Insect Pest Management

3

Best Management Considerations

INSECT PEST MANAGEMENT

This chapter provides information on the life cycle, identification, damage, monitoring, economic threshold, and control of major insect pests associated with standing and stored field crops grown in BC. This information is designed to encourage an integrated approach to controlling insect pests as described in the chapter *Integrated Pest Management, Chapter 1*. Additional useful information posted on the Internet is available through the Infobasket portal on the BC Ministry of Agriculture & Lands web site.

Economic threshold and insecticide recommendations listed for each pest/crop combination are based on the latest edition of the *Western Committee on Crop Pests Guide to Integrated Control of Plant Pests* posted at

www.westernforum.org/wccp_guidelines.htm

Information on application rates and timing, and other important instructions on proper use of control products recommended in this chapter, are available on-line from the Pest Management Regulatory Agency's label search web site at

http://pr-rp.pmra-arla.gc.ca/portal/page?_pageid=34,17551&_dad=portal&_schema=PORTAL

Another useful web site for information on the toxicity, use, harvesting and grazing restrictions for recommended control products is Alberta Agriculture & Food's The Insecticide Selector at

www.agric.gov.ab.ca /app23/pesticides/insecticides/getcrop.jsp

Technical information on recommended control products is provided in the on-line *2008 Guide to Field Crop Protection*© developed jointly by Saskatchewan Agriculture & Food

www.agr.gov.sk.ca/docs/ production/CropProtGuide2007_insect.pdf

and

Manitoba Agriculture, Food, and Rural Initiatives

http://www.gov.mb.ca/agriculture/crops/cropproduction/pdf/ gcp2007/insect.pdf

Additional information on sampling was obtained from the *2007 Guide to Field Crop Protection*; life cycle and damage information was obtained from *Insect Pests of the Prairies* (Hugh Philip and Ernest Mengersen, © University of Alberta 1989).

The application of best management practices to prevent or minimize crop losses due to insect pests begins with seeding and ends with the use or shipment of the crop after harvest. Best management practices to consider over the growing season include:

- Proper seeding density and depth to help the crop establish quickly and vigorously.
- Proper weed management to reduce competition and attracting plant pests that may move onto the crop.
- Proper nutrient management to optimize crop development that will help the plants withstand greater pest pressure.
- Weekly inspection of crops for the presence of insect infestations or signs of feeding damage.
- Applying integrated pest management practices (monitoring, accurate identification, use of economic thresholds) to determine if control action is required, what kind of action(s) to take, and when.

- Proper maintenance, calibration and operation of fertilizer spreaders and sprayers to ensure accurate application rates and coverage.
- Harvesting and storing the crop in a condition that will not attract or support insect and mite infestations.
- Thoroughly cleaning on-farm grain storage facilities to eliminate stored grain pests prior to harvest.
- Maintaining accurate records of crop and insect management activities in order to evaluate their outcomes and to make any necessary changes to overcome deficiencies the following season.

MONITORING AND CROP SAMPLING

Crop monitoring involves the continuous surveillance for a pest by regular crop sampling (daily, weekly, bi-weekly) or trapping using sticky traps, pheromone-baited traps, light traps, or pan traps. Sometimes the number of insects collected can be used to decide to spray the crop based on a recommended economic threshold value. Most often the trapping information has no bearing on the need for sprays but will identify crops that may be at risk of crop loss. To determine if and when a crop at risk needs to be sprayed, growers should conduct timely inspections of their crops for the presence and abundance of harmful and beneficial insects. Sampling plans are available for many field crop pests and they generally involve a systematic sampling protocol as follows. A 37.5 cm (15 inch) diameter insect sweep net makes the sampling for insects in crops much easier and more reliable in terms of pest detection. Check with your local BCMAL office for details on purchasing a sweep net. A canvas collection net is recommended over a mesh net for durability.

Once the presence of a pest or pests has been noticed in a crop and their numbers are of concern, beginning at one edge or in about 5 metres, follow a 'W' pattern across the field and at each of 5 – 10 sites along the pattern, examine 5 – 20 plants, or a prescribed area, or take 5 – 10 sweeps (depends on pest). One sweep is a 180º arc through the crop canopy as you walk into the crop. Record the numbers of insects found on each plant, in each sample area, or in each sweep net sample, and then calculate the average insects/sample. Compare this average value to the recommended economic thresholds to determine if the crop needs to be sprayed. Where possible, record the numbers of other pests present to provide early warning of a possible threat and need for later sampling. Use this sampling protocol to also determine the effectiveness of the control product and to determine if an additional spray is required (Is the pest population still over the economic threshold?). The spray need only reduce the population to below the economic threshold – 100% control is neither achievable nor warranted for most pests.

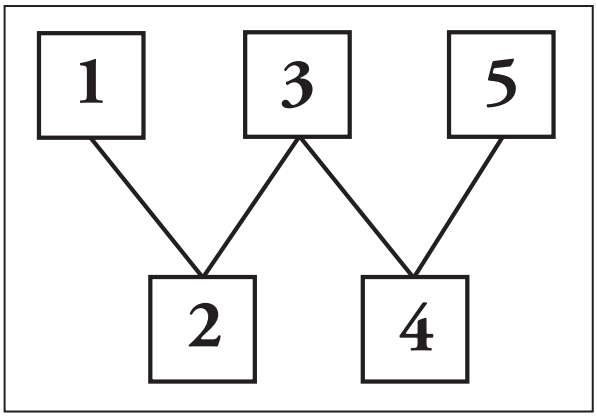

Figure 1. 'W' sampling pattern across a field showing five sample sites. More sample sites can be included along the pattern. The pattern can be repeated from each field margin if required.

INSECTICIDE RESISTANCE MANAGEMENT

Pest resistance to insecticides is caused by repeated exposure to insecticides that have the same mode of action (i.e. they kill the insects the same way). Within every population of insects there are individuals that can tolerate higher doses of insecticides. Repeated exposure of a pest population to the same type of insecticide selects the more tolerant individuals, and these eventually make up the total population. This results in failure of the insecticide product – and all related products – to control the pest.

To prevent or delay the development of insecticide resistance, follow these best management practices when selecting and using insecticides:

- Include non-chemical control methods (biological, cultural, physical) in pest control programs to minimize the need for or amount of insecticide application.
- Do not apply insecticides with the same Group Number (displayed on product labels) to the same generation of a pest or to successive generations. Rotate products with different Group Numbers within and between generations.
- Only apply an insecticide if the economic threshold is exceeded or damage is approaching unacceptable levels.
- Apply the rate(s) listed on the product label following proper mixing and application instructions.
- Keep accurate records of all insecticide applications, including product name, amount mixed per tank, volume of spray tank, spray volume per hectare or acre, and date of application. Weather conditions at the time of application and the following 2 days would also be useful.

When an apparent field failure occurs, availability of accurate spray records is essential to determine if the failure is a result of insecticide resistance development or misapplication of the product.

INSECT MANAGEMENT IN FIELD CROPS

Insect pests associated with the field crops described in this chapter.

Cereals, Corn	Forages (alfalfa, grasses)	Canola	Miscellaneous
Aphids Armyworm Barley thrips Cereal leaf beetle Cutworms Grasshoppers Hessian fly Wheat midge Wireworms	Alfalfa weevil Aphids Cutworms Grasshoppers	Alfalfa looper Aphids Bertha armyworm Cabbage maggot Cabbage seedpod weevil Clover cutworm Cutworms Diamondback moth Flea beetles Lygus bugs	Beet webworm European clover seed weevil and seed chalcids Red turnip beetle Seedcorn maggot Sweetclover weevil

Alfalfa Weevil *(Hypera postica)*

Hosts

Alfalfa, clovers, vetches

Life cycle

In the spring, female weevils move from over-wintering sites adjacent to fields into crops to lay eggs in holes chewed near the bases of the plant stems. Resulting larvae climb to the terminals where they feed for 3 – 4 weeks before pupating in leaf debris at the base of plants. The next generation of adults appears in July, feed for a short while, then disperse and remain inactive until September when they mate. Females seek sheltered sites outside the fields to over-winter.

Identification

The adult alfalfa weevil is a 5 mm long, and its head extends forward as a pointed snout with a couple of antennae close to the tip. It is gray with a wide dark band extending from the head backwards to about three quarters of the abdomen. Newly hatched larvae are light coloured but gradually turn green as they grow, and have a white stripe along the centre of the back. The head is always black; they are legless and 9 mm long when fully grown. These larvae closely resemble clover leaf weevil larvae in size and colour except the latter have brown heads.

