



Home & Garden Pest Management Guide For British Columbia

2019 Edition

Chapter 15 Pests of Vegetables



Pests of Vegetables

This chapter describes insect and disease problems of vegetable crops, beginning with pests that affect many different vegetables, followed by pests of specific vegetables. Management information describes preventative and cultural measures that may control the pest. Try these first. Sometimes the management information also mentions pesticides. When more than one pesticide is mentioned, the least toxic pesticide is listed first. Before using a pesticide, read and follow the manufacturer's label directions, including the precautions, rates and days-to-harvest. See the "Pesticide Table" in Appendix I for information on available home garden pesticides. Also read Chapter 8 "Using Pesticides to Manage Pests". It contains important safety information.

Proper identification of plant pests and diseases is an important step before attempting to control a pest or disease. Not all plant problems are caused by pests; some are caused by cultural, nutritional or environmental conditions. See Chapter 2 for information on how to get help identifying plant problems.

Pests Affecting Many Vegetable Crops

Insects

Aphids

Aphids are pear-shaped, winged or wingless, sap-sucking insects. They are small (2-3 mm), variously coloured, soft-bodied insects that usually occur in clusters or colonies on the underside of leaves and on new growth. Aphid colonies can increase quickly.

Nearly all vegetables are susceptible. Affected plants are wilted and stunted; new buds malformed. The leaves turn yellow and may become twisted and curled. Aphids secrete honeydew causing a shiny, sticky film on the leaves. In addition to the direct damage caused by aphids, some plant viruses are transmitted from plant to plant by aphids during feeding. There are many species of aphids. Some have a wide host range and can become established on a number of crops, and some have a narrow host range.



Green peach aphid

Management:

Aphids are best controlled as soon as they are noticed when colonies are small and before plant leaves start to curl. Do not spray insecticides if large numbers of ladybugs, aphid midges, hover fly larvae, lacewings or other predators are present (see “Beneficial Insects”, Chapter 6). Buying ladybugs to release is usually disappointing because they tend to fly away. In most gardens, there are enough native ladybugs present.

Aphids can be removed from many plants by hosing down the plants with water. Once knocked off tall plants, wingless aphids may not return to the plant. Repeat when aphids reappear. If an insecticide is needed, treat plants when aphids are first seen with insecticidal soap or pyrethrins. Follow the label instructions, and observe the days to harvest, which may vary from one vegetable crop to another.

Brown Marmorated Stink Bug



Adult brown marmorated stink bug



Brown marmorated stink bug nymphs

Brown marmorated stink bug was first detected in British Columbia in 2015. It is a serious pest and feeds on more than 100 different plant species including tree fruits, berries, grapes, vegetables, and ornamental plants. Both adults and nymphs feed by inserting their needle-like mouthparts into the flesh of fruit or vegetables, resulting in dead areas and distortions. They can be a nuisance to homeowners when the adults aggregate on and in buildings in the fall to seek warm overwintering sites.

The adult is shield-shaped, about the size of a dime, has a brown marbled back with alternating brown and white markings on the outer edge of the abdomen. It can be distinguished from other stink bugs by the presence of distinctive white bands on the antennae and legs. Immature stages (nymphs) range in colour from bright orange and black, black and white, to mottled brown in later stages. They are pear-shaped with white markings on legs and antennae.

Management:

Low numbers of brown marmorated stink bugs can be removed by hand, sweeping or a shop vacuum. Prevent entry into the home by sealing off any access points. The use of insecticides for controlling brown marmorated stink bugs in the home is not recommended. Traps to catch the adults and nymphs are available for purchase, or can be constructed at home. Traps will not eradicate the bugs from your area, but can be useful to remove some of them from your home and surrounding area.



Brown marmorated stink bug sticky trap and lure system

In spring and summer brown marmorated stink bugs are outside feeding on plants. Plants can be protected from bug feeding by using floating row covers, netting or mesh covers, put on before bugs become active, or when new plants are planted. Trap and lure systems continue to improve for brown marmorated stink bugs, and use can help with collecting and removing bugs from gardens. Be sure to remove any stink bugs from harvested fruit containers, to prevent any flavor impacts. Beneficial insects and mites prey upon and parasitize stink bug eggs and nymphs, and can help keep bug numbers in check.

Cutworms

Holes are chewed in leaves or young plants are cut off near the soil surface by cutworms. These are fleshy, soft-bodied caterpillars up to 4 cm long which curl up when disturbed. Most of these pests emerge from the soil at night to feed on the plants and then return to the soil during the day.



Variegated cutworm, photo courtesy of Ted Kropiewnicki, Bugguide.net

Management:

Protect plants from cutworms by placing a collar around them at transplanting time.

Use tin cans, milk cartons or tarpaper as collars for plants such as tomato and cabbage. This method is not suitable for closely-seeded plants such as peas and beans. When soil has warmed up in late May, insect parasitic nematodes can be watered into the soil one week before setting out transplants.

It is difficult to find cutworms particularly if the population is not high, and because they feed at the soil level and mostly at night. If there are only a few cutworms in your garden, you may be able to find them by scuffling the soil around damaged plants. A 1/4 cup of dish washing liquid in a pail of water, splashed on the ground around damaged plants,

will often bring cutworms to the surface. For climbing cutworms, you can also patrol the area where damage has been seen with a flashlight at night and pick them off the plants. Collect them in an ice cream bucket and freeze for at least 24 hours before dumping them in the compost or drop the caterpillars into a bucket of soapy water to kill them.

If climbing cutworms are too numerous to pick off or the above methods are not practical in your situation, spray plants with Btk (*Bacillus thuringiensis kurstaki*) or permethrin. Follow label instructions.

A cutworm bait can also be used. A bait consisting of 1 kg bran, 100 mL molasses or syrup, 1 L water and 25 to 50 mL of Btk will protect young transplants and seedlings. Place the bait at the base of the plant using about 5 mL for larger plants such as cabbage.

Remove crop residue and weeds throughout the spring and summer. Turn the soil in the fall and keep the ground weed-free during winter to reduce the incidence of cutworms in the following year.

Earwigs

These insects are 1.6 cm long, dark brown, with a pair of pincers at the rear end. They are useful predators of other insect pests and usually cause only minor damage to garden plants. Ragged or shredded looking holes in the leaves of vegetables can be caused by earwigs. Most damage occurs at night because earwigs hide in soil crevices or debris during daylight hours.



Earwig

Management:

Apply control measures in May and June before young earwigs appear or when damage is first noticed.

Since earwigs are active at night, they can be trapped in rolled or folded newspaper or rolled up corrugated cardboard placed near plants overnight. The earwigs will crawl into the traps at sunrise and you can drop them into a bucket of soapy water or place them in the freezer for 24 hours to kill them. Shake the dead earwigs into the compost and then reset your trap the next night. A plastic or tin container with some tissue paper crinkled up in the bottom, placed upside down on stakes among the plants, will provide a hiding place for earwigs, and is a suitable trap for earwigs. Destroy the earwigs captured in the paper daily as described above. Earwigs take refuge in old wooden posts, tree bark, so check your garden for these sources and remove or manage them.

Flea Beetles

Numerous tiny round holes in the leaves of cabbage, turnips, cauliflower, radishes, potatoes, beans, tomatoes and peppers are caused by small (3 mm) black beetles that jump readily.



Tuber flea beetle, Epitrix tuberis. Photo courtesy of ES Cropconsult



Tuber flea beetle larvae, Epitrix tuberis. Photo courtesy of Agriculture Canada, Ottawa, Bugwood.org



Crucifer Flea beetle on cabbage



Flea beetles and leaf damage on potato

Management:

Except for potatoes, fast-growing plants will normally outgrow flea beetle damage. Early planted transplants may be more susceptible to damage. Row covers for the first 3 to 4 weeks will exclude flea beetles. Yellow sticky traps are useful for monitoring for adult beetles. On potatoes, even small numbers of flea beetles will cause serious damage to the tubers. Harvest potatoes in a timely manner in later summer or early fall, to prevent the final generation of tuber flea beetles from infesting your crop. Late harvest has more damage than early harvest.

If you are concerned that your potato crop is at risk, treat young potato plants with a foliar application of pyrethrin insecticide at the first sign of beetle presence in the spring to prevent tuber damage by larvae. On other plants such as crucifer vegetables, if flea beetles are numerous and feeding on foliage, treat with pyrethrins according to label directions. A trap crop of Indian mustard can also be planted around cole crops to protect them from crucifer flea beetles (see page 15-29). The trap crop then needs to be sprayed to prevent the beetles from moving to the vegetable crop.

Garden Springtails

Bourletiella hortensis

Most species of springtails are not pests and feed on organic matter in high moisture soil. However, garden springtails are small (2-3 mm) pests that occasionally damage emerging seedlings by chewing small holes in the leaves. Seedlings may die if severely infested. Look for small, gray to black, wingless springtails that jump like fleas. Garden springtails are sometimes present in large numbers in the soil in spring. Crops like field peppers have been known to be affected by this pest in B.C.



Garden springtails. Photo courtesy of Mario Lanthier, CropHealth Advising & Research

Management:

If leaf damage occurs, apply diatomaceous earth (silicon dioxide) to the soil around the plants. Alternatively, hose off the springtails with a water spray, or apply a foliar spray of pyrethrins or other suitable insecticide to the affected plants.

Grasshoppers

There are several species of grasshoppers in B.C. Only a few are pests of crops, rangeland, and gardens. Grasshoppers can cause damage to most garden plants if numbers are high.



Eggs overwinter in the soil in pods laid by the females in the fall. Nymphs hatch in the spring (April-May) depending on the temperature and moisture levels. During May, nymphs can be found with sweep nets or visual inspections. Older nymphs, shortly before they become winged adults, do the most feeding damage to crops and gardens by feeding directly on the foliage. Once winged adults appear in mid-summer they are highly mobile and fly into gardens and other locations, where they can cause considerable damage to plants. Adults are 2- 3 cm long when full grown.

Management:

It is not necessary to control the small number of grasshoppers in coastal areas. In dry areas of B.C.'s interior, grasshopper populations can be high, and the insects move quickly from source areas to new locations. A loosely laid row cover over garden plants

will provide protection. Hand-picking can work if numbers are low, but is time-consuming and usually not practical. When young wingless grasshoppers appear, assess damage and if necessary, spray damaged plants and any grass or foliage surrounding the garden. Repeat 1-2 weeks later if more appear. The best time to spray for grasshoppers is at the nymph stages, before they become adults and fly to new locations. Cultivation in the fall will disturb egg laying and help limit grasshoppers in the following year. A microbial product called Nolo-bait, containing *Nosema locusta* can be purchased and applied as a granular to affected areas in the spring, and repeated over the season as per label instructions. This product is very specific to grasshoppers and will not impact other organisms.

Leatherjackets (Crane Fly)

Tipula paludosa and *T. oleracea*



Crane fly (leatherjacket) larvae



Crane fly (leatherjacket) adult

Leatherjackets are larvae that feed on grass roots, particularly in moist areas. Turf then becomes susceptible to drying and death due to root destruction by larvae. These larvae can be pests in gardens if perennial grass is present. Larvae will feed on roots of other plants but prefer to feed on grass. Adults are large (2 cm long) mosquito-like flies can be observed from May through September when they lay eggs for the next generation in soil at the base of grass. Eggs hatch within 2 weeks and leatherjacket larvae are present in the soil from then until the following June, when they reach a length of about 2.5 cm. *Tipula paludosa* has one generation per year, and adults can be seen laying eggs in August-September, and *T. oleracea* has two generations per year, so adults can be seen in summer and fall. Larvae can be found any time of year, but the most damaging and easy to find are the large spring larvae.

Management:

Healthy turf can withstand some larval feeding, but also can be a source for more leatherjackets. To prevent leatherjacket larvae from surviving in a vegetable garden, keep the soil weed and grass free during the fall, winter and early spring. Turning over or cultivating the soil a couple of weeks before planting in spring will also give birds a chance to pick out the leatherjacket larvae.

Lygus Bugs

These insects can be a problem in northern gardens. Adults are flattened, oval, and about 6 mm long. There is a characteristic white 'V' on the back of each adult lygus bug, with a mottled brownish colour pattern. Nymphs are green, resemble aphids, but are faster moving and more active than aphids. Both adults and nymphs feed by sucking sap from growing points and flower buds which can cause "blind plants", so a cabbage plant may not produce a head, or a cauliflower may not produce a curd.



Lygus bug adult and nymphs

Monitoring:

Yellow sticky traps can be used to determine the presence of lygus bugs and when they move into the garden from surrounding areas/fields, however, they should be used with caution in home gardens, since they will also catch beneficial aphid midges and other insects (see "Sticky Traps", page 5-11). If sticky traps are to be used, we suggest only putting out 2 traps per garden, in different areas. Put out traps early (April-May) when plants are actively growing and flowering. If traps become covered with dirt or insects, replace them. Check traps for lygus adults 2-3 times per week in spring. If many lygus bugs are caught on traps, or if they are observed feeding on plants, insecticide sprays may be justified to prevent crop damage.

