VG442
Trial training program for Granite Belt vegetable growers on pest and beneficials

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QLD Department of Primary Industries

Know-how for Horticulture™

VG442

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INTRODUCTION

Vegetable industries on the Granite Belt are valued at approximately $40 million per year. The major crops are brassicas ($11M), tomatoes ($5M), lettuce ($3M) and cucurbits ($2M). An important issue affecting the continued development of the vegetable industry is management of pest control while minimising biological and environmental concerns. Integrated Pest Management (IPM) is considered to be an important aspect of such management. The introduction of IPM is also supported by Queensland Department of Primary Industries (QDPI) program goals, and by a QDPI special funding initiative that will see $1.5 million spent over the next four years specifically on IPM activities in horticulture.

Many vegetable growers on the Granite Belt are interested in adopting IPM. The major reasons cited for this interest are:

- Community and environmental pressures to limit pesticide use.
- Domestic and export market pressures to reduce residues in crops.
- Personal and workplace health and safety issues relating to handling of agricultural pesticides.
- Increasing incidences of pest resistance to current pesticides.
- Reduction of production costs to boost farm income and loner term viability.

Less than 5% of growers have adopted IPM in their crops. Those who have adopted IPM are mainly growers who employ competent insect scouts. Growers indicate that the major reason for not adopting IPM is a lack of confidence in their ability to adequately monitor their crops and correctly identify pests and beneficial predators and parasites.

Through the Deciduous Sectional Group Committee (DSGC) of Queensland Fruit and Vegetable Growers organisation (QFVG) they have asked QDPI to provide training in this area.

Vegetable production on the Granite Belt, having been until recently at a fairly low level of production, has not developed the pest problems of other production regions such as the Lockyer Valley, Bundaberg and Bowen. There is an opportunity to prevent these problems occurring by developing suitable crop management systems, particularly in the area of crop protection, during these earlier establishment phases of the industry. Experience gained in these other production regions is available to help develop such systems.

There are continuing concerns among horticultural producers and the wider community about environmental/health issues related to pesticides, the development of pesticide resistance by many pests and the costs associated with pesticide application. IPM strategies have been developed and promoted as a means of reducing dependency on pesticides.

Many vegetable growers reported reluctance to adopt IPM strategies because they had difficulties in correctly identifying both pests and 'beneficial' predators and/or parasites found in their crops. They generally knew the major pests, but could not identify many of the wider range of insects and arachnids that they found. Other concerns centred around the many gaps in local knowledge of pest thresholds and the range and interactions of pests and beneficials in a crop. What applied in one location may not be relevant in another, so growers needed to be given the chance to gain skills which would help them to develop their own strategies.

This project is aimed at developing a training program consisting of laboratory and field workshops and a manual. This process will give growers basic skills and knowledge of insect and arachnid identification, their lifecycles and crop monitoring techniques. Growers have been encouraged to make their own insect collection. An evaluation of the training program has been undertaken to make improvements to future programs, both in other industries in the region and in the vegetable industry state wide.

Growers who participated in the training program were trained to identify major insect and arachnid orders and have an understanding of their lifecycle and damage. The insect collections they developed as part of the program were to be retained by participants for use as an on-farm reference tool.

The use of adult education principles and the involvement of growers in the development of the training program were employed to maximise the success of the program. An initial grower awareness meeting was held to obtain grower commitment to the program, and provide input to the structure an contents of the training delivered.

PROJECTED OUTCOMES

The projected outcomes of this project were that growers who complete the training program will be better able to implement IPM strategies on their properties, with resulting benefits to reduced pesticide use to both the grower and the community in general. These include savings in pesticide application costs, reduced environmental impact, a safer working environment, reduced pesticide residue on produce, better access to export markets with residue restrictions and the ability to cope with increasing pesticide resistance problems.

Defined outcomes of the project as proposed were:

1. The development of a training program and manual for identification of insects, arachnids and beneficials as in initial step to the introduction of Integrated Pest Management into vegetable cropping on the Granite Belt.

2. Participating growers will develop the following broad skills:

. Primary identification of insects and arachnids.

. Classification of insects and arachnids into major orders.

. Understanding of lifecycles of insects and arachnids associated with each order.

. Recognition of likely crop damage or beneficial effect of each order, the lifecycles stage at which significant crop damage occurs and the most opportune time within the lifecycle for control of the pest.

. Basic understanding of the linkages between pest control techniques and the promotion and management of beneficial predator levels.

3. Participating growers will develop a collection of pests and beneficials present in their crops for use as a farm reference tool.

4. Participating growers will be introduced to the basics of crop monitoring, pest thresholds and pest population dynamics.

5. Evaluation of the training program and manual using feedback from participating growers with a view to improving the program to be used with vegetable growers throughout the state.

MATERIALS & METHODS

The aim of this project was to develop and run an insect and arachnid (spiders and mites) identification training program for vegetable growers in the Granite Belt district. It was primarily directed at growers who wanted to implement Integrated Pest Management (IPM) strategies in their crops.

There were two main objectives for the project:

- to develop an insect and arachnid identification training program for Granite Belt vegetable growers that would facilitate the implementation and adoption of IPM in their crops.
- evaluate the training program and its components with a view to developing a state wide program for vegetable growers.

The training program objectives were for workshop participants to:

- be able to distinguish between insects, arachnids and other small creatures found in their crops,
- be able to identify the major groups (orders) of insects and arachnids that are pests or beneficials in their crops,
- be able to identify specific pests and beneficials found in their crops,
- understand the basic lifecycles of insects and arachnids,
- recognise the likely crop damage or beneficial effect caused by insects or arachnids of each order, and
- have a general understanding of monitoring techniques.

PROCEDURE

1. Involvement of growers

Vegetable growers were invited to an awareness meeting which aimed to obtain grower commitment to the project. Presentations by the Project consultant (John Hall) and a local grower and his pest scout introduced growers to how IPM has been used in other regions and locally and reinforce the benefits that can be gained by adopting IPM strategies. QDPI staff presented the proposal of the training workshops and manual. Extension techniques were then used to facilitate grower discussion of the proposal. Grower feedback was sought on their response to the proposal and when and where the workshops should be held.

2. Development of workshop manual

A team of entomologists and extension staff prepared a manual to be used by growers throughout the training program. This manual described the different groups of insects and

arachnids (both pest and beneficial), their lifecycles and the damage caused to crops or the benefit provided. This manual assisted growers to identify the group to which an insect/arachnid belongs. It was not aimed at allowing a specific identification of a pest. The manual contained high quality drawings illustrating the different groups of insects/arachnids.

A full copy of the final manual delivered to participants in the program is attached to this report as Appendix 1.

3. Development of training workshops

At the same time as the manual was being developed, the project team also prepared the content and format for the training workshops. The basic proposal was to run two separate series of workshops each of about eight (8) hours duration. Half of this time was to be spent in classroom/laboratory activities and the other half in field activities. Two series of workshops were required to keep grower numbers manageable and to allow different workshop formats to be trialed and compared. The formats used were developed in consultation with growers at the initial awareness meeting. Adult learning principles were used to ensure that growers obtained relevant, practical skills in pest identification which can be further developed in the future in the context of implementing IPM in their crops.

4. Insect collection

Participants were encouraged to collect and identify insects, arachnids and beneficials from their crops during the training program. This collection was intended to become an on-farm resource which can be used for future training of farm staff and reviewing skills and knowledge gained from the workshop.

5. Evaluation of training program

The training program was evaluated in three areas.

- Format and content of workshops.
- Format and content of manuals.
- Knowledge and skills gained by participants.

Format and content of workshops and manual was evaluated by taking growers through a review process at separate meetings following the conclusion of workshops. A range of extension techniques were used to do this. Details of this more formal evaluation process are included as Appendix 3 to this report.

Knowledge and skills gained by growers were evaluated at several levels. Informal reviews were conducted throughout the duration of the training program to assess the progress made by growers. A second level of evaluation in this area was the review of how well grower insect collections have been put together. At the conclusion of the training program, growers were also given a practical test to assess skills and knowledge obtained.

A copy of the participant skills evaluation sheets used are attached as Appendix 2 to this report.

The feedback obtained through all of these processes is intended to be used to modify the training program before its wider use with vegetable growers in other growing regions, and has been incorporated into the planning and design of the follow on project VG503 - Training program for growers on pests and beneficials in vegetable crops, led by Sue Heisswolf of QDPI Gatton.

RESULTS

A preliminary meeting with Granite Belt vegetable growers was held in November 1994 to gauge support for a training program and gain ideas on timing and general presentation. Grower support was positive so two workshops were developed.