Damage

Young larvae feed in terminal leaf buds. Older larvae skeletonize leaves by feeding on the green tissue between the leaf veins, causing the crop to take on a grayish hue as a result of the colour loss from the damaged leaves. Adults do no noticeable injury to alfalfa. Larval feeding reduces crop quantity and quality, and lost yield is not recovered in subsequent cuts. Re-growth after first cut is especially susceptible to damage if economic populations are not controlled prior to first cut.

Monitoring

Once the crop is about 15 cm tall in the spring, sample for adults using an insect sweep net and inspect plants for feeding damage or larvae as first cut approaches. Follow the sampling plan for aphids to determine the number of larvae/sweep or the proportion of damaged plants or leaves (see economic thresholds below). After the first cut, closely examine re-growth for larvae and follow the same sampling method to determine the need for control.

Control

Biological

The parasitic wasp, *Bathyplectes curculionis*, can kill up to 30% or more of alfalfa weevil larvae in a crop. Many predatory insects also feed on the larvae.

Cultural

When possible, take the first cut early to starve the larvae and reduce the next generation of weevils. This tactic will not work for alfalfa varieties that re-grow fast.

Chemical

Chemical control is not warranted unless the economic thresholds listed below are exceeded:

Alfalfa hay crops	24 – 50% of leaves on the upper 1/3 of the stem show damage; or
	50 – 70% of terminals show damage
Alfalfa seed crops	20 – 25 larvae/sweep (90º straight sweep); or
	35 – 50% of foliage tips show damage

Recommended control products:

Alfalfa hay crops: Cygon, Imidan, Malathion, Matador

Alfalfa seed crops: Cygon, Decis, Imidan, Malathion, Matador

Aphids

Hosts and species

Alfalfa

Pea aphid *(Acyrthosiphon pisum)*, cowpea aphid *(Aphis craccivora)*, spotted alfalfa aphid *(Therioaphis maculate)*, green peach aphid *(Myzus persicae)*

Canola

Turnip aphid *(Lipaphis erysimi)*

Cereals

English grain aphid *(Sitobion avenae)*, bird cherry-oat aphid *(Rhopalosiphum padi)*, rose grass aphid *(Metopolophium dirhodum)*, corn leaf aphid *(Rhopalosiphum maidis)*, Russian wheat aphid *(Diuraphis noxia)*, and the greenbug *(Schizaphis graminum)*

Life cycle

Aphids generally spend the winter as eggs on alternate hosts outside the fields. They fly into crops in the spring when the host crops have emerged to begin feeding and reproducing. Under warm, moist conditions, aphid populations can quickly grow and spread. The succulent growth of vigorously growing crops favours aphid population development.

Identification

Aphids are small (1 – 3 mm) soft-bodied insects that may or may not have wings, and vary in colour from yellow, green to reddish or black. Most aphids have two tube-like projections (cornicles) on the top of their abdomen and a narrowed tip at the end of the abdomen.

- **Pea aphid** – largest aphid on alfalfa (up to 3 mm long), pale green tips of cornicles black.
- **Cowpea aphid** – up to 2 mm long powdery purple to polished black with black cornicles, yellow legs and antennae; the only black species on alfalfa.
- **Spotted alfalfa aphid** – up to 2 mm long pale yellow with several rows of dark spots across their backs.
- **Green peach aphid** – up to 2.4 mm long, pale yellow to green adults (fall adults dark green to pink or red).
- **Turnip aphid** – up to 3 mm long, pale green with large, dark, elongated spots on back.
- **English grain aphid** – various colours (green, yellowish green, red or purple), 2.5 – 3 mm long with black antennae and cornicles; legs mostly black.
- **Bird cherry-oat aphid** – up to 2 mm long, olive-green to black aphids with a characteristic orange or red band across the back of the abdomen.
- **Rose grass aphid** – up to 3mm long light-green aphids with long legs and cornicles; legs, antennae, and cornicles are entirely pale. Resembles the greenbug but is lighter in color and larger.
- **Corn leaf aphid** – about 2 mm long, greenish-blue; cornicles, legs, and antennae are black; have a dark spot on the abdomen at the base of their cornicles.
- **Russian wheat aphid** – up to 2 mm long, pale green; cornicles are very short, rounded, and appear to be lacking; a unique characteristic is presence of two tail-like appendages on end of abdomen.
- **Greenbug** – about 2 mm long lime-green aphids with a darker green stripe down the middle of the back; cornicles are short; legs and cornicles have black tips.

Damage

Aphids feed by sucking plant sap that can weaken plants, especially under dry conditions. Infested leaves gradually wilt, discolour and die due to toxins in the saliva; infested grain heads can result in shriveled seed. Some species are capable of transmitting plant disease viruses such as barley yellow dwarf virus that can further reduce grain yields. Aphids also secrete sticky honeydew that causes leaves to appear shiny and on which black sooty mold can develop.

Monitoring

Check crops in June for aphids using sweep nets or beating plants over white cardboard. If their abundance is of concern, conduct a systematic sampling of the crop beginning about 5 metres

inside one edge and, following a 'W' pattern across the field, examine 20 plants or take 5 sweeps at each of 5 sites. Record the number of aphids per head, per stem, per terminal, or captured in the sweep net (depending on crop), and then calculate the average number of aphids per sample or sweep. This average value will be used to decide if chemical control is warranted based on the economic threshold (if available). Also record the number of predatory and parasitic insects present; control may not be required if most plants have one or more present.

Control

Biological

Several species of predatory insects such as adult and larval ladybird beetles, lacewings, ambush bugs, pirate bugs and hover fly larvae help bring aphid infestations under control. Parasitic wasps also help reduce aphid numbers. Their presence is indicated by brown or black, dark, mummified aphids.

Chemical

Apply a recommended control product only if pest populations exceed the following values based on field monitoring and few biological control agents are present.

Alfalfa: For pea aphid, 100 – 200 aphids/180º sweeps when the crop appears moisture stressed. For cowpea aphid, 10 – 15 aphids/stem for plants less than 25 cm (10 inches); 40 – 50 aphids/stem for plants greater than 25 cm high.

Recommended products: Matador, Malathion, Cygon/Lagon

Canola: 25 turnip aphids/10 cm shoot tip after flowering.

Recommended products: Cygon/Lagon, Gaucho Platinum seed treatment (suppression only)

Cereals: 12 - 15 aphids/per stem before the soft dough stage.

Recommended products: Cygon, Malathion

Armyworm, Cutworms, and Loopers

Armyworm *(Pseudaletia unipuncta)*, dark-sided cutworm *(Euxoa messoria)*, pale western cutworm *(Agrotis orthogonia)*, red-backed cutworm *(Euxoa ochrogaster)*, army cutworm *(Euxoa auxiliaris)*, alfalfa looper *(Autographa californica)*

Hosts

Cereals, canola, corn, forages, weeds, other cultivated crops

Life cycle

The dark-sided, pale western cutworm and red-backed cutworm over-winter as eggs in the upper 1-2 cm of soil. Larvae hatch the following spring once the soil warms up. By late June the larvae pupate in the soil and moths emerge about a month later to mate and lay eggs. The army cutworm and armyworm over-winter as small larvae in the soil and become active once the soil is warm. Over-wintering armyworm larvae mature in April and adults emerge in May to lay eggs that hatch into the first of two larval generations (June-July, September-October). Army cutworm larvae are present in April and May before pupating in the soil. Resulting adults seek sheltered sites to avoid high summer temperatures in July and August. In September eggs are laid and the new generation of larvae feed for a short time before entering the soil to over-winter. The armyworm has two generations per year: cutworms have only one.

The alfalfa looper over-winters as pupae in the soil from which adults emerge in the spring. Adults can also migrate up from the US if weather conditions are suitable. Females lay eggs on host crops (alfalfa, canola) in the spring. The larvae pupate on the host plants. A second generation of larvae appears in August and a few of these will survive disease and parasites to pupate in the soil.

Identification

Alfalfa looper, cutworm and the armyworm larvae are hairless, fleshy, smooth caterpillars that measure up to 40 mm in length when mature. They curl up when disturbed. The alfalfa looper gets it name from the looping motion of the greenish larvae as they move. There are many other species of cutworms that can be confused with their

more economically important cousins. There are many references available with colour images and descriptions to aid in distinguishing these larvae.

