CROP WALKERS' GUIDE

Field Vegetables

AHDB HORTICULTURE

Brassica

Every year a significant proportion of UK Brassica crops would be lost to insect pests and diseases if growers didn't monitor their crops and employ effective crop protection strategies.

This Crop Walkers' Guide is aimed at assisting growers, agronomists and their staff in the vital task of monitoring crops. It is designed for use in the field to help with accurate identification of pests, diseases, nutrient deficiencies and disorders within a crop.

Images of key stages in the life cycles of pests and diseases are included along with short easy-to-read comments to help with identification.

As it is impossible to show every symptom of every pest or disease, 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.

This guide does not offer any advice on the measures available for controlling these 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 can refer to other AHDB Horticulture publications that contain information on a range of control measures.

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SECTION 1 Invertebrate Pests

Cabbage aphid

Brevicoryne brassicae

- Serious pest of Brassicas. Severe infestations reduce yield and may kill young plants.
- Infestation causes distorted foliage and contamination of produce by aphids, wax, cast skins and honeydew.
- Important vector of several viruses including Turnip mosaic virus (TuMV) and Cauliflower mosaic virus (CaMV).
- Wingless aphids bluish-grey, up to 2.6mm long often covered with a thick layer of wax. Winged aphids less waxy.
- First symptoms are small bleached areas on leaves, which turn yellowish and crumpled.
- Early infestations found under leaves, later infestations move to other parts eg heads of Brussels sprouts.

Cabbage moth

Mamestra brassicae

- Feeding can rapidly skeletonise outer leaves of large plants or destroy small plants. Large caterpillars may bore into the heart of plants. Frass (droppings) and caterpillars contaminate fresh produce.
- Adults have a 35–50mm wingspan, patterned light/dark brown.
- Male moths can be captured using pheromone traps.
- Up to 50 eggs laid in a clump, hemispherical white, darkening close to hatching.
- Caterpillars feed in groups. Newly hatched they are green, patterned, darkening to brown or almost black, 40–50mm long when fully grown.
- Risk periods May to June and August to October. Second generation most damaging.

Cabbage root fly

Delia radicum

- Occurs throughout the UK affecting all Brassica species. Yield losses depend on impact of crop damage on plant growth and quality.
- Cosmetic damage problematic where larvae infest broccoli stems and Brussels sprouts buttons.
- Newly emerged drilled crops and recently transplanted young plants most susceptible.
- Control especially important where the root is marketed – swede, turnip, radish.
- Eggs are white, 1mm, laid in soil close to the stems of Brassica plants. Larvae, up to 8mm, then feed on plant roots, or aerial parts.
- Several generations per year depending on temperature. Numbers can be monitored.

Cabbage whitefly

Aleyrodes proletella

- Contaminant – scales from immature stages, excreted honeydew and resulting mould reduce product quantity, especially in kale and Brussels sprouts.
- Adults small, white, moth-like insects about 1.5mm covered in powdery wax that rise in clouds when host plants are disturbed.
- Eggs pale, less than 0.1mm laid in full or partial circles on leaf undersides.
- Larvae flat, oval, semi-transparent scales from 0.3–1.0mm.
- Pupae are off-white to brown flattened scales.
- All life stages accompanied by circular deposits of pale wax, a sign of adult presence even when no insects are seen.

Cutworm – Turnip moth

Agrotis segetum

- Cutworms are the larvae of certain Noctuid moths, particularly the turnip moth, which has a wide host range.
- Causes sporadic but severe damage leading to loss of plants and reduction in quality.
- Most problematic in hot, dry years, and on light sandy soils.
- Adults emerge from May onwards and, after mating, lay eggs on host plant leaves and roots.
- Larvae *c.*40mm long initially feed on aerial parts of the plant before descending underground to damage plant roots and stems, which may be severed.
- Pheromone traps can be used to ascertain risk. A cutworm forecasting system is available.

Diamondback moth

Plutella xylostella

- Occurs throughout the UK on Brassica crops. Usually a sporadic pest, but large infestations can cause significant crop loss. Crop contaminant.
- Adult moths *c.*6mm long, brownish with diamond shapes on the back.
- Caterpillar light green (maximum 15mm) with a tapering body that is widest in the middle.
- Yellow eggs laid singly or in small groups, mainly near leaf veins.
- Feed on undersides of leaves. If disturbed, caterpillars wriggle violently. Flimsy cocoons constructed on the leaf surface.
- Migrates to the UK in spring. Risk of infestation April to October. Does not overwinter in large numbers at present.

Flea beetles

Phyllotreta spp.

- Several species of flea beetles can be very damaging pests of seedling Brassicas, eg swede and rocket. Striped and turnip flea beetles are principally pests of spring Brassicas, but any crop may be at risk if growth is checked.
- Most damaging in cold, dry sunny weather.
- Feeding results in leaf pitting and 'shot-holes'.
- Adults (up to 3mm long), metallic blue-black or light brown. Some species are striped with yellow bands while others are a single dark colour.
- Adults quickly leap off plants when disturbed.

Garden Pebble moth

Evergestis forficalis

- Localised pest. Feeding causes leaf damage. Caterpillars, frass (droppings) and silk webbing are contaminants.
- Caterpillars feed under leaves, and may not be detected until after damage has occurred.
- Caterpillars: 18–20mm, yellowish-green when young, later becoming glossy pale green with yellowish stripes.
- Adults: 25–30mm wingspan, forewings yellowish-white with brown veins.
- Eggs are laid in batches of approximately 20 on leaf undersides, shiny, oval and flattened, initially translucent before becoming yellow.
- High risk periods May to June and August to September. Second generation most damaging.

Peach-potato aphid

Myzus persicae

- Important pest of a range of crops including Brassicas. Contaminant.
- Transmits viruses, which cause serious economic damage, especially *Turnip yellows virus* (TuYV).
- Severe infestations cause plant distortion.
- Often found under lower leaves at the base of plants. Does not occur in dense colonies like cabbage aphid.
- Wingless form is 1.0–2.1mm and pale green to pink, or almost black. Winged form is similar in size but has a black central abdominal patch on the upper surface with a pale underside.
- Risk period March to August, later in mild autumns. Populations peak early to mid-July, occasionally a small peak in late August/September.

Potato aphid

Macrosiphum euphorbiae

- A relatively uncommon pest aphid of Brassica crops.
- May infest vegetable Brassicas but a contaminant rather than causing severe damage to plants.
- Large, relative to other aphids, wingless forms 2.5–4.0mm long with pear shaped green to pinkish red body, with a dark stripe running down the back. Winged adults have a yellowish-brown head and green body.

Silver Y moth

Autographa gamma

- Migratory pest, so south and east of UK more at risk. Feeding causes leaf damage. Frass (droppings) and caterpillars contaminate fresh produce.
- Adults are grey to greyish-brown. Forewings 35–40mm span with distinct silver Y mark on each forewing.
- Eggs usually laid singly on foliage. Oval, white 0.5–0.6mm diameter, darkening close to hatching.
- Caterpillars, green 24–40mm long with dark green dorsal line edged with white, 'loop' as they walk and curl tightly when disturbed.
- Migrant pest that arrives in April/May depending on temperature, migrates September. High risk period May to July.

Slugs

Deroceras, Arion and other spp.

- Seedlings and Brussels sprouts particularly susceptible. Cosmetic damage and contaminant.
- Damaging between 5°C and 25°C in moist conditions. Grey field slug is active at close to freezing.
- Prefer heavy soils, open cloddy soil allows them easy movement. Plant residues, manure and weeds provide food and shelter.
- Crop damage often most severe when plant vigour is low and at field margins. Slow growth prolongs the vulnerable period of crop establishment.
- Keeled slugs are the largest species up to 75mm in length.
- Less active in very hot, dry or very cold weather.

