

Hardy Nursery Stock



Hardy nursery stock growers can encounter a wide range of crop problems that can quickly render plants unsaleable unless recognised, diagnosed and dealt with promptly. Often, such problems are linked to pests and diseases but nutritional and cultural related disorders may also be involved.

This AHDB Horticulture 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 disorders. Weed identification is not covered in this publication (see AHDB Horticulture's 'Practical weed control for nursery stock' handbook for further detailed information). Images of the key stages of each pest or pathogen, along with typical symptoms have been included, together with bullet point comments to help identification.

As the nursery stock industry produces a diverse range of crops it is impossible to show every issue associated with each crop. This guide, therefore, presents the most commonly occurring pests, diseases and disorders in hardy nursery stock crops. Growers are advised to familiarise themselves with the range of symptoms that can be expressed and be aware of new problems that may occasionally arise.

While covering some of the key biological pest control agents used in protected nursery stock production, this guide does not 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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Hardy Nursery Stock Crop Walkers' Guide

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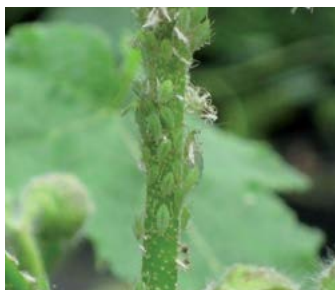
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Pests





- The melon-cotton aphid (*Aphis gossypii*, top) is small, pale to olive-green or black. The siphunculi (tubes at the rear of the body) are short and black.
- Host plants include: *Hebe*, *Hibiscus* and *Pyracantha*.
- The potato aphid (*Macrosiphum euphorbiae*, bottom) is long, pear-shaped, green or pink, often with a dark stripe down the back. The siphunculi are long and green.
- Host plants include: *Buddleia*, *Photinia* and *Solanum*.
- A range of other aphid species can also be problematic.
- Aphids cause leaf and shoot distortion, stunting and they secrete honeydew, leading to the development of sooty moulds.
- Resistance to insecticides can be an issue with a number of aphid species including *Aphis gossypii*.

Capsid bugs and tarnished plant bug

Lygocoris pabulinus and *Lygus rugulipennis*



- Common green capsid (*Lygocoris pabulinus*) adults (top left) and nymphs (top right) are bright green.
- European tarnished plant bug (*Lygus rugulipennis*) adults can be green, brown or black (bottom left). Nymphs are green or brown with pairs of dots on the upper side of the front body segments.
- Both bugs cause leaf marking, distortion and tattering, often with many small holes.
- The pests overwinter as eggs or adults, depending upon species, with two generations per year causing feeding damage.
- Host plants include: *Aster*, *Caryopteris*, *Fatsia*, *Hydrangea*, *Papaver* and *Prunus*.

Caterpillars – Leaf holing

Autographa gamma, *Lacanobia oleracea*, *Operophtera brumata*, etc



- Numerous species of both moth and butterfly caterpillar species feed on a wide range of plant species.
- Caterpillars can vary in size, shape and colour, from greens and browns to yellows and other colours.
- Some caterpillar species eat completely through leaves and shoots.
- Others feed only on the leaf underside, leading to transparent ‘windows’ in the foliage.
- Frass (droppings) may also be associated with feeding damage.
- A range of plant species are attacked including *Cornus*, *Malus*, *Prunus*, *Rhododendron*, *Syringa* etc.

Caterpillars – Leaf rolling

Cacoecimorpha pronubana, *Epiphyas postvittana*, etc



- Adult moths are small and patterned in various shades of brown and are active from May through to October.
- Caterpillars are small, pale or olive green and have a yellowish head with brown markings.
- They roll up the growing points and leaves of plants, spinning them together with silk to form a shelter in which they feed.
- Irregular leaf holing and extensive feeding damage can often result.
- The host plant range is extensive but includes: *Choisya*, *Euonymus*, *Salvia* and *Skimmia*.