Two series of workshops involving 32 growers and their employees were conducted between February and April, 1995. Each workshop consisted of four sessions - two using laboratory facilities at Applethorpe TAFE campus and two field sessions. Each session lasted two hours.

The content and conduct of the workshops was developed using adult learning strategies that

- recognised and built on the existing knowledge of participants,
- were as practical as possible,
- gave participants the ability to deal both the usual and not so usual pest/beneficial situation, and
- left participants with materials they could use as future reference or learning tools.

A workshop manual was developed and used as the main reference tool for the program. Participants were also asked to make an insect collection as a future reference.

A focus group involving participants from both workshops was used to evaluate the content and process. Details of this evaluation process are attached as Appendix 3 to this report.

The nine participants who did not complete the workshop were also contacted for their comments. Completed insect collections were used to check participants learning.

Most participants were happy with the workshop format. Minor modifications to content and presentation were suggested and noted, and have been included in the planning and format for the follow-on project VG503.

Most participants expressed a better awareness of what was happening within their crops - and indicated that monitoring their crops was now possible. Those who did not complete the workshop offered the excuse of other commitments rather than a dissatisfaction with the program. The insect collections that were examined showed some variation in the ability of participants to correctly identify specimens, showing the need for clearer instruction on some aspects of insect structure.

DISCUSSION

BENEFITS FOR & ADOPTION BY INDUSTRY

Vegetable growers from the Granite Belt who completed the training program have gained basic knowledge and understanding of the identification and management of insect pests and beneficials, and will therefore be better equipped to understand and implement IPM strategies in their crops.

Both the grower and the general community benefit from the adoption of IPM and the associated reduction in pesticide use through:

- estimated savings of between 10 and 20% of production costs.
- reduced environmental impact resulting from chemical use.
- a safer working environment.
- reduced pesticide residue on produce.
- better access to export markets with residue restrictions.
- ability to cope with pesticide resistance.

DIRECTIONS FOR FUTURE RESEARCH

This project has shown that this type of training program can be run successfully with a wide range of growers and their employees. The general objectives of giving growers the confidence to move towards IPM programs were achieved.

Planning for similar workshop programs in other districts is now under way as a separate project VG503 - Training program for growers on pests and beneficials in vegetable crops, led by Sue Heisswolf of QDPI Gatton.
Minor changes to the content, presentation and manual are being made as a result of the Granite Belt project. Similar programs can also be developed for other crops - and already one workshop for apple growers has been conducted.

ACKNOWLEDGMENTS

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The Project leader, Mr Andy Jordan, Would like to acknowledge the input of the following people to the conduct, preparation and review of the Trial Program:

Additional project members who were involved in presenting the training program:
Frank Page, Senior Entomologist, DPI Applethorpe
Peter Nimmo, District Experimentalist, DPI Applethorpe
Alex Banks, Senior Extension Horticulturist, DPI Applethorpe
Sue Heisswolf, Extension Horticulturist, DPI Gatton

Additional project members who provided support services and reviewed training program content:
Elaine Brough, Extension Entomologist, CTPM, UQ
John Hargreaves, Senior Entomologist, DPI Redlands
John Hall, Consultant, Crop Tech Research, Bundaberg
Peter Deuter, Senior Extension Horticulturist, DPI Gatton

APPENDIX 1 : WORKSHOP MANUAL PROVIDED TO PARTICIPANTS

IDENTIFICATION OF INSECTS AND ARACHNIDS

IN VEGETABLE CROPS

A Workshop manual

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INTRODUCTION

Many small creatures reside in your crop. Insects, spiders and mites will make up a large number of these. Some can easily be seen, while others can only be found with the aid of a magnifying lens or microscope.

Insects are very important members of the animal world. They make up about three-quarters of the known animal species with over 1 million species. Spiders and mites are collectively called arachnids and have around thirty thousand species. Other arachnids are ticks and scorpions.

The vast majority of insects and arachnids are not pests of agricultural crops. Many have a beneficial role as pollinators of plants and as predators or parasites of pests and weeds. But these "beneficials" can easily be harmed by the same insecticides used to control crop pests! With careful protection and proper management, parasites and predators will often prevent the build up of pests to numbers that cause significant crop damage - and you can reduce the amount of pesticide you use.

Proper identification of the insects and arachnids in your crop is the first step towards successful management of pests and beneficials.

BASIC IDENTIFICATION OF INSECTS AND ARACHNIDS

Insects and arachnids belong to a large division of animals called arthropods. Arthropods have a hard external skeleton or shell (compared with a bony internal skeleton as in mammals, reptiles, amphibians and fish) and jointed limbs. Crustaceans (crabs and crayfish) and myriapods (millipedes and centipedes) are other common arthropods.

Arthropods

The different arthropods can be most easily identified by their number of legs (including claws) and antennae:

* Insects have six legs and one pair of antennae.

Wasp Butterfly Beetle Thrip

Insects have a distinct head, thorax and abdomen. Wings and legs are attached to the thorax. Insects are the only arthropods with wings. Not all species have wings, and only adult forms have them fully developed.

* **Arachnids** have eight legs and no antennae.

Spider Mite Scorpion Tick

Arachnids have a fused head and thorax.

* **Crustaceans** have ten or more legs and two pairs of antennae.

Crayfish

Crustaceans have a separate head, thorax and abdomen, but in many species the head and thorax appear fused.

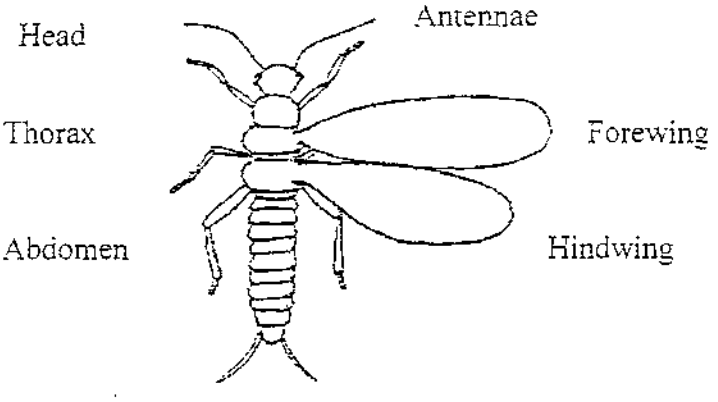
* **Myriapods** have ten or more legs and one pair of antennae.

Centipede

Myriapods have many body sections.

Key points for identification

The key points used to identify different insects are body shape and wing structure.

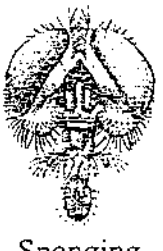


Mouthparts are harder to see, but can be used to identify how an insect feeds and what damage it is likely to do.

Chewing mouthparts

Piercing/sucking mouthparts

Coiled sucking mouthparts



Sponging mouthparts

Chewing/lapping mouthparts

Orders

Insects and arachnid species are classified into groups called orders. Species that belong to the same order often have similar characteristics that can be used for identification, and often cause similar damage. But there are always exceptions to the rule, and this manual will not always be able to outline all those exceptions.

There are many orders of insects and arachnids. This manual will concentrate on identifying the orders which are important to agriculture. Those orders are:

Insects
- Moths and Butterflies (Lepidoptera)
- True bugs (Hemiptera)
- Leafhoppers, Aphids and Scales (Homoptera)
- Thrips (Thysanoptera)
- Beetles (Coleoptera)
- Crickets and Grasshoppers (Orthoptera)
- Earwigs (Dermaptera)
- Flies (Diptera)
- Wasps, Bees and Ants (Hymenoptera)
- Lace Wings (Neuroptera)
- Dragonflies and Damselflies (Odonata)

Arachnids
- Mites (Acarina)
- Spiders (Araneae)

INSECT AND ARACHNID LIFE CYCLES

In insects and arachnids, the process of developing from egg to mature adult is called the life cycle. Species within the same order will have similar life cycles. Understanding these life cycles helps to identify young pests and beneficials and contributes towards a better understanding of how pests cause damage.

Metamorphosis

Newly hatched insects and arachnids change in form as they develop into adults. This process of change is called metamorphosis. There are three different types of metamorphosis - complete or abrupt metamorphosis, gradual metamorphosis and incomplete metamorphosis. All three types of metamorphosis are found in the insect orders; arachnids undergo gradual metamorphosis.

Insects and arachnids shed their external skeleton periodically during development. This is called 'moulting'. Between periods of moulting the insect is called an instar. The adult stage is reached when the insect or arachnid is fully developed with functional reproductive organs, and (in the case of winged insects) functional wings.

