Recognise major pests and diseases in brassicas

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Foreword

Dear reader,

Brassicas can be affected by many different diseases and pests both in the field and in storage, most of which can adversely affect crop yield and quality. This brochure, produced by Bejo, provides a description of the main pests and diseases in brassicas. It also offers pointers as to how to prevent and/or control them to allow successful crop production.

Plant breeders at Bejo are striving towards better quality hybrid crops with resistance to a wide range of pests and diseases. For advice about brassica varieties and product forms, please contact your Bejo or local sales manager/crop consultant. Other useful sources of information include the Bejo product catalogue and the Bejo website at www.bejo.com.

This publication does not include information on pesticides. Please ask your pesticide supplier for approved treatments.

Bejo Zaden hopes that this brochure will prove useful, and wishes you a successful crop.

Bejo Zaden B.V.

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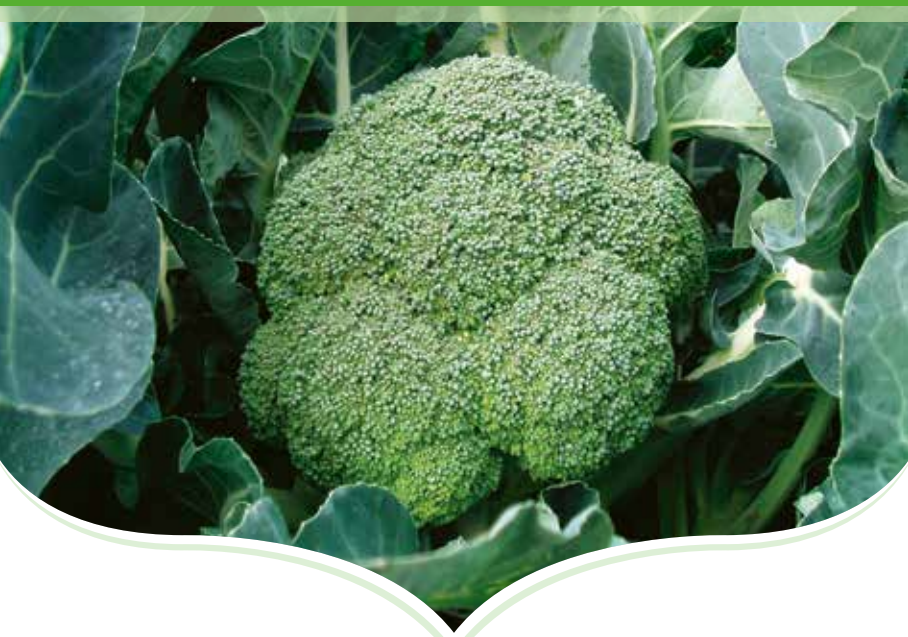


White blister (fungus)

Albugo candida

White blister can be a problem in cooler climates. The fungus can cause particular problems in broccoli, Brussels sprouts and headed cabbage. Wet and cool weather encourages the development of white blister. Symptoms are rarely seen during dry and hot periods.

Symptoms

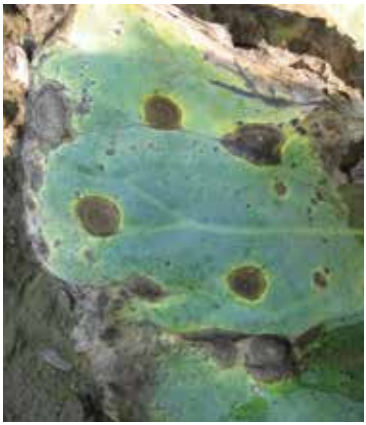
Small, progressing to large bulges or blisters from which a white powder (spores) is released, are the main symptoms. The infection can mainly be seen on the leaf, but can also be present on the stem and buttons of Brussels sprouts. Growth deformities can also be seen on broccoli (crowns).

Development and infection

Wind, rain and insects spread the released spores. Young plant parts are more easily infected than older tissue. The leaves need to have been wet for a period of a few hours for infection to occur. After approximately a week white spots will appear on the affected parts. It takes approximately 2 to 3 weeks for the spots to develop into bulges.

Prevention and control

After harvest, plough and incorporate all plant debris. This will lower the risk of infection in the following crop. As well as this, a wider crop rotation can help.



Dark leaf spot (fungus)

Alternaria spp.

Alternaria is a common disease that can affect all brassicas. The two most important types are *Alternaria brassicae* and *Alternaria brassicicola*. Damage is seen mainly on the leaves and can occur at all stages of crop growth.

Symptoms

In the initial stage of damage, small black spots appear on the leaf or the stem. If this occurs soon after germination, the seedling can die off. After some time the small black spots on the leaf become larger and then the difference between the two types of *Alternaria* can be seen more easily. *Alternaria brassicicola* produces small pitch black lesions that merge together. The other type, *Alternaria brassicae*, is characterised by larger brown lesions in which a black/brown mass of spores appear. After a while, the lesions tear, forming holes in the leaf. In early stages of development, lesions look similar to those of *Mycosphaerella* however, as the *Alternaria* lesions coalesce and become larger they are not bounded by leaf veins, unlike those of *Mycosphaerella*.

Development and infection

Alternaria produces enormous numbers of spores which can be spread by air, water and mechanically. The spores can remain viable for up to 14 days in favourable conditions. The disease is seed borne.

Prevention and control

Preventative spraying can help if long periods of wet weather are expected.

Grey mould rot (fungus)

Botrytis cinerea

Symptoms

The fungus *Botrytis* causes grey mould rot. Brown, watery spots form, which are then followed by a blanket of grey, white mycelium (fluffy fungal growth). The fungus produces a mass of spores, which is why the mycelium appears grey or grey brown. Symptoms often appear on damaged tissue as a result of mechanical or insect damage, freezing injury or damage from other pathogens, as these provide points of entry for the disease.

Development and infection

The fungus survives in the ground or in crop debris by means of sclerotia. Water and wind are responsible for spreading the spores that mainly form in cool, humid conditions. Because it is a very common fungus, infection can occur throughout the growing season and during storage. The fungus can infect the plant via damage and wounds. In wet periods the cabbages can sometimes rot in the field, but mostly the damage only becomes visible during storage. The optimum temperature for the fungus is 20°C, but even at 0°C *Botrytis* continues to grow. Once the fungus has settled in or on the cabbage, the rotting process will continue unabated.

Prevention and control

Because the fungus is very persistent, good hygiene is important. Stumps and other crop debris should be ploughed in quickly and waste from the cleaning process should be removed or destroyed. Spraying can help during the growing season. Damage to the crop must be avoided as much as possible.

Powdery mildew (fungus)

Erysiphe cruciferarum

Symptoms

Circular patches of powdery white mycelium with spores on the leaf's upper surface. Eventually the whole leaf surface can become covered with fluffy, fungal growth.