Leafhoppers

Eupteryx melissae, *Hauptidia maroccana*, etc



- Glasshouse leafhopper (*Hauptidia maroccana*) adults are whitish with two dark chevrons on the wings (top left). Sage leafhopper (*Eupteryx melissae*) adults are pale green with brown and black patches (top right).
- Nymphs of both species are smaller than the adults and have no mature wings (bottom left).
- Leafhoppers cause indistinct white spots or flecks on leaves. Main host plant species include: *Fuchsia*, *Lavatera*, *Nepeta*, *Perovskia* and *Salvia*.
- Other species of leafhopper tend to be associated with individual host plant species such as *Fagus*, *Rhododendron* and *Rosa*.

Leaf miners

Chromatomyia syngenesiae, *Phytomyza vitalbae*, etc



- Adults of species such as *Chromatomyia* and *Phytomyza* are often small, robust, grey or black flies (top left). Adult feeding causes small puncture marks on the leaf surface.
- Leaf miner larvae tunnel inside leaves, creating distinctive, whitish mines which can turn necrotic. Pupation can occur within the mine or externally (on the ground).
- Some species are host-specific such as the horse chestnut leaf miner, *Cameraria ohridella* (top right) and *Phytomyza vitalbae*, which attacks *Clematis* (bottom left).
- Other species attack a range of crops such as the chrysanthemum leaf miner, *Chromatomyia syngenesiae*.
- Frequent host species include *Astrantia* (bottom right), *Cheiranthus*, *Dahlia*, *Phlox* and *Primula*.



- Rodent pests can cause serious damage to crops in a short space of time and feed on a wide range of plants, eating leaves and shoots, uprooting bulbs and freshly transplanted plants in containers, and undermining root systems.
- Rabbits and other mammals including deer can also strip bark and girdle stem bases.
- Young plants and pot bulbs are especially attractive to mice, particularly under protection, while rabbits also graze established crops of species including: *Berberis*, *Cytisus*, and *Ilex*.

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.
- Adults and nymphs 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.
- Infested plants can also be contaminated with quantities of honeydew.

Mites (Tarsonemid)

Phytonemus pallidus and *Polyphagotarsonemus latus*



- Two main species occur on nursery stock: broad mite (*Polyphagotarsonemus latus*) and cyclamen mite (*Phytonemus pallidus*).
- Both are tiny mites that hide and feed in growing points and buds of plants.
- The mites feed mainly on the underside of leaves but will also invade unfurling leaves and plant tissue.
- Feeding causes 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.
- Host plants include *Aster novi-belgii* (Michaelmas daisy), *Fatsia*, *Hedera* (top right), *Leucanthemum* (bottom), *Viburnum* and *Weigela*.

Mite (Two-spotted spider)

Tetranychus urticae



- A common pest of nursery stock. The mites are small 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 speckling on leaves and leaf yellowing, which later becomes necrotic.
- In severe attacks webbing, produced by the mites, can be seen bridging gaps between leaves and shoots.
- Common host plants include: *Acer*, *Buddleia*, *Ceanothus*, *Choisya*, *Clematis*, *Hydrangea*, *Lonicera* and *Magnolia*.

Nematode (Leaf and bud)

Aphelenchoides fragariae and *A. ritzemabosi*



- 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.
- Under moist conditions symptoms spread rapidly up the plant.
- 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*).
- 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. Nymphs of both species are pale yellow or brown and flattened (bottom right).
- 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*.



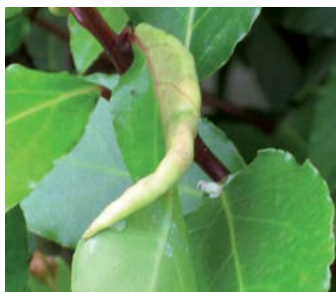
- Adult flies are small, black and gnat-like with long legs, long antennae and shiny wings. They are weak fliers, usually found on or just above the surface of the growing medium.
- Adults do not feed on plants but can spread disease pathogens, notably *Pythium* species.
- The larvae are shiny white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