Complete Metamorphosis

- The young insects are called larvae (singular - larva).
- The changes from larva to adult are very distinct.
- Larvae do not resemble adults.
- Larvae often feed in habitats that are different to the adults.
- When a larva is fully grown, it forms a pupa. The pupa is an inactive, non-feeding stage during which the adult structures (including wings) are formed. Once the adult is formed, it emerges from the pupa.

Examples: Butterflies, moths, beetles, bees, wasps, flies, lacewings.

Gradual Metamorphosis

- The young insects are called nymphs. Nymphal stages correspond with instars.
- Nymphs generally resemble adults.
- The changes from nymph to adult are gradual.
- Wing development is external, with wings showing first as small buds that get larger with each instar.
- Nymphs feed in the same habitat as adults.

Examples: Bugs, grasshoppers, thrips, earwigs.

Incomplete Metamorphosis

-This type of metamorphosis is found only in the order Odonata.
- Nymphs do not resemble adults.
- Nymphs are aquatic with gills.
- Development of the nymphs is gradual. The adult form emerges on the final moult.
- Adults have wings.

Examples: Dragonflies and damselflies.

Feeding Habits

In its developing phase as a larva or nymph, an insect or arachnid uses most of its energy to grow. It will consume large amounts of food, so pests will usually do the most damage during this phase; parasites and predators will do the most good!

During adulthood the insect uses most of its energy on reproduction and moving around so may not eat as much.

An Example of Complete Metamorphosis

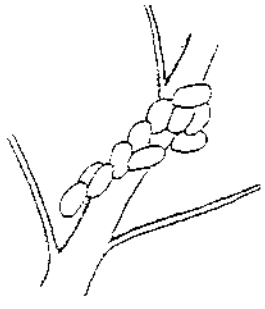
Cabbage Moth
(Plutella xylostella)

The life cycle of the Cabbage Moth takes three to seven weeks to complete depending on temperatures.

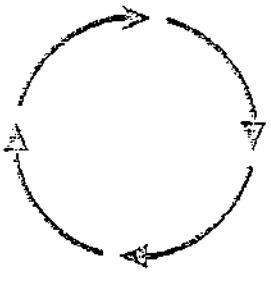
The Cabbage Moth female lays eggs singly or in small groups on leaves or stems of plants. The eggs hatch after three to eight days and the colourless caterpillars start feeding on the leaf tissue. They feed and grow for 10 days to a month and become bright green as they mature.

The caterpillars then spin flimsy, gauze like cocoons and pupate inside them. The brown pupae grow inside the cocoons for one or two weeks, then the adult Cabbage Moths emerge.

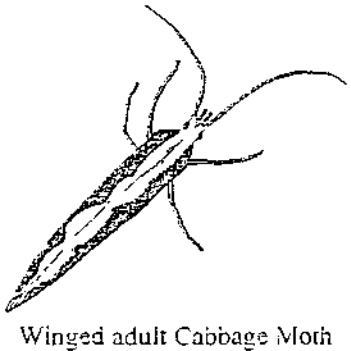
Caterpillars feed and grow in size



Eggs laid on along the veins of a leaf



Pupa inside a cocoon



Winged adult Cabbage Moth

The Lifecycle of the Cabbage Moth

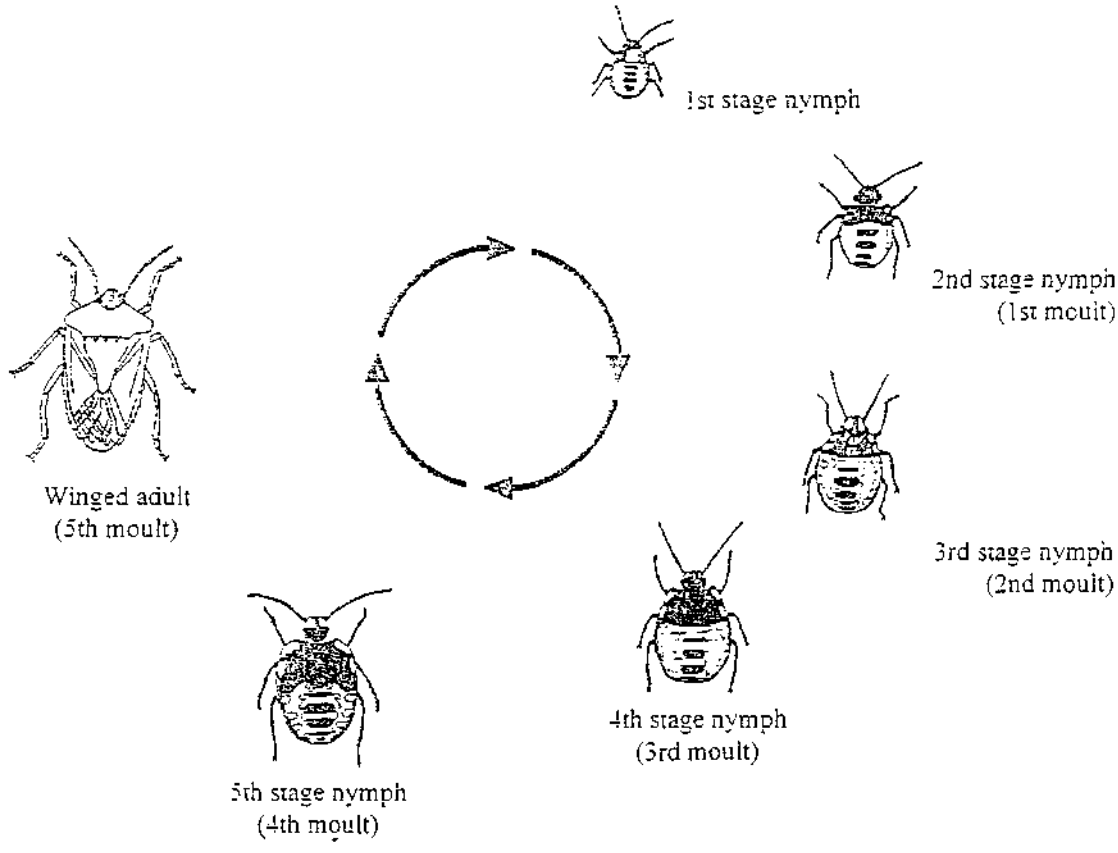
An Example of Gradual Metamorphosis

Green Vegetable Bug
(Nezara viridula)

The Green Vegetable Bug's life cycle from egg to adult is five to eight weeks in duration, depending on temperatures.

The female lays clusters or rafts of 20 to 150 eggs on the lower surface of leaves. The eggs hatch in five to nine days and the newly emerged nymphs are orange brown in colour. The nymphs undergo five moults and first develop black, yellow and red patterns. Later nymphal stages are mainly green in colour.

The adult Green Vegetable Bug is winged and is grass green in colour.

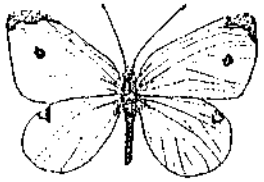


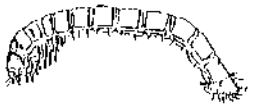
The Lifecycle of the Green Vegetable Bug

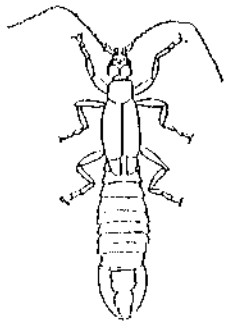
Order	Example	Basic Identification	Feeding Habits
Neuroptera Lacewings	 Brown Lacewing	Adults- 4 clear wings with many veins that are much larger than the insect's body. Chewing mouthparts. Fragile appearance; weak, erratic fliers. Larvae - Well developed thoracic legs, no abdominal legs. Large mandibles for grasping and piercing prey. Some (like antlions) dig pits to catch prey.	The adults of some species are active predators on other insects and arachnids. Larvae of all species are strong predators.
Hymenoptera Wasps Bees Ants	 Diadegma Wasp  Bee  Ant	Adult - 4 clear membranous wings. Worker ants are usually wingless. Most species have a constricted "waist" between the abdomen and thorax. Mouthparts are mainly biting/chewing, adapted in some species to lap up liquids. Female wasps and bees have a strong ovipositor - sometimes developed as a defensive sting. Larvae - usually soft bodied and legless. They are rarely seen as they are protected in nests, hives or the bodies of parasitised hosts. Most ant, many bee, and some wasp species are social insects, living in hives or nests. Social ants and bees have a strong "sexless" working class, with only one reproducing female in each nest or hive.	Most wasps are predators or parasites of other insects and arachnids. Eggs are laid in the eggs, larvae or adults of hosts. A few wasp species are plant parasites and lay their eggs in leaves or stems of plants. Bees feed on nectar and pollen and are important pollinators and produce honey and beeswax. Ants are usually scavengers. They often protect and spread sap sucking insects like scales, mealy bugs and aphids for their sugary secretions. They may harvest planted seeds. Some ants are predators of other insects.