Management:

Good weed control and fall tilling/cultivation and clean up/ sanitation of the garden will reduce lygus bug numbers. Be aware of other lygus host plants, including hay fields nearby. Netting or floating row cover over garden plants may be an option to prevent lygus damage.

If necessary, spray for control of lygus nymphs (non-winged) with pyrethrins, insecticidal soap plus pyrethrins, or pyrethrins alone. Follow label instructions carefully as rates and days to harvest differ for the different vegetable crops.

Sowbugs (Pillbugs, Woodlice), Millipedes, Centipedes

These are segmented, caterpillar-like creatures with many legs. Millipedes and centipedes are up to 4 cm long, while sowbugs are up to 1.5 cm long. They commonly occur in compost areas, decaying vegetation, or soil with high organic matter and where soil remains wet during the day. Sowbugs and millipedes occasionally feed on lower parts of healthy plants, including roots. They usually are not damaging except to young seedlings. Centipedes feed on other insects, and not on plants. They are fast moving and are beneficial.



European sowbug. Photo courtesy of Cheryl Moorehead, Bugguide.net



Millipede



Centipede. Photo courtesy of Liz Watkinson, Bugguide.net



Stone centipede. Photo courtesy of Liz Watkinson, Bugguide.net

Management:

Locate compost bins and piles as far as possible from the vegetable beds and allow the soil surface to dry between waterings. If additional control is required, dust along seedling rows with diatomaceous earth (silicon dioxide). Diatomaceous earth has very low toxicity to mammals and is effective at decreasing arthropods in general on the soil surface.

Spider Mites, including Two-spotted Spider Mite

Tetranychus urticae



Bronzing of cucumber leaves caused by spider mites



Spider mites and webbing on cucumber leaf

Spider mites are tiny, 8-legged, spider-like animals. Two-spotted spider mite adults are about 0.5-1 mm long, pale yellow to greenish with a black spot on each side of the body. Eggs are round and clear, very small and difficult to see with the unaided eye. There are many generations each year. Overwintering females are orange and overwinter in trash or in the soil at the base of plants. Their feeding causes speckling, drying and bronzing of leaves and fine webbing is also produced on leaves. Mites increase rapidly in number during hot, dry weather.

Monitoring:

Look for mites and webbing on the underside of leaves and speckling on the upper leaf surface. Use a 10X power hand lens to clearly see mites. Tap leaves over a white paper and look for crawling mites on the paper.

Management:

Healthy, well-maintained plants will tolerate higher mite populations than weak or stressed plants. Hosing plants with water disrupts colonies and slows down buildup of spider mites. Predator mites occur naturally, and can also be purchased and released onto infested plants. After release, do not apply insecticides that may harm the predators. For serious infestations, spray affected plants with registered insecticidal soap or pyrethrins. Check the pesticide label for use instructions and to be sure the crop you are treating is listed and for the days to harvest.

White Grubs (June Beetle Larvae)

Family: Scarabaeidae

There are several naturally occurring species in B.C., and at least one invasive species (European Chafer which is primarily a turf pest). White grubs feed on the roots of many plants injuring seedlings or transplants by cutting the main stem or roots below the surface. They also tunnel into tubers and fleshy-rooted plants. They will also damage lawns and roots of woody ornamentals and even conifers.

White grubs can be large, are curved, (“C-shaped”) while at rest, and have cream-coloured bodies with brown heads. They are found in the soil and may be numerous on land that was recently in grass. They have a 1 to 3-year life cycle, depending on the species.



White grub



June beetles



Ten-lined June beetle adult

Management:

Whenever possible, dig or till sod or grassland one year before planting and keep it fallow for a year. Birds will consume many of the grubs each time the soil is worked up. If numerous white grubs are present, work the soil several times before planting to expose more grubs to predation by birds, or hand collect and destroy the grubs to reduce the population. There are no domestic insecticides registered for control of white grubs in the home garden, although there are some products available for use on lawns. Parasitic nematodes have also been effective treatments for grubs in lawns. There may be suitable microbial products available soon in Canada for grub control; check with your garden center.



Ten-lined June beetle grubs

Wireworms (Click Beetles)

Family: Elateridae

Wireworms are the larvae of click beetles. There are several species in B.C. In recent years, European species in the genus *Agriotes* have become more prominent pests in B.C. Many types of garden plants are damaged by wireworms. Wireworms remain as larvae for up to 3 years, before pupating and becoming adults. These larvae feed directly on germinating seeds, roots and crowns of transplants and on developing tubers. Seedlings wilt and die, and root crops are tunneled and become distorted. Potato tubers may be so badly damaged that they are unable to be used. Wireworms are slender, up to 3 cm long, hard-bodied, yellow and shiny. They can be found in large numbers in soil that was recently in pasture or grass. Wireworms have a 3 to 5 year life cycle. They are most active and cause the most damage to crops and gardens in spring and fall when

temperatures are moderate and moisture is adequate in upper few cm of soil. Larvae go down lower in the soil when it is too hot and dry, or too cold on the surface.



Wireworm



Garlic plant damaged by wireworm feeding

Monitoring:

During March or April, test your garden for wireworms by using pieces of potato or 2 tablespoons of whole-wheat flour mixed with a bit of water to form a sticky ball, buried 10 cm down in the soil. This bait will attract the wireworms. Mark each site with a stake so you can dig up the bait 3 to 5 days later. Use one test spot for each 10 square meters of garden area. If wireworms are detected, use one of the suggested controls below.

Management:

Grassy areas dug up and planted for the first time often have wireworm problems. Whenever possible, dig or till sod land one year before planting and keep it fallow that year. If you have blackbirds or starlings in your area, they will eat large numbers of wireworms each time the soil is worked up. If garden plants were damaged the previous year, turn over the soil in beds several times before planting and collect any wireworms seen. This usually removes enough wireworms to alleviate the problem. Planting later in the season (June) helps to avoid damage as the wireworms burrow deeper when the soil warms up in the summer. Harvest potato crops as early as possible to avoid leaving tubers out during September rainfall, when the wireworms move up again.

Diseases

Damping-off and Wirestem

(*Pythium*, *Phytophthora*, *Fusarium*, *Rhizoctonia* and others)

Several soil-borne fungi and fungus-like organisms can cause pre- and post-emergence damping-off of seedlings. Pathogens can attack seedlings before they emerge causing the seed to decay or the seedlings to die (pre-emergence damping-off). After emergence, seedlings may be attacked near the soil line causing them to topple over (post-emergence damping-off). Some seedlings survive but later develop a sunken lesion girdling the stem known as 'wirestem' near the soil line. Such plants eventually die, and should be discarded as they will never produce a crop.

Management:

Under warm, fairly dry soil conditions, damping-off is seldom a problem. However, when seeding early in wet soil, losses can be severe. To avoid damping-off, do not seed too early in the season; use seed pretreated with a fungicide, especially when planting large-seeded crops such as beans, peas and corn; provide good ventilation in the cold frame or greenhouse; avoid dense plantings; space and thin seedlings. Use pasteurized soil or artificial mix for starting seedlings in flats. Use new flats or wash and disinfect used flats thoroughly.

Other Pests

Slugs and Snails

Slugs are soft-bodied, snail-like creatures without shells. They vary in size from 0.3 cm to 10 cm and may be orange, grey, brown or black. They are most active at night or during damp weather. These pests damage the foliage of most garden plants making large ragged holes in the leaves. Look for silvery, slimy trails on soil, grass and foliage as evidence of slugs or snails.



Common garden snail



Slug

Management:

Slugs and snails prefer damp, shaded areas. Remove vegetative trash and other daytime hiding places to help control them. Boards, stones, weedy areas, low growing branches, and dense ground covers are ideal sheltering spots.

Hand pick and destroy slugs and snails to reduce their population. This is most effective in the evening or on cloudy or rainy days, when they are more active. Place them in a container of soapy water to kill them. Slugs and snails may also be trapped by placing planks, grapefruit rinds or cabbage leaves on the ground overnight. The next day slugs and snails sheltering underneath can be destroyed. Slug traps baited with fermented liquids are commercially available or they can be home made, using beer or fermented yeast as a bait.

Another method is to use zinc or copper strips, which repel slugs, as barriers around raised beds. Diatomaceous earth (silicon dioxide) can also be used as a barrier around or under plants. As the slugs or snails crawl over the powder, their outer protection is scratched, causing them to dehydrate and die.

Where slugs or snails are a serious problem, slug and snail baits containing ferric phosphate can be used safely without the risk of poisoning pets and wildlife. Sprinkle the bait on the surface of the soil around plants under attack. This product is as effective as products containing metaldehyde and much safer to use.

To protect animals and birds, baits containing metaldehyde should only be used within a “bait station”. A simple bait station can be made out of a coffee can by cutting several holes along the side of the coffee can near the base using a can opener. Bait is placed in the bottom of the coffee can and the lid is replaced. This method will not protect dogs or cats that can knock over the covers or containers to get at the bait. If there are dogs or cats in the area and you wish to use metaldehyde, it is safer to use the RTU (ready-to-use) liquid formulation. Do not apply metaldehyde to plants after edible parts (fruit, tuber etc.) have formed. Follow all label directions and precautions carefully.

Pests Affecting Specific Crops

Asparagus

Insects

Asparagus Aphid

(Brachycorynella asparagi)

Asparagus aphids are small “waxy” green, soft-bodied, sap-sucking insects up to 1.5 mm in length. Feeding on leaves and stems causes distorted growth or a “witches’ broom” appearance. Roots and crowns are also damaged by above-ground aphid feeding. Crowns surviving infestations produce only a few late, weak spears the following spring.

This pest is found at Grand Forks, in the Okanagan and Similkameen areas, and as far north as Kamloops and Spences Bridge.

Management:

Overwintering eggs are laid at the base of ferns. Early infestations can be prevented by destroying all old fern growth before new growth appears in the spring. Cut spears close to the ground, remove volunteer plants, and destroy crop residues.

In young non-bearing plantings, insecticide can be applied when aphids or their damage appear on new growth.

In bearing plantings, after harvest is finished, an insecticide can be applied if aphids and feeding damage appear on the developing fern growth. Repeat treatments as needed. Use enough water and pressure to cover and penetrate fern growth.

Asparagus Beetle

(*Crioceris* spp.)

Two types of beetles occur on asparagus. The blue-black and yellow spotted beetle, which feeds on spears and foliage in both the larval and adult stages, causes the most damage. The orange and black spotted beetles feed on foliage, causing some injury, but their grubs feed on asparagus berries and cause little harm.



Common Asparagus beetle. Photo courtesy of David Cappaert, Michigan State University, Bugwood.org

Management:

Destroy dead fern growth in the fall to remove overwintering sites of the adults.

Harvest spears as early as possible,

remove volunteers, and bury crop residues in the fall to reduce beetle populations.

If large numbers of beetles and grubs are present and are causing damage to spears or foliage, spray with insecticidal soap or pyrethrins. Follow label instructions and adhere to required pre-harvest interval (days to harvest).

Onion Thrips

(*Thrips tabaci*)

These tiny (0.5-1 mm) slender insects are yellow to dark brown in colour. Winged and wingless stages may be present together on foliage and stems. Feeding damage causes stunting and abnormal growth.

Management:

Good weed management in and around the garden will minimize thrips infestation.

Insecticide sprays applied for asparagus aphid or beetles will also control thrips.

Diseases of Asparagus

Fusarium Crown and Root Rot

(*Fusarium oxysporum* f. sp. *asparagi*, *Fusarium* spp.)

Infected plants become stunted and yellow. Crowns become brown and rotted, and shoots may wilt and die. Plants grown on sandy soils and slopes are most often affected. High soil temperatures favour the disease. The pathogens occur naturally in some soils, but can also be introduced on seed and infected transplants.

Management:

Resistant varieties are not available, however many hybrids such as ‘Jersey Giant’ are tolerant to Fusarium diseases. When establishing a new planting, soak seed in 1 part household bleach diluted with 5 parts water for 2 hours and then wash repeatedly with water before seeding. Do not replant in areas where the disease has occurred or where asparagus was planted within the last 5 years. Avoid soil containing old corn residue. Do not transplant crowns from infected plants. Reduce stress on the plants by controlling weeds and providing adequate fertilizer and water. Do not harvest new plantings before the crowns are established.

Rock salt applied to asparagus beds at 100 grams per square meter each spring as an added fertilizer will increase the vigour of the crop and reduce damage from Fusarium crown and root rot. However, use with caution in home gardens. Annual use of rock salt over many years can damage soil structure and may damage other crops following asparagus. Salt can be damaging to the environment also if it leaches into water.

