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Kellogg Rural Leaders Programme 2009

Teacher and Student Resource for Integrated Pest Management in Protected Crops in New Zealand

Katherine Anne Williams
Kellogg Rural Leaders Programme 2009
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Introduction: IPM in NZ Protected Crops.

With my industry experience in the last 3 years I have found there is a large void of information available to both Teachers and Students when it comes to the topic of Integrated Pest Management (IPM) within the New Zealand Horticulture Sector.

Protected crops are considered to be those grown in a hothouse situation for example Glasshouse or Plastic House production.

These situations usually have control over temperature through heating and venting, as well as basic humidity control.

What is Integrated Pest Management

Integrated Pest Management (IPM) is an effective, environment-sensitively-sound approach to the management of pest organisms. IPM programmes have been developed for many horticultural and agricultural crops, and excellent programmes have been developed for greenhouse crops.

IPM relies on knowledge of the life cycles and habits of pests, and the naturally occurring factors that regulate their populations, such as environmental factors and natural enemies. Knowledge of how a pest reproduces, overwinters, disperses and how it causes damage is also essential for the development of IPM programmes.

A cornerstone of many IPM programmes is pest threshold levels which act as a trigger for the introduction of control methods. Only when pest is about to exceed a threshold, is a control application made. Some pest thresholds are based on economic considerations.

IPM programmes recognise that no two crops or properties have identical conditions, and that IPM programmes must be matched to the specific situation of each management unit. This often requires the assistance of crop management advisers and IPM scouts to identify and develop the most effect IPM programme.

IPM programmes are often part of a much wider integrated crop management (ICM) programme, which recognise that crop management practices such as nutrient and irrigation inputs, environmental conditions and other crop management practices may have an important effect on pests.
IPM programmes have five basic components:

Pest identification: It is essential to identify accurately all the pest organisms found on a crop. This is especially important when biological control agents are to be used, because biological control agents are often quite specific as to the pest(s) they attack.

Pest population assessment and monitoring: Pest populations fluctuate over time, and it is only when they begin to reach damaging levels that control action is warranted. Regular monitoring of the crop and environment can assist in determining when a pest is nearing damaging levels. Monitoring generally involves a combination of visual crop inspection, the use of insect traps or crop sampling and record keeping.

Pest threshold levels: The point at which economic damage is likely to occur is often called the ‘action threshold’. Some controls like pesticides can be used very close to the action threshold, while others like biological control must be introduced well before a pest reaches the action threshold. Reliable thresholds have not been developed for all pests, so advice from a crop or pest management consultant may be needed.

Preventing pest problems: Most pests are opportunists and exploit favourable conditions. By making conditions unfavourable for pests, for example, through the selection of pest resistant cultivars, maintenance of suitable environmental conditions and sound crop hygiene practices, can contribute to the reduction of pest problems.

Integration of control methods: Most pests can be managed by a combination of chemical and non-chemical control methods. For integrated pest management, these control methods must be compatible, i.e., not disrupt each other when they are used together. The combined effect of two or more control measures is often greater than that of a single method in the longer term. The order in which control methods are used and their timing in respect of the pest’s life cycle is also important. As biological control agents are susceptible to many pesticides, it is essential to determine what chemicals may be integrated into your IPM programme (see ‘Impact of Pesticides on Beneficial Insects and mites’).

Ref. Bioforce website (created by Anne Williams)

Why Is Integrated Pest Management Important?

Growing consumer awareness is pushing for Integrated Pest Management to become a required growing practice when producing a consumable food product. In the European Union IPM is to become a compulsory growing practice by 2015. It is hoped that New Zealand would follow suit in the foreseeable future.
Consumer awareness in New Zealand is pushing the food production of horticulture into becoming a safer and more sustainable area for many reasons, namely for consumer health safety, environmental impact and better growing practices.

My aim:

With my experience I have found either Teachers have no resources supplied to them or they are delivering out of date information in this area of study. I find this is not acceptable in this day of age because this is such a vital part of production horticulture which will have a great impact in years to come.

This is because of Consumer awareness – consumers not wanting deadly chemicals sprayed onto their food crops, and the fact that many chemical combinations just are not effective at controlling the pests and diseases like when they were first on the market – and this is only going to get worse in the short term!

With this project I aim to create a well rounded resource able to be used in a classroom teaching environment to help Horticulture/Agriculture students understand the principles and uses of IPM.

I aim to supply a useful and informative teaching tool to them so these principles are able to be understood to how vital IPM is for future of New Zealand Horticulture Hothouse food production.

With the following document I am hoping to spark an interest within the up and coming Horticulturalists and introduce them to a new practice that will benefit everyone in the long term.

Protected Crops:

This resource is based around protected crops in New Zealand; this is due to the unlimited scope of Horticulture production in our country.
What are Protected Crops?

This information paper is specific to the Protected Cropping situation in New Zealand (namely Hothouse fruit, vegetable, plant and flower production); this is able to be modified to suit a wider audience at it becomes necessary.

Protected crops is described as Glasshouse and Plastic House production of a variety of crops, from vegetables, fruit, cut flowers, plant to nursery production and everything else in between. E.g. generally these environments have the ability to control the environmental conditions (temperature and humidity) to an extent.

The beneficial insects mentioned are suitable for this situation, though most are also able to be used in the outdoor situation as the outside conditions and average temperature permits.

For more information on this contact myself on the above details.

The Future of IPM

Integrated Pest Management is going to be one of the leading ways of the future due to consumer demand and because chemical control is no longer fully efficient.

The European Union (EU) is to set a new initiative advising that IPM must be used as part of good growing practices. The wording of several of the documents and media releases is below and as follows:

ENDURE's definition of IPM

For ENDURE Integrated Pest Management (IPM) creates synergies by integrating complementary methods drawing from a diverse array of approaches that include biocontrol agents, plant genetics, cultural and mechanical methods, biotechnologies, and information technologies, together with
some pesticides that are still needed to address the most problematic pests and face critical situations.

Importantly, such a diversity of solutions is also needed for sustainability purposes: the continuous use of a single method to control a given pest, be it the most favourable solution initially, will rapidly induce pest populations to evolve and overcome this method, whether a chemical one or not.

ENDURE sees IPM as a continuously improving process in which innovative solutions are integrated and locally adapted as they emerge and contribute to reducing reliance on pesticides in agricultural systems. To face the rapid decrease in chemical options, very significant efforts are urgently needed to increase the range of effective and affordable solutions. This requires a coordinated plan to:

- **Encourage** public and private research on new crop protection technologies and facilitate the regulatory conditions for their availability on the market.

- **Support** multidisciplinary research on whole systems - an emerging field - as a way to design truly innovative IPM strategies.

