Crop Profile for Cherry in Canada, 2019

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Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada
Canada

Fourth Edition – 2021
Crop Profile for Cherry in Canada, 2019
Catalogue No.: A118-10/35-2019E-PDF
ISBN: 978-0-660-35254-1
AAFC No.: 13026E

Third Edition – 2018
Crop Profile for Cherry in Canada, 2016
Catalogue No.: A118-10/35-2016E-PDF
ISBN: 978-0-660-28851-2
AAFC No.: 12877E

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

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

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, 2019 »

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Preface

National crop profiles are developed by the Pest Management Program of Agriculture and Agri-Food Canada (AAFC). The crop profiles provide baseline information on production and pest management practices and document growers' needs to address pest management gaps and issues for specific crops grown in Canada. This information is developed through extensive consultation with stakeholders and data collected from reporting provinces. Reporting provinces are selected based on their acreage of the target crop (>10% of the national production) and provide qualitative data on pest occurrence and integrated pest management practices used by growers in those provinces. For cherry production, the reporting provinces are British Columbia and Ontario.

Information on pest issues and management practices is provided for information purposes only. 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. For guidance about crop protection products registered for pests on cherry, the reader is referred to provincial crop production guides and Health Canada's Pesticide label database.

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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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 *P. 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. 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. The sweet cherry breeding program at Agriculture and Agri-Food Canada's Summerland Research and Development Centre, 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 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. These winter-hardy, drought tolerant cherries grow as a shrub on their own rootstocks and reach heights of three meters.

Crop Production

Industry Overview

In 2019, Canadian sweet cherry production totaled 22,061 metric tonnes on 2,125 hectares, with a farm gate value of $89.3 million. Sour cherry production totaled 4,588 metric tons on 926 hectares and had a farm gate value of $4.3 million. Canadian exports of sweet and sour cherries in 2019 were $67.6 million and $10.6 million, respectively.

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 during processing. Their tart flavour tends to become sweeter with processing. The use of dwarf sour cherries (whether eaten fresh or processed) varies with cultivar.

Table 1. General production information in Canada, 2019

	Sweet Cherry	Sour Cherry
Canadian production[1]	22,061 metric tonnes 2,125 hectares	4,588 metric tonnes 926 hectares
Farm Gate Value[1]	$89.3 Million	$4.3 Million
Cherries available in Canada[2]	0.97 kg/ person (fresh) 0.35 kg/ person (processed)	
Exports[3]	$67.6 million	$10.6 million
Imports[3]	$166.1 million	$0.77 million

[1]Statistics Canada. Table 32-10-0364-01. Area, production and farm gate value of marketed fruits. (Database accessed: 2020-10-27).
[2]Statistics Canada. Table 32-10-0054-01. Food available in Canada. (Database accessed: 2020-10-27).
[3]Trade Data Online (Database accessed: 2020-10-27). HS # 080929, cherries, other; HS # 080921, sour cherries.

Production Regions

Due to their 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 1,964 hectares or 92% of total Canadian production in 2019. The key production areas are the Okanagan, Similkameen and Kootenay Valleys. Ontario accounted for 149 hectares (7%) of the remaining production, grown largely in the Niagara fruit growing area.

Sour cherries are grown primarily in Ontario, which accounts for 759 hectares or 82% of total Canadian production in 2019. 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. As well, sour cherries are grown in British Columbia (4% of national production) and Saskatchewan (8% of national production).

Table 2. Distribution of cherry production in Canada, 2019

Production Regions	Cultivated area[1,2] (national percentage)		Marketed production[1] (national percentage)		Farm gate value[1]	
	Sweet cherry	Sour Cherry	Sweet cherry	Sour Cherry	Sweet cherry	Sour Cherry
British Columbia	1,964 ha (92%)	37 ha (4%)	21,235 metric tonnes (96%)	not reported	$85.9 Million	$0.24 Million
Alberta	n/a[3]	31 ha (3%)	n/a[3]	113 metric tonnes (2%)	n/a[3]	$0.17 Million
Saskatchewan	n/a[3]	71 ha (8%)	n/a[3]	63 metric tonnes (1%)	n/a[3]	$0.3 Million
Ontario	149 ha (7%)	759 ha (82%)	792 metric tonnes (4%)	4,349 metric tonnes (95%)	$3.3 Million	$3.5 Million
Canada	2,125 ha	926 ha	22,061 metric tonnes	4,588 metric tonnes	$89.3 Million	$4.3 Million

[1]Source: Statistics Canada. Table 32-10-0364-01. Area, production and farm gate value of marketed fruits (accessed: 2020-10-27).
[2]Cultivated area includes bearing and non-bearing area.
[3]No production.

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 percent to allow for air drainage, surface water drainage and good light exposure. Location within three or four kilometers from a large 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. The use of wind machines can also be beneficial to mitigate potential blossom damage from spring frosts in marginal growing areas. 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 mid-winter temperature extremes, rainfall, sunlight, wind and spring 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 using dwarfing rootstocks and later maturing varieties. 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; review orchard renewal and long-term renovation plan.
	Soil Care	Prepare sites of new plantings; take soil samples in established sites for nutrient analysis.
	Disease Management	No action required.
	Weed Management	Monitor for weeds and apply controls, if required.
Late March to May (bud break and blossom)	Plant Care	Prune mature trees, remove brush and flail chop all pruning. In some growing regions, plant and prune new trees; irrigate as needed; place beehives in the orchard when first blossoms open and remove at petal fall, prior to insecticide applications. Activate wind machines for frost protection, as required. Initiate supplemental foliar nutrition and growth regulators, as required. Install deer fencing where required.
	Soil Care	Apply nitrogen to established orchards as needed; apply lime and other amendments as indicted by soil testing. Begin cultivation between rows, if required.
	Disease Management	Remove shoots which have bacterial, cytospora and coryneum blights; apply controls as required. Monitor conditions for brown rot/blossom blight, Botrytis and powdery mildew infection during and post bloom; apply controls as required.
	Insect Management	Monitor for leafrollers, fruitworms, budmoth, mites, aphids, apple mealybug, shothole borer, ambrosia beetles and beneficial organisms; apply controls as required. Apply delayed dormant controls for mites, scales, mealybugs and overwintering insects.
	Weed Management	Monitor for weeds and apply herbicides as required; mow alleyways.
June to August (blossom, fruit development and harvest of summer varieties (August)	Plant Care	Monitor tree growth, apply supplemental nutrient sprays as needed; monitor soil moisture and irrigate as needed; thin cherries if required; manage canopy density for air circulation and light penetration. In some growing regions, new trees will be planted and pruned. Apply rain split protectants as required. Have leaf analyses performed. Use bird control (noise deterrents). Hand harvest and deliver fruit to markets or cold storage.
	Soil Care	Apply supplemental nutrients as needed.
	Disease Management	Maintain disease control of brown rot, Botrytis and powdery mildew; cut out wood with bacterial canker and powdery mildew; monitor mature fruit for little cherry disease.