Development and infection

Dry and warm summers favour disease development, and the conidia (asexual spores) are easily spread by wind. Nevertheless, the fungus needs a certain amount of moisture for germinating the spores. The development of powdery mildew benefits from a short period of high humidity during the night and early morning. This disease seldom leads to significant damage under moderate conditions, however, leaves can become more susceptible to other diseases due to the damage caused by powdery mildew.

Prevention and control

Remove sources of infection and cruciferous weeds in the vicinity of the crop. Carry out plant protection control if necessary.

Fusarium 'yellows' (fungus)

Fusarium oxysporum f.sp. *conglutinans*

Fusarium is found throughout the world, but causes the greatest problems in warmer regions. Due to the wide availability of resistant varieties, the disease is not often serious. The fungus is important and there are many regions of the world where cabbage cultivation is only possible when resistant varieties are used.

Symptoms

Affected plants have dull green or yellow leaves. After a while the leaf twists, because the fungus causes blockages in the vascular bundles. Affected leaves become black or brown in colour and fall off. Infected plots in a field crop may show different stages of disease development. Some plants will die and others will develop into a small crop.

Development and infection

Fusarium is a soil borne pathogen which can remain dormant as resting spores for many years. The pathogen is suited to many types of cruciferous plants e.g. cabbage, rape, mustard and radish. The fungus enters the plant via the youngest or damaged roots, from there it invades vascular bundles causing blockage and ultimately the plant withers.

Prevention and control

Crop rotation of at least 5 years considerably reduces the chances of serious infection. Use resistant varieties on infected soils.

Downy mildew (fungus)

Hyaloperonospora parasitica

Downy mildew is a widespread fungal disease in moderate climate zones and it also occurs regularly in subtropical climate zones during the rainy season.

Symptoms

Downy mildew can produce visible symptoms in all growth stages. The fungus occurs systemically in the plant. In the germination stages a greyish white fluffy fungal growth is visible on the cotyledons. The early true leaves may fall off the young plant. In the most serious cases the seedling will die. In adult plants, areas with fluffy, white fungal growth appear, mostly on the underside of the leaves. These areas are bordered by veins. The upper facing leaf turns yellow. Initial infection can also cause irregular spots and specks. With cauliflower and broccoli the stem pith and the heads turn black. Infected cabbage will rot due to secondary damage caused by other pathogens. Downy mildew can cause dry rot in stored cabbage.

Development and infection

The fungus survives in crop debris where oospores (sexual spores) are formed. The following year these spores will cause an infection in the form of fluffy, white fungal growth. Oospores remain infectious for approximately 3 years. Conidiospores in the fluffy, white fungal growth are transported over great distances by cool and humid air and this is how the fungus quickly spreads through a plot. Downy mildew ultimately infects the plant via the leaf. Downy mildew is active in cooler weather with high atmospheric humidity. Night temperatures of 8 to 16°C and day temperatures below 24°C are necessary for its development. There are different races that affect other crucifers.

Prevention and control

There are no fully resistant varieties at the moment. Maintain good ventilation during plant raising and keep seedling leaves as dry as possible.

Ring spot (fungus)

Mycosphaerella brassicicola

Mycosphaerella prefers mild damp climatic conditions. Consequently, infection generally occurs in moderate coastal regions and tropical highlands.

Symptoms

The fungus causes grey brown ring-like lesions. Small, black fruiting bodies can be seen in the lesions. The fungus can attack all plant parts, but symptoms are mainly seen on the older leaves.

Development and infection

Mycosphaerella thrives on leaves that are wet and damp for a long period. The damage starts with small, sunken black spots, which become larger after a while. The spots are often alongside veins but very rarely grow across them. This is one of this fungus's most striking characteristics.

Prevention and control

If long, wet periods are expected preventative spraying can help. There are varieties available that have increased field resistance to this disease.

Stem canker (fungus)

Phoma lingam

Phoma is an extremely destructive disease that generally occurs in moderate climatic regions.

Symptoms

Symptoms can occur on all parts of the plant. On the leaf, *Phoma* manifests itself in the form of bleached, paper-like spots with black fruiting bodies. On the stem elongated and somewhat sunken dark patches can be seen, bordered by a purple edge. Sometimes small black points are visible in the lesions. Plants that are affected on the stem or roots display retarded growth. The leaves of these plants become red blue and often wilt.

Development and infection

The fungus survives on plant debris in the ground. Manure from animals that have eaten infected plant material, can act as an inoculum. The spores are spread via drops of water, machinery, or through human contact. The plant can die off early if seedlings become infected. Affected seedlings, plant debris or manure can easily transfer the disease to other plants. These plants develop the characteristic symptoms later. Small black points are sometimes visible in the affected areas. These are the fruiting bodies (pycnidia) from which the spores are released. The lesions gradually become larger and eventually lead to the plant wilting, then to plant and root death. Although the plant may continue to develop new roots, it lacks sufficient vigour to develop into a healthy plant, although a small cabbage or head may be produced. *Phoma* can also be seed borne.

Prevention and control

Remove infected material from the field or bury the debris. Do not feed infected plant parts to livestock. Avoid cropping infected land with brassicas for a few years.

Root rot (fungus)

Phytophthora spp.

Phytophthora occurs throughout the world in many crucifer and cabbage crops. It is mainly a problem in wet fields, where soil saturation can cause weakened roots.

Symptoms

Plants with *Phytophthora* look as if they have been waterlogged. The leaves turn red purple in colour and the plant often dies from the top down. More heavily affected plants wilt and can be easily pulled out of the ground. The rotting plant parts have a foul smell.

Development and infection

The fungus is soil borne and spores germinate under favourable conditions. After germination the fungus moves through soil water to a susceptible host. *Phytophthora* thrives at temperatures above 13°C and needs soil water to disperse. Water is especially important since the spores can only move through water. It is for this reason that the disease only manifests itself on wet ground or areas that have a disturbed soil structure. The spores can infect roots and other underground parts. Infected plants wilt and rot after some time. The fungus forms dormant spores in the plant which remain in the soil after cultivation and can cause further problems in following years.

Prevention and control

Good drainage and soil structure can prevent a lot of problems. Soil should not be saturated by irrigation, and any other actions that can cause compaction should be avoided. Fields with a history of *Phytophthora* should be given a rotation of at least 3 years with a non-susceptible crop.

Club root (fungus)

Plasmodiophora brassicae

Symptoms

Club root is a serious disease of the root system. The first symptoms are often observed on plant parts that are above the ground. The plant displays severe wilting, particularly in warm weather. When a plant is infected at a young stage, it can experience severe growth retardation and the crop can even fail. Infected plant roots become swollen and deformed. The deformations can vary from light swelling of the main and side roots to considerable tuberiform growths. Affected roots do not develop a protective barrier and consequently disintegrate quickly due to bacterial rot.

