Agriculture and Agri-Food Canada
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Crop Profile for Cherry in Canada, 2013

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Canada

First Edition - 2006
Crop Profile for Sweet Cherries in Canada
Catalogue No. : A118-10/12-2006E-PDF

Second Edition - 2015
Crop Profile for Cherry in Canada, 2013
Catalogue No.: A118-10/35-2013E-PDF
ISBN: 978-1-100-25807-2
AAFC No.: 12339E

Electronic version available at www.agr.gc.ca/pmc-cropprofiles

Paru également en français sous le titre: « Profil de la culture de la cerise au Canada, 2013 »

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Preface

National crop profiles are developed under the Pesticide Risk Reduction Program (PRRP), a joint program of Agriculture and Agri-Food Canada (AAFC) and the Pest Management Regulatory Agency (PMRA). The national crop profiles provide baseline information on crop production and pest management practices and document the pest management needs and issues faced by growers. This information is developed through extensive consultation with stakeholders.

Information on pest management practices and pesticides is provided for information purposes only. No endorsement of any pesticide or pest control technique discussed is implied. Product names may be included and are meant as an aid for the reader, to facilitate the identification of pesticides in general use. The use of product names does not imply endorsement of a particular product by the authors or any of the organizations represented in this publication.

For detailed information on growing cherry, the reader is referred to provincial crop production guides and provincial ministry websites listed in the Resources Section at the end of the profile.

Every effort has been made to ensure that the information in this publication is complete and accurate. Agriculture and Agri-Food Canada does not assume liability for errors, omissions, or representations, expressed or implied, contained in any written or oral communication associated with this publication. Errors brought to the attention of the authors will be corrected in subsequent updates.

Agriculture and Agri-Food Canada gratefully acknowledges the contributions of provincial crop specialists, industry specialists and growers in the gathering of information for this publication.

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Crop Profile for Cherry in Canada

Cherries (*Prunus* spp.) are stone fruits, members of the Amygdaloideae, a subfamily of the rose family, Rosaceae. The Amygdaloideae includes a number of commercially important fruit such as cherry, apple, pear, peach and plum as well as ornamental species.

Two types of cherry are important commercially world-wide: the sweet cherry *Prunus avium* and the sour or tart cherry *Prunus cerasus*. Both species are native to Europe and western Asia and are believed to have originated in the region between the Black and Caspian seas. The fruit has been cultivated since Roman times.

Cultivated cherries were introduced into North America in the 1800's by European settlers. Both sweet and sour cherries are produced in Canada.

Sweet cherries were first planted in the Okanagan Valley of British Columbia in the late 1800's. Production expanded significantly in the early 1900's with the development of the Kettle Valley Railway which provided a link to markets on the coast. The sweet cherry breeding program at the Pacific Agricultural Research Station at Summerland, British Columbia has produced many new commercial varieties of sweet cherry with improved traits such as self-fertility, improved fruit size and later harvest, which have helped to make the industry more competitive.

Sour cherry is grown primarily in southern Ontario where the moderate climate is more suitable to the production of this crop.

A dwarf sour cherry adapted to the colder climate of the Canadian Prairies has been developed by plant breeders at the University of Saskatchewan (www.fruit.usask.ca/dwarfsourcherries.html). The first cultivar, Carmine Jewel was released in 1999, with cultivars Romeo, Juliette, Valentine, Crimson Passion and Cupid released in 2004. These winter-hardy, drought tolerant cherries grow as a shrub on their own rootstocks and reach heights of 3 meters.

Crop Production

Industry Overview

In 2013, sweet cherries ranked ninth and sour cherries 12th in marketed production among other fruits grown in Canada (Statistics Canada, CANSIM database, Table 001-0009). Canadian sweet cherry production totaled 11,475 metric tons on 1,794 hectares, with a farm gate value of $44 million. Sour cherry production totaled 6,436 metric tons on 1,044 hectares and had a farm gate value of $4.6 million (Table 1).

Sweet cherries are normally consumed fresh. Sour cherries are used for processing as pie fillings, juice, preserves and as dried fruit as they retain their shape and remain firm with processing. Their tart flavour tends to become sweeter with processing. The use of the dwarf sour cherries (whether eaten fresh or processed) varies with cultivar.

Cherries are high in Vitamin C, potassium and fibre. Cherries are high in anti-oxidants known for their anti-inflammatory, anti-viral and anti-cancer properties.

Table 1. General production information

Crop	**Sweet cherry**	**Sour cherry**
Canadian Production (2013)[1]	11,475 metric tonnes 1,794 hectares	6,436 metric tonnes 1,044 hectares
Farm gate value (2013)[1]	$44 million	$4.6 million
Fruit available in Canada 2013[2]	0.79 kg/ person/ year (fresh cherries)	
	0.33 kg/ person/year (frozen cherries)	
Exports (2013)[3]	6,260 tonnes (fresh cherries)	
Imports (2013)[3]	24,800 tonnes (fresh cherries)	
	5,950 tonnes (frozen cherries)	

[1]Statistics Canada. Table 001-0009 - Area, production and farm gate value of fresh and processed fruits, by province, annual CANSIM (database) (accessed: 2015-01-22).

[2]Statistics Canada. Table 002-0011- Food available in Canada CANSIM (database) (accessed 2015-01-22).

[3]Statistics Canada. Table 002-0010 -Supply and disposition of food in Canada CANSIM (database) (accessed 2015-01-22).

Production Regions

Due to sensitivity to spring frosts and untimely rains, sweet cherries can be grown commercially in only a few areas in Canada. British Columbia is the largest producer of sweet cherries, accounting for 1,593 hectares or 89% of total Canadian production. The key production areas are the Okanagan, Similkameen and Kootenay Valleys. Ontario produces most of the remaining 11% or 197 hectares of sweet cherry.

Sour cherries are grown primarily in Ontario, which accounts for 892 hectares or 85% of national hectares. Regions of Ontario important for growing sour cherry (and sweet cherry) include the Niagara Peninsula, Essex and Kent counties and the Lake Huron shoreline southwards from Goderich.

Sour cherry production in Saskatchewan has expanded to comprise 80 hectares or 8% of the total sour cherry production in Canada (Table 2).

Table 2. Distribution of Cherry production in Canada (2013)[1]

Production Regions	Sweet Cherry	Sour Cherry
	Planted Area 2013 (hectares) (percent national production)	**Planted Area 2013 (hectares) (percent national production)**
British Columbia	1,593 (89%)	a[2]
Saskatchewan	-	80 (8%)
Manitoba	-	2 (<1%)
Ontario	197 (11%)	892 (85%)
Quebec	-	a[2]
Nova Scotia	4 (<1%)	-
Canada	1,794 (100%)	1,044 (100%)

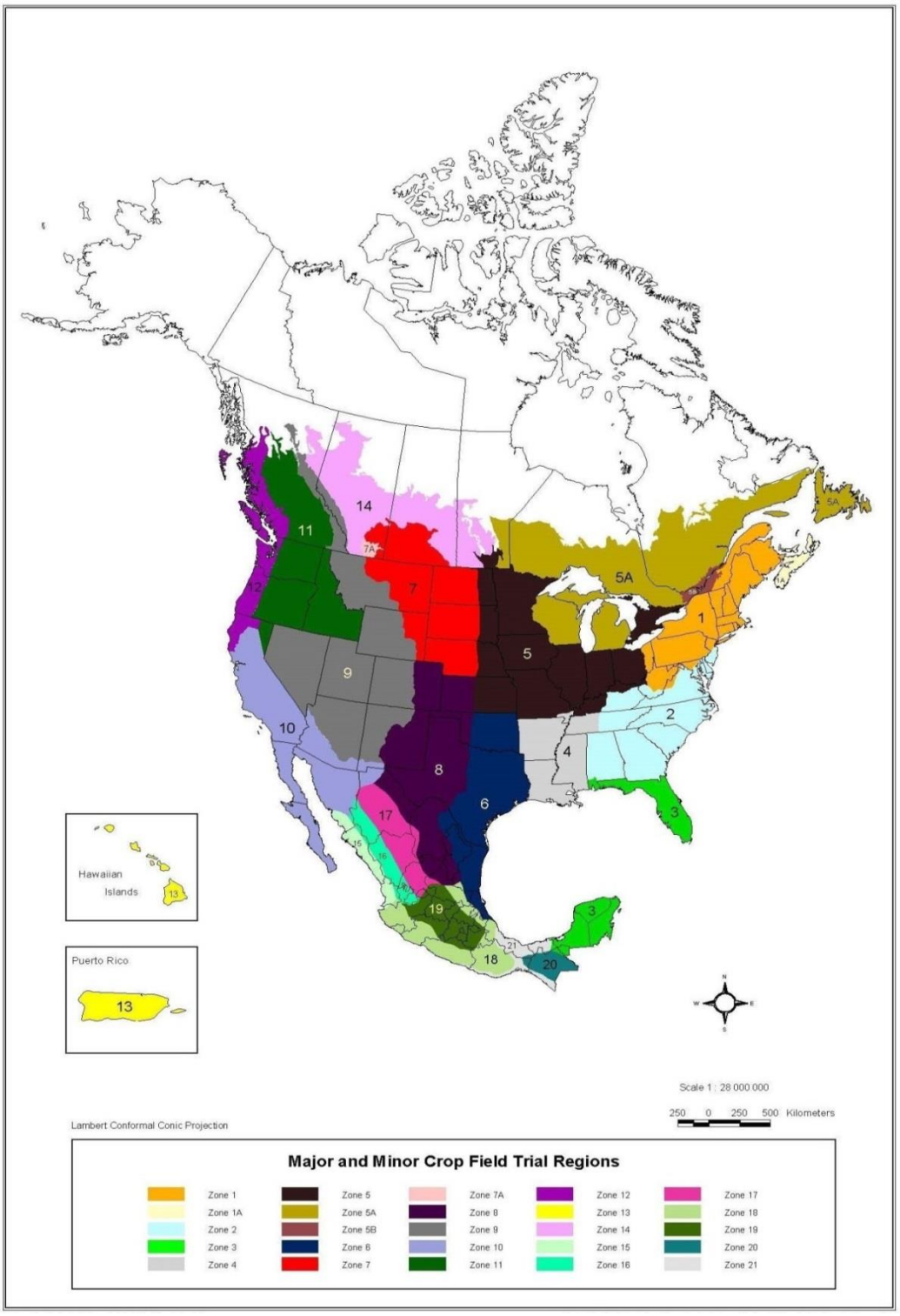
[1]Statistics Canada. Table 001-0009 - Area, production and farm gate value of fresh and processed fruits, by province, annual CANSIM (database). (Accessed: 2015-01 22)

[2]Suppressed to meet the confidentiality requirements of the Statistics Act.

Common zone map: North American major and minor field trial regions

The major and minor crop field trial regions were developed following stakeholder consultation and are used by the Pest Management Regulatory Agency (PMRA) in Canada and the United States (US) Environmental Protection Agency (EPA) to identify the regions where residue chemistry crop field trials are required to support the registration of new pesticide uses. The regions are based on a number of parameters, including soil type and climate but they do not correspond to plant hardiness zones. For additional information, please consult the PMRA Regulatory Directive 2010-05 "*Revisions to the Residue Chemistry Crop Field Trial Requirements"* (www.hc-sc.gc.ca/cps-spc/pubs/pest/_pol-guide/dir2010-05/index-eng.php).

Figure 1. Common zone map: North American major and minor field trial regions[1]



[1]Produced by: Spatial Analysis and Geomatics Applications, Agriculture Division, Statistics Canada, February 2001.

