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Foreword

Although the Australian olive industry is 150 years old, recent rapid industry expansion in all mainland states has led to increased problems with pests and diseases not previously encountered. Arthropod pests and diseases are often key constraints to economic production through their effects on both yield and quality. Apart from diseases caused by living organisms (pathogens), olive trees are also subject to disorders resulting from adverse environmental conditions and cultural practices. While Australia appears to be free of a number of cosmopolitan olive pests and diseases, the industry is vulnerable to their introduction.

This book originated from a national RIRDC-funded project on sustainable pest and disease management in the Australian olive industry, and was one of its major recommendations. Apart from invertebrate pests and disease-causing organisms, many other symptoms of damage to plants and fruit were encountered which are likely the result of physiological and other disorders due to irrigation or nutrients. In addition, a national survey conducted as part of the project indicated that while a number of growers thought they could identify pests and diseases, few could recognise beneficial species in their grove. This field guide takes all of these issues into account.

This field guide summarises information on most of the possible pests, diseases and disorders. It has been designed as a quick reference to take into the grove and
use to identify pests and diseases and the damage they cause. It is not definitive, as it is essentially a guide for recognition of damage and disorders in the field. Thus, it has only brief biological and other descriptors for each pest or disease. In addition, we have not included recommended pesticide control measures. A list of currently registered and permitted chemicals for use on olives is provided in a pocket at the back of this publication. The website of the Agricultural Pesticides and Veterinary Medicines Agency (www.apvma.gov.au) should be checked regularly to maintain up-to-date information on pesticide registrations and permits for the Australian olive industry.

Peter O’Bien
Managing Director
Rural Industries Research and Development Corporation
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Funds to produce this field guide were provided by RIRDC, the Spray Adjuvants Company of Australia Pty Ltd (SACOA), Nufarm Australia and the Rylstone Olive Press (Bentivoglio Olives). Without this funding, the field guide could not have been published.

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Council, which provided the image of olive moth from the *Olive Pest and Disease Management* book; and Ric Cother (NSW DPI) and Mark Whattam (AQIS Victoria) for images of olive knot. Last but not least, we would like to thank all the olive growers and consultants who have assisted in surveys, monitoring and supporting the research on sustainable pest and disease management in the olive industry.

This field guide is dedicated to the memory of Damian Conlan, who was a member of the initial project team, a good friend and a tireless worker for the Australian olive industry.
Integrated pest & disease management

Integrated pest and disease management (IPDM), developed in the 1960s and 1970s, is based on ecological principles. It encourages reduced reliance on pesticides through the use of a number of control strategies in a harmonious way to keep pests and diseases below the level causing economic injury. It came out of the realisation that too heavy a reliance on pesticides (particularly those with broad-spectrum activity) can cause major problems, notably:

- effects on human health and safety
- environmental contamination
- pesticide resistance in target and non-target organisms
- resurgence of secondary pests
- plant damage or yield loss (phytotoxicity)
- residues on fruit and products, with national and international consequences.

There is also general community concern about the use of pesticides, particularly on foods.

IPDM commonly utilises or encourages biological control through natural enemies such as predators, parasites, insect diseases and non-pathogenic antagonistic or competitive microorganisms. It also frequently involves cultural control strategies to minimise pest and disease entry and their spread in space and time. Cultural controls include protocols of entry to farms; manipulation of the field environment to discourage pests and diseases, such as opening crop canopies to increase
air movement and reduce humidity; the elimination of alternative hosts for pests; or growing nectar- and pollen-producing plants to encourage natural enemies. IPDM may also involve the physical destruction of infested materials and the use of tolerant or resistant plant species, where available. Chemical pesticides are used judiciously, and thus play a supportive role.

The major components of IPM systems are:

- identification of pests, diseases and natural enemies
- monitoring of pests, diseases, damage and natural enemies
- selection of one or more management options on the basis of monitoring results and action thresholds, from a wide range of pesticide and non-pesticide options
- use of selective pesticides targeted at the pest or disease—for instance, pesticides that will interfere least with natural enemies, targeted only at infested trees or parts of trees.

**Monitoring**

The most important part of any pest and disease management system is monitoring. This is because the mere presence of a particular pest does not provide enough information for decision-making. The pest or disease may not be sufficiently widespread, or the population levels may not cause enough damage, to warrant undertaking management strategies.
Regular monitoring, with effective recording of the results, provides important information that helps in making decisions on whether and when action should be taken, and how effective actions have been. The first step in the development of a pest and disease management program is to concentrate on the most serious pests and diseases, and build up records about the times and locations where problems are most likely to occur. Because natural enemies play an integral role in the system, they also need to be recorded.

In commercial situations, monitoring programs need to be quick and efficient while still providing accurate and repeatable results. Monitoring can be undertaken by growers, trained employees or commercial pest scouts. Monitoring commonly involves visual observations, usually based on sampling, and may involve actual counts, or the presence or absence of pests, diseases and their associated damage. Other supplementary monitoring methods are coloured sticky traps (yellow is the most common, and attracts small, flying, sap-sucking insects such as thrips, aphids and male scale insects, as well as beneficial species such as parasitic wasps), and chemical attractant traps that are often species-specific.

