Crop Walkers' Guide

AHDB

Outdoor Salads

Lettuce & Celery

HORTICULTURE

Every year, a significant proportion of the UK outdoor salads crop would be lost to invertebrate pests and diseases if growers did not monitor their crops and employ effective crop protection strategies.

This Crop Walkers' Guide is aimed at assisting growers, agronomists and staff in the vital task of monitoring outdoor salads. It is designed to help with the accurate identification of pests, diseases, nutritional deficiencies and physiological disorders within a crop.

Images of key stages in the life cycles of pests and diseases are included along with bullet point comments to help with identification.

It is impossible to show every symptom of every pest or disease, therefore growers are advised to familiarise themselves with the range of symptoms that can be expressed and be aware of new problems that occasionally arise.

This guide does not offer any advice on the measures available for controlling pests or diseases as both chemical active ingredients and their approvals frequently change. However, having identified a particular pest or disease in their crop, growers should acquaint themselves with the currently available control measures.

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Outdoor Salads Crop Walkers' Guide

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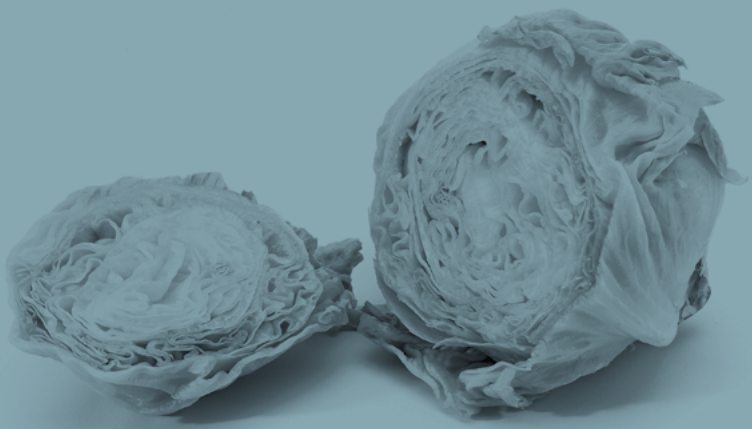
Lettuce
Invertebrate pests



Aphid – Currant-lettuce

Nasonovia ribisnigri

- Green to yellow-green body, 1.4–2.6mm long with long black jointed legs and dark diamond stripes across the dorsal part of the abdomen.
- Migration starts in May but is a major risk during the return migration period of September to October when large numbers can build up.
- Aphids can walk quickly into the heart of lettuce causing a rapid build up of colonies, especially in Iceberg and Cos lettuce.
- Overwinters on flowering blackcurrants and gooseberry Transmits *Cucumber Mosaic Virus* (CMV).
- Forecast available on AHDB Horticulture Pest Bulletin.

Aphid – Lettuce root

Pemphigus bursarius

- Overwinters as eggs on Lombardy poplar. Winged migration from mid-June from galls formed on the poplar tree.
- Aphid characterised by white or blue-white waxy filaments on abdomen and very short antennae.
- Adults alight on the plant and move down to the roots to feed and reproduce.
- Examine plant roots to locate the feeding aphids and the characteristic white waxy deposits.

Aphid – Peach-potato

Myzus persicae

- A common aphid with a wide summer host range including lettuce, potato, sugar beet, Brassicas and others.
- Colour varies greatly from pale yellow-green to dark green. Immature forms can be pink. Winged forms often with dark brown to blackish head with a green or sometimes red abdomen.
- Winged forms migrate from winter hosts, in May and June, peaking in July. Look under the older, outer leaves for colonies as this is where they are first seen.
- Transmits Lettuce mosaic, *Cucumber Mosaic* and *Turnip Yellows Viruses* (TuYV).
- Forecast available on AHDB Horticulture Pest Bulletin.

Cutworms

Various *Agrotis* spp.

- Adults emerge in April and May from pupae in the soil. Populations can be monitored with pheromone traps.
- Adult moths can be distinguished by kidney-shaped marks on the wing backs.
- Caterpillars feed on the foliage before descending to feed on the roots.
- First signs of damage are collapsing plants where the taproot is severed. Check the soil around the root to try and locate the caterpillars.
- Can be confused with leatherjacket attack.
- Forecast available on AHDB Horticulture Pest Bulletin.

Flax tortrix moth

Cnephasia asseclana

- An infrequent pest, usually found around headlands or alongside hedges and woods. They mainly overwinter on deciduous trees and drop into the crop in the spring.
- Caterpillar forms a silk web that sticks the leaf together. Pull apart the leaf to find the pest.
- Damage is normally only found in late spring.

Leatherjackets

Tipulidae spp.

- Leatherjackets are the larvae of crane flies or 'daddy long legs'.
- Leatherjackets can be distinguished from cutworm caterpillars as they have no legs and no distinct head.
- They are normally only a problem where land has come out of permanent grass and on field margins.
- First signs of damage are collapsing plants where the taproot is severed. Check the soil around the root to try and locate the larvae.

