Crop Walkers' Guide

Hardy Nursery Stock

HDC is a division of the Agriculture and Horticulture Development Board

Contents

Introduction

Hardy nursery stock growers encounter a range of crop problems on a regular basis which can quickly render plants unsaleable unless recognised and dealt with promptly. Often, such problems are linked to pests and diseases but nutritional and physiological disorders may also be involved.

This Crop Walkers' Guide is designed to assist growers, supervisors and nursery staff in the vital task of monitoring crops. It is designed for use directly on the nursery to help with the accurate identification of many of the economically important pests, diseases and other issues. Weed identification is not covered in this publication (see the HDC handbook 'Practical weed control for nursery stock' for further detailed information). Images of the key stages of each subject, along with typical symptoms have been included, together with bullet point comments to help identification.

The nursery stock industry produces a diverse range of crops and it's clearly impossible to show every subject or problem associated with each crop. The guide therefore presents the most commonly occurring ones listed alphabetically within each section.

While covering some of the key biological pest control agents used in protected nursery stock production, this guide does not attempt to offer advice on available control measures as these frequently change. Instead, having identified a particular pest, disease or disorder, growers should acquaint themselves with the currently available control measures.

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HDC Knowledge Transfer Manager (Ornamentals)

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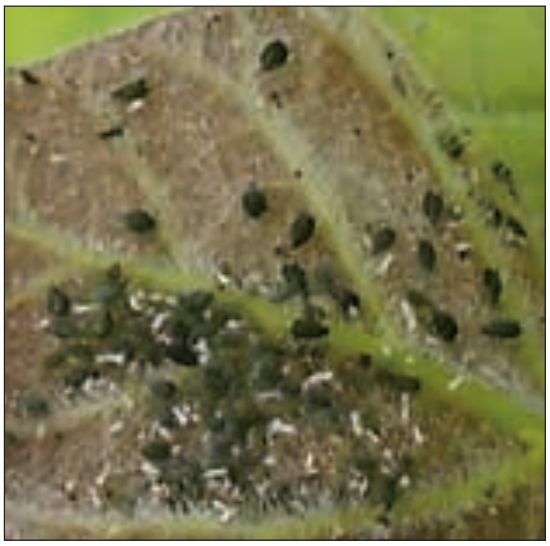
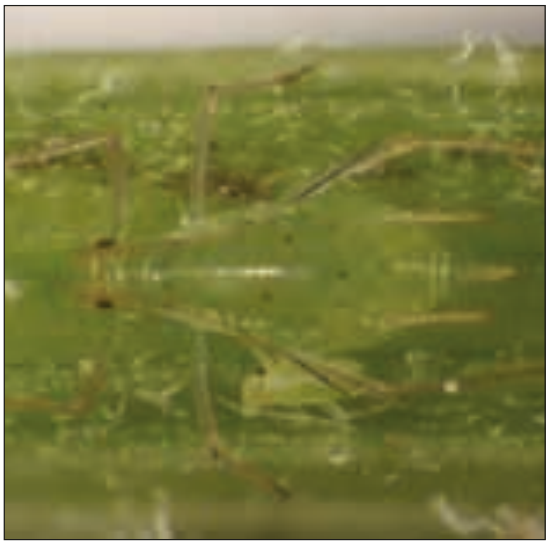
Pests

A

Aphids

(*Aphis gossypii, Macrosiphum euphorbiae*, etc.)





- The melon-cotton aphid (*Aphis gossypii*, top images) is small, pale to olive-green or black, sometimes with white waxy patches. The siphunculi are short and black. Host plants include: *Hebe, Hibiscus* and *Pyracantha.*
- The potato aphid (*Macrosiphum euphorbiae,* bottom images) is long, pear-shaped, green or pink, often with a dark stripe down the back. The siphunculi (tubes at the rear of the body) are long and green. Host plants include: *Buddleia, Photinia* and *Solanum*.
- Aphids cause leaf distortion, stunting and they secrete honeydew leading to the development of sooty moulds.

Capsid bug (*Lygocoris pabulinus*) **and tarnished plant bug** (*Lygus rugulipennis*)

- Common green capsid (*Lygocoris pabulinus*) nymphs (top left) and adults (top right) are bright green. Adults are 5-7mm long.
- European tarnished plant bug (*Lygus rugulipennis*) nymphs are green or brown with pairs of dots on the upper side of the front body segments. Adults can be green, brown or black (bottom left).
- Both bugs cause leaf marking, distortion and tattering, often with many small holes. Host plants include: *Aster, Caryopteris, Fatsia, Hydrangea, Papaver* and *Prunus.*

Caterpillar, carnation tortrix moth

(*Cacoecimorpha pronubana*)

- Caterpillars are small, pale or olive green and have a yellowish head with brown markings. They wriggle backwards when disturbed.
- They roll up the growing points and leaves of plants, spinning them together with silk to form a shelter in which they feed, causing irregular leaf holing.
- Adult moths are small (12-22mm) and either pale brown (females) or pale brown with orange-brown fore-wings and reddish-brown markings in the case of males (top right).
- Host plants include: *Chaenomeles, Choisya* and *Salvia.*

Caterpillar, light brown apple moth

(*Epiphyas postvittana*)

- A typical egg mass is shown top left. Caterpillars look similar to those of the carnation tortrix but the head is light brown, without the dark markings.
- Adult moths are larger (16-25mm) than those of carnation tortrix, with a pronounced pointed nose. Females (bottom left) are yellowish-brown with small dark spots, males (bottom right) are yellow-orange at the front and dark brown at the back.
- It has a similar plant host range to carnation tortrix, with the caterpillars twisting and tying growing points together and skeletonising/holing out the leaves.