- **Develop** information, education and recognition of these integrated strategies for the benefit of farmers, advisers and other actors in the food chain, including the general public.

- **Maintain** a momentum at the European level to create synergies from national efforts.

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**Public Release of IPM Plan January 22, 2009**

“Action needed to speed IPM development “

ENDURE is calling for sustained and determined action to promote the design and introduction of new solutions to help develop integrated pest management (IPM) schemes that contribute to sustainable development while keeping European agriculture competitive.

Public and private research needs to be encouraged. Copyright: Christophe Maitre, INRA Bordeaux, France.

The call, from ENDURE’s Executive Committee, is in response to the European Union’s strict stance on pesticides. This took a further step forward in January with the passing of legislation on a framework directive on the sustainable use of pesticides and a regulation dealing with the production and licensing of plant protection products (see news story Pesticide regulations get the green light for more details and reactions).

When the legislation package comes into force, Member States will face the challenge of introducing workable crop protection strategies that satisfy the framework directive with a narrower range of pesticides because of the regulation (some 60% of pesticides have already been withdrawn from the
European market over the past 10 years). The problems of managing pesticide resistance and protecting minor crops will be two particularly difficult areas.

However, the authors note, "...the challenge must become an opportunity to develop a diversity of methods and strategies as alternatives to single-solution chemically based crop protection. An in-depth reconsideration of crop protection solutions in European agriculture cannot be avoided."

The continuous use of a single method - chemical or not - will rapidly induce pest populations to evolve and overcome the method. Copyright: Jean-Marie Bossennec, INRA Paris, France.

ENDURE's research programme includes studies on the main pest, disease and weed problems affecting the arable, perennial and protected crops responsible for the highest use of pesticides across Europe. And its results already show there is significant potential to reduce pesticide risks by using new technologies, to reduce pesticide use by using alternative methods and to reduce reliance on pesticides by improving cropping systems and establishing healthy crops less vulnerable to pests. These studies also show that only a fraction of these solutions are currently available to farmers and advisors.

ENDURE is committed to providing science-based support for the implementation of the framework directive, particularly the introduction of IPM which will be compulsory across the EU by 2014. For ENDURE, IPM is a continuously improving process drawing on a wide range of approaches, including biocontrol agents, plant genetics, cultural and mechanical methods, biotechnologies and information technologies, together with some pesticides that are still needed to address the most problematic pests and in critical situations.

This diversity of solutions is the only way to ensure crop protection remains sustainable, notes ENDURE; the continuous use of a single method to control a given pest, even if it works initially, will rapidly induce pest populations to evolve and overcome this method, whether it is a chemical one or not.

Faced with the rapid decrease in chemical options, says ENDURE, major efforts are urgently needed to increase the range of effective and affordable solutions. This requires a coordinated plan to:

Encourage public and private research on new crop protection technologies and facilitate the regulatory conditions for their availability on the market

Support multidisciplinary research on whole systems - an emerging field - as a way to design truly innovative IPM strategies

Develop information, education and recognition of these integrated strategies for the benefit of farmers, advisers and other actors in the food chain, including the general public

Maintain a momentum at the European level to create synergies from national efforts.

Source: endure-network.eu
ENDURES Effect on New Zealand

It is widely thought within the industry that this a cutting edge document that is going to increase the need of IPM as a whole. It is thought that a similar document will become part of New Zealand's requirements in the future, not necessarily the short term.

It is important to growers that a sustainable and effective IPM system is able to be put in place and be successful before this sort of policy can be introduced in New Zealand.

It is these leading edge growers already adapting these IPM good growing practices within the Hothouse Industry, taking the initiative.

Many more growers are going to need to adopt growing practices that mean there operation will need to become more self sustainable, knowledge is going to be the key of making this a successful transition.
Conclusion:

Integrated Pest Management is the way of the future for Protected Cropping within New Zealand, not necessarily in the short term but definitely sometime in the foreseeable future.

This is because chemical resistance is now a big issue in the industry and because consumer awareness is pushing for these practices to take place.

I feel I have given a well rounded summary of IPM which should be of great use in the Horticulture and Agriculture curriculum at High Schools, Polytechnics and Universities as well as private training organisations.

I urge teachers to use this up to date information and provide a well rounded insight into the future of our industries, and adapt the methods as new criteria is bought into practice.
Student Resource for Integrated Pest Management in Protected Crops in New Zealand
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Mission Statement:

Bioforce breeds and sells beneficial insects for the sustainable, non-chemical control of many common horticultural pests.

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IPM programmes recognise that no two crops or properties have identical conditions, and that IPM programmes must be matched to the specific situation of each management unit. This often requires the assistance of crop management advisers and IPM scouts to identify and develop the most effect IPM programme. BioForce Ltd can assist you in setting up your IPM programme.
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For more information on this contact myself on the above details.
Enforce™  
*Encarsia formosa* – Parasitic wasp

**Pack Size:**
Small tag: 100 adult *Encarsia formosa* will emerge  
Maxi tag: 250 adult *Encarsia formosa* will emerge

**Target:**
Glasshouse whitefly (*Trialeurodes vaporariorum*) and tobacco whitefly (*Bemisia tabaci*) in the third and fourth larval stage.  
Preference is for glasshouse whitefly.

**Introduction:**
Open package carefully inside the greenhouse  
Tags generally come in strips of 10, bend then tear off to separate. Start tearing opposite hang-up hole  
Suspend the cards in the crop 75 cm under plant head, out of direct sunlight  
Do not touch the black pupae attached to the card

**Environmental Conditions:**
The 24 hour average temperature in the greenhouse should be at least 17°C

**Storage and Handling:**
Storage after receipt: maximum 1-2 days  
Storage temperature: 8-10°C in the dark

**Remarks:**
The black (empty) pupae remain on the card after hatching  
Intensive deleafing (in tomatoes) hinders the population build up of whitefly parasites
Appearance and General Information

Female adults: size ± 0.6 mm, black head, black thorax, yellow abdomen.

Males are of same size but completely black

Other stages: develop inside host

- Development time from egg to adult is 27 days at 20°C
- 98 to 99% female population, females don’t need to mate to reproduce
- Female can lay up to 60 eggs in her 12 day adult lifespan at 25°C degrees.
- Encarsia adults eats whitefly scale (host feeding), eats 3 scale per day, 1 adult female therefore can kill 96 whitefly in her adult lifespan
- Exact origin is unknown, first discovered in 1926 in England, mass produced since 1976.

Release Rates: Number of adults per m² of crop to be treated.