Slugs and snails

Deroceras panormitanum, etc, *Oxyloma pfeifferi*, etc



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



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

Thrips

Frankliniella occidentalis



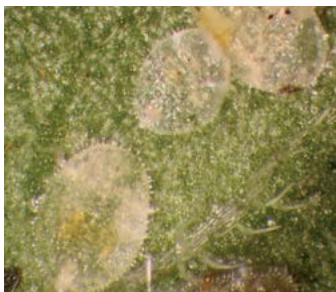
- Western flower thrips is the major species of thrips damaging a range of container-grown nursery stock, particularly under protection.
- Adults are yellow or pale brown with narrow, fringed wings (top left). Larvae are yellow and wingless (top right). Found on foliage and in flowers.
- Thrips feeding causes small white patches or flecks on the leaves and flower petals, causing leaf and flower distortion.
- Common host plants include: *Campsis*, *Chaenomeles*, *Choisya*, *Clematis*, *Lavatera*, *Lupinus*, *Verbena* and *Viburnum*.
- Western flower thrips can also spread a number of viruses including tomato spotted wilt virus.



- A common and damaging pest of container-grown nursery stock.
- Adults are wingless and black, with pale orange flecks on their backs.
- Adults usually feed at night, causing leaf edge notching.
- Larvae are legless, cream with a brown head, often lying in a C-shape around the roots.
- Larvae feed on roots and around stem bases, usually between late summer and spring.
- 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.
- Adults are moth-like, with white wings held flat across the back when at rest.
- The immature scale stages are white, oval and flat, and found on leaf undersides.
- Whitefly infestations 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*.

Beneficials

INTRODUCED

NATURALLY OCCURRING



Amblyseius, *Neoseiulus* and *Transeius* species

For the control of thrips and other pests



- *Neoseiulus* (*Amblyseius*) *cucumeris* (top) is the most commonly used but *A.swirskii* (bottom) and *Transeius montdorensis* are also available.
- Small, oval-shaped, straw-coloured predatory mites found on leaf undersides, and in growing points, buds and flowers.
- They feed on pollen, thrips larvae (bottom), mites and whitefly eggs and young scales.
- The latter two mentioned mite species are only licensed for release in fully enclosed structures in the UK.
- Supplied in tubs with a bran or vermiculite carrier for sprinkling over plants or in sachets.

INTRODUCED

Aphidius and other parasitoid wasp species

For the control of aphids



- Small black and brown parasitoid wasps used for aphid control.
- Adult wasps actively search 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. Adults emerge from holes cut into the mummy.
- Different species attack different aphid species, so correct identification of the aphid is important. However, mixes of parasitoid species are now available that attack several aphid species, reducing the need for aphid identification.
- Supplied in tubes or bottles as parasitised aphid 'mummies'.

Aphidoletes aphidimyza

For the control of aphids



- A predatory midge, the larvae of which eats most aphid species.
- The adult midges emerge from pupae and lay their eggs among aphid colonies.
- The pale orange larvae hatch from the eggs and feed on the aphids becoming a deeper orange as they develop.
- Supplied as pupae in vermiculite either in tubes, bottles or blister packs.

INTRODUCED

Dalotia (Atheta) coriaria

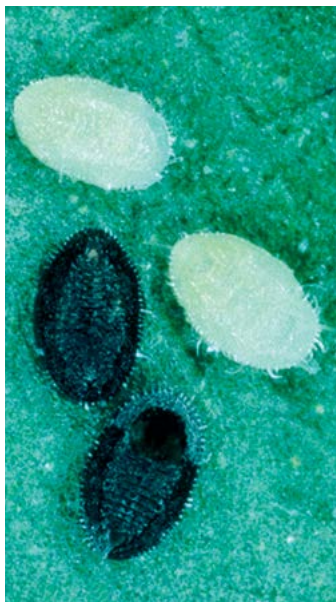
For the control of sciarid and shore fly



- A ground dwelling predatory rove beetle for the control of sciarid and shore fly eggs and larvae.
- The adult beetle is small, dark brown and shiny, often hidden in the growing medium or under containers/trays but can also fly in warm temperatures.
- 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 the larvae have three pairs of legs.
- Adults and larvae are supplied in tubes or bags with a carrier to sprinkle over the growing medium or matting.