IDENTIFICATION OF THE MAJOR ORDERS

Insects undergoing complete metamorphosis

Order	Example	Basic Identification	Feeding Habits
Lepidoptera Moths Butterflies	 Moth  Cabbage White Butterfly	Adults - 4 large coloured wings covered with small scales. Moths fold their wings along their body; butterflies fold them vertically. Moths generally have thicker bodies. Coiled, sucking mouthparts. Larvae - Soft bodied, elongated. Chewing mouthparts, 6 legs on thorax, 4 to 8 false legs on abdomen. Often called caterpillars or grubs.	Adults feed on nectar and other liquids. They may be minor pollinators. Larvae are usually the damaging stage. Most species are plant feeders. Many species are surface feeders on leaves, stems and fruit; some are leaf miners or fruit borers; occassionally stem borers. A few species are predators on other insects.
Diptera Flies	 Housefly	Adults- 2 clear membranous forewings (hindwings are replaced by small club-like structures). Usually large eyes. Larvae - Soft bodied, small, legless and elongated. Often called maggots.	Larvae of most species feed on decaying organic matter. A few are predators of other insect pests. A few feed on living plant tissue as fruit, leaf or stem borers. Adults feed on nectar, plant sap or liquid from rotting organic material. A few suck blood from other animals. Some are important pollinators.

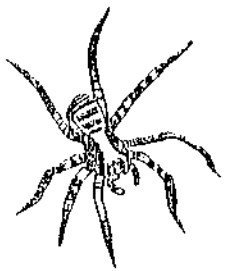
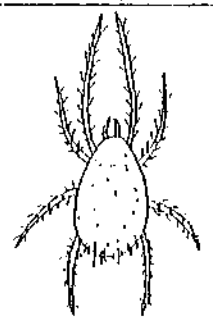
Order	Example	Basic Identification	Feeding Habits
Coleoptera Beetles ♦ Pasture beetles ♦ Leaf beetles ♦ Wireworms ♦ Weevils ♦ Woodborers ♦ Ladybird beetles	 Red Shouldered Leaf Beetle  False Wireworm  Weevil  Transverse Ladybird	There are a wide range of beetle species with widely different shapes. As a general description: Adults- 4 wings. The forewings form a hard cover for the clear membranous hindwings. They are hard bodied and have chewing mouthparts. Larvae - 6 thoracic legs, no abdominal legs. Chewing mouth parts.	Most beetle species feed on plants and stored products. Many are scavengers, while a few are predators of other insects. Adults feed on the leaves, stems and fruits of many plants. Larvae attack leaves, stems and roots. Many species are borers in stems.

Order	Example	Basic Identification	Feeding Habits
Dermaptera Earwigs	 Black Field Earwig	4 wings (a few wingless species), forewings very short and hard, covering clear membranous hindwings. Body is elongated and flattened, forceps on the end of abdomen. Chewing mouthparts. Nocturnal, living in soil cracks, under logs or rocks, and in rotting timber or other organic matter.	Most species are scavengers, eating both plant and animal material. Will occassionally chew on live plants, often young seedlings as they emerge from the soil. A few species are predators of other insects.

Insects undergoing incomplete metamorphosis

Order	Example	Basic Identification	Feeding Habits
Odonata Dragonflies Damselflies	 Dragonfly	Adults - 4 long, narrow, clear membranous wings, held rigidly at right angles to the body. Body is elongated and slender. Chewing mouthparts. Nymphs - aquatic and do not resemble adults.	Adults are predators of flying insects. Nymphs are predators of small aquatic animals.

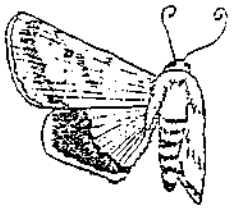
Arachnids undergoing gradual metamorphosis

Order	Example	Basic Identification	Feeding Habits
Areneae (Arachnida) Spiders	 Wolf Spider	Spiders have no wings, 8 legs, a head and thorax that are fused together. Usually have chewing mouthparts, with strong mandibles.	All spiders are predators of insects and other small animals. Some species stalk their prey, others wait in hiding and jump on it, while others snare it in webs.
Acarina (Arachnida) Mites	 Chilean Predatory Mite		Many species of mites are predators of other mites and small insects. Others feed on plants, chiefly by rasping the surface cells of leaves and stems and eating the contents. Some cause a russeting of leaves and stems, others cause blisters or galls.

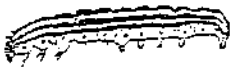
SPECIFIC PESTS AND BENEFICIALS THAT ARE IMPORTANT IN VEGETABLE CROPS

MOTHS AND BUTTERFLIES
(Lepidoptera)

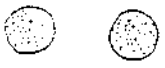
Heliothis
(also known as Budworm or Corm Ear Worm)
Helicovera spp.



Adult



Larva



Egg

Heliothis larvae feed as leaf eaters, bud and fruit borers on a wide range of plants.

- On lettuce and brassicas, caterpillars feed on the outer leaves and then feed towards the heart or centre of the plant
- In tomato crops, eggs are laid on the flowers and fruit. Young caterpillars burrow into flowers causing them to fall and cause pinhole damage to very young tomato fruit. Older caterpillars burrow into the fruit creating holes and encouraging rots to occur.
- In capsicum, caterpillars feed on the fruit and the seed inside the fruit.
- In sweet corn, caterpillars feed on the silks and the developing grains on the cob tip and sometimes on the leaves.
- In french beans and peas the caterpillars feed on the flowers, pods and developing seed inside the pods.

Adults have a wing span of 35 to 45 mm. Forewings are fawn or reddish brown, hind wings are cream with dark outer margins.

Young caterpillars are hairy, with black heads and cream, dark spotted bodies. Mature caterpillars are up to 50 mm long, vary in colour from green, yellow, brown to almost black. They have stripe like markings and their body segment is angled sharply downward.

Eggs are round, with a ribbed pattern; cream turning brownish as eggs mature.

Loopers
Chrysodeixis sp. -

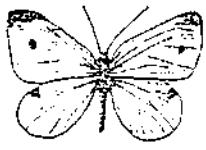
Larva

Eggs

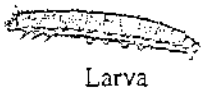
Looper larvae feed on the leaves and fruit of a wide range of vegetable crops including brassicas, lettuce, and tomatoes. The caterpillars grow up to 25cm in length and are green or blue green with white stripes along the back. They are easily identified by their distinctive 'looping' movement.

Smooth, oval eggs; white, turning bone as they mature

Cabbage White Butterfly
Pieris rapae



Adult



Larva

Egg

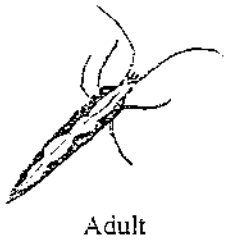
The larvae of the Cabbage White Butterfly are leaf eaters. Young caterpillars feed on the outer leaves of cabbage, cauliflower and broccoli plants. Mature caterpillars feed on outer leaves of cabbage hearts, and the curd of broccoli and cauliflower.

Adults have conspicuous black dots on their forewings.

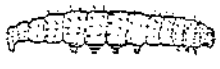
Young caterpillars are light green and opaque, mature caterpillars are 20 to 30 cm long, dull green and velvety with yellow stripes along the midline of their bodies.

Eggs are ribbed and bullet shaped; pale yellow turning orange yellow as eggs mature.

Cabbage Moth
Plutella xylostella



Adult



Larva

Egg

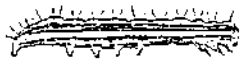
Caterpillars mine leaf tissues when they first hatch. Within a day or so they emerge to feed on the underside of leaves causing holes or windows. Caterpillars can damage the heart of cabbages and heads and stems of broccoli and cauliflower.

The buff coloured moth has a diamond shaped pattern on its folded wings.

Caterpillars are creamy green when mining the leaf tissue. When mature, caterpillars are bright green, plump and 10 mm long. Caterpillars wriggle backwards and drop from the plant on a thread when disturbed.

