A DECISION MODEL FOR MITICIDE USE IN APPLE ORCHARDS

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SUMMARY

A predator-prey model of the European red mite and *Typhlodromus pyri* was used to derive a spray decision model for seasonal miticide use in apple orchards. Based on numbers of predators and red mites on the leaves in spring, the model predicts whether no, one or more miticides will be required and when they should be applied. After one season's validation, the model was amended slightly. The impact of regional variation on the decision thresholds was investigated. The advantages of these spray thresholds over earlier thresholds and the implications for integrated mite control are discussed.

Keywords: mite control, spray thresholds, computer models, apples.

INTRODUCTION

A temperature-driven deterministic simulation model (Hayes 1989a) of the European red mite (ERM), *Panonychus ulmi* (Koch) and its predator *Typhlodromus pyri* has been extensively validated with data from apple orchards in Nelson and Hawke's Bay (Hayes 1989b). Using early season pest and predator densities per leaf, the model was accurate in its prediction of both peak ERM numbers and the timing of the peaks, when ERM numbers were below 100/leaf. Model performance was less accurate when pest and predator densities were very low in spring, when it underestimated the ability of the predator to control ERM. In the absence of a computer based information system for pest management in apples, the simulation model had limited practical applications to mite control. This paper reports on the development of a simple graphical decision model for seasonal miticide use in apple orchards, which was derived by summarising the output from many simulations. It does not require a computer for its operation and gives recommendations on the use of one or more miticides and on the most appropriate time for application.

METHODS

Model development

Numerous simulations starting in late October with different combinations of pest and predator densities, were run using average seasonal temperatures for Appleby Research Orchard, Nelson. The outputs of the simulations were classified as to whether the peak ERM density exceeded 5, 10 or 20, active stages per leaf, and related to densities of *T. pyri* actives, and ERM summer eggs in mid November. Although simulations started earlier than mid November, this is a practical time to make an estimate of mite densities in orchards and is sufficiently early to make decisions on miticide use at the key application times of December or January. Also, the first generation of ERM summer eggs reaches a stable peak at this time and is a good predictor of the next generation of ERM active stages.

An acceptable threshold for ERM is that the density of active mite stages should not exceed 20 per leaf for longer than 2 weeks (J.Walker pers. comm.). A slightly more conservative threshold, a peak of 20 ERM/leaf was used in the decision model. The line labelled 20 ERM/leaf (Fig. 1) summarises all mid November combinations of ERM eggs/leaf and predator active stages/leaf predicted by the model to result in a peak of

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20 ERM actives/leaf at some time during the season. Any combinations of ERM and predator densities in mid November to the left of this line would recommend miticide use, to prevent ERM exceeding 20 active stages per leaf, but combinations to the right of the line would not require miticide use to prevent ERM exceeding the threshold.

Decision graphs for Central Otago and for Hawke's Bay were similarly derived, using average temperature data for these two regions. The models differed only slightly from the Appleby model, with ERM control being slightly more difficult in Hawke's Bay (more predators required for the same level of control) and least difficult in Central Otago. These differences reflect only differences in average temperature regimes of the three regions and were not considered significant enough to develop separate regional decision models. Instead, the most sensitive (Hawke's Bay) model was used.

Figure 1: Spray decision model at 20 ERM/leaf compared with field data from Hawke's Bay. □ apple blocks with acceptable ERM control. ■ apple blocks with unacceptable ERM control.

Model validation

In order to validate the model, the decision making criteria were tested on mite population data from each apple block on seven commercial properties in Hawke's Bay during the 1989/90 field season. Varietal apple blocks were between 0.5 to 1.0 hectares in area. Random samples of 50 leaves per block were taken in mid November and brushed with a mite brushing machine to determine the mean numbers of ERM eggs and predator active stages per leaf. The model's recommendations of whether a miticide was required or not were compared with the actual outcome for ERM control (acceptable or not acceptable) determined by visual monitoring in January and February.