Purple Spot

(Stemphylium vesicarium)

This fungus causes purple or brown spots with a purple margin on spears and ferns. The pathogen overwinters on infected asparagus plant residue, and can also infect onion.

Management:

Remove all the old debris from the crop at the end of the season and burn, bury or otherwise dispose of it. Resistant varieties are not currently available.

Rust

(Puccinia asparagi)

This pathogen may infect spears as they emerge in the spring, however spears are usually harvested before symptoms appear. Later, elongated orange-red powdery areas appear on stems and foliage, turning dark brown in the fall. This rust has no alternate host, and overwinters on infected asparagus plant residue. The disease is not common in drier areas such as the Okanagan Valley. The rust fungus infecting asparagus can also cause a rust disease on onions and chives.

Management:

Plant tolerant varieties such as ‘Jersey Centennial’, ‘Jersey Giant’, ‘Mary Washington’ or ‘Viking’. If sprinkler irrigation is used, water early in day so the plants have time to dry off before night. Remove and burn or dispose of plant debris away from the garden after the plants die down in the fall to reduce the amount of over-wintering rust.

Beans

Insects

Aphids - See page 15-1.

Bean Seed Weevil

(*Acanthoscelides obtectus*)

This is a pest of dry beans in storage, so not normally a pest of gardens.

Management:

If this pest has occurred previously, freeze beans for 2 weeks after drying to kill any weevil eggs or grubs in them.

Flea Beetles - See page 15-5.

Seedcorn Maggot

(*Delia platura*)

The maggots are small, cream coloured, legless, and resemble cabbage root maggots, or other fly larvae in the genus *Delia*. They attack slowly germinating and rotting seed, and damage is worse in early planted, cool and wet conditions. Seed contents are partially or completely consumed, resulting in no plant growth or unthrifty growth. Larvae can inhabit and damage several garden crops including beans, peas, corn, melons, onions, peppers and potatoes. Adult flies are similar to house flies but slightly smaller. There are multiple generations per year.

Management:

Soak and sprout seeds prior to sowing to shorten germination time. Shallow seeding when soil temperature is 15 °C or warmer will promote quick emergence and avoid maggot damage. Insecticide treated seed, if available, will prevent or limit damage by larvae.

Springtails - See page 15-6.

Diseases of Beans

Grey Mold

(*Botrytis cinerea*)

Grey mold appears on stems and pods in wet weather. The fungus causing the disease usually infects through the blossoms and can often be seen spreading from moldy blossoms adhering to the plants. It is most severe on bush-type beans. *Botrytis* has a very wide host range, affecting many vegetable, fruit and ornamental plants.

Management:

Plant in an open, sunny part of the garden. Provide adequate spacing between rows and avoid long or repeated sprinkling from blossom to harvest. When watering, water the ground and keep the foliage dry. Avoid heavy applications of manure or nitrogen fertilizer which produce excessive foliar growth, which in turn causes too much shading and reduces air movement within the crop. Control weeds. There are no effective fungicides for control in home gardens. However a biofungicide containing *Bacillus subtilis* will help to suppress grey mold.

Rust

(*Uromyces appendiculatus*)

On bush, pole and scarlet runner beans, this disease causes small white spots on the leaves. These spots change to reddish-brown, then to black as the season progresses. This rust only infects beans. It is not common in drier areas such as the Okanagan.

Management:

Pole bean is more susceptible than bush bean. Burn, bury or compost crop refuse at the end of the season. Wash and disinfect poles used to support an infected crop, or use new poles. If rust is a common problem, spray preventatively with copper octanoate.

White Mold

(*Sclerotinia sclerotiorum*)

White mold appears on stems and pods, especially in wet weather. This fungus attacks a wide range of plants and is often seen on carrots and lettuce. Tomatoes, potatoes, peppers, cucumbers, melons, cole crops and many flowers, including sunflowers are also susceptible. Hard, black structures called “sclerotia” form on or inside the stems and other infected plant parts and can carry the disease over in the soil for several years. Like grey mold, this fungus usually infects beans through the flowers first, although the white mold may not be visible on the blossoms.

Management:

Rotate beans with beets, onions, garlic, spinach or corn. Follow cultural recommendations described for grey mold, above. There are no effective fungicides for this disease in home gardens. However a biofungicide containing *Bacillus subtilis* will help to suppress white mold.

When watering, water the ground and keep the foliage dry. Remove infected plants before the sclerotia fall to the ground. Dispose of them in the garbage or a landfill or place them in a sealed garbage bag so that the heat of the sun can destroy the fungus. Composting may not kill the sclerotia.



Bean plant girdled by *Sclerotinia*. Note white mold at base of plant.



Sclerotinia infected bean plant with white mold and black sclerotia

Beets

Insects

Beet Leafminer and Spinach Leafminer

(*Pegomya betae* and *P. hyoscyami*)

White maggots (larvae) of a small fly feed inside the leaves, causing light brown blotches. They also infest leaves of Swiss chard, spinach and some weeds such as dock, pigweed, sheep sorrel, lamb's-quarters and chickweed. Leafminer damage doesn't affect the root yield, but is a concern if you are harvesting the leaves. There are at least 2 generations in B.C. Flies emerge in spring from soil, and lay eggs on leaves of host plants. Small white cylindrical eggs can be seen in clusters on leaf surfaces. Larvae hatch and burrow into the leaves, where they grow and feed protected within the leaf. These species overwinter in the soil as pupae.



Beet leafminer damage

Management:

Keep the garden free of host weeds. Use row covers or mesh to protect beets from flies. Pick off beet leaves with blotchy mines and place in a bag or container, freeze overnight to kill the maggots, and then empty into the compost. This prevents development of the flies which lay more eggs. Foliar insecticide application for the adult flies can be done if desired; timing of spray can be planned for by using yellow sticky traps to detect flies, or by scouting for eggs on leaves. Fall tilling of the soil may help to kill some pupae, the overwintering stage. Planting beets (and other host crops) in a different location each year (crop rotation) may reduce damage.

Diseases of Beets

Scab

(*Streptomyces scabies* and other *Streptomyces* spp.)

The disease is caused by a soil-borne bacterium. Raised, circular scabby lesions appear on the beets in the soil. It also attacks potato, carrot, radish and rutabaga. In home gardens in coastal areas, this disease is usually most prevalent where high rates of lime or wood ashes have been added to the soil or where chicken manure has been applied, all of

which raise the soil pH. In the Interior, it may be a problem because of the natural high soil pH.

Management:

Avoid growing susceptible root crops where scab has been a problem as it will persist in the soil for many years. Lowering the soil pH by using sulphur or acid-producing fertilizers (those containing ammonium) may be helpful. Adding lime usually makes the disease more severe. Also see “Lime and Soil pH”, page 7-5.

Carrots

Insects

Carrot Rust Fly

(Psila rosae)



Carrot rust fly damage from larvae feeding



Carrot rust fly larvae (maggot)

The adult is a small, shiny, black fly with yellow legs. Eggs are laid in the soil near plants. Pale yellow, legless larvae (up to 6 mm long) feed on roots of parsley, carrots, parsnips, dill and celery, leaving rust-coloured tunnels. As a result of root damage, plants can become stunted, the roots deformed and the plants may be killed. Carrots may be so badly riddled with larval damage that they can be unusable. There are about 3 generations per year in B.C.

Management:

Exclude carrot rust flies by using mesh or floating row covers, early and late in the season, (see “Row Covers”, page 5-7). At the coast, covers should remain until late September to avoid the last generation of rust flies.

Carrot rust fly is more of a problem in a cool season than during a hot one. Plan to harvest carrots before September, when the last generation of larvae occur. Remove maggot-infested carrots (roots) from the field and dispose in bags in the garbage. Do not compost infested carrots. Remove any nearby weeds of the carrot family which are hosts of the carrot rust fly, such as Queen Anne's lace. Rotate for at least one year with crops other than those of the carrot family, which includes celery, dill, parsnip and parsley. Rust flies will move in from host plants in nearby gardens or weedy hedgerows, so while a good practice, crop rotation may have a limited effect on pest pressure.

Seed your first crop very early (mid-March in warmer areas) and harvest early. Delay seeding of the main crop until after mid-May to reduce the severity of attack from the first generation of flies. Plant rust fly resistant carrot varieties if available from seed suppliers. On the coast, fall seeding of certain varieties of carrots can yield early spring crops with no need for rust fly control.

Yellow sticky traps can be placed just above the crop to monitor for the presence of carrot rust fly. However, sticky traps will catch many other small, black flies and garden insects, including some beneficials. There are no effective insecticides currently available for control of carrot rust fly in home gardens.

Leafhoppers

Leafhoppers are small yellow/green insects that are very fast moving and jump quickly when touched. Leafhoppers may not be that damaging to carrot plants directly, but they can carry the aster yellows pathogen to carrots from nearby infected forage crops and weeds, particularly in the interior regions of B.C. Infected carrots have yellow to purple leaves and coarse, hairy roots. Other plants in the carrot family (Umbelliferae) and the Composite family, such as aster and coneflower (Echinacea), are also susceptible. See Hairy Root (Aster Yellows) below.

Diseases of Carrots

Cavity Spot & Rusty Root

(*Pythium* spp.)

Dieback of lateral roots may occur without any obvious above-ground symptoms. Carrots stop growing for a time and then may be rough and irregular after growth resumes. At harvest, oval sunken areas are apparent on the carrots. This condition is known as cavity spot. Cool, wet springs and excessive soil moisture, especially on heavier clay soils, favour both of these conditions, which are caused by soil-borne fungus-like organism, mainly *Pythium* species.

Management:

Grow resistant varieties such as ‘Six Pak’, ‘24 Karat’, ‘Spartan Premium’, ‘Dagger 78’ and ‘Orlando Gold’. Do not seed in cold, wet or waterlogged soil. Wait until soil has dried and warmed in the spring. Don’t over-water on heavy soils or leave carrots in the ground too long in the fall before harvest. Rotate for 2 years with other crops where there has been a problem with this disease. Avoid beans, peas and other root crops, such as rutabaga, in the rotation.

Leaf Spots and Blight

(*Cercospora carotae*)

Leaf spots and blight occur frequently in coastal areas, especially in unusually wet years, and can make carrot tops difficult to pull, but disease management is not usually warranted in home gardens. The fungus that causes carrot leaf blight only infects carrots, celery and other plants in the carrot family (Umbelliferae). Cleaning up the garden at the end of the summer will reduce the over-wintering fungus. Infected leaves should be buried in the compost pile so that they break down over the winter.

Sclerotinia White Mold (Watery Soft Rot)

(*Sclerotinia sclerotiorum*)

Carrots are infected in the ground then rot in storage, producing a soft rot and a white mold that spreads rapidly under warm, moist conditions. The fungus that causes this disease also attacks lettuce, beans, and many other crops.

Management:

For crop rotation, see “Beans, White Mold”, page 15-20.

If late-seeded carrots are to be wintered in the ground, select a well-drained area. Discard infected carrots showing white mold or black sclerotia in the garbage or bury them deeply in the ground. Do not place them on the compost pile or leave them lying on the surface of the soil. The sclerotia will overwinter and germinate to release spores the following spring. Wash and disinfect storage containers using a solution of 1 part household bleach to 9 parts water.



White mold (*Sclerotinia*) of carrot
Photo courtesy of P. Northover

Hairy Root (Aster Yellows) (Aster Yellows Phytoplasma)



Red leaf on carrot caused by aster yellows



Hairy root of carrot caused by aster yellows. Photo courtesy of P. Northover

Carrots are very susceptible to aster yellows, a disease caused by a virus-like organism called “phytoplasma”. Aster yellows is very common in the drier areas of the province, particularly the Central Interior. It is only occasionally found in the Lower Mainland. Leafhoppers carry the aster yellows pathogen to carrots from nearby infected forage crops and weeds. Leafhoppers are small yellow/green insects that are very fast moving and jump quickly when touched. Infected carrots have yellow to purple leaves and coarse, hairy roots. Other plants in the carrot family (Umbelliferae) and the Composite family, such as aster and coneflower (Echinacea), are also susceptible.

Management:

Plant carrots as far as possible from forage crops and cereal grain fields or weedy areas that harbour leafhoppers. Control weeds around the garden. Fine mesh row covers may help to keep leafhoppers off the carrots. If the disease has been serious in the garden in previous years and row covers are not effective, spray a boundary up to 10 meters (30 feet) wide around the perimeter of the garden with an insecticide when leafhoppers are first noticed. Follow label directions, including days to harvest.

Cole Crops

Cole crops, also called brassicas or crucifers, include cabbage, cauliflower, broccoli, Brussels sprouts, radish, mustards, kohlrabi and several Chinese vegetables including bok choi, pak choi and gai lan. For turnip and rutabaga, see page 15-67.