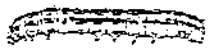
Eggs are oval, flat and smooth; pale yellow, turning dark yellow with brown markings at one end as they mature. Stuck singly or in small groups near the leaf veins.

Cluster Caterpillar
Spodoptera litura
and
Cabbage Cluster Caterpillar
Crocidolomia binotalis

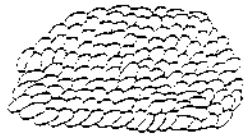


Cluster Caterpillar Larva

Cluster Caterpillar eggs



Cabbage Cluster Caterpillar Larva



Cabbage Cluster Caterpillar eggs

The larvae of both Cluster Caterpillar and Cabbage Cluster Caterpillar are leaf chewers in lettuce and brassica crops. Cluster Caterpillar is also a minor pest of tomatoes. Caterpillars feed in groups when young and tend to skeletonize the leaves they feed on. Older caterpillars produce a silken web.

Cluster Caterpillars are greyish brown, hairless with black triangles along the side of their bodies.

Cabbage Cluster Caterpillar is often difficult to distinguish from Cluster Caterpillars. It is hairy, with a more striped appearance.

Eggs of both species are laid in batches on the leaves.
Cluster Caterpillar eggs are round and smooth; cream, turning brownish cream when mature. Covered in gray/brown hair.

Cabbage Cluster Caterpillar eggs resemble overlapping scales. They are cream coloured, turning orange/yellow as they mature..

Potato Moth (Tomato Leaf Miner)
Phthorimaea operculella

Adult

Larva

Leaf miners and fruit borers in tomato, potato and capsicum. Damage to seedlings is common. Caterpillars mine the leaf causing an irregular brown blister. They may also tunnel into the leaf stalk and stem causing extensive damage. Larvae enter the fruit under the calyx or where two fruit touch. Larvae also tunnel into growing or stored potato tubers.

The adults are small, night flying moths with a wingspan of 12 mm. Colour is grey-brown.

Caterpillars are 10 - 12 mm long, cream, pale green or pale pink in colour with a dark head.

Eggs are very small, white and laid singly on the underside of leaves and fruit calyx.

Centre Grub
Hella hydralis

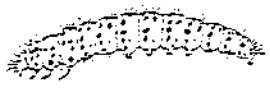
Larva

Larvae are stem borers in brassica crops. Young caterpillars burrow into the growing point of the plant. The tunnelling of the centre grub causes the death of seedlings or multiple branching. If older plants are attacked heads are usually unmarketable.

Caterpillars are pale yellow, with a dark head and seven brown stripes along their bodies.
The adult moth is gray with buff coloured markings on the wings.

Eggs are pale yellow, small, oval and laid on the young parts of brassica plants.

Bean Pod Borer
Maruca testulalis



Larva

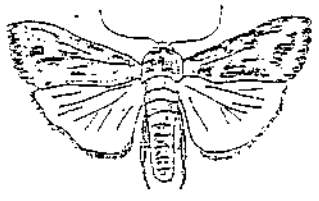
Larvae bore into flower buds and pods of beans and other legumes. Pods and flowers are often webbed together to form shelters for the feeding caterpillars.

Mature caterpillars are 20mm long, cream yellow or green with dark spots and a brown to black head.

Adult moths have yellowish brown forewings with white spots; hindwings are grey/white with a brown fringe.

Eggs are cream/yellow, oval and laid near flower buds.

Cutworms
Agrostis spp.



Adult

Larva

Cutworms feed on most vegetable crops. Larvae usually feed at night on the stems of seedlings near ground level. The seedling is often completely severed - and wilts and dies. Occassionally curworms climb mature plants and feed on the foliage.

Caterpillars are either black, green-brownish, pink-brown or grey. During the day, they may be found curled up in the top soil near damaged plants.

TRUE BUGS (HEMIPTERA)

Green Vegetable Bug
Nezara viridula


Adult


Nymph

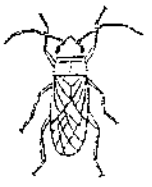

Egg

Adults and nymphs feed by sucking sap from young plant tissues, fruits and seeds. A wide range of vegetable crops is attacked. Feeding causes distorted growth, death of seeds and dry and corky fruit tissues. Attacked fruit are small, mottled and blemished.

Adults are 15mm long, green in warm weather and brownish grey in cool weather. Emerging nymphs are bright orange brown and wingless. As nymphs mature they are first marked with patterns of black, yellow and red then they turn green and develop wings.

Dark, barrel shaped eggs are laid in rafts.

Rutherglen Bug
Nysius vinitor


Adult

Adults and nymphs suck sap from leaves, stalks and fruits of a wide range of crops. Often attack in large swarms. If infestation is severe, leaves and shoots will wilt and die.

Adults are 5mm long, grey brown with a narrow body. The nymphs are pear shaped, wingless and reddish brown.

Assasin Bug
Coranus trabeatus


Adult

Adults and nymphs are predators of a range of insects, many of which are pests.

Adults can be 10 to 30mm in size. The head is well defined and the abdomen has a slight waist. The mouthpart is a strong curved beak used for piercing and sucking the body fluids from its prey.

Predatory Shield Bug
Oechalia schellenbergii


Adult

Adults and nymphs are predators on large caterpillars like Loopers and Heliothis. It uses its short mouthpart to impale the caterpillar and suck the body fluids.

The adult is 9-12mm long, mottled grey to brown with a large lateral spike on each side of the thorax.

Damsel Bug
Nabis spp.

Adult

Nymphs and adult Damsel Bugs pierce and suck the contents of eggs and caterpillars of Heliothis, loopers, leafhoppers, aphids and spider mites.

Adults are 7-9mm long with a tan or grey slender body. They have long legs and antennae.

LEAFHOPPERS, APHIDS, SCALES AND MEALY BUGS (HOMOPTERA)

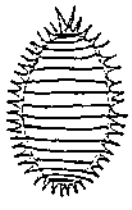
Vegetable Jassid
Austroasca viridigrisea

Adult

Adults and nymphs feed by sucking the sap from young shoots. fruit and leaves, often leaving small white spots. It is a pest in a wide range of vegetable crops including tomatoes, capsicums, and potatoes. Large populations may retard crop growth.

Adults are up to 4mm long and torpedo shaped. Both adults and nymphs are bright green.

Citrus Mealy Bug
Planococcus citri



Adult

Citrus mealy bug is a pest on oranges, grapefruit, passionfruit and custard apples. Nymphs feed by sucking sap from protected areas like the navel end of fruit. Secondary rots, sooty mould, early ripening and fruit fall are major damage.

Adults are oval shaped and covered with a white powder. Adult females are 3-4mm long and wingless. Adult males are 2mm long with one pair of wings. Nymphs are yellow and not covered in powdery wax.

Green Peach Aphid
Myzus persicae

Adult

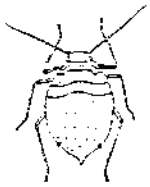
This aphid feeds on a wide range of vegetable crops, stonefruits and weeds by sucking the sap of leaves, growing points and fruits. Severe aphid attacks may result in leaves and fruit turning yellow, shrivelling and falling off. The adult and nymphs can transmit viruses when they feed.

Adults are 1.5 to 3mm long. Wingless adults can be green to pale yellow to pink. Winged adults are green with dark stripes on the abdomen. Nymphs are olive green.

Bean Aphid

Young plants attacked by aphids may look yellow and have retarded growth. Heavy infestation of aphids can cause malformed pods.

Grey Cabbage Aphid
Brevicoryne brassicae

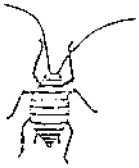


Adult

Adults and nymphs feed on brassicas by piercing softer tissues and sucking the sap. Under heavy aphid infestation plant growth may be suppressed and leaf curling may occur.

Adults are 2-3mm long, grey in colour and have a mealy covering. Nymphs are greenish.

Sowthistle Aphid
Hyperomyzus lactucae



Adult

Sowthistle aphid breed on the sowthistle weed and spread virus diseases to crops such as lettuce.

Winged and wingless adults are 2-3mm long. Adults and nymphs are light green in colour.

Mango Scale
Aulacaspis tubercularis

Scales feed in clusters on the upper and lower surface of the leaves forming white spots. Scales suck the sap of the leaves and can cause premature leaf fall.

The adult scale is small, yellow, pear shaped insect covered by a white papery scale. The female's scale is oval and 2.5mm long; the male's scale is about 1mm long and almost rectangular in shape.

Oleander Scales

These scales attack the leaves of oleander, palms and other semitropical plants.