Damage

Army cutworm larvae feed during the day on upper plant parts whereas armyworm larvae feed on foliage at night. Pale western and red-backed cutworm larvae also feed at night but on or just under the soil surface, often severing the plants. Crops seeded into land recently in grass pasture or forage are at risk of subterranean cutworm infestations. The alfalfa looper is an infrequent pest of alfalfa in southern BC and of canola in the Peace River region.

Monitoring

Check for larvae along the margins of patches or edges of crops that fail to 'green up', that thin out, increase in area or lighten up in colour. Use a sweep net to check for climbing larvae (alfalfa looper, army cutworms and armyworms), and examine the soil at the edge of patches for the presence of subterranean cutworms (pale western, red-backed, dark-sided) that hide in the upper 2 – 5 cm of soil during the day.

Control

Cultural

Summer fallow fields recently used for pasture or hay production for one season before seeding to annual crops to discourage female moths from laying eggs. This includes controlling weeds and as well as volunteer forages. Areas subject to soil erosion should be left with a grass cover.

Biological

There are several diseases as well as parasitic wasps and flies and predatory insects that attack alfalfa looper, cutworm and armyworm eggs and larvae. Field outbreaks of most cutworms and armyworms last only one season due to the high larval and pupal mortality due to parasitic and predatory insects.

Chemical

Apply insecticides only where infestations exceed the recommended thresholds, usually the perimeter of infested areas within the crop and along the front edge of infestations moving in from the margins.

Economic thresholds: pale western cutworm, 3 – 4 larvae m^2; red-backed and army cutworm, 5-6 larvae/m^2.

For subterranean cutworms (dark-sided, red-backed, pale western) and the armyworm that feed at night, chemical control is most effective if applications are made in the evening. Do not disturb the soil after insecticide application for at least 24 hours. For foliar-feeding army cutworm, apply insecticides when the insects are actively feeding up on the plants (weather permitting).

Recommended control products (check the labels for listed species):

Alfalfa: Sevin (armyworm only), Dibrom (alfalfa looper)

Canola: Pounce, Lorsban/Pyrinex/Nufos/Clorex

Cereals: Decis, Pounce, Ripcord, Lorsban/Pyrinex/Nufos/Clorex

Corn: Matador, Ripcord, Pounce, Lorsban/Pyrinex/Nufos/Clorex

Barley Thrips *(Limothrips denticornis)*

Hosts

Barley

Life cycle

Female barley thrips overwinter in grasses surrounding fields and move into developing barley crops to feed and reproduce throughout the growing season.

Identification

Adults look like iron filings (1-2 mm long), brown to black in colour; young thrips are pale greenish-yellow.

Damage

If populations build up early, then blasting of the head (white head) can occur. Later damage will be indicated by a whitened leaf sheath and pale coloured flag leaf.

Monitoring: Between the first appearance of the flag leaves and just as the heads are emerging, examine10 plants at five sites along crop margins adjacent to grassy headlands and shelterbelts. Peel down the upper two leaf sheathes and count the sometimes rapidly moving adult and young thrips present.

Control

Biological

None

Chemical

Treat when thrips are equal to or greater than the number calculated by:

Threshold (thrips/stem) = (Cost of control ÷ expected $ value/bushel) ÷ 0.4.

To be effective, control products must be applied before the crop has completely headed out.

Recommended control products: Cygon, Lannate, Malathion

Bertha Armyworm *(Mamestra configurata)*, **Clover Cutworm** *(Discestra trifolii)*

Hosts

Canola, flax, cruciferous weeds

Life cycle

Bertha armyworm and clover cutworm overwinter as pupae in the soil. Bertha armyworm moths are present from mid June to mid July; clover cutworm moths are present in June and the second generation appears in late July into August. Bertha armyworm females lay eggs in flat clusters on the undersides of leaves of host plants. Larvae feed for 3 – 4 weeks before dropping the ground to pupate. There is only one generation per year. Clover cutworm eggs are laid singly on undersides of leaves, and larvae are present late June – early July, and again in August (second generation), this latter generation coinciding with presence of Bertha armyworm larvae.

Identification

Bertha armyworm - green to light brown caterpillars when small, becoming velvety-black with pale orange stripe on sides as they mature. Some larvae will remain green or brown. Mature larvae are about 4 – 5 cm long. Moths are predominantly dark coloured with a distinctive green patch at the base of each forewing.

Clover cutworm – similar to Bertha armyworm but most larvae are greenish to brown with fewer black larvae. Pupae are a little smaller and have a greenish tinge on the round end which is absent in the reddish brown pupae of Bertha armyworm.

Damage

Most damage is caused by nearly mature larvae feeding on green bark tissue from stems and pods. Infested areas in crop develop whitish colour. Early detection and caterpillar counts, when the armyworms are young, are required to avoid serious crop losses. Clover cutworm outbreaks may coincide with Bertha armyworm outbreaks.

Monitoring

Pheromone-baited traps are available to detect the presence and abundance of male moths and to determine the risk of subsequent larval infestations. For the purposes of determining the need for control, larval populations must be assessed in late July to early August. At 3 sites spaced 50 metres apart in the crop, shake the plants in a _ m^2 area and carefully count the number of larvae on the soil surface and hiding under leaf debris (especially on hot days).

Control

Biological

Both pests are attacked by many diseases, parasitic wasps and flies and predatory insects.

Cultural

Fall and spring cultivation of infested fields will kill some pupae and leave others exposed to freezing and predation by insects and birds.

Chemical

Treatment is required only when the number of larvae equals or exceeds the economic injury level. This level represents the number of larvae per square metre at which the cost of spraying per acre/ha equals or is less than the value of the crop saved. Using the table below, you can determine the economic injury level for your crop. As an example, for a crop valued at $7.00/bushel and spraying is calculated to cost $10.00/acre, the number of larvae/m^2 (economic injury level) that should be present to justify control is 25.

$ Value of Seed to Producer								
$/bushel		6	7	8	9	10	11	12
$/tonne		265	309	353	397	441	485	529
$ Cost/Spray /acre	/ha	Number of larvae/m^2						
7	17	20	17	15	13	12	11	10
8	20	23	20	17	15	14	12	11
9	22	26	22	19	17	16	14	13
10	25	29	25	22	19	17	16	14
11	27	32	27	24	21	19	17	16

Based on an average of 20 larvae/m2 consuming the equivalent of 65 kg of seed per ha (1.16 bu/ac). These thresholds apply to both Argentine and Polish varieties of canola, but not to mustards that are higher because they are a less preferred host and have a greater ability to compensate for feeding damage.

Recommend control products: Decis*, Lannate*, Lorsban/Pyrinex/Nufos/Clorex, Matador, Monitor, Ripcord (* only products registered for clover cutworm).

Caution: Refer to Protecting Pollinating Insects on page 26.

Cabbage Maggot *(Delia radicum)*

Hosts

Canola, mustard, other crucifer plants

Life cycle

Over-winters as pupae in the soil. Flies emerge in April and May; eggs are laid at the base of host plants. Larvae (maggots) feed for 3 – 4 weeks before pupating in the root or nearby soil. Next generation of adults appear in late summer, sometimes overlapping with the first generation. Larvae of this generation feed on roots of harvested plants before pupating for the winter.

Identification

Cabbage maggot flies resemble house flies but are smaller. Larvae are white, legless 6 – 10 mm-long maggots. Pupae are reddish, oval, about half the size of a kernel of wheat.

Damage

Because of overlapping generations, cabbage maggot larvae are present throughout the growing season, first feeding on small roots and root hairs, then feeding on the surface and burrowing into the tap- root. Infestations tend to be higher following cool wet spring weather. Heavy infestations can prevent flowering and cause severe lodging and yield loss. Polish canola varieties are more susceptible to maggot feeding than Argentine types. Feeding injury also allows rot fungi to enter roots and further stress the plants.

Monitoring

Sweep netting and yellow sticky cards can be used to detect adult presence and abundance in late spring to early summer. Where plants appear to be under stress (wilting, slower growth, prematurely yellowed leaves), carefully pull plants out of the soil and examine the taproot for feeding damage (channels, holes) or the maggots. You may have to open the taproot to locate larvae.

Control

No economic threshold is developed for cabbage maggot in canola or mustard.

Biological

All stages are attacked by one or more types of biological control agents.

Cultural

Fall and spring cultivation of infested fields will kill some pupae and leave others exposed to freezing and predation by insects and birds. A moderate increase in seeding rate may decrease damage because the higher density causes plants to have smaller stem diameters that are less attractive to cabbage maggot flies. Rotation with non-host crops will aid in reducing populations, however the fly can move several kilometers in search of host crops. Control of alternative cruciferous weed hosts (shepherd's purse, stinkweed, wild mustard and flixweed) will also aid in reducing risk of and intensity of infestations.