Development and infection

Club root is caused by the soil fungus *Plasmodiophora brassicae*. This primitive fungus has no mycelium and during a certain period in its life cycle it consists of a cytoplasmic mass with multiple nuclei, in which the cells have no walls (plasmodium). Affected plant parts break up quickly in the soil. Large quantities of dormant spores are released. These survival structures produce swarms of spores under humid conditions that actively move using their whip tail and infect hair roots. During the rapid development of the fungus in the plant, new swarms of spores are formed. These spores infect the surrounding tissue and neighbouring plants. When host plants are unavailable, the dormant spores can survive in the soil for at least 15 years. It is almost impossible to eliminate infection.

Prevention and control

Infected water, soil and plants spread the dormant spores from field to field. Disease free young plants should therefore be used to prevent the introduction of the fungus and one should also ensure that tools and equipment are clean. The fungus does well in acid conditions. The extent of the damage on infected plots can be limited by increasing the soil pH, which should not fall below pH 7. Apply calcium carbonate or other liming agents regularly or according to soil analysis.

Light Leaf Spot (fungus)

Pyrenopeziza brassicae

Symptoms

Infection with the fungus can lead to loss of seedlings or retarded growth. Infected leaf parts eventually develop into irregular shaped areas with brown and cracked centers. This may be mistaken for herbicide or nitrogen scorch or frost damage. Characteristic concentric rings of spore masses are found at the edge of the spots. Stem lesions could easily be confused with similar symptoms of black leg, caused by *Phoma lingam*. Infection of cauliflower curds causes a brown discolouration and blackened lesions.

Development and infection

Pyrenopeziza brassicae produces two types of spores. Asexual spores (conidia) are dispersed locally by rain splash and are also wind borne. Ascospores, formed in the sexual cycle, are wind borne and are capable of being spread over greater distances. Free water is required for infection. Under optimal conditions (16°C and leaf wetness duration of 48 h), the latent period is about 10 days. Provided there is sufficient rain, secondary spread of conidia contributes to the development of epidemics. The fungus survives between infections as mycelium or conidia on crop debris or saprophytically on dead material.

Prevention and control

The pathogen is restricted to brassicas. Good crop rotation and isolation from other brassica crops reduce the risk of inoculum build up. It is important to destroy or remove crop debris. Spores rapidly lose their viability if debris is buried. Debris is the substrate for sexual recombination, its decomposition prevents development of new virulent biotypes.

Head rot (fungus)

Rhizoctonia solani

Rhizoctonia solani is a soil pathogen that is present throughout the world. The fungus comes in many different strains and the aggressiveness of a strain can vary per host plant. The fungus has a wide range of hosts, including beans, lettuce, cabbage, carrots, cucumbers, tomatoes, peppers and tulips. As well as head rot in adult plants, *Rhizoctonia solani* also causes wirestem during the seedling stage (see 'Wirestem' page 18).

Symptoms

Head rot is often not immediately visible on the cabbage, but after peeling off a healthy outside leaf, leaves underneath can be totally rotten. *Rhizoctonia solani* attacks the stump via leaf axils. Cutting open the stump vertically will reveal that it is brown and rotten at one or two axils. The entire leaf is attacked via the veins. Initial damage causes small brown, sunken spots in the mesophyll. The fungus grows quickly; an infected cabbage can rot away in 10 days. In a later stage white, fluffy fungal growth can be seen between the affected leaves. As well as this, small, brown sclerotia of approximately 5 mm can develop.

Development and infection

Sources of infection include the soil, previous *Rhizoctonia* damage and also irrigation water. The fungus can grow at 3 cm per day so infection can increase rapidly. The optimum temperature for development of the disease is 25 to 30°C.

Prevention and control

Use well hardened plants that have lost their cotyledons. Avoid transplanting affected plants and do not plant on extremely wet ground. Extensive crop rotation should be applied on plots where *Rhizoctonia* damage has been found.

Wirestem (fungus)

Rhizoctonia solani

Rhizoctonia solani is a soil pathogen that occurs throughout the world. The fungus has many strains and the aggressiveness of a strain can vary per host plant. The fungus has a wide range of hosts, including beans, lettuce, cabbage, carrots, cucumbers, tomatoes, peppers and tulips. *Rhizoctonia* causes wirestem in the seedling stage and also head rot in adult plants (see 'Head Rot' page 17). Wirestem in the plant bed or after transplanting causes the greatest problems.

Symptoms

Characteristic *Rhizoctonia* damage is the sharp transition in seedlings from brown black constricted tissue to healthy tissue. The constriction does not progress higher up than the cotyledons, and is sharply defined. This is in contrast with other seedling diseases, where the affected tissue is often brown, less sunken and less clearly defined. Damage after the seedling stage leads to constriction of the stump just above the ground, after which the stump turns black. The vascular bundles then become woody and the plant turns blue green. The plants may not die and can still grow for a while. Under good growing conditions they can recover completely.

Development and infection

The fungus is generally soil borne and causes problems when there are wide fluctuations in the moisture content of the soil. The fungus spends the winter as mycelium or in sclerotia in the soil or in crop debris. The optimum growing temperature is 26°C. Wounds in the plant, caused, for example, by a senescent leaf, are often a good point of entry for *Rhizoctonia*. As well as this, the fungus can cause infection via natural openings, such as stomata.

Prevention and control

Use well hardened plants, preferably those that have lost their cotyledons. Remove affected plants during transplanting. Control with plant protection products is possible.

White mould (fungus)

Sclerotinia sclerotiorum

Sclerotinia is a fungus that can cause problems in cabbage and many other crops throughout the world. The symptoms manifest themselves in the field, during transport and in storage.

Symptoms

Affected parts first become pink brown and watery. After some time a copious amount of white cotton-like mycelium forms on the affected areas, which will later contain the black fruiting bodies or sclerotia. The affected tissue wilts and the plant collapses, but there is no strong smell unlike wet rot caused by bacteria. *Sclerotinia* remains in the ground, which is why the lower parts of the plant are the first to be affected.

Development and infection

Sclerotinia survives as sclerotia which can remain dormant in the soil or plant debris for a number of years. The fungus also survives on weeds and other host plants. *Sclerotinia* forms spores, which under humid conditions are dispersed or "shot away", allowing them to reach and infect leaves and stem. The fungus enters the plant via wounds and older, weak tissue. Following this, the whole plant can become affected. Sometimes the damage in the field is such that the plant dies, but minor damage will only lead to visible rotting in storage.