Cultural Practices

Cherries are best adapted to well-drained soils and do not grow well on soils with poor drainage or under prolonged wet conditions. The ideal site for an orchard is on a sloping hill, with a grade of 4 to 8% to allow for air drainage, surface water drainage and good light exposure. Location within 3 or 4 kilometers from a body of water is also desirable as the water body can provide a moderating effect on temperatures in the spring and protect from spring frosts. A soil pH of 6.0 to 6.5 is ideal for cherry orchards. Orchard productivity and fruit maturity dates are affected by cultivar, site characteristics, including soil type, degree and direction (aspect) of slope and climatic conditions such as rainfall, sun, wind and frost. These factors must be taken into account when planting an orchard. Canopy management in cherry orchards is very important to maximize annual yields.

In recent years there is a trend towards higher density plantings. The higher density plantings require careful management to maintain air circulation and prevent certain fungal diseases.

Table 3. Cherry production and pest management schedule in Canada

Time of Year	Activity	Action
December to early March (winter-dormancy)	Plant Care	Prune trees.
	Soil Care	Prepare sites of new plantings; take soil samples in established sites for nutrient analysis.
	Disease Management	Remove shoots with bacterial, cytospora and coryneum blight.
	Insect Management	Apply delayed dormant controls for aphids, mites, scales, apple mealybug and other insects.
	Weed Management	Monitor for weeds and apply controls if needed.
Late March to May (bud break and blossom)	Plant Care	Plant and prune new trees; irrigate as needed; place beehives in the orchard when first blossoms open and remove prior to insecticide applications; brush removal.
	Soil Care	Apply nitrogen to established orchards as needed; apply lime as needed.
	Disease Management	Monitor for powdery mildew and brown rot during and post bloom; apply controls if needed.
	Insect Management	Set out and monitor yellow sticky traps for cherry fruit flies; monitor for leafrollers, fruitworms, budmoth, mites, aphids, apple mealybug, shothole borer, ambrosia beetles and beneficial organisms; apply controls if needed.
	Weed Management	Monitor for weeds and apply controls if needed.
June to August (blossom, fruit development and harvest of summer varieties (August)	Plant Care	Seed cover crop; apply supplemental nutrient sprays as needed; irrigate as needed; thin cherries; have leaf analyses performed; hand harvest and market fruit; grading and packing.
	Soil Care	Apply boron as needed.
	Disease Management	Treat for brown rot as needed; cut out wood with bacterial canker and powdery mildew; monitor mature fruit for little cherry disease.
	Insect Management	Set out and monitor pheromone traps for peach tree borer; continue monitoring cherry fruit flies, leafrollers, budmoth, mites, aphid, apple mealybug, shothole borer, ambrosia beetles and beneficial organisms; begin monitoring for pear sawfly; apply controls if needed; use bird control (noise deterrents).
	Weed Management	Monitor for weeds and apply controls if needed.
September to November (harvest and post- harvest care)	Plant Care	Irrigate as needed after harvest; remove dead, weak and diseased trees; begin dormant pruning.
	Soil Care	Take soil samples in established sites for nutrient analysis; begin preparation at sites of new plantings.
	Disease Management	Remove dead, weak and diseased trees; remove cankers; begin dormant pruning.
	Insect Management	Apply dormant oil; apply postharvest controls for cherry fruit flies, scales, mites and apple mealybugs, if needed.
	Weed Management	Mow weeds.

Abiotic Factors Limiting Production

Temperature extremes

Severe winter temperatures can cause cold injury to shoots, fruit spurs, trunks and even roots. Winter damage to cherry trees increases susceptibility to diseases and insects, particularly shothole borer and ambrosia beetle. Spring frost during bloom is also a threat in some regions.

Excessive Rain

Periods of heavy rain can cause rain split, which occurs when cherry fruit absorbs water and swells, eventually splitting. Over 50% loss can be experienced on sensitive cultivars. The wound caused by splitting serves as a point of entry for diseases, particularly brown rot and botrytis blight. Trees can be sprayed with calcium to reduce damage. Some growers use helicopters or airblast sprayers to avoid fruit split by drying the fruit.

Diseases

Key issues

- Fungicide resistance in cherry leafspot and brown rot pathogen populations is a primary concern for sweet and sour cherry producers.
- New fungicides are required to provide adequate control of many cherry diseases including brown rot, botrytis blight, coryneum blight, powdery mildew, black knot, perennial canker and post-harvest diseases, and to enable resistance management strategies.
- There are currently no controls available in Canada for the management of bacterial canker to which dwarf cherry varieties are particularly susceptible.
- Effective controls for nematodes in established plantings are required.
- Integrated disease management approaches including forecasting and monitoring to prevent early season infection and late season development of brown rot are required as there is no tolerance for this disease in domestic and export markets.
- A cost effective, in-field method for the identification of phytophthora infections on cherry trees and a strategy for the management of phytophthora crown, root and collar rot for trees infected with this disease, are required.
- The trend towards higher density plantings and later-maturing varieties has increased powdery mildew incidence and severity in cherry.

Table 4. Occurrence of diseases in cherry production in Canada

Disease	Sweet cherry		Sour cherry
	British Columbia	Ontario	Ontario
Brown rot			
Botrytis fruit rot and blossom blight			
Coryneum blight			
Cherry leaf spot (shot hole)			
Powdery mildew			
Black knot			
Canker diseases			
Bacterial canker			
Perennial canker			
Verticillium wilt			
Phytophthora crown, root and collar rot			
Little Cherry Disease			
Post-harvest diseases			

Widespread yearly occurrence with high pest pressure.

Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.

Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pressure.

Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.

Pest not present.

Data not reported.

[1]Source: Cherry stakeholders in reporting provinces.

[2]Please refer to Appendix 1, for a detailed explanation of colour coding of occurrence data.

Table 5. Adoption of disease management practices in sweet cherry production in Canada

Practice / Pest		Brown rot	Botrytis fruit rot and blossom blight	Bacterial canker	Cherry leaf spot (shot hole)	Little cherry disease
Avoidance	resistant varieties					
	planting / harvest date adjustment					
	crop rotation					
	choice of planting site					
	optimizing fertilization					
	reducing mechanical damage or insect damage					
	thinning / pruning					
	use of disease-free seed, transplants					
Prevention	equipment sanitation					
	mowing / mulching / flaming					
	modification of plant density (row or plant spacing; seeding rate)					
	seeding / planting depth					
	water / irrigation management					
	end of season crop residue removal / management					
	pruning out / removal of infected material before harvest					
	tillage / cultivation					
	removal of other hosts (weeds / volunteers / wild plants)					
Monitoring	scouting / trapping					
	records to track diseases					
	soil analysis					
	weather monitoring for disease forecasting					
	use of portable electronic devices in the field to access pest identification /management information					
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests					

…continued

Table 5. Adoption of disease management practices in sweet cherry production in Canada (continued)

Practice / Pest		Brown rot	Botrytis fruit rot and blossom blight	Bacterial canker	Cherry leafspot (shot hole)	Little cherry disease
Decision making tools	economic threshold					
	weather / weather-based forecast / predictive model					
	recommendation from crop specialist					
	first appearance of pest or pest life stage					
	observed crop damage					
	crop stage					
Suppression	pesticide rotation for resistance management					
	soil amendments					
	biological pesticides					
	controlled atmosphere storage					
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)					

This practice is used to manage this pest by at least some growers in the province.

This practice is not used by growers in the province to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]**Source: Stakeholders in sweet cherry producing provinces (British Columbia and Ontario).**

Table 6. Adoption of disease management practices in sour cherry production in Canada

Practice / Pest		Brown rot	Botrytis fruit rot and blossom blight	Bacterial canker	Cherry leafspot (shot hole)	Little cherry disease
Avoidance	resistant varieties					
	planting / harvest date adjustment					
	crop rotation					
	choice of planting site					
	optimizing fertilization					
	reducing mechanical damage or insect damage					
	thinning / pruning					
	use of disease-free seed, transplants					
Prevention	equipment sanitation					
	mowing / mulching / flaming					
	modification of plant density (row or plant spacing; seeding rate)					
	seeding / planting depth					
	water / irrigation management					
	end of season crop residue removal / management					
	pruning out / removal of infected material before harvest					
	tillage / cultivation					
	removal of other hosts (weeds / volunteers / wild plants)					
Monitoring	scouting / trapping					
	records to track diseases					
	soil analysis					
	weather monitoring for disease forecasting					
	use of portable electronic devices in the field to access pest identification /management information					
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests					

…continued

Table 6. Adoption of disease management practices in sour cherry production in Canada (continued)

Practice / Pest		Brown rot	Botrytis fruit rot and blossom blight	Bacterial canker	Cherry leafspot (shot hole)	Little cherry disease
Decision making tools	economic threshold					
	weather / weather-based forecast / predictive model					
	recommendation from crop specialist					
	first appearance of pest or pest life stage					
	observed crop damage					
	crop stage					
Suppression	pesticide rotation for resistance management					
	soil amendments					
	biological pesticides					
	controlled atmosphere storage					
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)					

This practice is used to manage this pest by at least some growers in the province.

This practice is not used by growers in the province to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]Source: Stakeholders in sour cherry producing provinces (Ontario).

Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]	
						Sweet cherry	Sour cherry
Agrobacterium radiobacter	biological	unknown	unknown	N/A	R	crown gall	
boscalid	pyridine-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	brown rot, monilinia blossom blight	
boscalid + pyraclostrobin	pyridine-carboxamide + methoxy-carbamate	C2: respiration + C3: respiration	complexe II : succinate dehydrogenase + complex III cytochrome bc1 (ubiquinol oxydase) at Qo site (cyt b gene)	7 + 11	R + R	brown rot, monilinia blossom blight, anthracnose, leaf spot, powdery mildew (suppression), rhizopus rot	
captan	phthalimide	multi-site contact activity	multi-site contact activity	M4	RE	brown rot, leaf spot (shot hole)	
chlorothalonil	chloronitrile (phthalonitrile)	multi-site contact activity	multi-site contact activity	M 5	RE	brown rot, blossom blight	brown rot, blossom blight, leaf spot (shot-hole), black knot
copper (present as copper oxychloride)	inorganic	multi-site contact activity	multi-site contact activity	M 1	R	bacterial canker	brown rot, leaf spot, bacterial canker
dodine	guanidine	unknown mode of action	cell membrane disruption (proposed)	U12	R	-	cherry leaf spot
fenbuconazole	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	blossom blight, fruit brown rot	blossom blight, fruit brown rot, black knot

….continued

Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]	
						Sweet cherry	Sour cherry
fenhexamid	hydroxyanilide	G3: sterol biosynthsis in membranes	3-keto reductase, C4-demethylation (erg27)	17	R	blossom blight, shoot blight, monilinia twig blight, brown rot	
ferbam	dithio-carbamate and relatives	multi-site contact activity	multi-site contact activity	M 3	RE	brown rot, leaf spot	
fludioxonil (post-harvest)	phenylpyrrole	E2: signal transduction	MAP/Histidine-Kinase in osmotic signal transduction (os-2, HOG1)	12	RE	blue mould, grey mould, brown rot, rhizopus rot	
fluopyram	pyridinyl-ethyl-benzamides	C2: respiration	complex II: succinate-dehydro-genase	7	R	brown rot, blossom blight	
fluxapyroxad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	blossom blight, brown rot and ripe fruit rot	
iprodione	dicarboximide	E3: signal transduction	MAP/Histidine-Kinase in osmotic signal transduction (os-1, Daf1)	2	RE	brown rot, blossom blight	
lime sulphur (calcium polysulphide)	inorganic	multi-site contact activity	multi-site contact activity	M 2	R	general clean-up (of overwintering fungal diseases)	
methyl bromide	alky halide[4]	miscellaneous non-specific (multi-site) inhibitor[4]	miscellaneous non-specific (multi-site) inhibitor[4]	8A[4]	PO	insects, nematodes, soil borne fungi and certain weeds	
myclobutanil	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	brown rot	brown rot, powdery mildew, leaf spot

…continued

Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]	
						Sweet cherry	Sour cherry
penthiopyrad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	brown rot blossom blight and fruit rot (*Monilinia* spp.), powdery mildew, scab, botrytis rots, suppression of cherry leaf spot	
propiconazole	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	brown rot, blossom blight, fruit brown rot, cherry leaf spot	
pyraclostrobin	methoxy-carbamate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	anthracnose, powdery mildew, monilinia blossom and twig blight	
quinoxyfen	aryloxyquinoline	E1: signal transduction	signal transduction (mechanism unknown)	13	R	powdery mildew	
sulphur	inorganic	multi-site contact activity	multi-site contact activity	M 2	R	brown rot	brown rot, powdery mildew
thiophanate-methyl	thiophanate	B1: mitosis and cell division	ß-tubuline assembly in mitosis	1	RE	brown rot	
trifloxystrobin	oximino acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	powdery mildew, leaf spot	

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of November 3, 2014. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Fungicide Resistance Action Committee. *FRAC Code List 2014: Fungicides sorted by mode of action (including FRAC code numbering)* (www.frac.info/) (accessed February 17, 2015).