**Monitoring methods**

Monitor every grove (or block in large groves) at least monthly during the growing season. Monitor priority blocks (e.g. those with a high fruit load or with a history
of pest or disease problems) more frequently. Divide large blocks into sub-blocks. On each sampling, select at least several rows within each sub-block in a semi-structured way. Sample different rows on each occasion, and combine detailed tree inspection with identification of infestations as soon as possible.

In larger groves, driving slowly down rows makes it possible to detect only high populations of pests and diseases that have already caused a significant level of damage or, in the case of black scale, produced a significant amount of honeydew. (Remember, though, that even when sooty mould is highly visible, it does not necessarily indicate active scale infestations.) Monitoring from a vehicle will also detect only advanced symptoms associated with severe root or limb disease, pesticide injury or nutrient imbalance.

Assessing individual trees is important for early detection of pests and diseases. Within the monitored rows, examine at least one tree in detail. Choose trees in a structured way so that, for example, you check a tree in the first third of the first checked row, then one in the middle third of the second checked row, and one in the last third of the third checked row. The position of the checked tree within the row in each sub-block should change with each visit. For example, the next time, check a tree in the second third of the first checked row, then one in the last third of the second row and so on.

Carefully examine individual trees from all sides and at all heights using a systematic approach. Inspect samples of twigs, flowers and fruit for the presence of pests,
diseases or damage using a 10× hand lens (if you find hand lenses difficult, you can use a magnifying glass, but be aware that their magnification and therefore the quality of the observations are inferior). Inspect trees for abnormal flower buds, and check for the presence of thrips by beating flower clusters onto a white background such as cardboard. Inspect fruit for the presence of fruit fly or other damage, as well as for symptoms of disease or deformity.

If scale or lace bug is detected, the life stage(s) should be assessed. Examine scale infestations carefully under magnification to determine the stage of scale development and the level of parasitism. Turn over adult scales to check for developing eggs or crawlers.

If a pest or disease is detected, check surrounding trees in the row and in adjacent rows to establish the extent of the infestation. Make note of the pattern of infection, which is the association of the disease or pest with:

- terrain (e.g. sheltered or exposed locations, low-lying areas)
- weather and aspect (e.g. prevailing wind direction, orientation to sun)
- tree characteristics (e.g. cultivar, tree age, part of tree affected)
- cultural practices (e.g. irrigation, fertilizers, pesticides, pruning, mulching).

Identification of disease pathogens is often more difficult, and if the symptoms are unclear, send specimens to a qualified plant pathologist for diagnosis.
Recording data

Record date, tree identification and position, pest or disease name, extent of damage, pattern of infection, life stage and any parasitism. Records of pesticide applications, cultural practices and weather greatly help in interpreting monitoring data.

Action thresholds

Action thresholds are the levels of pests, diseases or damage at which a decision is made about the action to be taken; they normally take into account natural enemy activity. The decision also needs to take into account previous experience, predicted weather, projected yield and market prices, and grower preference.

Unfortunately, no detailed action thresholds (requiring detailed research) have been determined for major olive pests in Australia, although they have been made for some of the same pests or diseases in different crops, or for olives grown overseas.

Once action is taken, follow up on its results by further monitoring, and by postharvest assessment of fruit and oil yield and quality.
Using this guide

The pests, diseases and disorders are separated into 3 sections. Use the table below to determine the possible causes of symptoms on your tree; the pest, disease or disorder can then be found alphabetically in the specific section based on common name.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Common name of:</th>
<th>Pest</th>
<th>Disease</th>
<th>Disorder</th>
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<td>Leaf yellowing &amp; branch dieback</td>
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<td>Black scale</td>
<td>Rhizoctonia</td>
<td>Tip death</td>
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<td>Armoured scales</td>
<td>Verticillium</td>
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<td>Phytophthora</td>
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<td>Charcoal rot</td>
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<td>Wound canker</td>
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<td>Leaf spots &amp; damage</td>
<td>Lace bug</td>
<td>Weevils</td>
<td>Peacock spot</td>
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<td>Grasshoppers</td>
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<td>Lt-brown apple moth</td>
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<td>Rutherglen bug</td>
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<td>Leaf/branch tip deformation</td>
<td>Olive bud mite</td>
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<td>Anthracnose</td>
<td>Apical end rot</td>
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<td>Black scale</td>
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<td>Peacock spot</td>
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<td>Fruit damage &amp; rot</td>
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<td>Green vegetable bug</td>
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<td>Olive fruit caterpillar</td>
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<td>Flower damage</td>
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<td>Olive knot</td>
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<td>Crown gall</td>
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<td>Stem cankers &amp; death</td>
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<td>Tree blackening</td>
<td>Ants, Black scale</td>
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<td>Sooty mould</td>
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Beneficial species

In this guide, we have used the term *beneficial species* to describe the natural enemies of olive pests that may be observed in olive groves, and that give some level of biological control of the pests. These beneficial species may be either native or exotic, and a number occur naturally in groves. In such situations, they can be conserved and encouraged by environmental modifications, such as the planting of nectar- and pollen-producing cover crops (which can bring negative benefits: see Thrips, p 35) and the reduction in use of broad-spectrum pesticides. Several beneficial species are mass-reared in Australia and are available for purchase (see Australasian Biological Control, www.goodbugs.org.au).

