Soybean Rust Prediction and Analysis in the United States for the 2006 Growing Season

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Introduction

Soybean rust spore dispersal predictions and disease favorability forecasts were made during the 2006 growing season using a climate-dispersal-disease coupled model. Built on the first-year experience in 2005 and simple laboratory experiments, some key parameters were calibrated using previous spore and disease information. Procedures used in making the predictions were also optimized to reduce computational costs and increase their consistency. The outbreaks of the disease in the East Coast area and along the Mississippi river during October and November are examined from the view of spore dispersal and disease spread performance that it captured the trends experienced in 2005 and simple consistency. The outbreaks of the disease was later verified by the USDA disease maps on (B) September 11 and (D) October 9. Black circles indicate positively related areas.

Model Adjustments

The dispersal model HYSPLIT (Fig. 1), the core of our modeling system, is sensitive to several key parameters. Based on the results of the experiment which was done in China by Li, Xun (see X. Li's poster), we modified the morphological and dynamical parameters of rust spore. We changed the spore source height as well. By using these new parameters, our model showed more realistic performance. A new method of estimating the escaping rate of spores from the canopy by applying turbulent kinetic energy budget to canopy regime is under development in our group (see D. Andrade’s poster). Monthly rainfall data consisting of 15-day observed and 15-day model predicted were used as input to the disease model last year. Noting that the monthly rainfall amount predicted by model is very close to observation, we used monthly model predicted rainfall data as input instead of the 15/15 combination.

Analysis

The model predictions of spore dispersal and disease development, including winds, and precipitation, were analyzed to identify key meteorological influences on the spread of soybean rust in 2006.

A persistently southerly low-level jet (LLJ) over Texas is present in late growing season. The right exit and left entrance regions of LLJ are convergent areas (Fig. 3). The convergence at 925mb indicates atmospheric downward motions over these areas, which facilitate the spore deposition and suppress upward motions of spores. These convergent areas also have weak wind (see Discussion).

Discussion

The model not only predicted the East Coast event but also captured important features in the outbreak along the Mississippi river.

As shown in Fig. 5, the northeastward trend of disease spread was well presented by model prediction. The "hot spot" at southeast Kentucky was picked up by model simulation as well. Only one week after the disease occurred at the "hot spot", the disease rapidly spread along the Mississippi river. Our model predicted high concentrations of spore over these areas. All disease confirmed locations are along the coast and river. A "hole" appears on the map. We try to interpret this phenomenon by investigating the low-level mean winds.

References


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Fig. 1 Schematics of model system

Fig. 2 Disease forecasts V.S. USDA disease maps

Fig. 3 Monthly mean winds at 925mb level NCEP reanalysis mean winds at 925mb. (A) June, (B) July, (C) August and (D) September. Black circles indicate convergent and weak wind areas.

Fig. 4 Observe rainfall V.S. USDA disease maps

Fig. 5 Predicted spore concentrations V.S. USDA disease maps Left panels are model predicted spore concentrations from the end of July to early September (A, C, E and G). Right panels are USDA disease maps on October 2, 16, 23 and 30 (B, D, F and H). Black circles indicate positively related areas.