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation, RES (yellow) - under special review as published in PMRA re-evaluation note *REV2013-06, Special Review Initiation of 23 Active Ingredients*, RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 31, 2014.

[4]Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 7.3; 2014)* (www.irac-online.org) (accessed February 17, 2015).

Brown Rot (*Monilinia fructicola*)

Pest Information

Damage: Brown rot causes serious damage to cherries and other stone fruits during wet seasons. The disease causes a blossom blight, fruit rot and twig blight. Blossoms and ripening fruit are most susceptible. Fruit may become completely rotted within 48 hours. Tan coloured tufts of spores develop in infected tissues. Early season infections may become latent, remaining invisible until the fruit begins to ripen or after harvest. This type of infection causes the greatest losses in cherry. There is no tolerance of brown rot infected fruit in the market-place.

Life Cycle: The fungus over-winters in mummified fruit or in infected tissues on trees and on the orchard floor. Spores produced in the spring are wind-dispersed and in the presence of moisture, infect young twigs or leaves resulting in twig and leaf blight. During bloom, prolonged wet weather may result in extensive blossom infection. Infection proceeds slowly above 30^{o}C and below 5^{o}C, however frost-injured blossoms are more susceptible to brown rot infection than non-injured blossoms. Spores (conidia) produced on blighted blossoms cause secondary infections. These infections spread to ripening fruit. Rotting fruit provide abundant inoculum that can infect additional healthy fruit. Infected fruits eventually turn into shrivelled, black mummies that may drop or remain attached to the tree through the winter.

Pest Management

Cultural Controls: Prevention is critical. Sanitation is essential in the orchard if a brown rot epidemic is to be avoided. Removing all remaining fruit and mummified fruit from the tree after the final picking removes a source of infection for the following year. A weed-free herbicide strip in sod culture/high density systems may also discourage the production of apothecia and spores from fruit mummies on the orchard floor.

Resistant Cultivars: Some sweet cherry varieties such as "Vega" are extremely susceptible to brown rot. Early season varieties tend to be more susceptible to brown rot than the later season varieties.

Chemical Controls: Sweet cherry fruit appears to be susceptible throughout the entire period of development and continuous protection of the sweet cherry crop from bloom to harvest is required. Fungicides registered for brown rot on cherry are listed in Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada.

Issues for Brown Rot

1. Access to new products is needed for control of brown rot and other pathogens post-harvest.
2. Efficient, cost effective monitoring and forecasting techniques need to be developed to forecast the need for brown rot fungicide sprays.
3. Resistance to fungicides remains a primary concern. Brown rot resistance to certain groups of fungicides (mainly group 2, 3 and 11 fungicides) has not been documented to date; however there is industry concern that there may be resistant isolates to one or more of these fungicide groups. There have recently been new fungicides registered for brown rot in stone fruit, however continued access to new cost effective products remains of importance to maintain good resistance management programs.

4. There is a need for the development of alternative, integrated pest management practices (IPM) to prevent early season infections (infections occurring during the bloom period that remain latent until the fruit begins to mature) as well as late season development of brown rot when conditions are favourable.

Botrytis Fruit Rot (*Botrytis cinerea*)

Pest Information

Damage: Botrytis cinerea can cause fruit rot problems in the orchard and post-harvest in cherries. When wet weather persists, green fruit rot may develop. Latent infections can cause rot as the fruit ripens. Infected fruit develop a firm, brown decay and become covered with light brown spores. This disease is often confused with brown rot in the field.

Life Cycle: The fungus overwinters in the soil and in plant debris. It becomes active under cool moist conditions. New infections are caused by spores produced in infected tissues. Fruit rot can spread in storage.

Pest Management

Cultural Controls: Ensuring adequate air circulation, good sanitation and avoiding overhead watering late in the day will help to prevent the development of botrytis. Other preventative measures include harvesting and storing only sound fruit, avoiding injuring or bruising fruit at harvest, burying of culls and rotted fruit promptly and ensuring fruit is pre-cooled and kept in cold storage until it reaches its destination. Control measures often target botrytis and brown rot at the same time.

Resistant Cultivars: None identified.

Chemical Controls: Fungicides registered for botrytis rot on cherry are listed Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada

Issues for Botrytis Fruit Rot

1. There is a need for the registration of additional active ingredients for the control of botrytis on stone fruit and to enable resistance management strategies.
2. There is a need for additional post-harvest fungicides for botrytis fruit rot (and other post-harvest pathogens) of sweet cherry.

Powdery Mildew (*Podosphaera clandestina*)

Pest Information

Damage: Cherry foliage, fruit and shoots are susceptible to powdery mildew. Infected tissues develop patches of powdery, white growth of fungal mycelium and spores with severely affected foliage often becoming distorted. Powdery mildew causes early defoliation and prevents shoot growth of young, vigorous trees. Fruit infection appears as a white powdery covering as the cherry ripens, resulting in unmarketable fruit. The trend towards higher

density plantings and later-maturing varieties has led to increased problems due to powdery mildew.

Life Cycle: Powdery mildew overwinters as cleistothecia, (spore producing bodies) in bark crevices or in leaf litter. In the spring, the cleistothecia give rise to ascospores (sexual spores) that cause primary infection of leaves, shoots and fruit. Conidia (asexual spores) are produced within the infected tissues and cause secondary infections. There are multiple generations throughout the growing season. Immature fruit is much more susceptible than mature fruit. Outbreaks of powdery mildew are triggered by wet weather during fruit development.

Pest Management

Cultural Controls: Cultural controls include increasing air circulation by pruning, avoiding dense plantings, removing infected water sprouts and keeping grass short beneath cherries with low-hanging branches.

Resistant Cultivars: Cultivars vary in their susceptibility to this disease.

Chemical Controls: Fungicides registered for powdery mildew on cherry are listed in Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada

Issues for Powdery Mildew

1. Access to new products is needed for the control of powdery mildew and to enable resistance management strategies.

Cherry Leaf Spot (Shot-hole) (*Blumeriella jappii*)

Pest Information

Damage: Leaves develop small purple to brown spots, with definite borders, in early summer. In July, the centres of the spots frequently fall out, giving a shot-hole appearance. The leaves turn yellow and fall. Cherry leaf spot often defoliates the tree by midsummer resulting in poor fruit development. Repeated defoliation weakens the tree, making it more susceptible to winter injury and causing a reduction in flowering.

Life Cycle: The fungus overwinters on fallen leaves. In spring following wet weather, spores form and are dispersed by wind to new leaves where they cause infection. The initial leaf infections form spots and more spores are produced in the spots. These spores are rain splashed and infect other leaves. Secondary spread and infection by spores continues repeatedly, whenever wet, warm weather occurs, until leaves fall in autumn.

Pest Management

Cultural Controls: Cultural controls include good pruning to allow for improved air circulation and rapid drying of foliage and good spray penetration. There are no practical methods to reduce primary inoculum.

Resistant Cultivars: None identified.

Chemical Controls: Most fungicides applied to sweet cherry for brown rot control will control cherry leaf spot. Copper applied for bacterial canker also helps to control leaf spot.

Fungicides registered for leaf spot on cherry are listed Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada

Issues for Cherry leaf spot

1. There is a need to determine whether the *B. jappi* pathogen has developed resistance to currently registered fungicides. There are concerns in the United States that this pathogen has developed some resistance to group 11 (strobilurin) fungicides.
2. There is a need to investigate the impact of premature leaf drop caused by cherry leaf spot on the winter hardiness of cherry, to enable more informed management decisions.

Coryneum Blight (*Wilsonomyces carpophilus*)

Pest Information

Damage: Coryneum blight causes small reddish-brown to purple spots on fruit, which may become "scabby" later in the season. Spots, which develop on leaves, drop out resulting in shot-hole symptoms. Lesions develop infrequently on twigs.

Life Cycle: The fungus overwinters in leaf and flower buds and twig cankers. Under suitable weather conditions, spores are produced in infected tissues in the spring and are blown to fruit and leaves where they cause new lesions. Disease development is favoured by frequent rainy periods at husk fall.

Pest Management

Cultural Controls: Disease monitoring and pruning out infected twigs during dormancy is the most common approach to cultural control.

Resistant Cultivars: None identified.

Chemical Controls: This disease is controlled by fungicides used for brown rot or leaf spot.

Issues for coryneum blight

1. There are no fungicides registered for coryneum blight in cherries.

Bacterial Canker (*Pseudomonas syringae* pv. *syringae*)

Pest Information

Damage: Bacterial canker attacks cherries, other stone fruits, pears, apple rootstocks and many species of ornamental trees. Young cherry trees and trees under stress are more susceptible to infection. Elongated, gummy cankers which eventually girdle the main trunk and branches develop on susceptible trees. Buds may be killed. Circular lesions, which drop out to give a "shot-hole" effect, may develop on leaves. Small, sunken, brown lesions may develop on immature fruit. Leaf and fruit symptoms are more common in areas or years with higher rainfall.

Life Cycle: The bacterium survives the winter in cankers, healthy buds and infected vascular tissue and is disseminated to blossoms and young leaves in the spring by rain. The bacterium is able to survive the summer on the surface of healthy young leaves and other plants in the orchard. The pathogen infects leaf scars and wounds caused by pruning, insects, frost and winter freezing.

Pest Management

Cultural Controls: The use of clean nursery stock is crucial to minimizing infection. Avoiding planting cherries in frost prone areas helps minimize frost injury and subsequent bacterial canker infections. Measures that minimize stresses on trees such as providing adequate moisture and nutrients, planting in areas with good drainage and suitable soil pH will help to reduce the development of bacterial canker. Trees with minor gumming may recover. Small cankers can be cut out with a disinfected pruning knife. Affected branches may be pruned throughout the season. Using a pruning technique known as "stubbing", as well as late pruning will reduce the risk of bacterial canker. Heavily infected trees may not recover and may have to be removed to prevent disease spread to other trees.

Resistant Cultivars: Dwarf sweet cherry trees are more susceptible to bacterial canker although there is no conclusive information as to the reason for this. It is possible that dwarf trees are more susceptible to stress, which predisposes them to the disease. Outbreaks in dwarf trees will move to standard size trees. MM2 and MM60 rootstocks appear to be less susceptible to bacterial canker than others.

Chemical Controls: Pesticides registered for bacterial canker on cherry are listed Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada.

