after disease detection to predict final disease severity. July and August were used for the US since the two months are the critical period for epidemic development for most regions in the country. Considering the uncertainty on the availability and timing of inoculum arrival at each location, two hypothetical scenarios were considered based on the time the disease is detected at each location.

Scenario I – early onset: disease detection in late June and development in July
Scenario II – late onset: disease detection in late July and development in August

Disease severity (SEV) was estimated by running the Brazilian rainfall model for scenarios I and II of the yearly historical rainfall series. Two suitability indices were created based on the frequency of an estimated severity greater than a light (25%) or severe (50%) level, in the total of years that averaged 50 for the locations.

$$\text{Suitability Index SEV} > X = \frac{\# \text{ cases SEV} > X}{\text{number of years}}$$

Where X is 25% or 50%, respectively for at least a light or a severe epidemic to develop. In our calculations, rust spores were assumed available locally and temperature effects were not considered.

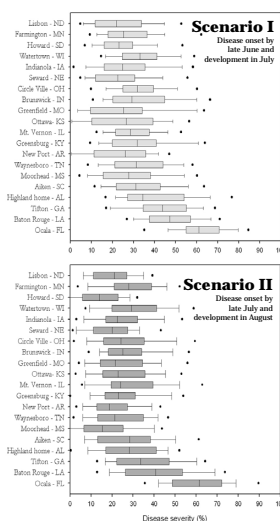


Figure 1. Box-plots for the distribution of severity estimations for 20-US locations based on 50-year data for two scenarios of disease onset. The lower, inner and upper lines of each box represent the 25th, median and 75th percentiles, respectively. Vertical bars extending beyond the boxes represent 10th and 90th percentiles. Dots represent the outliers.

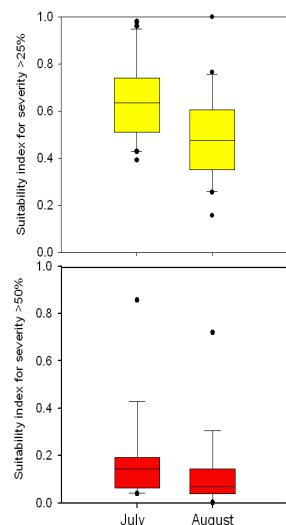


Figure 2. Box-plots for the distribution of suitability indices for epidemics estimated by a rainfall model for each location based on around fifty years rainfall data. Upper graph shows distribution of indices for epidemics > 25% (A) and lower graph distribution for epidemics > 50% (G) to develop in either July or August. The lower, inner and upper lines of each box represent the 25th, median and 75th percentiles, respectively. Vertical bars extending beyond the boxes represent 10th and 90th percentiles. Dots represent the outliers.