The commercial use of predators in biological control

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Summary

The use of carefully vetted biological control agents is now widely accepted as the most desirable means of controlling horticultural and agricultural pests. Future prospects are now good for cost/effective natural enemies. Specific markets need to be carefully researched. The effectiveness and acceptability of the current chemical controls and of likely future developments in chemicals and other methods must be considered.

Integration into horticultural crops requires that practical IPM programs must be devised. Less intensive growing environments – broadacre farming and pastures – will still require practical management guidelines in order to get the best results. The success of the project will depend on effective transmission of this information by the insect rearing company as well as the active support of Department of Agriculture research and extension personnel.

Mass production needs to be relatively easy, enabling the numbers needed for successful establishment to be delivered at an acceptable cost to the user. The level of environment control required and level of separation necessary between the predator and its prey will have great bearing on commercial viability. Demand throughout the year assists in efficient utilization of staff expertise, capital structures and equipment.

Introduction

The predatory mite, *Phytoseiulus persimilis* (Athias Henriot), predator of two spotted mite, *Tetranychus urticae* (Koch) was first commercially produced in Australia by Biocontrol Ltd in 1981. In 1987 Biocontrol Ltd restructured and Bio-Protection Pty Ltd was formed to carry on the predatory mite work and to investigate the commercial potential of other live biological control agents. Since this time, *Typhlodromus occidentalis* (Nesbit) another mite predator released into deciduous fruits by various government agencies during the 1970s and 1980s, has been reared for commercial release. In 1990, *Aphidius colemani* (Viereck) wasp parasitoid of green peach aphid, *Myzus persicae* (Sluzer), was reared and successfully released into peaches at Cobram, Victoria but commercial production has not yet commenced. A project, partly funded by H.R.D.C. to develop a pilot commercial production facility for *Trichogramma* spp. wasp parasitoid of *Heliothis* spp. is at present in progress.

What makes a biological control agent commercially viable?

Primarily, commercial insect rearing companies are interested in products that are practical to mass produce; cost/effective for the customer; profitable and for which there will be ongoing demand.

Laboratory culture procedures may provide the basis for commercial scale procedures but a considerable amount of evolution of expertise must occur before the operation can be profitable. Large scale facilities with complete environment control may be very costly and impractical. Fluctuations in the environment likely to be encountered in less elaborate facilities must be allowed for in the production cycle and needs to be incorporated in any assessment of commercial viability. In larger facilities the need for the isolation of predators or parasatoids from their hosts must be carefully addressed. Contamination can cause serious problems and recovery may take months. Considerable expertise and care is required in dealing with live organisms. Employees need to be dedicated, meticulous and prepared to put time in when the production process requires it no matter the time day or night, or day of week.

Similarly, biological agents for use in horticulture require special attention both by the mass rearing company and the user in order to be successfully integrated into management procedures. Guidelines for use must be practical and easy to follow. In this respect, releases into non-horticultural crops or crops where little if any chemicals are applied can be simpler than for horticultural crops. If effective and relatively safe chemicals are available for control measures, only a small proportion of horticulturists will embrace the biological alternative. Consequently, situations where chemical controls are too costly, too inefficient or too hazardous, provide the best opportunities for biological control agents.

If the natural enemy in mind is to be a short term or once off release, then the company undertaking the work would have to ensure that the level of profit is adequate to justify the necessary inputs. In Australia, where markets are generally small and widely dispersed, the question is always whether the market is big enough to support commercial production.

Natural enemies with good searching ability and mobility are particularly attractive and those with resistance to chemicals are useful. Persistence in the crop is desirable but not essential. Biological agents need to be assessed on a crop by crop and area by area basis as market niches exist for certain lines. This is illustrated below.

Phytoseiulus persimilis – predator of two spotted mite

Two spotted mite (TSM) the preferred host of *Phytoseiulus persimilis* is of major importance in many crops and of secondary importance in many more. *Phytoseiulus persimilis* is effective in a wide range of crops and climates, with production continuing throughout the year with a peak from October to February.

