BIOLOGICAL CONTROL OF GLASSHOUSE PESTS

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Sufficient information is now available about the biological control of glasshouse pests for it to be developed commercially as a management practice. Not only would such a scheme reduce the occupational hazards of the glasshouse worker to toxic chemical substances to which he is frequently exposed but it should also result in an increase in plant growth. It has also been the experience of European glasshouse growers that it results in more effective control because the dense planting makes adequate coverage of high volume sprays difficult.

The most persistent pests in glasshouses in southern Australia are the greenhouse white-fly (*Trialeurodes vaporariorum* Westwood), the long-tailed mealy bug (*Pseudococcus longispinus* Targ.), and two spotted spider mite (red spider) (*Tetranychus urticae* Koch). At times, aphids, usually the green peach aphid (*Myzus persicae* Sulzar), can also be a problem. Many and various insecticides are recommended and used regularly against one or more of these pests. However, all of these pests usually have associated with them a compliment of parasites and/or predators that, in the absence of insecticides, keep them under reasonable control. The use of an insecticide applied to control any one of these pests disturbs the natural balance of the others and they all become pests for which the grower is committed to regular insecticide applications. This remains economical while the insecticides are effective but eventually resistance develops and no control is possible.

The ever-increasing problems caused by the development of pesticide resistance in strains of two spotted spider mites and aphids has highlighted the need to reduce the selection pressure resulting from chemical control programs. The problem is particularly acute where the greater proportion of propagated plants are grown by a few large-scale producers who apply insecticides frequently in an effort to dispatch clean plants to their customers. Once pesticide tolerant strains of pests develop they are distributed to other nurseries, retail outlets and ultimately to the public at large. This method of production and distribution accounted for the rapidity with which organophosphorus resistance developed throughout the United Kingdom in 1964 (4). Even a partially successful biological control program may drastically reduce the number of pesticide applications which will, in turn, extend the life of the materials used. To date, most attention has been directed to insect natural enemies but the use of fungi, bacteria and viruses is also possible. The bacterial disease, *Bacillus thuringiensis*, is already available commercially in this country for the control of many kinds of caterpillars. The first attempt to develop biological control in commercial glasshouses was pioneered by Speyer (8) who used the parasite *Encarsia formosa* as a control for the whitefly, *Trialeurodes vaporariorum*. Within a few years this small wasp was being distributed to over 800 nurseries every year. There were two major reasons for the decision to discontinue this distribution scheme after the war. Firstly, the development of DDT afforded, for the first time, a really efficient and safe chemical control, and secondly, the rearing technique, based on large-scale glasshouse production, had fallen under some criticism as other pests such as spider mites and thrips were frequently, inadvertently, distributed to growers on the leaves carrying the parasitized whitefly scales. No further developments took place until Doutt (1) demonstrated that, on commercially grown gardenias, the mealy bug *Planoccoccus citri* could be successfully controlled by a combination of two encyrtid parasites *Leptomastix dactylopii* Howard, and *Leptomastidea abnormis* Girault, and the predatory ladybird *Cryptolaemus montrouzieri* Mulsant. Since that time a great deal has been discovered about the control of glasshouse pests. Today the management of these pests based upon the mass production and periodic colonization of various natural enemies is commercially practiced in England and the Netherlands (4). There is no reason why such practices could not be adopted in Australia. Natural enemies of our main glasshouse pests already exist in this country. The effective utilization of them in the glasshouse depends on creating favorable conditions for them to operate. In general, this means the establishment of the necessary balance early, and the judicious use of selective chemicals, especially fungicides, when necessary.

Control of Whitefly. Parr (5) obtained complete control of whitefly in 19 weeks by releasing the parasite *Encarsia formosa* Gahan at 1 per sq. ft. in a small scale experiment. In a large-scale trial on cucumbers Hussey in 1969 achieved control on 75% of the plants in 12 weeks. More recently, Gould, quoted in Hussey & Bravenboer (4), completed an exactly comparable experiment and achieved complete control on all plants. The effectiveness of the parasite is influenced by temperature. A minimum night temperature of 15°C is adequate as long as there is a reasonable number of sunny days to raise the mean temperature above 18°C. Given these conditions *Encarsia* can be safely used to control whitefly on all except the most highly pubescent hosts (3). *Encarsia* is well-established as a parasite of greenhouse whitefly in Australia.

Control of Mealy bug. The long-tailed mealy bug *Pseudococcus longispinus* in Australia has recently been studied by Furness (2) who found a number of native parasites and predators associated with it. The parasites include *Anagyrus fusciventris* (Girlt.), *Moranilia* sp., *Ophelosia crawfordi* (Riley) and *Hungariella pretiosa* (Timb.). The predators include *Chrysopa* sp, *Micromus tasmaniae* (Walk.), *Rhizobius ruficollus* (Lea) and *Stethorus* sp. In the absence of persistent broad spectrum insecticides the natural enemies reduce the numbers of mealy bugs to well below the economic threshold. If chemical treatment is required then aminocarb (Matacil (R)) should be used as it is very short-lived (1 day) and has a minimal effect on parasites & predators.