Prevention and control

Good weed control is necessary, given that certain weeds can be host plants. In addition to this, weeds provide favourable conditions for infection. Soil disinfection (chemically or with steam) can kill sclerotia, but the treatment does not always work effectively at depth. There are a number of chemical and biological remedies that can help control *Sclerotinia*. Good crop rotation of at least 3 years can reduce the number of sclerotia considerably. Do not use crops that are host plants for *Sclerotinia*.

Damping-off (fungus)

Pythium spp., *Fusarium* spp., *Rhizoctonia solani*

Damping-off is a collective name for a number of fungi that cause the loss of young plants in the plant bed. The hypocotyl is affected, causing the plant to collapse and die. Unfavourable germination conditions favour damping off and it tends to be found in patches.

Symptoms

Each pathogen displays different symptoms.

Pythium mainly affects the roots and root hairs with one characteristic being the ease with which the surface of the roots is sloughed off. *Pythium* causes a watery zone to form during the transitional period from healthy to affected tissue. The affected tissue has brown discolouration.

Fusarium causes yellow discolouration. The seedlings twist because the vascular bundles are blocked. The veins become mosaiced. Cutting open the plants will reveal that the vascular bundles have become brown. Seriously affected plants will have white or pink fluffy fungal growth. The fungus only causes damage with higher soil temperatures. The fungus does not grow at soil temperatures below 16°C.

Rhizoctonia causes wirestem. The constriction of the stem is sharply defined and is often restricted to the hypocotyl part of the stem. The affected tissue is dark brown to black and the plants turn blue green. For a comprehensive description of the disease, see under 'Wirestem' page 18. *Rhizoctonia* can also cause head rot later during cultivation (see 'Head Rot' page 17).

Development and infection
Poor germination conditions such as wet soil, low temperature and/or low light conditions promote damping off. The fungi remain dormant in soil for a long period of time, but provided germination conditions are good they do not present a problem. When the conditions are less favourable, the plants die off.

Prevention and control
It is possible to use chemical control on the plant bed. Ensure that early cultivation is carried out in clean trays. Irrigation during cultivation should be done carefully. High temperatures and allowing the plants to dry out should be avoided.

Verticillium wilt (fungus)

Verticillium longisporum

Verticillium is a disease that is mainly found in cauliflower, red cabbage, Brussels sprouts and white cabbage.

Symptoms

In the initial stages the symptoms can be confused with those of *Xanthomonas*. V-shaped lesions form on leaf edges. In severe infections the veins of the plant or leaves can become black. There are a number of characteristic differences compared with infection by *Xanthomonas*. A *Verticillium* infection produces darker coloured V-shaped lesions. In addition, the black discolouration of *Verticillium* develops from the roots, while with *Xanthomonas* this develops from the lesions on the leaf edges. Consequently, in the initial stages of *Verticillium* there are no black veins in the V-shaped lesions. In later stages the leaf will wilt completely on one side, while the other side remains healthy. The vascular bundles that are connected to the affected part of the leaf become blocked by the fungus, which leads to death. Affected parts often have a reddish brown colour. In this stage the disease can be compared with *Fusarium*.

Development and infection

The fungus infects the plant via the roots. After infection the fungus blocks the vascular bundles and so causes the leaves and sometimes the whole plant to wilt. *Verticillium* does not grow quickly and damage is often only visible after a warm, dry period.

Prevention and control

Disinfecting the ground and extensive crop rotation are the only methods that may prevent or control the disease.

Wet rot (bacteria)

Erwinia spp. and *Pseudomonas* spp.

Symptoms

Wet rot caused by *Erwinia* and *Pseudomonas* is characterised by watery spots that change the tissue into a soft, slimy mass. The rotting process is often accompanied by a stinking smell, resulting from secondary bacterial growth. Field damage is uncommon and is mostly associated with extremely wet conditions. Infection will often only be noticed during transport and storage.

Development and infection

The *Erwinia* and *Pseudomonas* types generally occur in the ground and survive on plant debris. *Erwinia* is a wound parasite that can easily enter the cabbage via wounds, caused by harvesting, fungal infections, frost and insect damage. The treatment of the harvested product and the storage conditions (free from moisture) determine whether or not problems will arise. *Pseudomonas* can enter plants if there has been a thin film of water on the tissue for a few days, on broccoli heads for example. The optimum temperature for the bacteria is between 25 and 30°C, but *Pseudomonas* can also cause serious problems at lower temperatures.

Prevention and control

Limit the entry points for *Erwinia* and *Pseudomonas*. This can be achieved by having good drainage, as little harvest damage as possible and ensuring that there is good insect control during the growing season. Do not apply too much fertiliser, this can cause rapid plant growth, which will cause them to loose their natural resistance. Ensure that the harvested product is dry before transportation and/or storage.

Peppery leaf spot (bacteria)

Pseudomonas syringae pv. *maculicola*

Pseudomonas is a bacterial disease that mainly occurs on cauliflower, but other types of cabbage can also be affected by it.

Symptoms

Small round spots with a yellow edge form on the leaf. Gradually the spots become larger and coalesce into an irregular shape. The inside part of the spot becomes paper-like and will tear, causing holes in the leaf. In case of a serious infection the leaves become completely yellow and fall off. The bacteria can also affect the cabbage itself to some extent. Following this, various secondary bacteria can cause wet rot.

Development and infection

The bacteria remain viable on crop debris and in the soil for 2 to 3 years. Distribution occurs via splashes of water (rain or irrigation) and possibly by insects. Development is fastest at temperatures around 24°C, in combination with the availability of sufficient moisture. The bacteria can enter and infect the plant via stomata, but cannot spread further through the plant's vascular system. In order to affect other parts of the plant, the bacteria have to be distributed again from outside by rain or irrigation water. This disease can cause serious problems, mainly in the wet season in Central and North America.

Prevention and control

Maintain an extensive crop rotation and avoid long periods of leaf wetness.

Xanthomonas leaf spot (bacteria)

Xanthomonas campestris pv. *raphani* (Xcr)

The bacteria *Xanthomonas campestris* pv. *raphani* (Xcr) is a minor problem compared to *Xanthomonas campestris* pv. *campestris* (Xcc). The initial symptoms can be compared with those of *Pseudomonas* and *Alternaria* and the damage is generally not too severe.

Symptoms

The first symptoms are small, dark green, transparent spots that gradually become larger and turn black. The spots can spread over the entire leaf. When there is considerable damage, the leaf will curl up, dry out and will look as if it has been burnt. After some time Xcr is no longer systemic and therefore cannot affect other parts of the plant, in contrast with Xcc.

Development and infection

The bacteria enter the plant via the stomata when water is available. Long periods in which the leaf surface is wet, are favourable for this bacterial disease and it generally occurs after periods of cool weather with excessive rainfall and/or dew. The disease can survive for a while in plant debris that is left on the field. Damage can provide points of entry for other diseases, such as Xcc.