Insects

Aphids

These small, soft, greyish, winged or wingless sucking insects are found clustered on the undersides of leaves or on stems. They cause leaf distortion and curling and may stunt plant growth. See “Aphids”, page 15-1.

Monitoring:

Check plants frequently and treat when aphids are first detected. Cabbage aphids are particularly difficult to manage as they are well hidden, cause significant leaf damage, and keep re-occurring over the season.



Cabbage aphids on broccoli
Photo courtesy of ES Cropconsult

Management:

See “Aphids, page 15-1 for management methods.
All ‘standard’ aphid management approaches are less effective on cabbage aphids.

Cabbage Maggot

(Delia radicum)

The adult is a grey fly, smaller than a housefly, which lays eggs at the base of the plants. Legless, white larvae (maggots) which grow up to 7 mm long, hatch out of the eggs, tunnel into roots and cause wilting and death of the plant. This insect attacks all brassica crops and weeds, including cauliflower, broccoli, Brussels sprouts, turnips, radishes, alyssum, stocks, and mustard.



Cabbage root maggot



Cabbage root maggot adult
Photo courtesy of Canola Council of Canada



Cabbage root maggot and damage in radish

Monitoring:

Adult flies can be monitored for using yellow sticky traps, secured just above the plant canopy on the edges of the garden or ends of the plant rows. Detection of the flies signal when the plants will be at risk.

Management:

Cabbage maggots may not be a problem in a new garden. However, once they appear, they tend to show up every year, and can continue to be a significant problem in both head and stem brassica crops at plant establishment, and root harvest (turnips and rutabagas).

To limit the impact of this pest considering implementing the following practices:

- Grow the crop under mesh or floating row covers to avoid infestation. See “Row Covers”, page 5-7.
- Destroy all crop debris by burying or composting immediately after harvest. Remove larvae-infested roots and dispose in the garbage or a landfill, or burn them where permitted.
- Control weeds in the crucifer family that can be hosts for root maggots.
- Rotate crops so members of the cabbage family are not continuously planted in the same site.
- Delay planting until after mid-May to reduce the severity of attack from first generation flies.
- Place tar paper squares or circles (20 cm in diameter) or other deterrent around the base of each plant, flat on the soil, to deter the adult fly from laying eggs in the soil at the base of the plants.

Caterpillars and Loopers

Caterpillars of the cabbage butterfly and cabbage looper moth feed and make holes in cabbage leaves. Radishes, turnips and mustard are also damaged. They occasionally feed on leaves of other crops such as tomatoes.



Cabbage looper larva
Photo courtesy of Brent Elliot



Imported cabbageworm larvae and damage
Photo courtesy of ES Cropconsult



Imported cabbageworm adults
Photo courtesy of Canola Council of Canada

Cabbage butterfly caterpillars are velvety green and up to 3 cm long. The adults, which are white or pale yellow butterflies, are often seen fluttering near the vegetables, and lay eggs that later hatch into more caterpillars. Cabbage looper moths are dusty brown with an oval white mark on the wings. Looper caterpillars are smooth, green with white stripes and raise their back when they move in an inching motion.

Management:

Hand-pick the caterpillars daily from vegetables if they are not too numerous. Floating row covers will protect plants from egg-laying moths and butterflies early in the season.

If further control is required, treat when caterpillars are first seen, or when their damage is noticed. If tiny holes are seen in leaves, check the underside of the leaves for small caterpillars. Use Btk (*Bacillus thuringiensis*), or pyrethrins (permethrin) according to label directions. Don't spray unless you see caterpillars in the crop. Although many butterflies may be present, their numbers do not necessarily indicate a damaging infestation because many caterpillars are killed by predatory wasps. Btk will not kill predatory insects, but pyrethrins will. Btk should be applied under dry conditions.

Observe the days to harvest on the label for the crop and insecticide combination you are using.

Crucifer Flea Beetles

(*Phyllotreta cruciferae* and other species)

Flea beetle adults feed on and make small holes in the leaves. Damage can be severe on young plants. Eggs are laid at the base of plants, and the larvae feed on crowns and roots. There are at least 2 generations per year in BC. Adults overwinter in non-crop areas.

Management:

Protect young plants with row covers. Cabbage, cauliflower and broccoli can be protected by seeding or transplanting a trap crop row or two among the cole crops in your garden. In Ontario, Indian mustard, *Brassica juncea* var. *crispifolia*, is used in agricultural crop fields for this purpose. Home gardeners unable to locate seed of Indian mustard can use either bok choy or pak choy. The flea beetles will stay on the trap crop and not bother the other cole crops in your garden, unless populations climb too high. If so, a foliar application of pyrethrins or insecticidal soap to the trap crop will suppress the flea beetle population. Do not let mustard go to seed or it can become a weed problem.



Crucifer flea beetles on kale

Btk will not control flea beetles. Observe days to harvest on the label for the crop you are growing.

Red Turnip Beetle

(*Entomoscelis americana*)

This pest occurs in interior regions of B.C. including the Peace River area. Both adult beetles and all larval stages feed on members of the cabbage family and on many weeds. Adult beetles are 6 mm long, bright red, with black spots near the head end, and three black lines on the wing covers. Young larvae are orange with black spots, but entirely black when fully grown (12 mm long).

Larvae first appear in May, and adults are present from July into October.



Red turnip beetle

Management:

Fall or early cultivation of soil will kill red turnip beetle eggs. Control volunteer plants including weeds of the mustard family. Rotate crops to reduce build up of beetles. If beetle numbers are high and damage is substantial, foliar application of an insecticide containing pyrethrins will suppress this pest. Observe days to harvest on the label.

Diseases of Cole Crops

Black Spot, Bacterial blight and Downy Mildew

(*Alternaria* spp., *Pseudomonas syringae* and *Xanthomonas compestris*, *Peronospora parasitica*)

Under cool, wet conditions, especially in coastal areas, brown to black spots may appear on leaves and heads of cauliflower, cabbage, broccoli and Brussels sprouts. These are caused by *Alternaria*, the bacteria or downy mildew pathogen.

Alternaria and bacterial infections cause both black spots and a soft, smelly rot which can be severe after the first frost in the fall. With downy mildew (*Peronospora*), black streaking may appear on stems and a fuzzy white growth may be visible in humid weather.



Downy mildew on gai lan
Photo courtesy of ES Cropconsult

Management:

Thin seedlings and avoid excessive nitrogen and over-watering. Protect cauliflower from fall rains and frost by covering the curds with wrapper leaves. Elastic bands are useful for this. Harvest and process broccoli promptly after the first hard frost. Remove infected crop residues from the garden. These diseases do not carry over in well-made compost. Preventative applications of copper spray will help to reduce damage from all of these diseases, provided the applications are started before the symptoms become widespread. A biofungicide containing *Bacillus subtilis* will also help to suppress downy mildew.

Clubroot

(Plasmodiophora brassicae)

Clubroot occurs in the Lower Mainland area of B.C. Plants with clubroot infection wilt on hot days, lower leaves turn yellow and plants become stunted with large, irregular lumps and swellings on the roots. Once introduced to a garden, the fungus-like organism that causes this disease will remain in the soil indefinitely. It only infects roots of crucifer plants in acid soils or soils with high organic matter and is not a problem in areas with alkaline soil. Plants in wet or over-watered soils develop more clubroot. Most cruciferous plants are susceptible.

Management:

Avoid introducing this disease into your garden by growing plants from seed only, or planting only healthy transplants with no lumps on their roots.

Once clubroot is established, it may be kept at a low level by following a long rotation in which members of the cabbage family are not planted in the same area more than once every 5 years. Early plantings and plants grown under dry conditions are more likely to escape serious infection. Rouging out infected plants before the roots start to rot will help to avoid buildup of the organism in the soil. This must be done promptly on a warm day as soon as wilting is noticed. Do not place diseased plant roots in the compost. Remove them to a garbage dump or bury them where they will never contaminate soil or water used for cole crop production.

Finely ground agricultural lime will reduce infection. Work 1 kg of lime per square meter into the soil the year before planting or mix a handful of lime with the soil in each transplanting hole just before planting. Note that soil treated with high rates of lime in this way should not be planted to scab-susceptible root crops such as potatoes, carrots, beets, radish or rutabaga (see “Beets, Scab”, page 15-21 and “Lime and Soil pH”, page 7-5).



Clubroot on cabbage
Photo courtesy of ES Cropconsult

Verticillium Wilt

(*Verticillium dahliae*)

As they mature, the affected plants become stunted, wilted and leaves turn yellow at the tips. This soil-borne fungus attacks a very wide range of crops and ornamentals, including potatoes, peppers, tomatoes, strawberries raspberries and many woody trees. It produces small “sclerotia” which persist in soil for several years. Onions, garlic, corn and grasses are not affected. The disease is more severe on light, sandy soils.



Verticillium wilt of melon

Management:

Rotate for at least 4 years with non-susceptible crops. Do not plant cole crops following potatoes that have yellowed and died off early. Early-maturing crops such as radish and early potatoes usually escape the disease. Removal and replacement of soil is one option in small garden plots. Some varieties are resistant; check seed packets or catalogues for V-resistance.

Other Disorders

Boron Deficiency

Boron deficiency is often seen in cole crops, especially during a dry summer. Symptoms include hollow stems and brown discoloration of the stems and florets.

Management:

If boron deficiency has been experienced in the past, a fertilizer containing boron should be added to the soil before planting (see “Boron”, page 7-10). A foliar spray application during the growing season using borax at the rate of 2-3 mL/L water is also effective. If you are growing turnips, rutabagas or beets, they will also benefit from a foliar application of borax. Caution! Do not use boron sprays on beans or cucumbers, or grow beans or cucumbers where boron has been applied to the soil as it can be toxic to these plants.

Corn

Insects

Corn Earworm

(*Helicoverpa zea*)

Large green, yellow or brown striped caterpillars up to 3.5 cm long feed on silks and developing kernels within the ears of corn. It is a sporadic pest in the Southern Interior but much less frequent at the Coast. Other caterpillars will periodically feed on tips of cobs, including armyworms, or rootworm beetles.



Corn earworm

Management:

In areas where corn earworm is expected, cobs can be protected by applying Btk or pyrethrins to the young silks of developing ears.

Alfalfa Loopers

(*Autographica californica*)

Olive green caterpillars up to 3 cm long with a pale head and lightly striped body chew into the centre of young corn plants. Loopers have three pairs of legs at the head end, two or three pairs of fleshy legs at the rear and move with a looping or “inching” action. Young plants can be killed if the growing point is eaten. The adult is a brownish moth with a white oval patch on each wing, which fly into BC in the spring.

Management:

Corn plants usually can outgrow the caterpillar feeding so no controls are necessary, however, if the caterpillars are seen, hand pick and destroy them. If numbers of caterpillars are high enough, foliar spray with Btk or pyrethrins may be warranted. Direct the spray into the whorl of leaves so that the spray runs into the center of the plant where loopers feed.

Western Corn Rootworm

(Diabrotica virgifera)

This is a new and significant corn pest in the Fraser Valley of B.C. (2016). It is not known to occur in the interior of B.C. or on Vancouver Island.

Yellow beetles with black stripes can be found feeding on foliage and silks in July-September. These beetles lay eggs in the soil in corn plantings. Next spring, the larvae hatch from eggs and feed on the new corn plants, causing root damage and poor plant growth. Corn plants can fall over from the lack of brace roots. Cob development can be hindered as if the silks are snipped by beetles, pollination will not occur.



Adult rootworm beetles feeding on a melon flower

There is one generation per year. Corn is the only crop that larvae can complete their development on. The beetles will feed on corn, melon plants, and many flower crops, as they are seeking pollen sources.

Management:

Crop rotation is the most important tool to prevent damage from this pest. Do not plant corn in the same spot more than 2 years in a row.

Corn Diseases

Smut

(*Ustilago zaeae*, *Sporisorium hoci-sorghii*)

Common smut causes gall-like swellings covered with a silvery membrane on ears, tassels, stems or sometimes on leaves. When the membrane breaks open it releases a mass of black spores. These spores fall to the ground where they can infect the next corn crop. Common smut spreads by airborne spores. Injuries on the plants caused by wind, hail or insects increase the susceptibility to common smut.

Head smut occasionally occurs on sweet corn in the Interior. Symptoms are similar to common smut, but the smut galls occur only on the ears and tassels. The smut spores can survive in the soil for over 10 years. Germinating seedlings are infected by spores in the soil, and the infection grows systemically in the corn plant.

Management:

Remove infected plants or cut out smut galls before the galls burst to prevent spores from contaminating the soil. Dispose of galls in the landfill. Avoid excessive use of nitrogen fertilizer. Where infected corn has been grown, rotate with other crops the following year. If garden soil is already heavily contaminated with head smut, select a cultivar of sweet corn that is resistant to head smut. These fungi only infect corn. An interesting note is that immature corn smut galls are considered a delicacy in Mexican cuisine!