…continued

Table 3. Cherry production and pest management schedule in Canada (continued)

Time of Year	Activity	Action
June to August (blossom, fruit development and harvest of summer varieties (August)	Insect Management	Set out and monitor yellow sticky traps for cherry fruit flies. Monitor for spotted wing drosophila and peach tree borer; continue to monitor for other insect pests and beneficial organisms. Apply controls as required.
	Weed Management	Seed cover crop in alleyways of new plantings; mow orchard alleyways. Monitor for weeds and apply controls as required.
September to November (harvest and post- harvest care)	Plant Care	Apply post-harvest nutrient sprays. 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. Apply lime if required.
	Disease Management	Remove dead, weak and diseased trees; remove cankers; begin dormant pruning. Apply controls for bacterial canker.
	Insect Management	Apply postharvest controls for spotted wing drosophila, cherry fruit flies, mites and mealybugs, if needed.
	Weed Management	Mow alleyways; apply residual or systemic herbicides as required.

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, and can result in reduced fruit set.

Excessive Rain

Periods of heavy rain can cause rain split, which occurs when cherry fruit absorbs water and swells, eventually splitting. Over 50 percent 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 air blast sprayers to avoid fruit split by drying the fruit.

Diseases

Key issues

- Resistance to fungicides is an on-going concern for the management of brown rot and cherry leaf spot with the cancellation of iprodione. Additional cost effective rotational fungicides are needed to allow for improved disease resistance management.

- Kasugamycin and copper products are now available for management of bacterial canker; however, there is still a need for additional rotational products for this disease.

- Effective controls for nematodes are required, particularly in British Columbia, in both replant and established cherry plantings.

- 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.

- The trend towards higher density plantings and later-maturing varieties has increased powdery mildew incidence and severity in cherries.

- There is a small acreage of sweet cherries grown under high tunnels in Ontario. Best management strategies need to be evaluated for disease control strategies when growing under high tunnels.

- Cherry leaf spot incidence is on the rise in sweet cherries in Ontario, and continues to be the disease with the greatest economic impact on sour cherry production. Climatic conditions over the past three to five years have been ideal for the continued development of this disease. Additional rotational control products are needed.

- The distribution of LCHV-2 in commercial orchards in the Pacific Northwest is at epidemic levels. Studies to assess the potential for re-establishment of the virus in British Columbia and its potential impact should be considered. As well, monitoring of insect vectors and potential control measures for the vectors should be determined.

- Caution should be taken when considering moving untested or non-certified virus free plant material from the United States to Canada due to the presence of X-disease phytoplasm (Western X) in the Pacific Northwest. Consideration should also be given to potential control measures for virus vectors.

Table 4. Occurrence of diseases in cherry production in Canada[1,2]

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			
Bacterial canker			
Perennial canker			
Verticillium wilt			
Phytophthora crown, root and collar rot			
Nematodes			
Virus diseases			
Little Cherry Disease			
X Disease Phytoplasma			
Post-harvest diseases			
Slip skin maceration disorder			
Cherry replant disease			
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 pest 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.			
Pest is present and of concern, however little is known of its distribution, frequency and importance.			
Data not reported.			

[1]Source: Cherry stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2017, 2018 and 2019 production years.
[2]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[1]

	Practice / Pest	Brown rot	Powdery mildew	Bacterial canker	Cherry leaf spot	Little cherry disease
Avoidance	Varietal selection / use of resistant or tolerant varieties					
	Planting / harvest date adjustment					
	Rotation with non-host crops					
	Choice of planting site					
	Optimizing fertilization for balanced growth and to minimize stress					
	Minimizing wounding and insect damage to limit infection sites					
	Use of disease-free propagative materials (seed, cuttings or transplants)					
Prevention	Equipment sanitation					
	Canopy management (thinning, pruning, row or plant spacing, etc.)					
	Manipulating seeding / planting depth					
	Irrigation management (timing, duration, amount) to minimize disease infection periods and manage plant growth					
	Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds, etc.)					
	End of season or pre-planting crop residue removal / management					
	Pruning out / removal of infected material throughout the growing season					
	Removal of other hosts (weeds / volunteers / wild plants) in field and vicinity					

…continued

Table 5. Adoption of disease management practices in sweet cherry production in Canada[1] (continued)

Practice / Pest		Brown rot	Powdery mildew	Bacterial canker	Cherry leaf spot	Little cherry disease
Monitoring	Scouting / spore trapping					
	Maintaining records to track diseases					
	Soil analysis for the presence of pathogens					
	Weather monitoring for disease forecasting					
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of diseases					
Decision making tools	Economic threshold					
	Use of predictive model for management decisions					
	Crop specialist recommendation or advisory bulletin					
	Decision to treat based on observed disease symptoms					
	Use of portable electronic devices in the field to access pathogen / disease identification / management information					
Suppression	Use of diverse product modes of action for resistance management					
	Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pathogen populations					
	Use of biopesticides (microbial and non-conventional pesticides)					
	Controlled atmosphere storage					
	Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)					
	Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					

…continued

Table 5. Adoption of disease management practices in sweet cherry production in Canada[1] (continued)

Practice / Pest		Brown rot	Powdery mildew	Bacterial canker	Cherry leaf spot	Little cherry disease
Specific practices	Monitoring and control of vector					
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: Cherry stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2019, 2018 and 2017 production years.