Issues for Bacterial Canker

1. Additional reduced risk pesticide registrations are required for the control of bacterial canker.

Perennial Canker (*Leucostoma cincta, L. persoonii)*

Pest Information

Damage: Slightly sunken cankers are produced on scaffold limbs or trunks of infected trees. The primary symptom is the presence of dead twigs or branches after the tree has leafed-out in the spring. Perennial canker may often be misdiagnosed as bacterial canker, as gum is produced by the tree at infection sites.

Life Cycle: Small, black, fruiting bodies of the fungus often develop under the bark in the cankered areas. Later in the spring, masses of spores are extruded from these structures. Conidia (spores) are most abundant in the fall and spring. During rain or irrigation, spores are splashed and blown around the orchard. Infection occurs through injuries to the bark such as pruning wounds, leaf scars, winter injury and sunburn. Cankers increase in size during periods of tree dormancy. With renewed growth in the spring, trees are able to form callous tissue and wall off infection. Cankers develop a target-like appearance as a result of this annual pattern of growth.

Pest Management

Cultural Controls: Cultural controls include pruning as late in the spring as possible to take advantage of the more rapid rate of wound healing which occurs at higher temperatures. Training trees so that wide angles develop between the trunk and the branches and pruning out cankers on scaffold limbs, which can be sources of spores, will help reduce disease development. Measures that minimize winter injury, sunburn, rodent damage and insect damage will reduce infection sites.

Resistant Cultivars: None identified.

Chemical Controls: There are no fungicides registered for perennial canker.

Issues for perennial canker

1. There is a need for the registration of fungicides for the control of this disease in sweet cherry.

Black Knot (*Apiosporina morbosa*)

Pest Information

Damage: Black knot results in dark, corky swellings on twigs and small branches. As the knots mature, they can encircle twigs and small branches, restricting nutrient and moisture flow and resulting in reduced vigour, growth and fruit production on the distal portions of affected branches. Knots can be up to 15 cm long and may coalesce, forming larger areas with black knot.

Life Cycle: This disease affects many *Prunus* spp. including ornamental, fruit and wild species. The fungus produces fruiting bodies and spores in mature black knots in the spring. Spores are released during rainy periods and are spread by wind to twigs where new infections develop. The current year's growth is susceptible from bud-break to terminal bud set. Two years are required for the black knots to mature.

Pest Management

Cultural Controls: Strict sanitation is important in the management of black knot. Orchards must be monitored and black knots removed in late winter before growth resumes in the spring. Removal of wild hosts within 150 meters of the orchard and placement of new plantings away from orchards infected with black knot will reduce the risk of infection.

Resistant Cultivars: None identified.

Chemical Controls: Fungicides applied for brown rot will help suppress the disease. There are no fungicides specifically registered for the management of this disease on sweet cherry. Fungicides registered on sour cherry for black knot control are listed in Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada.

Issues for black knot

1. There is a need for the registration of additional fungicides for black knot that are compatible with oil based materials.

Verticillium Wilt (*Verticillium dahliae*)

Pest Information

Damage: The pathogen grows within the xylem tissues of the tree causing yellowing and wilting of leaves and branch dieback, often on one side of the tree. One year old branches are most commonly affected. Some affected trees can lose vigour and die although mildly affected trees may recover.

Life Cycle: The causal fungus persists in the soil as microsclerotia (small, fungal resting bodies). The pathogen is more prevalent in soils that have been previously cropped to other susceptible plants. The pathogen invades through tree roots and grows within the vascular tissues.

Pest Management

Cultural Controls: Avoiding sites where verticillium susceptible crops have recently been planted will reduce the likelihood of disease development. The removal of affected and dead branches and providing optimal irrigation and fertilization will help trees recover.

Resistant Cultivars: None identified.

Chemical Controls: There are no fungicidal controls for verticillium wilt. Fumigation prior to planting to reduce re-plant disease will help to reduce verticillium levels in the soil.

Issues for verticillium wilt

1. The interplanting of low growing crops such as tomatoes, peppers, eggplants, strawberries and/ or melons between rows in young orchards is becoming more popular. Studies are required to determine the host specificity of verticillium isolates and to determine if these inter-planted crops increase the potential for infection from *V. dahlia* in cherries.

Phytophthora Crown, Root and Collar rot (*Phytophthora* spp.)

Pest Information

Damage: Phytophthora causes a dark, reddish-brown decay of crown and root tissues. Affected trees may exhibit poor vigour, yellowing and wilting of foliage, reduced shoot growth and undersized fruit. The disease causes problems where soils have remained wet for a prolonged period of time.

Life Cycle: Phytopthora may be soilborne or persist in infected tissues. Under conditions of excessive moisture, reproductive structures known as sporangia release infective spores called zoospores. The zoospores are motile and swim in water films to susceptible plant tissues where they cause infection. Zoospores may also be transported by run-off water to non-infested areas.

Pest Management

Cultural Controls: Measures which prevent disease development are important as infected trees cannot be cured. Planting disease-free nursery stock and avoiding sites with heavy soils and poor drainage, will reduce chances of disease development.

Resistant Cultivars: Rootstocks vary in their susceptibility to phytophthora.

Chemical Controls: There are no fungicidal controls available for phytophthora diseases of cherry.

Issues for crown, root and collar rot

1. There is a need to develop a quick, cost effective, in-field method of identification of phythophthora infections on cherry trees.
2. There is a need to develop a strategy for the management of phytophthora on trees confirmed to have this disease.

Little Cherry Disease (Little Cherry Virus (LChV-2 and LChV-1))

Pest Information

Damage: Cherries on trees affected by LChV-2 are not fit for the fresh fruit market as they lack flavour, sweetness, size and colour. Fruit symptoms are most pronounced in the cultivar Lambert, in which fruit can be as small as half the normal size. Affected fruit are dull red, and have a pointed shape. It is common for some fruits on a branch to be more severely affected than others. Symptoms are similar in other cultivars, but less severe and more variable. Some cultivars develop red leaf discolouration in the later summer or early fall. A second virus, LChV-1 has been detected in numerous orchards (in British Columbia) and causes symptoms similar to those of LChV-2. Little cherry virus is a regulated disease.

Life Cycle: LChV-2 is spread by the apple mealybug (*Phenacoccus aceris*) and is readily transmitted by grafting. Mealybug nymphs can be spread from tree to tree by wind during the summer. Transmission by pollen or seed, in the soil, or by pruning tools has not been demonstrated. Ornamental, flowering cherries are symptomless carriers of the disease. The vector of LChV-1 is unknown.

Pest Management

Cultural Controls: The use of certified, virus-free stock will prevent the introduction of little cherry disease in new plantings. The immediate removal of infected trees and other hosts such as Japanese flowering cherry and wild bitter cherry will eliminate sources of disease.

Resistant Cultivars: None identified.

Chemical Controls: There are no chemical controls available for little cherry diseases of cherry and the apple mealy bug vector in cherry.

Issues for Little Cherry disease

1. Further studies are required to determine the epidemiology of LChV-1.
2. Studies are required to determine the distribution of LCHV-1 in commercial orchards and its potential impact.

Post-harvest diseases: (Brown Rot (*Monilinia* spp.), Botrytis Rot (*Botrytis cinerea*), Alternaria Rot (*Alternaria* spp.), Rhizopus Rot (*Rhizopus spp.*) and Mucor Rot (*Mucor* sp.))

Pest Information

Damage: Post harvest diseases of cherry are caused by pathogens picked up in the orchard prior to harvest.

Life Cycle: Pathogens can remain in the orchard in infected tissues on the trees or on leaf litter. Fruit infections may be symptomless prior to harvest or may occur through wounding such as rain splits and insect feeding injury. Pathogens may sporulate in storage. Infections in storage can spread through spores or by vegetative growth of mycelium.

Pest Management

Cultural Controls: The management of diseases prior to harvest, ensuring adequate fertility, orchard sanitation, harvesting the fruit at proper maturity and maintaining proper storage conditions, will minimize disease development in storage.

Resistant Cultivars: None identified.

Chemical Controls: Fungicides registered for post-harvest diseases on cherry are listed Table 7. Fungicides and biofungicides registered for disease management in cherry production in Canada.

Issues for post-harvest diseases

1. There is a need for additional products for post-harvest disease control.

Insects and Mites

Key issues

- Spotted wing drosophila has become the most serious pest of cherries in Canada, and registrations of insecticides to control this pest are urgently needed. It is critical that the new materials have a short pre-harvest interval and contact mode of action that kills or repels adults before eggs are laid.
- Cherry fruit flies continue to be a serious problem requiring alternative products which have short pre-harvest intervals and effectively control female flies before eggs are laid.
- The registration of reduced risk alternatives to endosulfan, which will be phased out in 2016, is required for the management of peach tree borer and lesser peach tree borer. There is also a need for regional monitoring for lesser peach tree borer.
- There are currently no effective chemical controls for western flower thrips, which cause much of their damage during the blossom period.
- The potential increase in apple mealybug, the vector of little cherry disease virus, is of concern with the movement away from the use of organophosphate insecticides.
- The brown marmorated stinkbug is a new pest in cherry producing regions. Given its high potential for injury, it is important to continue monitoring the movement of this insect in advance of its possible spread into commercial orchards.
- Effective management strategies must be developed for the brown marmorated stinkbug.
- Management strategies are needed for the control of cherry fruitworm, which the Canadian Food Inspection Agency (CFIA) is increasingly finding in export fruit, some of which has been rejected due to the presence of this pest.

Table 8. Occurrence of insect pests in cherry production in Canada

Insect	Sweet cherry		Sour cherry
	British Columbia	Ontario	Ontario
Fruit flies			
Eastern cherry fruit fly			
Black cherry fruit fly			
Western cherry fruit fly			
Spotted wing drosophila			
Aphids			
Black cherry aphid			
Mealy plum aphid			
Green peach aphid			
Plum curculio			
Mites			
Two-spotted spider mite			
McDaniel mite			
European red mite			
Apple mealybug			
San Jose scale			
Tarnished plant bug			
Brown marmorated stinkbug			
Oriental fruit moth			
Spring feeding caterpillar complex			
Eastern tent caterpillar			
European leafroller			
Eyespotted bud moth			
Forest tent caterpillar			
Fruit tree leafroller			
Gypsy moth			
Red-banded leafroller			
Two generation leafrollers			
Oblique banded leafroller			
Three lined leafroller			
Cherry fruitworm			

…continued

Table 8. Occurrence of insect pests in cherry production in Canada (continued)

Insect	Sweet cherry		Sour cherry
	British Columbia	Ontario	Ontario
Borers			
Peach tree borer			
Lesser peach tree borer			
Shothole borer			
Ambrosia beetle			

Widespread yearly occurrence with high pest pressure.
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pressure.
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.
Pest is present and of concern, however little is known of its distribution, frequency and importance.
Pest not present.
Data not reported.

[1]Source: Cherry stakeholders in reporting provinces.