Corn smut.

Cucurbits (cucumbers, melons, squash, pumpkins and zucchini)

Diseases

Alternaria Leaf Spot

(*Alternaria* spp.)

Black spots appear on the leaves in late summer and early fall. In wet weather, leaves may be entirely destroyed as the spots enlarge and run together. Other cucurbits are also susceptible to this disease. Fruit is generally not affected.

Management:

Maintain good soil fertility and moisture in late summer to keep the plants in vigorous condition. Avoid prolonged overhead sprinkling. Clean up crop refuse at end of season by burning or burying in the compost. There are no effective fungicides for home garden use. Applications of copper spray may provide some control.

Angular Leaf Spot

(*Pseudomonas syringae* pv. *lachrymans*)

Angular yellow spots appear on leaves inside the veins, and on fruit. Spots later turn a tan colour. Droplets of gummy ooze appear on lower surfaces of leaves in humid conditions. A laboratory diagnosis may be needed to confirm this disease.

Management:

This is a seed-borne disease, so it is important to buy disease-free seed. Some seed packages will state the results of seed testing. Plant resistant or tolerant varieties. If this disease has been diagnosed, rotate out of cucumbers for 2-3 years. If the disease appears in the garden, copper sprays will provide some control if applied early, before the symptoms are widespread. Avoid overhead watering.

Cucumber Scab

(*Cladosporium cucumerinum*)

Scab lesions appear as angular spots on the fruit and leaves. Spots on the fruit become sunken, dark green to grey and ooze sticky droplets. In the early stages, this disease can be difficult to distinguish from other diseases and disorders, and a laboratory diagnosis may be needed. This disease also infects pumpkins and some squash varieties. (This is not the same scab disease that infects beets, potatoes, carrots and other root vegetables).



Scab (*Cladosporium*) on cucumber

Management:

Remove and dispose of all infected crop refuse by turning it under in the fall or burying it in the compost. Follow a 2 - 3-year rotation out of cucurbits. Select scab-resistant or tolerant varieties listed in vegetable seed catalogues. Sprays with copper will provide some control. Follow label directions. Do not apply copper within 1 day of harvest.

Fusarium Wilt and Stem & Root Rot

(*Fusarium* spp.)

Cucumbers, cantaloupe and watermelon are sometimes infected by *Fusarium* species. Seedlings wilt and damp-off with a yellow rot at the soil line. In the garden, mature plants wilt and rot at the soil line and stems dieback causing leaves to brown and wither. Fruit may also rot and brown at the stem end.

Management:

Select resistant crops or varieties. Most varieties of cucumber and melon have resistance to some, but not all, strains of *Fusarium*. Where fusarium wilt or stem and root rot has been found in the garden, do not grow cucumbers and melons in that soil for at least 4 years, and do not replant with the same varieties. The disease is believed to be seed-borne and can spread in seedling trays and seedbeds. Do not re-use seed trays where seedlings have damped-off previously, or wash and disinfect trays thoroughly before re-use.

Phytophthora Blight

(*Phytophthora capsici*)

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This aggressive blight was detected in 2004 in the Kelowna area, infecting peppers, pumpkin, squash and eggplants. The disease was not found in subsequent years. This pathogen can infect over 50 species of cultivated plants and weeds. Symptoms on cucurbits appear as a vine blight resulting in stem girdling, wilting and death of foliage. On fruit, large, water-soaked, circular lesions expand to cover the fruit with white mold. Fruit rot progresses rapidly, resulting in complete collapse of the fruit and invasion of secondary rots. Fruit rot can also develop after harvest.



Phytophthora blight on pumpkin

Management:

If this disease is suspected, send a sample to the Ministry of Agriculture plant diagnostic lab for confirmation. This disease is not yet established in B.C.. Remove dead and declining plants from the garden and dispose of them in sealed garbage bags or take to a landfill. Do not grow cucurbits or peppers, tomatoes or eggplants in the same spot the following year. There are no effective fungicides for use in the home garden.

Powdery Mildew

(*Sphaerotheca fuliginea*, *Erysiphe cichoracearum*)

Leaves of cucurbits are covered with a grey to white powdery mold in late summer.

Management:

Shady gardens with poor air circulation suffer most from powdery mildew. Space plants for good air circulation and control weeds. Varieties with tolerance are available. Chemical control is rarely worthwhile. Cucurbits are easily damaged by sulphur that is sometimes used to control powdery mildew on other crops. A biofungicide containing *Bacillus subtilis* or *Reynoutria sachalinensis* plant extract will help to suppress powdery mildew. A fungicide containing citric + lactic acid may also be used to suppress powdery mildew on squash, pumpkins and greenhouse cucumbers.



Powdery mildew on pumpkin

Verticillium Wilt - See "Cole Crops", page 15-8.

Sclerotinia White Mold - See "Beans", page 15-26.

Other Disorders

Bitterness

Cucurbits contain natural toxic compounds called furanocoumarins which protect them from grazing animals. If you live on a farm, you will know that cattle, for example, will not eat the leaves or stems of cucurbits. When plants are grown under stressful conditions, these compounds may become elevated in the fruit giving it a bitter taste. This is most common in cucumbers and zucchini.

Management:

Do not eat bitter-tasting cucumbers or zucchini as it could cause an upset stomach. Dispose of bitter fruit in the compost. Improve growing conditions for the plants. Providing balanced nutrition and enough soil moisture throughout the growing season will usually prevent bitterness. Some cucumber varieties, such as 'Sweet Slice' are selected to have little or no bitterness even in poor growing conditions.

Lettuce

Insects

Aphids

(*Nasonovia ribisnigri*, *Myzus persicae*)

Two kinds of aphids infest lettuce: the green peach aphid and the lettuce aphid. The former is mostly on the outside leaves of head lettuce, and the latter is throughout the head. Both types infest leaf lettuce.

Management:

Growing lettuce in fine-screened cages or under row covers prevents aphid infestation. If not too numerous, aphids are easily rinsed off lettuce leaves before consumption. Insecticidal soap or malathion may be used throughout the growing season if growing without covers. Days to harvest vary with product and between head and leaf lettuce. Consult the label.

Diseases of Lettuce

Head Rot

Plants may be infected, often where they touch the soil, at any time from emergence to harvest. They may turn yellow and die early or may produce a head which then rots after harvest. Common causes are bacterial slime rot, *Rhizoctonia* bottom rot, *Sclerotinia* white mold (“drop”) and *Botrytis* grey mold. (See also “Beans”, page 15-8.)

Management:

Avoid seeding or transplanting into cold, wet soil. Space head lettuce at least 25 cm apart to allow for good air circulation. Avoid watering near harvest. Harvest promptly when mature, and destroy crop refuse at the end of the season. Do not compost white mold-infected plants, as the hard, black, sclerotia of the fungus may not be destroyed by composting.

Downy Mildew

(*Bremia lactucae*)

Yellow to brown spots appear on leaves in cool, wet weather in spring and fall. The underside of the spots may be covered with white glistening spores. This species of downy mildew only attacks plants in the lettuce family.

Management:

Delay planting until soils are warm and dry. Turn under plant refuse promptly and rotate with non-lettuce crops. Plant resistant varieties, especially for late harvest. There are no fungicides available for control of lettuce downy mildew in the home garden. However a biofungicide containing *Bacillus subtilis* will help to suppress downy mildew.



Downy mildew on lettuce

Other Disorders

Tipburn

Tipburn is caused by poor calcium uptake, It is more severe when high soil fertility combines with high temperature and drought stress. Leaves become brown at the margins. Browning may occur only inside the head. Secondary bacteria may cause a slimy rot.

Management:

Plant tolerant varieties. Harvest heads before full maturity. Avoid water stress and do not over-fertilize where this disorder has been a problem. Nitrate nitrogen is preferable to ammonia forms. Calcium foliar sprays are usually ineffective. See “Calcium”, page 7-11.

Onions, Garlic, Leeks, Shallots

Insects

Onion Maggot

Delia antiqua



Onion damaged by onion maggots



Onion maggot larva



Onion maggot adult

The adult is a grey, bristly fly, slightly smaller than a house fly, which lays eggs at the base of plants. Small, white legless larvae (maggots), up to 8 mm long, feed on roots and tunnel into the base of bulbs. The first generation of larvae in the spring can kill young plants; they wilt and die. Second and third generations of larvae feed on and damage developing bulbs, enabling entrance of rot pathogens. Bulbs begin to decay. Larvae pupate in the soil, and the late summer larvae need onion debris in the fall and winter to survive.

Management:

Rotate with other crops so onions and garlic are not continually planted in the same site. Removal of all onions at harvest is critical to preventing build up of this pest. If larvae-infested onions are found, place the bulbs in a bucket or bag and place in the freezer for a day prior to composting. If there are also diseases present, it is better to put the plants in the garbage for pickup as freezing may not kill pathogens. Delay planting until after mid-May to reduce the severity of attack from first generation maggots. Use screen cages or floating row covers to keep out egg-laying flies. Limited natural control is provided by ground beetles, parasitic wasps and pathogenic fungi.

White sticky card traps can be used to monitor for adult flies, and consequently when to expect larvae. However, flies are difficult to identify as they look similar to many other species of flies, which will also be caught on these traps. (See “Cabbage Maggot”, page 15-26, and “Sticky Traps”, page 5-11).

There are no registered insecticides available for effective control of onion maggot in the home garden.

Onion Thrips

(Thrips tabaci)

Thrips are very small (0.5 to 1 mm), slender, yellowish to brown insects which may be winged or wingless. Adults are difficult to see because they fly when disturbed. They damage the plant by rasping the foliage and sucking the sap. Leaves take on a silvery, speckled appearance. This damage can resemble botrytis leaf blight or downy mildew. There are multiple generations per year and this pest can be present throughout the growing season. Onion thrips can be pests of cole crops, onions, garlic, and possibly other vegetable crops. They overwinter in non-crop areas.



Adult and immature thrips

Management:

Good weed control and removal of crop residues will help keep thrips populations low. However, if damage is anticipated and thrips are seen on the plants, foliar applications with insecticidal soap or pyrethrins will help decrease pest damage. Management for thrips will be ongoing through the season.

Diseases of Onion and Garlic

Downy Mildew and Leaf Blight

(*Peronospora destructor*, *Botrytis squamosa*)

Leaves become covered with white spots and streaks when infected with downy mildew. In humid conditions, the spots become covered with the purplish-grey fuzzy growth of the pathogen. Leaves wither from the top down and the plants die prematurely. Leaf blight (also called “blast”) is caused by another fungus, *Botrytis*, which causes white spots and streaks which also lead to complete withering of the tops. These diseases can resemble thrips injury.



Downy mildew on onion

Management:

Practice sanitation and rotation. Remove onion debris from the garden in the fall, including any unharvested bulbs. Dispose of debris in a landfill, or if composting, bury any cull onions so they do not sprout in the spring. Separate over-wintered or transplanted and spring-seeded crops as much as possible as the diseases tend to develop first on the older plants and then move to the younger seedlings. Plant in open, sunny locations. Do not apply high rates of nitrogen. Avoid sprinkler irrigation after July 1.

If fungicides are to be used, start spraying in early June using copper spray. Repeat at 7 to 10 day intervals. Do not apply within 1 day of harvest.

Fusarium Basal Rot

(*Fusarium oxysporum* f. sp. *cepae*)

Plants appear stunted and lopsided due to a soft, brown, mealy decay often on one side of the base.

Management:

Do not plant sets showing any type of decay. Follow a 4-year rotation with unrelated crops, such as carrots, celery, lettuce or beets. Control onion maggots.

Botrytis Neck Rot

(*Botrytis* spp.)

Bulbs rot during curing or storage. The rot usually starts in the neck and spreads to the rest of the bulb. Rotted tissue becomes water-soaked and soft, then covered with a grey mold containing hard, black bodies called sclerotia. Soft rot bacteria can also rot onion necks in wet weather, but no mold or sclerotia are seen.



Botrytis neck rot. Photo courtesy of P. Northover

Management:

When growing onions from seed, use early-maturing, tight-necked varieties such as ‘Copra’, ‘Norstar’, ‘Tarmagon’ and ‘Taurus’. Lift bulbs when two-thirds of the tops are down, and dry thoroughly for 8 to 18 days in the sun or slatted curing crates protected from rain. Artificial drying may be necessary in wet seasons. Greenhouse benches are suitable for drying small quantities of onions in September when the greenhouse is otherwise empty. After curing, store in a well-ventilated area at 0 to 4 °C with low humidity.