Host-specific natural enemies are discussed and illustrated along with their host pests. Many of these natural enemies are small (<2 mm) parasitic wasps (known as micro-Hymenoptera) in the superfamily Chalcidoidea, particularly in the families Aphelinidae, Chalcididae, Encyrtidae and Pteromalidae. Most members of these diverse families parasitise small arthropods, including scales, aphids and insect eggs. Larger wasps found in groves belong primarily to the families Braconidae, Ichneumonidae and Sphecidae, which prey on larger insects and spiders.

A number of species of ladybirds (family Coccinellidae) are also found in olive groves. Both immature (larval)
and adult ladybirds eat soft-bodied insects. Two of the most common species are *Cryptolaemus montrouzieri* and *Hippodamia variegata*:

- **Cryptolaemus montrouzieri**, known as the mealy-bug destroyer, is a native species commonly found on trees infested with scale insects and honeydew.
- **Hippodamia variegata**, known as the white collared or spotted amber ladybird, is a European species. It was first recorded in Australia in 2000, and is now common and widespread. *H. variegata* feeds on aphids, thrips and insect eggs.

Other common predators are spiders, lacewings (see Olive Lace Bug, p 30) and larvae (maggots) of hover flies (family Syrphidae). While these species eat a range of arthropods, their role and impact in olive ecosystems is yet to be fully determined.
Leafcurling spider *Phonognatha graeffei* in olive tree

L: Adult syrphid hover fly  R: Larva of the syrphid hover fly
Invertebrate pests

Ants (Hymenoptera: Formicidae)

Many species

**Size** 3–12 mm

**Biology and damage** Ants do not cause any direct damage to olives, but disrupt biological control of black scale (p 19). Ants enter the tree canopy searching for honeydew secreted by the scale and interfere with predators and parasites, thereby favouring the development of black scale infestations. In some cases, larger species of ants in foliage can be a source of annoyance for grove workers.

**Natural enemies** None significant.

**Comments** Baiting has been successful in other orchard crops.

Ants attending scales
Armoured scales (Hemiptera: Diaspididae)

Red scale, *Aonidiella aurantii* (most common)
Oleander scale, *Aspidiotus nerii*
Ross’s black scale, *Lindingaspis rossi*
Circular black scale, *Chrysomphalus aonidum*
Parlatoria scale, *Parlatoria oleae*

Size 2 mm

**Biology and damage** Armoured scales are most common in Queensland and WA. There are two to six generations per year. First-generation crawlers normally emerge in late spring. Hot, dry weather reduces the survival of crawlers.

Scales infest leaves and twigs and, sometimes, fruit. No honeydew or associated ants (p 19) or sooty mould (p 51) occur. Can cause fruit marking or pitting and scale-encrusted fruit. Leaf fall and twig dieback can occur in severe infestations.

**Major natural enemies** Small parasitic wasps, including *Aphytis melinus* and *A. lingnanensis*, both of which are mass-reared and commonly released into citrus orchards; wasps *Comperiella bifasciata* and *Encarsia* spp.; ladybirds, lacewings and predatory mites.

**Comments** Sprays need to be targeted at crawlers and young nymphal stages.
L: Red scale infestation on mid-vein of olive leaf
R: Red scale infestation on leaves and fruit of ‘Jumbo Kalamata’

L: Parlatoria scale infestation on underside of leaf
R: Red scale infestation on olive fruit

L: Armoured scale parasite Comperiella bifasciata with red scale. Note wasp emergence hole
R: Red scale parasite Aphytis melinus with red scale
Black scale, *Saissetia oleae* (Hemiptera: Coccidae)

**Size** 3–5 mm

**Biology and damage** Two or three generations occur per year. Widely distributed in Australia. First-generation crawlers normally emerge in late spring. Hot, dry weather reduces the survival of crawlers.

Scales attack leaves and twigs, resulting in leaf drop, reduced tree vigour and twig dieback in heavy infestations. Ants (p 19) and sooty mould (p 52) are commonly associated with the production of honeydew by adults and nymphs of black scale.

**Major natural enemies** Small parasitic wasps such as *Metaphycus* spp. and *Scutellista caerulea*; ladybirds (Coleoptera: Coccinellidae), lacewing larvae (Neuroptera) and the scale-eating caterpillar *Catoblemma dubia*.

**Comments** Sprays need to be targeted at crawlers and young nymphal stages.

L: Young adult female scales. Note H-shaped ridge on back
R: Adult scale on leaves

© UWS © NSW DPI
L: Adult female scale with eggs  
R: Black scale adults with emerging crawlers. Note wasp *Scutellista caerulea* (parasite and egg predator) on right

L: Adult *Scutellista caerulea* (parasite and egg predator) near black scale adult  
R: Cocoon of the scale-eating caterpillar *Catoblemma dubia*. Note black scale cases on the cocoon

Parasite *Metaphycus helvolus*
Cicadas (Hemiptera: Cicadidae)

Various species, particularly bladder cicada, *Cytosoma schmeltzi*

**Size** 30–40 mm

**Biology and damage** Cicadas have been recorded in central Queensland laying large numbers of eggs into olive twigs, causing severe damage. The females slit the twigs and insert rows of eggs. The emerging nymphs cause further damage before moving to the soil, where they feed on plant roots for several years. Adults emerge in spring to summer.