Table 6. Adoption of disease management practices in sour cherry production in Canada[1]

	Practice / Pest	Brown rot	Powdery mildew	Bacterial canker	Cherry leaf spot	Little cherry disease
Avoidance	Varietal selection / use of resistant or tolerant varieties					
	Planting / harvest date adjustment					
	Rotation with non-host crops					
	Choice of planting site					
	Optimizing fertilization for balanced growth and to minimize stress					
	Minimizing wounding and insect damage to limit infection sites					
	Use of disease-free propagative materials (seed, cuttings or transplants)					
Prevention	Equipment sanitation					
	Canopy management (thinning, pruning, row or plant spacing, etc.)					
	Manipulating seeding / planting depth					
	Irrigation management (timing, duration, amount) to minimize disease infection periods and manage plant growth					
	Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds, etc.)					
	End of season or pre-planting crop residue removal / management					
	Pruning out / removal of infected material throughout the growing season					
	Removal of other hosts (weeds / volunteers / wild plants) in field and vicinity					

…continued

Table 6. Adoption of disease management practices in sour cherry production in Canada[1] (continued)

Practice / Pest		Brown rot	Powdery mildew	Bacterial canker	Cherry leaf spot	Little cherry disease
Monitoring	Scouting / spore trapping					
	Maintaining records to track diseases					
	Soil analysis for the presence of pathogens					
	Weather monitoring for disease forecasting					
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of diseases					
Decision making tools	Economic threshold					
	Use of predictive model for management decisions					
	Crop specialist recommendation or advisory bulletin					
	Decision to treat based on observed disease symptoms					
	Use of portable electronic devices in the field to access pathogen / disease identification / management information					
Suppression	Use of diverse product modes of action for resistance management					
	Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pathogen populations					
	Use of biopesticides (microbial and non-conventional pesticides)					
	Controlled atmosphere storage					
	Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)					
	Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					

…continued

Table 6. Adoption of disease management practices in sour cherry production in Canada[1] (continued)

Practice / Pest		Brown rot	Powdery mildew	Bacterial canker	Cherry leaf spot	Little cherry disease
Specific practices	Monitoring and control of vector					
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: Cherry stakeholders in reporting province (Ontario); the data reflect the 2017, 2018 and 2019 production years.

Brown Rot Blossom Blight and Fruit Rot (*Monilinia fructicola*)

Pest Information

Damage: Brown rot causes serious damage to cherries and other stone fruits during wet seasons. The disease causes blossom blight, fruit rot, twig blight and fruit loss. Blossoms and ripening fruits 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 infected fruit begins to ripen or after harvest. Rotting fruit can act as a source of inoculum that can infect additional healthy fruit. 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. Conidia (asexual spores) produced on blighted blossoms cause secondary infections, which spread to ripening 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, mainly via 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 on fruit mummies present on the orchard floor. Refer to *Tables 5* and *6* for practices used by growers to manage brown rot.

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.

Issues for Brown Rot

1. Efficient, cost effective monitoring and forecasting techniques need to be developed to improve decision making for brown rot fungicide sprays.
2. Resistance to fungicides is an on-going concern for the management of brown rot with the cancellation of iprodione. Additional cost effective rotational fungicides are needed to allow for improved disease resistance management.
3. There is a need for the development of alternative, integrated pest management (IPM) practices to prevent both early season infections (infections occurring during the bloom period that remain latent until the fruit begins to mature), and late season development of brown rot.

Botrytis Fruit Rot & Blossom Blight (*Botrytis cinerea*)

Pest Information

Damage: Botrytis cinerea can cause fruit rot in cherry orchards and post-harvest. When wet weather persists, green fruit may rot and latent infections can cause rot as the fruit ripens. Infected fruits become soft and watery, then develop a firm and brown decay 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: Pruning to remove excess branches can increase air flow. 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 cool until it reaches market.

Resistant Cultivars: None identified.

Issues for Botrytis Fruit Rot

1. There is a continued need for the registration of additional active ingredients for the control of botrytis and other post-harvest diseases on stone fruit.

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. Severely affected foliage often becomes distorted and powdery mildew can cause early defoliation and prevent shoot growth of young trees. Fruit infection appears as a white powdery covering on the cherry as it ripens, resulting in unmarketable fruit. The trend towards higher density plantings and later-maturing varieties has led to increased powdery mildew pressure and damage.

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 are produced within the infected tissues and cause secondary infections. There are multiple generations throughout the growing season. Immature fruit is 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. Refer to *Tables 5* and *6* for practices used by growers to manage powdery mildew.

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

Issues for Powdery Mildew

1. Access to new products is needed for the control of powdery mildew to enable resistance management strategies. Products effective on both powdery mildew and cherry leaf spot would be beneficial, as sour cherry growers must manage both diseases during the growing season.

Cherry Leaf Spot (*Blumeriella jappii*)

Pest Information

Damage: Leaves develop small purple to brown spots with defined borders during 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 these spots. Spores are rain splashed and infect other leaves. Secondary spread and infection by spores continues repeatedly, whenever wet and 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. There are no practical methods to reduce primary inoculum. Refer to *Tables 5* and *6* for practices used by growers to manage cherry leaf spot.

Resistant Cultivars: None identified.

Issues for Cherry Leaf Spot

1. There is a need to closely monitor resistance to Group 3 and Group 11 fungicides. In the United States, some *Blumeriella jappii* isolates have been identified that are resistant to certain Group 11 fungicides.
2. There is a need to register more effective fungicides with new chemistries to compensate for resistance or losses due to re-evaluations of certain fungicides.
3. Cherry leaf spot incidence is increasing in Ontario sweet cherry production, and continues to be the disease with the greatest economic impact on sour cherries. Climatic conditions over

the past three to five years have been ideal for the continued development of this disease. Additional research is needed on disease forecasting and potential long-term impacts of premature defoliation.

Coryneum Blight or Shot Hole (*Wilsonomyces carpophilus*)

Pest Information

Damage: Coryneum blight causes small reddish-brown to purple spots on many stone fruits, 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 windblown 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.

Issues for Coryneum Blight

None identified

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. Mildly affected can recover but others can lose vigour and die.

