Implementation of Predictive Disease Control

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Predicting probable infection periods or increased severity of disease to guide disease control programs has been a goal of plant pathologists for several decades. To operate a disease forecasting or predictive system obligates departments of plant pathology to provide a timely service to the public, but such services are often in conflict with other obligations of the department. Yet, there has been a marked increase in recent years in our knowledge of plant diseases and how to predict them, and some new techniques for disease prediction "bridge the gap" between plant pathologists and farmers.

Some pathologists have envisioned centralized networks, possibly nationwide, linking computers and remote data acquisition units for implementing predictive systems (Krause and Massie. 1975. Annu. Rev. Phytopathol. 13:31-37). Even earlier, entomologists envisioned this approach (Haynes et al. 1973. Environ. Entomol. 2:889-899), and with extensive input of federal monies, several universities have attempted to develop the centralized network concept. Although the equipment and techniques needed to accomplish such a task are currently available, centralized systems for monitoring the weather in each field, making disease predictions, issuing warnings, and suggesting control strategies are largely experimental. They are still a hope for the future.

Efforts at formulating predictive models based on environmental parameters are currently a popular area of research, and many articles based on this research are appearing in the phytopathological literature. These articles generally expound the practical significance of this research, but in most cases, once published, the research is forgotten. There are several reasons why typical growers cannot utilize predictive models. First, they lack the equipment to acquire the needed environmental data, or if such equipment is available, they lack the time or understanding required to interpret the information they have collected. Second, if the data are from a data network, growers are concerned as to whether the data or predictions are relevant to their particular farms. And, finally, unless the network is dedicated to disease prediction and operational 24 hours a day throughout the growing season, the predictions are often too late to allow growers to cope with diseases in which infection progresses rapidly. In the early 1970s, Michigan's Apple Pest Management project was criticized by growers because apple scab infection predictions were not available until Michigan State University's computer started up each morning at about 9 a.m. By midmorning it was too windy to spray, and when spraying conditions became favorable again the fungicides were no longer effective. Predictions were needed at 6 a.m., not 9 a.m.!

We continue to believe computers can be utilized to issue disease predictions but have abandoned the centralized network concept in favor of small special-purpose computers with field sensors. These units collect data in the farmer's field, analyze them automatically, and provide predictions and disease control suggestions instantly on the spot. Predictions are obtained by using a keyboard and display, just as one would operate a calculator. It's a tool farmers can use. Also, this unit is designed so that the instructions for monitoring the environment and formulating the predictions are programmed onto a separate circuit board. For example, to change an apple scab predictor into a cherry leaf spot predictor, the circuit board for scab is replaced (or reprogrammed) with one for cherry leaf spot. Because of this programmable feature, models can be updated or new models added without modifying the hardware.

For plant pathologists to fully utilize this modern technology, they must work with individuals who have the necessary training, experience, and support equipment to develop and update the modules. A computerized system for apple scab (Jones et al. 1980. Plant Dis. 64:69-72) is currently being commercialized by Reuter-Stokes, Inc., 18530 South Miles Parkway, Cleveland, OH 44128. This unit, about 30 × 25 × 16 cm and mounted on a post in the orchard, monitors temperature, relative humidity, duration of leaf wetness, and rainfall amounts. In an independent test of this unit in Ohio under severe scab pressure, five fungicide applications were saved with no difference in control between a protective schedule and that timed with the Apple Scab Predictor (Ellis and Wilson. 1983. Fungic. Nematic. Tests 38:137).

Using a predictive system generally means control measures are applied after the onset of infection. In the past, this was a major deterrent because most available fungicides were effective only if applied before the onset of infection. They lacked curative action. The development in the last 10–15 years of excellent curative fungicides, such as the sterol-inhibiting compounds, has greatly reduced the risk formerly associated with the use of predictive systems. When applied within a few days after infection begins, these fungicides effectively control a number of diseases. In fact, the most efficient use of these chemicals is in conjunction with a predictive system because they are limited in protective action.

We have determined over a 5-year period that apple scab predictions can be "tailor-made" to a fruit grower's orchard. Moreover, we have demonstrated that researchers with weather-driven models can use microprocessor-based instruments to help refine and validate models in a timely manner. Once validated, the models can be implemented by industry. Without the input of research and extension personnel beyond the publication stage, however, commercialization of predictive models will be slow and never at a level sufficient to obtain the economic and ecological advantages attributed to them by many researchers. The cooperation of industry is essential because departments cannot perform this function in an effective and efficient manner.

Our focus to date has been on the use of instruments that stand in orchards as sentries, performing just one function. A grower with a personal computer, however, may wish to link disease predictors to the computer. The environmental data collection capabilities of the predictor could then be used to extend the operations performed by the computer. Although this approach is technically feasible, the merits need to be determined. Here again, industry will be required to provide the expertise needed to manufacture, market, and maintain such systems if they are to have widespread and lasting significance.