Cicada oviposition damage to woody twig

© Qld DPIF
Fruit flies (Diptera: Tephritidae)

Queensland fruit fly (QFF), *Bactrocera tryoni*, in NSW and Queensland
Mediterranean fruit fly (medfly), *Ceratitis capitata*, in WA

**Size** Adults: QFF, 6–7 mm ; medfly, 4–5 mm

**Biology and damage** Female flies lay eggs in ripening fruit, causing small piercing marks. Larvae may develop in fruit. Damaged fruits may prematurely ripen or fall, and are predisposed to fungal fruit rots.

**Natural enemies** Braconid parasites (Hymenoptera: Braconidae), the assassin bug *Pristhesancus plagipennis* and birds, although these rarely achieve economic control. Sterile insect release is used against QFF in south-western NSW, Victoria and SA.

**Comments** Commercial lures are available for both QFF and medfly. However, these target males and are not effective for direct control.
Grasshoppers (Orthoptera: Acrididae)

Plague locust, *Chortoicetes terminifera*
Spur-throated locust, *Austracris guttulosa*
Migratory locust, *Locusta migratoria*
Wingless grasshopper, *Phaulacridium vittatum*

**Biology and damage** Plague locust is the most devastating of the locusts, although wingless grasshopper can be a serious olive pest in southern and western Australia. In the non-swarming phase, grasshoppers feed primarily on terminal leaf margins, but the locust phase devours most green plant material, stripping trees rapidly.

**Comments** During plagues, immediate action is essential. Permits for pesticide use are normally issued in locust plague outbreak years.

Wingless grasshoppers
Green vegetable bug, *Nezara viridula* (Hemiptera: Pentatomidae)

**Size** 15 mm

**Biology and damage** This large stink bug damages fruit by piercing with its mouth parts. Immature nymphs are commonly gregarious (found in groups), and are dark-coloured with lighter white, yellow and orange spots.

**Natural enemies** A small egg parasite wasp, *Trissolcus basalis*, has been introduced and is well established in many districts.

R: Green vegetable bug adult (top centre) and nymphal stages

© Qld DPIF

L: Green vegetable bug egg parasite *Trissolcus basalis* with vegetable bug eggs

© Qld DPIF
Lightbrown apple moth, *Epiphyas postvittana* (Lepidoptera: Tortricidae)

**Size** Adult wingspan 18 mm

**Biology and damage** Lightbrown apple moth (LBAM), *Epiphyas postvittana*, is a native species of leafroller with a wide plant host range. It damages growing tips or inflorescences of olives, tying them together with silken threads to form a protected area within which it feeds.

**Natural enemies** Various parasitic wasps, including the minute egg parasites *Trichogramma* spp. LBAM is susceptible to the bacterial pathogen *Bacillus thuringiensis*.

**Comments** *Trichogramma carverae* and *Bacillus thuringiensis* are commercially available.

Above: Adult male LBAM

Above: LBAM larvae

L: *Trichogramma* wasp
Olive bud mite, *Oxyceorus maxwelli* (Acari: Eriophyidae)

**Size** 0.1–0.2 mm

**Biology and damage** Bud mite was first detected in NSW in 2000. The mites feed on developing buds, shoots and leaves, causing malformations and shortening of internodes between young leaves (‘witch’s broom’ effect). Most severe in young trees under conditions of warm temperature and high humidity.

**Natural enemies** Likely to be attacked by predatory mites (family Phytoseiidae) and small ladybirds (e.g. *Stethorus* spp.).

L: Olive bud mite damage on tree. Note witch’s broom effect  
R: Olive bud mites on young leaf (magnification 40×)

L: *Euseius elinae* mite, predator of eriophyid mites  
R: Bud mite damage on young olive leaves
Olive lace bug, *Froggattia olivinia* (Hemiptera: Tingidae)

**Size** Adults 3 mm

**Biology and damage** An Australian native species recorded in NSW, Queensland, Victoria and SA. Adults are mottled brown. There are two to four generations per year. Spiny nymphs occur in clusters on undersides of leaves; the first generation commonly emerge from leaves in spring. All stages attack leaves with piercing mouthparts, causing yellow spotting. Black tar spots occur on undersides of leaves. Leaf drop and twig dieback may occur in severe infestations.

**Natural enemies** Few have been recorded; green lacewings have been observed predating on lace bug nymphs, and birds may also be predators.

**Comment** The native green lacewing *Mallada signata* is commercially available.

L: Olive lace bug damage to leaves
R: Female olive lace bug and feeding and oviposition marks
L: Olive lace bug adult with 5 nymphal instars
R: *Mallada signata* adult

L: Green lacewing egg
R: *Mallada signata* larva predating on lace bug nymphs
Olive fruit caterpillar, Cryptoblabes sp. (Lepidoptera: Pyralidae)

**Size** Adult 15 mm wingspan

**Biology and damage** An unidentified species of Cryptoblabes has recently been recorded feeding on fruit in southern Queensland. The moth, which probably migrates from neighbouring cereal crops, lays eggs, which hatch into larvae that feed on the surface of fruit, producing webbing and frass (faeces).

**Comments** Unlikely to be a problem unless olives are located near cereal crops such as sorghum.

*Cryptoblabes* damage to immature olives. Note brown frass
Rutherglen bug, *Nysius vinitor* (Hemiptera: Lygaeidae)

**Size** Adult 5 mm

**Biology and damage** Commonly breeds on weeds, especially developing seeds. Occasionally reaches plague numbers in spring and summer and may swarm onto trees. Heavy feeding can cause severe damage with scorched appearance of leaves and death of twigs.