Chemical

None.

Cabbage Seedpod Weevil *(Ceutorhynchus obstrictus)*

Hosts

Canola, brown and wild mustard, other cruciferous plants. The pest is not known to occur in the Peace River region.

Life cycle

Adults over-winter in the soil under leaf litter in headlands, fencerows, and wooded areas adjacent to fields. Adults move into host crops in the spring to feed, mate and lay eggs in developing pods. Larvae feed inside the pods for 6 weeks before exiting the pods to pupate in the soil. The new generation of adults emerges in about 10 days and feed for a few weeks before entering over-wintering sites. There is only one generation per year.

Identification

The ash-gray 3 - 4 mm long adults have a long snout, typical of weevils. They play dead when disturbed. The white grub-like larvae have no legs or eyes.

Damage

Crop loss is caused by adults destroying developing flower buds and by larvae destroying seeds. One larva consumes up to 5 seeds during its development. Infested pods are also more susceptible to shattering. Under humid conditions, destructive fungi can enter pods through the exit holes of mature larvae and damage the remaining seeds.

Monitoring

Use a sweep net to collect adult weevils beginning at the bud stage and continuing through blossom. Following a 'W' sampling pattern beginning at the field margin, take ten 180º sweeps at each of 10 sites. Record the total weevils collected at each, then divide the total to calculate the average number of weevils/sweep. Consider also counting any lygus bugs present to determine if they pose a threat.

Control

Biological

Two parasites are known to attack the larvae in BC, however their low levels suggests they have little impact on keeping cabbage seedpod weevil populations below damaging levels.

Cultural

Alberta research has shown that a trap crop seeded around the perimeter of the main crop can effectively protect the main crop. The trap crop is either a Polish canola variety seeded around a later emerging Argentine variety, or the same variety as the main crop seeded 7 – 10 days earlier. The trap crop is sprayed as required to control adults and thus prevent infestations from reaching the main crop.

Chemical

The economic threshold for cabbage seedpod weevil is 3 – 4 adult weevils per sweep. Foliar sprays are most effective if applied when 10 – 20 % of the flowers are open (70% of plants have 3 – 10 open flowers). Application later in the day will minimize risks to beneficial insects and pollinators.

Recommended control products:

Foliar treatments: Decis, Matador

Seed treatments: Gaucho Platinum (suppression of larvae only)

Cereal Leaf Beetle *(Oulema melanopus)*

Hosts

All cereals (barley, wheat, oats, rye), corn, timothy, brome grass, rye grass, orchard grass, reed canary grass, quackgrass and other cultivated and wild grasses. In BC this pest is only found in the East Kootenays, the Creston Valley and the North Okanagan.

Life cycle

Adult beetles over-winter in and along the margins of grain fields in protected places such under crop and leaf litter, and in the bark crevices of shelterbelt trees. They emerge in the spring and begin feeding on grasses, then move into winter cereals and later to spring cereals. Eggs are laid on the plants upon which the adults feed for 6 weeks and where the larvae will feed for about 3 weeks (June) before entering the soil to pupate. Adult beetles emerge and feed for a couple of weeks before seeking over-wintering sites. There is one generation per year.

Identification

Adult beetles (4.5 - 5.5 mm long) have shiny bluish-black wing-covers, head, antenna and abdomen. The thorax and legs are light orange-brown. Eggs are cylindrical, measuring 0.9 mm by 0.4 mm, and yellowish in colour. Eggs darken to black just before hatching. The slug-like larva is slightly longer than the adult. The head and legs are brown-black; the body is yellowish. Larvae are usually covered with a secretion of mucus and faecal material, giving them a shiny black, wet appearance. To view colour photos of the life stages, visit the BCMAL web site

www.al.gov.bc.ca/cropprot/clbeetle.htm

Damage

Both the adults and larvae chew out long strips of tissue between the veins of leaves. Adults eat right through the leaf, but larvae eat the upper leaf surface leaving a thin membrane, giving a window-pane effect. Larvae attack the flag leaf, beginning at the tip and moving down the leaf. When damage is extensive the leaves turn whitish and the plant takes on the appearance of frost damage. Young plants may be killed or the yield may be seriously reduced.

Monitoring

Although crops may appear to be severely attacked, it is important to assess cereal leaf beetle abundance to ensure the value of potential crop loss is greater than the cost of chemical control. Host crops should be sampled before and after the boot stage. To determine if the action threshold has been reached, closely examine 10 tillers (stems) at 10 random sites throughout the crop (not within 2-3 metres of the field margins). Record the number of eggs and larvae per stem at each location.

Control

Biological

The parasitic wasp, Tetrastichus julis, was released in the Creston Valley in 2001 and 2003 to provide biological control of the cereal leaf beetle larvae.

Chemical

Chemical control is necessary if an average of 3 eggs or larvae, or both, per tiller are found before boot stage, and if an average of one larvae/flag leaf is found after boot.

Recommended control products: Malathion, Sevin

Diamondback Moth *(Plutella xylostella)*

Hosts

Canola, mustard, cruciferous weeds

Life cycle

Diamondback moths migrate each spring from the U.S. Outbreaks occur when high numbers arrive when canola crops have emerged on which mated females can lay eggs. All stages from eggs to adult moths will be present in the crop. There are up to 3 generations per season (21 – 51 days per generation).

Identification

Larvae are light green in colour, up to 13 mm long, and wriggle rapidly backwards and hang from a silk thread when disturbed. Adults are small, 9 mm-long grayish moths with white markings on wings that are folded along the back when at rest. Pupae are formed in lace-like cocoons attached to host plants.

Damage

Larvae initially mine the leaves before feeding for 10 – 21 days on the undersides of leaves causing irregular small holes. They also feed on the outer green tissue of stems and pods, causing the plants to appear bleached or whitish in colour. Severe debarking of pods causes reduced seed weights and increases shattering of pods. Larvae feed on or clip off flowers that can delay crop maturity and reduce yields, respectively.

Monitoring

Once the small moths are noticed flitting among the plants when disturbed, or captured in pheromone traps, sweep the crop weekly to check for larvae and adults. If numbers of larvae are a concern, shake plants in 50 cm by 50 cm area at 5 different sites 50 metres apart and count the larvae on the ground. Alternatively, carefully remove the plants from the sample area, shake over a light-coloured surface and count the larvae. Multiply the number of larvae counted by 4 to get the number of larvae per m^2.

Control

Biological

A number of parasitic and predatory insects, as well as spiders and birds, feed on the larvae. A fungal disease can reduce late-season populations to non-injurious levels. Inclement weather conditions (cool, wet, windy) can adversely affect adult mating and egg-laying activity and larval survival.

Cultural

None

Chemical

Recommended if larvae exceed 100 – 150/m^2 in immature to flowering plants and 200 – 300/ m^2 (2-3 larvae/plant) in plants with flowers and pods in crops with normal plant density. Threshold values are lower for thin stands and for Polish varieties, and higher for mustard.

> Recommended control products: Decis, Lorsban/Pyrinex/Nufos/Clorex, Malathion, Matador

Flea Beetles

Crucifer flea beetle *(Phyllotreta cruciferae)*, striped flea beetle *(Phyllotreta striolata)*

Hosts

Canola, mustard, other cruciferous plants

Life cycle

Over-winter as adults under leaf litter in the field or adjacent fence rows, shelterbelts and headlands. Adults emerge with warm spring weather in time to feed on host weeds and crops prior to mating and laying eggs in the soil. Larvae feed for 3 – 4 weeks before pupating in the soil. Adults emerge in late July – early August and remain active for a month or so before seeking overwintering sites. There is only one generation per year.

Identification

Crucifer flea beetles are 2-3 mm long and shiny black; striped flea beetles are same length and colour but have two wavy yellow stripes down their backs. Both species jump like fleas when disturbed.

Larvae are dirty-white in colour with brown heads, and measure 6 mm when mature.

Damage

Spring adults feed on emerging canola seedlings and on the cotyledons of emerged seedlings, causing thinned stands, delayed maturity and reduced yields. Severely attacked seedlings have a 'shot hole' appearance. Crops under stress due to hot dry weather suffer greater losses. Under windy wet conditions, flea beetles will hide under the cotyledons and attack the stems of seedlings, severing the stems or weakening them. Severely attacked crops may have to be reseeded. Plants at or beyond the 3 – 4 true leaf stage are able to withstand flea beetle attack. The summer generation of flea beetles feeds on pods but rarely causes noticeable crop loss.