Silver Y moth

Autographa gamma

- The most serious caterpillar pest of lettuce, it can bore through petioles as well as eating through the leaves.
- Caterpillar has only three pairs of pro-legs, a pale green body with white longitudinal stripes.
- Migration from April onwards. Large numbers arrive in the UK following southerly winds in the middle of summer, when adults are blown across the channel from Europe.
- Monitor adult activity using pheromone traps. The adult moth has a distinctive silver Y shape on the wing back.
- Caterpillar forecast available on AHDB Horticulture Pest Bulletin.

Slugs

Various spp.

- The common grey field slug is the most often found.
- Damp moist soils are favoured by slugs. They will stop feeding during very dry or cold frosty weather.
- Symptomatic holes on the leaf can be confused with caterpillar damage – check for slime trails.
- Look in the top 25mm soil under the plant for hiding slugs. Slugs feed on decaying organic matter in the soil as well as above ground when conditions permit.

Lettuce
Predators and Parasitoids

Common stiletto fly larvae

Thereva nobilitata

- Stiletto fly larvae are thin, around 25–30mm long, a creamy white colour and live in the soil.
- They are commonly mistaken for wireworms. These larvae are however legless whereas wireworm have three pairs just behind the head. Wireworms are also normally of a darker golden brown colour.
- Larvae feed on worms, insect larvae, leatherjackets and wireworms.
- Take care when handling them – they have very strong mouthparts and can bite.

Ground beetles and rove beetles

Various spp.

- Many species of ground beetles and rove beetles inhabit the soil and the soil surface around lettuce plants.
- They are mainly black or dark brown, are predatory and have powerful jaws.
- Both adults and larvae feed on other insects consuming a range of adults, larvae and eggs.
- Some of the Carabid types such as *Pterostichus melanius* eat slugs.

Hoverfly larvae

Syrphus ribesii

- The currant hoverfly adults have a yellow and black striped body that can, at a glance, be mistaken for a common wasp. Hoverfly though have only one pair of wings to the wasps' two.
- Adults feed on the nectar of many common flowers, especially *Compositae* and *Cruciferae*.
- Larvae are pale yellow, soft bodied, about 12mm long, legless and leech-like in appearance. Each one can eat up to 500 aphids before pupating.
- Prior to pupation larvae attach themselves to a leaf, so, like lacewing larvae, they too can become contaminants.

Lacewing larvae

Chrysopa perla

- Adult lacewings are pearly blue-green with a wingspan of about 20–32mm and are around 14mm long. The wings are transparent with the appearance of lace.
- The adults will eat some aphids but it's the larvae that are voracious feeders.
- Larvae are plump, around 8mm long, covered in bristles and have a cream body with brown patches.
- Larvae are slow moving and tend to get covered in honeydew. They therefore do not dislodge easily at harvest and can become contaminants.

Ladybirds

Various spp.

- The two spotted ladybird is the most commonly found. Adults are easily recognisable but the larvae are often mistaken for pests.
- Both adults and larvae are predatory, feeding mainly on aphids.
- The larvae are up to 6mm long with a clearly segmented body. Their colour is a dark slate-grey with small yellow patches on each side of the first and fourth abdominal segments.
- The larvae, like most predators, are very mobile. However they sometimes remain on lettuce at harvest and can become the cause of customer complaints.

Parasitic wasps

Various spp.

- Wasp parasites from the groups *Aphidids, Aphedelinids, Eulophids* and *Trichogrammatids* all play a part in reducing pest numbers through parasitism.
- *Aphidius* spp. are commonly found on and around lettuce plants. They are tiny black active wasps that are particularly effective in controlling peach-potato aphid.
- Check under older leaves for the small browny-grey aphid mummified cases.
- One female aphidius adult wasp can parasitise 200 or more aphids.

Lettuce Diseases

BACTERIAL DISEASES

FUNGAL DISEASES

OOMYCETE DISEASES

VIRAL DISEASES

Diagnosis of viral diseases from symptoms is problematic and should always be confirmed by laboratory investigation

Bacterial infection

Various spp.

- Damp black spots on the leaves, necrotic to a greater or lesser extent. Surrounded by a yellow halo.
- If free water is present for a long period, leaves in the head may rot completely.
- Bacteria infecting lettuce include Erwinia spp, and *Pseudomonas* spp.
- Most common after periods of heavy rain, may be distributed from soil onto leaves by rain splash.

Bottom rot

Rhizoctonia solani

- Causes a brown basal rot that infects through the lower leaves that are in contact with soil. A common fungus that attacks many crops.
- Reddish-brown spots and flecks first appear on the mid-rib of the lower leaves.
- Plants can collapse following secondary infection with Botrytis and soft rotting bacteria.
- Occurs under a wide range of conditions but is more progressive in wet conditions.

Grey mould

Botrytis cinerea

- Grey or grey-brown spores which form a dense downy mass are produced in abundance.
- Most common and progressive in cool, humid and wet conditions, especially in early planted crops and at the very end of the season.
- Can enter damaged tissue, especially at planting. Early fleece must cover crops thoroughly.
- Affected plants can collapse completely and die.