Control of Aphids. In Australia there are two very effective parasites of aphids, namely *Aphelinus* sp. and *Aphidius* sp., the former being very common and effective in glasshouses. Predators commonly associated with aphids are the ladybirds *Leis conformis* (Boisduval) and *Coccinella repanda* Thunberg, the green lace-wing *Chrysopa* sp. and the brown lace-wing *Micromus tasmaniae* (Walk). Richardson and Westdal (7) controlled the aphid *Myzus persicae* in glasshouses with *Aphelinus semiflavus* Howard. Wyatt (9) showed that even small numbers of *Aphidius* sp. can check an aphid's increase in 8 weeks and almost exterminate it within 15 weeks.

Control of Spider Mites. Mites are probably the most persistent and most difficult pests that have to be controlled in the glasshouse. Their control is made difficult by the necessity to completely cover the surface area of the plant. It is made more difficult by the fact that mites have become resistant to most of the chemicals that are available for control. In Europe these mites have been successfully controlled by introducing the predatory mite *Phytoseiulus persimilis* (Athias-Henriot). In Holland, biological control of mites was successfully achieved in about 50 nurseries during 1969 (4). A single grower reared the predator and sold it to others.

The predatory mite *Typhlodromus occidentalis* Nesbitt was introduced into Australia by the C.S.I.R.O. in 1972. It has been mass-reared and released into fruit gardens. It has been so successful in Victoria that the Department of Agriculture has a very ambitious mass-rearing program under way. It has been less spectacular in South Australia but has achieved satisfactory commercial control in many localities. However, in South Australia two spotted mite is not a pest in the absence of persistent broad spectrum insecticides. This is due principally to two native ladybird predators, *Stethorus loxtoni* Britton & Lee and *S. vagans* Blackburn. *S. loxtoni* is a very efficient predator and is capable of keeping mite populations well below the economic injury level. It can be easily reared and when tested in California under glasshouse conditions it was able to control a well-established mite population within 3 weeks (6). Unfortunately it is very susceptible to insecticides so its use to control mites depends on the judicious use of insecticides or the adoption of biological control practices for the other pests that occur in glasshouses. The undesirable side effects of chemical applications can be avoided by a strategy based on a separation of chemical and biological controls in time or space. For instance, "spot" chemical treatment of localized outbreaks of less serious pests. The most practical method to avoid the complications of the integration with chemicals would be to control the principal pests on a crop by the simultaneous use of several natural enemies. The success of the first attempts at biological control on a commercial scale in England and Holland suggests that the technique could be extended. However, the commercial future depends on the development of economic and reliable rearing techniques to provide the required number of natural enemies. The effective utilization of biological control will demand more skill on the part of the grower but the rewards can be substantial. Yield increases of glasshouse cucumbers of at least 20%, amounting to $7200 per acre, have been reported where biological control was used (4). These yield increases are attributed partly to superior red spider mite control by the predatory mites as compared to chemical control and partly to the lack of phytotoxicity under a biological control program. The alternative chemical method, frequent applications of petroleum oils and acaracides causes plant damage. Integrated control of glasshouse cucumber pests is now practiced commercially. Similar benefits could occur in other glasshouse crops.

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PROPAGATION OF DAPHNE ODORA

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The most important aspect of *Daphne* propagation is the use of clean healthy stock plants. Spraying regularly with systemic fungicides and insecticides is essential. Also a regular fertilizing program is necessary. The fertilizer must contain trace elements.

Cuttings are taken from the 1st week in September (spring) to the 1st week in April (mid-autumn), using a very sharp knife or razor blade. I recommend a throw-away Stanley knife.

Soft cuttings taken are 1 to 3 cm in length not including leaves. As each cutting is taken it is submerged in a bucket of warm Benlate solution of recommended strength for up to 10 minutes. Cuttings are transferred to 10″ pot to drain where they may be left up to 24 hours.

The next step is to remove the bottom leaves carefully by pulling them off (*not* cutting off).

Cuttings are then placed in copper naphthenate-treated Victorian seedling boxes (flats) containing a mixture of 25% peat and 75% sand with 64 well-spaced cuttings to a box. They are watered in with 1/2 strength Benlate.

The boxes are placed under mist in an Igloo or poly house and are covered with a terylene net which has been previously dipped in copper naphthenate. The net is removed approximately 2 weeks later, depending on weather conditions. The net is removed on a cool day and replaced if the weather becomes too hot.

Mist is applied 10 seconds every 20 minutes and the Igloo temperature may reach 35°C.

Cuttings can be taken from young plants only 12 months old. This improves the plants and also gives a good source of extra cuttings. Of 12,000 cuttings taken, 10,500 were potted and 700 returned and potted later.