Managing Predator and Parasite Populations in Production Nurseries

INTRODUCTION

There are a growing number of production nursery businesses that are using predators and parasitoids as their main strategy to manage nursery pests. This can be achieved by using a combination of naturally occurring and commercially available predators and parasitoids, cultural management practices, pest scouting and selective use of pesticides. This approach can be very successful and produce high quality plants in an environmentally friendly manner and is often termed, Integrated Pest Management (IPM).

For many, moving away from a pesticide-based pest management approach can be difficult. There are many additional factors that must be taken into account and a learning process that often requires several years to become proficient. Furthermore, the use of predators and parasitoids does not produce the instant fix that comes with the successful use of a pesticide. However, the benefits associated with an IPM approach as the main method to manage pest populations include:

- Reduced health risks associated with applying pesticides
- Reduced dependence on pesticides, which are increasingly expensive
- Increased environmental stewardship; reduced environmental contamination
- Improved plant health, quality and production
- Reduced development of pesticide resistance (products are preserved for when they are really needed)

The predatory mite, Californicus, feeding on spider mites.

This factsheet will assist production nursery managers that would like to improve their use of predators and parasitoids, including information on their general biology, the types of pests that can be managed, details on how to preserve beneficials in production nurseries, and actions that lead to successful and unsuccessful use of these biocontrol agents.

GENERAL BIOLOGY OF BENEFICIALS

Many refer to ‘beneficials’ to include insect and mite predators, parasitoids and pollinators. Successful use of beneficial organisms requires some knowledge of their biology. Each species is slightly different, but all have certain environmental requirements to survive and kill pests, mainly temperature and humidity. Low or high temperatures can cause beneficial organisms to become inactive; more

extreme temperatures will cause them to die. For many beneficial species, optimal conditions are between about 15–30°C. While air temperature is used as a proxy, most organisms will move to cooler areas when it is very hot and may survive in deeply shaded areas of a plant, particularly if they are well hydrated. Some beneficials are susceptible to low humidity environments (i.e. less than about 50%RH), though nurseries that use overhead irrigation may not be limited by this factor.

PARASITOID VS PARASITE

All parasites feed on their host, either internally or externally. Most parasites will keep their host alive for most (or all) of their development. True parasites are parasitic during their entire lifecycle. Parasitoids are a specific type of parasite in which the larval stage is parasitic, but the adult is not. For insect parasitoids, eggs are laid in or on the host, the larva develops feeding on the host until it finishes developing and emerges as an adult. In most cases, parasitised insects stop feeding once they have been parasitised and die after the parasitoid finishes development. The adults of many parasitoids are also predators, feeding on prey for nourishment and hydration.

All beneficials require food and water. If there are no prey organisms on which to feed, some will feed on pollen or nectar to survive. Some species will become inactive and wait until prey become available, e.g. the predatory mite, Occidentalis. Other species will move in search of prey, sometimes covering a relatively large distance when the supply in the current area runs out, e.g. Persimilis.

It is important to understand how the beneficial organisms in your crop move. Some species only move short distances, e.g. most soil mites. Others can move a substantial distance, but only when foliage is touching the neighbouring plant, e.g. most foliar predatory mites. Most beneficial insects have stages that fly and can potentially move between cropping areas in search of their prey or suitable habitat. However, keep in mind that many small flying insects (most parasitoid wasps), will not fly when wind speeds are significant. In many instances, biological control is enhanced in protected cropping environments where the beneficials are somewhat contained within the structure.

Each species is a little bit different. Specific information for each commercially available beneficial species can be found on the product guide of the biological control agent producers' website. For other species that may not be commercially available, information can often be found online.

TABLE 1. BENEFICIAL SPECIES COMMERCIALLY AVAILABLE IN AUSTRALIA TO MANAGE NURSERY PESTS. LINKS TO ALL SUPPLIERS OF EACH PRODUCT ARE PROVIDED WITH SPECIFIC INFORMATION ON OPTIMAL APPLICATION.