Sclerotinia rot

Sclerotinia sclerotiorum, S. minor

- Produces a characteristic dense white fluffy growth of mycelium.
- Black resting bodies (sclerotia) can be found in the later stages. Sclerotia persist in the soil for years.
- Affected plants can completely collapse.
- More progressive in warm, humid conditions. Initial infection is normally from soil-borne sclerotia.

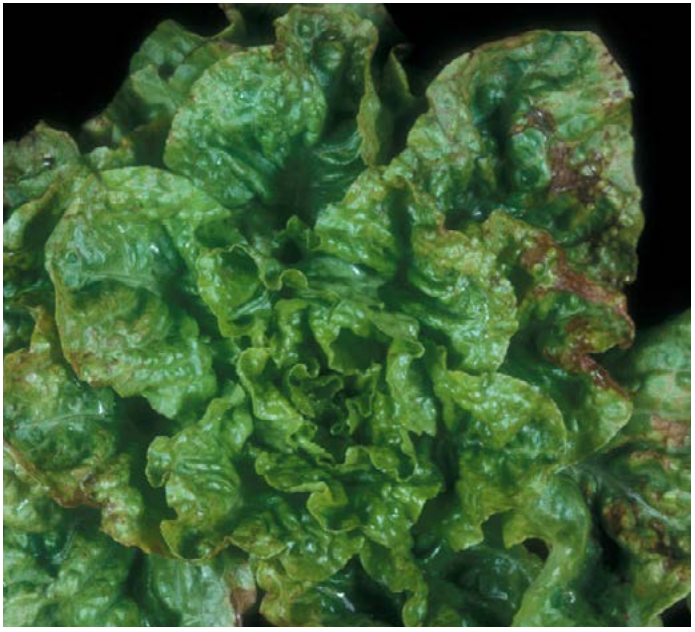
Downy mildew

Bremia lactucae

- Typically first seen from above, characterised by angular yellow patches limited within a boundary of the leaf vein. Turn over the leaf to find white downy fungal growth underneath.
- Most common and progressive in warm, humid, wet conditions with an optimal temperature of around 15ºC.
- A number of races exist that can infect lettuce – specific varieties may be resistant to or tolerant of a number of races.
- Can lead to extensive losses and high peeling costs, especially in early autumn.

Cucumber Mosaic Virus

CMW



- Affected plants are stunted with yellow or necrotic spots.
- It is not easily distinguishable from LMV therefore laboratory diagnosis is recommended.
- It is not thought to be seed borne in lettuce. Alternate hosts are weeds. It can be spread by aphids, primarily the peach-potato aphid.
- Plants with combined LMV and CMV show severe stunting and chlorosis.

Lettuce Big Vein associated Virus

LBVaV

- Affected plants have crinkled or blistered leaves and can be slow to heart. More common on Iceberg types.
- If you hold an affected leaf up to the light you will see a widened extra thick vein.
- This virus is transmitted by a soil-borne fungus *Olpidium brassicae*.
- Once the fungus has acquired the virus it will persist in the soil almost indefinitely. Spores can spread in water and soil.
- Peat block transplants and propagation trays can be a source of infection. Propagation hygiene is important in control.

Lettuce Mosaic Virus

LMV

- *Lettuce Mosaic Virus* can cause chlorotic mottling, crinkling of leaves and necrotic spotting on the stems and leaves. It can also stunt plants.
- It is more common and damaging on Cos and Little Gem types than on Iceberg.
- The virus is transmitted by aphids, primarily the peach-potato aphid.
- The virus may originate from seed-borne infection or cross contamination from infected lettuce or composite weeds such as groundsel or thistle.

Ring spot

Microdochium panattonianum

- Small circular brown spots on the leaves and sunken brown markings on the mid-ribs.
- The centres of the spots often fall out giving a 'shot-hole' effect.
- Spreads rapidly from plant to plant after heavy and continuous rainfall.
- Virus is specific to lettuce and can be carried over in soil to infect subsequent lettuce crops.

Turnip Yellows Virus (TuYV)

Formerly known as *Beet western yellows virus* (BWYV)

- Affected plants have interveinal yellowing especially on the lower leaves. This can look similar to magnesium deficiency in the early stages.
- This virus can affect all lettuce types as well as beet, spinach and some Brassicas.
- It is transmitted in a persistent manner with a long acquisition and transmission period.
- Good aphid control will therefore help prevent the spread of this virus. It is not seed-borne or transmitted by mechanical means.

Lettuce
Nutrient deficiencies

The importance of early diagnosis of crop nutrient deficiencies

Suspected nutrient deficiencies based on the appearance of symptoms should be confirmed by leaf nutrient analysis. In such cases, the leaf nutrient concentrations will usually be well below the 'critical level' and there should, therefore, be little doubt about the diagnosis.

Leaf nutrient analysis should preferably be used to test for sub-clinical deficiencies or toxicities which may be already limiting growth but which are not yet resulting in visible symptoms. Guidance on collecting leaf samples is described on RB209 and other AHDB publications. Interpretation of laboratory results is possible by comparison with normal levels expected for the crop.