Life Cycle: The causal fungus persists in the soil as microsclerotia (resting bodies). The pathogen is more prevalent in soils that have been previously cropped to other susceptible plants. The pathogen invades through tree roots ad 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 optimal irrigation and fertilization will help trees recover.

Resistant Cultivars: None identified.

Issues for (Verticillium dahlia)

1. The interplanting of low growing crops such as tomatoes, peppers, eggplants, strawberries and/ or melons between rows in young orchards has increased in popularity. 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 *Verticillium dahlia* 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. It is a problem in young cherry orchards in the interior of British Columbia. 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. Outbreaks are often associated with prolonged periods of cold, wet weather with late spring frosts.

Life Cycle: The bacterium survives the winter in cankers, healthy buds and infected 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. Refer to *Tables 5* and *6* for practices used by growers to manage bacterial canker.

Resistant Cultivars: Dwarf sweet cherry trees seem to be more susceptible to bacterial canker, possibly because dwarf trees are more susceptible to stress, which predisposes them to the disease. Outbreaks in dwarf trees can serve as infection sources for standard size trees. MM2 and MM60 rootstocks appear to be less susceptible to bacterial canker than others, and the F12-1 Mazzard rootstock is reported to be resistant to bacterial canker.

Issues for Bacterial Canker

1. Additional reduced risk pesticide registrations are required for the control of bacterial canker. Copper-based products are currently registered; repeated applications of copper over time may result in high levels of copper in soils. Kasugamycin (antibiotic) is also registered; however, it should be used judiciously in the orchard.

Perennial Canker (*Cytospora leucostoma, Leucostoma 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 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.

Issues for Perennial Canker

1. There is a need to develop and register effective chemical controls as well as educating growers on best management practices (e.g., timing of pruning & borer control) to reduce the amount of perennial canker infections 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. Monitoring orchards and removal of black knots in late winter before growth resumes in the spring will reduce the risk of infection. Removal of wild hosts within 150 m of the orchard and placement of new plantings away from orchards infected with black knot will also reduce the risk of infection.

Resistant Cultivars: None identified.

Issues for Black Knot

1. There is a need for the registration of additional fungicides for black knot management that are compatible in spray mixes with oil-based materials.
2. Additional research is needed on black knot removal methods and timing in order to properly manage black knot infections while maintaining tree health.

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 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: Phytophthora 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 to 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.

Issues for Crown, Root and Collar Rot

1. There is a need to develop a strategy for the management of phytophthora on trees confirmed to have *Phytophthora* spp.
2. There is a need to expand current fungicide labels or register additional fungicides effective against phytophthora on non-bearing cherry trees.

Little Cherry Disease (Little cherry virus 1 (LChV1), Little cherry virus 2 (LChV2))

Pest Information

Damage: Infected cherries are not fit for the fresh fruit market as they lack flavour, sweetness, size and colour. Affected fruit are dull red and have a pointed shape. Some cultivars develop red leaf discolouration in the late summer or early fall. Lambert and Bing cultivars are highly susceptible.

Life Cycle: Little cherry virus 1 and LChV2 are transmitted by all types of grafting; in addition, LChV2 is also vectored and transmitted by apple (*Phenacoccus aceris*) and grape (*Pseudococcus maritimus*) mealybugs. Mealybug nymphs can be spread from tree to tree by wind during the summer. Transmission by pollen, seed, in the soil or on pruning tools has not been demonstrated. The disease develops over several years. Early infections (year 1) are often restricted to one branch or cluster followed by systemic disease development (years 2 and 3) whereby affected cherries are observed in various parts of the tree canopy. Late infection (year 4+) where there is a noticeable reduction in fruit yield.

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 ornamental flowering cherries (e.g., bitter cherry, nanking cherry, St. Lucie cherry) will eliminate sources of the disease. Monitoring and management of mealybugs may reduce virus transmission. Refer to *Tables 5* and *6* for practices used by growers to manage little cherry disease.

Resistant Cultivars: None identified.

Issues for Little Cherry Disease

1. Further studies are required to determine the epidemiology of LChV1. Caution should be taken when considering moving untested or non-certified virus-free plant material from the United States to Canada due to the presence of little cherry disease in the Pacific Northwest.
2. Studies are required to determine the distribution of LChV1 in commercial orchards.
3. The distribution of LChV2 in commercial orchards in the Pacific Northwest is at epidemic levels. Studies to assess the potential for re-establishment of the virus in British Columbia and its potential impact should be considered. Consideration should be given to identifying and monitoring vectors, and potential control measures for both LChV1 and LChV2.

X Disease Phytoplasma (Western X)

Pest Information

Damage: Infected cherries are smaller in size, pale in colour and often have a leathery skin. Symptoms of Western X may differ depending on rootstock. Symptoms range from yellowing of foliage and death of rootstock on some rootstocks (e.g., Mahaleb) to shoot tip dieback and bitter tasting, small cherries on other rootstocks (e.g., Mazzard, Colt).

Life Cycle: Western X is caused by a spiroplasma. The disease is vectored and transmitted by several species of leafhoppers through feeding of the vascular phloem of infected trees. As well, the disease is transmitted by all types of grafting. The phytoplasma replicates in the phloem, overwintering in the roots and moving up to the aerial portions of the tree in the spring. Once infected, a tree will remain infected for the rest of its life as there is no cure.

Pest Management

Cultural Controls: Use only certified, virus-free stock in new plantings. Immediately remove, burn or bury infected trees and nearby hosts (e.g., chokecherry, herbaceous weeds). Monitoring and management of leafhoppers, including the removal of weed cover for leafhoppers, may reduce virus transmission.

Resistant Cultivars: None identified.

Issues for Western X

1. Caution should be taken when considering moving untested or non-certified virus-free plant material from the United States to Canada due to the presence of Western X in the Pacific Northwest.

Post-harvest diseases: Brown Rot (*Monilinia* spp.), Botrytis Rot (*Botrytis cinerea*), Alternaria Rot (*Alternaria* spp.), Rhizopus Rot (*Rhizopus* spp.) and Blue Mold Rot (*Penicillium expansum*)

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.