Thrips

Thrips tabaci

- Causes cosmetic damage of stored cabbage and Brussels sprouts.
- Several host crops, including Brassicas. Cereals may also be used as an overwintering host.
- On cabbage, feeding by thrips can result in small, brownish-grey growths on the leaf surface and silver-coloured lesions.
- With rising spring temperatures, female thrips start to lay eggs and may disperse to new hosts.
- Following egg hatch, there are two active larval stages and two inactive stages (pre-pupa and pupa).
- A complete generation (egg to adult) takes about 52 days at 12.5°C and 15 days at 25°C.

White butterfly – Large

Pieris brassicae

- Common throughout the UK.
- Feeding on both leaf surfaces, often in large groups can skeletonise leaves. Frass (droppings) and caterpillars contaminate fresh produce.
- Adults are white with a 60–70mm wingspan.
- High risk periods May to June and August to September. Second generation most damaging.
- Eggs yellow and flask shaped (1.5mm) laid in large batches of 20–100 on leaf undersides of only a few plants so these can be severely damaged while other plants escape.
- Caterpillars (maximum 40mm) initially pale green, becoming mottled blue-green, with black markings, three longitudinal yellow stripes and stiff white hairs.

White butterfly – Small

Pieris rapae

- Common in the UK, caterpillar feeding damages upper and lower surfaces of foliage. Frass (droppings) and caterpillars contaminate fresh produce.
- Adults are white with a 50mm wingspan. Forewings have conspicuous black tips.
- Eggs are yellow and bottle shaped, laid singly on leaf undersides.
- Caterpillars solitary, green with dorsal yellow line, 25mm when fully grown.
- Risk periods May to June and August to September, with second generation most destructive.

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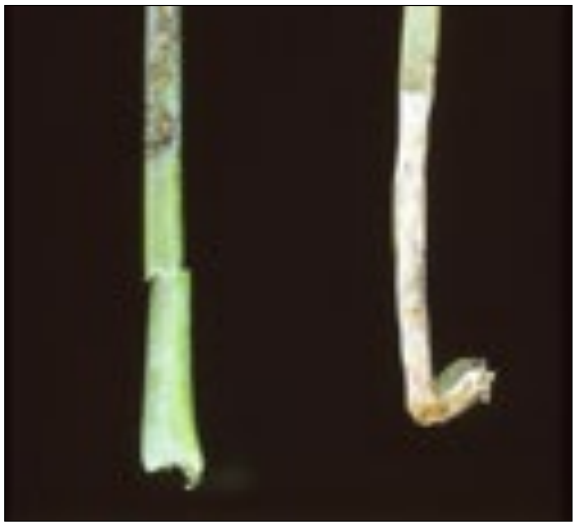
SECTION 2 Minor and/or Emerging Pests

Cabbage stem weevil

Ceutorhynchus spp.



- Minor pest of all Brassicas. Causes cosmetic damage to high value crops.
- Caterpillars tunnel into leaf stalks and stems causing loss of vigour and possibility of fungal infections.
- Adults small (3mm long) with a long snout, reddish legs and antennae. Mealy appearance, with a white spot in the middle of the back.
- Blisters near the main vein on lower leaves and leaf stalks in early summer indicate where eggs have been laid.
- Caterpillars grow to 4–5mm long, creamy white body, brown head and no legs.
- Mature caterpillars bore an exit hole in the lower stem and drop to the soil to pupate.

Leaf miner

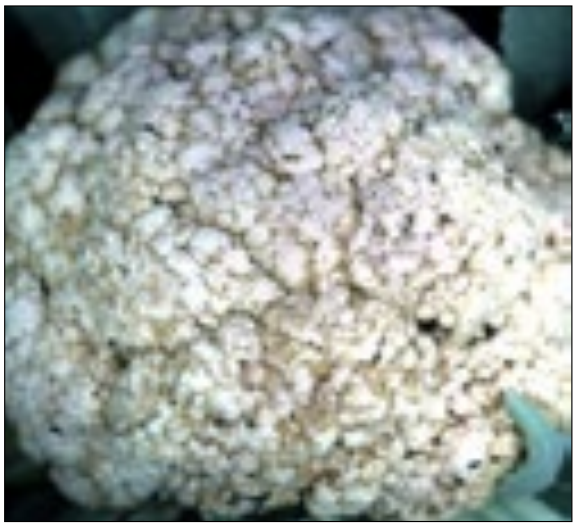
ME

Scaptomyza flava

- Recently recognised pest of economic importance especially salad crops and other leafy Brassicas.
- Crop damage caused by adult females, which puncture the lower leaf surface to lay 300 or more eggs.
- Adult *c.*3mm long, pale brown with faint stripes on the thorax, red eyes and long wings.
- Larva 0.4–0.5mm long, cylindrical, and becomes greenish in colour, producing the characteristic white 'corridor-blotch' mines when feeding between the upper and lower surfaces of the leaf.
- Eggs 0.3–0.4mm long, are laid close but singly.
- Mines typically seen between July to October.

Pollen beetle

Meligethes spp.



- Adults are occasional pests of cauliflower and broccoli, feeding on curds or florets in mid-summer when new adults emerge from oilseed rape crops.
- Feeding damage causes cauliflower and broccoli florets to turn brown.
- Adults are small (*c.*2.5mm) metallic greenish-black with clubbed antennae.
- Overwintering adults lay eggs on oilseed rape in spring where larvae feed on pollen inside buds and flowers.
- Crops most at risk when weather dry and warm (above 15°C).
- A new generation of adults emerge in June to July and feed on flowers and horticultural Brassicas before finding sheltered overwintering sites in late summer.

Swede midge

Contarinia nasturtii

- Sporadic pest in the UK. Attacks Brassicas causing loss of quality and yield.
- Damage includes swollen flowers, scarring or death of the growing point, leaf petioles and flower stalks, blindness and crinkled leaves. Feeding often kills the growing point causing a proliferation of side shoots.
- Adults tiny greenish-yellow to light-brown fly 1.5–2.0mm with hairy wings. Female lays 60–120 eggs.
- Eggs very small 0.3mm, transparent then turn creamy white as they develop.
- Larvae are small maggots, 0.3mm reaching 3–4mm. Initially translucent becoming lemon yellow at maturity.

Turnip sawfly

Athalia rosae

- Sporadic, minor pest, but increasingly important. More common in Europe, can migrate to the UK, therefore southern counties are at greatest risk.
- Larvae have the potential to cause significant economic damage.
- Adults 7–8mm long, predominantly orange with a black head. Recognisable by presence of orange colouration on upper surface of thorax and orange legs with black bands.
- Adults only fly at temperatures above 18°C.
- Caterpillar-like larvae, black, dark green or dark slate grey with paler sides, 16–18mm.
- Damage caused by larvae feeding gregariously on leaves, quickly leaving a leaf skeleton.