Generally of minor importance, although may be prevalent in some districts in favourable seasons.

**Comments** Closely related species with similar habits include grey cluster bug *Nysius clevelandensis*, coon bug *Oxycarenus arctatus*, and cottonseed bug *O. luctuosus*.

Adult (L) and nymph (R)
Snails (Mollusca: Gastropoda)

Snails, including the small brown snail *Microxeromagna vestita* and the while Italian snail *Theba pisana*, are a problem in some areas of SA and WA. They appear to cause limited feeding damage, but they rest in trees, smothering trunks and branches, and occasionally causing broken limbs from their weight. In SA they move off trees in autumn and are not present during the critical harvest period, when they could contaminate the fruit.

White snails on olive tree
Thrips (Thysanoptera)

Plague thrips, *Thrips imaginis*
Western flower thrips, *Frankliniella occidentalis*

**Size**
- *T. imaginis* fem. 1.0–1.3 mm, male 0.8–1.0 mm
- *F. occidentalis* fem. 1.4–1.8 mm, male 0.9–1.1 mm

**Behaviour and damage**
Thrips are small, elongated insects. Adults range in colour from yellow to mid-brown. Larvae are white or cream and wingless. Both species have been recorded in olive flowers, but plague thrips is the more common in flowers and on sticky traps in groves. Thrips commonly feed on understorey weed flowers in the grove or in nearby fields, swarming between spring and autumn. Flower infestations have been implicated in scarred and misshapen fruit.

**Natural enemies**
Predatory thrips and predatory mites (Acari: Phytoseiidae) may attack thrips larvae.

**Comments**
Predatory mites (e.g. *Eusius montdorensis*) are being developed commercially for use in greenhouse crops against *F. occidentalis*. Field use is doubtful.
Weevils (Coleoptera: Curculionidae)

Curculio beetle, apple weevil, *Otiorhynchus cribricollis*, in inland NSW, SA & WA
Garden weevil, *Phlyctinus callosus*, mainly in WA

**Size** *Otiorhynchus cribricollis*, 9 mm  
*Phlyctinus callosus*, 7 mm

**Biology and damage** Adults are nocturnal and flightless, and climb trees to chew leaf margins. Severe infestations can damage growing tips, especially in young trees. The soil-dwelling larvae (legless grubs) may damage tree roots.

**Comments** An effective alternative to insecticide application to butts of trees is the use of either a sticky or a fibrous barrier applied to the tree trunk. In the latter case, garden weevils in particular become enmeshed in the fibres.

Poultry such as guineafowl have been reported to contribute to garden weevil control in orchards and vineyards.

L: Weevil damage to olive leaves  
R: Adult *Otiorhynchus cribricollis*
L: Adult *Phlyctinus callosus*  R: Weevil larva

L: Weevil barrier applied to tree trunk
Diseases

Anthracnose

**Cause** Fungus: *Colletotrichum acutatum,* *C. gloeosporioides*

**Symptoms** Causes soft circular rots on the fruit, usually on the shoulder, and at high humidity produces an orange slimy mass of spores on the fruit surface. Commonly seen close to harvest when fruit softens.

**Transmission** Survives on infected mummified fruit. Spores are spread by rain splash and wind. Can infect ripe fruit and form new spores within 4 days.

**Favoured by** Wet conditions with high humidity.
Charcoal rot

**Cause** Fungus: *Macrophomina phaseolina* (also called *Rhizoctonia bataticola*)

**Symptoms** Plants die back from the shoots, and leaves drop. Infected roots appear grey and are dotted with tiny (pinhead-sized) black sclerotia, which are survival structures of the fungus. Severely affected roots blacken and rot away.

**Transmission** Soilborne. This fungus survives in soil for many years and can infect roots and stems of a wide range of plants. It spreads in irrigation water and infected soil on farm machinery.

**Favoured by** Warm and dry soils. Leaf symptoms develop when plants are heat stressed.
Crown gall

**Cause** Bacterium: *Agrobacterium tumefaciens*

**Symptoms** Forms swellings and galls on stems and roots near soil level. Galls start as small, pale lumps of tissue, which enlarge, darken and become convoluted. Galls can vary considerably in size. Can be confused with olive knot galls (p 43). Trees may become unthrifty.

**Transmission** The bacteria live in soil and infect plants through wounds. Infected cells receive a cancerous factor from the bacteria, which causes them to divide uncontrollably and thus form the galls. The bacteria infect a wide range of plants, particularly woody perennials.

**Favoured by** Continued in-ground planting of susceptible hosts. More prevalent on young nursery stock. Wounding by grafting, budding, cultivation etc. provides entry points for the bacteria.

L: Gallng at soil level on potted olive tree
R: Galling on lower roots of olive seedling
Leaf mould

**Cause** Fungus: *Pseudocercospora* (= *Cercospora* = *Mycocentrospora*) *cladosporioides*

**Alternative names** Cercospora leaf mould, olive leaf spot, cercosporiosis

**Symptoms** Grey mouldy blotches develop on the underside of the leaves. The tops of the leaves turn yellow then brown, then leaves fall. Often occurs together with peacock spot, causing significant defoliation and damage to new growth and reduced crop production. Fruit are rarely infected, but, if so, show round, reddish-brown spots.