Issues for Post-harvest Diseases

1. There is a need for additional products for post-harvest control of pathogens, including *Monilinia* spp., *Botrytis cinerea, Alternaria* spp., *Rhizopus* spp., *Penicillium expansum*, and cherry leaf spot.
2. Additional research and disease forecasting is required to determine the risk level for the development of post-harvest diseases. Growers are questioning the need for post-harvest fungicide applications during low pressure seasons with little to no evidence of active infections pre-harvest.

Cherry Replant Disease

Pest Information

Damage: Specific replant diseases in stone fruits have resulted in the poor growth of many fruit and plantation crops when planted on land previously occupied by the same or closely related stone fruit species. Replant diseases have been associated with the progressive decline in fruit trees due to the difficulty in establishing new orchards in nurseries or on old orchard sites. Overcoming replant disease is critical for the successful establishment of high-density orchards.

Life Cycle: Replant disease is not a specific disease caused by a single agent. It is not well understood in cherry orchards but it is thought to arise from the interaction of several biotic and abiotic factors. Among these factors, pathogens, insects and soil contaminants may all play a role. Plant parasitic nematodes are frequently associated with replant failure, poor growth and yield in stone fruits, especially with apples, peach, and cherries.

Pest Management

Cultural Controls: Replant disease can be prevented by avoiding planting orchards on old orchard sites. While in the past, chemical fumigants were used to control replant problems in orchards many broad-spectrum fumigants are no longer available following phase out mandated under the Montreal Protocol. Some non-fumigant nematicides suitable for post-planting applications have been successful in cases where nematodes are closely associated with the replant disease.

Resistant Cultivars: None identified.

Issues for Cherry Replant Disease

1. There is a need to continue to study, understand and find solutions to cherry replant disease.

Slip Skin Maceration Disorder

Pest Information

Damage: Sweet sherry slip-skin maceration (SSM) disorder is a problem affecting the quality of primarily late season sweet cherry (*Prunus avium* L.) in British Columbia. Affected tissue develop radially causing breakage of the skin and during shipping the affected areas may form sunken craters on the fruit's surface while the rest of the cherry remains firm. It has been described as a post-harvest disease/ disorder caused primarily by *Mucor piriformis,* and also by yeasts. *M. piriformis* is the only *Mucor* spp. found to have caused serious losses in cold storage of pears, apples and plums grown in California. Cherry-SSM disorder is not visible until immediately after harvest and symptoms continue to develop in storage and during shipping. This disorder continues to be a problem affecting the quality of sweet cherry in British Columbia.

Life Cycle: Preliminary investigations suggest both physiological and pathological factors, involving different yeast species within the genera *Hanseniaspora*, *Aureobasidium, Cryptococus, Candida* and *Rhodotorula* and fungi such as *M. piriformis* which develops rapidly at freezing temperatures of 0 ºC. Sporangiospores of *M. piriformis* are mostly contained in the first 2 cm of the soil where it colonizes organic matter such as fallen fruit. The fungus survives best in cool, dry soil. Therefore, infected soil and debris are the major sources of inoculum carried by picking bins.

Pest Management

Cultural Controls: Sanitation measures such as removing fallen fruits from the ground can reduce inoculum sources and control rot in storage. As *M. piriformis* can survive on wooden fruit bins, bins should be washed or steam-cleaned and covered with paper or plastic pads to protect fruits from bruising.

Resistant Cultivars: None identified.

Issues for Slip Skin Maceration Disorder

1. Slip skin maceration disorder is an emerging issue affecting a number of mid-to-late season cherry cultivars. More investigation into this complex disorder is required. There are no known control methods at this time.

Nematodes: Dagger nematode (*Xiphinema americanum*), Northern root-knot nematode (*Meloidogyne hapla*) and Root lesion nematode (*Pratylenchus penetrans*)

Pest Information

Damage: Nematodes feed on cherry tree roots by piercing plant cells with their needle-like mouthparts and sucking-out cell contents. Feeding can reduce tree vigour, growth and yield. Root-knot nematodes induce the formation of galls at their feeding sites which reduce the uptake of water and nutrients by the tree. Dagger nematodes are vectors of viral diseases. Nematode damage usually appears in patches throughout the orchard, although entire blocks of orchard can be uniformly affected. Damage caused by nematodes in many crops can also provide an infection site for other disease-causing organisms, which further reduces yields.

Life Cycle: Most plant parasitic nematodes lay eggs in the soil or roots of host plants or are retained within the female body or cyst. Nematodes complete their life cycle within three to six weeks during the growing season depending upon available moisture and temperature. After the eggs hatch, the juvenile nematodes swim to nearby plant roots and feed on them. Extreme moisture and temperatures will kill some species of nematodes. In general, most plant pathogenic nematodes develop from eggs, through four larval stages to become adults. Adult nematodes mate and lay eggs within the host or in soil in the vicinity of host roots. Some nematodes such as *Xiphinema* spp. feed and develop completely external to the plant. Others, including *Pratylenchus* spp. and *Meloidogyne* spp. spend a part of their life cycle within plant roots.

Pest Management

Cultural Controls: Soil testing may be carried out prior to planting a new orchard to determine whether plant parasitic nematodes are present.

Resistant Cultivars: Nematode resistant rootstocks are available.

Issues for Nematodes

1. There are currently no nematicides registered for cherries.

Insects and Mites

Key issues

- Spotted wing drosophila (SWD) continues to be a serious pest of cherries in Canada. Additional registrations of insecticides are required to maintain proper resistance management techniques. There is a need to maintain funding to trap and monitor SWD populations across all provinces, to determine overall pressure from this pest at different periods through the harvest season.

- There is continuing need to register effective control products and alternate control strategies for use in orchards that are not utilizing mating disruption technology for peach tree borers. Controlling borers is important in minimizing bacterial canker infections.

- There are currently no effective chemical controls for western flower thrips or onion thrips on cherries during the blossom period, when these pests cause damage. Additional research is needed on the activity patterns of these insects in cherry orchards so that management strategies can be implemented.

- The potential increase in mealybugs in cherry orchards, which are vectors of little cherry disease virus, is of concern with the movement away from the use of broad spectrum insecticides.

- Currently, brown marmorated stink bug is a primary concern in late ripening commodities because populations peak after most of the tender fruit crop has been harvested. However, with increased interest in planting late season cherry cultivars in British Columbia, careful monitoring needs to continue in order to identify any change in this pest's population dynamics. Economic thresholds need to be established for late season cherry cultivars.