<table>
<thead>
<tr>
<th>Infestation</th>
<th>Cucumbers</th>
<th>Ornamentals</th>
<th>Tomatoes</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventative</td>
<td>2-6</td>
<td>1-3</td>
<td>1-3</td>
<td>1-3</td>
</tr>
<tr>
<td>Light</td>
<td>6-12</td>
<td>3-6</td>
<td>3-6</td>
<td>3-6</td>
</tr>
<tr>
<td>Heavy</td>
<td>12+</td>
<td>9+</td>
<td>9+</td>
<td>9+</td>
</tr>
</tbody>
</table>

Mode of Action

Female adult parasitic wasp parasitizes the larva of the whitefly.

Host feeding takes place at a rate of 3 whitefly 2\textsuperscript{nd} to 4\textsuperscript{th} instar scale per day.

Visual Effect:

After 2-3 weeks (temperature dependant), the first parasitised pupae can be seen in the crop. Parasitised pupae of whitefly (*Trialeurodes vaporariorum*) turn black.

The adult parasitic wasp emerges from the pupa through a round hole, the pupa stays attached to the card or leaf once adult has emerged, an eye lens is required to see if this has taken place.
Mite-E™

*Phytoseiulus persimilis* – Predatory mite

**Pack Size:** 250 ml bottle containing at least 1000 Mite E.

**Contains:** 1000 mites of mixed life stages in a vermiculite carrier.

**Target:**

Two spotted spider mite (*Tetranychus urticae*). All stages, preferring younger stages. The predatory mite can only survive on two spotted spider mites (*Tetranychus spp.*). If no two-spotted spider mites are available they will cannibalise on each other.

**Introduction:**

Turn and shake the bottle gently before use

Sprinkle contents of the bottle on leaves, focusing on known “hot-spots” first but also dispersing throughout whole crop.

**Environmental Conditions:**

Relative humidity should be greater than 75% and the temperature above 20°C for some hours of the day.

**Storage and Handling:**

Storage after receipt: 1-2 days

Storage temperature: 8-10°C in the dark (bottle horizontally)

**Appearance:**

- Adults: bright red, very active, spherical, stands high on its legs
- Eggs: oblong, first pink and transparent, later on darker, twice as big as spider mite eggs
- Larvae/nymphs: pale to light red
Release Rates: General

Indoor crops: 1000 mites per 250m²

Outdoor crops: 1000 mites per 350m²

Mode of Action

Adult predatory mites and nymphs search actively for their prey and suck them dry.

Without fertilization the female cannot lay eggs. At 20°C (68°F) she deposits about 54 eggs during 22 days, but this can mount up to 75 eggs.

Development time from egg to adult is 7 days at 20°C.

Mite E can eat up to 20 spider mite eggs or larvae, 13 protonymphs or 5 adults per day.

Originates from Chile.

Visual Effect:

Adult red spider mites that have been eaten change colour from pale green to black and can be identified as tiny black dots on the leaves. This should not be confused with living, light-brown to dark-red spider mites. This happens when the temperature is lower.
Aphidius

*Aphidius colemani* – Parasitic wasp

**Pack Size:** 100 mummies in Petri dish

**Contains:** Parasitised aphids (mummies) and some hatched adults.

**Target:**

Aphids, in particular the cotton aphid *Aphis gossypii*, green peach aphid *Myzus persicae* and the peach potato aphid *Aulacorthum solani*.

Use Aphidius at first sign of aphids for best results

**Introduction:**

Spread material on rockwool or disperse throughout the crop in petri dishes (or similar), ensure the material remains dry and at its introduction site for a few days

**Environmental Conditions:**

Efficacy reduces at high temperatures (greater than 30°C).

**Storage and Handling:**

Storage after receipt: 1-2 days

Storage temperature: 8-10°C in the dark

**Appearance:**

- Adults: black, 3mm long
- Other stages: develop inside host

**Release Rates:**
Moderate Infestation: 100 Aphidius mummies per 200m², adjust according to aphid pressure.

**Mode of Action:**
Female adult parasitic wasp parasitizes the aphids (lays her egg which kills the host), killing it over several days.

- Females have to mate to produce eggs; sex ratio is female 2:1.
- Development time from egg to adult is 13 days at 20°C
- *Aphidius colemani* can lay up to 300 eggs in her 10 day adult lifespan (18-22°C).

**Visual Effect:**
Parasitised aphid swells and hardens into a leathery, grey or brown coloured mummy. The adult parasitic wasp emerges through a round hole at the rear of the mummy. The first mummies can be seen in the crop approximately 2 weeks after the first introduction.
HYPO-MITE™

*Hypoaspis aculeifer* – Predatory mite

**Pack Size:**
- 1,000 ml cardboard tube
- Bulk volumes of up to 10 litres per bag.

**Contains:** 10,000 predatory mites per litre (all stages) in peat base with some vermiculite.

**Target:**
- Eggs, larvae and pupae of Fungus gnats (Shore and Sciarid flies),
- Juvenile thrips whilst pupating in the soil.

**Introduction:**
Turn and shake the tube or bag gently before use
Spread material evenly on soil or rockwool blocks
Do not apply in too close to stem (to prevent plant damage by the food mites)

**Environmental Conditions:**
Soil must be moist but not too wet, have an open structure and minimum temperature of 15°C

**Storage and Handling:**
Storage after receipt: 1-2 days
Storage temperature: 10-15°C in the dark (bottle horizontally)

**Remarks:**
Always apply HYPO MITE to the soil surface, not on the plant. Test on small scale prior to application in crops where this mite has not been used before.

Appearance:

- Adults: size to 1 mm, brown
- Larvae/first nymphal stage: white

Release Rates:

1 litre of media per 200m², adjust according to pest pressure, spread evenly throughout the crop.

Mode of Action:

Adults and nymphs feed on larvae of sciarid flies and other soil living insects.

Visual Effect:

The mites can be observed in and on the soil and at the base of plant stems. *Hypoaspis aculeifer* seldom occurs on the plants. Slow but steady reduction of the infestation level of sciarids/bulb mites will take place.
**Mite-A™**  
*Amblyseius cucumeris – Predatory mite*

**Pack Size options:**
- 1,000 ml tube
- bulk of up to 15 litres per bag
- breeder sachets containing 200 Mite A of various stages (minimum order applies)

**Contains:** 10,000 mites per litre of mix and mould mites (for food during transport) in a bran carrier.

**Target:**
- Various thrips species. Hatching eggs and the first larval stage Mite A can also eat
- Spider mites
- Honeydew
- Pollen.

**Introduction:**
Turn and shake gently before use
Sprinkle material on leaves, 2.5 ml per plant

**Environmental Conditions:**
Relative humidity should be above 75% and the temperature above 20°C for some hours of the day. MITE A contains a strain of *Amblyseius cucumeris* which is not susceptible to diapause. Therefore the predators can be used all year.