Monitoring

Examine seedlings for shot holes caused by flea beetle feeding. Estimate the amount of leaf area missing (%) in each of 10 seedlings at 5 sites along a 'W' sampling pattern in the crop. Total the estimated percentages of leaf loss and divide by 10 to calculate the average % leaf loss/cotyledon.

Control

Biological

Not considered a factor in preventing or reducing flea beetle infestations.

Cultural

Damage to canola and mustard is greater in conventional tillage than with zero tillage. In conventional tillage, flea beetle damage to seedlings may be reduced by increasing seeding rates to 10 kg/ha and widening row spacings to 25 cm. In zero tillage, optimal rates to reduce flea beetle damage are about 8 kg/ha. Planting at the proper depth into a firm soil bed improves uniformity of seed germination and rate of establishment of seedlings and growth that improves their ability to withstand flea beetle attack.

Chemical

Canola and mustard can be protected by seed treatments, foliar sprays, or a combination of both under high or prolonged flea beetle attack. Yellow mustard seedlings are tolerant to flea beetle attack and should not require foliar or seed treatments.

Recommended control products:

Seed treatments: (no on-farm seed treating is permitted; seed drill application only) clothianidin, imidacloprid, thiamethoxam. Insecticidal seed treatments should be considered in fields with a history of flea beetle damage, or if flea beetles are present on crucifer weeds or volunteer crop plants prior to seeding. Seed treatments protect plants for 7 – 14 days after seeding.

Foliar treatments: Decis, Malathion, Matador, Ripcord, Sevin. Foliar sprays may be required where adult flea beetle feeding activity persists after the residual activity of the seed treatments has worn off. The economic threshold is 25% destruction of the leaf area of cotyledons and first true leaves, and beetles are present. If the damage and beetles are present only along field margins, limit sprays to the field margins. It is important to apply sprays quickly and preferably on warm days when the beetles are active and exposed to sprays.

Grasshoppers

Several species of grasshoppers attack field crops throughout BC, the most common being migratory *(Melanoplus sanguinipes)*, clearwinged *(Camnula pellucida)*, twostriped *(Melanoplus bivittatus)*, and Packard's grasshoppers *(Melanoplus packardii)*. For more detailed information on grasshoppers monitoring, identification and control, obtain a copy of the fact sheet *Grasshopper Monitoring and Control in British Columbia* from your nearest BCMAL office or download a copy from the BCMAL web site

www.al.gov.bc.ca/cropprot/ grasshopper.htm

The USDA-Agricultural Research Service Sydney, MT Research Lab's web site at

www.sidney.ars. usda.gov/grasshopper/

contains a useful on-line field guide to recognizing common western grasshoppers.

Hosts

Cereals, grasses, alfalfa, other crops

Life cycle

The species of grasshoppers that attack field crops over-winter as eggs laid during mid-July to early September in the soil in pods of 20 to 30 eggs. Eggs begin to hatch the following spring about mid-May, depending on the weather. The newly hatched grasshoppers (3 – 5 mm long) take about a month to mature into winged adults that may live until freeze-up. The female lays 2 to 3 egg pods a week until she dies.

The clear-winged grasshopper tends to lay eggs in concentrations or beds around sloughs and draws under range conditions. Egg beds will also be found in unbroken sod along roadsides, fences and pastures. In the first stage young hoppers are blackish with a prominent white collar. Where this type of grasshopper occurs, treatment of the egg bed area will prevent the infestation from spreading over larger areas. The migratory, two-stripped and Packard's grasshoppers tend to scatter their eggs on the drier hillsides and in weedy areas. The adults prefer to lay eggs where the sod has been disturbed and vegetation is sparse, such as stubble fields.

Identification

There are several identification guides published on the Internet to aid in identification of the common grasshopper species attacking field crops in BC.

Monitoring

It is important to locate infestations as early as possible in the spring. This is made easier by noting where grasshoppers congregate in the late summer to mate and lay eggs. To detect young grasshoppers, an insect sweep net is essential. Contact your nearest BCMAL office for information on purchasing a sweep net. A net can be made by putting a cloth bag on the rim of an ordinary fish net.

Damage

High grasshopper populations can destroy developing crops if left uncontrolled. Damaging infestations can start within fields or move in from adjacent ranges when the native grasses dry up in the summer. Grasshoppers can strip cereals and forages of leaves, and clip cereal heads near harvest. Grasshoppers compete directly with livestock for range forage, and left uncontrolled can reduce available forage and hence decrease expected weight gains of range cattle.

Control

Grasshoppers have a long history of cyclical isolated outbreaks throughout BC that may last 2-4 years.

Biological

Grasshoppers are attacked by at least 5 diseases, several species of parasitic flies and wasps, predatory insects (ants, ground beetles, etc.), spiders, and birds.

Chemical

Use the following table as a guide for taking a control action. The values represent the total number of both young and adult grasshoppers present per square metre.

Rating	Field	Roadside	Control Action
Normal	0 – 3	0 – 6	None required
Light	4 – 6	7 – 12	Usually not required
Moderate	7 – 12	13 – 24	May be required
Severe	13+	25+	Required

For rangeland, use the values under Roadside to establish infestation rating. The quality and quantity of the forage (AUM value), cost of alternative or supplemental forage sources and cost of control (product and application) should be considered when deciding whether control is justified.

Spraying should be done when most of the grasshoppers are in the third or fourth stage, about 6 - 8 mm long. This is usually during June. If sprays are applied too early, many eggs will not have hatched. If they are applied after grasshoppers have started to fly, control will be less effective and more costly because the adults will have spread over a large area and become more difficult to spray, and

higher application rates will be need (if allowed). Ranchers must get a permit from the Ministry of Environment before spraying which will only approve certain reduced risk products for hopper control on Crown land.

Recommend control products:

Alfalfa, Range pasture: Eco Bran*, Cygon/ Lagon, Malathion, Matador, Sevin

Canola: Eco Bran, Decis, Cygon/Lagon, Lorsban/Pyrinex/Nufos/Clorex Matador, Malathion, Ripcord, Sevin

Cereals: Eco Bran, Decis, Lagon, Lorsban/ Pyrinex/Nufos/Clorex Matador, Malathion, Ripcord (wheat and barley only), Sevin,

*Eco Bran is a spreadable bran bait containing Sevin that requires a special truck- or ATV-mounted applicator for proper application. The product should be targeted against young grasshoppers.

Hessian Fly *(Mayetiola destructor)*

Hosts

Wheat (preferred) barley, rye (oats are not attacked), quackgrass, timothy, western wheatgrass.

Life cycle

The fly over-winters as pupae that looks like a flax seed and is attached to the plant just below soil level. Adults emerge in the spring and lay eggs on leaves of developing plants. Maggots hatch 10-14 days later. There is one generation in the spring and one in the fall.

Identification

The adult is a delicate, small, mosquito-like fly, slightly less than 3 mm long. The body colour is grayish-black. Females have orange-red abdomens. The maggot-like larvae are orange when young and gradually turn white as they mature.

Damage

Maggots feed in the crown of the plant, causing the leaves of infested plants to turn bluish-green and stand more erect than un-infested plants. High populations can cause lodging, shriveled heads, reduced yields, and in extreme situations, plant death.

Monitoring

There is no monitoring method to determine the abundance of Hessian fly for the purpose of chemical control. Examine the crown area of plants for the presence of the flaxseed pupae or the small maggot-like larvae.

Control

Economically damaging populations have not been reported from British Columbia. Some export markets list Hessian fly as a quarantine pest.

Biological

None

Cultural

Never plant wheat in the same field for 2 consecutive years in areas where Hessian fly is a problem. Winter wheat planted in September will likely be free of Hessian fly. Eliminating or reducing volunteer wheat may reduce fly pressure. Deep plowing right after harvest is helpful.

Chemical

None

Lygus Bugs *(Lygus* spp.*)*

Hosts

Canola, mustard, alfalfa, many weeds

Life cycle

Lygus bugs over-winter as adults under plant debris adjacent to fields. The spring adults feed, mate and lay eggs on weed hosts upon which the immature Lygus bugs (nymphs) develop. The resulting adults move into near-by crops in late May to mid July (depending on region) to lay feed, mate and lay eggs. Nymphs develop on the crop and the next generation of adults appears in late August and September. These adults feed briefly before seeking sheltered over-wintering sites outside the fields.