**Transmission** Overwinters in old infected leaves. Usually infects in autumn, targeting the young spring growth.

**Favoured by** High humidity and rain, 12–28 °C.

L: Grey mouldy blotches on underside of yellow to brown leaves  
R: Mouldy appearance from fungal spores

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Nematodes

Root knot nematode, *Meloidogyne* sp.
Citrus nematode, *Tylenchulus semipenetrans*
Root lesion nematode, *Pratylenchus* spp.

**Symptoms** Vary from unthriftness to stunting and leaf yellowing. Root knot nematodes cause distinctive root galling.

**Transmission** Soilborne organism, spread with movement of soil, water and infected plants.

**Favoured by** Soil that previously grew host plants. For example, citrus and root lesion nematodes are common in old citrus land, and root knot nematode is common in old vegetable soil. Damage would be expected to occur with high populations.

Root galls caused by root knot nematode
Olive knot

**Cause** Bacterium: *Pseudomonas savastanoi pv. savastanoi*

**Symptoms** Rough galls or swellings of variable size occur on twigs, branches, trunks, roots, fruit or leaves. Galls can appear either singly or close together. They are most common on twigs and young branches, but will also form around wounds on the main trunk. Starting as small swellings 3 to 5 mm across, they grow rapidly into smooth, spherical green knots, increasing in size as they mature and becoming darker and more furrowed.

**Transmission** The bacteria live in the galls and ooze out in wet weather. They enter the tree through wounds, including leaf scars, damage by hail and frost, pruning wounds or wounds caused during harvesting.

**Favoured by** Trees at most risk are those with wounds during periods of rain. Some cultivars are more susceptible, e.g. ‘Barnea’, ‘Frantoio’.

**Note** Olive knot has not been detected in all states. If you see symptoms, notify your state agriculture dept.

Above L: Young and older galls on olive branch  
Below L: Galling around wound  
R: Bacteria inside olive knot
Peacock spot

**Cause** Fungus: *Spilocaea oleagina*

**Alternative names** Olive leaf spot, bird’s-eye spot

**Symptoms** Round spots from 2 to 10 mm in diameter on the upper surface of the leaf, and occasionally on stems and fruit. Spots first appear as small pale blotches, later becoming muddy green to black, often with a yellow halo. Spots on underside of leaves are grey. Severe infection may cause defoliation, which can kill new wood and reduce production in the following year. Young leaves may remain symptomless.

**Transmission** Fungus overwinters in old infected leaves. Spores germinate in free water and are blown or splashed onto the leaves. Movement between trees is limited.

**Favoured by** High humidity and rain. Usually occurs sporadically, particularly in wet weather in spring. Disease is inactive during summer.
Phytophthora root rot

**Cause** Water mould: *Phytophthora* spp. (several species)

**Symptoms** Root and crown cankers that may extend up the trunk. Leaves wilt, yellow and may drop. Trees may die suddenly, or slowly decline over several years. Sudden death is common when stress is placed on the tree, such as during flowering, fruit development or hot weather.

**Transmission** Soilborne organism, spread by movement of soil, water and infected plants.

**Favoured by** Phytophthora root rot is consistently associated with excessively wet soils, clay-panning (p 50) or poor drainage. Care must be taken when using feral plants as rootstocks, as many grow in areas where *Phytophthora* is present in the soil.

L: Crown canker on 5-year-old tree  
R: Severe rotting of roots and lower stem
Rhizoctonia root rot

Cause Fungus: *Rhizoctonia* spp.

Symptoms Roots turn brown, and outer bark may slough off. Black sclerotia (survival structures) may form on roots. Above-ground symptoms are similar to droughting, and include leaf tip death, defoliation and plant death.

Transmission Soilborne organism, spread by movement of soil and infected plants.

Susceptibility Young nursery plants are most affected. Healthy mature trees appear to be less susceptible. Several species of *Rhizoctonia* have been detected in olive roots, but it has not yet been determined whether all these species cause disease.

L: Browning of roots on olive seedling
R: *Rhizoctonia* sclerotia on roots

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Verticillium wilt

**Cause** Fungus: *Verticillium dahliae*

**Symptoms** One or more branches wilt, usually early in the growing season. Dead leaves remain on the tree. Roots are repeatedly infected over several seasons and trees gradually die. Internal tissue of lower stems may darken as the fungus disrupts the ring of sap-carrying tissue under the surface. Olive cultivars vary greatly in susceptibility, and symptoms may not be seen for 4 to 8 years after planting. Another form of this fungus in Europe causes defoliation.

**Transmission** Soilborne. The fungus survives in soil for many years and can infect the roots of a wide range of plants. It can spread in irrigation water and infected soil on farm machinery and tools.

**Favoured by** Cool and moist soils when daytime temperatures range between 20 and 25 °C. Suppressed by higher temperatures. Common in land where alternate hosts (e.g. cotton, lucerne, brassicas) have been grown.