Boron

B

- Produces leaf edge puckering and necrotic brown or black spotting on the youngest leaves. It can affect all the leaves around the growing point.
- A leaf tissue test will determine if boron is deficient.
- Most common at high pHs and after the end of a period of moisture deficit.
- Normal leaf tissue range 20–40ppm.
- Deficiency below a leaf tissue level of 15ppm. Foliar sprays may help but take care as boron application can cause leaf damage.

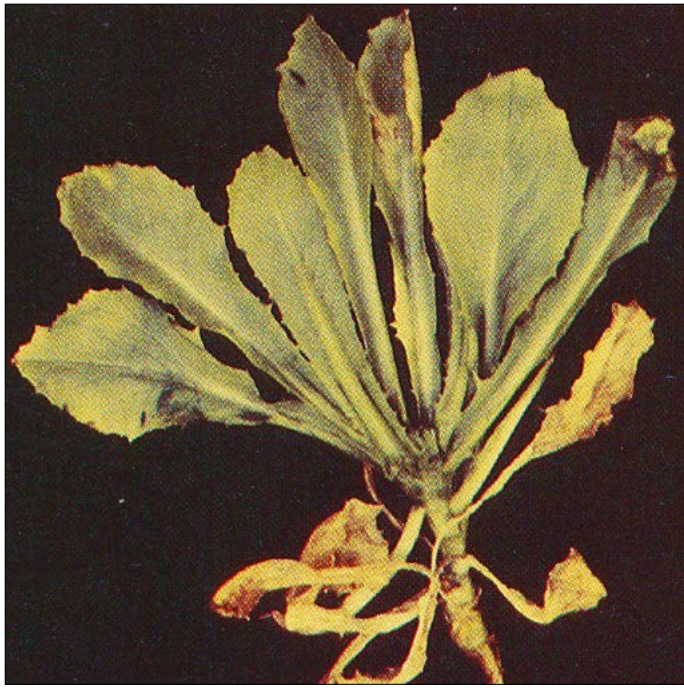
Calcium

Ca

- Puckering and black necrotic spotting along the leaf edge of the youngest leaves.
- Leaf calcium levels are variable and dependant on the plant's transpiration stream. Waterlogging, drought, poor rooting and high humidity can all affect transpiration.
- Periods of rapid growth can lead to calcium deficiency.
- Whole leaf tissue testing is not a reliable diagnostic tool for calcium deficiency. Normal leaf tissue range is 1–2%.
- Foliar applications are normally ineffective in reducing symptoms or enhancing leaf calcium levels of hearted lettuce types.

Copper

Cu



- Leaves are elongated and yellow around the edges. Younger leaves are cupped with the edges turned downwards.
- Most common on peaty, chalky or sandy soils. Test soil before cropping on suspect soil types.
- Common leaf tissue range 3–7ppm.
- Deficient below a leaf tissue level of 2ppm.

Iron

Fe

- Iron deficiency results young in leaves developing light interveinal chlorosis from the base, and it progressing outwards towards the tip.
- Over time, interveinal chlorosis intensifies and the pattern becomes less interveinal.
- Chlorotic symptoms are reversible if correctional measures are taken.

Magnesium

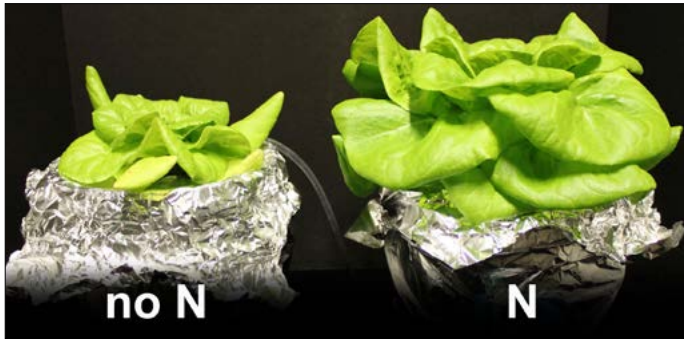
Mg

- Magnesium deficiency shows as interveinal yellowing on the older leaves.
- It can look a very similar symptom to *Turnip Yellows Virus* (TuYV).
- Normal leaf tissue range 0.3–0.5%.
- Deficiency below a leaf tissue level of 0.2%. Rectified by foliar applications of magnesium sulphate.
- Can be induced by poor root activity caused by soil conditions such as compaction or waterlogging.

Manganese

Mn

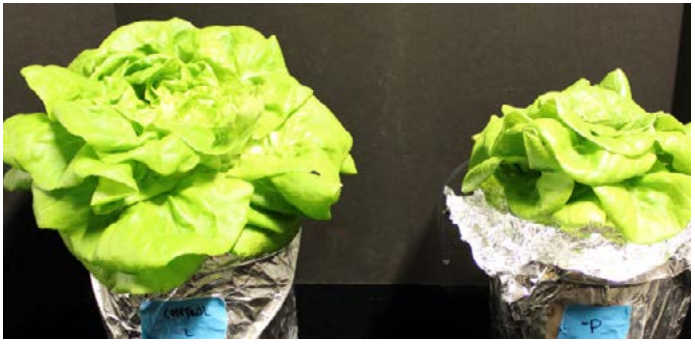
- Most common on organic soils or sandy soils with a high pH.
- Unlike magnesium the yellowing symptoms will normally start on younger leaves but can develop onto older ones.
- Normal leaf tissue range 30–50ppm. Toxicity seen at above 250ppm.
- Deficiency seen below a leaf tissue level of 20ppm.
- Easily rectified by foliar applications of manganese sulphate.