- Management strategies are needed for the control of cherry fruitworm as they are increasingly found in fruit for export from British Columbia, which is resulting in shipment rejections.

- Overall presence and distribution of European cherry fruit fly (*Rhagoletis cerasi*) needs to be established in Ontario orchards. This pest was first discovered in North America (Ontario) in 2015 and is a quarantine pest; restricting cherry export from Ontario to markets in the United States. New registrations of insecticides with short pre-harvest intervals are required to maintain control of all identified fruit fly species, including SWD.

Table 7. Occurrence of insect pests in cherry production in Canada[1,2]

Insect	Sweet Cherry		Sour Cherry
	British Columbia	Ontario	Ontario
Eastern cherry fruit fly			
Black cherry fruit fly			
Western cherry fruit fly			
Spotted wing drosophila			
Plum curculio			
Black cherry aphid			
Two-spotted spider mite			
McDaniel mite			
European red mite			
Plum rust mite			
Grape mealybug			
Brown marmorated stinkbug			
Western flower thrips			
Oriental fruit moth			
Eastern tent caterpillar			
European leafroller			
Eyespotted bud moth			
Forest tent caterpillar			
Fruit tree leafroller			
Gypsy moth			
Red-banded leafroller			
Oblique banded leafroller			
Three lined leafroller			
Cherry fruitworm			
Peach tree borer			
Lesser peach tree borer			
Shothole borer			
Ambrosia beetle			
Wasps (European paper, yellow jacket, bald faced hornet)			

....continued

Table 7. Occurrence of insect pests in cherry production in Canada[1,2] (continued)

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 pest 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 (British Columbia and Ontario). The data reflect the 2017, 2018 and 2019 production years.

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

Table 8. Adoption of insect pest management practices in sweet cherry production in Canada[1]

	Practice / Pest	Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Oblique-banded leafroller	Mites
Avoidance	Varietal selection / use of resistant or tolerant varieties						
	Planting / harvest date adjustment						
	Rotation with non-host crops						
	Choice of planting site						
	Optimizing fertilization for balanced growth						
	Minimizing wounding to reduce attractiveness to pests						
	Reducing pest populations at field perimeters						
	Use of physical barriers (e.g., mulches, netting, floating row covers)						
	Use of pest-free propagative materials (seeds, cuttings or transplants)						
Prevention	Equipment sanitation						
	Canopy management (thinning, pruning, row or plant spacing, etc.)						
	Manipulating seeding / planting depth						
	Irrigation management (timing, duration, amount) to manage plant growth						
	Management of soil moisture (improvements to drainage, use of raised beds, hilling, mounds, etc.)						
	End of season or pre-planting crop residue removal / management						
	Pruning out / removal of infested material throughout the growing season						
	Tillage / cultivation to expose soil insect pests						
	Removal of other hosts (weeds / wild plants / volunteer crops) in field and vicinity						

…continued

Table 8. Adoption of insect pest management practices in sweet cherry production in Canada[1] (continued)

Practice / Pest		Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Oblique-banded leafroller	Mites
Monitoring	Scouting / trapping						
	Maintaining records to track pests						
	Soil analysis for pests						
	Weather monitoring for degree day modelling						
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of pests						
Decision making tools	Economic threshold						
	Use of predictive model for management decisions						
	Crop specialist recommendation or advisory bulletin						
	Decision to treat based on observed presence of pest at susceptible stage of life cycle						
	Use of portable electronic devices in the field to access pest identification / management information						
Suppression	Use of diverse pesticide modes of action for resistance management						
	Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pest populations						
	Use of biopesticides (microbial and non-conventional pesticides)						
	Release of arthropod biological control agents						

…continued

Table 8. Adoption of insect pest management practices in sweet cherry production in Canada[1] (continued)

	Practice / Pest	Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Oblique-banded leafroller	Mites
Suppression	Preservation or development of habitat to conserve or augment natural controls (e.g., preserve natural areas and hedgerows, adjust crop swathing height)						
	Mating disruption through the use of pheromones						
	Mating disruption through the release of sterile insects						
	Trapping						
	Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)						
	Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms						

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: Cherry stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2017, 2018 and 2019 production years.

Table 9. Adoption of insect pest management practices in sour cherry production in Canada[1]

	Practice / Pest	Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Oblique-banded leafroller	Mites
Avoidance	Varietal selection / use of resistant or tolerant varieties						
	Planting / harvest date adjustment						
	Rotation with non-host crops						
	Choice of planting site						
	Optimizing fertilization for balanced growth						
	Minimizing wounding to reduce attractiveness to pests						
	Reducing pest populations at field perimeters						
	Use of physical barriers (e.g., mulches, netting, floating row covers)						
	Use of pest-free propagative materials (seeds, cuttings or transplants)						
Prevention	Equipment sanitation						
	Canopy management (thinning, pruning, row or plant spacing, etc.)						
	Manipulating seeding / planting depth						
	Irrigation management (timing, duration, amount) to manage plant growth						
	Management of soil moisture (improvements to drainage, use of raised beds, hilling, mounds, etc.)						
	End of season or pre-planting crop residue removal / management						
	Pruning out / removal of infested material throughout the growing season						
	Tillage / cultivation to expose soil insect pests						
	Removal of other hosts (weeds / wild plants / volunteer crops) in field and vicinity						

…continued

Table 9. Adoption of insect pest management practices in sour cherry production in Canada[1] (continued)

Practice / Pest		Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Oblique-banded leafroller	Mites
Monitoring	Scouting / trapping						
	Maintaining records to track pests						
	Soil analysis for pests						
	Weather monitoring for degree day modelling						
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of pests						
Decision making tools	Economic threshold						
	Use of predictive model for management decisions						
	Crop specialist recommendation or advisory bulletin						
	Decision to treat based on observed presence of pest at susceptible stage of life cycle						
	Use of portable electronic devices in the field to access pest identification / management information						
Suppression	Use of diverse pesticide modes of action for resistance management						
	Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pest populations						
	Use of biopesticides (microbial and non-conventional pesticides)						
	Release of arthropod biological control agents						

…continued

Table 9. Adoption of insect pest management practices in sour cherry production in Canada[1] (continued)

	Practice / Pest	Fruit flies	Spotted wing drosophila	Aphids	Spring feeding caterpillar complex	Oblique-banded leafroller	Mites
Suppression	Preservation or development of habitat to conserve or augment natural controls (e.g., preserve natural areas and hedgerows, adjust crop swathing height)						
	Mating disruption through the use of pheromones						
	Mating disruption through the release of sterile insects						
	Trapping						
	Targeted pesticide applications (e.g., banding, spot treatments, use of variable rate sprayers)						
	Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms						

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: Cherry stakeholders in reporting province (Ontario); the data reflect the 2017, 2018 and 2019 production years.