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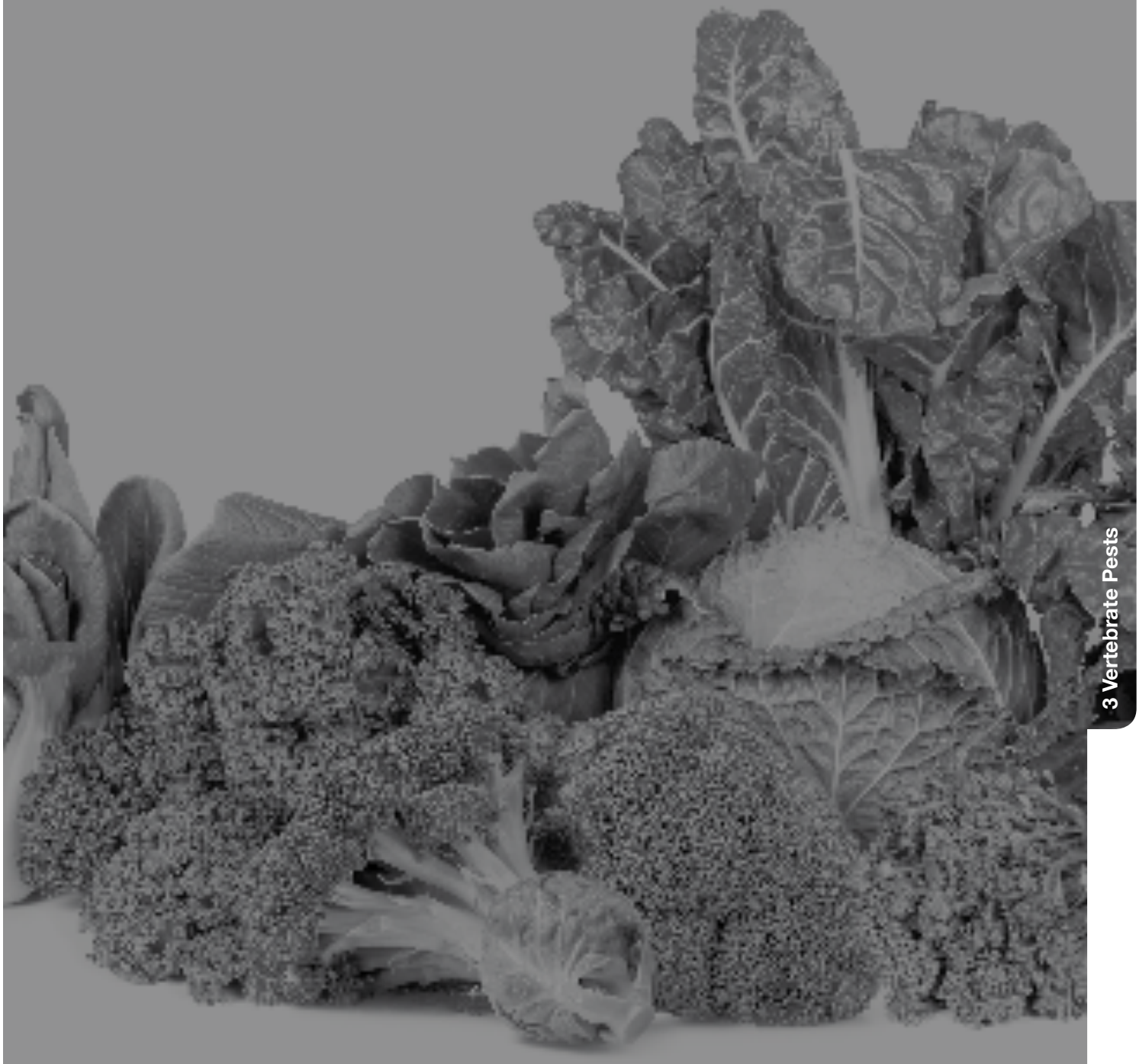
SECTION 3 Vertebrate Pests



Pigeons

Columba palumbus

- Major agricultural pest in the UK. Population widespread, estimated at 5.4 million pairs in 2009, increasing.
- Largely grey with a white neck patch and white wing patches, clearly visible in flight. Breast is pale pink. Both tail and flight feathers are black.
- Feeds on vegetable Brassicas and oilseed rape, also leafy salads and peas.
- Feeding reduces yield and crop quality; may cause cosmetic damage and microbial contamination.
- Breeding mainly from April to October, but has been recorded all year round.
- Gregarious, forming very large flocks outside the breeding season.

Mammal damage

- Deer and rabbits are common pests of Brassicas.
- Deer can cause damage to crop covers allowing other pests access to the crop.
- Damage often occurs during the winter months when other food sources are scarce.

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SECTION 4 Naturally Occurring Predators

Beetles – Ground

Carabidae

- 20–30 species are important for biocontrol; 5–10 are abundant on farmland.
- Generalist predators, providing a background level of control for a wide range of pests such as aphids, fly/moth/butterfly eggs and larvae, slugs and weed seeds.
- Most remain within 60m of field edges.
- Adults variable in size (2–25mm) typically black or brown, often with metallic sheens; some are brightly coloured. Usually nocturnal.
- Larvae elongated with biting mouthparts; eggs are ovoid and usually laid singly in or under the soil.
- Encouraged with beetle banks, field margins and minimum tillage.

Beetles – Rove

Staphylinidae

- 40–50 species are important for biocontrol, 5–10 are important on farmland.
- In agricultural crops, most are omnivorous. Prey on fly/moth/butterfly eggs and larvae, springtails, aphids and slugs.
- Adults are of variable size (1–25mm), elongated with flattened bodies. Some have distinctive colours, usually red and black, but most are black.
- Occupy most habitats, including crops, grassland and woodland. Overwinter outside the crop in sheltered places or as larvae in the soil.
- For most species, adults emerge between May and August.
- Encouraged with beetle banks, field margins and minimum tillage.

Hoverflies

Syrphidae

- Six species are important for biocontrol, two of which are very abundant.
- Highly effective predators because of their mobility and short generation time, capable of preventing aphid outbreaks.
- Aphids are the predominant prey of species with predatory larvae, each consuming up to 1,200 aphids.
- Adults are highly mobile and feed upon pollen and nectar of simple open flowers, usually white or yellow such as Apiaceae (umbellifers) and daisies, and assist with pollination.
- Larvae are largely nocturnal, so rarely seen on plants.
- Encouraged by presence of annual arable flowers and hedgerow plants.

Lacewings

Neuroptera

- Green and brown lacewings are important for pest control. A female can lay up to 1,500 eggs and each larva can consume 1,500 or more aphids.
- Adults have large translucent wings that are longer than their bodies.
- Eggs can develop in 6–30 days and are followed by three predatory larval stages.
- Larvae have distinct arrow-shaped bodies with large pincers. They sometimes attach the remains of their prey to their backs as camouflage.
- Adults may be attracted to flower-rich areas and plants supporting aphids. They are known to be attracted to strips of buckwheat.

Ladybirds

Coccinellidae

- Most commonly consume aphids and scale insects.
- Yellow to dark orange eggs 1–1.5mm, laid in batches.
- Larvae are distinctive, brightly coloured and commonly seen feeding on aphids in crops.
- Adults are attracted to simple open flowers eg wild carrot where they feed on nectar and pollen.
- Adults (1–10mm) are, typically bright coloured, yellow orange or scarlet, usually with patterned (spots, bands or stripes) wing covers.
- The use of broad spectrum insecticide sprays should be avoided.

Parasitic wasps/parasitoids

Brachonids, Chalcids and *Ichneumons*

- Over 3,000 species. Each wasp species parasitizes a particular species or group of pest species. Aphids, flies and caterpillars are the usual hosts.
- Parasitoids are important in the control of most pests, sometimes providing sufficient control to prevent pest outbreaks alone.
- They are very vulnerable to the direct and indirect effects of pesticides.
- Avoid using broad spectrum insecticides and avoid drift into uncropped areas.
- Alternative supplies of nectar provided by simple, open flowers will benefit adults.
- Larvae often overwinter in soil and are encouraged by minimum tillage.