- Plants exhibit a generally pale colour and reduced growth. Older leaves are especially yellow and may die off.
- Leaf tissue nitrogen levels are variable with maturity of plant.
- Common range 4–5% up to hearting. Down to 3.5–4.5% at hearting.
- Deficient below a leaf critical limit of 2.5–3.5% depending on maturity stage.
- More common in cold wet soils or when excessive rainfall has caused leaching of nitrogen from the soil.

Phosphorous

P



- Leaf margins of older leaves exhibit chlorotic regions followed by necrotic spots after four weeks of deficiency.
- Causes dwarfing.
- Deficient below a leaf critical limit of 3%.
- A soil test may be useful to aid confirmation of the cause of deficiency.

Potassium

K

- Leaves become dark green. Older leaves particularly exhibit severe marginal and interveinal scorch. Botrytis may follow.
- Deficiency may be seen more on texturally lighter soil types.
- Normal leaf tissue range 4–7%.
- Deficiency seen below a leaf critical limit of 2%. A soil test may also be useful to aid confirmation of the cause of deficiency.

Sulphur

S

- Deficiency rarely seen in the UK. New leaves are uniformly golden yellow and can be cupped or deformed.
- Use a leaf test to identify deficiency.
- Normal levels 0.25–0.4%.
- Deficiency seen below a leaf tissue level of 0.2%.

Zinc

Zn

- Normally only found in situations where there are light soils that have a high pH combined with high phosphate levels.
- In such situations soil applications of zinc may be beneficial, foliar applications can also help.
- Normal leaf tissue range 20–60ppm.
- Deficiency occurs below a leaf tissue level of 20ppm. Confirm deficiency by leaf and soil testing.

Lettuce
Physiological disorders

Bolting

- Bolting is the early development of a seed head within the plant. This can occur during periods of abnormally high temperatures, especially at night during mid-summer.
- Seed head development starts as an elongated core in the centre of the plant. This can cause the plant to become misshapen especially in the case of Iceberg lettuce.
- Lettuce that has begun to bolt can develop bitter flavours and internal problems such as tipburn.
- Some varieties are more prone to bolting than others.

Tipburn

- Tipburn is black or brown necrosis at the leaf margins or edges, starting as tiny flecks. These can coalesce into larger areas of up to 1cm across.
- Tipburn or leaf-edge breakdown is thought to be caused by interruptions to the transpiration stream leading to highly localised calcium deficiency.
- Waterlogging, drought, poor rooting and high humidity can all affect transpiration and therefore leaf calcium content.
- Often occurs during periods of high air humidity. It often occurs in Cos lettuce once the outer leaves have closed around the heart, as these prevent water from evaporating from the younger leaves.

Celery
Invertebrate pests

Aphid – Peach-potato

Myzus persicae

- A common aphid with a wide summer host range, including celery, potato, sugar beet, Brassicas and many other plants.
- Colour varies greatly from pale yellow-green to dark green, immature forms can be pink. Winged forms often have a dark brown to blackish head with a green or sometimes red abdomen.
- Winged forms migrate from winter hosts, in May and June, peaking in July.
- Colonies can often be seen under the outer older leaves from July/August onwards.
- Forecast available on AHDB Horticulture Pest Bulletin.

Aphid – Willow-carrot

Cavariella aegopodii

- The wingless aphids are small green/yellow coloured and can be difficult to find. The winged aphids are generally darker and more easily seen. They infest freshly planted young celery plants in June and July.
- Overwinters in the egg stage on willow trees but can overwinter on carrot foliage or hedgerow Umbelliferous weeds.
- By late July/early August a winged generation returns to hedgerow Umbelliferae and willow trees. Aphids found on celery after this are probably the peach-potato aphid.
- Transmits Celery mosaic virus.
- Refer to AHDB Factsheet 01/16 'Pest insects infecting carrot and other Apiaceous crops' and AHDB Horticulture Pest Bulletin.

Capsid bug

Orthops campestris

- Small shiny, metallic, slightly flattened green bugs about 5mm in length with a brown patch at the bottom of the abdomen.
- The common green capsid overwinters in the egg form, often in trees and hedgerows around field margins.
- Adults hatch out in April and May and may be present in the crop through the summer months. Use an insect net or shake the plant to watch them fly out.
- Feeding damage causes brown spots and/or cracks in the petioles.
- Refer to AHDB Factsheet 01/16 'Pest insects infecting carrot and other Apiaceous crops'.