THRIPS (THYSANOPTERA)

Onion Thrips
Thrips tabaci

Adult

Adults and nymphs feed on the leaves of onion crops. They rasp the leaf surface and suck the sap leaving a white flecked or silvery white leaf. Bulb size may be affected if the thrips population is large (> 50 thrips/plant).

Adults are 2mm long and yellowish-grey to brownish in colour. Immature thrips are creamy yellow.

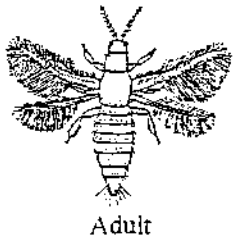
Plague Thrips
Thrips imaginis

Adult

Adult Plague Thrips feed by rasping the surface cells and sucking the sap from the blossoms of weeds, fruit trees, vegetables and ornamental garden plants. Immature thrips feed upon young leaves and the pistil and stamens inside the flowers. This can interfere with fruit set and damage young fruit.

Adults are light brown and 2mm long (drawing shows thrips with folded wings). Immature thrips are creamy yellow.

Bean Blossom Thrips
Megalurothrips usitatus



Adult

Adults and nymphs feed by rasping and sucking in the flowers when the pod is being formed. This feeding causes the pods to twist and curl thus being unmarketable. Adult thrips feeding on maturing pods may cause russetting.

Adults are dark brown and about 1.5mm long. Immature thrips are pale yellow and emerge from eggs laid in plant tissues. Older nymphs are deep yellow or orange red.

GRASSHOPPERS AND CRICKETS (ORTHOPTERA)

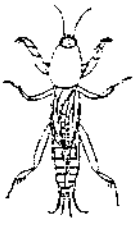
Wingless Grasshopper
Phaulacridium vittatum

Adult

Adults males are smaller than adult females. Shanks of adults are red and wings are reduced to small scales. The hoppers resemble adults but are smaller in size.

Adults and hoppers chew the leaves of grasses, weeds and a range of vegetable and fruit crops.

Mole Cricket
Gryllotalpa spp.

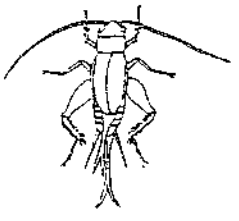


Adult

The mole cricket burrows in the soil and chews on the roots or tubers of potatoes, pasture grasses and other crops. It also feeds on seedlings.

Adults are 40mm long and brown in colour. Their forelegs are broad and flat to assit them with digging. Nymphs resemble adults but are smaller.

Black Field Cricket
Teleogryllus commodus



Adult

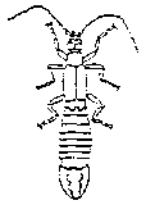
The adults and nymphs feed on vegetables, pastures and field crops causing seed, seedling and root damage. Some crops fail to emerge because of damage to germinating seed.

Adults are 25-30 mm long and black in colour. Adult males have rough wings which produce a song when rubbed together.

EARWIGS (DERMAPTERA)

Black Field Earwig

Nala lividipedes



Adult

Adults and nymphs feed mainly on decaying organic matter, but may chew young seedlings of many vegetables as they emerge. They also feed on the roots of some crops.

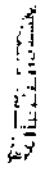
Adults are small, shiny black and up to 12mm long. They have short wings and a pair of pincers at the end of the abdomen. Nymphs are pale white but change to brown as they mature.

FLIES (DIPTERA)

Queensland Fruit Fly

Dacus tryoni

Adult



Larva

Egg

Larvae are fruit borers. Maggots feed on most cultivated fruits including tomato and capsicum. Adult females lay small batches of eggs beneath the surface of the fruit. The larvae hatch as the fruit ripens, then tunnel in the flesh. Rots soon develop and skin discolouration occurs around the sting mark.

The adult is 8mm long, has red and yellow markings and is "wasp-like" in appearance.

Larvae (maggots) are white and grow to 7mm long when mature.

Eggs are laid into plant tissue; white and sickle shaped.

BEETLES (COLEOPTERA)

Pumpkin Beetle
(Plain & Banded)
Aulacophora spp.

Adult

Adults feed in swarms by chewing on leaves, flowers and small fruit in cucurbit crops. Seedlings can be completely defoliated. Larvae feed on roots causing swelling and discolouring in the roots. This can check the growth of the plant. Fruit lying on the ground can also be attacked by larvae.

Banded adults are orange-yellow with 2 black bands across the wings. Plain adults are orange-yellow with no markings. Adults are 6mm long. Larvae are curl grubs, up to 12mm long and cream in colour.

28 Spotted Ladybird

Epilachna cucurbitae

Larva

Adult

Egg

Adults and larva feed by chewing on a range of vegetable crops. They feed mostly on leaves, but flower and developing fruit injury may also occur. Adults feed on the upper surface of the leaves and larvae mostly feed on the underside of leaves. This results in a fine transparent window remaining between the network of veins.

Adults are 6mm long, oval, yellowish brown with 24 to 28 black spots on the wing covers. Larvae are yellow and covered in many black, branched spines.

Smooth, bullet shaped eggs are laid in clusters on the underside of leaves and on plant stems; yellow, turning orange/yelow as they mature.

Red-shouldered Leaf Beetle
Monolepta australis

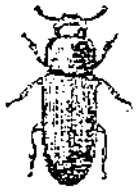
Adult

Adults feed in swarms on foliage and flowers.of avocados, lychee, macadamia nut, citrus, maize, stonefruit and cotton.
Larvae feed on plant roots - usually in pastures and grasslands.

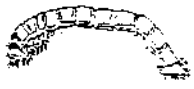
Adults are 7mm long, yellow with red shoulders. Larvae are small, cream coloured curl grubs.

Eggs are laid in the soil.

False Wireworm
Gonocephalum carpentariae



Adult



Larva

Larvae feed by chewing on germinating seed and young seedlings. Adults and larvae chew the base of seedlings of many plants including vegetable crops. Larvae may also tunnel into the stem.

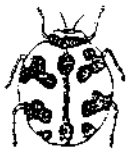
Adult beetles are 7-8mm long, broad and greyish black in colour. Larvae are slender, 30mm long, light brown with a dark brown head.

Cucurbit Stem Borer
Apomecyna histrio

Larvae are stem borers of cucurbits. This feeding causes the stem and leaf nodes to swell as they are filled with the excreta of the Stem Borer. A minor pest of choko, cucumber, marrow, melon, squash, zucchini.

Adults are 10 mm long, gray with white spots that make 3 conspicuous V marks across the wing covers. Larvae are up to 20mm long and cream in colour.

Transverse Ladybird
Coccinella repanda



Adult

Adults and larvae are predators of aphids, scales, mites, and the eggs and caterpillars of moths and butterflies.

Adults are yellow-orange with black V shaped marks on each wing cover. The mature larva has a yellow coloured mark on each side just behind the head.

Bean Fly

Ophiomyia phaseoli

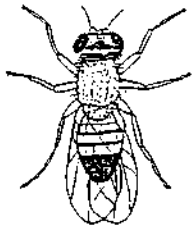
Adult

Larvae are leaf miners and stem borers of beans and some other legumes - first mining the leaves, then tunnelling into the lower stem where they pupate. Infested young bean plants will wilt and die. In mature plants, larval tunnelling will cause leaf stalks and stems to swell and crack. The plant is then susceptible to breaking in the wind at ground level. Surviving plants will have reduced yields. White puncture marks on bean leaves are symptoms of a bean fly infestation.

Adults are 3 to 5mm long and glossy black. Maggots are dark brown, about 2.5mm long, and can be found inside damaged stems.

Rot Fly

Drosophila spp.



Adult

Larva

Rot flies are attracted to and feed on well ripened fruit and other organic matter. The adult females lay their eggs on fruit that is decaying or damaged. Maggots develop and feed in the fruit.

Adults are 3mm long, reddish brown with bright red eyes. Maggots are 4mm long.

Tachinid Fly

Family Tachinidae

Adult

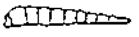
Larvae are internal parasites of a wide range of insect larvae and adults. Larvae of moths and butterflies are often targeted. The eggs of tachinid species are laid on the host. After hatching, the maggots bore into the host and feed on its tissues.

Adults are hairy and most species are grey in colour. Size of flies varies depending on the species.

Hover Fly

Family Syrphidae

Adult



Larva

Larvae are important predators of aphids. Adult hoverflies feed on nectar and pollen.

Adults resemble bees and wasps due to the black and yellow bands on their abdomen. Larvae are blind and slug like.