Encarsia formosa

For the control of glasshouse whitefly

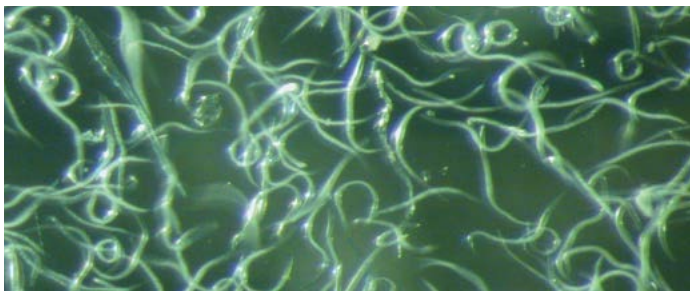


- A small, yellow and black parasitoid wasp that lays its eggs in whitefly scales located on the underside of leaves.
- The young parasitoid develops inside the scale, turning it from white to black. The new adult then emerges through a round hole cut in the black scale.
- Adult wasps feed on honeydew and from wounds made to whitefly scale.
- Supplied as black parasitised scales on cards, in strips, which are hung on plants.

INTRODUCED

Heterorhabditis and *Steinernema* species

For the control of sciarid fly, thrips and vine weevil



- Microscopic worm-like nematodes used for the control of a number of pests.
- Applied in water as a growing media drench for the control of sciarid fly (*Steinernema feltiae*, bottom left) and vine weevil (*Heterorhabditis bacteriophora* and *S. Kraussei*, bottom right) or as foliar sprays for the control of thrips larvae (*S. feltiae*).
- Nematodes seek out hosts, enter the body and release a bacteria that kills the target pest.
- Different species have varying optimal temperatures.
- The nematodes are supplied in a gel like carrier in plastic trays.

Macrocheles robustus and *Stratiolaelaps scimitus*

For the control of sciarid fly and thrips



- 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.
- Adult mites are off-white in colour with a pale brown shield covering most of the upper surface of the body, nymphs are paler in colour.
- The predators are very active and found in/on the growing medium, floor or bench cover or under containers and trays.
- Supplied in tubs with a peat and vermiculite carrier for sprinkling on the growing medium, floor or benches.

INTRODUCED

Neoseiulus (Amblyseius) californicus

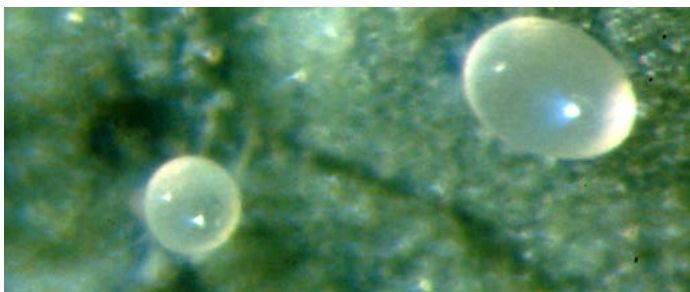
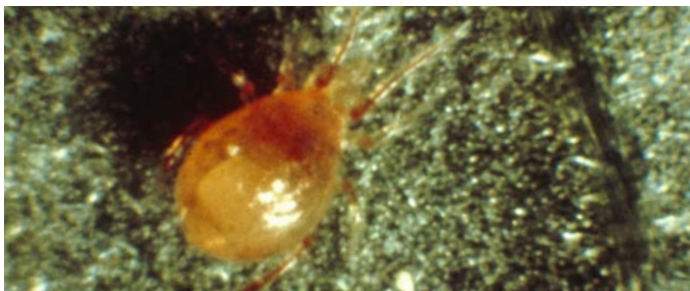
For the control of two-spotted spider mite



- A small, oval, straw-coloured predatory mite, found most easily on leaf undersides.
- The eggs are oblong, transparent to white, and are attached to hairs along veins on the underside of leaves.
- Can persist in the absence of spider mites on a range of small prey and pollen.
- A useful supplement to *Phytoseiulus persimilis* as it has a wider temperature range and is more tolerant of low humidity.
- Only licensed for release in fully enclosed structures in the UK.
- Supplied in bottles of bran or vermiculite to sprinkle over 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.
- Adult predators are orange-red and relatively long legged. Nymphs are smaller in size and paler in colour.
- Adults can be mistaken for spider mite adults but are slightly larger with longer legs and a shiny body.
- The predator eggs are pale pink, oval and about twice the size of the clear, round spider mite eggs (bottom).
- Predators and eggs are found on leaf undersides.
- Supplied in tubes or bottles with a bran or vermiculite carrier that is sprinkled over the plants.

