12.7 AN INNOVATIVE APPROACH TO WEATHER-BASED DECISION-SUPPORT FOR AGRICULTURAL MODELS

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1. INTRODUCTION

Computer modeling has provided a tool for using weather data to predict disease and insect pest outbreaks. Traditional pest models have used accumulated degree day units or favorable hours to predict organism development and identify times of high pest risk. These types of models use recorded weather data to track when enough favorable pest hours have occurred to warrant management action. These models have been an integral part of integrated pest management (IPM) control measures. Traditional models provide seasonal data through the previous 24-hour period ending at midnight. The models are updated daily. Data from these models are often compiled into tables. New models from the Oklahoma Mesonet on the Oklahoma AgWeather website utilize collected weather data and National Weather Service Forecasts to provide hourly disease risk information.

2. IPM DISEASE MODELS

The Oklahoma Mesonet has created two new IPM models that incorporate graphical data display formats, table data display, disease hour forecasts, and historical data. The first of these models was the Spinach White Rust Model developed in 2004 and operational in January 2005. The other model was the Pecan Scab Model developed in the first half of 2005 and operational in June 2005. The new features included in these new models are seasonal data through the last hour, hourly model updates, table data, graphical data, historical disease hour trends, 84 hour forecast, interactive selection of Oklahoma Mesonet tower location, interactive model adjustment for crop stage, and ability to enter the date of last fungicide application.

The uniqueness of the Oklahoma Mesonet model format can be seen by comparing traditional IPM disease models available from universities and commercial companies (5.1, 5.2 and 5.3 tables). Only the Oklahoma Mesonet and HortPlus, New Zealand models are using weather forecasts to show hourly disease risk. The Oklahoma Mesonet and HortPlus models represent the next generation of IPM modeling. Some examples of traditional IPM disease models are available via the University of California Online IPM PestCast Disease Model Database and from Spectrum, Inc. There are a large number of these models in use for disease and insect pest management. They rely on past weather data.

Examples of regional models that provide forecasts are those maintained by North American Plant Disease Forecast Center, North Carolina State University and AWIS Weather Services, Inc. These models provide daily risk assessment over a broad area. They use collected weather data and forecasts to estimate disease risk over large geographical areas.

Spinach white rust and pecan scab are foliar fungal diseases. Spinach white rust causes leaf discoloration and death that makes spinach leaves unacceptable for fresh or processing market use. The pecan scab fungus attacks both leaves and nuts of pecan trees. It is considered to be the most devastating foliar disease of pecans and in severe cases can render the entire crop unmarketable.

Weather data for the Spinach White Rust and Pecan Scab Models are collected at the 116 Oklahoma Mesonet tower locations. The towers are 10 m tall with instruments above, at, and below ground. Towers are approximately 20 miles apart. This provides one tower for every 400 square miles.

The Spinach White Rust Model home page allows the user to select the Mesonet tower location and then choose the display product to be viewed. The fungicide decision support module (5.4 figure) allows the user to customize the model calculations by selecting the date of the first true leaf stage or the date of the last fungicide application. After the user has entered a date or left the default date as is, a graph and summary text page are displayed. The text on the page verifies the current date, the date of first true leaf stage or last fungicide application date, the start and end of the fungicide control window, the accumulated infection hours, and the last effective spray date.

The Spinach White Rust Model fungicide decision support and 18-day graphs display the accumulating disease hours for the last 14 days (up to the most recent hour) and a forecast of disease hours, for up to 84 hours. The green line graphs the accumulation of disease hours. The blue line shows the forecasted disease hours, based on the National Weather Service Eta digital model. The red line shows the 10-year average of disease hours for the time period of the graph. The black line shows the disease hours from the previous year. When a date of last fungicide application date is entered, the model uses a fungicide control window of seven days, when no disease hours accumulate.

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In addition to providing data for individual stations, a color-contoured statewide map display product is available that shows the accumulated disease hours from beginning of the pest season to the current date. The Spinach White Rust Model is functional from September 15 through May 15, while the Pecan Scab Model is functional from March 1 to August 31. A legend to the right of the map identifies the value for each color band from zero to the maximum number of accumulated disease hours. The zoomable map can be viewed statewide or zoomed to view a selected region.

The Pecan Scab Model design and user interface follows the same style as the Spinach White Rust Model. The Pecan Scab Model includes an additional product, the 14-day Statewide Cumulative Scab Hours Map. This product is useful because in research conducted at Oklahoma State University it was shown that only disease hours during the last 14 days contribute to pecan scab disease infection.

The 18-day Pecan Scab Hours graph has the same format as the Spinach White Rust graph described previously.

Eleven sites were used to compare the forecasted pecan scab disease hours to the actual disease hours (5.5 table). For the period from July 1 to July 4 the difference between the forecasted and actual disease hours averaged 1.8 between the eleven sites. From July 5 to July 8 the average difference in disease hours was 2.5.

3. AGRICULTURAL PRODUCER IMPACTS

Adding a forecast to IPM pest models improves the models use as a management tool. A future forecast of pest impact allows the agricultural producer more lead time to plan and implement pest control strategies. This additional lead time allows the producer to make applications before field conditions deteriorate and make it too difficult to move equipment through the field. Better timing often reduces the number of fungicide applications for the season, while maintaining crop quality.

The statewide map provides the agricultural producer a "birds-eye view" of disease risk regionally and statewide.

