Agronomic Spotlight

Seminis grow forward

Plant Disease Forecast Models

- Plant disease forecast models provide information to help growers make appropriate pest management decisions.
- Many plant disease forecast models use weather data to estimate the likelihood that disease outbreaks will occur.
- Technological advances are improving the accuracy and ease of use of plant disease forecast models.

Similar to insect degree-day models, which indicate when certain insect life stages will develop, plant disease forecast models assess risks and predict diseases. Disease forecast models may also be referred to as disease predictors, warning systems, decision aids, decision support systems, predictive systems, and risk indexes.[1]

Disease forecast models are most useful when they recommend whether or not treatments are needed to prevent disease outbreaks. Some growers use forecast models with the goal of reducing the number of treatments needed for adequate disease control, while others primarily use forecast systems to improve disease management outcomes.[1,2]

Makeup and Platforms

Plant disease epidemics are often initiated by specific environmental conditions, with temperature and moisture usually having the most impact. Many disease forecast models use weather data and other information to determine the potential for disease development and severity.[3] The data used as input variables in forecast models can include meteorological variables, remote sensing images, and biological factors such as plant growth stages and pathogen spore counts. Commonly used meteorological variables include minimum and maximum air temperatures, relative humidity levels, rainfall amounts and frequencies, hours of leaf wetness, wind speed, evaporation rates, and solar radiation (intensity and duration). Remote sensing imagery can be used to detect infected plants, even before symptoms become visible to the naked eye, as selective wavelengths of light can help distinguish healthy and diseased plant foliage.[4]

The input variables in models can come from in-field weather sensors, regional weather stations, grower surveys, and regional and national governmental services.[4] The outputs from models can include indexes of disease risk, disease incidence and severity predictions, and inoculum arrival or development. The model output may then be used to develop management recommendations, often the application of fungicides and bactericides. Growers should evaluate model outputs and recommendations to make sure that they are appropriate for their particular location and production practices. Recommendations may also vary depending on the types of fungicides used (protectant, translaminar, and systemic products) and the presence of fungicide-resistant pathogen strains.[5]

Disease forecast models may be included in the software of stand-alone, in-field weather monitoring systems. The advantage of these systems is that they provide site-specific information that is usually more accurate for that location than is data from regional weather stations. Howerver, some disadvantages of these systems are that they can be expensive, easily damaged (lightning, field equipment accidents), and require periodic maintenance and sensor calibration.[6] Several companies such as Spectrum Technologies, Inc. and Weather INnovations (WIN) provide stand-alone systems that run disease forecast models.

Companies and organizations can also maintain and manage forecast models using data collected from regional weather stations. These centralized model systems can also be interactive, allowing users to input data. In the past, data input and dissemination of results and recommendations was done over the phone. Now, most interactive systems are web-based, with users able to access information on their computer or smartphone. The Enviro-weather system managed by Michigan State University and the Cucurbit Downy Mildew Forecasting system managed through the ipmPIPE program are examples of centralized forecast model systems.[6]

Examples

Forecast models do not have to be complicated or require specialized equipment or software to be useful. The Stewart's wilt severity prediction model for sweet corn is an example of a simple forecast model that is very useful and effective. This model estimates the severity of Stewart's wilt on sweet corn from the average temperatures in December, January, and February. The bacterium that causes Stewart's wilt overwinters in and is vectored by the corn flea beetle. When average winter temperatures are below 27°F, few flea beetles will survive, and the severity of Stewart's wilt will be low. When the average winter temperatures are above 33°F, flea beetles and the bacteria within them are more likely to overwinter successfully; therefore, the severity of Stewart's wilt could be high on susceptible sweet corn hybrids.[7]

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Disease Forecast Models

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The forecast model BLIGHTCAST was developed to determine the potential severity of late blight on potatoes and tomatoes based on rainfall, relative humidity (RH), and temperature data. Specifically, 24-hour rainfall totals and the maximum and minimum temperatures when the RH is above 90% are used to calculate severity values. The accumulation of severity values over time is used to indicate the likelihood of infection by the late blight pathogen and provide recommendations on the need to apply fungicides.[7,8] BLIGHTCAST was originally provided by Penn State University as a phone-in service. Derivations of the BLIGHTCAST model are now available on several platforms, including as software on stand-alone weather monitoring systems and as regional forecast systems.

The Pacific Northwest late blight warning system also provides forecasts on the severity of late blight, but this model uses long-range weather (rain) forecasts to predict the likelihood of late blight outbreaks on a regional scale. Growers who use the system are notified when a first fungicide application is needed. Recommendations on further applications are based on weather forecasts, canopy development, and the probability of late blight outbreaks.[1]

The FAST (**F**orecasting **A**lternaria **s**olani on **T**omatoes) model uses hourly measurements of leaf wetness and temperature to calculate severity values for early blight on tomato. These values are then used to create recommendations for fungicide applications. The FAST model has been adapted to forecast the severity of other tomato diseases including Septoria leaf spot and anthracnose in model called TOMCAST. The TOMCAST model has also been adapted to forecast diseases of potato, asparagus, carrot, celery, and pistachio.[1,10]

The Cucurbit Downy Mildew (CDM) ipmPIPE forecasting system is different from the models described above. This system forecasts the spread of CDM spores over North America. Data for the model comes from a reporting network of growers, extension specialists, researchers, and agricultural professionals who monitor commercial cucurbit fields and sentinel plots for the presence of CDM. This data is combined with weather forecast data and models on the movement of particles in the atmosphere to predict when conditions will favor the spread of inoculum and infection of plants. The program is run by the North American Plant Disease Forecast Center at North Carolina State University.[1,11] The CDM forecast system generates real-time maps showing locations that are at risk for infection. The risk levels can be adjusted based on specific cucurbit crops grown and by pathogen biotypes that may be resistant to fungicide applications. It is estimated that use of the system saves growers an average of two to three fungicide applications a year compared to using a calendar-based spray program. The maps can be viewed on the CDM ipmPIPE website, and alerts can be sent by text or email to the user, based on geographic area.[12,13]

Expectations and Experiences

Disease forecast models have been shown to improve disease management outcomes, reduce fungicide use, and lower management costs. However, relatively few growers use models regularly. Some of the reluctance to use forecast modes comes from a sense of risk versus perceived benefits. Particularly with high value crops, some growers perceive that the potential benefits are not worth the risk of disease outbreaks and choose to use calendar-based application schedules.[1]

Predictive systems should provide the information needed to reduce the uncertainty of making management decisions. Some models teach the growers about the disease system. After some time using the model, the grower develops their own set of criteria for making management decisions and no longer needs to consult the model. However, advances in data collection, expert systems, artificial intelligence, and the ease of information delivery are making forecast systems more valuable, especially for diseases where disease outbreaks are difficult for growers to predict on their own.[1,6]

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Websites verified 11/11/2021

For additional agronomic information, please contact your local seed representative.

Performance may vary from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields. The recommendations in this article are based upon information obtained from the cited sources and should be used as a quick reference for information about vegetable production. The content of this article should not be substituted for the professional opinion of a producer, grower, agronomist, pathologist and similar professional dealing with vegetable crops.

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