L: Mature tree with wilted branch  
R: Young tree with wilted branch  
Inset: Darkened ring of water-conducting tissue inside stem
Wound cankers

**Cause** Opportunistic wound invaders
Fungi: e.g. *Botryosphaeria* sp., *Pycnoporus coccineus* (white wood rot)
Bacteria: e.g. *Pseudomonas syringae*, *Ralstonia solanacearum*, *Xanthomonas campestris*

**Symptoms** Vary from slow decline of trees and tree death to localised cankers around wound sites with occasional branch death above infection. Can also cause brown staining of the vascular (sap-carrying) system.

**Transmission** All are wound pathogens. Can be borne by wind, water and soil. Most are common organisms that opportunistically infect through wounds.

**Favoured by** Wounds, wetness and high humidity causing moisture films around wound sites.

Top L: Entry of bacteria at pruning wound caused stem death
Bottom L: *P. syringae* causing localised wounds at leaf scars
R: Brown internal staining from *Ralstonia* infection

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Disorders

Apical end rot

Alternative names Apical end desiccation, soft nose

Symptoms The apical (blossom) end of the fruit shrivels, mostly close to maturity. The internal flesh and pip may be blackened, either at the apical end only or throughout the whole fruit. Sometimes secondary fungal rots infect the shrivelled end.

Cause The cause is unknown. It may result from sudden changes in temperature and humidity, which produce partial dehydration of the fruit at the apical end. It has also been associated with calcium and boron deficiencies, and with changes in watering regimes.
Clay-panning & root plaiting

Clay-panning and root plaiting are disorders in root architecture that can lead to unthrifty plants that are subject to stress-related dieback and infections.

Clay-panning is caused by poor soil structure and ground preparation, whereby a hard layer of subsurface soil prevents roots from growing downwards. Affected trees may also be subject to temporary waterlogging, which can lead to further disorders and infections. Conversely, dry soil can exacerbate stresses, because plants cannot draw moisture from deeper in the soil. Trees may also be subject to blowing over in strong winds because of their poorly anchored root systems.

Root plaiting occurs when plants become pot-bound during their nursery production. Plants have reduced and weaker root systems, which allow environmental stresses to lead to various disorders and infections.

L: Clay-panning
R: Root plaiting
Sooty mould

**Cause** Fungi: *Capnodium* sp. (most common); also *Fumago, Scorias & Aureobasidium* spp.

The fungi are wind blown and attach to the honeydew excretions from sap-sucking insects, particularly black scale (p 22), but also aphids, mealybugs and psyllids.

**Symptoms** A black soot-like growth which can cover all surfaces of the plant. Severe infections can indirectly cause plant stunting and un thriftiness, as the soot coverage prevents sunlight penetration and thus photosynthesis by the plant.

**Control** To manage sooty mould, the insects producing the honeydew must be controlled.
Sphaeroblasts and oedema

Sphaeroblasts are knob-like growths up to 10 mm wide which protrude from stems. When they are cut open, a spherical lump of wood can be removed from the surrounding tissue. Their cause is unknown, and they commonly occur on the cultivar ‘Barnea’.

Symptoms of oedema are small, brown, corky growths up to 5 mm wide that form on the surface of stems or roots from enlarged lenticels (breathing holes in bark). They occur when high soil moisture causes excessive water uptake, which engorges the cells near the lenticels. These cells can rupture from the high water pressure, and the plant forms callus tissue in an effort to heal. When roots experience periods of high soil moisture, some tissue may also asphyxiate (because of reduced oxygen levels). Consequently, these roots are predisposed to infection by a range of minor pathogens or opportunistic invaders such as *Fusarium, Pythium* and various bacteria.
Stem death

**Symptoms** The stem of the plant dies a few centimetres above ground level. The base is generally healthy and new shoots will appear below the dead stem. Most common on young trees in their first and second years in the field.

**Cause** Unknown. Damage occurs to the young tree and allows entry of wound-invading bacteria and fungi (see Wound Cankers, p 48). Damage is often associated with cold temperatures, sun scald and herbicide, but in many cases the cause has not been determined.

L: Sun scald on young olive tree
Middle & R: Stem death on young olive tree
Tip death

**Symptoms** Ends of branches die for no apparent reason. Tip death appears to have no effect on the general health of the tree or its productivity. Branches can be removed if this is considered necessary for cosmetic purposes. Inspection of the stem below the dead tips is needed to determine whether the death has a specific cause which should be further investigated (see Wound Cankers, p 48). Root rot and trunk cankers can also cause tip death, and so should be investigated.
Miscellaneous leaf damage

There are many other symptoms seen on leaves that have no known cause. They may result from infection by biotic agents or from environmental or nutritional effects. Symptoms include white spotting, pale brown blotches, striping and yellowing, and dead tips.
Key olive pests & diseases not detected in Australia

There are many pests and diseases both of olives and other crops overseas that are potential threats to the olive industry. For example, *Phytophthora ramorum*, the cause of sudden oak death in California and Europe, can cause disease in some olive cultivars.

The following pests and diseases are of more immediate concern to the Australian olive industry.

**Phytoplasmas**

Phytoplasmas are small infectious agents usually spread by leaf hoppers. Symptoms include bushy growth, witch’s broom, chlorosis and deformation of leaves, flower abortion, bud failure, and formation of sphaeroblasts (p 52) with rosettes of shoots.
Viruses and virus-like diseases

At least 14 different viruses and several virus-like diseases are known to occur in olives overseas, and some have been detected in symptomless trees. While many viruses have been recovered from affected trees, there is often no proof that the virus causes the symptoms observed. They can be transmitted by soil-borne vectors such as nematodes, and by aphids and pollen. These viruses may already be present in Australia but remain undetected. All imported olives are currently tested for viruses.