Leafhoppers

(*Eupteryx melissae* and *Hauptidia maroccana*)

- Nymphs of both species are smaller than the adults and have no mature wings (top left). Glasshouse leafhopper (*Hauptidia maroccana*) adults are whitish with 2 dark chevrons on the wings (top right). Sage leafhopper (*Eupteryx melissae*) adults are pale green with brown and black patches (bottom left). Both species are 3-4mm long.
- Leafhoppers cause indistinct white spots or flecks on leaves. Main host plant species include: herbs, *Fuchsia, Lavatera, Nepeta* and *Perovskia.*

Leaf miners

(*Chromatomyia syngenesiae, Phytomyza vitalbae,* etc.)

- Some species attack a range of crops such as the chrysanthemum leaf miner, *Chromatomyia syngenesiae* (adult, top left). Frequent host species include *Astrantia* (top right), *Cheirianthus, Dahlia, Phlox* and *Primula*.
- Some species are host-specific such as the horse chestnut leaf miner, *Cameraria ohridella* (bottom left) and *Phytomyza vitalbae* and *P. katenbachi*, which attack *Clematis* (bottom right).
- *Phytomyza* and *Chromatomyia* species are small, robust grey or black flies. Larvae tunnel inside the leaf, creating whitish leaf mines.

Mammals

(mouse and rabbit)

- Both pests can cause serious damage to crops in a short space of time and feed on a wide range of plants, attacking leaves and shoots, uprooting bulbs and plants in pots and undermining root systems. Rabbits also strip bark and girdle stem bases.
- Young plants and pot bulbs are especially attractive to mice, particularly under protection, while rabbits also damage established plants; *Berberis, Cytissus* and *Ilex* for example are frequently attacked crops.

Mealybug, New Zealand flax

(*Balanococcus diminutus*)

- The New Zealand flax mealybug (*Balanococcus diminutus*) is the most important species on nursery stock. It occurs only on *Phormium* and is hardy enough to withstand sub-zero temperatures.
- Nymphs and adults (4-5mm) are pale white or greyish in colour and covered with copious amounts of white wax, which protects the colony.
- Colonies usually form in and around the base of the leaves or below the surface of the growing medium.

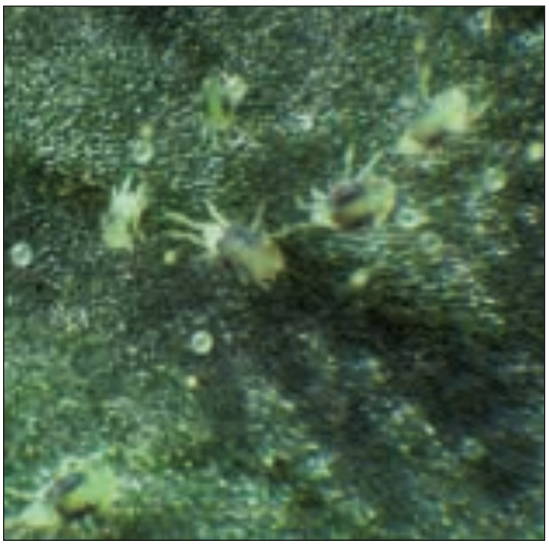
Mites, tarsonemid

(*Phytonemus pallidus* and *Polyphagotarsonemus pallidus*)

- Two main species occur on nursery stock: broad mite (*Polyphagotarsonemus pallidus*) and cyclamen mite (*Phytonemus pallidus*).
- Both are tiny (0.2mm long) mites which hide and feed in growing points and buds of plants such as *Aster novi-belgii* (Michaelmas daisy), *Fatsia, Hedera* (top right), *Leucanthemum* (bottom image), *Viburnum* and *Weigela.*
- The mites cause leaf bronzing, brittling, inward-curling of leaf margins and distortion of young growth. Damage can be confused with other causes and microscopic examination is needed to confirm their presence.

Mite, two-spotted spider

(*Tetranychus urticae*)



- A common pest of nursery stock. The mites are small (up to 0.6mm) and usually found on leaf undersides. The young mites and summer adults are green with two black patches on their backs. In the autumn, the females turn brick-red prior to overwintering.
- Feeding damage causes fine yellow speckling on leaves and leaf yellowing, which later becomes necrotic. In severe attacks, webbing occurs.
- Common host plants include: *Acer, Buddleia, Ceanothus, Choisya, Clematis, Hydrangea, Lonicera* and *Magnolia*.

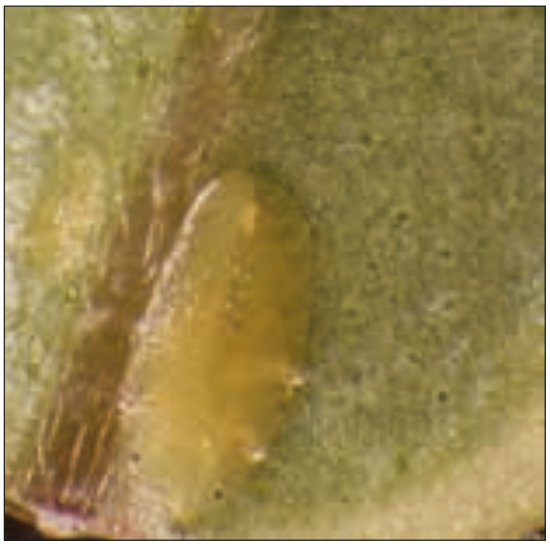
Nematode, leaf and bud

(*Aphelenchoides* species)