The field data are compared with the decision model (Fig. 1). Whilst the field data were sparse and somewhat clustered, they were consistent with the decision model. A discrepancy occurred at low predator levels (less than 0.3 actives/leaf) when the model predicted unsatisfactory seasonal control of ERM. However, the field data indicated 11 instances where both low predator and low ERM densities had resulted in adequate control. Using these field data, a further condition in spring which should not require miticide use was defined as: when the density of ERM summer eggs is below 0.5/leaf and at least one predator mite is present in a 50 leaf sample.

Model enhancement

An enhancement to the decision model was to include recommendations on the use of one or more miticides, and on the most appropriate timing. Starting with predator-prey density combinations in spring known to result in the 20 mites/leaf threshold being exceeded during the season, model simulations were carried out which included the application of a miticide in December or in January. The model for applying a miticide (Hayes 1990) was based on field and laboratory data for the currently available IMC compatible miticides (propargite, fenbutatin oxide, azocyclotin) and assumed no detrimental effects on predator mites, a 98% kill of ERM actives and a 15% kill of ERM summer eggs. The graphical decision model was then enhanced to include all the combinations of spring pest and predator densities which, with the application of one miticide in December or January, would keep ERM densities below 20/leaf.

RESULTS

The final decision model (Fig. 2) shows conditions for the following recommendations: no miticide, one well-timed December miticide, and one well-timed January miticide. There is also a small region where either a December or January spray would be suitable. The remaining regions recommend use of more than one miticide because of the low predator density. This region of the decision model is not so well defined, because of the model discrepancy described earlier and also represent situations where action is required earlier (ovicidal control of ERM winter eggs).

Figure 2: Spray decision model incorporating recommendations on using one or more miticides.

DISCUSSION

Amongst the range of situations which can be brought under control by the application of a single miticide, a December application appears to be more useful than a January application. December has always been recommended as a key time to spray for mites (Walker *et al.* 1979) and is often preferable to a January miticide because the smaller overlap in mite generations results in greater miticide efficacy. It is also late enough in the season to allow a build up of predator numbers and there are no restrictions in miticide use because of withholding periods. In general, a December application is preferable when ERM levels are high and predator levels low to moderate, since the chosen threshold of 20 mites per leaf will be exceeded before January. A January miticide application is preferable for only a small range of situations, when predator levels are low and ERM levels moderate in spring, because the delay in using a miticide allows sufficient build up of predators to prevent a late season increase in red mite numbers.

The decision model presented here has the potential to reduce monitoring time compared to previous methods (Cook 1980) by pinpointing the time for samples to be taken, by counting only some of the mite stages and by incorporating some predictive ability.

Integrated mite control (IMC) has been threatened in recent years by the use of disruptive fungicides for black spot control and by the continued use of ovicidal miticides resulting in a gradual decline in predator levels over a number of seasons. As a resistance management strategy, it is imperative that IMC programmes are maintained in apple orchards, whilst also providing substantial cost benefits to the users. However, to be successful, the monitoring associated with IMC must not be so labour intensive as to exceed the cost of a miticide application. In deriving a quick and seemingly robust monitoring and decision system, it is hoped that judicious use of miticides and a return to the benefits of IMC can be achieved.

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REFERENCES

- Cook, C., 1980. Mites - Integrated Control on Apples. Horticultural produce and Practice, Aglink series 2/3000/10/82:HPP 197, 1st revision. Maf Media Services, Wellington, New Zealand (unpubl.), 5pp.
- Hayes, A.J., 1989a. Simulation model of the European red mite and *Typhlodromus pyri* in New Zealand Apple Orchards. *Experimental and Applied Acarology* 6: 109-122.
- Hayes, A.J., 1989b. Computer modelling to reduce pesticide use against mite and insect pest of apples. In: Hayes, A.J., Markwick, N.P., and Walker, J.T.S. Summary of Field Research funded by the New Zealand Apple and Pear Marketing Board, 1988-1989. DSIR Entomology Division Report to NZAPMB.
- Hayes, A.J., 1990. Computer modelling to reduce pesticide use in apples. In: DSIR Plant Protection Report to the New Zealand Apple and Pear Marketing Board, 1989-1990.
- Walker, J.T.S., Ashley, E., Wearing, C.H. Thomas, W.P. and McLaren, G.F., 1979. Timing sprays for efficient European red mite control. *Orchardist of N.Z.* 52: 289-290.