Identification

The oval, slightly flattened adult lygus bugs are about 5 mm long and vary in colour from pale green to reddish-brown. They have a distinctive triangle or "V" mark about one-third of the distance down

the back, just in front of the wings. They are active fliers when disturbed. Young nymphs resemble pale green aphids except that they are more active. As the nymphs mature their appearance becomes for like adults but do not have wings.

Damage: Lygus bugs feed on growing parts of the plants. In canola, this means the flower buds, flowers, young pods and developing seeds. The feeding action on flower buds will destroy the blossoms; feeding on seeds causes the seeds to collapse or destroys the seed contents with no outward evidence of damage. Noticeable yield loss can occur if control action is not taken. Canola crops adjacent to alfalfa crops are very susceptible to invasion by lygus leaving the alfalfa when it is harvested.

Monitoring

Sample the crop using a standard insect sweep net at the end of flowering and again at the early pod ripening stage. Take a minimum of 10 sweeps per field at each of 15 sites beginning at the field margin following the 'W' sampling pattern described above. Sample on sunny days when the temperature is at least 20°C and the crop is dry. Do not confuse turnip aphids with young lygus bug nymphs. The latter move quickly whereas aphids walk very slowly and have the two 'tailpipes' extending from the top of their abdomens.

Control

Biological

All stages of lygus bugs are attacked by parasitic wasps, predatory insects and spiders. However their presence cannot prevent economic infestations under crop and weather conditions that favour lygus bug population development.

Cultural

There are no crop management practices to aid in managing lygus bug populations. When possible, do not harvest alfalfa adjacent to canola crops in early bloom to early pod ripening in order to avoid forcing the lygus bugs into the susceptible canola crop. If not possible, consider leaving a 10 metre-wide strip of un-harvested alfalfa adjacent to the canola to intercept lygus bugs. This may delay their movement into the canola and allow the crop to develop past the growth stages susceptible to lygus injury.

Chemical

Chemical control is not required when seeds are ripening (yellow or brown). The economic threshold for lygus bugs in canola is 10 – 18 bugs/10 sweeps from the end of flowering to early pod development in the upper canopy and 15 – 25 bugs/10 sweeps in early pod ripening stage. Alternatively, use the thresholds in the following table based on expected crop values and control costs. Under adequate moisture conditions during the bloom period, canola plants can partially compensate for lygus bug damage.

Recommended control products: Decis, Lorsban/Pyrinex/Nufos/Clorex, Matador, Gaucho Platinum (suppression only)

Application Costs ($/ha)	Canola Crop Stage[1]					
	4.4 – 5.1			5.2		
	Lygus bugs/10 sweeps					
22.00	14	12	10	20	17	15
24.00	16	13	11	22	18	16
26.00	17	14	12	24	20	17
28.00	18	15	13	25	22	19
Canola Price ($/t)[2]	220	260	300	220	260	300

[1]Crop stages 4.4 – 5.1 = the end of flowering to early pod development in the upper canopy; 5.2 is early pod ripening.
[2] Canola price is the weighted average price.

Wheat Midge *(Sitodiplosis mosellana)*

Hosts

Spring wheat is most susceptible to damage; however, winter wheat can be attacked if flowering occurs during adult midge presence.

Life cycle

Over-winter as larvae in the soil and pupate in the spring when soil moisture levels are high (outbreaks are usually preceded by exceptionally wet May and June). Adults emerge when crop is heading out and lay eggs in the developing heads. Mature larvae drop to the ground prior to harvest, although under hot dry conditions, larvae can be harvested with the crop.

Identification

Adults are small (3-4 mm) delicate flies with brownish bodies; females have orange abdomens. Young maggot-like larvae are white but gradually turn bright orange as they mature. Eggs are pale orange, about 1 mm long attached to seed heads. To view colour photos of the life stages, visit the BCMAL web site at

www.al.gov.bc.ca/cropprot/wheatmidge.htm

Damage

Larvae feed on developing kernels, causing the kernels to shrivel and be blown out of the hopper, or blemishing the kernels such that the grain is downgraded. Outbreaks are usually preceded by an exceptionally wet May and June.

Monitoring

Between boot stage and flowering of the wheat crop, examine 10 plants at 10 different sites throughout the crop at dusk. Record the number of adult midges on or near the heads, and calculate the average number of midge adults per head. Yellow sticky traps attached to metre-high stakes placed inside crop margins may be used to detect adult activity.

Control

Biological

Two species of parasitic wasps attack this pest in the Southern Interior, however they cannot prevent the midge from causing economic damage when conditions favour midge development and emergence in the spring.

Cultural

Seed alternate crops including barley. Farming practices that promote greater crop uniformity during heading and flowering (uniform seeding depth, higher seed rates to reduce tillering) reduce midge kernel damage but may not eliminate the need for chemical control.

Interior — Plant fall (winter) wheat.

Coast — Plant fall (winter) wheat, early planting of spring wheat.

Chemical

To avoid yield loss of up to 15%, control is recommended if 1 midge is found per 4 to 5 heads during this period. To prevent loss in seed quality, control is recommended if 1 adult fly is found per 8 – 10 plants. Applications should be made in the late afternoon or early evening when temperatures exceed 15°C and the wind speed is less than 10 km/hr; applications can also be done under similar weather conditions. Apply the insecticides in 20 to 80 L of water/acre (50 to 200 L/ha) with 45° nozzle orientation and fine droplets in order to obtain the full benefits from the insecticidal sprays.

Recommended control products: Cygon, Lorsban/Pyrinex/Nufos/Clorex

If using Cygon, apply immediately after treatment threshold (1 midge per 4-5 heads). Another treatment is required if midge persists 3-7 days after first treatment and the crop has not completed flowering. If using Lorsban/Pyrinex/Nufos/Clorex, wait until 70% of the wheat heads have emerged. These products kill eggs and young larvae, so application can be delayed up to 4 days after midge threshold is reached. Timing of the spray application is critical to ensure good control.

Wireworms

Several economic species of wireworms are present in BC. Two species of wireworms in the Lower mainland originate from Europe – the dusky wireworm *(Agriotes obscurus)* and the lined wireworm *(Agriotes lineatus)*. These species have yet to be reported from the Interior.

Hosts

Cereals, corn, root crops, grasses, potatoes

Life cycle

Wireworms are the larvae or immature stages of click beetles. Adult beetles emerge in the spring and from late April to June, females lay eggs in the soil. Larvae hatch and begin feeding on germinating seeds and plant roots or tubers. All larval stages are spent in the soil and, depending on availability of food, may require 2 – 6 years to reach maturity.

Identification

Young wireworms are small (3 mm), white and worm-like with 3 pairs of legs. Later stages become long (1 – 4 cm), slender, shiny yellow-brown with hard 'wiry' bodies. Adults are 1 – 2 cm long black beetles most of which can fly. Adults are known as click because of the characteristic click sound the make when they try to right themselves when overturned.

Damage

Only the larvae damage crops. Preferred food plants are mainly the roots and germinating seeds of grasses and cereal grains, but when unavailable, the below ground parts of weeds and other plants are fed on. Additional crop loss occurs when birds, especially crows, pull young seedlings from the ground in search of wireworm larvae feeding on the seed and roots.

Wireworms are highly attracted to CO2 given off by growing seeds and roots. Food plants are located by following CO2 concentration gradient to their source. Newly hatched wireworms must feed within 1 – 3 weeks or starve, but older larvae are able to survive for up to 2 years without feeding. Wireworm populations are usually highest and more damaging to crops seeded into newly broken sod.

Monitoring

Because there are no control options for wireworms after crops are seeded, growers should determine the presence of wireworms before planting a susceptible crop. All the methods of detection outlined below for the lower Fraser Valley are also effective in the Interior except that the wireworms in the Interior may descend to a depth of 60 cm in the fall and may not return to near the surface until the soil warms up sometime in May. Attempts to determine the presence of wireworms in these areas before this time may indicate a lower population than actually exists.

There are several methods of detecting the presence of wireworms in a field. In the lower Fraser Valley and on Vancouver Island wireworms stay within disc depth all year. Therefore by following the plough or disc, growers can determine the presence and severity of an infestation. After ploughing and before planting, baits of whole wheat flour can be used to determine the presence of wireworms. This is done by placing 30 mL (2 tbsp) of flour or oatmeal patty at a depth of 10 cm in the soil using a shovel and marking the location of the bait with a stake. At least 50 baits should be used per hectare. (see Note below). Four days later dig up and examine the baits for wireworms. An average of 1 or more wireworms per bait can cause severe damage to susceptible crops such as corn or potatoes. Baits can be used from April to September in the lower Fraser Valley but are not effective in cold, wet, or dry conditions. In the BC Southern Interior, baits should be set out in late April and May prior to seeding. Since wireworms can take several years to mature, fields that have a record of wireworm damage are still infested. Fields adjoining an infested field should be checked before planting. The natural habitat of wireworms is sod, therefore populations increase under these conditions.