By adding forecasted pest hours and a variety of display outputs the new IPM Spinach White Rust and Pecan Scab Models represent the next generation in IPM modeling.

4. REFERENCE WEBSITES

AWIS Weather Services, Inc.
http://awis.com

HortPlus
http://www.hortplus.com/Brochure/MetWatch/MWSoftware.htm

North American Plant Disease Forecast Center, North Carolina State University
http://www.ces.ncsu.edu/depts/pp/cucurbits

Oklahoma Mesonet Oklahoma AgWeather
http://agweather.mesonet.org

UC IPM Online, California PestCast: Disease Model Database, University of California at Davis:
http://www.ipm.ucdavis.edu/DISEASE/DATABASE/diseasemodeldatabase.html

5. Illustrations and Tables

Traditional	Oklahoma Mesonet Agricultural Decision Support
Season data through yesterday	Seasonal data through the last hour
Model updated daily	Model updated hourly
Table data	Graph and table data
	Historical rust hour trends
	Model output adjusted for crop stage and last fungicide application
	Towers evenly distributed
	NWS Eta 84-hour forecast

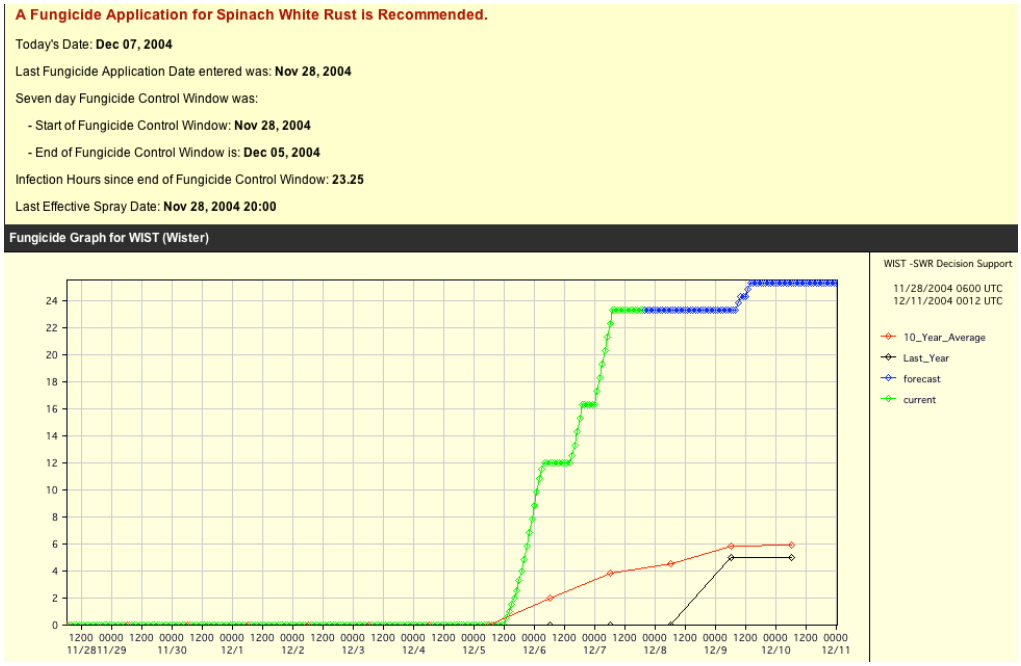
5.1 Integrated Pest Management Model Comparison Table

Traditional: Past data (examples)	Regional: Forecast	Next Generation: Forecast
University of California IPM Online, PestCast Disease Model Database: Listing of university models for agronomic crops, fruits, nuts, and vegetables.	North American Plant Disease Forecast Center, NCSU: • Cucurbit Downy Mildew • Soybean Rust • Tobacco Blue Mold	Oklahoma Mesonet: • Pecan Scab • Spinach White Rust

5.2 University IPM Disease Models Table

Traditional: Past data	Regional: Forecast	Next Generation: Forecast
Spectrum SpecWare, Illinois: • Apple Scab, Fire Blight, Sooty Blotch • Cherry Leaf Spot • Grape Botrytis, Black Rot, Downy Mildew, Powdery Mildew • Potato Early and Late Blight • Tomato Anthracnose, Early Blight, Septoria • Turfgrass Brown Patch, Dollar Spot, and Pythium	AWIS Weather Services, Inc: SE Peanut Leafspot and harvest	HortPlus, Cambridge, New Zealand: • Apple Blackspot and Fire Blight • Grape Botrytis, Downy Mildew, Powdery Mildew • Onion Downy Mildew • Peach Brown Rot and Leaf Rust • Potato Early and Late Blight

5.3 Commercial IPM Disease Models Table



5.4 Spinach White Rust Fungicide Decision Support Graph

	7/1 noon to 7/4 noon		7/5 noon to 7/8 noon	
	Forecast	Actual	Forecast	Actual
Bristow	**8**	**7**	**0**	**8**
Claremore	**0**	**0**	**0**	**1**
Eufala	**2**	**7**	**0**	**6**
Hectorville	**7**	**3**	**0**	**3**
Nowata	**0**	**3**	**0**	**2**
Oilton	**2**	**2**	**1**	**3**
Okmulgee	**2**	**3**	**0**	**4**
Sallisaw	**4**	**3**	**1**	**1**
Skiatook	**0**	**0**	**0**	**0**
Vinita	**0**	**1**	**0**	**2**
Webber Falls	**4**	**8**	**4**	**4**

5.5 Pecan Scab Disease Hours Forecast versus Actual Table