INTRODUCED

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 parasitised (bottom).
- Adult parasitoid wasps are yellow or yellow and black with bright red eyes, short antennae, and compact bodies.
- Supplied as parasitised black moth eggs on cards that are hung on plants, labels or stanchions.

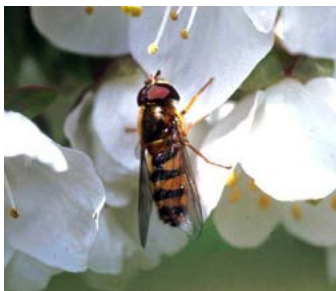
Ground and rove beetles

Carabus and *Staphylinus* species, etc

- Both ground beetles (left) and rove beetles (right) are generally found feeding on the soil stages of ground dwelling pests, including caterpillars and vine weevil larvae.
- The adults and larvae of many species found on nurseries are predatory.
- Both ground and rove beetle adults tend to be dark in colour and active foragers.

Hoverflies

Episyrphus and *Heliophilus* species, etc



- Hoverfly larvae feed mainly on aphids but also on other small prey.
- Larvae are voracious feeders, particularly in established aphid colonies.
- Adults are brightly coloured, with stripes or bands of yellow, gold or brown covering their bodies.
- 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 predatory.
- Adults are green or brown in colour with transparent wings.
- Adults feed at twilight and also in the hours of darkness.
- Eggs are laid singly or in groups on the end of slender stalks on the underside of leaves close to aphid colonies.

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 adults and larvae are predatory.
- All stages of the life cycle can be found on crops.
- Adults are coloured red, orange or yellow with black spots on their wing cases.

Parasitoid flies and wasps

Apanteles and *Praon* species, etc

- Parasitoid flies and wasps are important biocontrol agents of many insect pests, including caterpillars and aphids.
- Species differ in which host life stage is attacked: eggs, larvae, pupae or adults.
- In the case of caterpillars, the parasitoid fly larvae usually develop internally, but can also be external.
- Pupation often occurs alongside the dead host, sometimes under a loose silk covering.
- Different species of parasitoid wasp are often specific to different species of aphid.
- Adult wasps lay eggs in aphids, which then develop a characteristic mummified appearance.

Predatory bugs

Anthocoris and *Deraeocoris* species, etc



- Anthocorids feed on a variety of pests, including aphids, midge larvae, scale insects, mites, caterpillars and insect eggs.
- Both adults and nymphs are predatory.
- Adults are good fliers and can migrate around nurseries.
- Adults have soft, elongated, oval, flat bodies, often patterned in black, brown and white.
- Nymphs are pinkish and develop immature wing buds on the sides of the body.

Predatory midges

Feltiella acarisuga, etc

- The tiny delicate adult midges lay ovoid orange eggs in colonies of two-spotted spider mites.
- The larvae which emerge are cream/brown and predate the mites.
- Silken pupae are formed alongside veins on leaves.
- Often associated with high pest populations.

Spiders and harvestmen

Araneus and *Mitopus* species, etc



- Spiders are web-spinning or actively hunting generalist predators of many pests.
- A range of spiders of different sizes and colours may be present in crops.
- Their predatory potential in crops is probably underrated as they are often active at night.
- Although related, harvestmen (bottom) are not venomous and do not produce silk.