In some crops they are applied once per season – strawberries, field crops, blackcurrants, hops, while in nurseries occasional 'top ups' are necessary. In cut flowers regular inundative releases are becoming the norm among users of predatory mites

The all year demand has enabled an "Order as Required" system to evolve. *Phytoseiulus persimilis* is resistant to most fungicides and miticides and some insecticides, so integration is not difficult in many crops where chemical use is low to moderate. Where heavy chemical use is the norm, integration is very difficult.

Phytoseiulus persimilis usage has increased considerably in recent years due to the removal of some effective miticides from the market and the increasing resistance of TSM to the remaining miticides. The phytotoxic effects of some miticides is also a contributing factor.

Typhlodromus occidentalis – predator of two spotted mite

Typhlodromus occidentalis is well established in deciduous fruits in New South Wales and Victoria. Mites can be a serious pest in deciduous fruits and IPM is seen by most growers as a necessary practice for mite control in these States. *Typhlodromus occidentalis* is a relatively persistent predator with occasional 'top ups' required. It is resistant to most chemicals used in deciduous fruits and has enabled growers to reduce their dependence on miticides. Nevertheless, many orchardists have not yet released *Typhlodromus occidentalis*. The use of synthetic pyrethroids for control of dimple bug and thrips has been the main obstacle to its complete acceptance. As producers of *P. persimilis* it is relatively easy for us to include *Typhlodromus occidentalis* as the hosts are the same. Contract or advance ordering is necessary due to a short suitable application period (December/February) and the long lead up production time (six months) from a predator culture which needs to be carried through the winter.

Aphidius colemani – wasp parasitoid of a range of aphids

Peaches in the Goulburn Valley provide a potential market for this parasitoid. Most

growers in this area are now using pheromones for oriental fruit moth *Cydia molesta* (Busck.) control so the integration of this parasitoid is relatively easy. A preliminary trial in 1990 was very successful. At the first sign of aphids, parasitised aphid mummies were distributed in 1 ha of a 10 ha orchard (20,000 ha^{-1}). The parasitoids subsequently controlled the emerging aphid population and spread throughout the entire orchard. No insecticide spraying was required. Other orchardists in the district sprayed 2 – 3 times for aphids. Yearly applications may be necessary as only low numbers of parasitoids are able to survive over winter. Advance orders would be necessary.

Trichogramma spp. parasitoid of Heliothis spp.

Bio-Protection Pty Ltd has recently begun work toward a pilot production facility for *Trichogramma* as it is seen as potentially commercially attractive. Recent developments in Europe have shown that *Trichogramma* can be highly cost effective in broad acre crops. *Trichogramma*, being highly susceptible to chemicals will be unsuitable for many situations. Where *Heliothis* spp. is the major pest – cotton, sweet corn, etc– prospects are promising.

Light brown apple moth, *Epiphyas posvittana* (Walker) is also a host for *Trichogramma spp.* Pheromone treated peaches and eventually pheromone treated pome fruit are therefore seen as other market opportunities. It would be applied as inundative releases – 500,000 parasitised grain moth eggs *Sitatroga cerealella* per ha during pressure periods. Growers would order a program for the season in advance.

Each of the above products or potential products serves a number of specific niche markets each with its own peculiarities and requirements.

Commercial production of *Phytoseiulus persimilis*

P. persimilis dispatches are made weekly throughout Australia. Crops treated include cut flowers, strawberries and field vegetables, nurseries, orchards, blackcurrants, pawpaws and hops. The continuous demand through the year is helpful in maintaining commercial viability and in keeping a large colony of both TSM and *Phytoseiulus persimilis* through the winter, ready for rapid expansion in the spring.

Many growers now incorporate predators into their pest management program, so it is important to able to supply predators at the optimum time for release into the crop. Being able to fulfil the demands of reliable supply is clearly a prerequisite for the commercial success of *P. persimilis* being used in high value crops with low tolerances to mite damage.

Other factors which when taken together have encouraged more and more growers to utilize *Phytoseiulus persimilis* are noted below.