Prevention and control

Avoid long periods of leaf wetness after periods of heavy rain or dew, so keep crops free of weed and do not plant too close to windbreaks. Fast removal or ploughing in crop debris and a rotation of 3 years with a non-cruciferous crop can considerably reduce the risk of Xcr damage. Good phytosanitary hygiene during cultivation is necessary. Avoid overhead irrigating as much as possible.

Black rot (bacteria)

Xanthomonas campestris pv. *campestris* (Xcc)

This bacterial disease is one of the most important diseases in brassicas worldwide. The disease occurs in all cabbage regions and can cause considerable harvest and quality loss. Heavy infection can destroy an entire harvest or make it unmarketable. All brassica types are susceptible as are many cruciferous weeds, which can act as host plants.

Symptoms

Xanthomonas can affect plants in each stage of growth. The cotyledons can become infected in seedlings, causing them to shrivel up and fall off. On leaves, yellow, V-shaped lesions containing black veins at the leaf edges become visible. The tissue wilts and will eventually die as the lesions become larger. They then turn brown and dry. The first symptoms can often be seen in wet parts of the field. Sometimes chlorotic spots will appear in the centre of a leaf, indicating the infection is systemic. Badly affected plants display retarded growth and shed affected leaves. Affected parts often have to cope with secondary disease symptoms, such as rot.

Development and infection

Xanthomonas can survive on seeds, crop debris, in the ground and on some cruciferous weeds. The bacteria are spread by wind, rain, irrigation water and insects. Mechanical spread (by people and machinery) is also possible. Because plants on a seedbed or in the plant nursery are at high density, infected plant material can cause an epidemic. This enables the bacteria to spread quickly and easily.

Infection mostly occurs via hydathodes (vein ends) at the leaf edges, but also via stomata or wounds. The disease manifests itself mainly in warm weather (25 to 30°C), but the infection continues under cooler conditions. Development stops at temperatures lower than 10 to 15°C. The risk of infection is greatest in periods with warm days and cool nights. During cool nights, water exudes out of the leaves and small droplets accumulate by the hydathodes, which are an ideal entry point for the *Xanthomonas* bacteria.

The bacteria enter through the vascular tissue, become systemic and spread through the whole plant. The supply of water and nutrients within the plant is disrupted causing retarded growth, a smaller crop and an unmarketable product.During storage the bacteria continue to develop and secondary rots can also arise.

Prevention and control

In a number of crops there are varieties available that have a high resistance level. Good phytosanitary hygiene during cultivation is necessary. Avoid overhead irrigating as much as possible. Good weed control, quick removal of infected plants, ploughing in crop debris, and crop rotation with a non-cruciferous crop can considerably reduce the risk of *Xanthomonas* damage.

Cauliflower mosaic virus (CaMV) (virus)

Symptoms
Depending on the brassica species and the virus strain, the symptoms vary from a fine mosaic of light and dark green leaf parts to yellowing of the veins. In contrast with Turnip Mosaic Virus (TuMV), there is no twisting of leafs in Chinese cabbage. Plants that are infected at a young stage can eventually die. Cauliflowers display clear mosaic patterns, just like small, oily spots. In headed cabbage the symptoms are less pronounced. Affected plants and their veins sometimes have a lighter colour. Yellow spots or oily dark patches with a grey centre can appear. Cauliflower Mosaic Virus can occur together with TuMV. The combination of both viruses is more harmful than an infection with one of the components alone.

Development and infection
Cruciferous crops are the only host species for CaMV. The virus is transferred in a semi-persistent manner by leaf aphids. A lengthy systemic infection of the aphid is needed, and not a short lived external infection of the fascicle. The green peach aphid *(Myzus persicae)* and the cabbage aphid *(Brevicoryne brassicae)* are the most important aphids that transfer the virus. The virus can also be transferred mechanically.

Prevention and control
Start with an aphid free crop. Given that the virus can be transferred after short-term contact between the leaf aphid and the plant, aphid control will have little effect. The damage will be more severe if the plant is younger when infection occurs. Therefore it can be sensible to cover early plantings. It is also important to keep the crop free of cruciferous weeds.

Turnip mosaic virus (TuMV) (virus)

Symptoms
The symptoms vary from a fine mosaic of light and dark green leaf parts to small necrotic spots. It is noticeable with Chinese Cabbage that affected young leaves display more growth retardation on one side of the leaf causing a characteristic twisting. Plants that are affected at a young stage may die. Symptoms in headed cabbage include dark spots shaped as a horseshoe or ring. In this crop, the virus can cause serious internal damage. When a cabbage is cut open a pattern of blacks rings becomes visible, even if there are no visible symptoms on the outer leaves. Turnip Mosaic Virus can occur together with Cauliflower Mosaic Virus (CaMV). The combination of both viruses is more harmful than an infection with one of the components alone.

Development and infection
Turnip Mosaic Virus is most harmful in cruciferous crops like Chinese cabbage, stock feed turnips, swede, mustard and radish, but also occurs in lettuce, endive and spinach. The virus is transferred in a non-persistent way (i.e. as a short-lived external infection of the fascicle) by leaf aphids, the green peach aphid *(Myzus persicae)* and the cabbage aphid *(Brevicoryne brassicae)* being the most important. The virus can also be transferred mechanically.

Prevention and control
Combating aphids has little effect, since brief contact of the leaf aphid with the plant can be sufficient to transfer the virus. The damage is more severe when young plants are infected, which is why covering transplants can be a sensible option.

Turnip yellow mosaic virus (TYMV) (virus)

Symptoms
Affected plants display very pronounced virus symptoms. A colourful mosaic of clear yellow and light green spots appears on the leaf. Veins sometimes turn yellow. Young plants that are infected with the virus lose vigour quickly and eventually collapse.

Development and infection
The virus is mainly a problem in crops such as Chinese cabbage and pak choi. Important vectors of the virus are flea beetles *(Phyllotreta striolata* and *Phyllotreta cruciferae)*. TYMV can easily be transferred mechanically.

Prevention and control
Given the ease with which this virus can be transferred mechanically, it is vital to work hygienically particularly when planting out seedlings. Flea beetles should be dealt with if necessary, as it is known that they can spread the virus under fleece coverings.

Cabbage aphid (insect)

Brevicoryne brassicae

Symptoms

These grey green aphids only feed on crucifers and are covered with a grey, powder-like substance. The aphids can be found on or under leaves, or in the heart of the plant. After establishing themselves on the plant, yellow, lumpy patches can be seen on the leaves. Affected leaves usually curl around the aphid colony. Sometimes the plant will display red discolouration, due to the formation of anthocyanins. The cabbage aphid can also introduce up to 20 different viruses, including the *Turnip Mosaic Virus* and *Cauliflower Mosaic Virus*.