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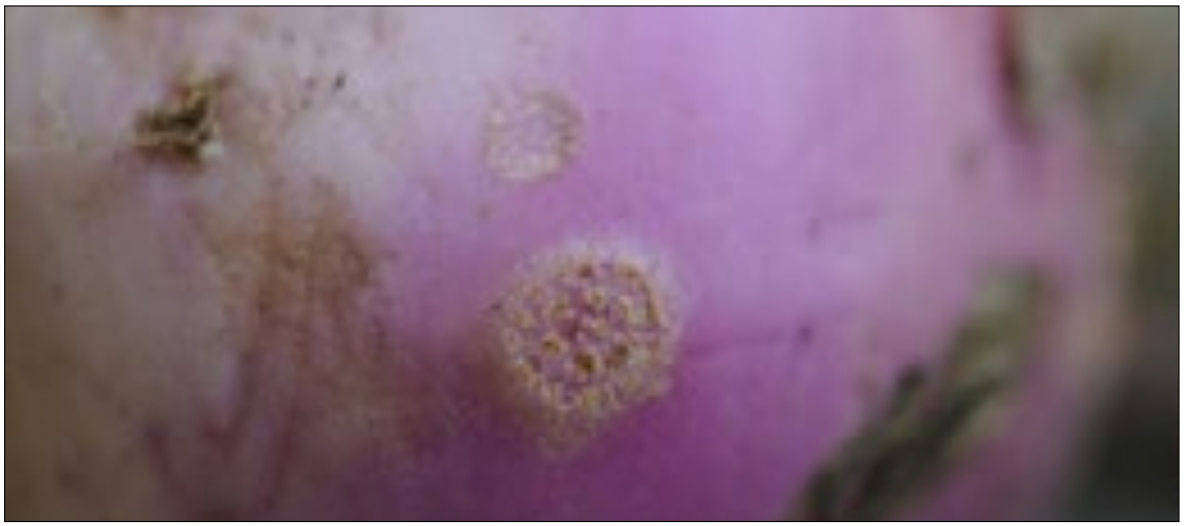
SECTION 5 Diseases

Scab

Streptomyces spp.

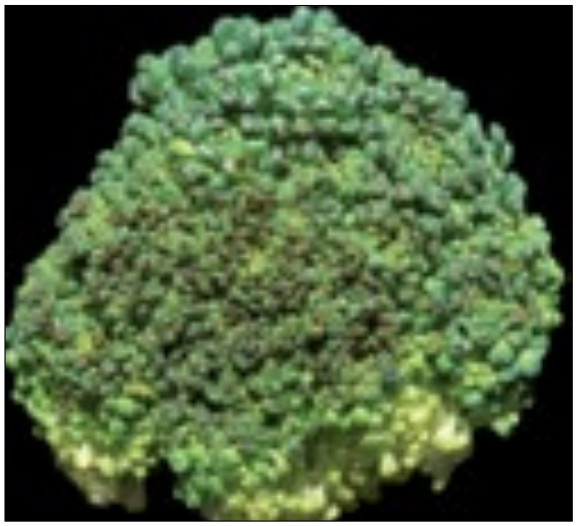


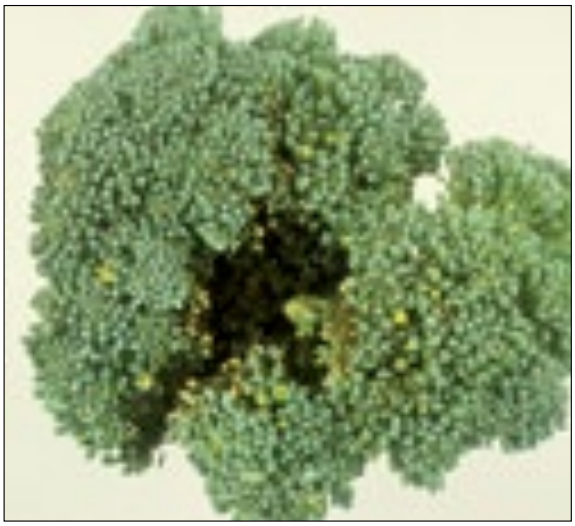
- Affects root Brassicas causing considerable reductions in quality, resulting in loss of marketable yield.
- Scab causes root lesions, of variable size.
- Lesions coalesce and affect large areas of the root.
- Associated with high pH.
- Infection is favoured by water stress at early growth stages.

Spear rot

B

Pseudomonas sp., **Pectobacterium* sp.



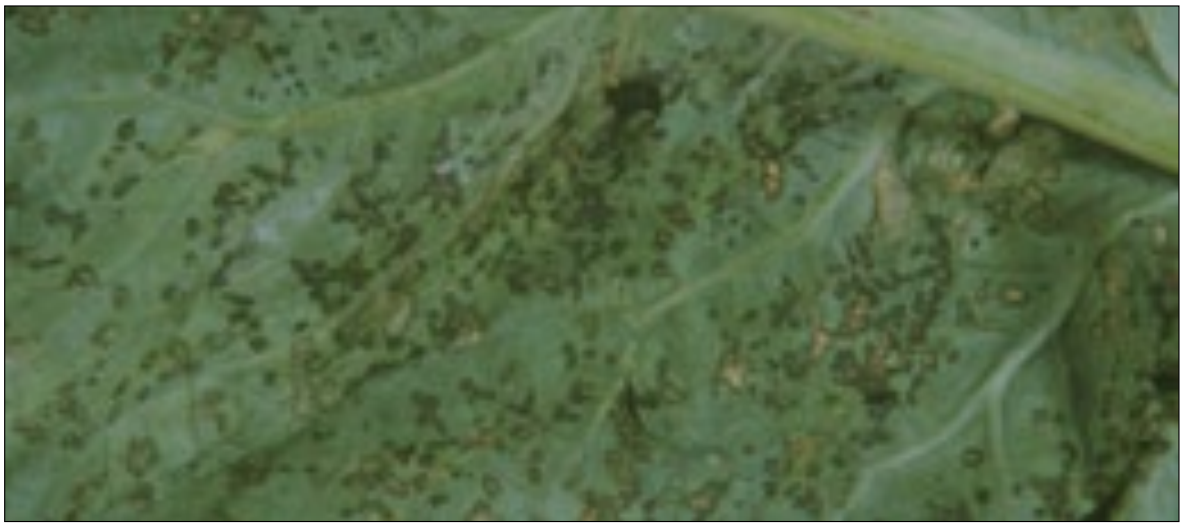


- Affects flowerhead Brassicas, losses sporadic – low level to almost complete crop loss.
- Small black water-soaked buds found on developing heads. Affected area increases in size developing into dark wet rot.
- Symptoms can appear within three days of continuous wetness or after long periods where dew is present.
- Spread is most likely via rainsplash. Encouraged by overhead irrigation and soft growth.
- Causal bacteria survive on plant residues, possibly also on seed.
- **Pectobacterium* sp., possibly secondary invaders.

B

Xanthomonas black rot

Xanthomonas campestris pv. *campestris*



- Considered the most important disease of vegetable Brassicas worldwide, attacking all cultivated Brassicas, radish and numerous cruciferous weeds.
- Characteristic yellow 1–3cm V-shaped lesions at the leaf margin, which expand towards the midrib, developing a pale brown centre with veins within the lesions which are dark brown or black.
- A bacterial disease that is seed-borne, spread by rainsplash.
- Systemic infection, often resulting from seed contamination, causes yellow blotches and darkening of the veins within the leaf.

Xanthomonas black rot – continued

B

Xanthomonas campestris pv. *campestris*

- Symptoms can also develop where infection occurs as a result of leaf damage from pests, hail or chemical scorch.
- The causal bacterium overwinters on affected crop debris.
- Marginal lesions occur at 16°C, while those within the leaf tend to occur at temperatures above 20°C. Symptoms can appear in 10–14 days at 25°C.

F

Botrytis (grey mould)

Botrytis cinerea

- Losses can be considerable in stored cabbage and swede.
- Initial small areas enlarge to cover the outer leaves of storage cabbage with a grey soft mushy rot.
- As disease progresses the lesion is covered with extensive fluffy grey sporulation.
- Infection in the field may occur as a secondary issue following damage caused by other diseases.
- Damage provides an entry point for the pathogen, so careful harvest and handling post-harvest will help reduce disease incidence.