Carrot fly

Psila rosae

- Adult flies are about 5–8mm long and have a shiny black thorax and abdomen. They have red eyes but are distinguished by their translucent yellow legs and clear wings.
- There are normally two or three generations per year. The first generation, which is active between April and June, is the most important for celery growers.
- Damage to celery plants can be mining of the outer petioles or mining in the crown of the plant by larvae (maggots).
- Monitor adult fly activity using orange sticky traps around the field margins.
- Forecast available in the AHDB Horticulture Pest Bulletin.

Celery fly

Euleia heraclei

- Adult flies are around 5mm long, tawny-brown with mottled shiny wings and dark shiny green eyes.
- There are two or three generations but these can overlap so damage may be seen from May through to October.
- The larvae (maggots) mine and destroy the inside of the leaves leaving a trail like a leafminer. If you open up a blistered leaf you will often find larvae inside.
- Damaged leaves are usually trimmed off and so control measures are rarely worthwhile unless the leaves are to have a culinary use or the pest is on parsley.

Cutworms

Various *Agrotis* spp.

- Adults emerge in April and May from pupae in the soil. Populations can be monitored with pheromone traps.
- Adult moths can be distinguished by kidney-shaped marks on the wing backs.
- Caterpillars feed on the foliage for about a week before descending to feed on the roots.
- First signs of damage are normally collapsing plants where the taproot is severed, check the soil around the root to try and locate the caterpillars.
- Forecast available in AHDB Horticulture Pest Bulletin.

Silver Y moth

Autographa gamma

- The most serious caterpillar pest of celery, it can bore through petioles especially towards the top of the plants as well as eating through the leaves.
- Caterpillar has only three pairs of pro-legs, a pale green body with white longitudinal stripes.
- Migration from April onwards. Large numbers arrive in the UK following southerly winds in the middle of summer, when adults are blown across the channel from Europe.
- Monitor adult activity using pheromone traps. The adult moth has a distinctive silver Y shape on the wing back.

Slugs

Various spp.

- The common grey field slug is the most often found, both as a contaminant of the product and a cause of damage to the crop.
- Damp moist soils are favoured by slugs. Slugs stop feeding during very dry or frosty weather.
- They make holes in the lower part of the petioles. Pull apart the lower parts of the plant to find them.
- Look in the top 25mm soil under the plant for hiding slugs. Slugs feed on decaying organic matter in the soil as well as above ground where conditions are damp enough to permit this.

Celery
Predators and Parasitoids

Hoverfly larvae

Syrphus ribesii

- The currant hoverfly adults have a yellow and black body that can, at a glance, be mistaken for a common wasp. Hoverfly though have only one pair of wings to wasps' two.
- The adults feed on the nectar of many common flowers, especially *Compositae* and *Cruciferae*.
- The larvae are pale yellow, soft bodied, about 12mm long, legless and leech-like in appearance. Each one can eat up to 500 aphids before pupating.
- Prior to pupation the larvae attach themselves to the leaf, so, like lacewing larvae, they too can become contaminants.

Lacewing larvae

Chrysopa perla

- Adult lacewings are pearly blue-green with a wingspan of about 20–32mm and are around 14mm long. The wings are transparent with the appearance of lace.
- The adults will eat some aphids but it's the larvae that are voracious feeders.
- The larvae are plump, around 8mm long, covered in bristles and have a cream body with brown patches.
- The larvae are slow moving and tend to get covered in honeydew; they therefore don't dislodge easily at harvest and can become contaminants.

Ladybirds

Various spp.

- The two spotted ladybird is most commonly found. The adults are easily recognisable. Larvae are often mistaken for pests.
- The larvae are up to 6mm long with a clearly segmented body. Their colour is a dark slate grey with small yellow patches on each side of the first and fourth abdominal segments.
- Both adults and larvae are predatory, feeding mainly on aphids.
- The larvae, like most predators, are very mobile. However they sometimes remain on celery at harvest and can become the cause of customer complaints.

Parasitic wasps

Various spp.

- Wasp parasites from the groups *Aphidids, Aphedelinids, Eulophids* and *Trichogrammatids* all play a part in reducing pest numbers through parasitism.
- *Aphidius* spp. are commonly found on and around celery plants. They are tiny black active wasps that are particularly effective in controlling the peach-potato aphid.
- Check under older leaves late in the season for the small brown-grey mummified aphid cases.
- One female Aphidius adult wasp can parasitise 200 or more aphids.

Celery Diseases

FUNGAL DISEASES

Leaf spot/late blight

Septoria apiicola

- Appears on older leaves first, but will spread to younger leaves and on to the petioles.
- Affected areas become brown or necrotic, examine the centres of lesions with an eyeglass to look for tiny black spots (pycnidia). Spores can be dispersed by rain or water splash to start fresh infection.
- The disease is most common after long periods of leaf wetness and spells of heavy driving rain.
- Avoid people and machines travelling through infected crops and spreading the disease. Remove affected plants wherever possible.
- Refer to AHDB Factsheet 13/15 'Management of celery leaf spot'.