Smut

(*Urocystis magica*)

Elongated, black blisters appear on the side of the bulb extending up into the leaves. Young seedlings may die. Leaves are often stunted, curled, and fleshy-looking. Eventually, the blisters split open and powdery, black fungal spores spill out into the soil where they will remain until the next crop of onions is seeded.

Management:

Infected seed sets or transplants can introduce this disease into your garden. Inspect transplants or sets carefully and if they appear to be infected do not plant them into a garden where the disease does not occur. Once the soil is infested, seed later in the season after the soil warms up, or use sets or transplants instead of seed, as they will not get infected provided they are healthy to begin with. Remove infected plants from the soil as soon as they are seen to minimize the shedding of spores. The disease may survive composting. Dispose of infected plants and debris in sealed garbage bags or take to a landfill.

White Rot

(*Sclerotium cepivorum*)



White rot on garlic



Close up of white rot, including white mycelium and small black sclerotia

Infected seed sets or transplants can introduce this disease into your garden. First symptoms are dwarfing of the plants at any stage of growth. When gently pulled, infected plants easily come away from the soil, since most of the roots have disintegrated. A white, fluffy mold peppered with tiny black dots (sclerotia) may be visible at the base of the bulb. Only plants in the *Allium* (onion) family are affected.

Management:

If the garden is free of this disease, keep it that way by growing only from seed. The fungus remains in the soil for 10 years or more, so be careful not to move or track infested soil into new onion or garlic beds. Plants can become infected in the soil at any time from seeding to harvest. Remove infected plants from the soil as soon as they are seen to minimize the shedding of spores. **DO NOT COMPOST.** Dispose of infected plants and debris in sealed garbage bags or take to a landfill. Fungicides are not effective.

Rust

(*Puccinia allii*)

Rust is primarily a disease of garlic, although onion, leeks, shallots, and wild *Allium* spp. can also be infected. Leaves become covered with yellow-orange pustules that later turn black. Spores are air-borne.

Management:

Rust is a sporadic disease that can sometimes cause considerable damage. It may be a concern on summer green onions



Onion rust

or chives where the leaves are consumed. The fungus probably overwinters on garlic and volunteer *Allium* species. If rust is a problem, rotate to non-onion family crops for a year, and destroy any volunteer onions or garlic.

Parsnips

Insects

Carrot Rust Fly – See page 15-22.

Diseases

Leaf Spot and Canker

(Phoma complanata, Itersonila perplexans)

Spots appear on leaves in wet weather and a rusty-brown to black canker and decay develops on roots. Cankers are often found at the crown (shoulder) or where carrot rust fly larvae have injured the root. Bacteria may cause a secondary soft rot.

Management:

Rotate out of parsnips for at least 1 year and plant resistant varieties such as ‘Gladiator’ or ‘Andover’. Cover shoulders of parsnips with soil to prevent infection by spores washing down from leaf spots.

Peas

Insects

Aphids

See “Aphids”, page 15-1. Seed or transplant peas in late March or early April, so they can be harvested before aphids build up.

Pea Leaf Weevil

(Sitona lineatus)

This weevil is common only in the Lower Mainland and on Vancouver Island. Adult weevils become active during spring evenings and chew semi-circular notches out of the leaf margins of pea seedlings. Leaves of young pea plants can appear ragged and plants can be killed if feeding is excessive. Adult pea leaf weevils are about 3 mm long and grey. They lay eggs at the base of plants, and larvae feed on roots. This weevil will also damage broad bean plants, and can survive on many other legumes, both wild and cultivated. After spending the summer feeding on roots, the larvae pupate, and the new adult weevils emerge in late summer, feed on leaves of legumes, and overwinter as adults wherever perennial legumes are present.



Weevil feeding damage on pea leaves in spring

Management:

Destroy crop debris after harvest and practice crop rotation. Plant early if possible; larger plants can withstand more damage. In home gardens, pea plants usually outgrow early adult feeding damage, so treatment may not be necessary.

If damage has been severe in the past, consider a foliar application of pyrethrins or diatomaceous earth when leaf notches are first seen. Repeat treatment several days later if fresh leaf notches are seen.

Pea Weevil and Pea Moth

(Bruchus pisorum, Cydia nigricana)

Peas in the pods are fed on by small, greenish caterpillars or grubs about 3 mm long. Damage is not easily seen on the outside of the pod. While both insects are present in B.C., in the Fraser Valley, the pea moth (*C. nigricana*) is the most likely insect to feed inside of developing peas.

Management:

Peas seeded or transplanted in March or early April are usually not affected. Bury or compost all plant debris immediately after harvest if peas were infested with caterpillars or grubs. If the pests were present the previous year, practice crop rotation or spray peas just after blossoming with pyrethrins.

Diseases

Powdery Mildew

(Erysiphe polygoni)

Leaves develop a white, powdery covering that may eventually cover the pods, vines and leaves.

Management:

Destroy vines as soon as the crop is harvested. Peas seeded early in the season usually escape powdery mildew infection. Avoid locating late plantings close to early plantings. If chemical control is needed, sulphur dusts or sprays may be used, but they are only partially effective. Do not apply within 1 day of harvest. 'Knight' and 'Oregon Sugarpod II' are said to be resistant to powdery mildew.

Root Rot and Wilt

(Aphanomyces, Fusarium, Pythium, Phytophthora & Rhizoctonia)

Pea seeds germinate, but roots become brown and rotten. Seedlings and young plants grow poorly or die. In the case of true wilt disease, plants may grow normally until just before harvest, when they wilt and wither. This disease also affects sweet peas.

Management:

Plant seed that has been pre-treated with a protective fungicide. Do not plant peas year after year in the same location, and destroy plant debris in the fall by burning, composting or turning it into the soil. Where root rot has been a problem, plant early maturing varieties.

Peppers

Insects

Aphids - See page 15-1.

Flea Beetles - See page 15-5.

Diseases of Peppers

Bacterial Spot

(*Xanthomonas campestris* pv. *vesicatoria*)

Brown spots develop on leaves and small, brown “scabby” spots develop on fruit and pedicels. Leaves can quickly become ragged and covered with spots. Young green fruit may drop or fail to develop.

Management:

There is no good control for this disease. Copper sprays every 7 to 10 days may help if applied when spots first appear. Other fungicides have no effect on bacterial diseases. Avoid overhead watering if possible. Bacterial spot of pepper is often seed-borne. Seed packages may state whether seed have been tested for and are free of the bacterium. The pathogen will not carry over in soil if crop debris is removed or well-decayed before replanting the following year. Hot water treatment of seed will destroy this bacterium, but is difficult to do at home. See ‘Tomatoes, Bacterial Diseases’, page 15-62.

Grey Mold and White Mold Rot

(*Botrytis cinerea*, *Sclerotinia sclerotiorum*)

Botrytis grey mold causes a soft rot on fruit and brown cankers or rot on stems in wet, cloudy weather at the coast. Greenhouse transplants are also affected when humidity is high and plants are crowded. Peppers are also affected by sclerotinia white mold (see “Beans”, page 15-8).

Management:

Don’t plant peppers in the shade of larger plants. Space plants to improve air circulation. Avoid sprinkler or overhead irrigation. Use trickle or drip irrigation in the garden or water plants individually to avoid wetting leaves, flowers and fruit. A biofungicide containing *Bacillus subtilis* will help to suppress grey mold.

Verticillium Wilt

(*Verticillium* spp.)

Plants appear somewhat stunted. Later, lower leaves start to yellow early and plants wilt in hot weather. Eventually, they wilt down completely and do not recover when watered. When the lower stem is cut open, the vascular system (xylem and phloem) appears yellow and discoloured. The fungus enters through the roots, moves upwards through the vascular system and gradually plugs up the vascular system of the plant, causing the plant to wilt. The fungus will stay in the soil for several years.

Management:

Avoid rotating with potatoes, tomatoes, eggplants, raspberries and strawberries. This soil-borne fungus is more common in the drier, sandy soils of Vancouver Island and the Interior. Resistant pepper varieties are not available. Fungicides are not effective for this disease.

Impatiens Necrotic Spot Virus (INSV)

This virus is spread by thrips, mainly in greenhouses. Infected plants are often quite stunted and leaves are distorted with a yellow mottle. Blackening may occur on the stem, petioles or fruit pedicels, but there is no rot. Fruit may be small and distorted, or normal size but with black streaks or a ringspot pattern on the skin.



Tomato spotted wilt virus on pepper

Many flowering plants in greenhouses are also affected by INSV. In gardens, the source of infection is usually greenhouse transplants, but symptoms may not be seen until after young transplants are put out in the garden. Thrips in the garden can then spread the virus to other plants, including flowers. Pepper plants infected secondarily in the garden usually have milder symptoms and may grow normally except for streaks and ring spots on fruit. The virus is not known to carryover more than one growing season in the garden, since infected thrips do not survive the winter outdoors in B.C.

Management:

Start with clean, disease free plants. Remove infected plants promptly from the garden when seen. Thrips are difficult to manage or exclude from the garden.

Other Disorders**Blossom-end Rot (calcium deficiency)**

See “Tomatoes”, page 15-66.

Sunscald

Tan to white soft areas appear on fruit. Large fruits exposed to direct sunlight may be damaged on particularly hot days. Black and purple varieties are most severely damaged while light coloured varieties are less susceptible.

Management:

The more top growth and shading of fruit, the less sunscald. However, dense foliage can lead to botrytis grey mold on the coast. In the Interior, sunscald is the greater problem.

Potatoes

Insects

Colorado Potato Beetle

(*Leptinotarsa decemlineata*)



Colorado potato beetle



Colorado potato beetle larva feeding on eggplant

Beetles are 1.5 cm long with yellow and black stripes. Adult beetles overwinter in weedy hedgerows and move into the garden in the spring. They lay clusters of bright yellow eggs on the underside of leaves. The larvae (grubs) are reddish-orange with black spots on their sides. There may be 2 generations per year. Foliage is eaten by both adults and larvae, but larvae cause the most damage. Potatoes, eggplants and nightshade weeds are their preferred food, but young tomato plants are also attacked. The beetle is not a problem in coastal areas but is becoming more common in the Interior.

Management:

Plant early maturing varieties of potatoes, and harvest as soon as the crop is mature, to reduce food sources for late-season beetles. Use row covers to prevent migrating beetles from gaining access to potato plants. Hand pick beetles and larvae from plants if they are

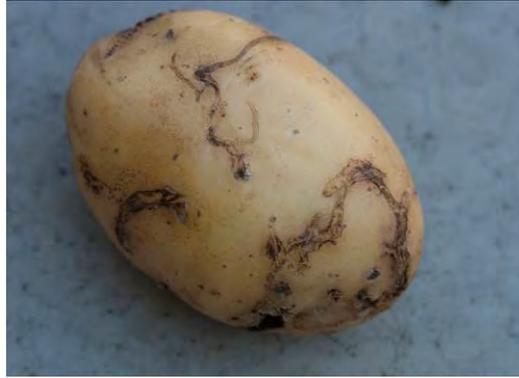
not too numerous. Larvae and egg masses can be killed by freezing or dropping infested leaves into a pail of soapy water. Trap beetles with eggplant, pick trap plants frequently. Remove nightshade weeds to help decrease the number of beetles. If needed, larger infestations or older larvae can be sprayed with pyrethrins. Follow label instructions and days to harvest.

Tuber Flea Beetle

(Epitrix tuberis)



Tuber flea beetles and feeding damage to leaf



Tuber flea beetle larval feeding damage to potato tuber

Tuber flea beetles are small (3 mm), black, fast-jumping beetles that eat numerous small, round holes in the leaves causing a shot-hole effect. The larvae feed in potato tubers by tunneling beneath the skin, making thread-like tunnels that fill with corky brown tissue. Extensive tunneling near the surface may resemble scab disease. The tunnels give the tubers a musty flavour even after the visible damage has been peeled off. Adult flea beetles overwinter in adjacent vegetation, and move to potato plants in spring to feed and lay eggs. There are 3 generations in B.C., and damage to potato tubers can occur right up to harvest.

Management:

Remove and destroy any volunteer potato plants in the garden or the compost pile. Control weeds in the nightshade family which serve as alternate hosts.

If potatoes were damaged the previous year, spray foliage of plants when beetles or feeding damage on the leaves first appear in spring or early summer. Use pyrethrins at label rates. Repeat this treatment if holes appear in new leaves or if beetles reappear. For best control, both the upper and lower surfaces of the leaves should be treated. It is possible that foliar-applied dusts such as diatomaceous earth will help suppress flea beetle adults.

Also see “Flea beetles”, page 15-5

Wireworms

(*Agriotes* spp.)

Wireworms tunnel into potato tubers. Large infestations can make potatoes inedible. See Wireworms, page 15-12.

Diseases of Potatoes

Choosing Seed

For a healthy crop, buy only B.C. Certified Seed Potatoes. In all but the most isolated areas, home gardeners should purchase new certified seed each year. Seed potatoes saved from previous crops or table potatoes from a supermarket are likely to be infected with viruses or other diseases. Table potatoes may have been treated to prevent them from sprouting.