- Chemical resistance is a major consideration, particularly for orchardists and cut flower growers. Many growers have sustained serious losses due to an inability to control mites with chemicals. Likewise, the predators ability to hunt out its prey in dense foliage and in difficult to spray areas becomes even more attractive as chemicals loose their effectiveness.
- Phytotoxic effects of some miticides is a particular hazard for strawberry and ornamental growers.
- Increasing dislike of chemicals in general and of chemical spraying in particular. Greenhouse growers have become more conscious of chemicals in an enclosed environment and of the intensive handling of the product, such as in cut flowers.
- *Phytoseiulus persimilis* is resistant to most fungicides and miticides and a range of insecticides. This enables integration into a range of crops where chemical use is low to moderate. Without this capacity situations suitable for use would be limited.
- *Phytoseiulus persimilis*is a particularly voracious and effective predator with a high reproductive rate when supplied with ample food. This enables quick recovery after applications of 'partly hazardous' chemicals.
- In hot humid conditions *Phytoseiulus persimilis* multiples 10+ times per week and adult female kill or destroy over 20 TSM per day while laying about 50 eggs in their lifetime. Further, with a male/female ratio of 1:4 it is not surprising that *Phytoseiulus persimilis*is such an effective predator. Control with *Phytoseiulus persimilisis* is therefore frequently very impressive and clearly visible to the customers.
- Ease of application of predatory mites – no spray tanks to wash; no protective clothing required; no disruption to workers; no withholding periods.
- Information provided to users is comprehensive with likely questions clearly answered. IPM program for specific crops have been devised and videos are available. Customer back up by telephone and on farm visits have aided problem solving and improved the understanding of IPM principles.
- Improved production efficiency has enabled prices to increase by only 14% in 10 years. This has meant that areas that previously would not consider predators on economic grounds are now doing so (e.g., hops, field crops, orchards). Likewise, existing predatory mite users are using more *Phytoseiulus persimilis* as regular inundative releases and finding practice compares favourably to the costs of chemical control.

Production requirements

In order to meet grower demands of price, supply, quality and fast delivery, an efficient production system is essential. The predator cannot be stockpiled and has a transit life of five days. With a growing cycle of 5 – 7 weeks, (depending on temperature) and with demand for *Phytoseiulus persimilis* on a weekly basis, production must be well planned so that allowances are made for the peak demand periods.

The system is moulded around the biological attributes of the pest and predatory mites; the numbers required to be despatched each week; transit life and of the demands of delivery:

- *P. persimilis* feeds only on TSM or its close relatives. Soy beans which can tolerate high populations of TSM are grown in greenhouses. Soy beans also have slightly hairy leaves which enables them to be packed into containers without the leaves sticking together. Most of our facility (80%) is devoted to the rearing of TSM, as enormous numbers of TSM are required to satisfy the hunger of *Phytoseiulus persimilis*. At the time of introducing the predator to the mite infested plants, mite numbers (all life stages) may be in excess of 1000 per leaf (all life stages). At the time of despatch, predator numbers may be around 40 per leaf (all life stages) with only low numbers of TSM remaining.
- The length of each phase of this process needs to be adjusted according to seasonal changes. The reproductive rates of the pest and predator are affected differently by temperature and humidity. *Phytoseiulus persimilis's* reproductive rate decreases markedly at humidities lower than 50% while TSM's increases. *Phytoseiulus persimilis* prefers 25 – 33°C while TSM continues to thrive over 35°C.
- Controlled environment greenhouses enable an environment conducive to both pest and predator development at respective phases of the production process and enables this process to be timed in relation to optimum despatch days – Monday, Tuesday, Wednesday – enabling the package to reach its destination by the end of the week.
- Predators must be introduced to the TSM infested plants at an appropriate ratio in relation to the number of mites per leaf. Otherwise, at one extreme, the plants may be prematurely destroyed by the mites or at the other, predators may run out of food before the desirable despatch days.
- The resulting maximum achievable number of predators per leaf enables the despatch of a high number of predators in a relatively small package – 10,000+ predators (all life stages) in a cardboard tube 100 mm diameter by 300 mm long.
- Two million predators may be despatched in one week during peak season.