Development and infection

The eggs of the cabbage aphid and the aphid itself survive the winter on crop debris or on other crucifers, and because of this, the aphids can sometimes be seen early in spring. During the growing season the population exists almost exclusively of females that reproduce asexually. Males are produced at the end of the growing season, which is followed by sexual reproduction. This reproduction results in small, black, elongated eggs that are deposited on the leaf. The offspring has no wings when the population on a plant is not too dense. When the density of the population increases, the new borne aphids will get wings. A total of 20 generations per year is not exceptional.

Prevention and control

Remove cruciferous weeds and crop debris from the previous year in good time. In addition to this, it is sensible to regularly monitor crops during the season to avoid aphid and virus problems. Secondary fungi can attack the plant on the mix of excrement, honeydew and aphid skins, particularly when cabbages (and Brussels Sprouts) start to form hearts (or buttons). There is also a variety of biological predators and ichneumon wasps that can help to keep the damage under control.

Cabbage stem weevil (insect)

Ceutorhynchus spp.

There are several species of cabbage stem weevils that are active in brassicas, each causing problems to different parts of the plant.

Symptoms

Lumps or galls in the root or in the heart of the plant, failure to form a heart, yellow and senescing leaves.

Development and infection

Cabbage stem weevils lay their eggs at the base of the stem, in the heart or leaf axil. A lump or gall containing larvae forms in the cabbage heart or base of the stem. The larvae then gnaw at the plant parts, and those in the leaf axils make tunnels in the stem and leaf stalks. The damage to the plant's stem or root can generally be tolerated. The galls in the heart of the plant can damage the growing point resulting in failure to form a heart. Tunnels in the stem can cause wilting and the plant may die off. Damaged leaves wilt and senesce. In all cases, damage caused by larvae also provides an entry point for secondary fungi and bacterial diseases. These can become a problem if the conditions are unfavourable and humid.

Prevention and control

The use of plant protection products is vital for control of this pest. This mainly helps against the galls in the stem and the heart. Measures taken to control the cabbage root fly incidentally affects the cabbage stem weevil larvae.

Swede midge/Whiptail (insect)

Contarinia nasturtii

Swede midges can cause 'whiptail', particularly in cauliflower, broccoli and kohl rabi.

Symptoms

Whiptail occurs after the swede midge has damaged or destroyed the growing point. The leaf starts to twist in the growing point resulting in abnormal plant growth.

Development and infection

The swede midge spends the winter in the ground, appears in May and lays eggs in the heart of young cabbage plants. The midge's larvae suck on the growing point and the young leaves, causing damage to them. Unaffected tissue and leaves that are still growing, start to twist. Sometimes the damage is so severe there is no further growth in the heart. Later flights can also cause damage to Brussels sprouts.

Prevention and control

Swede midge can be controlled chemically, but to do this a strict spraying schedule has to be maintained. Extensive crop rotation can reduce the population of swede midges. Do not cultivate on, or close to a plot that was affected by swede midges the previous year. Affected plants have to be destroyed. Ensure that cultivation is open and there should not be too much shelter near the crop. Keep the crop weed free and keep plot borders (verges, sides of ditches and headlands) narrow.

Cabbage root fly (insect)

Delia radicum

Symptoms

Damage caused by cabbage root fly generally becomes visible during early cultivation or just after planting. Young plants affected by cabbage root fly larvae may wilt and die. Affected plants have their roots eaten, and tunnels in the stem. Maggots may be visible. In later stages pupae can be seen around the base of the plant. If the attack is not serious, or if growing conditions are favourable, new roots can develop and the plant may recover.

Development and infection

The cabbage root fly attacks all cruciferous crops. They overwinter in the ground as pupae, and emerge in April. Females lay their eggs (1 mm long, oval and white) on soil around the base of the plant. After hatching, the maggots gnaw on the roots and enter the stem provided it is not too woody. The maggots pupate after 3 to 4 weeks in soil, close to the host plant. The pupae are 5 mm long, red/brown in colour and oval. After 2 to 3 weeks new cabbage root flies emerge. The new generation causes problems for summer planted brassicas, such as winter cauliflower and may also lay their eggs in leaf axils of Brussels Sprouts. A proportion of the maggots from the last generation of the year pupate in the ground, where they spend the winter.

Prevention and control

Insecticide treatment of seed reduces the chance of cabbage root fly damage. Plant protection products can be applied at planting and further treatments can be made to the growing crop. Use of a fleece during plant raising and after planting can reduce the build up of the population. This only helps when there are no cabbage root fly pupae present in the ground as it is possible that pupae may be present from previous cruciferous crops. Mechanical weed control may also help control cabbage root fly; the soil near the base of the plant becomes disturbed and any eggs near them will then become exposed and dry out.

Flea beetles (insect)

Phyllotreta spp.

Symptoms

Small, rounded or irregular holes in the leaf. In cases with severe damage the leaves appear to have been peppered with fine shot.

Development and infection

Flea beetles are very small (2-3 mm), shiny dark, active beetles, that use their well developed rear legs to leap. The adult beetles cause the most damage, because they feed on the underside of the leaf. The insect can cause considerable damage to a young crop, particularly in dry, sunny weather. The eggs are deposited at the beginning of summer several centimeters under the soil surface. After hatching, the larvae gnaw at the plant's roots and generally do not cause noticeable damage. The mature flea beetles overwinter in weeds and organic matter. The beetles appear again early the following spring and feed on weeds. They become more difficult to control when the weeds become exhausted as their main source of food, as they then migrate to cultivated crops.

Prevention and control

Flea beetles prefer cruciferous crops (cabbage, radish, etc.). Ensure that the crop is growing quickly so that the crop does not remain vulnerable for too long.
Because the beetle spends the winter on weeds, it is also important to plough in or harrow grass, broad leaved weeds and crop debris before the winter. In this way the beetle will loose its shelter.

Cabbage white butterfly (insect)

Pieris rapae and *Pieris brassicae*

Symptoms

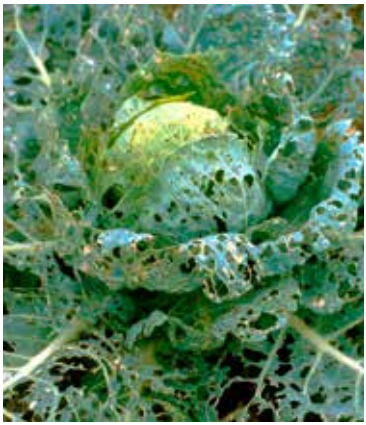
The caterpillars of the Small Cabbage White Butterfly (*Pieris rapae*) and the Large Cabbage White Butterfly (*Pieris brassicae*) gnaw holes in the leaf and later in the heads as well. The veins often remain unaffected. Sometimes the damage from this insect can lead to secondary infections of fungi or bacteria.