Symptoms include deformed fruit, poor fruit set, reduced yield, leaf distortion, narrow twisted leaves, bushy growth, small leaves, bright yellow discoloration of leaves, chlorotic to yellow vein discoloration, defoliation and dieback.

The main viruses detected are Strawberry Latent Ringspot Virus, Olive Latent Ringspot Virus, Arabis Mosaic Virus, Cherry Leafroll Virus and Olive Latent Viruses 1 and 2.

Olive fly, *Bactrocera oleae* (Diptera: Tephritidae)

**Size** 5 mm long

**Biology and damage** Olive fly is the most important pest of olives worldwide. It is endemic to the Mediterranean and is established in Mexico and California.

The female lays eggs in fruit, and developing larvae (maggots) feed on the olives, usually causing fruit drop. Mature larvae may pupate in the fruit or leave and pupate in the soil, where they overwinter. Fruit rot and lower oil quality are associated with damage. In the USA, olive fruit is required to be <1% infested for processing. If uncontrolled, olive fly can result in 100% loss of the table olive crop and 80% loss of the oil crop. It appears that olive fly has a preference for some cultivars, particularly large-fruited ones.

Olive fly adult on olive leaf
Olive fly is related to, and looks similar to, the Queensland fruit fly (p 25), but is smaller, has dark marks on its wing tips and has slightly different markings. It is attracted to a specific pheromone (communication chemical) that is different from those of both QFF and medfly, which is used to monitor it and as part of a control strategy. Control is difficult and costly.

Damage caused to olives by olive fruit fly larvae (below), and larva in fruit (bottom).
Olive moth, *Prays oleae* (Lepidoptera: Yponomeutidae)

**Size** Adult moth 6 mm long, 13 mm wingspan.

**Biology and damage** Olive moth is widespread in Mediterranean countries and also occurs in Central and South America. The only host is olive. Adult moths are silvery grey, and have long antennae.

There are normally 3 generations per season. The first generation arises from eggs laid by overwintered adults on flower buds and flowers. Emerging caterpillars feed on pollen, anthers and female parts of flowers. Caterpillars of the second generation burrow into fruit and feed near the kernel, causing severe fruit damage and fruit drop. Those of the third generation feed on leaves. Reported crop losses are variable.

Control is achieved most commonly by pesticides. Pest presence (but not population size) is monitored by using a synthetic pheromone (sex attractant for male moths), or light or food traps. Pheromones are also being evaluated to manage olive moth by disrupting mating.
Diseases present in Australia but not yet detected on olives

Some diseases present in Australia on other crops have been reported as diseases of olives overseas, but have not yet been detected on olives in Australia.

**Armillaria root rot**

*Cause* Fungal: *Armillaria* spp.

Causes gradual decline and death. White to yellow fan-shaped mycelial mats are observed between the bark and wood.

**Black root rot**

*Cause* Fungal: *Thielaviopsis basicola*

Causes foot and root rot of mature olives, leading to tree decline.

**Cause Phytophthora fruit rot**

Water mould: *Phytophthora* spp.

Causes fruit rots, particularly in wet weather.
Glossary

Abiotic—Caused by non-living factors.
Beneficial organism—An organism that helps the crop.
Biological control—The use of living organisms to control pests or diseases.
Canker—Dead or diseased area on a branch or stem.
Chlorotic—Pale yellow.
Crawler—The juvenile stage of scale insects.
Defoliation—Loss of all leaves from a branch or tree.
Disease—Any adverse effect on plant growth and development. In this book we have used ‘disease’ to describe damage caused only by pathogens.
Disorder—Any adverse effect on plant growth and development from an abiotic cause.
Gall—An abnormal growth of plant tissue from proliferation of cell division, similar to callus tissue.
Honeydew—A sugary solution excreted by many sap-sucking insects.
Integrated pest and disease management—The combination of several strategies to control pests and diseases for maximum results with minimum drawbacks (p 9).
Larva—The juvenile stage of an insect; commonly used for caterpillars and grubs.
Lenticels—Natural pores or breathing holes in the outer layer of plant tissue.
Nymph—The juvenile stage of an insect in which the juvenile and adult look very similar.

Opportunistic—Making use of an opportunity that presents itself, rather than looking for a goal. Often used to describe an organism that infects plant material through wounds or damage inflicted by another cause, either abiotic or biotic.

Oviposition—The laying (positioning) of an egg (ovum).

Parasite—An organism that derives its nourishment from another organism without killing it.

Parasitoid—An organism that derives its nourishment from another organism and eventually kills it.

Pathogen—Any organism that causes disease, e.g. bacterium, fungus, virus.

Predator—An organism that catches others for food.

Pupa—The case-like intermediate stage of many insects between larva and adult, in which the insect develops.

Sclerotia—Small black resting bodies of a fungus which enable it to survive without the plant host.
Further reading

These books provide additional information on olive diseases (1, 2, 3) and insect pests and beneficial insects (4, 5). Books 1 and 2 are available through the Australian Olive Association. There are also many websites that provide good information on olive production and olive pests and diseases.


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