Fruit Flies: 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 sour cherry crops and wild cherries. Primary damage results from the feeding of the larvae (maggots) in the fruit. Maggots and their frass, within the fruit, render it unmarketable. Larvae are undetectable from the exterior of the cherry, but they are easily visible when the cherry is opened. There is a zero tolerance for cherry fruit flies in marketed 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 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 upward movement of flies in early summer and downward movement of larvae in later summer has been used successfully as part of an integrated pest management (IPM) program. Baited, yellow sticky boards can be used to monitor the presence of adult fruit flies. Refer to *Tables 8* and *9* for practices used by growers to manage fruit flies.

Resistant Cultivars: None identified.

Issues for Cherry Fruit Flies

1. Additional products are required for the control of cherry fruit flies. It is important that new products have short pre-harvest intervals, are efficacious on spotted wing drosophila, and effectively control female flies in the pre-oviposition period.
2. Overall presence and distribution of European cherry fruit fly (*Rhagoletis cerasi*) needs to be established in Ontario orchards. This pest was first discovered in North America (Ontario) in 2015 and is a quarantine pest; restricting cherry export from Ontario to markets in the United States.
3. New registrations of insecticides with short pre-harvest intervals are required to maintain control of all identified fruit fly species.

Spotted Wing Drosophila (*Drosophila suzukii*)

Pest Information

Damage: Spotted wing drosophila (SWD) 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, SWD will attack and oviposit within 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 an adult fly. In the spring, flies mate and lay eggs under the skin of ripening fruits. Larvae feed and develop within the fruit. Due to the short generation time and extended period of egg laying by adults, there can be several, overlapping generations each year. This 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 risk of infestation and reduce sources of continued infestations. Flies can be monitored using apple-cider vinegar traps. Refer to *Tables 8* and *9* for practices used by growers to manage spotted wing drosophila.

Resistant Cultivars: None identified.

Issues for Spotted Wing Drosophila

1. Spotted wing drosophila has become a very serious pest of cherries. Full registrations of insecticides to control this pest are needed. Materials already registered for control of cherry fruit fly should be investigated for label expansions to include SWD. Materials with a short pre-harvest interval and with contact modes of action that kill or repel adults before eggs are laid or the development of bait sprays, should be explored.
2. The use of commercial lures for mass trapping of overwintered populations in the spring should be explored.
3. There is a need to maintain funding to trap and monitor SWD populations across all provinces, to determine overall pressure from this pest at different periods through the harvest season.

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

Pest Information

Damage: A number of caterpillars may feed on blossoms, foliage and developing fruit in 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 in the borders and edges of orchards.

Life Cycle: Spring feeding caterpillars overwinter as eggs or larvae in hibernacula (shelters/ refuges) on trees. Young larvae become active in the spring, feeding on leaves and buds. Adult moths emerge later to lay eggs on the trees.

Pest Management

Cultural Controls: The presence of these insects can be monitored visually. Egg masses for some insects may be removed by pruning. Pheromones are available for use against these pests. Refer to *Tables 8* and *9* for practices used by growers to manage spring feed caterpillars.

Resistant Cultivars: None available.

Issues for Spring Feeding Caterpillars

1. Need to investigate spring feeding caterpillar damage thresholds on young trees to determine the need for control.

Oriental Fruit Moth (*Grapholitha molesta*)

Pest Information

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

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 be expected.

Pest Management

Cultural Controls: A pheromone is available to monitor male moths. Typically new growth is inspected in spring for larvae or feeding damage, and growing tips and fruits are monitored for larvae as the season progresses.

Resistant Cultivars: None identified.

Issues for Oriental Fruit Moth

None identified.

Two-Generation Leafrollers: Obliquebanded Leafroller (*Choristoneura rosaceana),* Three-lined Leafroller (*Pandemis limitata*) and Cherry Fruitworm (*Grapholita packardi*)

Pest Information

Damage: These insects attack a range of fruits 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 appear on mature fruit. Feeding by the second summer generation results in small holes on fruits that may develop rot.

Life Cycle: The obliquebanded leafroller and three-lined leafroller have two generations per year, and the cherry fruitworm has one generation per year. All three species overwinter as larvae in cocoons formed 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 treatment sprays, especially into the upper canopy where leafrollers are most active. Elimination or spraying of unmanaged tree-hosts in close proximity to commercial orchards helps to reduce leafroller pressure. Monitoring is an important practice used to determine if pest levels warrant treatment. A pheromone product which reduces pest pressure through mating disruption is registered in Canada. Refer to *Table*s *8* and *9* for practices used by growers to manage obliquebanded leafroller.

Resistant Cultivars: None identified.

Issues for Obliquebanded Leafroller

1. There is a need for continued monitoring of obliquebanded leafroller presence in sour cherry orchards to determine presence, pressure and development rates when the insect feeds on 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, rendering the fruit 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 tree-host.

Pest Management

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

Resistant Cultivars: None identified

Issues for Plum Curculio

1. The proposed restriction of Group 4 insecticides will limit insecticide options for plum curculio beyond the 2020 growing season. Additional insecticides are needed for control and resistance management.
2. Studies are required to incorporate new trap monitoring methods into effective integrated pest management systems.
3. Research is needed to develop better attractant lures so that trapping methods can be more efficiently used to aid in early warning and timing of sprays.

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 that can slow down the growth of young trees. Aphids cause little direct fruit damage but can leave undesirable deposits of sticky honeydew on fruit, which 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. A number of beneficial species will help to reduce aphids to non-damaging levels, including lady beetles, lacewings, syrphid flies and parasitic wasps. Refer to *Tables 8* and *9* for practices used by growers to manage aphids.