[2]Please refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

Table 9. Adoption of insect pest management practices in sweet cherry production in Canada

Practice / Pest		Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Two generation leafrollers	Mites
Avoidance	resistant varieties						
	planting / harvest date adjustment						
	crop rotation						
	choice of planting site						
	optimizing fertilization						
	reducing mechanical damage						
	thinning / pruning						
	trap crops / perimeter spraying						
	physical barriers						
Prevention	equipment sanitation						
	mowing / mulching / flaming						
	modification of plant density (row or plant spacing; seeding rate)						
	seeding depth						
	water / irrigation management						
	end of season crop residue removal / management						
	pruning out / removal of infested material before harvest						
	tillage / cultivation						
	removal of other hosts (weeds / volunteers / wild plants)						
Monitoring	scouting / trapping						
	records to track pests						
	soil analysis						
	weather monitoring for degree day modelling						
	use of portable electronic devices in the field to access pest identification /management information						
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests						

…continued

Table 9. Adoption of insect pest management practices in sweet cherry production in Canada (continued)

	Practice / Pest	Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Two generation leafrollers	Mites
Decision making tools	economic threshold						
	weather / weather-based forecast / predictive model (eg. degree day modelling)						
	recommendation from crop specialist						
	first appearance of pest or pest life stage						
	observed crop damage						
	crop stage						
Suppression	pesticide rotation for resistance management						
	soil amendments						
	biological pesticides						
	arthropod biological control agents						
	beneficial organisms and habitat management						
	ground cover / physical barriers						
	pheromones (eg. mating disruption)						
	sterile mating technique						
	trapping						
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)						
New Practices (by province)	augmentation of biological controls (British Columbia)						
	conservation of biological control agents (British Columbia)						

This practice is used to manage this pest by at least some growers in the province.

This practice is not used by growers in the province to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]**Source: Stakeholders in sweet cherry producing provinces (British Columbia and Ontario).**

Table 10. Adoption of insect pest management practices in sour cherry production in Canada

Practice / Pest		Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Two generation leafrollers	Mites
Avoidance	resistant varieties						
	planting / harvest date adjustment						
	crop rotation						
	choice of planting site						
	optimizing fertilization						
	reducing mechanical damage						
	thinning / pruning						
	trap crops / perimeter spraying						
	physical barriers						
Prevention	equipment sanitation						
	mowing / mulching / flaming						
	modification of plant density (row or plant spacing; seeding rate)						
	seeding depth						
	water / irrigation management						
	end of season crop residue removal / management						
	pruning out / removal of infested material before harvest						
	tillage / cultivation						
	removal of other hosts (weeds / volunteers / wild plants)						
Monitoring	scouting /trapping						
	records to track pests						
	soil analysis						
	weather monitoring for degree day modelling						
	use of portable electronic devices in the field to access pest identification /management information						
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests						

...continued

Table 10. Adoption of insect pest management practices in sour cherry production in Canada (continued)

	Practice / Pest	Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Two generation leafrollers	Mites
Decision making tools	economic threshold						
	weather / weather-based forecast / predictive model (eg. degree day modelling)						
	recommendation from crop specialist						
	first appearance of pest or pest life stage						
	observed crop damage						
	crop stage						
Suppression	pesticide rotation for resistance management						
	soil amendments						
	biological pesticides						
	arthropod biological control agents						
	beneficial organisms and habitat management						
	ground cover / physical barriers						
	pheromones (eg. mating disruption)						
	sterile mating technique						
	trapping						
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)						

This practice is used to manage this pest by at least some growers in the province.

This practice is not used by growers in the province to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]Source: Stakeholders in sour cherry producing provinces (Ontario).

Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
acetamiprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	R	Oriental fruit moth, cherry fruit fly (suppression), plum curculio (suppression only when high populations are present)
Bacillus thuringiensis subsp. *kurstaki* strain ABT-351	*Bacillus thuringiensis* or *Bacillus sphaericus* and the insecticidal proteins they produce	microbial disruptor of insect midgut membranes	11A	R	leafrollers (fruittree, European, obliquebanded, threelined), fruitworm
Bacillus thuringiensis subsp. *kurstaki* strain EVB113-19	*Bacillus thuringiensis* or *Bacillus sphaericus* and the insecticidal proteins they produce	microbial disruptor of insect midgut membranes	11A	R	leafrollers (fruittree, European, obliquebanded, threelined), fruitworm
carbaryl	carbamate	acetylcholinesterase inhibitor	1A	RES*	codling moth, eastern tent caterpillar, oak leafhopper, prune leafhopper, apple maggot, black cherry aphid, cherry fruit fly, cherry fruitworm, eyespotted bud moth, fruittree leafroller, lesser peachtree borer, mealy plum aphid, peach twig borer, plum curculio, redbanded leafroller, scale insects
chlorantraniliprole	diamide	ryanodine receptor modulator	28	R	Oriental fruit moth, peach twig borer, cherry fruit fly (suppression), obliquebanded leafroller, threelined leafroller, redbanded leafroller, Japanese beetle (suppression)

…continued

Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
cyantraniliprole	diamide	ryanodine receptor modulator	28	R	Oriental fruit moth, obliquebanded leafroller, threelined leafroller, fruittree leafroller, European leafroller, eyespotted bud moth, green peach aphid, plum aphid, cherry fruit fly, western cherry fruit fly, plum curculio, Japanese beetle, spotted wing drosophila, peach twig borer
cypermethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	spotted wing drosophila (suppression)
diazinon	organophosphate	acetylcholinesterase inhibitor	1B	PO (expiry date of use Dec. 31, 2016)	San Jose scale, fruit tree leafroller, eyespotted bud moth, cherry fruit flies, black cherry aphid, mites, rust mite
dimethoate	organophosphate	acetylcholinesterase inhibitor	1B	RE	black cherry fruit fly maggots, western cherry fruit fly maggots
endosulfan	cyclodiene organochlorine	GABA-gated chloride channel antagonist	2A	PO (expiry date of use Dec. 31, 2016)	peach tree borer, lesser peach tree borer, black cherry aphid, peach silver mite, plum rust mite, green peach aphid, mealy plum aphid, twig borer, tarnished plant bug, stink bug, leafhopper, eyespotted bud moth
imidacloprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	RES	aphids (except woolly apple), leafhoppers, western cherry fruit fly, black cherry fruit fly
lime sulphur (calcium polysulfide)	not classified	unknown	N/A	R	San Jose scale, European scale, mites, general clean-up
malathion	organophosphate	acetylcholinesterase inhibitor	1B	R	black cherry aphid, fruittree leafroller, plum curculio, mealy plum aphid, black cherry aphid

....continued

Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
malathion	organophosphate	acetylcholinesterase inhibitor	1B	Emergency use reg. expiry Nov. 30, 2014	spotted wing drosophila
methyl bromide	alky halide	miscellaneous non-specific (multi-site) inhibitor	8A	PO	insects, nematodes, soilborne fungi and certain weeds
mineral oil (sour cherry)	not classified	unknown	N/A	R	San Jose scale, lecanium scale, European red mite, pear psylla, scales, spider mites
phosmet (sour cherry)	organophosphate	acetylcholinesterase inhibitor	1B	RE	peach twig borer, plum curculio, redbanded leafroller, cherry fruit fly, eastern tent caterpillar, elm spanworm, gypsy moth, Japanese beetle, spring cankerworm; European red mite and two spotted spider mite suppression
potassium salts of fatty acids	not classified	unknown	N/A	R	aphids, mites, earwigs, mealybugs, psyllids, sawfly larvae (pear slugs), scale insects, spider mites
pyridaben	METI acaricide and insecticide	mitochondrial complex I electron transport inhibitor	21A	RE	European red mite, apple rust mite, two spotted spider mite, McDaniel mite, pear psylla
spinetoram	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activator	5	R	Oriental fruit moth, obliquebanded leafroller, threelined leafroller

....continued

Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
spinosad	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activator	5	R	obliquebanded leafroller, threelined leafroller, fruittree leafroller, European leafroller, eyespotted budmoth, cherry fruit fly, spotted wing drosophila
spirodiclofen	tetronic and tetramic acid derivative	inhibitor of acetyl CoA carboxylase	23	R	European red mite, two spotted spider mite, McDaniel mite, peach sliver mite
sulfoxaflor	sulfoxaflor	nicotinic acetylcholine receptor (nAChR) agonist	4C + 5	R	San Jose scale, green apple aphid, mealy plum aphid
sulfoxaflor + spinetoram	sulfoxaflor + spinosyn	nicotinic acetylcholine receptor (nAChR) agonist + nicotinic acetylcholine receptor (nAChR) allosteric activator	4C + 5	R + R	Oriental fruit moth, obliquebanded leafroller, threelined leafroller, green peach aphid, mealy plum aphid, San Jose scale

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of November 13, 2014. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 7.3; 2014)* (www.irac-online.org) (accessed February 17, 2015).

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation , RES (yellow) - under special review as published in PMRA re-evaluation notes *REV2013-06, Special Review Initiation of 23 Active Ingredients* OR *REV2014-06 Initiation of Special Reviews: Potential Environmental Risk Related to Peponapis pruinosa Exposure to Clothianidin, Imidacloprid and Thiamethoxam Used on Cucurbits*, RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 31, 2014.

Table 12. Pheromone products registered on cherry in Canada

Product Name[1]	Targeted Pests
Isomate CM/LR TT	codling moth, obliquebanded leafroller, fruittree leafroller, threelined leafroller, European leafroller
Isomate - CM/OFM TT	codling moth, Oriental fruit moth, lesser appleworm
Isomate-P Pheromone	peach tree borer, apple clearwing moth
Isomate DWB	dogwood borer
Isomate OFM TT	Oriental fruit moth

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all pheromone products registered as of December 2, 2014. The product label is the final authority on use and should be consulted for application information. The information in this table should not be relied upon for pheromone application decisions and use.

Cherry Fruit Fly: Eastern Cherry Fruit Fly (*Rhagoletis cingulata*), Black Cherry Fruit Fly (*R. fausta*) and Western Cherry Fruit Fly (*R. indifferens*)

Pest Information

Damage: Cherry fruit fly species attack sweet and tart cherries and wild species of cherries. Primary damage results from the feeding of the larvae (maggots) within the fruit. Maggots and their frass within the fruit render it unmarketable. Larvae are undetectable from the exterior of the cherry, but are easily visible when the cherry is opened. There is zero tolerance for this insect in fruit.

Life Cycle: All species of fruit flies have similar life cycles. Adults emerge from June through August, depending on temperature and moisture conditions. Populations generally peak close to harvest. Female flies can lay up to 250 eggs, but deposit usually only one egg per cherry. Larvae feed within the fruit for one to two weeks. At maturity larvae cut exit holes and drop to the soil where they overwinter as pupae. Only one generation of cherry fruit fly develops each year, though some of the pupae may remain in the soil for two years.

Pest Management

Cultural Controls: The removal of unmanaged, wild hosts near the orchard will eliminate sources of infestation. The use of landscape fabrics or other materials to impede downward movement of larvae in summer and upward movement of flies in early summer has been used successfully as part of IPM systems. Baited, yellow sticky boards can be used to monitor the presence of adult fruit flies.

Resistant Cultivars: None identified.

Chemical Controls: Refer to Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada**,** for pesticides registered for the control of cherry fruit flies.

Issues for the cherry fruit fly and the black cherry fruit fly

1. Additional products are required for the control of cherry fruit flies. It is important that new products have short pre-harvest intervals and effectively control female flies in the pre-oviposition period.

Spotted Wing Drosophila (*Drosophila suzukii*)

Pest Information

Damage: Spotted wing drosophila is a serious pest of soft fruit and berries. This fruit fly is known to infest raspberry, blackberry, blueberry, strawberry, cherry, peach, nectarine, apricot and plum as well as numerous wild hosts. Unlike other fruit flies, spotted wing drosophila will attack sound fruit. Larvae feed within fruit causing softening and breakdown of flesh which makes the fruit unmarketable. Wounds caused by egg-laying serve as entry points for disease.

Life Cycle: The insect overwinters as adult flies. In the spring the flies mate and lay eggs under the skin of ripening fruit. Larvae feed and develop within the fruit. The entire life cycle from eggs, through larval and pupal stages to adult, varies between 7 days at 28˚C to 50 days at 12˚C. Due to the short generation time and extended period of egg laying by adults, there can be several, overlapping generations each year. The insect is spread short distances by wind and can be carried to new areas through the movement of infested fruit.