Development and infection

The Small Cabbage White Butterfly lays its yellow eggs singly on the underside of the leaves. The eggs of the Large Cabbage White Butterfly are deposited in a circular shape. The caterpillars of the Small Cabbage White Butterfly are green with a yellow stripe and grow a length of 3 cm. Caterpillars of the Large Cabbage White Butterfly are yellow green in colour and grow to a length of 4 cm. The Small Cabbage White Butterfly has a wingspan of 4-5 cm, the Large Cabbage White Butterfly is slightly larger. Both butterflies can have a number of generations each year.

Prevention and control

Control focuses on the caterpillars. They can be effectively controlled with plant protection products and also with *Bacillus thuringiensis*. As the caterpillars have striking colours they are easy prey for birds and ichneumon wasps.



Diamondback moth (insect)

Plutella xylostella

Symptoms

The Diamondback Moth can affect almost all crucifers and generally appears in May or June. The insect is grey to brown in colour, and small; its wingspan is about 13 mm. There are white to silver diamond shaped marks on the wings which can be clearly seen when it is at rest. The green caterpillars (up to 14 mm long) gnaw small round holes in the leaf and often leave a thin layer of leaf untouched (a window).
The caterpillars are very active and mobile. When disturbed in the crop, the moths fly upwards and the caterpillars descend from the leaves on thin threads.

Development and infection

The eggs can be laid separately or in small groups, on the stem or along the leaf veins, often at the underside of the leaf. When the eggs hatch, the caterpillars start to feed, making the typical "window pane" effect. In warm, dry weather an adult moth grows from an egg within 25 days. During wet, cool weather the development is slower. This insect can cause serious problems in a relatively short time, because a female can lay more than 150 eggs in 2 weeks and 2 to 5 generations per year are possible.

Prevention and control

The Diamondback Moth can be effectively controlled with both chemical pesticides and the biological control *Bacillus thuringiensis*. In addition to this, crop debris from previous brassica crops should be incorporated or removed. There are various species of ichneumon wasps that prey on the Diamondback Moth.

Thrips (insect)

Thrips tabaci

Symptoms

A number of varieties of thrips can be found on cabbage, but *Thrips tabaci* is the most common. *Thrips tabaci* is a very polyphagous organism and can also affect leeks, onions, carrots, winter wheat and clover. Both the larvae and the adult insects infect the cabbage plant by piercing cells and sucking them empty. This can result in cosmetic damage such as wart like spots (oedema) and bronze like stripes, particularly in headed cabbage. When thrips are present on the plant when the heart forms, damage can continue during storage, making the cabbage unmarketable.

Development and infection

The thrips can survive the winter as eggs, larvae or adult insect. *Thrips tabaci* has a very large number of host plants and the insect can fly. Because of this, infection can come from a neighbouring plot, where winter wheat or other types of grain grow. Development from egg to adult insect takes 14 to 30 days, depending on the temperature. During warm and dry periods, the population's increase can be explosive and the (storage) quality of the cabbage can be very badly affected.

Prevention and control

Thrips tabaci is a small insect (0.8-1.2 mm long) that prefers to hide itself in the crop. Because of this, an infestation of thrips is fairly difficult to determine. It is sensible to monitor the crop regularly and to take controlling measures at the right time. It is difficult to control thrips once the cabbage begins to form a heart.

Root-knot nematode (nematode)

Meloidogyne spp.

Symptoms

Infected roots have deformaties, are thicker and have more branching. On first inspection, the symptoms show some similarity to clubroot. Early infestation on severe infected plots can cause complete loss of seedlings. Infection can restrict water and nutrient uptake leading to symptoms such as stunting, wilting and chlorosis (yellowing).

Development and infection

Nematodes present in the soil are attracted to the plants following the release of root exudate. The larvae enter the roots and attach themselves to the vascular tissue, causing surrounding cells to multiply rapidly. Young female larvae grow quickly from slim, active juveniles into static adults. The surrounding root tissue undergoes morphological changes and produces swellings and lumps. Eventually the tissue bursts around the female's abdomen, releasing several hundred eggs in a jelly-like mass, from which new larvae develop. The root-knot nematode has many host plants, particularly scorzenera, potatoes, peas, clover, lettuce and carrots. Damage is often localised. Nematode infected soil can be spread by people, machinery etc.

Prevention and control

Use a crop rotation of at least 1 year in 5. Non-host crops can reduce the population of nematodes.

Cyst nematodes (nematode)

Heterodera schachtii and *Heterodera cruciferae*

The two most important cyst nematodes are the sugar beet cyst nematode (*Heterodera schachtii*) and the brassica cyst nematode (*Heterodera cruciferae*).

Symptoms

White or brown cysts can be seen on the root system.

Development and infection

Nematode larvae enter the young root via existing wounds or by boring into the root's epidermis with their fascicle. The males leave the root after a short time whilst the females remain in the root tissue for their entire life. The females produce 200 to 600 eggs, which are retained in their own body. This causes their body to swell up and it then develops into a spherical casing, which is also called a cyst. The cyst is initially white and later turns brown. When the root is pulled up, most cysts remain in the soil. When cabbage or chenopodiacea crops (beet, spinach) are grown in the same soil, their root exudates trigger larvae to emigrate from the cyst and move towards the host plant. The life cycle is then repeated. When a host plant is unavailable, the larvae can survive for many years in the cyst. The nematodes are spread by soil that is attached to people and machinery.

Prevention and control

Crop rotation can reduce the population density of the nematode, and a cycle of at least 4 to 6 years is recommended. It is thought that a cabbage crop can support a large number of nematodes before damage is noticeable. The nematodes can cause more damage on light soils.

Brown bead (physiological)

Brown bead is a physiological defect that occurs in broccoli. This symptom is only found in adult broccoli plants that are almost ready for harvesting.

Symptoms
The beads of the broccoli heads turn brown and show retarded growth. Individual beads discolour, firstly to yellow or orange and in a later stage they turn brown and dry out. Secondary infection can also occur, particularly wet rot caused by the bacteria *Pseudomonas* and *Erwinia*.

Development and infection
Damage occurs occasionally and is associated with periods of fast growth, high temperatures and abundant rainfall.

Prevention and control
Avoid extreme variations in relative humidity as much as possible. This promotes a constant supply of nutrients that are necessary for building strong cell walls. A constant calcium supply is particularly important. When conditions are such that severe drying out is occurring, the flow of sap is often insufficient to reach the head from the roots. Symptoms appear a number of weeks after the plants have dried out. Boron deficiency has also been implicated as a cause of brown bead.

Grey speck (physiological)

Grey speck is a physiological problem which generally occurs in white cabbage and Chinese cabbage. Little is known about its causes.