PEST GROUP	BENEFICIALS COMMERCIALLY AVAILABLE
Aphids including green peach aphid, cotton aphid, potato aphid, foxglove aphid and others	Aphelinus, Aphidius colemani[1,2] including banker plants, A. ervi, Harmonia conformis, Coccinella transversalis and Hippodamia variegata
Caterpillars	Beneficial nematodes for cutworms and armyworms, Diadegma for cabbage moth, Ladybirds, green lacewing [2,4]
Selected scale insects including red scale	Aphytis melinus, A. lignanensis, Lindorus, Chilocorus
Mealybugs and some soft scales	Cryptolaemus, Lindorus
Scarab beetle larvae and selected other beetles	Beneficial nematodes
Spider mites	Californicus[1,2], Occidentalis, Persimilis[1,2,3]
Broad mite	Californicus[1,2], Cucumeris[1,2,3], Doreenae, Montdorensis[1,2]
Fungus gnats	Dalotia, Hypoaspis[1,2,3], H. aculeifer, Gnatnem
Thrips pupae (in growing media)	Dalotia, Hypoaspis[1,2,3], H. aculeifer
Thrips larvae and adults (on foliage)	Cucumeris[1,2,3], Montdorensis[1,2], Orius[1,2] and banker plants, Javae, Lailae
Whitefly	Encarsia, Eretmocerus hayati[1,2], E. warrae, Orius[1,2] and banker plants, Montdorensis[1,2], Lailae
Generalist predators feeding on a range of pests often including aphids, whiteflies, mealybugs, scales, thrips, mites, moth eggs, small caterpillars, other small larvae, etc	Ladybirds, green lacewing[2,4]

Where multiple biological control agent producers supply the same species they are indicated by a superscript number that links you to the relevant supplier of that product:

1 Biological Services
2 Bugs for Bugs
3 Bio Works
4 BioResources

WHAT PESTS CAN BE MANAGED USING BIOLOGICAL CONTROL?

There is a large and growing number of pests that can be managed using commercially available biological control agents, including spider mites, fungus gnats, aphids, caterpillars, thrips, whitefly scale insects, mealybugs and various other insects. Research by Australian biological control agent producers continue to increase the number of predators available to manage major pests, e.g. the

predatory mites Doreenae for broad mites and rust mites and Javae for greenhouse thrips (both being developed through Biological Services).

It is important to understand that many predators and parasitoids are specific to certain pests. Therefore you may need to seek advice on the identification of the pest species to select the correct biocontrol agent. Specific recommendations on the use of particular products against nursery pests can be found in many pest management plans.

WHERE DO BENEFICIALS COME FROM?

Beneficials that can be found in production nurseries have a number of sources. They can fly or be blown into the nursery from the surrounding landscape. Many of these will feed on a wide range of prey species and will never be commercially available for mass release, e.g. spiders, assassin bugs, bdellid mites and many others. The species present will be strongly influenced by the type of landscape around your nursery (e.g. flowering garden plants or native habitats). Beneficials may be brought into your nursery on incoming stock, depending upon the extent that the supplier applies pesticides that are detrimental to beneficials. Beneficials can also be purchased and released from biocontrol agent producers (Table 1).

The prevalence of weeds in and around your business will also influence populations of beneficials. Weeds tend to harbour many pests (on which beneficials feed and develop), which is why they can sometimes increase numbers of beneficials. Unfortunately, weeds tend to produce more pests than beneficials and are pests themselves. They can also harbour plant diseases such as viruses. Therefore, it is always recommended to remove weeds as they cause more harm than good in a production nursery setting.

Stethorus are small beetles (1–2mm long) that feed on spider mites that may occur naturally in production nurseries.

BENEFICIAL NEMATODES

Some nematodes infect, feed, reproduce and kill insects. These beneficial nematodes have often been referred to as insect eating nematodes or entomopathogenic nematodes. They move in water films through growing media and can be applied through irrigation lines (where filters and stops have been removed). They enter insects through small openings on their abdomen and cause them to stop feeding. The infected pest will eventually rupture and release tens of thousands of infective juvenile nematodes. Beneficial nematodes are negatively impacted by some pesticides. They are available for use against a wide range of pests, some of which are relevant to the production nursery industry (Table 1). It is recommended to contact Ecogrow prior to using these products for the first time.