- Nematodes look like very small transparent worms and can only be seen with a microscope.
- Damage symptoms include leaf distortion and thickening, dark brown angular leaf markings delineated by leaf veins and plant stunting. Badly affected leaves shrivel and die.
- Principal hosts include: *Anemone hupehensis* var. *japonica, Buddleia, Geranium, Penstemon, Viburnum* and *Weigela.*

Scale insects

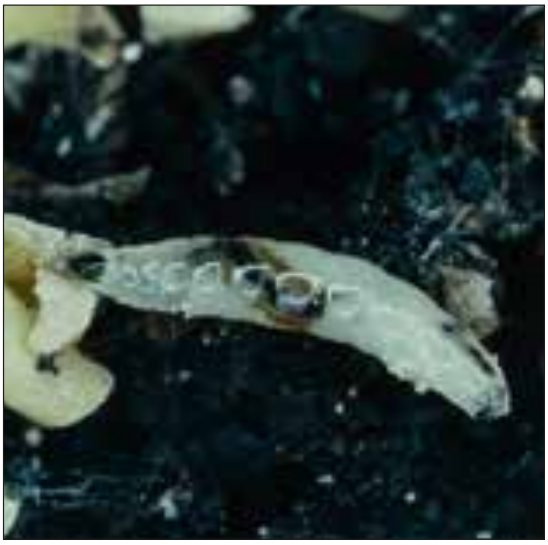
(*Coccus hesperidum, Parthenolecanium corni,* etc.)



- Many species occur on nursery stock but only two are found on a range of hosts. These are the brown soft scale (*Coccus hesperidum*) and the brown scale (*Parthenolecanium corni*).
- Nymphs of both species are pale yellow or brown and flattened (top left). Adults of the brown soft scale are flat and oval with dark markings, while brown scale adults are very convex, with a hard rough exterior.
- Scale insects reduce plant vigour and secrete honeydew leading to the development of sooty moulds.
- Common host plants include: *Camellia, Euonymus, Hedera, Ilex, Laurus nobilis* (bottom left) and *Myrtus*.

Sciarid fly

(*Bradysia difformis*)



- The larvae are shiny white with a black head and no legs and are found in the growing medium, feeding on fungi, plant roots and stem bases.
- Adult flies are small (3-4mm), black and gnat-like with long legs, long antennae and shiny wings. They are weak fliers, usually found on or just above the surface of the growing medium. They do not feed on plants but can spread disease pathogens, notably *Pythium.*
- Young seedlings, cuttings and slow rooting species are particularly vulnerable to attack.

Slugs (*Deroceras panormitanum,* etc.) **and snails** (*Oxyloma pfeifferi,* etc.)

- The main species which can damage the shoots and foliage of nursery stock are the chestnut slug (*Deroceras panormitanum*) and the water snail (*Oxyloma pfeifferi*).
- Chestnut slugs are brownish-grey, up to 35mm long with a pale halo around the breathing hole on the side.
- Water snails are typically 9-12mm long, pale brown or black and found in damp places, under pots and along irrigation lines.
- Both species are favoured by warm, wet conditions. *Choisya, Cordyline* and *Phormium* are especially prone to attack, as are herbaceous perennials.

Suckers

(*Psylla buxi, Trioza alacris,* etc.)

- The main host-specific species damaging nursery stock are the bay sucker (*Trioza alacris*), the box sucker (*Psylla buxi*), the eleaegnus sucker (*Cacopsylla fulguralis*) and the eucalyptus sucker (*Ctenarytaina eucalypti*).
- The nymphs and adults are found on shoots, leaf undersides and in the case of bay and box sucker, in protective galls formed by distorted young leaves.
- Adults have large, transparent wings and the nymphs are often covered in white wax. Large colonies can develop, creating honeydew which leads to sooty moulds.

Thrips, western flower

(*Frankliniella occidentalis*)

- Western flower thrips is the major species of thrips damaging a range of container grown nursery stock, particularly under protection.
- Larvae are yellow and wingless. Adults are 2-3mm long, yellow or pale brown with narrow, fringed wings. Found on the foliage and in flowers.
- Thrips feeding causes small white patches or flecks on the leaves and flower petals and leaf and flower distortion.
- Common host plants include: *Campsis, Chaenomeles, Choisya, Clematis, Lavatera, Verbena* and *Viburnum.*