Sclerotinia rot

Sclerotinia sclerotiorum

- Produces a characteristic dense white fluffy growth of mycelium.
- Black resting bodies (sclerotia) can be found in the later stages as they persist in the soil.
- Whole plants or just the petiole tips may collapse.
- More progressive in warm, humid conditions. Initial infection normally from soil-borne sclerotia but can spread aerially between petioles and plants.

Celery
Nutrient deficiences

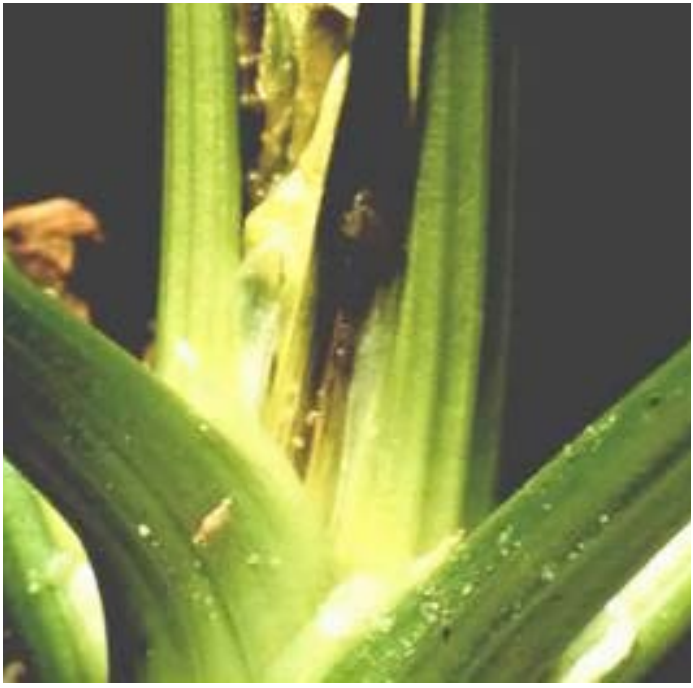
Boron

B

- Symptoms of deficiency can vary. Small transverse cracks can appear on the petioles, the epidermal area can then peel back and go brown.
- Other symptoms include the development of auxiliary shoots, with or without the death of the growing point and the brown necrotic lesions on the inner side of petioles.
- A leaf tissue test will determine if boron is deficient.
- Most common at high pHs and after the end of a period of moisture deficit.
- Normal leaf tissue range 20–40ppm.
- Deficiency below a leaf tissue level of 15ppm.

Calcium

Ca



- Seen in the field as the symptom blackheart. Blackening and dieing back of the growing tip in the centre of the plant.
- Normally only seen during periods of high temperatures and high water use, or when the plants are drought stressed.
- Normal leaf tissue range is 1–2%. Deficiency symptoms may be seen at leaf tissue levels below 1%.
- Foliar applications of calcium during periods of high temperatures and high water demand may help delay or prevent symptom onset.

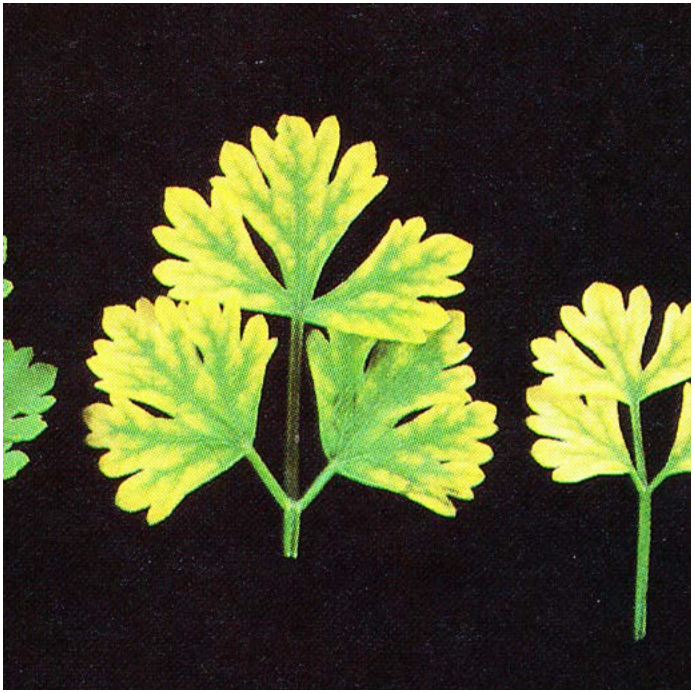
Magnesium

Mg

- Magnesium deficiency shows as leaf margin yellowing, starting on the older leaves, but can spread across the leaf. Margins eventually turn pink.
- Normal leaf tissue range 0.3–0.5%.
- Deficiency below a leaf tissue level of 0.2%.
- Can be induced by poor root activity caused by soil conditions such as compaction or water logging. Apply foliar sprays of magnesium sulphate to correct.

Manganese

Mn



- Most common on organic soils or sandy soils with a high pH.
- Interveinal rather than marginal chlorosis differentiates manganese deficiency from magnesium deficiency.
- Normal leaf tissue range 30–50ppm.
- Deficiency below a leaf tissue level of 20ppm.
- Easily rectified by foliar applications of manganese sulphate.