Clubroot

F

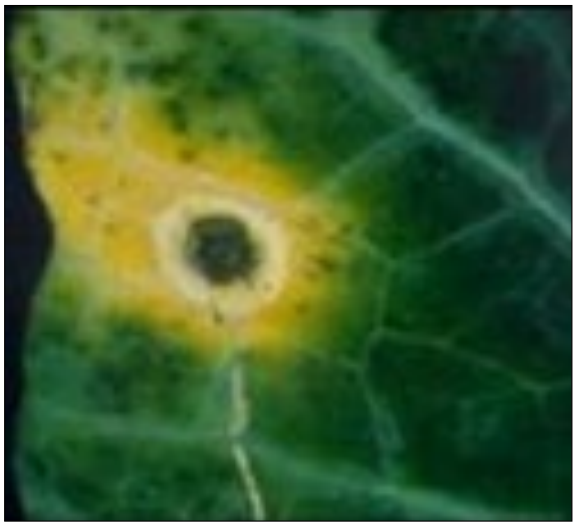
Plasmodiophora brassicae

- Plant vigour is affected by clubroot infection causing subsequent crop loss.
- Characteristic galls are formed on the plant roots.
- Water and nutrient uptake are seriously impeded by gall formation, resulting in stunted plants.
- Disease development is favoured by low soil pH.
- Infected plants, soil and manure can spread the disease.
- Resting spores are released from galls and these can remain viable for up to 18 years in the soil.

F

Dark leaf spot

Alternaria brassicae and *A. brassicicola*



- All major Brassica types affected, causes foliar, pod, seed and broccoli head symptoms.
- Reduces crop quality and appearance, especially important in leafy Brassicas and Brussels sprouts.
- Leaf spot appears as small, dark specks that enlarge into circular tan to brown spots, visible from both sides of the leaf.
- Spots enlarge to 5–25mm containing concentric rings, giving a target-like appearance, sometimes with yellow haloes.
- Spots are most apparent on older leaves. On petioles, they tend to be oval in shape.
- Seed-borne.
- Also occurs on stored crops at low temperatures.

Light leaf spot

F

Pyrenopeziza brassicae

- Brussels sprouts and processing cabbage are worst affected. Symptoms vary, influenced by weather and host susceptibility.
- Susceptible hosts show large white blotches which contain small green flecks surrounded by white concentric rings.
- Infection of young plants or the growing point can cause leaf distortion and stunting.
- Brussels sprouts lesions (1–2cm) are black and resemble a thumb print on leaf undersides and on sprouts. Severe infections can cause early senescence and rotting of outer leaves.
- On flowerhead Brassicas petioles may show pink/brown, black discolouration.
- Optimum temperature for disease development 15–16°C.

F

Phoma leaf spot/Canker

(also known as black leg, and dry rot on roots)

Phoma lingham

- Important disease of root Brassicas, symptoms are leaf spots only or progress to stem canker.
- Leaf spots variable shaped white/pale brown with numerous brown dots within the lesion, leaf underside greenish.
- Several weeks after leaf spots it invades the stem, cankers form on the lower stem and roots showing a distinct black margin.
- As leaf spots enlarge a darker margin may develop with surrounding yellowing, leaf veins darken indicating the pathogen is spreading systemically towards the stem.
- Leaf wetness and warm temperatures encourage disease development.
- Sunken dry rot can weaken or kill the plant, often just before maturity.

Powdery mildew

F

Erysiphe cruciferarum

- Affects all crucifers, differences in susceptibility between species and varieties.
- Yields affected most in root Brassicas, especially under nets; cosmetic damage on Brussels sprouts.
- Resistant varieties, colonies grey and restricted in size as host reaction produces black speckling beneath the colony.
- Characteristic white powdery appearance on leaves starts as scattered colonies, progressing to cover most of the aerial plant surfaces in susceptible varieties.
- On Brussels sprouts, black speckling in radiating lines on the outer leaves of buttons.
- Severe attacks cause chlorosis, early defoliation and necrosis of leaf tips in young cauliflower and cabbage.

F

Ringspot

Mycosphaerella brassicicola

- Major foliar disease of UK head and leafy Brassicas, causing significant yield loss.
- Initially spots dark, 3–5mm diameter and green/brown or grey/black.
- Spots surrounded by yellow halo; yellowing extends to the whole leaf when severe and leaves drop prematurely.
- Spots enlarge to 2–3cm, grey when dry but appear black when wet. Typical concentric zones of tiny, densely packed black fruiting bodies around spots form 3–4 weeks after infection.
- Visible both sides of the leaf, restricted by leaf veins, so often angular.
- Symptoms usually first seen on oldest leaves and lower sprouts.

Wirestem

F

Rhizoctonia solani

- Wide range of Brassica crops are affected.
- Occurs from sowing onwards – one of several pathogens causing seedling damping off.
- First signs are poor emergence and collapsed seedlings.
- Cauliflower seedlings are especially susceptible. Webs of fungal mycelium can spread over leaf undersides and soil.
- Roots and lower stems of affected seedlings show browning and cracking of the outer stem tissues around soil level; 'wirestem' symptoms – where only the core of vascular tissue remains.
- In radish, swedes and turnips infection causes disfiguring black spots on roots of up to 1cm in diameter, becoming sunken as the rot progresses.

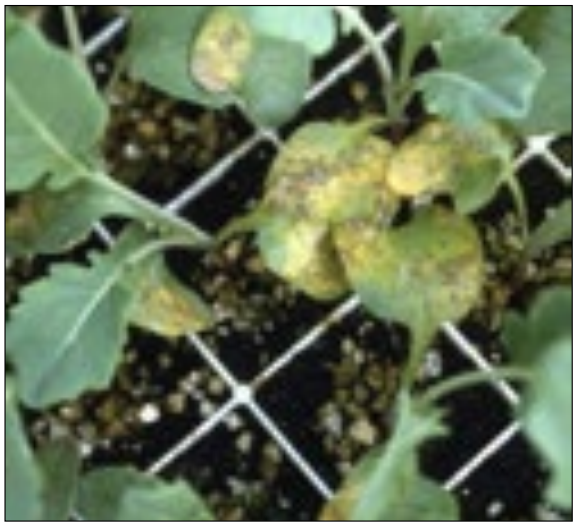
Sclerotinia

Sclerotinia sclerotiorum

- Occasional disease of head Brassicas, specifically storage cabbage.
- All growth stages affected.
- Occurs where there are senescent, scorched leaves or mechanical damage, when conditions are suitable.
- Symptoms can progress to stem rotting and plant collapse.
- Flowering Brassicas prone to attack when petals drop onto leaves in damp conditions.
- Encouraged by cool, moist weather.

Downy mildew

Hyaloperonospora brassicae
(syn. *Hyaloperonospora parasitica* subs. *brassica)*



- Occurs on cultivated Brassicas and cruciferous weeds.
- Affects all stages, seedlings and young plants most susceptible.
- Causes stunting of seedlings making them unsuitable for transplanting, even if not killed.
- Cool (10–15°C), moist conditions favour infection; lesion expansion most rapid at 20°C.
- First seen on cotyledons and leaves of Brassica seedlings as pale green, yellowish growth on leaf undersides. On older plants causes irregular angular yellow blotches, which may have dark speckling.
- Systemic infection can occur in cauliflower and broccoli causing grey or black flecking and streaking of internal tissues.