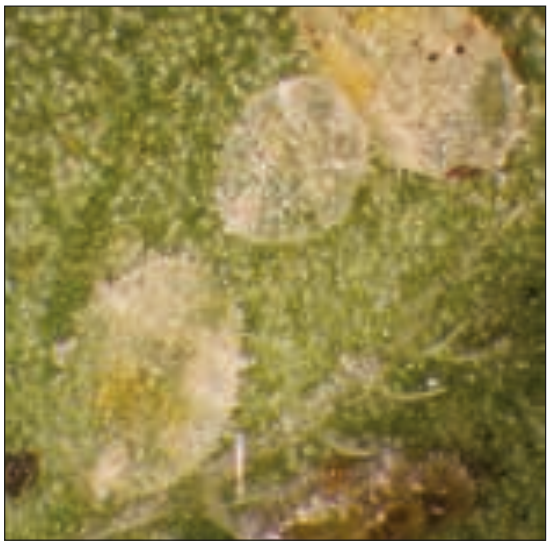
Vine weevil

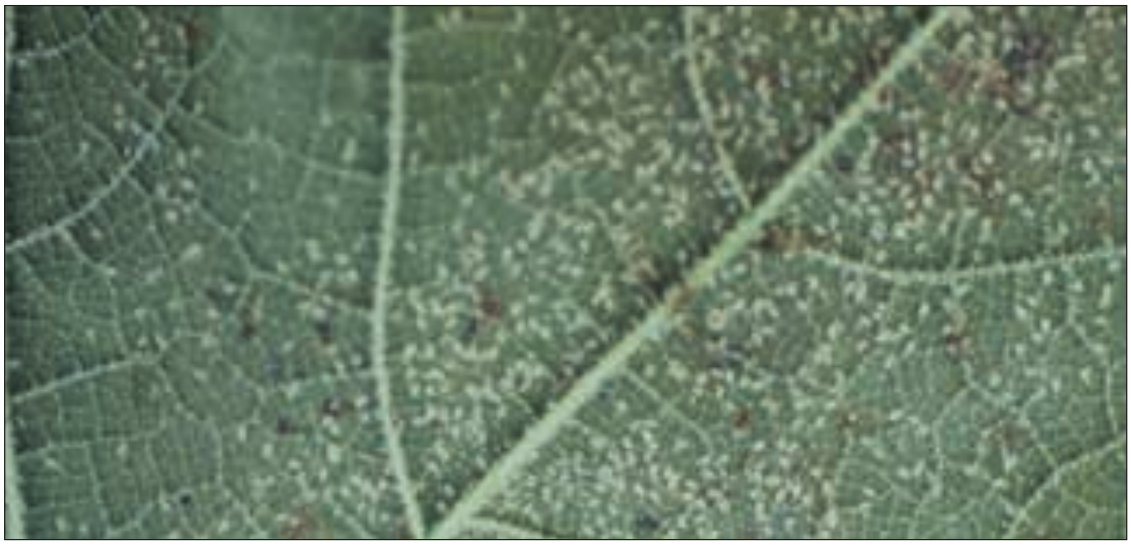
(*Otiorhynchus sulcatus*)

- A common and damaging pest of container-grown nursery stock.
- Larvae are legless, cream with a brown head, often lying in a C-shape around the roots. They feed on roots and around stem bases, usually between late summer and spring.
- Adults are 6-8mm long, wingless and black, with pale orange flecks on their backs. They usually feed at night, causing leaf edge notching.
- Host plants include: *Bergenia, Cotoneaster, Euonymus, Fuchsia, Heuchera, Hosta, Primula, Rhododendron, Sedum, Taxus* and *Viburnum davidii.*

Whitefly, glasshouse

(*Trialeurodes vaporariorum*)





- Glasshouse whitefly is the most common species affecting protected nursery stock.
- The immature scale stages are white, oval and flat and found on leaf undersides. Adults are 1-2mm long, with white wings held flat across the back when at rest.
- Whiteflies cause leaf yellowing, leaf drop and a reduction in crop vigour. Honeydew secreted by them often leads to sooty mould growth on foliage.
- Common hosts include: *Abelia, Abutilon, Ceanothus, Fuchsia, Primula* and *Salvia*.

Biological Control Agents and Beneficials

B

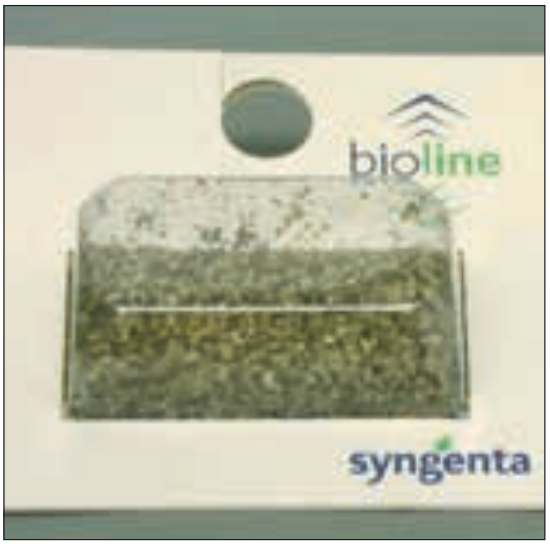
Aphidius and other parasitoid species

(For the control of aphids)

- Small brown and black parasitic wasps used for aphid control.
- Different species attack different aphid species, so correct identification of the aphid is important. However, mixes of parasitoid species are now available which attack several aphid species, reducing the need for aphid identification.
- Supplied in tubes as parasitized aphid ‘mummies’.
- Adult wasps emerge from the mummies and fly to find suitable aphids in which to lay eggs. The wasp larva develops inside the aphid, turning it into a parasitised mummy, the colour of which varies with the parasitoid species.

Aphidoletes aphidimyza

(For the control of aphids)



- A predatory midge that eats most aphid species.
- Supplied as pupae in vermiculite in either tubes or blister packs. The adult midges emerge from the pupae and lay their eggs amongst aphid colonies.
- The orange larvae hatch from the eggs and feed on the aphids.

Atheta coriaria

(For the control of sciarid and shore fly larvae)

- A ground dwelling predatory rove beetle for the control of sciarid and shore fly eggs and larvae.
- Larvae are white when young and brownish-yellow when older and live in the growing medium. The head is the same colour as the body and there are three pairs of legs.
- The adult beetle is small (3-4mm), dark brown and shiny, often hidden in the growing medium or under pots/trays but can also fly in warm temperatures.
- Adults and larvae are supplied in tubs with a carrier to sprinkle over the growing medium or matting.

Encarsia formosa

(For the control of glasshouse whitefly)

- A small (0.6mm long) yellow and black parasitic wasp that lays its eggs in whitefly scales on the undersides of leaves.
- The *Encarsia* larva develops inside the scale, turning it from white to black. The new adult then emerges through a round hole in the black scale.
- Supplied as black parasitized scales on cards, which are hung on the plants.