ANTS AND WASPS (HYMENOPTERA)

Diadegma Wasp

Diadegma spp.

Adult

Larvea are parasites of Cabbage Moth larvae. The wasp larva develops inside the Cabbage Moth caterpillar and in the pupal stage a wasp cocoon develops instead of a cabbage moth pupa. A Diadegma wasp not a cabbage moth emerges. These wasps can greatly reduce Cabbage moth numbers in brassica crops.

The adult is about 5mm long, black with yellow markings on the hind legs. It has a long thin waist.

Apanteles Wasp

Apantales glomeratus

Adult

Larvae parasitise Cabbage White Butterfly caterpillars.

Small, black adults appear stouter than Diadegma due to their shorter waist constriction.

Trichogramma Wasp

Trichogramma spp.

Adult

Larvae parasitise the eggs of a range of insects. The adult lays up to 3 eggs into the eggs of several insect pests like budworms.

Adults are very small wasps, black and with very little wing venation.

BEETLES (COLEOPTERA)

Pumpkin Beetle
(Plain & Banded)
Aulacophora spp.

Adult

Adults feed in swarms by chewing on leaves, flowers and small fruit in cucurbit crops. Seedlings can be completely defoliated. Larvae feed on roots causing swelling and discolouring in the roots. This can check the growth of the plant. Fruit lying on the ground can also be attacked by larvae.

Banded adults are orange-yellow with 2 black bands across the wings. Plain adults are orange-yellow with no markings. Adults are 6mm long. Larvae are curl grubs, up to 12mm long and cream in colour.

28 Spotted Ladybird

Epilachna cucurbitae

Larva

Adult

Egg

Adults and larva feed by chewing on a range of vegetable crops. They feed mostly on leaves, but flower and developing fruit injury may also occur. Adults feed on the upper surface of the leaves and larvae mostly feed on the underside of leaves. This results in a fine transparent window remaining between the network of veins.

Adults are 6mm long, oval, yellowish brown with 24 to 28 black spots on the wing covers. Larvae are yellow and covered in many black, branched spines.

Smooth, bullet shaped eggs are laid in clusters on the underside of leaves and on plant stems; yellow, turning orange/yelow as they mature.

Red-shouldered Leaf Beetle
Monolepta australis

Adult

Adults feed in swarms on foliage and flowers of avocados, lychee, macadamia nut, citrus, maize, stonefruit and cotton.
Larvae feed on plant roots - usually in pastures and grasslands.

Adults are 7mm long, yellow with red shoulders. Larvae are small, cream coloured curl grubs.

Eggs are laid in the soil.

LACEWINGS (NEUROPTERA)

Green Lacewing

Chrysopa spp.

Adult

Larvae are predators of a wide range of caterpillars, aphids, scale insects and moth eggs. Larvae clamp their jaws on soft bodied insects or eggs, then suck up the contents.

Adults are green to yellow in colour, 10 to 18mm long and have lacy, see-through wings. Larvae (aphidlions) are squat with 6 legs and sickle shaped jaws. They have long hairs and often camouflage themseleves with the remains of their prey.

Brown Lacewing

Micromus tasmaniae

Adult

Larva

Adults and larvae are both predators of moth caterpillars and aphids and their eggs. Larvae suck the contents of their prey through their large jaws and adults chew their prey.

Adults are pale brown and smaller than green lacewings. Their wings have a brown speckled appearance. Larvae are smooth with brown and white markings. They are longer and thinner than green lacewing larvae and do not camoflage themselves with the corpses of their prey.

DRAGONFLIES AND DAMSELFLIES (ODONATA)

Dragonfly

Macromia magnifica

Adult

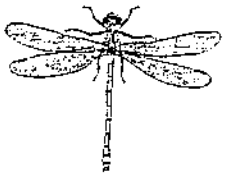
Nymph

Adults are predators of flying insects including moths, bugs and beetles. The aquatic larvae feed on small water animals, beetles, mosquito larvae etc..

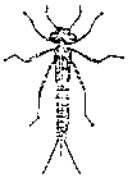
Adult are slender bodied with a large head. Forewings and hindwings are different in shape and venation. Nymphs do not resemble adults.

Damsel Fly

Archilestes californica



Adult



Nymph

Both adult and nymphs prey on a range of insects. The adults catch various insects in flight. Nymphs feed in the water on mosquito larvae and other small aquatic insects.

Adults are similar in appearance to dragonflies, but are smaller and forewings and hindwings are the same shape and have similar venation. Nymphs are aquatic.

SPIDERS AND MITES (CLASS ARACHNIDA)

Wolf Spider

Lycosa spp.

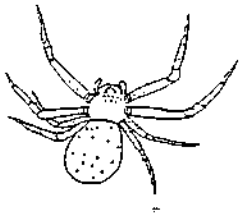
Adult

Wolf spiders are predators of insects including caterpillar pests eg. cotton budworm larvae.

Adults are about 18mm long and grey to brown with black, brown, grey or orange markings. They tend to be ground dwelling but may climb onto plants.

Flower Spider

Diaea spp.



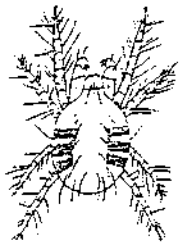
Adult

Flower spiders prey on small insects that are attracted to the pollen and nectar of flowers.

Adults are smooth, shiny and usually white with yellowish, crablike legs. They have often brightly coloured with flecks of red, brown and orange.

Two Spotted Mite (Red Spider Mite)

Tetranychus uerticae



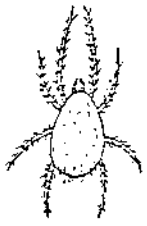
Adult

Adults and nymphs feed by puncturing surface cells on leaves and soft stems on a wide range of plants.

Individual mites are just visible to the naked eye being about 1.5mm long. Females are oval and pale green to yellow. They may change colour to orange or light red. Two dark spots can be seen on the females body. Males are smaller and elongate. Eggs are small, clear and round. As the embryo develops red eyespots can be seen with magnification. They are usually found on the underside of leaves surrounded by the webs that they spin. Feeding causes mottling and yellowing of leaves and reduced production.

Chilean Predatory Mite

Phytoseiulus persimilis



Adult

Predator of the Two Spotted Mite which is now being produced commercially for release into a number of horticultural crops for management of Two Spotted Mite.

Larger with longer legs than the two spotted mite. It has a shiny, orange, pear shaped body. Eggs are ellipsoid in shape and also larger. Two eye spots are not visible as they are in the two spotted mites. Juvenile predatory mites are a pale salmon colour.

APPENDIX 1 GLOSSARY

Anal legs or claspers	Soft fleshy prolegs at the end of the abdomen.
Antennae	A pair of short or long structures attached to the front of the insect's head. Can be slender, segmented, branched or feathery and sensitive to touch, smell and sometimes sound.
Chrysalis	The pupa of a butterfly.
Cocoon	The pupa of a wasp.
Egg raft	A cluster of eggs.
Eye spots	The head capsule of an insect within the egg which may become visible as the insect matures within the egg.
Forewings	The first pair of wings.
Halteres	Reduced hindwings which are used as balancing organs in flies.
Hindwings	The second pair of wings.
Instar	The term for immature insects between moults.
Larva	The immature stage of insects which hatch from eggs and pass through a complete lifecycle (common terms: grub, caterpillar, maggot).
Metamorphosis	A change of form. The phase between the egg and adult life stages of insects.
Moult	The shedding of skin from the previous instar.
Mouth parts	The chewing, sucking, rasping and sucking, or sickle shaped part of the head which takes in food. The mouth parts determine both the type of food the insect feeds on and how it is obtained.
Nymph	Immature stage of insects which undergo gradual metamorphosis.
Prolegs	Soft fleshy legs usually attached to the abdomen.
Pupa	The stage between the larva and the adult (sometimes called cocoon or chrysalis).
Thoracic legs	Legs attached to the thorax.
Thorax	The section between head and abdomen in an adult insect's body to which the legs and wings are attached.
Wing venation	The pattern of veins in an insect's wings.

APPENDIX II FORMAT OF INSECT IDENTIFICATION WORKSHOP

Workshop objectives

At the conclusion of 4 x 2 hour sessions, participants will:-

a) Know how to collect and preserve insects for identification.

b) Be able to classify most common insects (particularly those of horticultural significance) into broad groups.

c) Appreciate the importance of these groups in pest, predator and parasite identification and management

d) Have collected and classified some insect pests, predators and parasites of horticultural importance.

