2005: Introduction and spread of soybean rust spores in the North Central United States

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Introduction

In 2004, the presence of Asian Soybean Rust (ASR, *Phakopsora pachyrhizi*) was reported for the first time in the United States in nine southeastern states. *P. pachyrhizi* relies on continuous production of urediniospores on live plant material for its survival and dispersal. In the continental United States ASR is not likely to survive typical winters except for southernmost Texas and Florida, coastal areas in the Gulf Coast and southern California. Past studies with rusts of corn and small grains indicate that aerial dispersal of urediniospores from Mexico, southern Texas, and Louisiana can contribute to development of spring-summer disease epidemics in the North Central U.S. Thus, long range transport and deposition of viable spores will be an important mechanism for annual reintroduction of ASR in the north. At large distances from the source, precipitation is the dominant mechanism for spore deposition and the most likely cause for infecting crops that are hundreds or thousands of kilometers from the source regions.

Objectives:

1)To determine if spores of *P. pachyrhizi* are present in rain samples collected at relevant locations across the United States.

2)To determine the possible origin of ASR spores in rain samples collected at the National Atmospheric Deposition Program (NADP) sampling sites in the upper mid-west.

Materials and Methods

Spore Collection: Weekly rain samples are collected in automated rainfall collectors (Fig. 1a) at 124 NADP/National Trends Network (NTN) sites (122 in the eastern half of the US, 1 in Puerto Rico, and 1 in the Virgin Islands) (Fig. 1b) . All samples are sent to the Central Analytical Laboratory (CAL) at the Illinois State Water Survey. Following pH and conductance measurements, the samples were vacuum-filtered to remove insoluble matter (e.g., spores). The filters were then dried in a desiccator, sealed in Petri dishes, and were sent to the USDA-ARS Cereal Disease Laboratory for the detection of ASR spores.

Spore Detection: ASR spores on the filters were detected by QPCR (real-time, Quantitative Polymerized Chain Reaction) specific to the ASR – DNA. In addition, the results were confirmed independently by gradient gel electrophoresis and the presence of DNA bands specific to ASR. As a cross check, DNA sequencing was also done among others, on selected samples from MO, MN and SD.

Atmospheric Spore Transport: During the weeks when the rust spores were detected in the rain samples at a particular location, back air trajectories were calculated using the HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) model for periods of up to 168 hours prior to the occurrence of the rain, at two heights above the surface representing in-cloud (> lifted condensation layer) and below-cloud (>mixed boundary layer) scavenging processes.

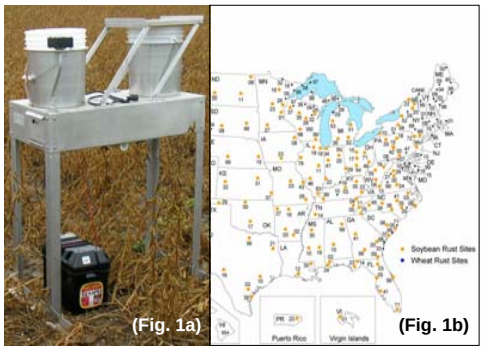

Fig. 1a) National Atmospheric Deposition (NADP) rainfall collector. 1b) NADP/NTN sampling sites in the eastern and centralStates in 2005.

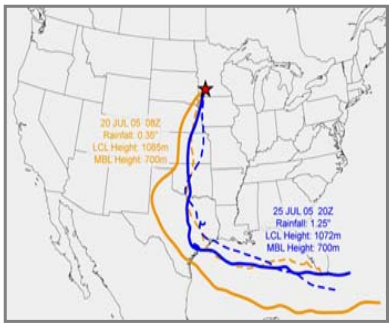

Fig. 2) 168-hour back air trajectories at two levels of the atmosphere for period preceding the rainfall at *Lamberton, MN* on 20 and 25 July, 2005.

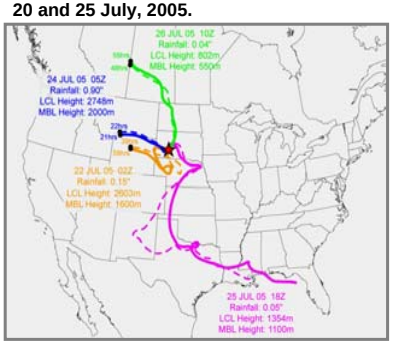

Fig. 3) Back air trajectories at two levels of the atmosphere for periods preceding the rainfall at *Cottonwood, SD* on 22, 24, 25 and 26 July, 2005. Although all back trajectories were computed for 168 hours, some are shown only in part to reduce the clutter in the figure.

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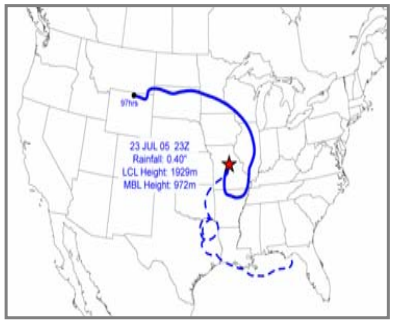

Fig. 4) Back air trajectories at two levels of the atmosphere for periods preceding the rainfall at *Ashland Wildlife, MO* on 23 July, 2005. Although all back trajectories were computed for 168 hours, some are shown only in part to reduce the clutter in the figure.

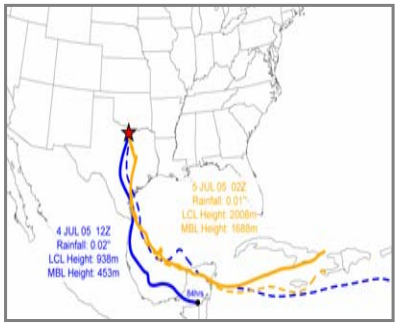

Fig. 5) Back air trajectories at two levels of the atmosphere for periods preceding the rainfall at *LBJ Grasslands, TX* on 5 July, 2005. Although all back trajectories were computed for 168 hours, some are shown only in part to reduce the clutter in the figure.

Results and Conclusions

- Samples from one South Dakota (***Cottonwood, SD08***) and one Minnesota (***Lamberton, MN27***) NADP site tested positive for ***P. pachyrhizi*** DNA during 19-26 July 2005 rain events (Figs. 2-3).
- ASR spores were also found at a Missouri site (*Ashland Wildlife, MO03*) from a rain event on 23 July (Fig. 4) and at ***LBJ Grasslands in Texas*** (***TX56***) on 5 July, 2005 (Fig. 5).
- The results from the HYSPLIT model suggest that ASR spores were transported long distances (more than a 1000 km from Texas) before being removed and deposited (i.e., scavenged) by rain at the South Dakota and Minnesota NADP sites.
- The source for the early presence of ASR in Texas appears to be the Yucatan Peninsula in Mexico (Fig. 5).
- In general, these results are consistent with similar observations previously made with the aerial transport and spread of cereal rusts from the south to the north.