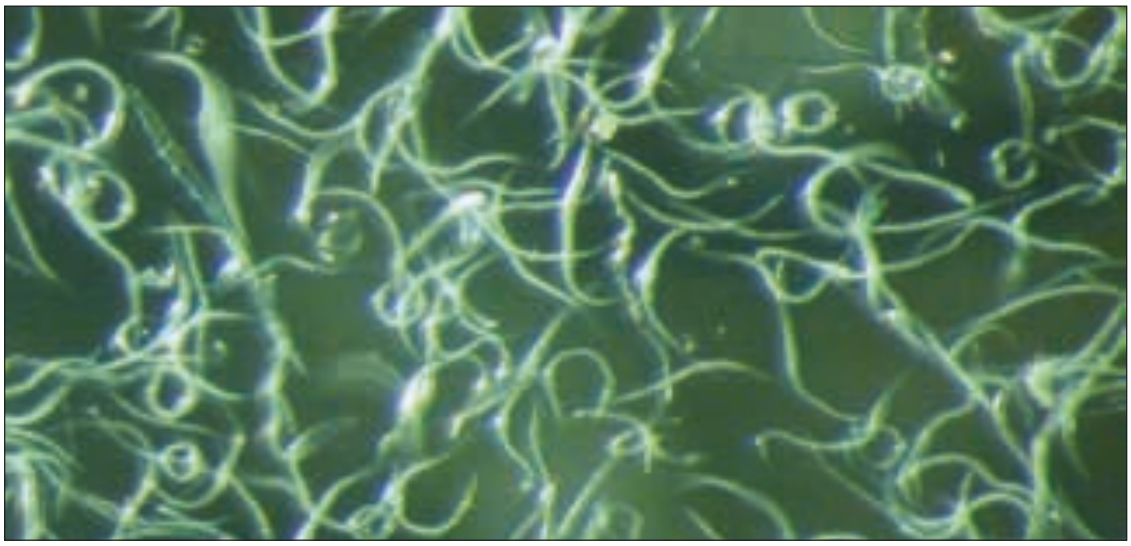
Hypoaspis species

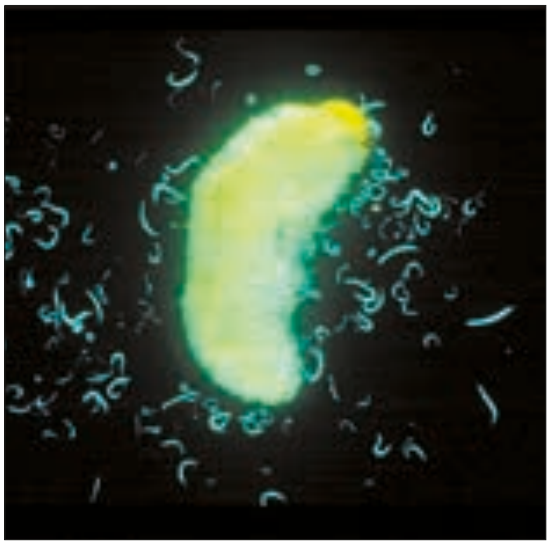
(For the control of sciarid fly larvae and thrips pupae)

- Ground dwelling predatory mites used primarily to control sciarid fly eggs and larvae but will also feed on other prey, including thrips larvae and pupae.
- Off-white in colour with a pale brown shield covering most of the upper surface of the body.
- Supplied in tubs with a peat and vermiculite carrier for sprinkling on the growing medium, floor or benches.
- The predators are very active and found in/on the growing medium, floor or bench cover or under pots and trays.

Nematode species

(For the control of sciarid fly, thrips and vine weevil)





- Microscopic worm-like nematodes supplied in a gel-like carrier in plastic trays.
- Applied in water as a drench to the growing medium (for vine weevil and sciarid fly control) or as a foliar spray (for thrips control).
- Nematodes seek out hosts, enter the body and release bacteria that kill the target pest.
- Use *Steinernema feltiae* to control sciarid fly (bottom left) and thrips and *Steinernema kraussei* and *Heterorhabditis* species to control vine weevil larvae (bottom right).

Neoseiulus (Amblyseius) californicus

(For the control of two-spotted spider mite)

- Only licensed for release in fully enclosed structures in the UK, not in open-sided tunnels or outdoors.
- Small (less than 0.4mm), oval and straw coloured predatory mite, found most easily on leaf undersides.
- Can persist in the absence of spider mites on a range of small prey and pollen and is a useful supplement to *Phytoseiulus persimilis* as it has a wider temperature range and is more tolerant of low humidity.
- Supplied in tubs with a carrier of bran or vermiculite to sprinkle over plants.

Neoseiulus, Amblyseius and *Transeius* species (For the control of thrips)

- *Neoseiulus (Amblyseius) cucumeris* (top left) is the most commonly used but *A. swirskii* (bottom left) and *Transeius montdorensis* are also available. The latter two are only licensed for release in glasshouses in the UK.
- Small (less than 0.4mm), oval shaped straw coloured predatory mites found on leaf undersides, growing points, buds and flowers. They feed on pollen, young thrips larvae and will also eat mites.
- Supplied in tubs with a bran or vermiculite carrier for sprinkling over plants or in controlled release sachets for hanging on plants.

Phytoseiulus persimilis

(For the control of two-spotted spider mite)

- An orange-red predatory mite that feeds on spider mite eggs, nymphs and adults.
- The predator eggs are pale pink, oval (top left, right) and about twice the size of the clear, round spider mite eggs (top left, left). Eggs and mites are found on leaf undersides.
- Adults can be mistaken for spider mite adults but are slightly larger with longer legs and a shiny body.
- Supplied in tubes with a bran or vermiculite carrier that is sprinkled over the plants.