**Storage and Handling:**
Storage after receipt: 1-2 days
Storage temperature: 10-15°C in the dark (tubes horizontally)

Remarks:

The product MITE A contains mould mites (Tyrophagus putrescentiae) for food during transit and establishment in the crop, small field test is recommended to test sensitivity on crops or varieties not having used this product before.

Used commercially since 1985.

Release Rates:

1 litre of media per 200m², adjust according to pest pressure. Spread evenly throughout the crop.

Appearance:

Mobile stages: beige-pink, droplet shaped, 'pushed down' position on short legs, often at hidden places like along veins and in the flowers.

0.4mm long, very difficult to see in a crop.

Eggs: transparent white, attached to leaf hairs along veins on the underside of leaves

Mode of Action:

• Adult predatory mites search actively for their prey and suck it dry.
• Mating is essential for egg laying to take place. Females lay approximately 35 eggs in her lifetime.
• Development time from egg to adult is 11 days at 20°C. Adults live for up to 22 days.
• Mite A will consume 1-3 thrips per day, generally of an immature stage.
Glossary of terms

Diapause: A physiological state of dormancy with very specific triggering and releasing conditions. It is used as a means to survive predictable, unfavourable environmental conditions, such as temperature extremes, drought or reduced food availability. Source: Wikipedia

Honeydew: A sweet sticky substance excreted by various insects, especially aphids, on the leaves of plants. Source: Answers.com

Larvae: Juvenile from of animal with indirect development, undergoing metamorphosis (for example, insects or frogs). The larva can look completely different from the adult form. Source: Webster’s Dictionary

Mite: Any of numerous very small to minute arachnids often infesting animals or plants or stored foods. Source: Webster’s Dictionary

Mumme (Aphidius): The hardened body used as a host by the Aphidius wasp to undergo metamorphosis.

Nymph: The immature stage in the life cycle of those orders of insects characterized by gradual metamorphosis. Source: Webster’s Dictionary

Parasitoid: The host is usually killed after the full development of the other organism. This type of relationship only occurs in organisms that have fast reproduction rates (like insects or mites). Source: Webster’s Dictionary

Parasitize/Parasitised: A parasite that ultimately destroys its host, as any of various wasp larvae which feed progressively on the tissues of an immature stage of a host species. Source: Webster’s Dictionary

Pollen: A fine powder produced by the anthers of seed-bearing plants; fine grains contain male gametes. Source: Webster’s Dictionary

Predator: Any animal that lives by preying on other animals. Source: Webster’s Dictionary

Pupae: A pupa (plural: pupae or pupas) is the life stage of some insects undergoing transformation. The pupal stage only occurs in insect that undergo a complete metamorphosis. It follows the larval stage and precedes adulthood. Source: Webster’s Dictionary

Sciarid fly: Minute blackish gregarious flies particularly destructive to mushrooms and young seedlings. Source: Webster’s Dictionary

Thrip: Any of various small to minute sucking insects with narrow feathery wings if any; they feed on plant sap and many are destructive. Source: Webster’s Dictionary

Two spotted mite: Extremely small, barely visible with the naked eye as reddish or greenish spots on leaves and stems; the adults measure about 0.5 mm. Source: Wikipedia

Whitefly: Minute insect that feeds on plant juices. Source: Webster’s Dictionary
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Integrated Pest Management (IPM) is an effective, environmentally-sensitive and economically-sound approach to the management of pest organisms. IPM programmes have been developed for many horticultural and agricultural crops, and excellent programmes have been developed for greenhouse crops.

IPM relies on knowledge of the life cycles and habits of pests, and the naturally occurring factors that regulate their populations, such as environmental factors and natural enemies. Knowledge of how a pest reproduces, overwinters, disperses and how it causes damage is also essential for the development of IPM programmes.

A cornerstone of many IPM programmes is pest threshold levels which act as a trigger for the introduction of control methods. Only when pest is about to exceed a threshold is a control application made. Some pest thresholds are based on economic considerations.

IPM programmes recognise that no two crops or properties have identical conditions, and that IPM programmes must be matched to the specific situation of each management unit. This often requires the assistance of crop management advisers and IPM scouts to identify and develop the most effect IPM programme. BioForce Ltd can assist you in setting up your IPM programme.

IPM programmes are often part of a much wider integrated crop management (ICM) programme, which recognise that crop management practices such as nutrient and irrigation inputs, environmental conditions and other crop management practices may have an important effect on pests.

IPM programmes have five basic components:

Pest identification: It is essential to identify accurately all the pest organisms found on a crop. This is especially important when biological control agents are to be used, because biological control agents are often quite specific as to the pest(s) they attack.

Pest population assessment and monitoring: Pest populations fluctuate over time, and it is only when they begin to reach damaging levels that control action is warranted. Regular monitoring of the crop and environment can assist in determining when a pest is nearing
damaging levels. Monitoring generally involves a combination of visual crop inspection, the use of insect traps or crop sampling and record keeping.

**Pest threshold levels:** The point at which economic damage is likely to occur is often called the 'action threshold'. Some controls like pesticides can be used very close to the action threshold, while others like biological control must be introduced well before a pest reaches the action threshold. Reliable thresholds have not been developed for all pests, so advice from a crop or pest management consultant may be needed.

**Preventing pest problems:** Most pests are opportunists and exploit favourable conditions. By making conditions unfavourable for pests, for example, through the selection of pest resistant cultivars, maintenance of suitable environmental conditions and sound crop hygiene practices, can contribute to the reduction of pest problems.

**Integration of control methods:** Most pests can be managed by a combination of chemical and non-chemical control methods. For integrated pest management, these control methods must be compatible, ie, not disrupt each other when they are used together. The combined effect of two or more control measures is often greater than that of a single method in the longer term. The order in which control methods are used and their timing in respect of the pest's life cycle is also important. As biological control agents are susceptible to many pesticides, it is essential to determine what chemicals may be integrated into your IPM programme (see 'Impact of Pesticides on Beneficial Insects and mites').
Enforce™
*Encarsia formosa* – Parasitic wasp

*Enforce™* is a tiny parasitic wasp that specializes in parasitizing whitefly, specifically greenhouse whitefly (*Trialeurodes vaporariorum*), although it will attack other whitefly species.

It is very useful in greenhouse crops as part of an Integrated Pest Management programme, and has been used successfully in crops such as tomato, cucumber, eggplant and ornamental plants.

The Pest: Greenhouse Whitefly

Greenhouse whitefly adults are small, white, fly-like insects that are generally found in the head of plants and the undersides of the leaves, and cause damage by sucking sap from the plant.

Greenhouse whitefly lay their eggs on the underside of leaves, where they mature through four nymph or ‘scale’ stages before emerging as adults. All nymph and adult stages cause damage to the plants, and in severe infestations they may kill plants.