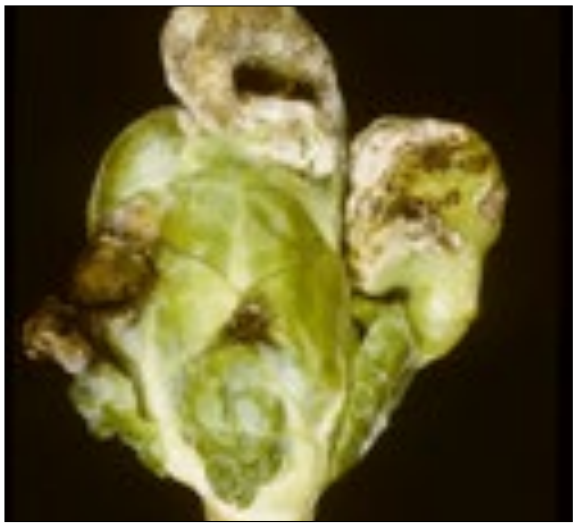
Phytophthora storage rot

Phytophthora brassicae (previously *Phytophthora porri*)

- Affects Brassicas, especially cabbage and swede.
- Occurs primarily in storage, causing up to 50% loss.
- On cabbage plants, field symptoms begin as water-soaked lesions (5–20mm), which turn dark grey/black, eventually drying up pale grey.
- Affected cabbage in store show dark brown discolouration extending from stem base into leaves within the head.
- Associated with wet conditions at harvest, cut stems are infected by soil or contaminated cutting knives.
- Storage rots appear slowly at 0–2°C, rapidly at 20°C. Usually little spread in cold storage; but occurs if heads are re-trimmed.

White blister (white rust)

Albugo candida



- Occurs in vegetable Brassicas.
- Affects young, immature tissue often causing distortion known as ‘stagshead’.
- Symptoms first occur as yellow spots, developing into white round/oval blisters, usually on the underside of the leaf.
- Infection of immature tissues can occur within four hours at temperatures of 10–24°C.
- The incubation period varies with temperature. At a constant 10°C, a 14-day incubation period means that the disease can become well established in crops before symptoms are visible.
- Weeds can act as alternative hosts.

Turnip yellows virus (TuYV)

- Wide host range including most Brassicas.
- Infection causes stunting of growth. Symptoms are often difficult to spot and are easily confused with nutrient deficiency, plant stress, and senescence.
- Reddening or purple around the edges of leaves are common, as is interveinal yellowing or reddening. Symptoms may also be absent.
- *Turnip yellows virus* (TuYV) is a cause of tipburn in white cabbage.
- The peach-potato aphid *Myzus persicae* is the main aphid vector. Early infection of plants by TuYV reduces yield much more than later infections.
- Many common weeds act as alternative hosts.

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SECTION 6 Nutrient Deficiencies

The importance of early diagnosis of crop nutrient deficiencies

Introduction

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 subclinical deficiencies or toxicities that may be already limiting growth but which are not yet resulting in visible symptoms. Guidance on collecting leaf samples is described in RB209 and other AHDB publications. Interpretation of laboratory results is possible by comparison with normal levels expected for the crop.

Boron (B)

- Brassica deficiency symptoms vary with species.
- All crops – first symptoms curling of leaves with brittle margins. Cracked and corky stems, petioles and midribs. Hollow stems. Interveinal chlorosis on old leaves.
- Cauliflower – large cotyledons with subsequent thick, brittle, new leaves. Hollow curd turns brown.
- Brussels sprout – few sprouts or small/loose sprouts.
- Cabbage – small swellings on stem and under leaf petioles. Premature fall of older leaves. Heads often yellow/small.
- Broccoli – first symptoms similar to cabbage but leaves turn red/yellow. Premature fall of older leaves.
- More likely on sandy soils with pH above 7.

Calcium (Ca)

- Necrotic lesions on leaf tips and margins (tip-burn), distortion of young leaves, which may lead to death of growing point.
- Affected areas are deformed because only necrotic areas of leaves stop growing.
- Internal browning of sprouts is attributed to calcium deficiency.
- Can be associated with rapid growth in hot, humid weather, excessive soluble salts and soil compaction.

Copper (Cu)

- Seldom occurs.
- Cabbage may show faint, diffuse interveinal chlorosis of expanding and mature leaves and withering.
- Poor, stunted root system.
- Has only been diagnosed in a few specific soil situations – peats, leached sandy soils, and thin organic soils over chalk.

Iron (Fe)

- Rare in Brassica crops.
- Young leaves turn yellow and later virtually white (bleached) with some green colour remaining along the midrib and main veins.
- In turnip and swede chlorotic mottling of all foliage.
- More likely to occur at high pH and as a result of heavy metal toxicity.
- May be confused with Manganese deficiency.

Magnesium (Mg)

- Chlorosis between the veins gives a mottled or marbled effect while veins remain green.
- Older leaves show symptoms first and may be very striking.
- Older leaves are stiff and fall down prematurely, and may wither and die.
- Occurs on acidic soils, particularly if soil compaction is present, or on very sandy soils subject to leaching after heavy rainfall.

Manganese (Mn)

- Causes interveinal chlorotic yellowing of older leaves, giving a mottled appearance.
- In severe cases the whole leaf may become stunted and bleached.
- Areas of necrotic tissue may develop (cabbage).
- Associated with high pH; can be induced by over liming.

Molybdenum (Mo)

- Cauliflower is sensitive to molybdenum deficiency.
- Causes the symptom known as ‘whiptail’ – growth of the leaf lamina is severely restricted causing narrow strap-like inward cupping of the leaves. The remaining lamina is small and irregular in outline, puckered and brittle.
- Symptoms begin on younger leaves.
- Growing point may become blind.
- Associated with loose curds in cauliflower.
- Only occurs on acidic soils, as it is more available at pH 6.5 or higher.

Nitrogen (N)

- Pale green/yellow leaves with red and purple tints.
- Stunted, erect, thin stems.
- Abscission of oldest leaves.
- Common where insufficient nitrogen is available, especially on strongly acidic or alkaline soils, and sandy soils following heavy rainfall where excessive leaching or waterlogging has occurred.
- Also occurs where organic matter levels are low or where high levels of un-decomposed organic matter have been added, eg straw.

Phosphorus (P)

- Growth reduction, but few foliage symptoms.
- Plants may be stiff and erect.
- Lower, older leaves dull, with bluish-green tints, especially the underside.
- Occurs where insufficient phosphorous available, especially on strongly acidic soils.
- Temporary deficiencies can occur on cold, wet soil.

Potassium (K)

- Leaf margins turn yellow (chlorotic) and then increasingly brown as the tissue dies off.
- In older leaves, leaf edges curl up.
- Tissue collapse can occur, with 'scorch' symptoms on leaf margins.
- Worse on sandy soils and at low pH (acid).
- May be a result of leaching due to heavy rain.

Sulphur (S)

- Small, spindly plants characterised by interveinal chlorosis of the young leaves.
- Older leaves may also show reddening.
- Affected plants are stiff, with thin petioles. Leaves curl inwards.
- May be confused with nitrogen deficiency, but sulphur deficiency begins in younger leaves as sulphur is not as mobile as nitrogen within the plant.
- Crops are most at risk of sulphur deficiency where they are grown on acidic soils, light sandy soils, soils with a low organic matter content, and in high rainfall areas.

Zinc (Zn)

- Extremely rare in the UK.
- Expanding cabbage leaves cupped with out-curved margins and interveinal bronzing of older leaves.
- Associated with coarse, sandy soils which are high in pH.
- May be induced by excessive phosphate applications.