Annual sampling for wireworms will determine the need for continued use of seed treatments, which in most fields, are only required for 2 – 3 years following conversion from pasture or hay production.

Note: Fewer bait stations might be used over a large field to give an indication whether wireworms are present.

Control

Biological

Research is underway on the use of a strain of fungus infecting wireworms near Agassiz. Wireworms are attacked by parasitic nematodes.

Cultural

Leave fields recently used for perennial crops (pasture, hay, sod production) as summerfallow for one year before seeding. Cultivate summerfallow fields in late spring to mid-summer. Removing all vegetation will starve newly hatched wireworms and help reduce infestations.

Chemical

There are no products registered for control of wireworms once the crop is seeded. Treating seed with a control product formulated for such use is the only effective way to protect germinating seeds and seedlings from wireworm attack. Seed treated with one of the recommended seed treatments is only available from seed suppliers. Before using seed treatments, be sure wireworms are the cause of damage, as other factors could be responsible (drought, ground squirrels, cutworms).

Recommended control products (treated seed is only available from authorized dealers):

Cereals: Cruiser Maxx, Poncho

Corn: Cruiser Extreme, Poncho

See dual purpose seed treatments in the Field Crop Seed Treatment Section of this guide, page ??.

Best returns will be obtained with wireworm seed treatments if used:

1. for spring seeding into broken sod or after summerfallow;
2. in fields where previous wireworm damage has occurred;
3. with good seeding methods that promote early, vigorous and uniform plant growth.

MISCELLANEOUS PESTS

This section briefly describes some pests that occur very intermittently and are thus not considered major pests of field crops. However they can cause economic losses in outbreak levels so producers should be aware of their existence.

1. Red turnip beetle *(Entomoscelis americana)*

The red turnip beetles are 7 – 10 mm long, bright red with three distinct black stripes running down their backs. They over-winter as eggs in canola crops. The eggs hatch in spring and larvae feed on volunteer canola and crucifer weeds. Mature larvae pupate in the soil and adults emerge around late may to early June. If the volunteer and weed hosts are consumed, the adults walk to nearby seedling canola crops where they can destroy crops if left uncontrolled, and reseeding may be required. Often the seedlings recover, however the damaged plants mature later and harvest may be delayed and disrupted by inclement harvest weather in the fall. Beetles hide in the soil under crop debris during June and July, then emerge and disperse in late July – early August to mate and lay eggs at the base of canola plants. The late summer feeding does not cause economic injury as the populations are not concentrated as in the spring.

Control

Cultural: Spring cultivation of volunteer canola and cruciferous weeds will starve larvae. Fall cultivation will bury eggs and decrease egg hatch and larval emergence the following spring. Avoid seeding canola as a nurse crop for forage crops as the canola supports red turnip beetle population development in the spring.

Chemical

If red turnip beetles were a problem the previous year, closely monitor the margins of newly emerged canola crops for migrating adult beetles. If insecticide application is necessary, wait until the majority of the beetles have entered the crop and spray the moving "front", or make repeat applications as the beetles appear along the field margins.

Recommended control products: Furadan

2. Beet Webworm *(Loxostege sticticalis)*

Beet webworm moths are small, light brown and easily spotted flying among plants when disturbed. Larvae are slim, active, dark green to black caterpillars measuring up to 30 mm long when mature. Mature larvae have an irregular black stripe on backs formed by two white stripes and circular markings. They eat leaves, flowers and the green tissue from stems of canola, the latter producing a whitish appearance in the crop. There are two generations each year with crop damage occurring in July and again in August.

Control

Chemical

If insecticide control is warranted when the crop is in bloom, check the Protecting Pollinating Insects section before spraying.

Recommended control products: Decis, Lannate.

3. Clover Seed Weevil *(Tychius picirostis)* and Clover Seed Chalcid *(Bruchophagus patypterus)*

Immature stages feed and destroy the developing seeds within pods reducing yields. The small (2.5 mm) weevils attack alsike, white and ladino clovers while the tiny (1.5 mm) chalcids attack all clovers and alfalfa.

Control

Chemical

Treat clovers when an average of two adult weevils is present in sweep net samples and before 20% of the heads have turned brown. This spray will also help control seed chalcids.

Recommended control products: Malathion

Caution: to protect bees, spray only in evening and do not bring hives into fields for a minimum of 24 hours after spraying.

4. Sweetclover Weevil *(Sitona cylindricollis)*

Crescent shaped notches are eaten from the edges of leaves by grayish weevils. When disturbed, weevils fall from plant and "play possum". They feed at night on seed and hay crops. The larval stages are small white grubs that feed on clover roots. Only the adult stage over-winters. Early weevil feeding on seedling plants, and the defoliation occurring in August and September on first year plants, causes most severe damage.

Control

Cultural

Locate new plantings as far as possible from 2nd year stands to avoid damage from weevil migrations. Cultivate shallow as soon as possible after harvest to destroy new populations of weevils in the soil.

Chemical

In the spring of the year the crop is seeded, treat when there is one weevil per 3 to 5 seedlings. In late summer treat when defoliation begins or treat only the margins of fields where weevil migration is occurring.

Recommended control products: Cygon/ Lagon, Malathion

5. Seedcorn maggot *(Delia platura)*

Adults are small flies that resemble small house flies. Larvae are small (6 mm long) yellowish-white legless maggots that attack germinating seeds. Partly eaten kernels may germinate but in most cases soon die. Damage may be scattered over the field and go unnoticed. It becomes worse when any condition delays germination.

Control

There are no controls for active infestations of seedcorn maggot.

Cultural

Later seeded crops are less at risk of seedcorn maggot damage because the seeds germinate faster and more seedlings become established. Also,

fields kept free of plants prior to seeding are less attractive to egg-laying female flies.

Chemical

Only seed treatments are effective in reducing seedcorn damage.

Recommended control products: Agrox, Cruiser, Diazinon

PESTS OF FARM STORED GRAIN

Grain to be used for either human or animal consumption should be kept clean and free of any contamination. During storage, insect and mite infestations can contaminate and destroy the grain, making it unfit for food or feed purposes. In British Columbia there are only a few storage insects that cause losses periodically. Rusty grain beetles are the main insects in the Peace River area; granary weevils and mites are more of a problem in coastal areas in feed grains. Red flour beetles and saw-toothed grain beetles are less often found to infest grain. If grain is contracted to a local mill, check to determine their insecticide preference.

1. Rusty Grain Beetle *(Cryptolestes ferrugineus)*

This is the worst stored grain pest in the Peace River grain growing area. The beetle is reddish-brown, 2 mm long, narrow and flattened. At temperatures above 24ºC the beetles will fly. They move quickly in warm grain. Eggs are laid among grain kernels where they hatch in 3 to 5 days. A larva feeds first on the kernel then penetrates the germ of the kernel. In wheat, at 32ºC and 15% moisture content, adults take 3 weeks to develop from eggs. Adults live 6 to 9 months and each female can lay 100 – 200 eggs.

2. Red Flour Beetle *(Tribolium castaneum)*

The beetle is reddish-brown and 4 mm long. Each female can lay 300 to 400 eggs. However, egg laying only takes place above 20°C. The larvae are whitish with pale brown bands across the body. They reach 6 mm in length when fully grown. Development from egg to adult, at 35°C and 70 – 90% relative humidity, takes 15 – 20 days. The beetles fly at temperatures above 25°C. Temperature limits for complete development are 20°C – 40°C, a factor which accounts for their presence in low numbers.

3. Sawtoothed Grain Beetle *(Oryzaephilus surinamensis)*

This slender beetle is brown, flat, and 3 mm long. The body part behind the head bears six tooth-like projections on each side. Beetles live 6 - 10 months, during which time a female can lay 150 eggs. Eggs hatch in 3 – 5 days; larvae feed and develop fully in 2 weeks. Pupation lasts 1 week. Development from egg to adult takes 3 – 4 weeks in warm weather. This beetle can exist at great depths in grain; it destroys the germ of the wheat kernel and causes grain to heat.

