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ASSESSING THE PROGRESSION OF PESTS AND PATHOGENS USING THE WEATHER DATA DERIVED FROM THE WEATHER RESEARCH AND FORECAST (WRF) MODEL

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1. INTRODUCTION

Peanut is an important crop in the southeastern USA. In Georgia, the total losses associated with peanut pests and disease vectors in 2004 were approximately $17 million. Thrips was responsible for over $6.4 million of the losses (Guillebeau et al., 2006). The population dynamics of peanut disease vectors and pests in part depends on air temperature and associated weather parameters. Therefore, weather information is crucial for pest and disease forecast models, especially for evaluating the vectors and pest population progression, and pathogens development on host crops. Weather information is typically obtained from a weather network or National Weather Service forecasts. The goal of this study was to develop a decision support tool based on high resolution weather forecasting data obtained from the weather research and forecast (WRF) model to assist peanut growers in their decision making process. The specific objective was to assess the progression of pests and peanut diseases using the weather data derived from the WRF model.

2. METHODS

The peanut disease vectors that were used in this study included *Frankliniella fusca* (Tobacco thrips) and *Frankliniella occidentalis* (Western flower thrips), the pests *Helicoverpa zea* (Corn earworm) and *Tetranvchus urticae* (Two-spotted spider mite), and Leaf spots disease caused by *Cercospora arachidicola*. Downscaled weather data from the Weather Research and Forecasting (WRF) model was adapted to derive high resolution surface sensible weather over Georgia for agricultural and environmental applications. High resolution weather forecast data were utilized as input for pests/pathogens models to derive spatial and temporal distributions of imminent disease forecasts and risk assessments.
The WRF model was initially parameterized with physical parameterizations and evaluated against Georgia Automated Environmental Monitoring Network (AEMN; www.georgiaweather.net) observations (Hoogenboom, 2001). The initialization data used in the model were from the North American Regional Reanalysis (NARR). Downscaled hindcast data were obtained for April to June during the 2007 growing season to develop the disease forecast model. WRF model hindcasts were carried out for every 3 x 3 km grid over Georgia. A model evaluation against the AEMN dataset demonstrated a high accuracy in predicting temperatures across Georgia (Prabha et al., 2007; Prabha and Hoogenboom, 2008).

The spatial and temporal air temperature data from the hindcast dataset were used for the thrips population model. The model was formulated according to the degree day accumulations of hourly temperature at each grid point in the WRF model.

Table 1. Peanut vector and pest base temperatures and degree day requirements

Peanut disease vector/ pest	Base-T (^oC)	DD/Gen (^oC)
Tobacco thrips	10.5	234.1
Western flower thrips	9.5	194.0
Corn earworm	12.6	484.9
Two-spotted spider mite	10.0	169.7

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The degree day accumulation was calculated based on hourly temperature exceeding the base temperatures (*Base-T*). The accumulated generations of vectors or pests life-cycle were calculated according to degree day requirement for completion of the generation from egg to adult (Table 1).

A spatial risk distribution of leaf spot infection initiation on the peanut plant was also generated based on the *Oklahoma peanut leaf spot model.* The model was coupled with WRF output to generate a spatial map of accumulated "*daily infection hours*" in peanut using air temperature and relative humidity. Infection hour was based on RH >= 90%, and Temp = 15.8 - 30 ^{o}C. The spatial progression of disease vectors and pests, and the accumulated "*daily infection hours"* were evaluated with available field observations. In all cases the planting date was assumed to be May 1st, hence calculations started on May 1st.

3. RESULTS AND DISCUSSIONS

Spatial maps were examined for individual days and an example of results during a 6 day period showing the progression of the pest population is presented in Figure 1. The spatial maps indicate a possible emergence of Western flower thrips and an increase in the population during a short period of time.

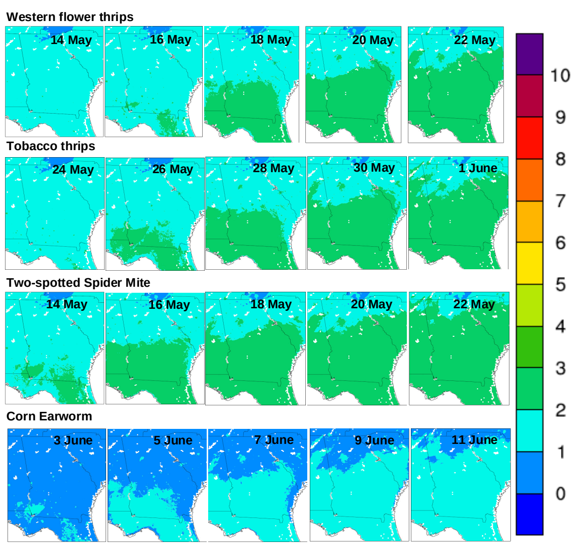

Figure 1. Spatial and temporal maps of possible peanut pest and disease vector emergence.