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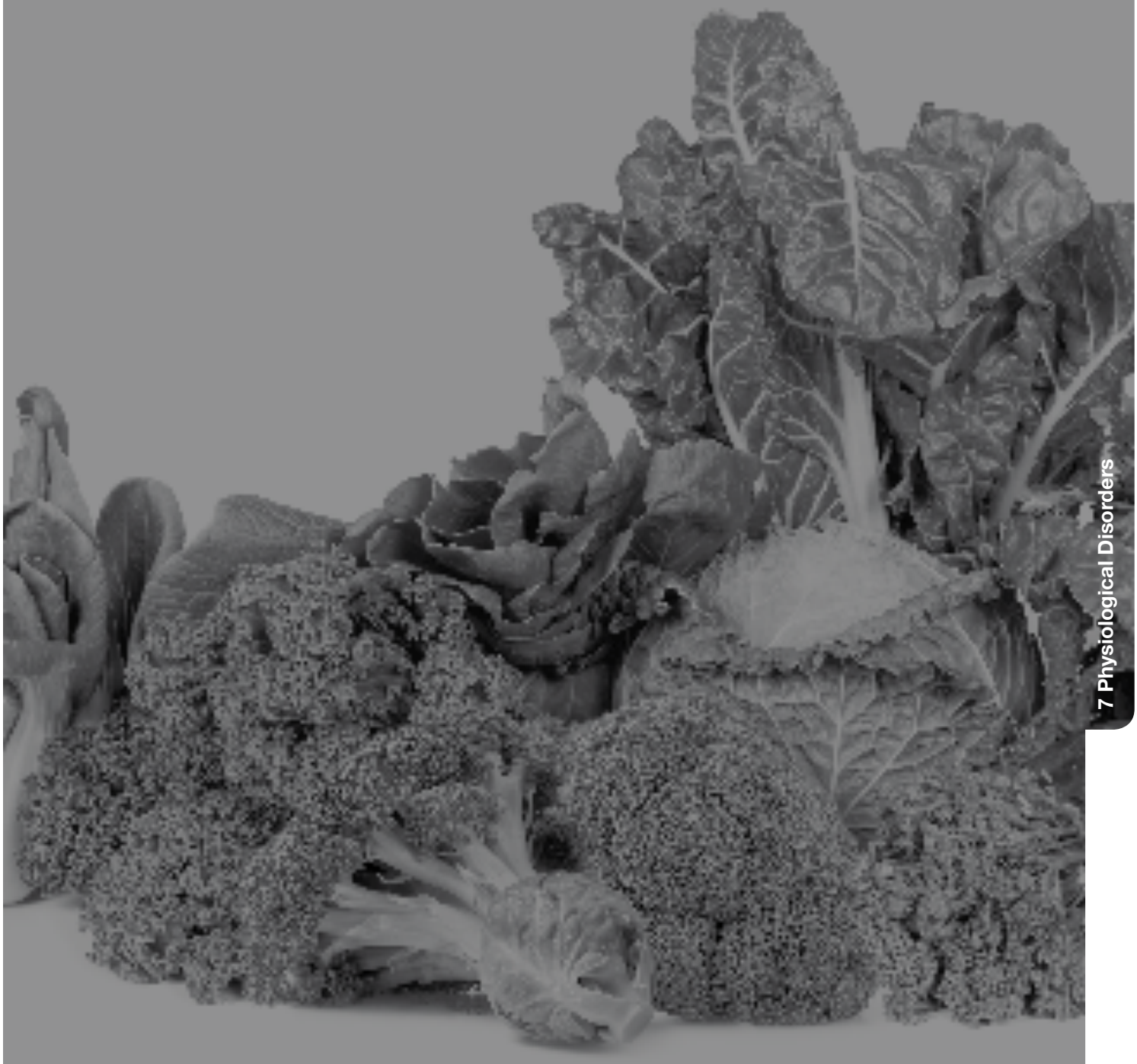
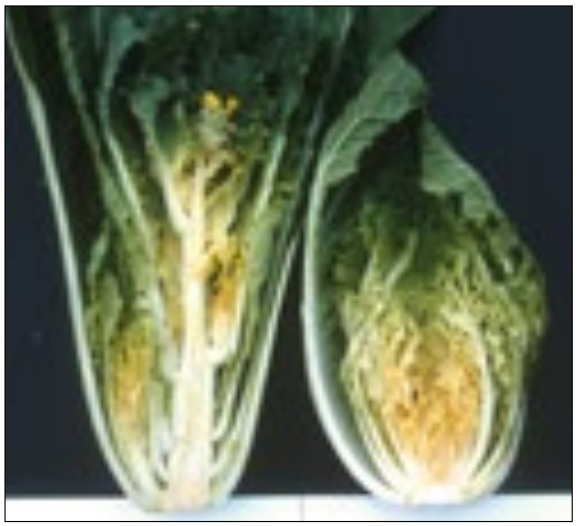
SECTION 7 Physiological Disorders



Blindness

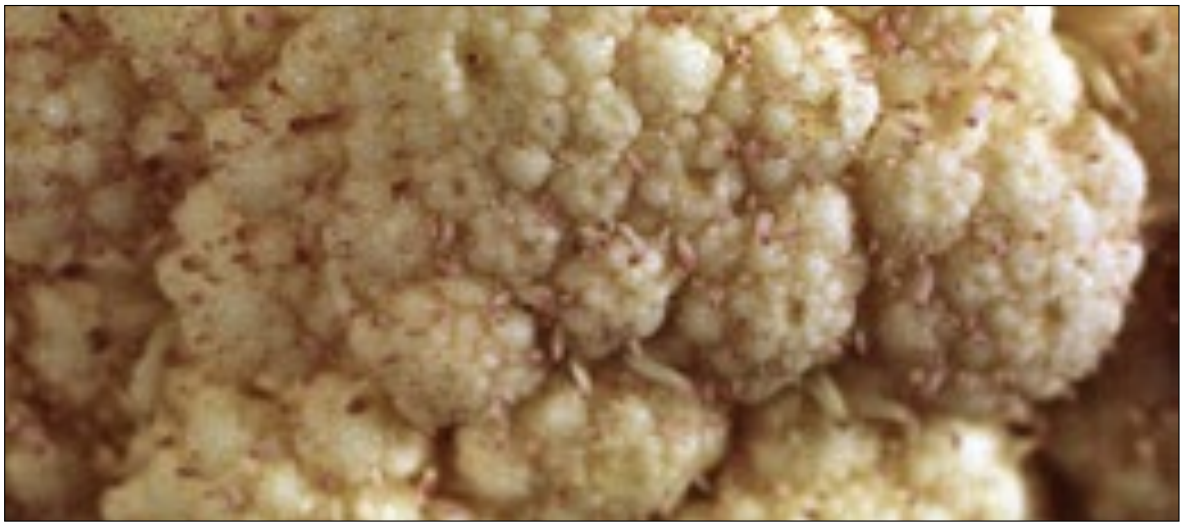
- Blindness is loss of the growing point.
- Results in misshapen leaves, which appear swollen and a glossy green colour or as leaves without blades.
- During plant raising combinations of low temperature and low levels of solar radiation can cause blindness of plants.
- Usually seen in field once plants have established.
- Cold temperatures, slightly above freezing, will induce the symptom in spring planted cauliflower.

Bolting



- Occurs when a plant flowers prematurely before full vegetative growth has been completed.
- Seen initially as development and elongation of a flowering stalk.
- May be caused by conditions during plant raising.
- Flowering is brought about by relatively low temperatures in a process called vernalisation.