4. Granary Weevil *(Sitophilus granarius)*

This beetle is dark brown to blackish, 5 mm long, with the head prolonged into a long slender snout, and flightless. Beetles live 7 – 8 months and females lay about 150 eggs during that time. The female chews a small hole into a kernel, lays one egg in it, and seals it with a gelatinous material. The white legless grub feeds and develops inside the kernel. The new adult chews its way out of the kernel. Development from egg to adult can be completed in 4 weeks in summer.

5. Grain Mite *(Acarus siro)*

There are two species of mites that infest grain. They are not insects, though they are controlled with the same methods and materials as insects.

They are minute in size, grayish to brown with hairy bodies. They do not live as long as the insects described earlier; females lay only 20 to 30 eggs, and development takes 2 – 3 weeks from egg to adult.

Grain must contain at least 14% moisture for high mite numbers to develop. The surface layer in a bin is most prone to mite infestations.

Infestation Prevention and Control

Prevention

It is much easier to prevent an infestation than to control one. Start with clean and dry (12% moisture or less) grain. The bin or granary must be free of insects and mites. Cracks and crevices in walls and floors should be vacuumed clean with a power vacuum. Burn all sweepings. Then use premium grade deodorized malathion to spray the walls and floor at least 2 – 4 weeks before putting new grain in. In addition, spray around the outside edge of bins and elevators. All machines used in grain handling must be free of old grain residues from the previous season, as grain insects are certain to be breeding there. Machinery used for moving feed grain during the year should be thoroughly cleaned of old grain.

Products such as Insecto and Protect-It containing diatomaceous earth (silicon dioxide) are registered for control of stored-grain insects in empty grain bins as crack and crevice treatments. The material provides a physical method of control. Weeks to months are needed to complete control.

Control

If an infestation is detected in winter, moving the grain and cooling it to below -7°C for 6 weeks will control infestations. At -20°C, infestations will die in a few days. Since more farmers now have aeration equipment, treatment is easier to carry out. Use the aeration system when outside temperatures are -20°C to -30°C to lower the grain temperature to the desired level.

If the grain has to be dried, drying temperatures between 50 to 55°C for more than 15 minutes will kill all stages of stored grain insects present.

If it is necessary to use a chemical to control grain pests, malathion, especially formulated to be used in grain, can be metered into the auger. Do not apply those within 7 days of selling, or within 60 days for standard grades of malathion (check label). Diatomaceous earth products can also be augered in with the grain.

Fumigation with aluminum phosphide products can be done only by a certified applicator in British Columbia. Fumigation should not be attempted when grain temperatures are below 4°C.

NOTE: *If grain is to be processed into cereal products, check with the mill (processor) before treating for possible restrictions on the use of malathion for stored grain insect control or bin disinfestation. Some importing countries have zero tolerance for malathion residues in cereal products for human consumption. Products containing aluminum phosphide or diatomaceous earth are suitable and effective alternatives for stored grain insect control.*

FOLIAR FIELD CROP INSECTICIDE RECOMMENDATIONS

The following table summarizes insecticide products prescribed for use in British Columbia on field crops described in this chapter. Information provided includes the insects and crops the products are registered for, the pre-harvest interval, the active ingredient and the insecticide resistance group. Rotate products with different group numbers for resistance management purposes. Always refer to the product label for complete use instructions, precautions and limitations. Labels are available on the PMRA website at:

http://pr-rp.pmra-arla.gc.ca/portal/page?_pageid=34,17551&_dad=portal&_schema=PORTAL.

Table 6: Field Crop Foliar Insecticides

Insecticide	Active Ingredient	Crops	Insects	PHI*	Comments
Clorex, Lorsban, Nufos, Pyrinex	chlorpyrifos Group 1B Insecticide	Barley, oats, wheat	Armyworm, cutworms, grasshoppers, aphids, wheat midge	60 days	Refer to label for rates and number of applications per season.
		Canola	Alfalfa looper, Bertha armyworm, cutworms, diamondback moth, lygus bugs	21 days	Apply one application per season (max. 4 for diamondback moth)
		Field corn	Black, dark-sided, red-backed cutworms	70 days	Apply pre-plant or at 2 to 5 leaf stage of crop.
Cygon, Lagon	dimethoate Group 1B Insecticide	Alfalfa	Aphids, alfalfa weevil	2 days	
		Alfalfa (seed production)	Lygus bugs	28 days	Apply at least 10 days before placing leafcutter bees in field.
		Canola	Aphids, grasshoppers	21 days	
		Alsike and red clover, sweetclover	Sweetclover weevil	28 days	
		Alfalfa, grass/clover forage crops, pasture	Grasshoppers	2 days	Apply in the 2 to 4 nymphal stage and prior to wing development.
		Barley, oats, wheat	Aphids, grasshoppers, thrips	2 days	
		Wheat	Wheat midge, Russian wheat aphid	21 days	2nd application can be made if population persists at 3 to 7 days.
Decis	deltamethrin Group 3 Insecticide	Alfalfa (seed production)	Alfalfa weevil, lygus bugs	20 days	Max. 1 application per year on Bertha armyworm, cutworms and diamondback moth. Max. 3 applications for other pests. Pastures may be grazed immediately after application.
		Barley, oats, wheat	Cutworms, grasshoppers	40 days (barley, wheat) 31 days (oats)	
		Pasture	Grasshoppers		
		Canola	Bertha armyworm, clover cutworm, diamondback moth, flea beetles, grasshoppers, cabbage seedpod weevil	7 days	
Dibrom	naled Group 1B Insecticide	Alfalfa	Alfalfa looper	4 days	
Eco Bran	carbaryl Group 1A Insecticide	Barley	Grasshoppers	28 days	Repeat as necessary but not more than once per week for high infestation or twice per week for moderate to low populations. Beef cattle re-entry (1 day) Dairy cattle re-entry (2 days)
		Oats, rye, wheat		14 days	
		Field corn		1 day	
		Canola		(seedlings only)	
		Alfalfa, clover		2 days	
		Pasture			

Table 6: Field Crop Foliar Insecticides *Continued*

Furadan	carbofuran Group 1A Insecticide	Canola	Red turnip beetle	60 days	
Imidan	phosmet Group 1B Insecticide	Alfalfa	Alfalfa weevil	7 days	Max. 1 application per cutting. Do Not apply during bloom.
Lannate	methomyl Group 1A Insecticide	Canola	Bertha armyworm, beet webworm	21 days	
		Barley	Thrips	20 days	
Malathion	malathion Group 1B Insecticide	Cereals	Aphids, cereal leaf beetle, grasshoppers	7 days	In forages and pasture remove cattle prior to spraying. Cattle can be returned immediately after treatment.
		Alfalfa	Alfalfa weevil, aphids, grasshoppers	7 days	
		Canola	Diamondback moth, grasshoppers, flea beetles	7 days	
		Alsike, white and Ladino clover	Clover seed weevil	7 days	
		Sweetclover	Sweetclover weevil		
		Pasture	Grasshoppers	0 days	
Matador	cyhalothrin lambda Group 3 Insecticide	Alfalfa	Alfalfa weevil, aphids, lygus bugs		
		Canola	Bertha armyworm, cabbage seedpod weevil, diamondback moth, flea beetles, grasshoppers, lygus bugs	7days	Apply at the bud to early flowering stage for cabbage seedpod weevil control. Larvae developing inside the pod are not controlled.
		Field corn	Cutworms, fall armyworm	14 days	Apply to cutworms in moist conditions in evening/night when cutworms most active.
		Cereals	Grasshoppers	28 days	Do not graze for 14 days after application.
		Timothy		14 days	
Monitor	methamidophos Group 1B Insecticide	Canola	Bertha armyworm	10 days	
Pounce	permethrin Group 3 Insecticide	Cereals, canola	Cutworms		Only surface feeding or climbing stages of cutworms are controlled.
Ripcord	cypermethrin Group 3 Insecticide	Barley	Grasshoppers	45 days	
		Wheat		30 days	
		Canola	Bertha armyworm, flea beetles, grasshoppers	30 days	
Sevin	carbaryl Group 1A Insecticide	Alfalfa	Armyworm, grasshoppers	2 days	Remove cattle from area being sprayed. Beef cattle re-entry (1 day) Dairy cattle re-entry (2 days)
		Canola	flea beetles	(seedling only)	
		Barley	flea beetles, cereal leaf beetles	28 days	
		Wheat, oats, rye		14 days	

*PHI = pre-harvest interval, or days to harvest. Indicates the minimum number of days between final application and harvest date as specified on the pesticide label.