Pest Management

Cultural Controls: Strict sanitation measures are important in the field and in processing areas. The frequent harvest of all ripe fruit and removal of unmarketable fruit culls from the orchard will help to reduce the chances of the fly infesting the fruit and reduce sources of continued infestations. Flies can be monitored using apple-cider vinegar traps.

Resistant Cultivars: None identified.

Chemical Controls: Fruit must be protected throughout the ripening period. Insecticides registered for spotted wing drosophila are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for spotted wing drosophila

1. Spotted wing drosophila has become the most serious pest of cherries. Registrations of insecticides to control this pest are urgently needed. Materials with a short pre-harvest interval and with contact modes of action that kill or repel adults before eggs are laid, are required.

Spring Feeding Caterpillar Complex: Eastern Tent Caterpillar (*Malacosoma americanum*), European Leafroller (*Archips rosanus*), Eyespotted Bud Moth (*Spilonota ocellana*), Forest Tent Caterpillar (*Malacosoma disstria*), Fruittree Leafroller (*Archips argyrospila*), Gypsy Moth (*Lymantria dispar*) and Redbanded Leafroller (*Argyrotaenia velutiana*)

Pest Information

Damage: A number of caterpillars may feed on blossoms, foliage and developing fruit in the early spring. Feeding damage is apparent as holes in leaves, defoliation, rolled leaves and small holes and corky scars on fruit. These insects feed on many other deciduous trees and shrubs and tend to be more prevalent towards the edges of orchards.

Life Cycle: Spring feeding caterpillars overwinter as eggs or larvae in hibernacula (shelters) on trees. Young larvae become active in the spring, feeding on leaves and buds. When fully grown, larvae pupate with adult moths later emerging to lay eggs on the trees. The fruit tree and European leafrollers overwinter as eggs. Eggs hatch in the spring and the newly hatched larvae disperse on silken threads. Larvae enter buds and feed on flower parts, eventually moving to the leaves and nearby fruit. Mature larvae pupate within leaf rolls. Adults emerge from June to August, mate, and lay overwintering eggs. There is one generation per year.

Pest Management

Cultural Controls: The presence of these insects can be monitored visually. Egg masses for some insects may be removed by pruning. Refer to table 12. Pheromone products registered on cherry in Canada for pheromones available for use against these pests.

Resistant Cultivars: None available.

Chemical Controls: Refer to table 11. Insecticides and bioinsecticides registered for the management of insect and mite pests in cherry production in Canada for pesticides registered for the control of spring feeding caterpillars.

Issues for leafrollers

1. Fruittree and European leafrollers in the Okanagan Valley are resistant to organophosphate insecticides.

Eyespotted Bud Moth (*Spilonota ocellana*)

Pest Information

Damage: In the spring, bud moth larvae web together bud clusters and leaves and feed on leaves. The next generation larvae web fruit and leaves together and feed on the surface of fruit.

Life Cycle: The eyespotted bud moth overwinters as partially grown larvae in silken cocoons in the crotches of twigs and branches. The young larvae emerge during bloom and build nests of leaves and blossoms in which they feed. Moths emerge in mid-June to late July following pupation in the nests. After mating, females lay eggs singly on leaves. Summer larvae feed on the surface of fruit and in September seek overwintering sites on the trees.

Pest Management

Cultural Controls: Monitoring is done to determine whether treatment is necessary. Larvae can be manually removed when observed. The elimination of unmanaged host trees in close proximity to the orchard will reduce potential sources of infestation. Pruning orchard trees to open-up the canopy (especially upper canopy) will allow for good air circulation and improved spray penetration and facilitate pesticide controls. Control of the spring generation of bud moth larvae will reduce the need to control the summer generation that causes the economic damage.

Resistant Cultivars: None identified.

Chemical Controls: Insecticides registered for eyespotted bud moth are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada

Issues for the eyespotted bud moth

None identified.

Oriental Fruit Moth (*Grapholitha molesta*)

Pest Information

Damage: The Oriental fruit moth attacks primarily *Prunus* spp., but is also known to attack apple and pear. Depending on the host crop, the larvae feed on shoots and fruit.

Life Cycle: Mature larvae of the Oriental fruit moth overwinter on or near the host. The larvae pupate in the spring and the first generation of adults emerges in early May. Eggs are laid on foliage and the larvae feed within the shoots. Larval broods appear in June, late July, early September and October (the overwintering brood). Up to four generations per year may occur.

Pest Management

Cultural Controls: A pheromone is available to monitor male moths. Refer to Table 12. Pheromone products registered on cherry in Canada. Typically new growth is inspected in spring for larvae or feeding damage, and growing tips and fruit are monitored for larvae as the season progresses.

Resistant Cultivars: None identified.

Chemical Controls: There are no pesticides registered for control of this pest on cherry.

Issues for Oriental fruit moth

1. This pest does not occur in British Columbia and is a quarantine pest. All species, hybrids, varieties, fruit and seed of apricot, nectarine, peach, plum and quince from any country or province of Canada where Oriental fruit moth occurs, requires fumigation prior to entry into British Columbia.

Two Generation Leafrollers: Obliquebanded Leafroller (*Choristoneura rosaceana),* Threelined Leafroller (*Pandemis limitata*), Cherry Fruitworm (*Grapholita packardii*)

Pest Information

Damage: These insects attack a variety of fruit and woody ornamental plants in addition to cherries. First generation insects feed on leaves, buds and flowers. Feeding injury on fruit is evident as irregular holes and russet scars in mature fruit. Feeding by the second summer generation, results in small holes on fruits which may develop rot.

Life Cycle: The obliquebanded leafroller and threelined leafroller have two generations per year. They overwinter as larvae in cocoons in bark crevices. The larvae emerge in the spring and feed on flower parts, leaves and young fruit. Pupation occurs within leaf rolls and moths emerge to lay eggs in June and July. Second generation moths are present from August to October. These moths lay eggs that hatch into larvae which overwinter.

Pest Management

Cultural Controls: Pruning trees will open up the canopy and help to remove egg-masses and allow sufficient penetration of sprays, especially into the upper canopy where leafrollers are most active. Elimination or spraying of unmanaged host trees in close proximity to commercial orchards helps to reduce leafroller pressure. Monitoring is important to determine if pest levels warrant treatment. A pheromone product is registered in Canada and can reduce pest pressure through mating disruption. Refer to Table 12. Pheromone products registered on cherry in Canada.

Resistant Cultivars: None identified.

Chemical Controls: Bacillus thuringiensis var. *kurstaki* provides some control of leafrollers. Refer to Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada**,** for pesticides registered for the control of two generation leafrollers.

Issues for two generation leafrollers

1. There is a need to better understand the biology of oblique banded leafroller (OBLR) in sour cherry. There are concerns about small leafroller larvae present in harvested bins and questions regarding the developmental rate of OBLR when feeding on sour cherry.

Plum Curculio (*Conotrachelus nenuphar*)

Pest Information

Damage: Hosts include plum, apricot, cherry, apple, pear, gooseberry and chokecherry. Adult curculios feed on young fruit. Females lay eggs in young fruit and leave a characteristic crescent-shaped scar near the egg laying site. Infested fruit may become deformed, drop prematurely or may remain infested until harvest, and be unmarketable.

Life Cycle: Adults overwinter in debris close to orchards and emerge in the spring to feed on buds, fruit spurs and developing fruit. Adult curculio beetles lay eggs in fruit and after hatching larvae feed within the fruit. At maturity the larvae drop to the soil to pupate. The subsequent generation of adults appears from late July to early September when they feed on fruit before seeking overwintering sites near the host trees.

Pest Management

Cultural Controls: The regular collection and disposal of fallen fruit will help reduce the population.

Resistant Cultivars: None identified

Chemical Controls: Insecticides registered for plum curculio are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for Plum Curculio

1. Studies are required to incorporate new trap monitoring methods into effective IPM (integrated pest management) systems.

Black Cherry Aphid (*Myzus cerasi*)

Pest Information

Damage: Feeding on terminal shoots by the black cherry aphid results in inward curling of leaves and shoot deformities which can slow the growth of young trees. Aphids cause little direct fruit damage but can leave undesirable deposits of sticky honeydew on fruit that can promote sooty mould growth. The level of tolerance for the black cherry aphid on young trees is very low.

Life Cycle: Aphids overwinter as eggs on the host plant. Eggs hatch at bud break. Young aphids infest blooms and later, growing tips. In July and August adults migrate to summer hosts but return to cherry to lay overwintering eggs. Several generations are produced per year.

Pest Management

Cultural Controls: Monitoring is used to determine when controls are required. The removal of infested terminals reduces populations. Controls including lady beetles, lacewings, syrphid flies and parasitic wasps can reduce aphids to non-damaging levels.

Resistant Cultivars: None identified.

Chemical Controls: Insecticides registered for aphids are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for Aphids

None identified.

Brown Marmorated Stinkbug (BMSB) (*Halymorpha halys*)

Pest Information

Damage: Although the BMSB has not yet been identified as a pest in crops in Canada, it has caused significant crop injury in other jurisdictions where it is established in agricultural crops. This insect has a broad host range including tree fruit, berries, grapes, ornamentals, grain crops, tomatoes, peppers and sweet corn. Injury is caused by feeding of adults and nymphs. The insect injects saliva with digestive enzymes into the plant and ingests the liquefied plant material. Each feeding puncture results in crop injury.

Life Cycle: The insect spreads through natural means and also as a "hitchhiker" in cargo and vehicles. It has been intercepted in many provinces over the years and in 2012 an established population was identified in the Hamilton, Ontario area. It readily moves between host crops throughout the growing season. BMSB overwinter as adults. In the spring, adults mate and lay eggs on host plants. Both nymphs and adults feed on host plants. Adults are long-lived and females may lay several hundred eggs over an extended period of time. In the fall, the adults move back to protected overwintering sites. They have frequently entered structures in the fall where they are a nuisance pest.

Pest Management

Cultural Controls: Monitoring for the insect may be done through aggregation pheromones and by scouting. Although thresholds have not been established, small numbers of nymphs and adults can cause considerable damage in a growing season.

Resistant cultivars: None available.

Chemical controls: Pesticides registered for the management of brown marmorated stink bug are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for brown marmorated stinkbug

1. The brown marmorated stinkbug is a new pest in cherry producing regions. Given the high potential for crop injury, it is important to continue monitoring the movement of this insect and its possible spread into commercial orchards. Effective management strategies must be developed in advance of the establishment of this insect.

Mites: Two-spotted Spider Mite (*Tetranychus urticae*), McDaniel Mite (*Tetranychus mcdanieli*) and European red mite (*Panonychus ulmi)*

Pest Information

Damage: Lightly infested leaves become speckled; heavily infested leaves become bronzed and covered with webbing. Injured leaves may fall.

Life Cycle: Red to orange-coloured, adult females overwinter beneath bark or in trash at the base of trees. In early spring they move up the tree trunk to leaves near the main limbs. They spread throughout the tree and produce several generations depending on temperature. Rust mites overwinter at the base of buds, under bud scales and leaf scars, or in bark crevices on branches and twigs. When the buds open, mites move to the flower parts and leaves. Around petal-fall, rust mites move onto fruit. Several generations are produced during the spring and summer. Overwintering forms of rust mite may appear in late July and move to overwintering sites on the tree.

Pest Management

Cultural Controls: Healthy, well-maintained trees will tolerate higher mite populations than weak or stressed trees. Monitoring is important to determine treatment thresholds. Several predatory mites are effective at controlling pest mite populations. Monitoring is important to determine if treatment is required.

Resistant Cultivars: None identified.

Chemical Controls: Insecticides registered for mites are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for mites

None identified.