Signs and symptoms of a greenhouse whitefly infestation may include:

- Adult greenhouse whitefly present on the plant, generally near the top on new growth
- Greenhouse whitefly eggs and pupae may be present on the plant (a hand lens may be required to see some nymph stages)
- Plants may appear weak, and growing poorly
- Honeydew and black sooty mould may be visible on stems and leaves

The Solution – *Enforce™*

The *Enforce™* wasp is 0.6 mm long and is recognisable by its black head and thorax and a yellow abdomen.
A female wasp inserts her eggs into 3rd and 4th instar nymphs of greenhouse whitefly. The egg hatches and the wasp's larva develop inside greenhouse whitefly nymph eventually killing it.

After about 10 days, the greenhouse whitefly nymph will begin to turn black, and about 10 days later an adult wasp will emerge.

Once the Enforce™ wasp has hatched, it will seek out more whitefly nymphs to parasitize, leaving the black case behind.

Enforce™ is not considered harmful to humans and animals, and no environmental impacts are expected.

Environmental Conditions Required

Enforce™ works best at temperatures of 20-28°C, below 18°C wasp activity decreases. Wasps will not survive above 38°C. A wasp life cycle will take between 10 and 30 days, depending on temperature.

Release Rates

The number of Enforce™ wasps required per m² of crop.

<table>
<thead>
<tr>
<th>Infestation</th>
<th>Cucumbers</th>
<th>Ornamentals</th>
<th>Tomatoes</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventative</td>
<td>2-6</td>
<td>1-3</td>
<td>1-3</td>
<td>1-3</td>
</tr>
<tr>
<td>Light</td>
<td>6-12</td>
<td>3-6</td>
<td>3-6</td>
<td>3-6</td>
</tr>
<tr>
<td>Heavy</td>
<td>12+</td>
<td>9+</td>
<td>9+</td>
<td>9+</td>
</tr>
</tbody>
</table>

Enforce™ should ideally be introduced to the crop when greenhouse whitefly populations are low.

Tags can be concentrated in greenhouse whitefly 'hotspots' within your crop. Enforce™ adults are able to fly about 20 metres and disperse readily.

Higher release rates may be required during the winter when temperatures are lower and control is more difficult.

Monitor your plants once a week, and after four weeks black 'scale' should be present. When 80% of the 'scale' is black, the release rate can be re-evaluated.

Packaging

Enforce™ is supplied as black parasitized greenhouse whitefly nymphs or black 'scale' on cardboard tags, and the adult wasp emerges from this 'scale'.

Enforce™ tags are sent via fast-post or courier (at the customer’s request).

Two tag sizes are available:
- Mini tags = 100 viable Enforce wasps will emerge
- Maxi tags = 250 viable Enforce wasps will emerge
Post Release

*Enforce™* adults will begin to emerge from the black 'scale' on the tags within 2-6 days at 20°C. The black case will stay attached to the tags. A small hole should be visible with a hand lens once the adult has emerged.

After three weeks it is safe to assume all Enforce wasps have hatched, so the tags may be removed if desired.

Within four weeks of release, black 'scale' should be present within your crop, on the lower leaves of your plants. Adult wasps should emerge within 2-3 weeks.
Mite-E™

*Phytoseiulus persimilis* – Predatory mite

Mite-E™ is a highly active predatory mite that specialises in feeding on two-spotted spider mites (*Tetranychus urticae*) and other plant-feeding mite species in the family Tetranychidae.

Mite-E™ is known to be useful in both greenhouse and outdoor crops, such as rose, orchid, bean, capsicum and strawberry as part of an integrated pest management programme.

The Pest – Spider Mites

Female two-spotted spider mites are pale yellow-green with two large dark green or black spots on the upper part of their body, and are approximately 0.6 mm long. Orange overwintering forms may be found in late autumn, winter and early spring.

Two-spotted spider mites are normally found on the underside of leaves within the crop. When the infestation is high, webbing will be visible on the tips of the leaves and may hang down like a silken rope. This is a dispersal mechanism for this species.

Signs and symptoms of two-spotted spider mites include:
- Speckling and yellowing of leaves within your crop
- Small mites on the underside of the leaves in your crop - use a 10x hand lens to see the mites
- Webbing on the tips of leaves in severe cases, especially on young leaves

The Solution – Mite-E™

Mite-E™ is a small highly active predatory mite, orange to bright red in appearance. Adult females are 0.5-0.6 mm long.

Adult female Mite-E™ lays her eggs amongst colonies of two-spotted spider mites.

Both nymph and adult predatory mites actively search for their prey and will feed voraciously on all stages of spider mite from eggs through to adults.
Under optimal conditions (20°C and 65% RH) Mite-E™ has the potential to devour up to five adult spider mites and twenty eggs and larvae per day, thus reducing two-spotted spider mite populations over several weeks.

Mite-E™ is almost entirely dependent on two-spotted spider mite as a source of food; once all prey has been consumed they will go out in search of a new food supply. If no food is found, the mites may become cannibalistic.

Under optimal conditions, Mite-E™ has a substantially faster life cycle than two-spotted spider mite. The sex ratio of adult Mite-E™ is four females to each male, and females are capable of laying up to 60 eggs in their life time. These factors contribute to the success of Mite-E™ as a predator.

Mite-E™ is not considered harmful to humans and animals, and no environmental impacts are expected.

Environmental Conditions

Favoured conditions for Mite-E™ are temperatures above 20°C for a time during the day and a relative humidity of 65%.

Mite-E™ will consume two-spotted spider mites and reproduce at temperatures and humidity that are not ideal, but at a slower rate.

Release Rates

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Release Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse crops</td>
<td>4 predator mites per square metre</td>
</tr>
<tr>
<td>Field crops</td>
<td>1 predator mite per 2.5 square metres</td>
</tr>
<tr>
<td>Strawberry crops</td>
<td>1 predator mite per 2.5 square metres</td>
</tr>
</tbody>
</table>

Packaging

Mite-E™ is supplied in units of 500 or 1000 adult mites in either in Vermiculite or on bean leaves. Each unit has a small quantity of two-spotted spider mites as a food source during transit.

Post Release

After 2-4 weeks, following the release of Mite-E™, you should be able to see signs of the predator working.

Two-spotted spider mites that have been eaten change from pale green to brown and appear shrivelled. Use a 10x hand lens to check, as live and dead mites can appear similar to the naked eye.
Aphidius

*Aphidius colemani* – Parasitic wasp

Aphidius is a small parasitic wasp that specialises in parasitising green peach aphid (*Myzus persicae*), melon aphid (*Aphis gossypii*) and many other aphid species.

Aphidius is known to be useful in indoor and outdoor crops such as, capsicum, cucumber, tomato, chrysanthemum and other ornamentals as part of an integrated pest management programme.