Diseases

BACTERIAL

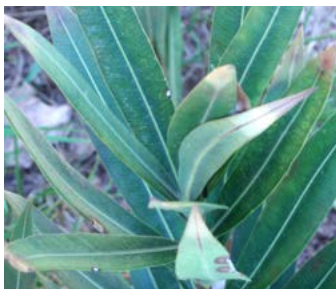
FUNGAL

OOMYCETE



Dieback, cankers and leaf scorch

Pseudomonas syringae and *Xylella* species



- *Pseudomonas* causes necrotic sunken lesions on stems, branches and twigs. A sticky gum is sometimes also noted.
- Other symptoms include blossom blast, bud death, leaf spots and shot-holes, death of fruiting spurs, dieback of shoots and spots on immature fruits (top).
- The pathogen primarily infects *Prunus* species, although other species can also be infected.
- *Xylella* gives rise to a range of leaf scorch symptoms which can lead to premature leaf fall, wilting, dieback and eventually plant death (bottom).
- *Xylella* has been found on a wide range of species including: *Cistus*, *Lavendula*, *Nerium*, *Olea*, *Polygala*, *Prunus* etc.

Leaf spots

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 that 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 in evergreen laurel, for example.
- Host crops include *Aucuba*, *Delphinium*, *Hedera*, *Lavandula*, *Magnolia*, *Philadelphus* and *Prunus* (notably, species of the evergreen laurel).

Black root rot

Thielaviopsis basicola

- A soil-borne pathogen of roots that reduces vigour and causes top growth to collapse. Affected roots become blackened and decay.
- A black or grey rot in distinct segments on the roots indicates *Thielaviopsis*, a more general grey/brown rotting often indicates the presence of *Pythium*.
- An increasingly wide container-grown nursery stock host range is affected, including: *Choisya*, *Clematis*, *Fuchsia*, *Genista*, *Ilex* and *Skimmia*.

Box blight

Cylindrocladium buxicola and *Pseudonectria (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 dieback.
- *Pseudonectria buxi* infection causes leaves to turn pale brown.
- In humid conditions, white fungal spores of *C. buxicola* and orange-pink spores of *P. buxi* may be seen on the undersides of affected leaves.

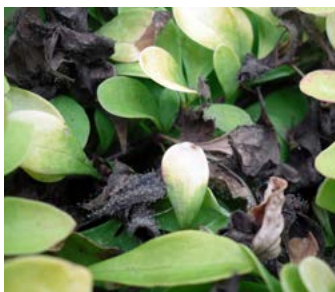
Clematis wilt

Calophoma (Phoma) clematidina

- A common and serious disease of *Clematis* caused by the fungus *Calophoma 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 whole plant wilt and death.
- Small flowered plant species appear less susceptible than large flowered types.
- Infection can also occur via plant wounds.

Grey mould or *Botrytis*

Botrytis cinerea



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

Leaf blights

Insolibasidium deformans, *Monochaetia karstenii*, etc



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

Leaf spots

Glomerella cingulata, *Septoria exotica*, etc



- Fungal leaf spots are usually dark brown-purple in colour, forming circles or more irregular patches that may or may not coalesce and enlarge, depending on the causal pathogen. They can be confused with bacterial infections.
- A range of fungal pathogens are involved, notably species of *Glomerella*, *Phoma*, *Septoria* (bottom left) and *Stemphylium* (bottom right).
- Symptoms can progress to cause leaf necrosis, leaf drop and stem dieback.
- They affect a range of subjects, including: *Ajuga*, *Cornus*, *Escallonia* (top), *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*.
- The pathogen gives rise to a pale brown necrosis of the leaf blade and orange-brown lesions on leaf petioles, leading to wilting and collapse of top growth. Infected stems and flower pods can become twisted.
- Can overwinter in dormant crowns to reinfect new top growth in the spring.
- A number of other *Colletotrichum* species cause leaf and dieback symptoms on a range of other plant hosts.

Needle blights

Didymascella thujina, *Pestalotiopsis funerea*, 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 dieback of needles and stem sections, frequently at the tips of shoots. Tiny black spore cases are often noted on affected *Juniperus*.
- Symptoms can be confused with other dieback pathogens, notably *Phytophthora* species, so correct diagnosis is important.

