INTEGRATED PEST CONTROL IN GREENHOUSE CROPS

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SUMMARY

The two most important greenhouse pests in New Zealand are greenhouse whitefly (*Trialeurodes vaporariorum*) and two-spotted mite (*Tetranychus urticae*) because of their recurring resistance to pesticides. The integration of biological control with other methods of pest and disease control offers a solution to the problems of resistance. The greenhouse whitefly parasite, *Encarsia formosa* and the two-spotted mite predator *Phytoseiulus persimilis*, are used overseas. Integrated control procedures which include use of the two biological control agents are outlined for cymbidium orchards, roses, greenhouse grapes and tomatoes in New Zealand.

INTRODUCTION

The two most important pests of greenhouse crops in New Zealand are whitefly and two-spotted mite. Both species breed rapidly and have stages, such as eggs, which are not affected by most pesticides. Because they live on the underside of leaves they are difficult to reach with chemicals, especially contact sprays. For all these reasons pesticides need to be applied frequently giving ideal conditions for development of pesticide resistance. Whitefly and two-spotted mite are reported to be resistant to 8 and 56 pesticides respectively by Georgiou (1981) and whitefly resistance to three further pesticides have since been reported (Elhag and Horn 1983, Anis and Brennan 1982). In New Zealand growers have observed pesticide resistance in whitefly and two-spotted mite and there are three published cases of resistance in the mite (Georgiou 1981). Recent tests in Auckland of suspected resistance in whitefly to synthetic pyrethroids were negative (Workman unpublished data). Resistance to pesticides is a major reason for the increased interest in biological control (Ulbricht 1983). Whitefly and two-spotted mite are suitable for control with parasites and predators because low numbers of these pests can be tolerated as long as none are found on produce being exported. On most crops however, it is still necessary to use some pesticides and to develop a programme of integrated pest control. This method of control changes the approach to pest and disease management.

INTEGRATED CONTROL

Biological control agents

The basis of integrated pest control programmes for greenhouse crops are a wasp, *Encarsia formosa*, parasitic on whitefly, and a predatory mite, *Phytoseiulus persimilis*, attacking two-spotted mite (Woets and Lenteren 1981). *E. formosa* was introduced into New Zealand in 1933 (Muggeridge 1934) and *P. persimilis* was brought into the country in 1967 and 1977 (Walker *et al* 1981). Entomology Division, DSIR, Auckland maintains colonies of both species for the development and adaptation of integrated control to local environmental conditions and growing practices.

Advantages

The use of biological control and less pesticide means that the chance of resistance to pesticides is reduced. There is less phytotoxicity (Wardlow pers comm), lower chemical residues on produce and greater safety to greenhouse workers. Biological control agents are easier and quicker to distribute than the application of pesticides and give cheaper control (e.g. > 50% cost saving for whitefly on tomatoes (Lenteren 1983)).

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Use of pesticides

Pesticides are still necessary within an integrated management programme, to control diseases and secondary pests. Selective pesticides are used where possible without harming parasites or predators (Table 1). Pesticides harmful to the biological control agents can be applied in ways which are ecologically selective (e.g. drenches). The availability of suitable pesticides is often restricted because no registration or data on chemical residues exists (e.g. Martin and Workman 1984). An important part of our work is the integration of pesticides with biological control.

RESEARCH IN PROGRESS

Research, mainly conducted in commercial greenhouses in collaboration with growers, is on four major crops, tomatoes, cymbidium orchids, roses and greenhouse grapes but we have also carried out preliminary observations in beans, capsicums, babacos and pepinos.

The means of controlling pests and diseases in the four main crops are summarised in Table 1 together with some of the problems being investigated. While in some crops a single introduction of the parasite or predator may give season long control, the *P. persimilis*-two-spotted mite interaction needs regular monitoring on roses (Burgess 1984) and cymbidium orchids. Simple monitoring systems and actual thresholds are based on the presence or absence of the predator and prey on a shoot or leaf. The need for monitoring arises because *P. persimilis* has a voracious appetite for all stages of two-spotted mite and can breed faster than its prey. This leads to local extinction and two-spotted mite reappears in isolated pockets which may need additional releases of the predator.

