Soybean Rust Dispersal Prediction and Analysis in the US for 2005 Growing Season

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INTRODUCTION

Soybean rust predictions were made during the 2005 growing season based on a hybrid modeling framework that uses a simulation model for spore dispersal and an empirical model for disease favorability. The models were run quasi-operationally on a weekly basis and disease outlooks were issued accordingly. The outlooks, 2 to 4 weeks in advance in the US soybean regions, were based on an expert assessment of model results to predict spore dispersal and climatic favorability for Asian soybean rust epidemics. While an accurate prediction of soybean rust remains challenging, the model's overall performance is encouraging, given that several key parameters are unknown and this is first year experience.

MATERIAL AND METHODS

Data and models used

- ECPC GSM for global prediction (Roads et al., 2001)
- Regional model MM5 for downscaling (Grell et al., 1993)
- HYSPLIT model for particle transport, dispersion, and dry/wet deposition (Draxler and Hess, 1998)
- NOAA's daily-observed rainfall data (ftp://ftpprd.ncep.noaa.gov)
- Monthly rainfall model for epidemic favorability (Del Ponte et al., 2005)

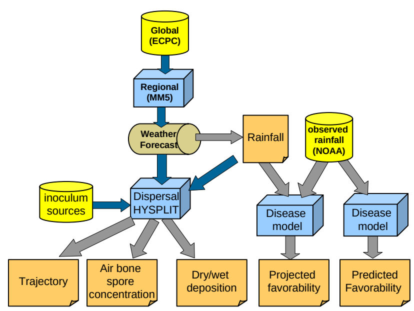

Fig. 1 Schematics of model system

Modelling procedures - We used the long-term prediction system that integrates MM5 climate model with pathogen dispersal model HYSPLIT (Pan et al, 2004) to forecast within-season spore dispersal. Starting in early April, the spore model was run every Saturday to forecast concentration of spores in the air up to four weeks in advance. The location of known inoculum sources were fed into the system, being adjusted weekly according to the new findings published on USDA's website. A procedure was developed to accumulate spore concentration in the air since early April by using data from the first week of spore simulation. The spore forecasts were qualitatively compared with limited spore traps deployed in the production regions.

New procedures were developed to predict favorability for epidemics using a monthly rainfall disease model that uses rainfall amount (mm) and the number of rainy days to predict disease severity (Del Ponte et al., 2005). Disease favorability maps were produced using NOAA daily-observed rainfall data over the US (ftp://ftpprd.ncep.noaa.gov) for the past 30-day period or combined with MM5 rainfall forecast. We accumulated NOAA daily rainfall data to a 15-day observed rainfall grid. MM5 rainfall data were adjusted to the same format as NOAA's data, forming a combined monthly rainfall dataset consisting of 15-day observed and 15-day modeled.

Soybean rust outlooks - Starting from late April, 10 disease outlooks (April to August) with risk interpretation for epidemics to develop in both Gulf coastal and central northern regions were issued based on the expert assessment of both spore dispersal and disease favorability maps (Fig. 4).

LITERATURE CITED

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RESULTS AND DISCUSSION

Analysis of wind patterns in the 2005 season

-Winds were lighter in the south, possibly suppressing mechanical lifting of the spores out of the canopy and limiting local spread (Fig. 2 a,b).

-Northward winds were weaker (Fig. 2c), likely demoting northward transport of the disease, which is in agreement with the absence of corn rust in Iowa that typically migrates northward.

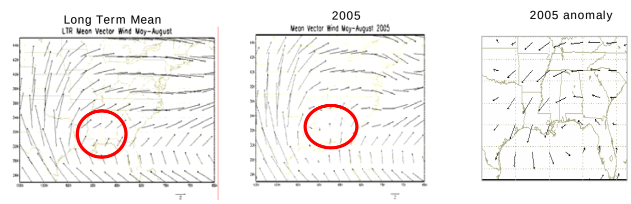


Fig. 2. 850 mb wind (~1500 m above sea level averaged over May-August).

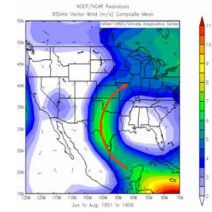
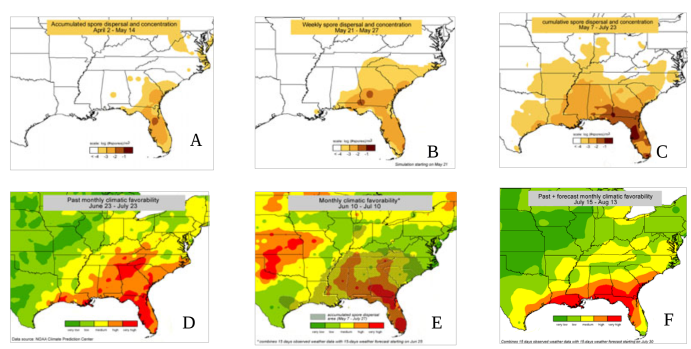


Fig. 3 Climatological wind pattern, showing strong low-level strong wind belts that would likely transport the rust spores to the central US., if the spores have had entered the belt in western Texas.



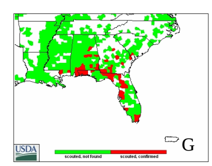


Fig. 4. Weekly spore dispersal predictions during early (A) and mid-season (B). Cumulative spore concentration in the air from early May to late July (C). Predicted favorability for epidemics from mid June to mid July (D). Projected favorability for most of June (E) and from mid July to mid August (F). Confirmed presence of soybean rust in the US as of late October (G) (source: USDA website)

The spore dispersal model was able to predict the general within-season dispersal patterns from known inoculum sources. The model seemed to overestimate spore concentration in the air based on a qualitative comparison with spore trap results deployed in the production regions and also limited disease movement. Analysis of the wind pattern showed that northward winds were weaker in the South, which may have contributed to local confinement of the rust mainly to coastal states for 2005.

The predictions for disease favorability showed a consistent higher risk for southern regions, compared to a lower favorability for disease to establish in the northern states, if spores have reached the region. The drier conditions that prevailed in the northern regions may have limited both spore deposition and infections even if spores were present in the air.

The modeling framework proved to be an useful tool for an expert assessment of the risk of regional disease spread, establishment, and epidemic development during the season. In early August the latest disease outlook issued predicted a low risk of soybean rust to establish in the northern regions.

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