Apple Mealybug (*Phenacoccus aceris*)

Pest Information

Damage: The apple mealybug does not directly injure cherry, but is the primary vector of little cherry virus. Due to the seriousness of little cherry virus, there is no tolerance of this insect. Adult mealybugs are found in bark crevices, pruning scars and in the crotches of small twigs where they appear as small, white powdery patches.

Life Cycle: Apple mealybugs have one generation per year. They overwinter as nymphs on their host trees and become active in May. Eggs are laid from June to July, and nymphs are present from July to October. Nymphs can be spread from tree to tree by wind.

Pest Management

Cultural Controls: There is no IPM program used for apple mealybug.
Resistant Cultivars: None identified.
Chemical Controls: Insecticides registered for mealybugs are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for Apple Mealybug

1. With the movement away from the use of organophosphate insecticides, there is concern about the potential for apple mealybug, the vector of little cherry disease virus, to increase in prevalence.

San Jose Scale (*Quadraspidiotus perniciosus*)

Pest Information

Damage: The San Jose Scale is a pest of all tree fruits and many ornamental trees and shrubs. It can cause damage to the bark, kill areas of inner bark, girdle twigs and branches, cause small, brown, dead spots on leaves in the summer and cause fruit spots and deformities. Heavy infestations can cause a loss in tree vigour, growth and productivity.
Life Cycle: San Jose scale overwinters in the immature "blackcap" (second nymphal) stage on bark in tops of trees. Adults mature in spring and winged males fly or walk to reach pheromone-emitting females. The sedentary, shelled females produce living young known as crawlers. Crawlers move to new feeding sites on fruit or bark, insert their sucking mouthparts to feed and then secrete a wax to form a shell. There are 2 to 3 generations per year.

Pest Management

Cultural Controls: Scale populations can be reduced through pruning and the removal of large, old trees with encrusted scale. Close monitoring to enable timely treatments, is important especially in orchards with a history of scale.
Resistant Cultivars: None identified.
Chemical Controls: Insecticides registered for San Jose scale are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for San Jose scale

None identified.

Peach Tree Borer (*Synanthedon exitiosa*), Lesser Peach Tree Borer (*S. pictipes*)

Pest Information

Damage: Damage caused by the peach tree borer results from larval tunnelling under the bark at or below the ground level. Masses of gum mixed with sawdust and excreta near the soil line of the tree trunk are evidence of attack. Young trees can be girdled and killed while older trees are weakened and become susceptible to attack by other insect pests. Larvae of the lesser peach tree borer feed in cankers and wounds throughout the tree.

Life Cycle: Adult peach tree borers are a clear winged moth and are active from late June until September. Female moths lay their eggs on tree trunks near the soil line. After hatching, the larvae bore into the tree and feed on the sapwood. They may take up to 2 years to mature. The larvae overwinter in their feeding tunnels or in the soil and become active in the spring. The life cycle of the lesser peach tree borer is similar to that of the peach tree borer. Adults of the lesser peach tree borer are active May through September. Larvae overwinter in feeding tunnels. Pupation occurs in the spring with adult moths emerging to lay eggs in cankers and cracks in bark.

Pest Management

Cultural Controls: It is important to monitor for borers. A mating disruption pheromone is available in Canada for peach tree borer and appears to be an effective control method. Refer to Table 12 for registered pheromone products. Physical barriers may be placed around the base of trees to deter egg laying by the peach tree borer. Pupal skins found in cankered areas are evidence of lesser peach tree borer. Cultural practices that reduce problems due to canker diseases and maintain tree health will minimize problems caused by lesser peach tree borer.

Resistant Cultivars: None identified.

Chemical Controls: Insecticides registered for borers are listed in Table 11. Pesticides and biopesticides registered for the management of insect pests in cherry production in Canada.

Issues for Peach Tree Borer and lesser Peach Tree Borer

1. There is a need for the registration of reduced risk alternatives to endosulfan for the management of peach tree borer.

Shothole Borer (*Scolytus rugulosus*)

Pest Information

Damage: The shothole borer is attracted to healthy as well as diseased or stressed trees. Small holes at the base of buds, sometimes exhibiting a clear gum or resin exudate is characteristic of damage caused by this insect. Larval feeding on the cambium results in a network of tunnels under the bark. Feeding reduces leaf and bud expansion and can result in yellowing and wilting of foliage.

Life Cycle: There are two generations per year. Adults emerge in May and tunnel under bark to lay eggs. Larvae are present from April to July. A second adult generation appears from August to September, lays eggs and produces the overwintering larval generation. Hosts include native and cultivated trees, with cherry trees the preferred host. Migration into orchards occurs from forested and urban areas.

Pest Management

Cultural Controls: Removing dead and weakened wood from the orchard and following practices that encourage tree vigour, will help reduce problems due to shothole borer. Placing trap logs around the orchard and destroying the trap logs before adult emergence will help to control this insect.

Resistant Cultivars: None identified.

Chemical Controls: There are no registered controls for this pest.

Issues for shotholer borer

1. There is a need for the registration of chemical controls for shothole borer.

Ambrosia Beetle (*Xyloborus dispar*)

Pest Information

Damage Caused: Larvae tunnelling in the sapwood of small branches causes wilting and dieback of leaves and delayed emergence in the spring. Young trees may be girdled. Severely infested branches and small stems are weakened by tunnelling and are susceptible to breakage.

Life Cycle: Ambrosia beetles overwinter as adults in tunnels in trees. Adults appear in April and after mating, tunnel into a host to lay eggs. Larvae are present from May to July (in British Columbia) and tunnel in sapwood and into heartwood. Larvae feed on the ambrosia fungus that develops in the tunnels. New adults remain in the host to overwinter. One generation occurs per year.

Pest Management

Cultural Controls: Since ambrosia beetles are attracted to weakened trees, minimizing stress and maintaining trees in good vigour will help reduce damage caused by this pest. Ethanol-baited traps can be used to monitor adults.

Resistant Cultivars: None identified.

Chemical Controls: There are no pesticides registered for the control of this pest.

Issues for Ambrosia beetle

1. None identified.

Weeds

Key Issues

- Weed species that are tolerant to glyphosate are becoming more prevalent. There is a need to register additional contact herbicides that are effective against a wide range of broadleaf weeds and grasses as alternatives to glyphosate. There is a need to register additional pre-emergent, residual herbicides that are safe for use in young plantings in all tree fruit.
- There is a need for weed surveys to identify and determine the distribution of problem weeds.

Table 13. Occurrence of weeds in cherry production in Canada

Weed	Sweet cherry		Sour cherry
	British Columbia	Ontario	Ontario
Annual broadleaf weeds			
Perennial broadleaf weeds			
Annual grass weeds			
Perennial grass weeds			
Widespread yearly occurrence with high pest pressure.			
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.			
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pressure.			
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.			
Pest not present.			
Data not reported.			

[1]Source: Cherry stakeholders in reporting provinces.

Table 14. Adoption of weed management practices in sweet cherry production in Canada

Practice / Pest		Annual broadleaf weeds	Perennial broadleaf weeds	Annual grass weeds	Perennial grass weeds
Avoidance	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	optimizing fertilization				
	use of weed-free seed				
Prevention	equipment sanitation				
	mowing / mulching / flaming				
	modification of plant density (row or plant spacing; seeding)				
	seeding / planting depth				
	water / irrigation management				
	weed management in non-crop lands				
	weed management in non-crop years				
	tillage / cultivation				
Monitoring	scouting / field inspection				
	field mapping of weeds / record of resistant weeds				
	soil analysis				
	use of portable electronic devices in the field to access pest identification /management information				
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	economic threshold				
	weather / weather-based forecast / predictive model				
	recommendation from crop specialist				
	first appearance of weed or weed growth stage				
	observed crop damage				
	crop stage				
Suppression	pesticide rotation for resistance management				
	soil amendments				
	biological pesticides				
	arthropod biological control agents				
	habitat / environment management				
	ground cover / physical barriers				
	mechanical weed control				
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				

This practice is used to manage this pest by at least some growers in the province.

This practice is not used by growers in the province to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]**Source: Stakeholders in sweet cherry producing provinces (British Columbia and Ontario).**

Table 15. Adoption of weed management practices in sour cherry production in Canada

Practice / Pest		Annual broadleaf weeds	Perennial broadleaf weeds	Annual grass weeds	Perennial grass weeds
Avoidance	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	optimizing fertilization				
	use of weed-free seed				
Prevention	equipment sanitation				
	mowing / mulching / flaming				
	modification of plant density (row or plant spacing; seeding)				
	seeding / planting depth				
	water / irrigation management				
	weed management in non-crop lands				
	weed management in non-crop years				
	tillage / cultivation				
Monitoring	scouting / field inspection				
	field mapping of weeds / record of resistant weeds				
	soil analysis				
	use of portable electronic devices in the field to access pest identification /management information				
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	economic threshold				
	weather / weather-based forecast / predictive model				
	recommendation from crop specialist				
	first appearance of weed or weed growth stage				
	observed crop damage				
	crop stage				
Suppression	pesticide rotation for resistance management				
	soil amendments				
	biological pesticides				
	arthropod biological control agents				
	habitat / environment management				
	ground cover / physical barriers				
	mechanical weed control				
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				

This practice is used to manage this pest by at least some growers in the province.

This practice is not used by growers in the province to manage this pest.

This practice is not applicable for the management of this pest.

Information regarding the practice for this pest is unknown.

[1]Source: Stakeholders in sour cherry producing provinces (Ontario).

Table 16. Herbicides and bioherbicides registered for weed management in cherry production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
First year, before transplanting or in newly planted trees					
bentazon (present as sodium salt)	benzothiadiazinone	inhibition of photosynthesis at photosystem II	6	R	broadleaf weeds
methyl bromide (fumigant, pre-plant soil application)	alky halide[4]	miscellaneous non-specific (multi-site) inhibitor[4]	8A[4]	PO	insects, nematodes, soil borne fungi and certain weeds
metribuzin	triazinone	inhibition of photosynthesis at photosystem II	5	R	annual weeds
napropamide	acetamide	inhibition of cell division (Inhibition of VLCFAs)	15	R	annual weeds
pendimethalin	dinitroaniline	microtubule assembly inhibition	3	R	annual grasses and labelled broadleaf weeds
s-metolachlor	chloroacetamide	inhibition of cell division (inhibition of VLCFAs)	15	R	annual grasses and broadleaf weeds
simazine	triazine	inhibition of photosynthesis at photosystem II	5	RES	annual grasses and broadleaf weeds
terbacil	uracil	inhibition of photosynthesis at photosystem II	5	R	annual weeds
trifluralin	dinitroaniline	microtubule assembly inhibition	3	RES	most annual grasses and many broadleaf weeds

....continued

Table 16. Herbicides and bioherbicides registered for weed management in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Established trees					
2,4-D (various salts)	phenoxy-carboxylic-acid	action like indole acetic acid [synthetic auxins]	4	RES	broadleaf weeds
carfentrazone-ethyl	triazolinone	inhibition of protoporphyrinogen oxidase (PPO)	14	R	broadleaf weeds
dichlobenil	nitrile	inhibition of cell wall [cellulose] synthesis	20	RES	annual grasses, broadleaf weeds and certain perennial weeds
fluazifop-p-butyl	aryloxyphenoxy-propionate 'FOP'	inhibition of acetyl CoA carboxylase (ACCase)	1	RES	grasses
flumioxazin	N-phenylphthalimide	inhibition of protoporphyrinogen oxidase (PPO)	14	R	annual broadleaf weeds
glufosinate ammonium	phosphinic acid	inhibition of glutamine synthetase	10	R	annual and perennial weeds
glyphosate (various salts)	glycine	inhibition of EPSP synthase	9	RE	annual and perennial weeds
indaziflam	alkylazine	cellulose Inhibitor	29	R	annual grass and broadleaf weeds
linuron	urea	inhibition of photosynthesis at photosystem II	7	RES*	annual weeds

....continued

Table 16. Herbicides and bioherbicides registered for weed management in cherry production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Established trees					
metribuzin	triazinone	inhibition of photosynthesis at photosystem II	5	R	annual weeds
paraquat	bipyridylium	photosystem-I-electron diversion	22	RES	many grasses and broadleaf weeds
s-metolachlor	chloroacetamide	inhibition of cell division (inhibition of VLCFAs)	15	R	annual grasses
sethoxydim	cyclohexanedione 'DIM'	inhibition of acetyl CoA carboxylase (ACCase)	1	R	grass weeds
terbacil	uracil	inhibition of photosynthesis at photosystem II	5	R	broadleaf weeds
Hooded sprayer application and sucker management					
carfentrazone-ethyl	triazolinone	inhibition of protoporphyrinogen oxidase (PPO)	14	R	broadleaf weeds

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of November 5, 2014. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Herbicide Resistance Action Committee (HRAC). *Classification of Herbicides According to Site of Action (2014)* (www.hracglobal.com) (accessed February 17, 2015). Herbicide resistance groups are based on the Weed Science Society of America classification system as reported by HRAC (www.hracglobal.com).