The Pest – Aphids

Many different species of aphid are present in New Zealand. Some species are quite specific to particular crops, while other species infest a wide range of crops.

Aphids are soft-bodied insects that have globular bodies, long thin legs and antennae. Adult body length is normally 2-3 mm, and colour varies from pale yellow, green to dark brown or black. Some forms have wings and they can disperse rapidly.

Under optimum conditions, the life cycle of an aphid can be completed in 10-12 days. Many species reproduce asexually, and therefore populations can build up very rapidly.

Aphids feed with piercing-sucking mouthparts and can cause stunting and distortion, especially to younger leaves. Aphids are often plant virus vectors, and therefore rapid and effective control is essential to minimize crop losses.

Symptoms and signs of aphids include:

- Stunting and distortion of the leaves and flowers
- Yellowing and wilting of leaves
- Honey dew and sooty mould present on the plants
- Aphids visible on the stem, leaves and flower buds
The Solution – *Aphidius colemani*

*Aphidius* is a black wasp 3-5 mm in length.

The female wasp inserts and egg into the body of an aphid which hatches into a larva. The larva remains within the aphid’s body feeding on the internal tissues and eventually kills it. Both immature and adult aphids, as well as winged and wingless forms of aphids can be parasitised.

The *Aphidius* larva then pupates within the aphid and spins a cocoon which, in turn, makes the aphid body wall appear gold or bronze in colour. This is known as an aphid “mummy”.

The adult wasp will chew a neat circular hole in the abdomen of the mummy and emerge. This hole is visible once the *Aphidius* has emerged.

The development of *Aphidius* from egg to adult takes approximately 14 days at 21°C. An adult female can live for about 10 days at this temperature, and lay up to 300 eggs in her lifetime. A sex ratio of two females to one male is common.

*Aphidius* adults feed on plant nectar and honey dew produced by the aphids. Females are very mobile and will actively search for a colony of aphids, even locating quite small colonies.

Female adult parasitic wasp parasitizes the aphids (lays her egg which kills the host), killing the host over several days.

Females have to mate to produce eggs; sex ratio is female 2:1.

*Aphidius colemani* can lay up to 300 eggs in her 10 day adult lifespan (18-22°C).

Development time from egg to adult is 13 days at 20°C.

*Aphidius* are naturally occurring in the northern parts of New Zealand, and may be found in the home garden during late spring, summer and early autumn. Generally there are insufficient wasps present to provide effective control of aphids in these situations.

*Aphidius* is not considered harmful to humans or animals, and no environmental effects are expected.

**Environmental Conditions**

*Aphidius* is best suited to temperatures between 18°C and 30°C, and sustained temperatures over 30°C may reduce the effectiveness of this parasite.

**Packaging**
Aphidius is dispatched as “mummies packed in a Petri dish or vial. Some Aphidius may emerge in transit, but this is normal.

Release rate

Release rate that are commonly recommend range from 1-5 Aphidius per square metre for low to high infestations, respectively

Because aphids breed very quickly, it is recommended that Aphidius is released at the first sign of aphid appearance.

Post Release

Aphidius will start parasitising aphids immediately on release, although you will not be able to confirm this until the parasitised aphid starts turning golden after 7 days (at 26°C) or longer if the average temperature is lower.
HYPO-MITE™

*Hypoaspis aculeifer* – Predatory mite

**Hypo-Mite™** is a soil-dwelling predatory mite that feeds on fungus gnats (= mycetophilids, sciarid flies) and other insects, mites and nematodes in soil and growing media.

**Hypo-Mite** is known to be useful in greenhouse vegetable and ornamental crops, including bulbs, as part of an integrated pest management programme.

**The Pest – Fungus gnats**

Fungus gnats are small, dark, two-winged flies with long legs similar to mosquitoes. Adults are approximately 3 mm long and are weak, erratic fliers. They are more prevalent in greenhouses, but may also become numerous outdoors.

The larvae of fungus gnats are white or transparent and are legless, and have a shiny black head. They are usually found just below the soil surface in association with decaying plant material, moss and algae.

The life cycle of fungus gnats takes approximately 25 days at temperatures above 20°C.

Ideal conditions for fungus gnat outbreaks are high humidity, high soil or growing media organic matter, water-saturated soil or growing media, presence of moss and algae and decaying plant material.

Fungus gnat larvae cause damage to plants by feeding on the roots. Fungus gnats can also spread plant fungal disease throughout a greenhouse on adults, and by larvae through the soil.

Signs and symptoms of fungus gnats include:

- Plants lack vigour and leaves may turn yellow
Small brown scars are evident on roots, and root hairs are eaten off. With heavy larval infestations, plants can be weakened severely and die.

The Solution — Hypo-Mite™

Hypo-Mite™ is a small pale brown mite with a distinct V-shaped dorsal shield. Adult mites are 0.5-1.0 mm long and are commonly found in the top few centimetres of soil or compost.

Females lay their eggs near the soil surface, and these hatch into six-legged larvae. There are two further nymph stages and a life cycle can be completed in 10 days at 25°C, but can vary from 7-30 days depending on temperature.

Below 12°C, Hypo-Mite™ becomes inactive, and development stops when temperatures fall below 8°C. The species does not hibernate (= diapause) and is able to survive for 6-8 weeks without prey by feeding on decaying organic matter.

Hypo-Mite™ uses its saw-like mouth parts to puncture and slice prey tissue which is then sucked up leaving a shrivelled prey body. They prefer feeding on younger fungus gnat larvae, and adults can consume 1-5 prey per day. Both adult and immature Hypo-Mite™ are predatory.

Hypo-Mite™ is also a predator of thrips pupae in the soil, however, alone they do not provide sufficient control of thrips.

Hypo-Mite™ is not considered harmful to humans or animals, and no environmental effects are expected.

Environmental Conditions

Hypo-Mite™ survives well in most greenhouse conditions and is not harmed by regular watering, although flooded or waterlogged areas are not tolerated. Optimum conditions for development are 20-30°C, and soil temperatures above 30°C are harmful.

Hypo-Mite™ will survive in most potting mixes, rockwool and perlite.

Release rate

- Greenhouse crops: Use 1 litre per 100 square metres, or, one litre per cubic metre growing media
- Outdoor crops: Use 20 litres per hectare

Repeated applications may be needed for heavy pest infestations.

Packaging

Hypo-Mite™ is supplied in a mixture of vermiculite and mould as a food source for the mites. There are 10,000 mites per litre of mixture.
Post release

Hypo-Mite™ may take 2-3 weeks to exert an effect on pest populations. Hypo-Mite™ can be hard to find in soil or growing media, therefore monitor pest numbers to determine the need for further releases.