METHODS TO PRESERVE AND ENCOURAGE BENEFICIAL POPULATIONS

As indicated above, beneficials have a number of requirements to survive and flourish. These include a food supply, correct environmental conditions and places to hide and rest. When there are sufficient pests in the crop, beneficials can flourish and grow to large numbers. However, when pests decrease in number it can be valuable to have alternative food sources nearby. Flowering plants present either in the growing area and in non-growing areas can provide places to rest and sources of pollen and nectar.

Cryptolaemus larva feeding on mealybugs. These larvae can be confused with mealybugs.

ALTERNATIVE FOOD SOURCES

The plant species used as alternative food sources can be important and will need to be altered depending on the geographic area of your business, the main pests at your business and the plant lines that you produce. Some commonly used species that are often used are those plants with small flowers that are present for extended periods, e.g. buck wheat, alyssum, Asteraceae flowers, with compact heads are excellent places for small beneficials to rest, hide and consume nectar and pollen if required. When using alternative food plants in non-cropping areas it is recommended to:

- Evaluate the use of different plant species that are suited to your climatic region and season that produce pollen or nectar; monitor the species of insects and mites present over time. Preferentially choose plant species that have more beneficials and fewer pests.
- Grow plants in large containers or raised beds that can be easily removed if they become infested with pests or diseases. It is not recommended to grow large shrubs or trees as permanent plants in garden beds for this purpose.
- Make a plan for your nursery for the types of plants that are effective in each season.
- Monitor the plants on a regular basis as part of normal scouting through the nursery. Some plants may be effective sentinel plants for initial pest populations and increase beneficial populations throughout the nursery.
- Replace alternative food plants periodically, especially if it is a plant that is also grown as a crop line. This will help prevent situations where the food-plants become infected with pests and diseases that spread into the nursery.

BANKER PLANTS

There are a growing number of production nursery businesses that are using banker plants to rear specific pest species to support beneficial insect populations. As a result beneficial species increase, crop pests decrease and the pests provided in the banker plants do not effect crop plants. The host and pest species is carefully chosen. For example, one of the more common systems involves the use of barley or wheat to grow the aphid pest, *Rhopalosiphum padi* a pest of grain crops (and some grass species). This species is a good host for the parasitoid wasp, *Aphidius colemani*, which also controls the very common and highly polyphagous pests, green peach aphid and cotton aphid. As a result, growers can produce large numbers of aphid parasitoids at an economical rate on an ongoing basis. This system is relatively inexpensive and safe to use in many production nurseries (except perhaps where grass species susceptible to *R. padi* are grown). It is recommended to consult your biocontrol agent producer when setting up this system.

EFFECT OF PESTICIDES ON BENEFICIALS

Many pesticides are highly toxic to most beneficial species. In fact, sometimes even slight residues can cause high death rates on beneficial populations weeks (or even months) after application. In addition, some products can cause non-lethal side effects to beneficials, i.e. the beneficial remains alive but is impacted in other ways. This may include one or more of the following:

- It may not live as long.
- It may not lay as many eggs.
- It may not kill as many prey.
- It may not be as energetic or move around as often perhaps influencing its ability to survive harsh environmental conditions, escape predation etc.

Each beneficial has slightly different tolerances and susceptibilities to different pesticides. Even IPM compatible products may cause non-lethal deleterious effects in certain cases. The above negative impacts will be greater with more frequent pesticide applications. In addition, the negative impacts will be greater with increased concentration of the applied product.

Note that fungicides and other products applied to foliage can also negatively impact beneficial populations. A great deal of research is available online on the side effects of pesticides on biological control agents. Toxicity information is available through your local suppliers, mobile apps and online, e.g. those produced by Koppert and Biobest.