The spatial map (Fig. 1) indicates that the south and southwestern region of Georgia was initially more favorable for thrips development. A risk of early occurrence of pest development was also noticed in this region. The eastern coastal regions of Georgia are less favorable, due to relatively lower temperatures. The thrips population map during these six days period clearly indicates that the threshold was reached at several locations during a short period of time. Incidentally, the occurrences of the thrips population peak have also been observed during the second week of May based on scouting data and studies (McPherson et al., 1999; Riley and Pappu 2000; 2004). However, these observations were mostly conducted at two-week intervals.

The 2007 scouting data obtained by Dr. David Riley group at the University of Georgia showed that thrips population peaks occur in May (Fig. 2) based on number of thrips collected from sticky traps and weeds sample from two counties in Georgia.

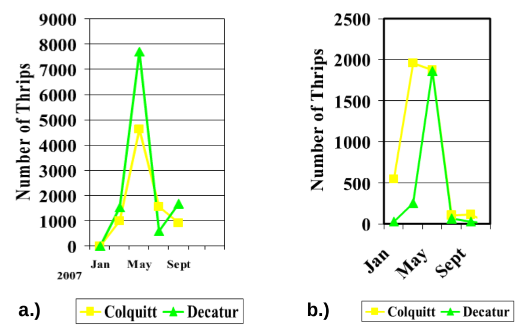

Figure 2. Number of thrips collected from a.) sticky traps, and b.) weeds in 2 south Georgia counties (Dr. David Riley, UGA) (http://www.tomatospottedwiltinfo.org/thrips/preseasonrisk.htm)

As indicated in Figure 1, scouting conducted at 7-15 days interval would have missed the timing and location information about the surge and spread of Western flower thrips between 14 May and 18 May, and could already be late for the spraying of insecticide thereby causing damage or infection initiation. A spatio-temporal thrips population map along with the inferences from scouting will be very valuable and economical in this context to take necessary actions. Such maps would be very helpful in the overall decision making process of the farmer, such as when and where to conduct insecticide applications, and whether excessive use of pesticide can be avoided.

On leaf spot, the accumulated daily infection hours based on the *Oklahoma leaf spot model* (Fig. 3) shows regions of low values as time progresses until the thresholds of 36 hours were met. The maps indicate that fields in the southeast Georgia would be more vulnerability to leaf spot disease of peanut due to favorable weather conditions for infection initiation based on the model criteria and the period that was evaluated.

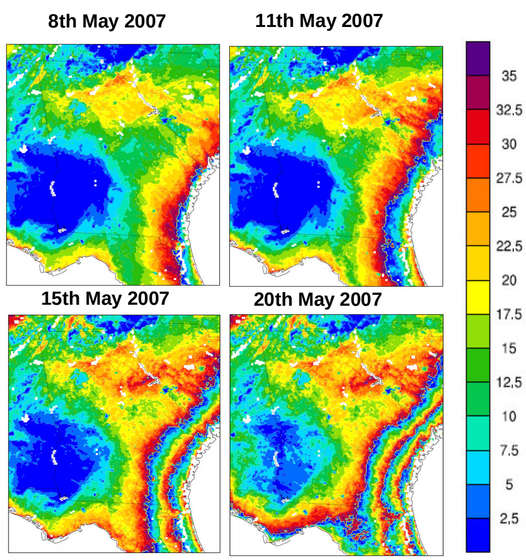

Figure 3. Spatial and temporal maps of daily infection hours favorable for leaf spot disease initiation and development.

4. CONCLUSION

The advance knowledge about thrips and pests populations, and clear understanding of favorable weather conditions required for leaf spot disease initiation and development could improve the growers' decisions on timing and identifying locations for field scouting, so that critical thrips or pests population peak period or infection initiation periods are not missed. An accurate prediction of pest and disease could assist peanut growers with determining the optimum timing of fungicide and insecticide applications.

5. ACKNOWLEDGEMENTS

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