Re-application of Hypo-Mite™ is recommended to ‘hot spots’ should some pests remain.
Mite-A™
*Amblyseius cucumeris* — Predatory mite

Mite-A™ is a highly active predator of thrips, especially onion thrips, *Thrips tabaci*, Western flower thrips, *Frankliniella occidentalis*, New Zealand flower thrips, *Thrips obscuratus* and other thrips species. Mite-A™ will also eat two-spotted spider mite and other mite species.

Mite-A™ is known to be useful on greenhouse crops such as tomato, cucumber, pepper and ornamental plants as part of an integrated pest management programme.

The Pest — Thrips

Thrips are small slender insects and adults about 1-1.5 mm long, with feathery wings. Their colour varies from pale yellow to light or dark brown. The immature stages (nymphs) look similar to adults but are smaller, paler in colour and lack wings.

Thrips have piercing-sucking mouth parts and feed by puncturing the surface of leaves, flowers and fruit. Both adults and nymphs cause damage.

Signs and symptoms of thrips include:
- Yellow speckled or silvered appearance of leaves and fruit
- Black spots of excrement on leaves
- Small insects in the flowers or on the undersides of young leaves in your crop

Thrips may also be responsible for the transmission of some virus diseases.
The Solution – Mite-A™

Mite-A™ is a small, highly active predatory mite and is pale in colour. Adult females are approximately 0.4 mm long.

Mite-A™ feeds on the early larval stages of thrips, consuming 1-3 thrips per day depending on temperature and humidity. This reduces the number of thrips in the crop slowly, and so an immediate reduction in adult numbers may not be apparent.

Mite-A™ also feeds on other mites, such as mould mites, and on the eggs and early stages of two-spotted spider mite.

Adult predatory mites search actively for their prey and suck it dry.

Mating is essential for egg laying to take place. Females lay approximately 35 eggs in her lifetime.

Development time from egg to adult is 11 days at 20°C. Adults live for up to 22 days.

Mite-A™ can use pollen as a food source which helps it survive under low prey conditions. Capsicums and other crops provide a ready pollen source, but if pollen is too plentiful, this can reduce the effectiveness this predator.

Mite-A™ is not considered harmful to humans and animals, and no environmental impacts are expected.

Environmental conditions

Optimum conditions for Mite-A™ are warm (20-25°C), semi-shaded conditions with relative humidity greater than 65%. Plants planted close together or with dense foliage provide these conditions.

Release Rates

Sachet application: greenhouse crops 500 sachets per 1000 square metres, or approximately 1 sachet per 4-5 plant stems

Broadcast application: greenhouse crops 25 ml mite mixture per square metre sprinkled over or under the crop

Mite-A™ will emerge from the sachets over a period of 2-4 weeks. In capsicum, introductions of predators should be made every 6 weeks throughout the winter. In summer, one introduction should be sufficient.

Packaging

Mite-A™ is supplied in either sachets or as a bulk mixture.

Sachets contain approximately 40 ml or 5 g of bran mixture with a minimum of 400 predatory mites per sachet, and mould mites which act as a source of food for the predators.
Neither Mite-A™ or the mould mites damage living plants.

Post Release

Mite-A™ disperse rapidly on release and aggregate on high-density patches of thrips larvae.

An immediate effect on thrips populations is usually not observed, as feeding by the predator is mostly restricted to early immature stages of thrips.

Thrips populations should be closely monitored to determine whether additional Mite-A™ need to be released, or a selective chemical application is needed to reduce adult thrips number.
Release and Storage Instructions for Beneficial Insects

For Enforce tags

- Do not touch the black ‘scale’ on the tags
- Do not expose the tags to direct sunlight
- Hang the tags immediately within the crop,
- If the tags must be stored, store them in darkness at 10-15°C.
- DO NOT REFRIGERATE
- Do not store the tags for more than 2 days
- Tags come in strips of up to 10; tags should be separated and hung individually
- Hang tags one metre below heads of crop, so the wasps work upwards
- Hang tags in shade
- Ensure tags are hung in different places each week
- Tags should be distributed evenly through the crop
- Leave tags in crop for at least 14 days

Release and Storage Instructions of Beneficial Mites – Hypo, Mite A and Mite E

- On arrival, release as soon as possible
- Do not expose to direct sunlight
- Can be stored in darkness for a maximum of 2 days at 10-15°C
- DO NOT REFRIGERATE
- Open the container only once you reach the area mites are to be released

For Hypo Mite:
- Sprinkle the mixture on the soil around infested plants, or incorporate into the growing media before potting-up plants

For Mite A:
- Sprinkle onto the leaves of the plants, concentrating on the “hot spots” but also distributing throughout the whole crop

For Mite E:
- Gently rotate the bottle so as to mix the mites back into the Vermiculite.
- Open only 1 container at a time and apply the contents immediately

Release and Storage Instructions

Aphidius need the following handling and treatment:

- On arrival, release Aphidius into the crop as soon as possible
- Do not expose Aphidius to direct sunlight
- DO NOT REFRIGERATE
- Open the Petri dish or vial only once you are in the area in which Aphidius are to be released
- Release Aphidius near an aphid ‘hot spot’, and then evenly distribute the mummies throughout the area requiring treatment
Glossary of terms

Diapause: A physiological state of dormancy with very specific triggering and releasing conditions. It is used as a means to survive predictable, unfavourable environmental conditions, such as temperature extremes, drought or reduced food availability. Source: Wikipedia

Honeydew: A sweet sticky substance excreted by various insects, especially aphids, on the leaves of plants. Source: Answers.com

Larvae: Juvenile from of animal with indirect development, undergoing metamorphosis (for example, insects or frogs). The larva can look completely different from the adult form. Source: Webster's Dictionary

Mite: Any of numerous very small to minute arachnids often infesting animals or plants or stored foods. Source: Webster's Dictionary

Mummie (Aphidius): The hardened body used as a host by the Aphidus wasp to undergo metamorphosis.

Nymph: The immature stage in the life cycle of those orders of insects characterized by gradual metamorphosis. Source: Webster’s Dictionary

Parasitoid: The host is usually killed after the full development of the other organism. This type of relationship only occurs in organisms that have fast reproduction rates (like insects or mites). Source: Webster’s Dictionary

Parasitize/Parasitized: A parasite that ultimately destroys its host, as any of various wasp larvae which feed progressively on the tissues of an immature stage of a host species. Source: Webster’s Dictionary

Pollen: A fine powder produced by the anthers of seed-bearing plants; fine grains contain male gametes. Source: Webster’s Dictionary

Predator: Any animal that lives by preying on other animals. Source: Webster’s Dictionary

Pupae: A Pupa (plural: pupae or pupas) is the life stage of some insects undergoing transformation. The pupal stage only occurs in insect that undergo a complete metamorphosis. It follows the larval stage and precedes adulthood. Source: Webster’s Dictionary

Sciarid fly: Minute blackish gregarious flies particularly destructive to mushrooms and young seedlings. Source: Webster’s Dictionary
Thrip: Any of various small to minute sucking insects with narrow feathery wings if any; they feed on plant sap and many are destructive. Source: Webster’s Dictionary

Two spotted mite: Extremely small, barely visible with the naked eye as reddish or greenish spots on leaves and stems; the adults measure about 0.5 mm. Source: Wikipedia

Whitefly: Minute insect that feeds on plant juices. Source: Webster’s Dictionary
What is BioForce

- BioForce breeds and sells beneficial insects for the sustainable, non-chemical control of many common horticultural pests.
- Small privately owned company located in Karaka, South Auckland.
- Caters mainly for protected cropping environments e.g. environment controlled areas, glasshouse and plastic house growers.