ACTIONS TO AVOID NEGATIVE PESTICIDE SIDE EFFECTS

As stated above, pesticides can negatively impact beneficial species. The following recommendations will minimise the amount of damage imposed on beneficial insect populations:

- Put in place as many cultural management actions as possible to prevent pest populations
- Monitor your crops regularly (preferably at least weekly) for pests, diseases and beneficial insects
- Only apply pesticides when pests are present and in numbers that will cause damage

- Spot spray pesticides in hot spot areas
- Avoid application of broad spectrum and highly residual products. In particular, older compounds tend to have greater negative effects including many compounds from the following groups (note that there are exceptions, e.g. the active pirimicarb is a relatively safe aphidicide even though it is a carbamate compound):
  - Carbamates (1A)
  - Organophosphates (1B)
  - Fiproles (2B)
  - Pyrethroids (3A)
  - Neonicotinoids (4A)
- The negative effects of pesticides tend to be greater within protected cropping structures. Therefore, if highly residual and broad spectrum products must be used, avoid using them within protected cropping structures.
- When product labels give a range of application rates against certain pests, e.g. 2–4mL/L, use the minimum rate to achieve a successful application. Higher rates of application produce greater negative side-effects. Therefore, use your experience or small trials to determine the lowest application rate possible to successfully kill pests that are present.

Predatory mites being released to control spidermites. Photo by Bugs for Bugs.

USING BIOCONTROL TO MANAGE PESTS IN PRODUCTION NURSERIES

Applying beneficial species to manage pests can be very successful. However, there is a lot more information required to do it well compared to reliance on pesticides to manage pests. If you are considering using this approach, it is important to develop a strong relationship with your biocontrol agent supplier/s and or a consultant experienced with using biocontrol in a production nursery setting. This will help avoid failures leading to the opinion that it does not work.

It can be tempting to start using biocontrol in a small area of your nursery before rolling it out everywhere. However, this can cause problems with pesticide residues and contaminated irrigation water reducing the efficacy of beneficials in that small area. In other words, any pesticides used on or around the property can reduce the efficacy of beneficials in other areas of the nursery.

You may also benefit from choosing to start with a crop and pest that is relatively easy to manage using beneficials and that is attacked by only a small number of pests. For example, spider mites are relatively easy to monitor and manage on a wide range of nursery crops using persimilis and other predators (Table 1).

It is important to realise that biocontrol will not work in every situation. For example, when growing conditions are very hot or cold, biocontrol agents may not be effective. If massive outbreaks of a pest occur biocontrol is unlikely to be successful. Low risk pesticides are recommended during periods where biocontrol is not suited to manage the problem. Then, when conditions are more suitable, biocontrol agents can become established more easily.

If you are considering using biocontrol to manage pests there are three areas that are absolutely critical.

1. Crop monitoring must become the foundation on which pest management actions are built. It must be scheduled into your daily/weekly plan. If crop monitoring does not occur, pests will increase and you are likely to end up with an outbreak situation that causes crop loss.
2. Improve cultural strategies to prevent pests and diseases from entering the nursery. Employ as many cultural practices as possible and always be thinking about ways to increase hygiene practices. Complete small-scale trials to test your ideas and make continual improvements.

3. It is very important to have no pesticide residues present. Where water is recycled irrigation water can become contaminated and may negatively impact beneficials when reapplied to crops.

SUMMARY

Beneficial organisms as part of an IPM program can be used successfully to manage pests in production nurseries. Using them well can result in improvements in crop health and production and has environmental and health benefits. This approach relies on monitoring crop health and using cultural practices to limit pests in the nursery. Pesticides will still be part of your IPM program, however, their use will be more targeted. Biocontrol agents are available for many pest groups across much of Australia and are effective. There is a great deal of support available in Australia for businesses to adopt IPM, including from crop consultants, biocontrol agent producers and literature specifically written for Australian production nurseries. Take advantage of these resources.

FURTHER READING

- Australian Biocontrol agent producers (Biological Services, BioWorks, Bugs for Bugs, Ecogrow) have a great deal of information on their products.
- Australian production nursery factsheets, management plans and webinars on pests and diseases. These include information on cultural practices and pesticide side effects
- Insecticide mode of action and resistance management nursery paper

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