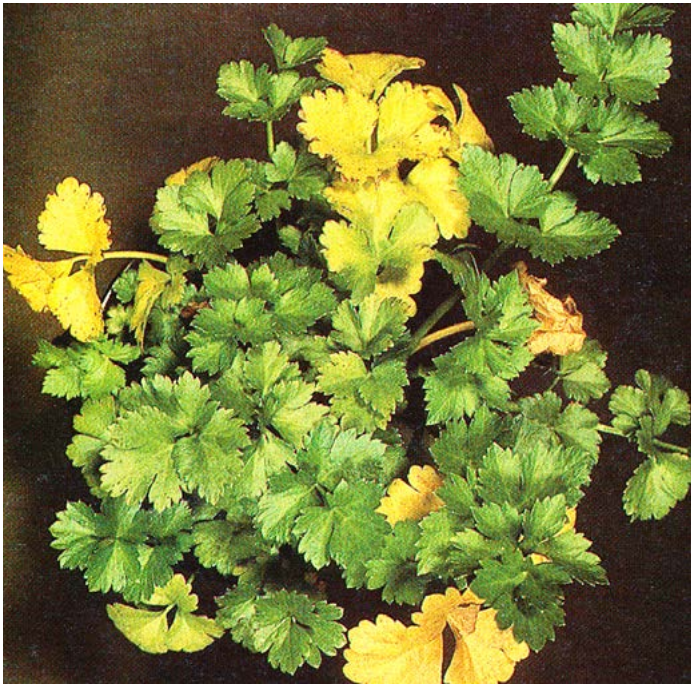
Nitrogen

N

- Plants exhibit a generally pale colour and reduced height. Older leaves are especially yellow and may die off.
- Leaf tissue nitrogen levels are variable with maturity of plant. Common range 2–4%.
- Deficient below a leaf critical limit of 1.5–2%.
- More common in cold wet soils or when excessive rainfall has caused leaching from the soil.

Phosphorus

P

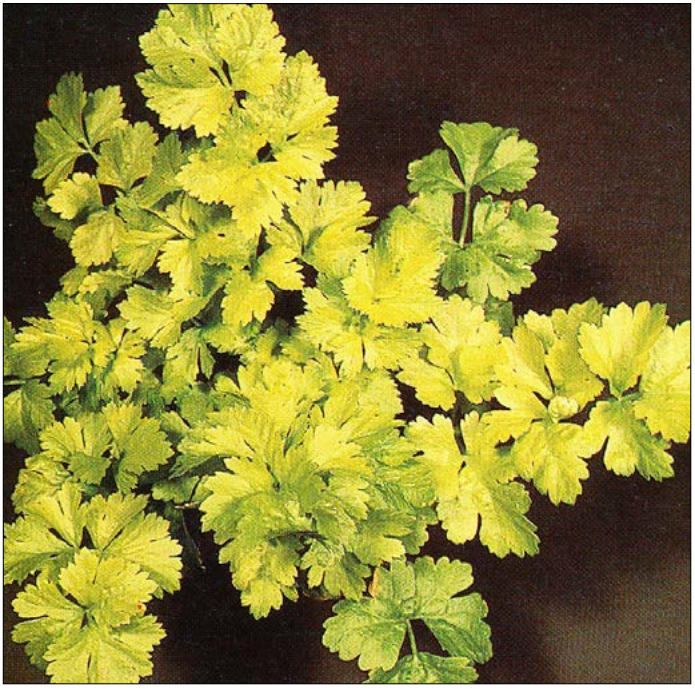


- Phosphorus deficiency causes dwarfing with blue/green foliage. Older leaves turn yellow and die off early.
- Normal leaf tissue range 3–5%.
- Deficient below a leaf critical limit of 3%.
- A soil test may also be useful to aid confirmation of the cause of deficiency.

- Growth is stunted with pale brown necrotic spots on the foliage. Leaves are convex, shiny and very dark green.
- Deficiency may be seen more on texturally lighter soil types.
- Normal leaf tissue range 4–7%.
- Deficiency below a leaf critical limit of 3%. A soil test may also be useful to aid confirmation of the cause of deficiency.

Sulphur

S



- Deficiency rarely seen in the UK. New leaves are uniformly golden yellow and can be cupped or deformed.
- Use a leaf test to identify deficiency.
- Normal levels 0.25–0.4%.
- Deficiency below a leaf tissue level of 0.2%.

Celery
Physiological disorders

Bolting

- Bolting is the early development of a seed head within the plant. This occurs more early in the season, when plants have been exposed to cold conditions during propagation. It is triggered by the change from short to long days.
- If you cut open the plant longitudinally the centre changes from domed to pointed as bolting initiates. The seed head grows up through the centre of the plant.
- Celery that has begun to bolt can develop bitter flavours and internal problems such as blackheart.
- Bolting is more common when the plants have been subjected to a growth restriction caused by poor soils, nutrition, compaction or drainage problems.

References

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We hope that the guide proves a helpful aid to your businesses.

Photographic credits

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