Above: Karaka rearing unit, Below: Nursery rearing unit.
What is Integrated Pest Management? - IPM

IPM is a pest control strategy that uses a variety of complementary strategies including: mechanical & physical devices, biological, cultural management, and chemical management with the main goal of reducing or eliminating the use of pesticides - while at the same time managing pest populations at an acceptable level.
The Pest - **Greenhouse Whitefly** - *Trialeurodes vaporariorum*

- White winged insect 1.5 mm long
- Found year round in greenhouse crops and outdoors in warmer parts of the country
- Infests crops such as tomatoes, cucumbers, and anything else in the garden generally
- Whitefly suck plant juices thus weakening the host plant thus reducing yields
- Causes honeydew and sooty mould on plants

*Above:* Whitefly adults

*Above:* Whitefly adult & beneficial wasp *Encarsia formosa*
The solution - **Enforce** - *Encarsia formosa*

- Parasitic wasp that specialises in controlling whitefly, specifically greenhouse whitefly
- Adult is tiny = 0.6mm long
- 99% female population
- Lays her egg into scale stage of whitefly, egg hatches & goes through larval stages inside the whitefly casing, emerges as an adult Encarsia killing the whitefly in the process
- Works best at temperatures of 20-28°C
- Poses no risk to humans

![Encarsia scale, whitefly scale](image1)

![Whitefly adult & beneficial wasp](image2)
The solution - **Enforce** - *Encarsia formosa*

- Development time from egg to adult is 27 days at 20°C
- 99% female population, females don’t need to mate to reproduce
- Females lay up to 60 eggs in 12 day adult lifespan at 25°C
- *Encarsia* adults also eat whitefly scale, eats 3 scale per day
- 1 adult female therefore can kill 96 whitefly in her adult lifespan
- Supplied on tags from which 100 or 250 adult wasps will emerge

**Top:** Standard tag (100 to emerge)  
**Below:** Maxi tag (250 to emerge)
The Pest – Two-spotted spider mite

- Found on a wide range of fruit, vegetable, ornamental plants and weeds e.g., roses, orchids, cucumbers and capsicum
- Symptoms include speckling and yellowing of leaves, mites visible on underside of leaves and “webbing” on the tips of leaves
- Loss of vigour and possibly death of the plant

Top: Two-spotted mite, below Beneficial mite – Mite E
The solution - **Mite E** - *Phytoseiulus persimilis*

- Predatory mite that specialises in feeding on two-spotted spider mites
- Useful in greenhouse and outdoor crops
- Adult females are 0.5-0.6 mm long
- Mite E feeds voraciously on all stages of spider mite
- Potential to devour up to five adult spider mites and twenty eggs and larvae per day

*Above:* Top: Two spotted mite, below beneficial mite – Mite E

*Above:* Mite E amongst 2 spot colony
The pest - Aphids

- Wide spread pest found on crops including roses, lettuce, potato and many weeds
- Body colour varies from yellow to green to black
- Causes wilting & distortion & transmits plant viruses
- Other symptoms are honeydew on leaves and fruit, with black sooty mould fungus

Above: Green peach aphid colony
The Solution - **Aphidius** - *Aphidius colemani*

- Small parasitic wasp that specialises in parasitising 40 aphid species
- It is a black wasp 3-5 mm in length that poses no threat to humans
- Useful in indoor and outdoor crops
- The female wasp inserts and egg into the body of an aphid which hatches into a larva. Larva remains within the aphid’s body feeding on the internal tissues and kills it. An adult eventually emerges from the mummy.
The Solution - **Aphidius** - *Aphidius colemani*

- Female adult parasitic wasp parasitises aphids (lays her egg which kills the host), kills the aphid over several days.
- Females have to mate to produce eggs; sex ratio is female 2:1.
- *Aphidius colemani* can lay up to 300 eggs in her 10 day adult lifespan (18-22°C).
- Development time from egg to adult is 13 days at 20°C.
The pest – Fungus Gnats

- Also known as Sciarid Flies
- Live in damp media – soil, potting mix etc
- Larvae are legless, about 4-5 mm long, clear segmented bodies and black heads
- Adults are black flies 3 mm long, fly from the soil when disturbed
- Eat seedling roots thus weakens the plant

Top: Sciarid fly larvae, below: adult
The solution - Hyper Mite

- Soil-dwelling predatory mite that feeds on fungus gnats, insects, mites and nematodes in soil and growing media
- Adult mites are 0.5-1.0 mm long
- Uses its saw-like mouth parts to puncture and slice prey tissue which is then sucked up leaving a shriveled prey body

Above: Hyper Mite adult
The pest - Thrips

- Small, slender insects less than 2 mm long
- Many host plants, including rhododendrons, onions, capsicum, roses & weeds
- Small insects visible with silvered appearance of older leaves, black spots of excrement on leaves & potential death of plant

Top: Adult thrip
Bottom: Thrip damage on Rhododendron vireya, with new growth emerging
The Solution - **Mite A** - *Amblyseius cucumeris*

- Mite A feeds on the early larval stages of thrips, consuming 1-3 thrips per day
- Adult mites are < .5mm long
- Also eats two spotted spider mite and other mite species.
- Will survive on pollen if no thrips or other pests are available to eat
- Not harmful to humans in any form

*Above*: Mite A adult
The Solution - Mite A - *Amblyseius cucumeris*

- Adult predatory mites search actively for their prey and suck it dry.
- Mating is essential for egg laying to take place. Females lay approximately 35 eggs in her lifetime.
- Development time from egg to adult is 11 days at 20°C.
- Adults live for up to 22 days.

*Above: Mite A adult*
Conclusion

- IPM is an industry that is moving forward, a consumer driven industry
- Focusing on reducing harsh chemical usage
- Cost of beneficials is comparable to using chemical sprays, without the potentially unsafe side effects
- Environmentally sustainable practices, safer for workers and consumers

What IPM is helping to avoid!