For an early crop, green sprout it by spreading the tubers out in a sunny window until planting time. Discard any tubers which show signs of decay or which do not sprout properly.

One of the best areas in North America for growing seed potatoes is the B.C. Pemberton Valley, due to its isolation and cold winters that keep aphid numbers low. To keep Pemberton seed potatoes disease-free, the valley has been designated as a “Seed Control Area”. It is against the law to bring potatoes for planting from other areas into Pemberton without special permission.

Bacterial Ring Rot

(*Clavibacter michiganensis* subsp. *sepedonicus*)

This disease does not occur in B.C. certified seed potatoes. But, it can accidentally be brought into the garden on infected seed tubers from outside the province.

Soon after the potatoes have bloomed, the lower leaves may wilt with a slight upward rolling of the leaf margins. Hot, dry weather favours rapid development of this disease. When the tuber is cut across, a creamy yellow to light brown rot shows in the vascular ring just beneath the skin. Externally, the skin cracks and later the entire centre of the tuber breaks down leaving only a thin, outer shell.



Bacterial ring rot of potato

Management:

To avoid bacterial ring rot, plant only B.C. certified seed potatoes.

This disease is regulated by B.C., therefore, if bacterial ring rot is suspected, contact your local B.C. Ministry of Agriculture office and send a sample for confirmation to the provincial Plant Diagnostic Laboratory in Abbotsford.

If bacterial ring rot occurs in your garden seek advice from the B.C. Ministry of Agriculture for appropriate eradication measures. Do not save any potatoes for seed. Non-decayed tubers may be eaten, and any tubers showing signs of rot should be bagged and sent to a landfill. It is necessary to thoroughly disinfect all equipment such as shovels or spades that may have been in contact with the crop, as well as storage areas. Discard any bags that were used to hold the potatoes. Rotate out of potatoes for 2 years, or move potato production to a different garden. Destroy any volunteer potatoes during the rotation.

Blackleg

(Erwinia carotovora)

A dark brown or black discolouration develops at the stem base of potato plants and the stem end of the tubers. Individual stems or the whole plant may wilt. In storage, tubers develop a soft, smelly rot. Cool, wet soil and poor storage conditions encourage this bacterial disease.

Management:

Remove crop debris and dispose of rotted tubers in storage immediately. Use certified seed and rotate crops so that potatoes are not continually planted in the same spot..

Common Scab

(Streptomyces scabies and other Streptomyces spp.)

Tubers develop round or oval corky scabs, which may be raised or slightly sunken, or roughening (russeting) on the skin surface. The bacteria that cause this disease carry over in the soil. High soil pH favours scab. Occasionally, powdery scab, a disease with similar symptoms caused by a soil-borne fungus, is also a problem.



Common scab of potato
Photo courtesy of ES Cropconsult Ltd.

Management:

Reduce common scab by avoiding the use of lime, ashes or fresh manure on soil where potatoes will be grown. Do not plant obviously infected tubers. Lowering the soil pH by using sulphur or acid-producing fertilizers (those containing ammonium) may be helpful. Maintain adequate soil moisture. Rotate potatoes with other crops. The following varieties have some resistance and are recommended for Interior areas where soils tend to be alkaline, or where scab has previously been a problem: 'Avon', 'Cherokee', 'Onoway', 'Huron', 'Nooksack', 'Norking', 'Norgold', 'Maverick', 'Hilite Russet', 'Krantz', 'Niska', 'Redsen', 'Russet Burbank', 'Russet Norkotah', and 'Superior'.

Early Blight

(Alternaria solani)

Symptoms include brown to black, target-like spots with concentric rings on the leaves. Spots later run together and leaves can appear burned, yellow and drop. Sometimes the fungus causes a brown to black, slightly sunken decay on the surface of tubers. Early blight rarely occurs on the Coast, but is common in the Interior.

Management:

Avoid frequent overhead watering, increase soil fertility; and clean up crop debris after harvest. If chemical control is required, apply weekly copper sprays or potato/tomato dusts or sprays containing other fungicides according to label directions.

Late Blight

(Phytophthora infestans)

This disease is famous as the cause of the Irish potato famine in the 1800's. Large, soft, greyish-green to tan areas first appear on leaves. In humid conditions, such as when early morning dew is present, a greyish white, fuzzy mold can be seen on the spots underside of the leaves. Shoot tips may turn brown or black. Brown to black lesions also develop on stems and leaf petioles. In wet weather, the entire plant may die back to the ground. If the disease is present at harvest, and rain occurs, tubers may be infected resulting in a firm brown decay that starts at a sunken spot on the skin. Eventually, infected tubers will rot from late blight and secondary soft rot bacteria. This disease also affects tomatoes.



Late blight of potato

Photo courtesy of ES Cropconsult Ltd.

Management:

Plant B.C. certified seed. Avoid over-watering and over-fertilizing with nitrogen. Avoid overhead watering. Do not crowd plants, and plant in a sunny spot where leaves will dry quickly. Avoid planting close to tomatoes or in the same place you grew potatoes or tomatoes the previous year. If the disease appears late in the season, cut off and remove foliage about 2 weeks before harvesting. Harvest only in dry weather. Discard any infected tubers and do not store them with healthy tubers. Do not allow any volunteer potato plants to grow in the garden or sprout on compost piles, as these will provide a source of infection for the current year's crop.

New and highly aggressive strains of late blight have appeared across North America, including B.C. One strain affects both tomatoes and potatoes; another strain affects only potatoes. Home gardeners are asked to destroy severely infected tomatoes and potatoes to prevent the development and spread of new strains. Severely diseased plants should be burned (where permitted), buried or sent to a landfill. Spores from these new strains may carry over in soil and may survive the composting process. For more information, consult the factsheet [Late Blight on Home Garden Potatoes and Tomatoes](#) on the B.C. Ministry of Agriculture website.

If the late blight starts early in the garden, or if weather is wet, control of the disease with fungicides is virtually impossible. However, in warm, dry years or if blight does not appear until August, copper sprays every 5 to 7 days will help to control it. Sprays should be started in late summer before the disease appears and before wet weather resumes. Consult the label for rate of application. Do not use within 1 day of harvest.

Most varieties of potato have little or no resistance to the new strains of late blight. 'Brador' potato has some tolerance to the tomato/potato infecting strain but seed is not always available. The cultivars 'Fundy', 'Island Sunshine', 'Kennebec', 'Nooksack' and 'Sebago' also have some tolerance to certain strains of late blight. No cultivars are immune.

Leak and Pink Rot

(*Pythium* spp., *Phytophthora erythroseptica*)

In storage, tubers infected with *Pythium* leak collapse and turn watery. When cut open, rotten tubers are black in the centre or have a creamy soft rot in the centre with a black ring on the outside of the rotted area. Tubers infected with *Phytophthora* rot will turn pink when cut open. Both of these rots are caused by soil-borne fungi-like organisms, mainly species of *Pythium* and *Phytophthora*.

Management:

Heavy applications of nitrogen and high levels of organic matter favour these diseases, which are more common at the coast. Avoid harvesting tubers on hot days and do not let

them sit on warm soil after digging. Cool quickly to about 10 °C and cure at that temperature for about one month. Then, if possible, lower the temperature gradually to about 5 °C for the remainder of the storage period. Store in clean, sanitized bins or boxes in a dark room. Sacks do not allow adequate ventilation for best storage. Do not plant potatoes after beans which are a good host of *Pythium*.

Black Scurf

(*Rhizoctonia solani*)

Rhizoctonia attacks the potato stem below the ground. Stems may collapse completely. In less severe infections, tubers may be small or knobby in shape and small, green tubers may form on shoots. The fungus also causes “black scurf”: small, superficial, black spots on tubers that are left in the soil for more than 2 weeks after the tops are dead. Some strains of *Rhizoctonia* cause “wirestem” on tomatoes, cabbage, beans and other crops. However, these strains do not usually attack potato, or vice versa.

Management:

Delay planting until the soil is warm. Plant shallowly and then hill gradually as the shoots grow. Harvest promptly once skins are set. If severe problems persist, plant potatoes in new soil. NOTE: Newly-turned sod is likely to be infested with wireworms (see page 15-12) and may also increase problems with common scab.

Silver Scurf

(*Helminthosporium solani*)

Silver scurf is a fungal disease that spreads on infected seed-pieces. Silvery blotches form on the tubers and red varieties may lose colour. When potatoes are stored in warm, moist conditions, sooty or smudgy spots and black lumps also develop on the skins.

Management:

Plant only B.C. certified seed. Harvest tubers as soon as they mature, and store in a cool, well-ventilated place. Wash and disinfect storage bins each year with a 1:9 solution of household bleach before harvest.

Verticillium Wilt (Early Dying)

See “Cole Crops”, page 15-26, and “Peppers”, page 15-48.

Virus Diseases

Several viruses cause yellow leaf mottle, distorted leaves and stunted potato plants. Most are spread by aphids, and can be introduced to a garden in infected seed potatoes. Most are minor problems in home gardens. Viruses can be avoided by planting only B.C. certified seed potatoes, removing any plants with virus symptoms as they appear in the garden and controlling aphids. One of the most common and damaging virus diseases is leaf roll.

Leaf Roll (*Potato leafroll virus*, PLRV)

When seed tubers infected with potato leaf roll virus are planted, the resulting plants are dwarfed with rolled lower leaves. Plants infected during the growing season by aphids, which spread the virus, are not as easily recognized. With some varieties, infection results in a network of brown streaks under the skin of the tubers, radiating out from the stem end, called “net necrosis”, and tubers may be few or small.

Management:

To combat this virus disease, plant only B.C. certified seed. Do not keep tubers to plant next year if this disease has occurred in your garden. Rogue out diseased plants that are stunted and have curled lower leaves. Destroy volunteer potatoes, and do not allow discarded potatoes to sprout on your compost pile.

Control aphids that spread the disease, (see page 15-1).

The variety “Russet Burbank” is very susceptible, among others. “Kennebec” and many of the newer varieties are tolerant of leaf roll, that is, they will produce a good crop of tubers in spite of the virus infection. Check with your seed supplier or catalogue.

Other Disorders

Greening

Potato tubers turn green when exposed to sunlight for several hours in the field. Like the green leaves and stems of potatoes, green tubers are mildly poisonous to both people and livestock, and eating green tubers can cause stomach aches and upset.

Management:

Hill the growing crop to keep all tubers well covered with soil. Move harvested tubers into dark storage within one day of digging. The variety ‘Kennebec’ should not be left lying on the surface for more than a couple of hours under sunny conditions. Discard green potatoes or cut off any green portions of tubers before cooking.

Hollow Heart

Larger tubers are more prone to hollow heart. When tubers are cut, they have irregular hollow areas in the center. The cavity is usually outlined in brown and if the cracks extend to the surface, the tubers may rot. As a rule there is no decay involved and the tubers may be used with a little extra trimming.

Management:

Cool, wet soils around flowering time, when tubers are being initiated, will increase hollow heart. Oversized tubers, or tubers that size up too quickly, will have more hollow heart. Closer plant spacing, less nitrogen in the fertilizer and less water will help to avoid this disorder. Severity will vary from year to year depending on the variety and growing conditions. Potassium deficiency also contributes to hollow heart, but is rarely a problem in home garden soils.

Radishes

Insects

Root Maggot –See “Cabbage Maggot”, page 15-26.

Flea Beetle - See page 15-5.

Red Turnip Beetle - See page 15-29.

Diseases

Black Root

(Aphanomyces raphani)

Black, sunken bands girdle or deform roots.

Management:

Small, globe-shaped varieties are less susceptible than long varieties. Since this is a soil-borne disease, a 4-year rotation between radish crops is recommended if the disease has become troublesome.

Spinach and Swiss chard

Insects

Leafminer

(*Pegomya hyoscyami*)

For a description see “Beets”, page 15-21.

Management:

Leafminer damage to chard and spinach can be avoided by harvesting all mature leaves as soon the first larval mines are found. The leaves are fine to use fresh or frozen. By the time the next crop of leaves is produced by the plants, the egg-laying generation of leafminers has usually passed. There is at least 2 generations of leafminers in B.C. so watch leaves throughout the season. Destroy weed host plants such as lamb’s quarters, chickweed, and nightshade.

Tomatoes

Insects

Colorado Potato Beetle - See page 15-51.

Cutworms, Tomato Fruitworm and other Caterpillars

These worms are grey, brown, or green, and up to 4 cm long. The adults are moths. Cutworms feed at night, and cut off new transplants or young plants at the soil line or climb and feed on leaves and shoots. During the day they can be found in the soil near damaged plants. The later generation in summer can chew holes up to 6 mm deep in green tomato fruit. A common species of climbing cutworm seen feeding on developing tomato fruit in summer is the variegated cutworm (*Peridroma saucia*). This species is relatively abundant in coastal B.C. See also “Cutworms” page 15-3.