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation , RES (yellow) - under special review as published in PMRA re-evaluation note *REV2013-06, Special Review Initiation of 23 Active Ingredients*, RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 31, 2014.

[4]Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 7.3; 2014)* (www.irac-online.org) (accessed February 17, 2015).

Annual and Perennial Weeds

Pest Information

Damage: Weeds compete with orchard trees for moisture and nutrients. A variety of annual and perennial broadleaf weeds may be present in cherry orchards. Annual grass weeds that occur in sweet cherries include annual bluegrass, wild oats and barnyard grass

Life Cycle: Summer annual weeds germinate in the spring, flower and fruit in the summer or fall and die before the onset of winter. Winter annuals germinate in the fall, overwinter in a vegetative state, flower in the spring, form seeds and then die. Perennial weeds live for many years. They spread through flowering and seed production as well as through expansion of their root system. Perennials can also be spread vegetatively through the movement of tubers, rhizomes and root systems.

Pest Management

Cultural Controls: Mechanical weeding, hand weeding, cover cropping and mulching may be used to control weeds. Cover crops are grown between orchard trees to provide weed control, as well as protection from leaching and erosion. Early season weed control will minimize the impact of competition and reduce weed seed development. Tillage and cultivation are used only in the year prior to orchard establishment.

Chemical Controls: Residual and non-residual herbicides are used to control orchard floor vegetation. The rotation of herbicides is dependent on the spectrum of weeds to be controlled. Herbicides registered for weed control in cherry orchards are listed in Table 16. Herbicides and bioherbicides registered for weed management in cherry production in Canada.

Issues for Weeds

1. Weed species that are tolerant to glyphosate are becoming more prevalent. There is a need to register additional contact herbicides that are effective against a wide range of broadleaf weeds and grasses as alternatives to glyphosate
2. There is a need to register additional pre-emergent residual herbicides that are safe for use in young plantings in all tree fruits.
3. There is a need for weed surveys to identify problem weeds and determine the distribution of problem weeds.
4. The use and environmental impact of innovative methods of weed control (for example flaming, mulch application, use of cultivators) need further study. Methods for the low cost production of mulches are also required.
5. Chemical controls for horsetail and vetch, serious problems in some orchards, are required.

Vertebrate Pests

Deer, bears, birds and rodents are the primary vertebrate pests of cherry orchards. Cherry orchards are generally fenced at planting to protect the trees from ungulates such as deer (and elk in British Columbia). The animals chew buds, spurs, shoots and leaves, and trees that are damaged when they are young may not develop into commercially productive plants. Woven wire fences at least 2.4 meters in height provide the best protection, but are expensive to install. In some areas, bears invade orchards in the fall in years when native berry crops are poor. Losses include destroyed fruit as well as broken tree limbs. Birds such as starlings, robins and crows often attack cherries. Starlings, which cause the most severe damage, can cause serious crop loss.

Field Mice (Meadow Mice, Meadow Voles) (*Microtus sp.*)

Pest Information

Damage: Field mice cause damage by gnawing the stems and roots of trees. Injury to the trees can begin in late summer or when food becomes scarce in the fall, but usually occurs in winter under a protective snow cover. Below ground injury may be extensive but not visible from the surface until the plants fail to leaf out normally. Severe damage, such as complete girdling of the trunk or roots can kill trees.

Life Cycle: Field mice are found in areas of dense vegetation where they feed on seeds, tubers, rhizomes and other plant material. They create a network of runways on the ground surface through which they travel. They nest in cavities in the ground. Litters are produced monthly throughout the growing season.

Pest Management

Cultural Controls: Vegetation in and around the orchard is managed to discourage rodents. Maintaining a weed free strip within tree rows reduces mouse habitat. Physical barriers placed around tree trunks are occasionally used. A number of wild predators help to keep the mouse population in check including hawks, coyotes, foxes and weasels.

Chemical Controls: Registered active ingredients include diphacinone, chlorophacinone, and zinc phosphide. Tree trunks can also be treated with repellents containing thiram which discourages rodent feeding because of the taste.

Issues for Rodents

None identified.

Birds

Pest Information

Damage: Birds feed on ripening fruit and can destroy an entire crop. Damage becomes less noticeable in older orchards due to the larger crop size. Common birds causing damage in cherries are red-wing blackbirds, starlings, robins, goldfinches, orioles, blue jays, cedar waxwings and gulls.

Pest Management

There are three types of bird repellent methods currently available to growers:

- Acoustical repellents: Acoustical repellents use sound to scare birds away.
- Visual repellents: Birds generally have very good eyesight and react to both movement and objects that resemble their enemies (for example, osprey kites). Visual deterrents are usually used together with acoustical systems.
- Physical exclusion: Nets may be draped directly on top of the trees or fastened to an overhead structure which totally encloses the orchard.

Once birds establish, they are difficult to deter from feeding on the crop. Controls must start early in the season. An integrated approach, using a variety of these repellent methods must be used.

Issues for Birds

1. Birds continue to be a pest of concern in sweet cherry orchards. Acoustic deterrents are problematic when used close to residential areas. There is a need for continued research on bird control in cherry orchards.
2. There is a need for further investigation of the use of methyl anthranilate (a compound found naturally in labrusca grapes) or dimethyl anthranilate as a safe way to deter problematic bird species.
3. There is concern over the lack of research on pest birds.

Resources

Integrated Pest Management/ Integrated Crop Management resources for production of Cherry in Canada

Websites

British Columbia Ministry of Agriculture, Food, and Fisheries. Tree Fruits Publications.
http://www.agf.gov.bc.ca/treefrt/

Health Canada, Pest Management Regulatory Agency
http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php

Ontario Ministry of Agriculture, Food and Rural Affairs, Crop Publications
http://www.omafra.gov.on.ca/english/crops/publications.html

Ontario Ministry of Agriculture, Food and Rural Affairs, Ontario Crop IPM
http://www.omafra.gov.on.ca/IPM/english/index.html

University of Saskatchewan (fruit program)
http://www.fruit.usask.ca

Publications

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British Columbia Ministry of Agriculture. *Tree Fruit Insect Pests and Diseases*
http://www.agf.gov.bc.ca/cropprot/tfipm/treefruitipm.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Publication 360, Guide to Fruit Production 2014-15, 310 pp.* http://www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm

Philip, Hugh and Linda Edwards. 1991. Harmful and Beneficial Insects and Mites of Tree Fruits, 3rd ed. British Columbia Ministry of Agriculture
http://www.agf.gov.bc.ca/cropprot/fieldguide/main.htm

Provincial Crop Specialists and Provincial Minor Use Coordinators

Province	Ministry	Crop Specialist	Minor Use Coordinator
British-Columbia	British Columbia Ministry of Agriculture and Lands www.gov.bc.ca/al	Jim Campebell, Industry Specialist – Tree Fruit and Grapes jim.g.campbell@gov.bc .ca	Caroline Bédard caroline.bédard@gov.bc.ca
Saskatchewan	Saskatchewan Agriculture www.agriculture.gov.sk.ca	Forrest Scharf forrest.scharf@gov.sk.ca	Danielle Stephens danielle.stephens@gov.sk.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca/english/index.html	Wendy McFadden-Smith, Tender Fruit and Grape IPM Specialist wendy.mcfadden-smith@ontario.ca	Jim Chaput jim.chaput@ontario.ca

National and Provincial Cherry and Fruit Grower Organizations

British Columbia Cherry Association (http://bccherry.com.50-21-229-37.cableweb3.ca/)

British Columbia Fruit Growers Association (www.bcfga.com)

Canadian Cherry Producers Inc. (www.cherryproducers.ca/)

Canadian Horticultural Council (www.hortcouncil.ca)

Ontario Fruit and Vegetable Growers Association (www.ofvga.org)

Saskatchewan Fruit Growers Association (www.saskfruit.com)

Appendix 1

Definition of terms and colour coding for pest occurrence table of the crop profiles.

Information on the occurrence of disease, insect and mite and weed pests in each province is provided in Tables 4, 8 and 13 of the crop profile, respectively. The colour coding of the cells in these tables is based on three pieces of information, namely pest distribution, frequency and importance in each province as presented in the following chart.

<table>
<tr><th>Presence</th><th colspan="4">Occurrence information</th><th>Colour Code</th></tr>
<tr><td rowspan="12">Present</td><td rowspan="10">Data available</td><td>Frequency</td><td>Distribution</td><td>Pressure</td><td></td></tr>
<tr><td rowspan="6">**Yearly** - Pest is present 2 or more years out of 3 in a given region of the province.</td><td rowspan="3">**Widespread** - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.</td><td>**High** - If present, potential for spread and crop loss is high and controls must be implemented even for small populations.</td><td>Red</td></tr>
<tr><td>**Moderate** - If present, potential for spread and crop loss is moderate: pest situation must be monitored and controls may be implemented.</td><td>Orange</td></tr>
<tr><td>**Low** - If present, the pest causes low or negligible crop damage and controls need not be implemented.</td><td>Yellow</td></tr>
<tr><td rowspan="3">**Localized** - The pest is established as localized populations and is found only in scattered or limited areas of the province.</td><td>**High** - see above</td><td>Orange</td></tr>
<tr><td>**Moderate** - see above</td><td>White</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="6">**Sporadic** - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">**Widespread** - as above</td><td>**High** - see above</td><td>Orange</td></tr>
<tr><td>**Moderate** - see above</td><td>Yellow</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="3">**Localized** - as above</td><td>**High** - see above</td><td>Yellow</td></tr>
<tr><td>**Moderate** -see above</td><td>White</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data **not** available</td><td colspan="3">**Not of concern:** The pest is present in commercial crop growing areas of the province but is causing no significant damage. Little is known about its population distribution and frequency in this province; however, it is not of concern.</td><td>White</td></tr>
<tr><td colspan="3">**Is of concern:** The pest is present in commercial crop growing areas of the province. Little is known about its population distribution and frequency of outbreaks in this province and due to its potential to cause economic damage, is of concern.</td><td></td></tr>
<tr><td>Not present</td><td colspan="4">The pest is not present in commercial crop growing areas of the province, to the best of your knowledge.</td><td>black</td></tr>
<tr><td>Data not reported</td><td colspan="4">Information on the pest in this province is unknown. No data is being reported for this pest.</td><td>grey</td></tr>
</table>

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http://www.agf.gov.bc.ca/busmgmt/budgets/tree_fruits.htm

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