Trichogramma brassicae

(For the control of caterpillars)

- A tiny wasp that parasitises moth eggs including those of the light brown apple moth and carnation tortrix moth. Eggs turn black once parasitized (top right).
- Supplied as parasitised black moth eggs on cards which are hung on the plants, labels or stanchions.

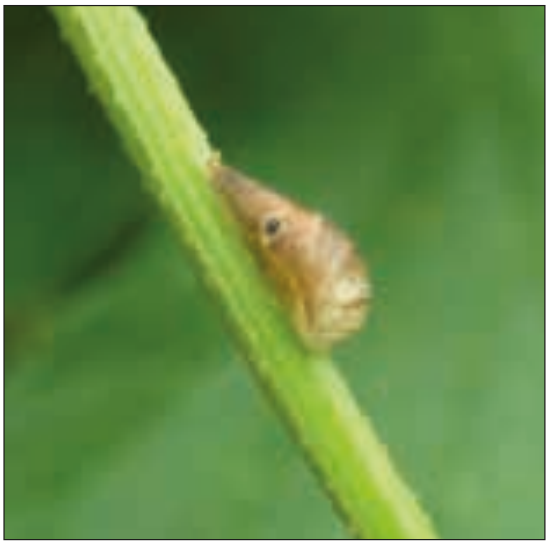
Ground beetles and rove beetles

(*Carabus* and *Staphylinus* species, etc.)

- Such beetles are generally found feeding on the soil stages of ground dwelling pests, including caterpillars and vine weevil larvae.
- Both the larvae and adults of many species found on nurseries are predatory.
- *Atheta* is used commercially for sciarid and shore fly control.

Hoverflies

(*Episyrphus* and *Heliophilus* species, etc.)



- Hoverfly larvae feed mainly on aphids, but also on other small prey.
- Adults are not predatory, but many feed on pollen and nectar, so may be important pollinators.

Lacewings

(*Chrysoperla* species, etc.)

- Lacewings are particularly good predators of aphids.
- All larvae and some adults are predators.

Ladybirds

(*Adalia* and *Coccinella* species, etc.)

- Aphids are the preferred prey, but ladybirds will also feed on moth eggs, midge larvae, small caterpillars and mites.
- Both larvae and adults are predatory.
- All stages of the life cycle can be found on crops.

Parasitoid wasps

(*Apanteles* and *Praon* species, etc.)

- Parasitic wasps are important biocontrol agents of many insect pests including aphids and caterpillars.
- Different species of parasite may be specific to different species of pest.
- Adult wasps lay eggs in aphids, which then have a characteristic mummified appearance.
- Larvae usually develop internally, but can be external.
- *Aphidius* is used commercially for aphid control.

Predatory bugs

(*Anthocoris* and *Deraecoris* species, etc.)

- Anthocorids feed on a variety of pests, including aphids, midge larvae, scale insects, mites, caterpillars and insect eggs.
- Both nymphs and adults are predatory.
- Adults are good fliers and can migrate around nurseries.
- *Orius* is used commercially for the control of thrips and other pests.

Spiders and harvestmen

(*Araneus* and *Mitopus* species, etc.)

- Spiders and harvestmen are web-spinning or actively hunting generalist predators of many pests.
- Their predatory potential in crops is probably underrated as they are often active at night.

Diseases

C

Black root rot

(*Thielaviopsis basicola*)

- A soil-borne disease of roots that reduces vigour and causes top-growth to collapse. Affected roots become blackened and decay.
- An increasingly wide container-grown nursery stock host range including: *Choisya, Clematis, Fuchsia, Genista, Ilex* and *Skimmia*.

Box blight

(*Cylindrocladium buxicola* and *Volutella buxi*)

- A serious leaf and stem blight specific to *Buxus* caused by two fungi, which are often found together.
- Affected leaves turn brown, senesce and drop prematurely, creating bare patches on stems. *Cylindrocladium buxicola* is the more damaging of the two pathogens, causing distinctive dark brown spots on leaves, stem lesions and die-back. *Volutella buxi* infection causes leaves to turn pale brown.
- In humid conditions, white fungal spores of *C. buxicola* and orange-pink spores of *V. buxi* may be seen on the undersides of affected leaves.

Clematis wilt

(*Phoma clematidina*)

- A common and serious disease of *Clematis* caused by the fungus *Phoma clematidina*.
- Leaf and stem infections cause leaf spotting, wilting and browning, with stems becoming black inside. Infection can also occur via the roots. Infection rapidly causes wilting and death.
- Small flowered plant species appear less susceptible than large flowered types.

Downy mildews

(*Peronospora grisea, Peronospora sparsa,* etc.)

- Symptoms include a yellowing and browning of the upper leaf surface, leaf spotting (sometimes angular), premature leaf drop, necrosis, stunting and distortion.
- Sporulation is usually, but not always, visible as a soft, felty growth on the leaf undersides, typically white to brown-grey in colour.
- The pathogen is often host-specific. Major hosts are *Hebe* and *Rosa*. Other common hosts include: *Buddleia*, evergreen *Prunus* and several herbaceous perennials, for example: *Digitalis, Gaillardia, Geranium* and *Lamium*.