Management:

Inspect plants regularly and if cutworms are seen, remove them by hand and destroy them. Cutworms are mostly active in evenings or at night depending on temperature and cutworm age, so night monitoring using a flashlight can be effective. Additional control recommendations on page 15-3.

Flea Beetles

Young plants, early in the season, may be damaged by flea beetles.
See page 15-5.

Tomato Hornworm

(Manduca quinquemaculata)

Foliage and fruit are eaten by large, green or brown caterpillars, up to 6 cm long, with a short, red horn at the back end. Adults are large flower feeding moths, called sphinx moths or 'hawk' moths.

Management:

Destroy worms by hand-picking them from plants. Rarely are hornworms too numerous to hand-pick. If they are, plants may be sprayed with Btk, insecticidal soap or pyrethrins. All products are more effective if applied when caterpillars are small (less than 2 cm). Btk will not affect beneficial insects. Digging or rototilling the garden in the fall will destroy overwintering cocoons. Predatory insects such as lady beetles, lacewings and wasps feed on larvae. Parasitic wasps are sometimes effective and should be conserved in gardens. The cocoons of parasitic wasps look like grains of rice on the back of the larvae. Do not move or destroy parasitized larvae.



Braconid wasp parasite cocoons on tomato hornworm

Whiteflies

These small, delicate, white moth-like insects suck sap and are usually found resting on the undersurface of leaves or fluttering about plants. Leaf surfaces become covered with sticky honeydew excreted by these insects. Leaves become pale or discoloured, and the leaf surfaces may turn black due to the growth of sooty mold.

Management:

Whiteflies are not usually a problem outdoors, but can build up in greenhouses or polyhouses. Lady beetles, lacewings, big eyed and minute pirate bugs feed on immature stages of whiteflies. Handpick heavily infested leaves, vacuum adults early in the



Whitefly adult

morning, use aluminum foil or reflective plastic mulches to repel whiteflies away from plants. They are easily caught on yellow sticky traps placed on stakes among the tomato plants. Do not allow sticky traps to contact leaves. Replace traps if they become covered in insects or debris. If trapping does not give enough control of whiteflies, foliar spray of plants with insecticidal soap or pyrethrins at label rates will help suppress the insects.

Diseases of Tomatoes

Bacterial Spot, Speck and Canker

(*Pseudomonas syringae* pv. *tomato*, *Xanthomonas campestris* pv. *vesicatoria*, *Clavibacter michiganensis* subsp. *michiganensis*)

All of these bacterial diseases are primarily seed-borne. Bacterial speck (*Pseudomonas*) causes relatively minor black spots on leaves (often with a yellow halo) and black spots on fruit. On seedlings it can cause black stem lesions that lead to poor growth or death of the plant. Bacterial spot (*Xanthomonas*) causes large brown spots on leaves and small circular spots on fruit similar to bacterial spot on peppers. Bacterial canker (*Clavibacter*), which is common in the Interior, causes an internal brown discoloration of plant stems starting at the crown, brown and yellow spotting and burn at leaf margins and distinctive, small white spots, called “birds-eye spots” on green fruit. Not all green fruit on infected plants will have these white spots, so check several fruit clusters. Heavily infected plants show wilting and dieback.



Birds-eye spot caused by bacterial canker



Bacterial canker symptoms on leaves



Bacterial speck



Wilting and death of tomato plants caused by bacterial canker

Management:

For bacterial spot and speck, copper sprays applied weekly from transplanting or when symptoms are first seen will help prevent spread of the disease. A biofungicide containing *Reynoutria sachalinensis* plant extract will help to suppress bacterial spot. Apply preventatively.

Plant clean transplants with no symptoms. Grow tomatoes in a dry sunny area and avoid overhead watering. None of these bacterial diseases carry over in soil or compost if crop debris is well-rotted before the next crop is planted.

For bacterial canker, only the use of disease-free seeds or transplants will avoid the problem. If you experience repeated bacterial canker outbreaks in your tomato crop, try a different variety or seed source. A fungicide/bactericide containing citric + lactic acid may help to suppress bacterial canker in field and greenhouse tomatoes.

Hot-water-treatment of seed at 50 °C for 20 minutes will kill bacterial spot and speck and will reduce (but not completely eliminate) canker bacteria. Hot water treatment of tomato and pepper seed can be done at home, but it is difficult to keep a steady temperature and avoid damaging the seed. Seed should be spread out to dry and planted within a few days of treatment. Commercial certified seed purchased from a seed company should not need to be treated at home to kill these bacterial diseases.

Early Blight

(*Alternaria solani*)

Leaf spots are dark brown to black with concentric rings. Black spots develop on stems and large, black, leathery, sunken spots on the fruit. This disease is common in the Interior of B.C. but is less often seen at the Coast.



Early blight of tomato

Management:

Avoid overhead sprinkling. Pick off and destroy the older leaves if they have spots on them. Space and prune plants for good air circulation. If chemical control is required, apply copper spray at 7 to 10-day intervals. If insects are to be controlled at the same time, a potato/tomato dust or spray containing another fungicide may be used in place of some of the copper sprays. Read the label for days to harvest. If the plants are staked, the stakes should be washed and disinfected with 1:9 bleach and water between crops.

Fruit Rot

(*Colletotrichum coccodes*, *Alternaria* spp.)

Sunken black spots and rot develop on fruit caused by anthracnose (*Colletotrichum*) and black rot (*Alternaria*) fungi. Dark brown spots may appear on leaves in wet weather.

Management:

Grow early maturing varieties, and avoid wetting foliage late in the season. Staked varieties will have less fruit rot. Mulching is beneficial as it keeps the fruit from contact with the soil.

During a dry summer/fall, fruit rot is minimal. However, if wet weather arrives when there is still a lot of fruit on the vines, a spray program is recommended. Apply copper spray every 7 –10 days. Do not apply within one day of harvest. To avoid spraying in the coastal area, it is necessary to erect shelters over the tomatoes to keep the rain off.

Late Blight

(*Phytophthora infestans*)



Late blight on tomato petiole



Late blight on tomato fruit

Irregular greenish-black, water-soaked blotches appear first on older leaves or stems. Black lesions form on stems and greenish-brown, leathery spots develop on fruit. Cool, wet weather is ideal for this disease which also affects potatoes and can spread from one to the other, (see “Potatoes”, page 15-55). When green fruits are taken inside to ripen in the fall, they often turn brown and leathery on the outside due to late blight infection that occurred in the garden. Secondary bacterial infections may cause a soft, watery rot of infected fruit.

Management:

New aggressive strains of late blight have appeared affecting both tomatoes and potatoes, (see “Potatoes”, page 15-55). For more information, consult the factsheet [Late Blight on Home Garden Potatoes and Tomatoes](#) on the B.C. Ministry of Agriculture website.

Avoid overhead watering. Avoid late blight by growing early maturing varieties in a sunny area. Cherry tomatoes and other varieties grown in containers on porches or balconies often avoid infection due to the hot, dry environment. For soil-grown plants in the garden, avoid wetting the foliage when watering; adequately space the plants and do not over-fertilize with nitrogen. If only a few plants are to be grown, they may be protected from rain by growing them under the eaves on the south wall of a building. A temporary clear plastic roof erected over the plants to keep the rain off will also help prevent infection.

Remove diseased leaves or shoots immediately and all plants that are severely diseased. Bury them, or seal them in a plastic bag and take to a landfill. Do not compost diseased plants. At the end of the season remove tomato or potato debris from the garden to prevent carry over of disease.

Aggressive strains of late blight may cause complete browning and death of tomato plants within days of the first stem lesion appearing. At the coast, apply copper spray according to label instructions immediately after planting out and every 5 to 10 days, using shorter intervals in wet weather. A biofungicide containing *Reynoutria sachalinensis* plant extract will help to suppress late blight when applied preventatively. Sprays may also be needed in the Interior, depending on the weather and presence of blight in the area. Read the label for days to harvest.

Pepino Mosaic (*Pepino mosaic virus*, PepMV)

This virus is mainly a problem in greenhouse tomatoes but may be introduced to the garden through infected seedlings. Infected tomato plants show mild yellow-green mosaic and a bubbly appearance on leaves. Foliage may be stunted and thin. Fruits show uneven ripening and may have a yellow and red mosaic pattern on the fruit surface. The virus can spread mechanically by plant to plant contact, contaminated tools, hands, and clothing.



Pepino mosaic virus on tomato

Management:

Remove and destroy plants with symptoms. Limit handling of infected plants. Sanitation of hands and clothing are essential to prevent spread to healthy tomato plants and other solanaceous plants such as potato. Greenhouse growers reduce virus transmission by submerging hands and tools in skim milk prior to, and after working with infected plants.

Tomato Spotted Wilt

(*Tomato spotted wilt virus*, TSWV)

Plants are stunted and leaves are distorted, with a bronze colour. Fruit develop yellow and black ring spots. This virus is mainly a problem in greenhouse-grown tomatoes but may be introduced to the garden through infected seedlings. The virus is transmitted by thrips.



Tomato spotted wilt virus on tomato

Other Disorders

Blossom-end Rot

The blossom end of the tomato fruit develops a circular black spot up to 3 cm in diameter. It may appear on green or ripe fruit. This condition is caused by a lack of calcium in the growing fruit. Uneven moisture supply and excess nitrogen fertilizer contribute to the problem.



Blossom end rot on tomato

Management:

Maintain a high calcium level in the soil by incorporating finely ground limestone at the rate of 1 to 2 kg/10 m² prior to planting. Provide uniform soil moisture throughout the growing season; mulching helps in this respect. Avoid over-fertilizing with nitrogen.

Foliar calcium sprays do not usually correct the condition in fruit since calcium does not readily move from leaves to fruit in the mature plant.

Leaf Roll

Plants are stunted; leaves roll up and become brittle. Unlike potato leaf roll, tomato leaf roll is not usually caused by a virus. Some varieties are more prone to leaf rolling, especially in hot, dry weather.

Management:

Tomato leaf roll may be caused by stressful growing conditions. Rolling can be reduced by improving soil fertility and ensuring adequate moisture is available at all times. Mulching will help to achieve this.

Turnips & Rutabagas

Insects

Red Turnip Beetle - See page 15-29.

Turnip Maggot and Cabbage Root Maggot

(*Delia radicum*)

This pest is the most significant pest of turnips and rutabagas in B.C. Turnip and rutabaga roots are tunneled and etched on the surface. This damage may later result in root rot or callused roots. The damage is done by white larvae, up to 6 mm long (see description and pictures on page 15-26). There are multiple generations per year, so damage can occur at any time up to harvest. In fact, the later damage can be the worst, as pest population builds up over the season and the roots are large and easy for the larvae to access.

Management:

Because turnips and rutabagas are such long-season crops, turnip maggot and cabbage maggot are very difficult to control. See cabbage maggot under cole crops, page 15-26, for information on management.

Diseases

Scab

(*Streptomyces scabies* and other *Streptomyces* spp.)

See Common scab in Potatoes on page 15-54. Rutabaga roots may have rings of scab, particularly in dry soil or in areas with high pH or high levels of potato scab.

Management:

Avoid excessive applications of lime, poultry manure or wood ashes to the soil, which will raise the soil pH. Avoid areas where potato scab has occurred. Provide moderate but uniform soil moisture during the growing season.

Crater Rot

(Rhizoctonia solani)

Circular depressions of 1 cm in diameter or larger are present on turnips or rutabagas at harvest. The infected area enlarges continually during storage, and by spring can destroy the entire root. It is caused by a common soil-borne fungus (*Rhizoctonia*) that enters roots during wet weather, or following wounding that may occur while hoeing or cultivating.

Management:

If damage occurs, plant in new garden soil. *Rhizoctonia* will also cause wirestem on cole crops and some other vegetables such as beans, peppers and tomatoes. (See “Wirestem”, page 15-13). Newly turned soil is preferred, but beware of wireworms (see page 15-12). Control cutworms, slugs and rodents that may damage rutabaga roots. Consume roots showing any crater rot first, as they will not keep as long as healthy ones.

Other Disorders

Brown Heart (boron deficiency)

Boron deficiency is very common in turnips and rutabagas especially in the Interior. Affected roots are dark brown and water-soaked in the centre. In severe cases, the centre becomes punky and hollow.

Management:

In the home garden, boron must be used with care because some vegetables, such as cole crops and tomatoes, require levels that will kill cucumbers and beans. One or 2 sprays during the growing season using borax at the rate of 2-3 mL/L water are recommended for turnips and rutabagas.

Caution: Do not apply boron to beans or cucumber (cucurbits) or to soil where they are to be grown.