Workshop sessions

The workshop will consist of 4 x 2 hour sessions consisting of:

- 1 classroom/laboratory session
- 1 field session
- 2 week insect collection period
- 1 classroom/laboratory session
- 1 field session

Laboratory/classroom session are for presenting information and discussingthe following topics:-

- Insect classification (relationships with other animal groups, particularly spiders).
- Insect groups
- Horticulturally important examples
- Collecting and preserving insects
- Practical period for identifying examples from each of the major groups
- Significance of the groups in identification and management

Field sessions are to gain practical experience in finding insects in crops and understanding their interaction with other insects.

Insect collection

Participants will be expected to collect and preserve 20 specimens of pests, parasites and predators of horticultural significance during the workshop.

Assessment

Participants will be assessed on their ability to classify the insects collected.

APPENDIX III

FIELD COLLECTION LIST

Twenty insects, spiders and mites are to be collected and preserved. Try to find at least some predators and parasites important to commercial horticulture.

Lepidoptera	2 adults (different species)
Hemiptera	2 adults (1 Heteroptera, 1 Homoptera)
Thysanoptera	1 specimen
Coleoptera	1 adult
Orthoptera	1 specimen
Dermaptera	1 specimen
Hymenoptera	2 adults (different species)
Neuroptera or Odonata	1 adult
Orthoptera	1 specimen
Class Arachnida	1 specimen
Plus	2 nymphs (from different orders)
	2 larvae (from different orders)
	2 eggs (from different orders)

APPENDIX 2 : SAMPLE OF PARTICIPANT SKILLS EVALUATION SHEETS USED IN PROGRAM

VEGETABLE INSECT, SPIDER AND MITE IDENTIFICATION WORKSHOP

We would like to check this group's learning progress so that we can make appropriate adjustments to the information we present to you and other groups. Without using your manual, please answer the following questions. This isn't an exam, so we don't require your name.

Question 1 Circle the appropriate number

An insect has ..... 4 6 8 ..... legs

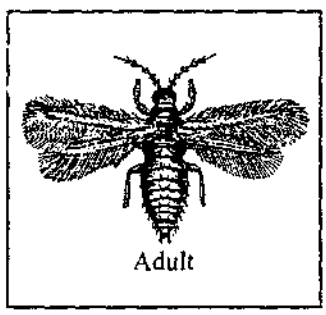
An insect has ..... 0 2 4 ..... antennae

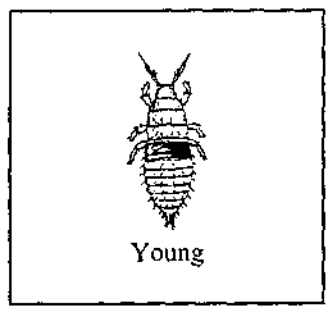
A mite has ..... 4 6 8 ..... legs

A mite has ..... 0 2 4 ..... antennae

Question 2 The following pictures are of an adult insect and one of its its younger stages in its life cycle. Which type of metamorphosis or change does each example represent? Circle the appropriate answer.

Example A



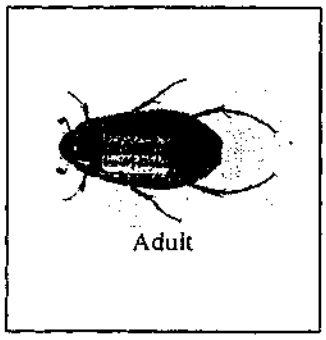


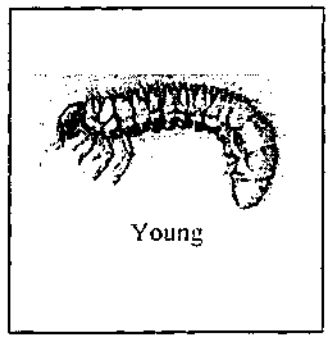
This is an example of .....

Gradual Metamorphosis

Complete Metamorphosis

Example B



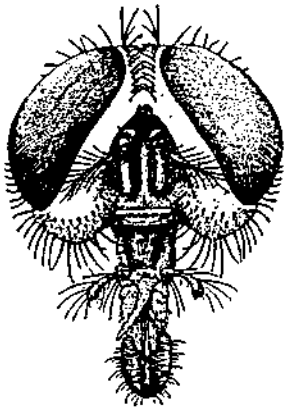


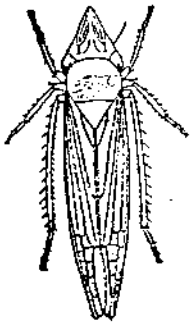
This is an example of .....

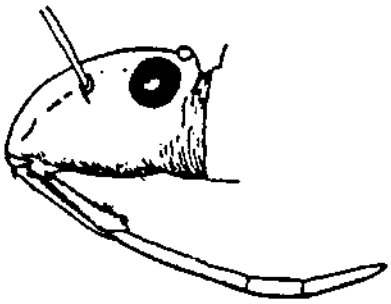
Gradual Metamorphosis

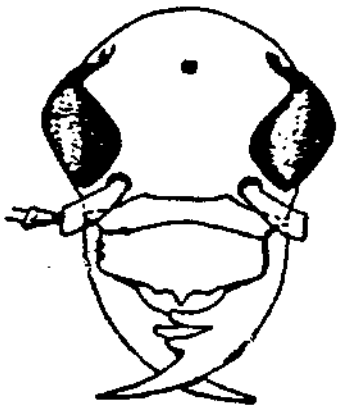
Complete Metamorphosis

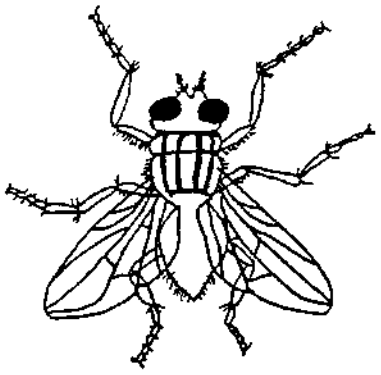
Question 3 Draw a line connecting the insect to the appropriate mouthparts











Question 4 Name the group or order to which these belong and list two features that helped you to decide what each one was.

This is a .....

Features that helped me decide

a).....

b).....

This is a .....

Features that helped me decide

a).....

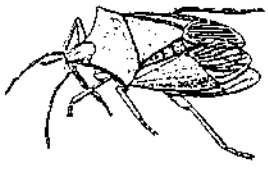
b).....

This is a .....

Features that helped me decide

a).....

b).....



This is a .....

Features that helped me decide

a).....

b).....

APPENDIX 3 : DETAILS OF FORMAL EVALUATION CONDUCTED ON CONCLUSION OF PROGRAM

Evaluation of Pilot workshops on the Granite Belt

IDENTIFICATION OF INSECTS, SPIDERS AND MITES
in vegetable crops

Suggested agenda and process for the meeting 15 June 1995 - 2.00pm to 4.30pm

1. Reconstruct the awareness meeting, four workshop sessions (main focus) and evaluation BBQ using butchers paper. Particularly look at:
- the main objectives of each session/meeting
- were the methods/materials used suitable?
- did we achieve the objective?

2. Look back over the overall workshop objectives. From the workshop manual these were:
- Know how to collect and preserve insects for identification
- Be able to classify most common insects into broad groups
- Appreciate importance of these groups in pest, predator and parasite ID & management
- Have collected and classified some insect pests, predators & parasites from hort crops

Did the workshop achieve these objectives?
- by looking back over the information generated during reconstruction of the workshop (see 1.)
- by going through the evaluation results from growers

3. How can we improve the workshop process?
How can we improve the manual? How to best upgrade the manual into colour?
How useful were the collections?

4. How can we (better) build the evaluation into the workshop process?
According to Bromley and Kitson (a pair of evaluation gurus) there are four types of evaluation:
- *Reaction - usually a questionnaire and commonly the only evaluation done because its relatively simple, doesn't really say much except how well or little participants enjoyed the experience*
- *Learning - measuring of principles, facts, skills and attitudes, short exam type of sessions probably gave us some of that information*
- *Behaviour - what has changed as a result of the training?*
- *Results - changes in behaviour leading to concrete changes at the farm level*

The last two are difficult to evaluate and farmer participation would be useful as it involves some before and after measurement of ????? ... $ spent on chemicals? $ spent on predatory mites? on bugchecker? I don't know how to tackle these one but I'd like some feedback on the above ideas (if we have time). I also think that at some stage we need to have a look at mechanisms for helping interested growers to continue learning about IPM. Andy mentioned something about this already.

5. Action plans (rough and ready) for the main project which starts in July
- Who does what
- When -deadlines

Possible locations for workshops and timetable - next season?