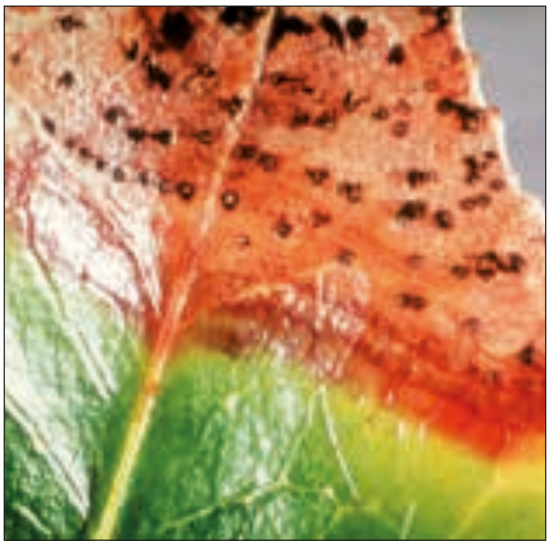
Grey mould or *Botrytis*

(*Botrytis cinerea*)

- A damaging disease affecting a range of subjects and most aerial parts of the plant. Characterised by pale brown tissue decay followed by fluffy fungal strands bearing grey-brown spore clusters.
- Readily infects damaged or senescent plant tissue, including flowers but can infect without wounds.
- Protected crops are particularly susceptible, especially during the autumn-winter period.

Leaf blights

(*Insolibasidium deformans, Monochaetia karstenii,* etc.)



- Commonly linked with various fungal and bacterial infections.
- Initial symptoms are dark brown leaf-spots or blotches, often around leaf margins. Further necrosis can lead to leaf-drop, stem lesions, twig blight, cankering and die-back.
- Host plants include: *Berberis, Camellia, Chaenomeles, Leucothe,* evergreen *Lonicera* (notably, 'Baggessen's Gold'), *Pieris* and *Syringa*.

Leaf spots (bacterial)

(Pseudomonas syringae, Xanthomonas hortorum, etc.*)*

- The main bacterial pathogens are species of *Pseudomonas* (such as *P. syringae*) and *Xanthomonas* (for example *X. hortorum* pv. *hederae*).
- Usually appear as small water soaked or necrotic spots which can be circular, angular or irregular in shape, which when numerous coalesce, leading to leaf necrosis. Necrotic spots often lead to a ‘shot-hole’ symptom.
- Host crops include *Aucuba, Delphinium, Hedera, Lavandula, Magnolia, Philadelphus* and *Prunus* (notably, species of the evergreen laurel).

Leaf spots (fungal)

(*Glomerella cingulata, Septoria exotica,* etc.)

- Fungal leaf spots are usually dark brown-purple in colour, forming circles or more irregular patches which may or may not coalesce and enlarge, depending on the causal pathogen. Easily confused with bacterial infections.
- A range of fungal pathogens are involved, notably species of *Glomerella, Phoma, Septoria* (bottom left) and *Stempylium* (bottom right), which can progress to cause leaf necrosis, leaf-drop and stem die-back.
- They affect a range of subjects, including: *Ajuga, Cornus, Escallonia* (top image), *Garrya, Hebe, Hedera, Helleborus, Iris, Mahonia, Viburnum* and *Vinca*.

Lupin anthracnose

(*Colletotrichum acutatum*)

- A debilitating disease of lupin caused by the fungal pathogen *Colletotrichum acutatum*. This fungus has a wide host range.
- The pathogen gives rise to a pale brown necrosis of the leaf blade and orange-brown lesions on leaf petioles, leading to a wilting and collapse of top growth. Infected stems and flower pods can become twisted. Often begins on leaf margins. Can over-winter in dormant crowns to re-infect new top growth in the spring.

Needle blights

(*Didymascella thujina, Pestalotiopsis* species, etc.)

- A common problem of conifers, notably ground cover junipers and *Thuja.*
- Often linked with the fungal pathogen *Pestalotiopsis* on *Juniperus* species and *Didymascella thujina* (formerly *Keithia thujina*) on *Thuja.*
- The pathogens cause browning and die-back of needles and stem sections, frequently at the tips of shoots. Tiny black spore cases are often noted on affected *Juniperus*.
- Can be confused with other die-back pathogens, notably *Phytophthora* species so correct diagnosis is important.

Phytophthora root rot

(*Phytophthora cinnamomi, Phytophthora citricola,* etc.)

- Soil and water-borne pathogens affecting a wide host range including: *Choisya, Hebe, Lavandula* and various herbaceous perennials and conifers.
- Infection leads to a gradual, usually pale discoloration of foliage and progressive decay of roots, crown and stem bases, resulting in wilting and collapse of plants.
- Leaf death can also follow direct foliar infection of specific hosts, for example, *Rhododendron* by notifiable *P. ramorum* and *P. kernoviae*.

Powdery mildews

(*Erysiphe alphitoides, Podosphaera pannosa,* etc.)

- Infection leads to the development of white or off-white fungal spots or patches on leaves and stems. Often on upper leaf surfaces but leaf undersides can be affected too. Systemic infection of buds can result.
- Several host-specific fungi cause powdery mildew infection.
- Commonly seen on a wide range of host plants including: *Acer, Aster, Crataegus, Delphinium, Hydrangea, Malus, Phlox, Rosa* and *Spiraea*

Rust diseases

(*Puccinia malvacearum, Uromyces geranii,* etc.)

- The pathogen gives rise to distinctive, brightly coloured pustules, usually white, yellow, orange, brown or black, produced most commonly on the undersides of leaves.
- Normally visible on the upper leaf surface as pale yellow spots or blotches as a result of the fungus growing within the leaf. Leaves may become distorted.
- Hosts include: *Althea, Betula, Campanula, Carex, Euphorbia, Fuchsia, Heuchera, Hypericum, Mahonia, Populus, Salix, Vinca* and *Tradescantia*.

Scab

(*Venturia cerasi, Venturia inaequalis,* etc.)