Encarsia formosa presents different problems. The parthenogenetic females only feed on and parasitise the larval whitefly. So that adult parasites are present when all whitefly pass through the larval stage parasites must be introduced three to four times over a 5 to 7 week period. In addition, because whitefly has a high egg-laying capacity, less than one adult whitefly per ten tomato plants must be present in the crop at the start of the parasite introductions otherwise honeydew from the whitefly and the accompanying sooty mould will form.

This threshold, determined overseas, has been validated for New Zealand conditions. We have been fortunate that several overseas workers have included the New Zealand strain of *E. formosa* in studies of the biology of the parasite (Kajita, van Vianen, Walker pers comm).

Evaluation of pesticides

Overseas studies have resulted in lists of pesticides that are toxic and harmless to *E. formosa* and *P. persimilis* (Ledieu pers comm). However, because the N.Z. strain of *P. persimilis* appears resistant to additional pesticides, laboratory tests are being conducted here (M. Bryham pers comm) based on the standard IOBC method (Samsoe-Peterson 1983). Because of discrepancies between the results of laboratory tests and field experience, we have also developed a semi-field test to measure the effects of pesticides sprayed onto two-spotted mite-*P. persimilis* populations on pots of dwarf beans. A programme to develop a pyrethroid resistant strain in *P. persimilis* is in progress (Dr N. Markwick pers comm) and such a strain would have immediate application in crops such as pepino where pyrethroids are used to control poroporo fruit borer.

For integrated pest control to succeed, the commercial production of *E. formosa* and *P. persimilis* is essential, and consultants must be trained to supervise the programme with growers. It is proposed to establish commercial production and extension in close collaboration with the research group to ensure full transfer of the technology. Lenteren (1983) emphasised the importance of intensive guidance for the grower for biological control to succeed. We have found a need among growers for advice on all aspects of crop production and have noted that growers often lack basic knowledge of common pests.

CONCLUSION

This programme for integrated pest control in greenhouse crops should provide a better and more stable system of pest control by overcoming the recurring problem of resistance to pesticides. It will help conserve existing pesticides while allowing change to suitable new but safer products. Because the introduction of integrated pest control needs supervision there could also be improvement in the services and information available to growers for other aspects of crop management. Our experience has shown that within the field of pest and disease control there needs to be a holistic approach to each crop.

TABLE 1: Preliminary outline of integrated pest control strategies for four greenhouse crops.

Cymbidium orchids	
Problem	Control measure
two-spotted mite	<i>P. persimilis</i> and selective miticide harmless to flowers (e.g. fenbutatin oxide)
scale insects, caterpillars and aphids	insecticide harmless to <i>P. persimilis</i> (e.g. diazinon, pirimicarb)
spiders and immigrating insects during flowering	suitable pesticide under investigation
bumble bees during flowering	- coarse netting over air intake and air vents
diseases	environmental manipulation, fungicides compatible with <i>P. persimilis</i>
pollencap blackening	under investigation
mould mite	soil drench with pesticide (e.g. chlorpyrifos)
Greenhouse grapes	
Problem	Control measures
spiders	After pruning washdown glasshouse, inside and outside and spray with pesticide (e.g. pirimiphos-methyl)
mealy bug (key pest)	bark stripping in winter (bad infestation), insecticides (budburst, e.g. prothiophos; later, short-lived systemic)
two-spotted mite	<i>P. persimilis</i> assisted by selective miticides.
other mites	Weed control in winter and spring
leaf rollers and other caterpillars	colloidal sulphur before flowering
diseases	<i>Bacillus thuringiensis</i> fungicides harmless to <i>P. persimilis</i>
Greenhouse roses	
Problem	Control measures
two-spotted mite	<i>P. persimilis</i> and selective miticides
aphids	insecticides harmless to <i>P. persimilis</i> (e.g. diazinon and pirimicarb)
greenlooper and other caterpillars	<i>Bacillus thuringiensis</i>
diseases	fungicides harmless to <i>P. persimilis</i>

Tomatoes

Problem	Control measures
whitefly	<i>E. formosa</i> and pesticides (autumn, oxamyl; later, short lived e.g. methomyl) weed control in and around greenhouse between crops.
greenlooper caterpillar	<i>Bacillus thuringiensis</i>
aphids	insecticide harmless to <i>E. formosa</i> (e.g. pirimicarb)
diseases	resistant varieties environment manipulation fungicides harmless to <i>E. formosa</i>

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