Symptoms
Grey coloured spots, about 1-3 mm in size, become visible on the cabbage. The spots are sharply defined and sometimes have a narrow yellow edge. The symptoms occur superficially on the outer side of the leaf, not on the inner, and are sometimes visible on the veins or only between them on the mesophyll. The grey speck will change to a brown discolouration as the tissue dies.

Development and infection
Grey speck is seen in crops close to harvest but becomes progressively worse during storage.

Prevention and control
The causes of grey speck are unknown, but research indicates that its presence could be linked to high levels of nitrogen and phosphate, and soils that have a pH over 8. There may be varietal differences to the susceptibility to grey speck.

Hollow stem (physiological)

Hollow stem occurs in cauliflower and broccoli and is a physiological problem.

Symptoms
The stem is split or "hollow" as a result of it growing too quickly in relation to the pith. The stem can be hollow for its entire length, and can create open wounds which are entry points for fungi and bacteria. Wet rot is often seen in broccoli hollow stems.

Development and infection
Irregular growth and excessive nitrogen fertiliser application encourage hollow stem, high temperatures promote the disorder. Boron deficiency is regarded as being a possible cause of hollow stem.

Prevention and control
Avoid excessive nitrogen application and do not encourage rapid growth. There is some varietal difference in susceptibility.

Internal tipburn/Tobacco Leaf (physiological)

Internal tipburn is a physiological disorder caused by early growth problems. The symptoms are also called 'tobacco leaf' or 'internal black.'

Symptoms
Circular, dark brown to black spots or leaf edges which are visible after cutting the cabbage open. When the severity is relatively low, only small dark spots or specks are visible on the surface of the cut. Sometimes the entire mesophyll displays the same symptoms.

Development and infection
Symptoms are related to the availability of calcium to the plant cells. Calcium is needed at the start of cell wall formation, and a shortage of it can result in weak cells which may collapse and die. Calcium is relatively immobile. If it is fixed it cannot be transported in the plant. A calcium shortage in the plant is a result of low soil pH, which reduces availability of the element to the root, and/or dry conditions in which case calcium transport is inadequate to leaves furthest from the roots.

Prevention and control
There must be sufficient calcium available to the plants roots. The soil should be fertile with a pH which is not too low and evapotranspiration from the leaves must be in balance with water uptake. Plants must not be allowed to dry out. Sandy soils will dry out quicker than heavier ones. There are varieties that are less susceptible to internal tipburn.

Potassium deficiency
Photo: Josef Schlaghecken

Nutritional deficiencies (deficiency)

In addition to good crop husbandry and fertiliser application, trace elements are also important for plant development. A shortage of trace elements often results in weak or retarded plant growth. There are various symptoms which depend on the specific mineral deficiency.

Symptoms

Nitrogen
A shortage of nitrogen results in small plants which are often blue or purple in colour. The problem mainly occurs on light soils and after heavy rainfall.

Potassium
The edges of older leaves become yellow and shrivelled. When there is a shortage of potassium, the leaves sometimes have a dull blue green colour. Quality falls and the crop has less resistance to frost. It generally occurs on clay type soils where the potassium is less freely available and on poor, sandy soils. A dry period shortly before the summer can promote a potassium shortage.

Phosphate
A phosphate deficiency results in brittle leaves which can easily be snapped off the plant. The plants are shorter and leaves turn blue green with a purple or red discolouration on the underside. Phosphate deficiencies can occur after heavy rainfall when there is an oxygen shortage in the soil.

Magnesium deficiency

Magnesium
Older leaves have defined yellow patches between the veins, which later turn necrotic. The leaf size remains normal. Magnesium shortages mainly occur on sandy soils with a low pH in combination with high ratio's of potassium and calcium. There is a greater chance of a magnesium shortage in wet years.

Boron
Cauliflower curds display glazed patches that turn brown in a later stage. The stem has split cavities (see also 'Hollow stem' page 44). In swedes, brown internal glazed patches occur (water disease). Crops are more prone to boron deficiency on light soils in dry periods.

Molybdenum
A shortage of the trace element molybdenum leads to blindness. This abnormality is described in this brochure on page 48.

Prevention and control
Ensure that basic fertilisation is good, based on soil analysis results. Trace elements can be applied during crop production as foliar sprays.

Blindness (deficiency)

Blindness mainly occurs in cauliflower and broccoli. This deformity can also cause problems with Brussels sprouts and headed cabbage.

Symptoms
The growing point of the plant ceases development and only initiated leaves continue to grow. Leaves can bulge, become thicker than normal and often turn purple. If the deformation is present in the seedling stage, only the cotyledons continue to grow. The symptoms can easily be confused with damage caused by insects.

Development and infection
Blindness is caused by a shortage of the trace element molybdenum. Molybdenum is necessary for the maintenance of chloroplasts and nitrate reduction in plants.
To a large extent, an increase in soil acidity determines the availability of molybdenum. Soils with a low pH (below 6.5) reduce the availability of molybdenum. Blindness can also be caused by low temperatures during plant raising or damage caused by the swede midge *(Contarinia nasturtii)*.

Prevention and control
Treat the plant's potting compost or plant bed with sodium molybdate as early as possible. If this is not possible, the leaves can also be sprayed with sodium molybdate. Do not give too much nitrogen fertiliser to the soil during plant raising and do not give too much in one application. Give sufficient phosphorus and potassium. Watch out for growth disorders caused by low temperatures or drought. Do not cultivate cauliflower on acid soils with a low pH. Different varieties display differing degrees of susceptibility. No problems should be expected during plant raising with soils that contain clay.

Photo: Government of Manitoba

Aster yellows (phytoplasma)

Symptoms

The symptoms can be easily confused with physiological disorders, as the crop appears to be nutrient deficient, or damaged from herbicides or suffering from drought. The youngest leaves turn yellow, followed by prolific development of new shoots; older leaves often turn red.

Development and infection

The disease is caused by a phytoplasma; an irregularly formed bacteria-like organism, enclosed by a membrane without a real cell wall. The pathogen is transferred from plant to plant by sucking insects. The most important carriers are certain types of cicadas *(Macrosteles* spp.), which feed from the transport vessels in the plant's phloem. Insects, particularly cicadas, are attracted to plants when they are full of sap during good growing conditions. Cicadas can pick up the pathogen after feeding for a couple of hours on infected plants. They can then re-infect plants following an incubation period of a further 2-3 weeks. Once they are infectious, cicadas can continue spreading the disease pathogen for the rest of their life (a few more weeks). Aster Yellows is a common disease, which is regarded as being of secondary importance in most countries. The small loss in harvest yield is outweighed by the costs of controlling the insect that transfers the phytoplasma. The pathogen has a wide range of vegetable crops as host plants, including carrots, celery, onion, lettuce and endive.

Prevention and control

Keep crops free of weeds such as clover, as they are a source of food and shelter for insects.

Notes

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