- Common and serious fungal pathogens of *Malus* (left image), *Pyracantha* (right image) and *Pyrus*, appearing as an olive-green, brown or blackish blotch or scab on leaves and fruits, in severe cases causing the latter to crack.
- Affected leaves may fall prematurely, creating wound tissue and in turn entry points for further infection.
- Some cultivars are claimed to be scab resistant.

Shab

(*Phomopsis lavandulae* and *Septoria lavandulae*)

- A common and debilitating fungal disease of *Lavandula*, particularly affecting container-grown plants.
- Typical symptoms include a dark brown to black irregular leaf blotching, necrosis and stem die-back.

Specific and General Nutritional Disorders

D

Calcium
(Ca)

- Deficiency can result in distorted or even aborted growing tips, an unsightly ‘tip-burn’ of foliage as leaf margins turn brown and necrotic and abnormally small leaves, which may become curled and aborted.
- Leaves may become light green or exhibit an uneven chlorosis while root growth is often poor with short, thick ‘stubby’ roots.
- Unlike nitrogen, calcium is not a mobile element within plants, so symptoms are most commonly seen towards the top of plants, amongst young leaves and growing points.

Iron
(Fe)

- Deficiency is usually characterised by an interveinal chlorosis and paling of the younger leaves as iron is a relatively immobile element within plants.
- Symptoms may be transitory during periods of active growth, when demand temporarily exceeds nutrient supply.
- A common deficiency problem in container-grown nursery stock and usually associated with high pH of the growing medium.
- Poor root development may also lead to iron deficiency.

Magnesium
(Mg)

- Often related to wet conditions and poor root growth, typical symptoms include an interveinal chlorosis and necrosis of the older leaves.
- Symptoms usually progress from older to younger growth and affected leaves may become completely chlorotic and fall off.
- Magnesium toxicity can induce calcium deficiency and older leaves may discolour and develop russet.

Potassium
(K)

- Deficiency leads to slow growth and an interveinal yellowing and necrosis of older foliage, starting at the leaf margins.
- The necrosis can extend from the margins to cover all the leaf and premature leaf drop may occur. A downward curling of leaves may also occur.
- Potassium toxicity can induce calcium and magnesium deficiencies.

High electrical conductivity
(EC)

- Electrical conductivity (EC) is the standard term used to describe the level of total soluble salts in the growing medium. A high EC means a high level of soluble salts.
- Symptoms include poor root growth, root scorch, stunted top growth, leaf discoloration and necrosis. Leaf tips often turn pale, become brown and then necrotic.
- High temperatures creating ‘flash release’ of nutrients from controlled release fertilisers can increase conductivity, so can an uneven distribution of fertiliser prills in cell grown plants and irrigation water with high salt levels.

Low nutrient levels

- Affected plants are usually smaller and lack vigour. Other symptoms include leaf purpling, paling, yellowing and chlorosis, poor growth and stunting.
- Commonly seen with over-wintered plants and older stock, where fertiliser levels have diminished or where excessive nutrient leaching has occurred following heavy rainfall or overhead irrigation.
- Nitrogen deficiency creates similar symptoms.

Cultural and Physiological Disorders

E

High humidity

- High humidity can limit the rate of water loss from plant leaves, leading to a physiological disorder known as Oedema, often seen in *Eucalyptus.*
- Oedema occurs when plant roots take up water faster than it can be used by the plant or transpired through leaf cells, causing them to rupture. This rupturing takes the form of raised corky lumps on the underside of leaves.
- Overwatering, poor ventilation, high ambient humidity and low light intensity also favour other leaf symptoms, such as ‘glassiness’ or water soaking.

Pesticide damage

- The most common symptom of pesticide damage is a physical scorch of the leaves, which often turn pale, become bronze and then necrotic and may drop off.
- Soft young foliage is usually more susceptible, particularly under protection and if pesticides are applied during bright, sunny conditions. Plants under stress are also at greater risk.
- Plants often grow away from symptoms unless they are severely damaged.

Sun scorch

- Sun scorch typically causes pale, bleached areas across the leaf, sometimes followed by necrosis and leaf-drop.
- Soft, new growth is particularly sensitive to damage, especially when in full sun. Young crops moved from low to high light intensity situations are also susceptible to sun scorch.
- Yellow or golden leaved subjects are often prone to scorching or bleaching, as are evergreens such as *Aucuba, Camellia, Pieris* and *Skimmia*, which may lose colour if exposed to strong sun for lengthy time periods.

Water scorch

- Often associated with overhead irrigation, applied during hot, bright conditions. New growth is most susceptible, particularly with seedlings, cuttings, plug raised plants and liner crops.
- Foliage tends to scorch and turn necrotic (left image) quite quickly as water droplets on the leaf surface evaporate. Often the pattern and distribution of the damage follows that of the water droplets, which intensify the burning effect of the sun (right image).

Waterlogging

- A common cause of root death and plant die-back, usually due to poor drainage of container beds and growing media and/or over-watering.
- Affected plants are slow to establish, turn pale, lose colour and suffer root decay, which can be extensive where waterlogging occurs over a lengthy period. Wilting and collapse of plants usually follows; often associated with water-borne diseases, notably *Phytophthora* species.

Winter injury

- Symptoms include leaf burning, discoloration and necrosis from cold, desiccating winds and chilling temperatures, branch die-back, root death, physical damage due to heavy snow loading and a sudden collapse of new growth due to root death, particularly common with deciduous subjects.
- Sustained periods of wet and cold arriving early in winter before stock is fully hardened or acclimatised is a particular hazard, although frequent cycles of freezing and thawing may be more damaging.

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