DEVELOPMENT OF A DECISION AID FOR PEST AND DISEASE MANAGEMENT IN FRUIT CROPS

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SUMMARY

Rational pest and disease (pest) control decisions require the collection and integration of much information. Absence or inaccessibility of information frequently constrains decision-making, often leading to over-control of pests to ensure production. Information's accuracy and ease of access can be improved by using computer technology to monitor orchard conditions and record data required for informed orchard management. Models and expert systems can integrate the information stored in an orchard database and tailor it to the individual. The principles of such a decision aid for apple pest management, are discussed.

INTRODUCTION

The New Zealand apple industry currently depends on high pesticide usage to meet market quality and phytosanitary requirements. However, political forces in the major European pipfruit markets are demanding ever lower residues and a related change to reduce chemical inputs (Hoelgaard 1989). In addition, United States EPA guidelines have severely restricted use of many fungicides, the latest being the dithiocarbamate group. These, and other threats to chemical use, such as pesticide resistance, are forcing a move towards reduced pesticide regimes. To maintain the New Zealand apple export industry, pest management methods that reduce chemical inputs are of vital importance. The best way to achieve reductions in pesticide use is to combine a range of control measures for each pest into an integrated pest management (IPM) system for the crop.

Weather-based disease models have successfully reduced apple pesticide applications in research and extension trials (Thomson *et al* 1977; Zuck and MacHardy 1981; Hayes *et al* 1988). Ideally the meteorological inputs to such models represent actual orchard weather with a temporal resolution of the order of 1 hour. Electronic data logging has developed to a point where it is technically and financially feasible to record an individual orchard's microclimate as part of an operational pest management system (Jones 1986). The recording and later manipulation of data in this way is best achieved using some form of electronic computer.

COMPUTER USE IN PEST MANAGEMENT

Centralised systems, operating on large multi-user computers, represent one approach to the extension of computer models. Examples of this type of network include SCAMP and PMEX (Welch 1984). In systems of this type the computer is usually accessed by the grower's advisors, who input grower data and interpret the computer output for the grower. At the other end of the size scale, stand-alone orchard-based microcomputer monitors, like the Reuter Stokes predictor (Jones 1986), use environmental measurements to predict development of specific diseases for each orchard. Affordable personal computers (PCs) are a recent innovation which offer the computational capability of centralised machines, with the site specific advantages of small orchard-based monitors.

Adoption of computer-based pest control strategies has generally been low. Wearing (1988) identified barriers to IPM implementation. The following are particularly pertinent to computer-based IPM: 1) Growers lack incentive to change
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from existing pest control perceived to be satisfactory. Growers do not have confidence in new systems until they have been proved in operation. 2) New systems must compare favourably with the relative simplicity and low cost of standard chemical control. IPM systems requiring extensive data collection and input are unlikely to be well received. 3) Biological monitoring is an expensive component of most systems. Relating pest and disease levels to reductions in final income is often difficult.

Successful IPM systems have to meet the following criteria: 1) Fruit from IPM systems have to meet market quality and phytosanitary requirements. 2) System outputs should be tailored to individuals. This requires site and situation specific inputs (e.g. previous pest management actions). 3) IPM models and systems must address significant, difficult decisions, and their advice must integrate with other management operations. 4) A system must be accessible and easy to use, and its output should be easy to interpret. 5) A system should be adaptable to a range of uses, equally able to provide recommendations for specific problems, or to evaluate potential outcomes from management options.

Export market access protocols for New Zealand fruit currently limit the extent to which pesticide use can be reduced. However, pest models for an IPM control approach already exist for the diseases fire blight (*Erwinia amylovora*) (e.g. Thomson *et al* 1977) and black spot (*Venturia inaequalis*) (e.g. Jones 1986) and for European red mite (*Panonychus ulmi*) (Hayes *et al* 1988). These models have yet to be integrated in a single, pest management system, in part because the computer hardware and software required has only recently become available. The interactive colour graphics of personal computers (PCs) facilitate presentation and interpretation of information. New software technologies, especially expert systems, provide enormous potential advances in data manipulation and presentation to users. Expert systems are computer programmes that can simulate the behaviour of human experts (Stock 1987), and could be used to provide advice on pest control options. A possible structure for an apple IPM delivery system using these technologies is outlined.

THE PROPOSED SYSTEM

The proposed system is based on a network of grower PCs, linked to a central minicomputer via standard telephone modems. The network configuration will give the timeliness, and communications capabilities of a centralised computer, with the control and ease of use of a PC. Standard climatological data loggers will be placed at strategic locations throughout a production region, each serving one or more nearby growers.

The central computer will store up-to-date weather and spray details, and provide the linkage to local orchard-based data loggers. Weather records, forecasts and other general information, placed on the central computer will automatically be accessed daily by growers' machines. Routine programme maintenance and updates of models will also be done automatically via the central computer as required. Because the users' PCs will carry much of the processing burden, the central computer could be smaller than that required for a regional multi-user system. Information could also be returned to the central computer for use by scientists, consultants, and other users. For example, regional measurements could be readily amalgamated for crop monitoring and forecasting work.

System subscribers will receive a suite of decision support tools based on the following major components: 1) environmental sensing and remote data logging, 2) graphics-based software that let growers keep better spray and phenological records, 3) expert systems which take account of previous management by the grower to provide tailored management recommendations rather than pest warnings, 4) models of pests, diseases and spray cover which provide information both to the expert system and directly to the grower, 5) a database storing orchard weather data management actions, crop phenology records, and other relevant monitoring information.

The orchard database will serve as the foundation on which these applications are constructed. The consistency of the database structure and graphical interface will make the applications easy to learn and use. Also, information entered and stored in the database by one application will be readily available to any other, including applications

added later. Management records (e.g. pesticide use) and crop information (e.g. growth stages, pest monitoring) will be recorded in the database via graphical representations of grower's orchard blocks and rows. Models will use the microclimate and spray applications recorded in the database to establish the threat posed by individual pests and diseases and, if there is a need, recommend action to control a pest or disease. An expert system will analyse the factors involved in pest control, to advise on the most suitable spray and/or other management action for the given situation.

CONCLUSION

The system proposed is not a fanciful prediction of what may be possible in the distant future. The market is driving changes in pesticide use. The computer hardware and software required already exist and are becoming more cost effective all the time. Much of the biological information required exists, and can be improved with more research. User adoption of the system is likely to be limited by the real and perceived risks of crop loss. The risks inherent in the proposed system need to be established in field trials, and are likely to be reduced as the system is used and further developed. MAF and the DSIR are currently examining the potential for a cooperative research project of the type described.

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