Powdery mildews

Erysiphe alphitoides, *Podosphaera pannosa*, etc



- Several host-specific fungi cause powdery mildew infections.
- 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. Can result in systemic infection of buds and growing points.
- 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 various rust pathogens give rise to distinctive, brightly coloured pustules – usually yellow, orange, brown, black or white – produced most commonly on the undersides of leaves.
- Normally only 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.
- Host plants include: *Althea*, *Betula*, *Campanula*, *Carex*, *Euphorbia*, *Fuchsia*, *Heuchera*, *Hypericum*, *Mahonia*, *Populus*, *Salix*, *Vinca* and *Tradescantia*.

Venturia cerasi, *Venturia inaequalis*, etc



- Common and serious fungal pathogens of *Malus* (left), *Pyracantha* (right) 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 plant varieties are claimed to be scab resistant.

Shab

Phomopsis lavandulae

- A common and debilitating fungal disease of *Lavandula*, particularly affecting container-grown plants.
- *Phomopsis* is the pathogen usually associated with shab, although leaf spotting resulting from *Phoma lavandulae* and *Septoria lavandulae* has also been reported.
- Typical symptoms include a dark brown to black irregular leaf blotching, necrosis and stem dieback.

Downy mildews

Peronospora grisea, *P. sparsa*, etc

- Symptoms include a yellowing or 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*, *Geum* and *Lamium*.

Phytophthora root rot

Phytophthora cactorum, *P. cinnamoni*, etc



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

Nutrient disorders



The importance of early diagnosis of crop nutrient disorders

Suspected nutrient disorders based on the appearance of symptoms should be confirmed by growing media and leaf analysis.

General guidance on collecting both growing media and leaves for analysis can be found in the AHDB factsheet 10/16 'Sampling methodologies and analysis interpretation for growers of hardy nursery stock'.



- Deficiency can result in distorted or even aborted growing tips, an unsightly tipburn 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, among young leaves and growing points.

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 initiating flash releases of nutrients from controlled release fertilisers can increase conductivity, so can an uneven distribution of fertiliser prills in cell-grown plants and irrigation water containing high salt levels.



- 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.

Low nutrient levels



- Affected plants are usually smaller and lack vigour. Other symptoms include leaf paling, yellowing and purpling.
- Leaf symptoms intensify and become more obvious with time if not addressed.
- Commonly seen with overwintered 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.



- 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.

Cultural disorders

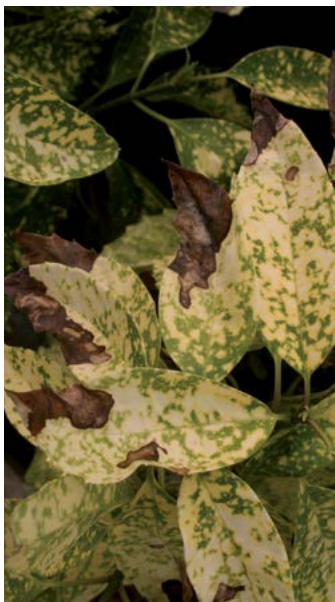




- Symptoms include leaf burning, discoloration and necrosis as a result of cold, desiccating winds and chilling temperatures, branch dieback, root death, physical damage due to heavy snow loading and a sudden collapse of new growth due to root death.
- Sustained periods of cold and wet arriving early in winter before plants are fully hardened or acclimatised is a particular hazard, although frequent cycles of freezing and thawing may be more damaging.



- 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 roots take up water faster than it can be used by the plant or transpired through leaf cells, causing the cells to rupture. This rupturing takes the form of raised corky lumps on the underside of leaves.
- Over-watering, poor ventilation, high ambient humidity and low light intensity also favour other leaf symptoms, such as 'glassiness' or water soaking.



- 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) quite quickly as water droplets on the leaf surface evaporate.



- Often the pattern and distribution of the damage follows that of the water droplets remaining on foliage, which intensify the burning effect of the sun (right).

Overwatering



- A common cause of root death and plant dieback, usually due to poor drainage of container beds and growing media and/or overwatering.
- 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.



- 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.
- 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 high light intensities for lengthy time periods.

References



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Hardy Nursery Stock Crop Walkers' Guide

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