Bracting

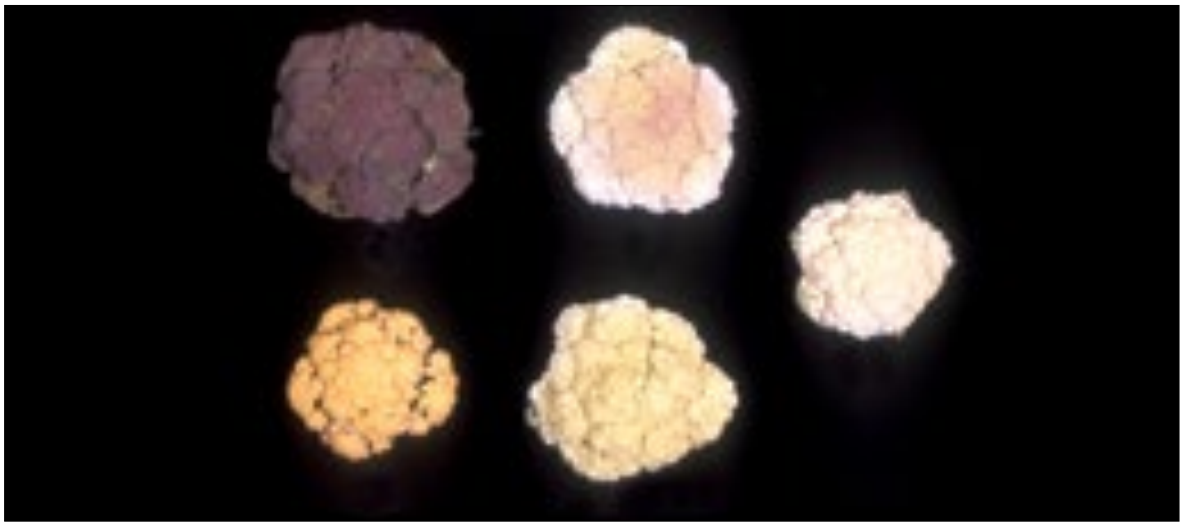


- In periods of high temperatures after curd formation bracts become visible around individual florets.
- Bracts are normally white, but may show varying degrees of green or purple colour.
- Due to reversion to vegetative growth.
- Some varieties are more sensitive to bracting than others.

Buttoning

- Occurs in broccoli and cauliflower.
- Development of small curds (buttons) on immature plants. Plants that develop buttons are small with small leaves that do not cover the developing head.
- Premature shift from vegetative to generative growth.
- Cold temperature shock to young transplants, such as when relatively large transplants are planted into cool field conditions, (varieties differ in their cold tolerance).
- Exacerbated by stressful growing conditions, especially severe nitrogen deficiency.

Curd discolouration



- Discoloured curds can be produced in varieties that form relatively few leaves to protect the developing curd, often early maturing varieties.
- Found in plants with insufficient overlapping leaves.
- Brown colouration of the curd can be caused by boron deficiency.

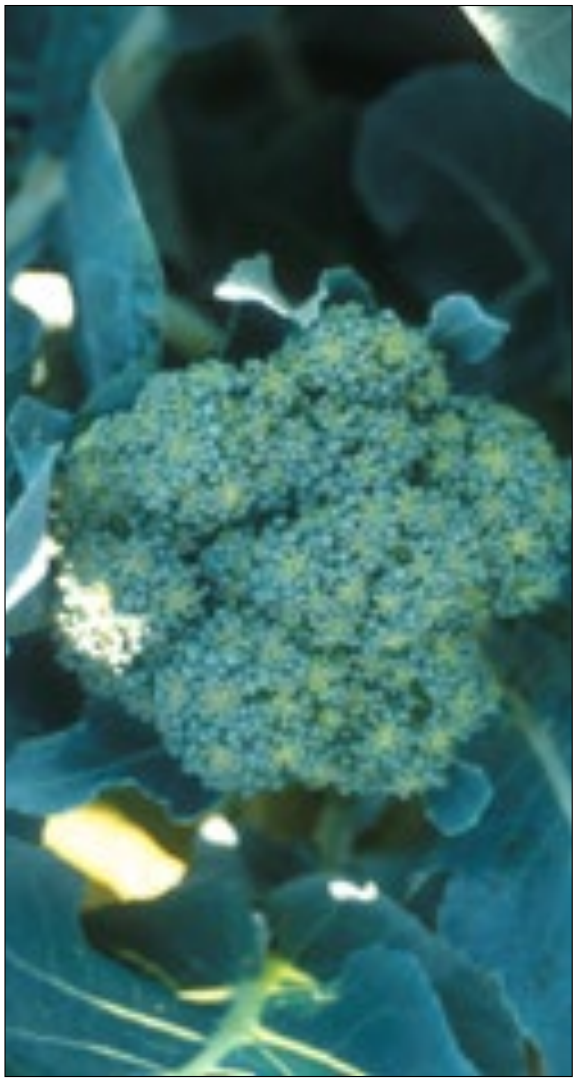
Hollow stem

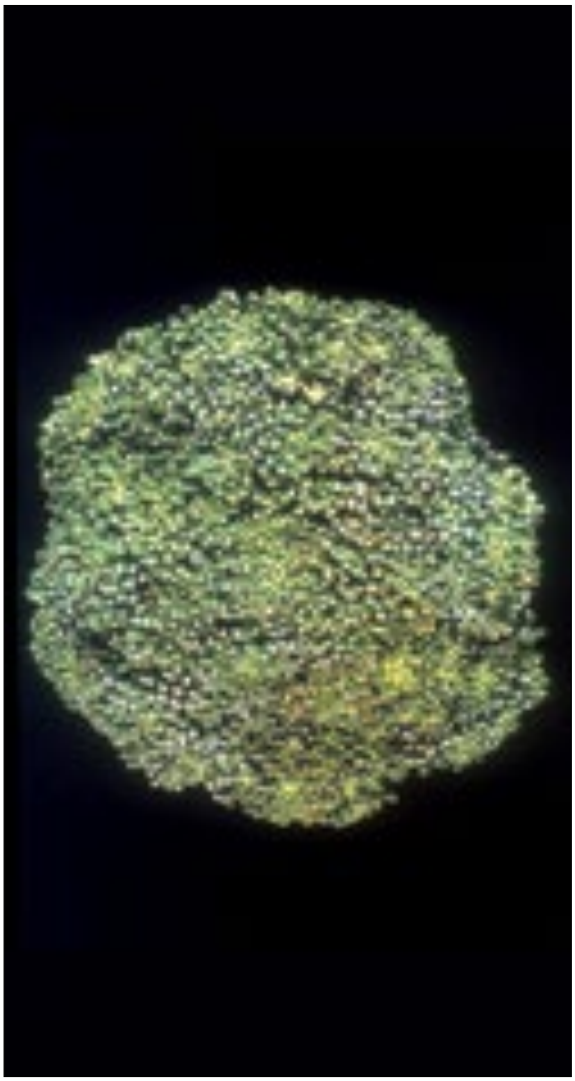
- Hollow areas in stems can extend up to the curd or head.
- Most severe in situations where individual plants grow rapidly (eg wide spacing and high nitrogen levels).
- Walls of the cavities are not usually discoloured, but there is the potential for bacterial infection and spoilage after harvest.
- Boron deficiency can cause similar symptoms.

Interposing leaves

- Temperatures outside ‘normal’ range during early curd development may cause a partial reversion to the vegetative state.
- If temperatures are much higher, immediately after initiation, leafy bracts may grow through the curd.
- A similar problem may occur in broccoli heads.

Pheasant eye





- The cause of the disorder pheasant eye is unknown.
- Pheasant eye (or cat's eye) results from uneven development of buds in the broccoli floret.
- Relatively immature (light green) buds occur at the centre of the floret surrounded by more mature (dark green) buds.

Riciness

- Appears as a grainy surface, similar to boiled rice, on cauliflower curds.
- Affected head may show the problem in several places.
- Riciness is attributed to extreme temperatures during curd development.
- Aggravated by rapid development and excessive nitrogen.

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SECTION 8 References

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