Resistant Cultivars: None identified.

Issues for Black Cherry Aphid

1. The loss of some broad spectrum insecticides coupled with the proposed cancellation of neonicotinoids is a concern for the management of black cherry aphid as there are few replacement or alternative products available.

Brown Marmorated Stinkbug (*Halymorpha halys*)

Pest Information

Damage: Although the brown marmorated stinkbug (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, with each feeding puncture resulting in fruit injury in cherry crops.

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 among 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, 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.

Issues for Brown Marmorated Stinkbug

1. Currently, brown marmorated stink bug is a primary concern in late ripening commodities because populations peak after most of the tender fruit crop has been harvested. However, with increased interest in planting late season cherry cultivars in British Columbia, careful monitoring needs to continue in order to identify any change in this pest's population dynamics. Economic thresholds need to be established for late season cherry cultivars.

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

Pest Information

Damage: A light infestation of mites can cause leaf specks but a heavy infestation can cause leaf bronzing and loss of foliage. Prolonged mite feeding can stress infested cherry trees, and reduce shoot growth and fruit bud setting the following year.

Life Cycle: Mites progress through several immature stages including a six-legged larva and eight-legged nymph. They may overwinter at the base of buds and in leaf scars or in bark crevices. All listed mite species have multiple, overlapping generations per year; dispersing by wind over wide areas, possibly from apple orchard to cherry orchard. Two-spotted spider mite and McDaniel populations continue to thrive until cool, late summer weather reduces their activity. In the spring, nymphs move down from the trees to begin feeding on weeds. Two-spotted spider mite and McDaniel mite infestations are often accompanied by more silk webbing on the leaf surface compared to European red mite. In the case of rust mite, the pest moves to the flower parts at bud opening and several generations can be produced during the growing season.

Pest Management

Cultural Controls: Natural enemies of mites include some predatory mites and thrips. Care in choosing products and application rates that are least toxic to the predatory mites may favour control by these beneficial species. Natural egg hatching of overwintering mites can be reduced by extreme winter weather. Healthy, well-maintained trees will tolerate higher mite populations than weak or stressed trees. Herbicide sprays can also negatively affect the number of predator mites within a cherry orchard. Clean, weed-free areas under the trees in the fall and an early spring can eliminate optimal habitat for predaceous mites and without predator mite presence early in the season, two-spotted spider mite populations can grow unchecked. Refer to *Tables 8* and *9* for practices used by growers to manage mites.

Resistant Cultivars: None identified.

Issues for Mites

1. Additional miticides with activity on all life stages and quick knockdown are needed to allow for proper resistance management.

Grape Mealybug (*Pseudococcus maritimus*)

Pest Information

Damage: Grape mealybugs may transmit little cherry virus, a serious threat for cherry growers. Crawlers, the most mobile phase, are capable of transmitting the virus. In heavy infestations, mealybug may move to fruit clusters. As they feed, they excrete a sugary honeydew which supports the growth of sooty moulds, which may cause fruit marking and rejection.

Life Cycle: Grape mealybugs have two generations per year. The mealybugs overwinter as eggs under the loose bark of trunks. Summer populations increase and move to new tissue growth to feed. Eggs can be laid on all plant parts and hatch from mid-June to July. Adult females will appear in late summer and early fall. Some females will oviposit in the fruit clusters but the majority of the females move to old wood to lay their overwintering eggs. Ants are often found in association with mealybugs as they feed on the honeydew and tend to the mealybugs, protecting them from predators and pathogens.

Pest Management

Cultural Controls: Older standard trees are most susceptible to mealybug infestations because they provide more hiding places for all stages and less exposure to insecticide sprays, particularly if they are not properly pruned to open up the canopies. Mealybugs prefer to feed on tender new growth, so sucker removal will aid in reducing the risk of damaging population levels. Integrated management practices used for grape mealybug in Ontario vineyards will likely also be helpful in cherry orchards. Once established, parasites and predators of grape mealybugs can help keep populations down, but an infestation may slowly spread unless controlled with insecticides. When it is necessary to spray, leaving an untreated refuge for natural enemies and using an insecticide that is not toxic to beneficial species will also help to conserve important mealybug predators.

Resistant Cultivars: None identified.

Issues for Grape Mealybug

1. With the movement away from the use of organophosphate insecticides, there is concern for grape mealybug as a potential vector of little cherry disease virus.

Peach Tree Borer (*Synanthedon exitiosa*) and 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 trees and feed on the sapwood and may take up to two years to mature and overwinter in their feeding tunnels or in the soil. The larvae then 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 from 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: A mating disruption pheromone is available in Canada for peach tree borer and appears to be an effective control method. Physical barriers may be placed around the base of trees to deter egg laying by the peach tree borer. Monitoring for borers is a helpful practice and 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.

Issues for Peach Tree Borer and Lesser Peach Tree Borer

1. There is a continuing need for the registration of effective control products or alternate control strategies for use in orchards that are not utilizing mating disruption technology. Controlling damage caused by peach tree borers is the most important management practice to minimize canker infections
2. There is a need for additional resources to better track peach tree borer populations, to aid in determining optimal timings for trunk sprays, especially in young orchards where mating disruption is not being used.

Shothole Borer (*Scolytus rugulosus*)

Pest Information

Damage: The shothole borer is attracted to both healthy, stressed and diseased 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 of the insect 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 an overwintering larval generation. Hosts include native and cultivated trees, with cherry trees being 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 reduce crop damage due to this insect.

Resistant Cultivars: None identified.

Issues for Shotholer Borer

1. Additional research is required to determine the distribution of shothole borer in production areas and to establish thresholds for the development of management strategies, if necessary.

Ambrosia Beetle (*Xyloborus dispar*)

Pest Information

Damage: Ambrosia 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 bored into trees. Adults appear in April and after mating, tunnel into the 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 overwinter in the host. 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.

Issues for Ambrosia Beetle

1. Additional research is required to determine the distribution of ambrosia beetle in production areas and to establish thresholds for the development of management strategies.

Western Flower Thrips (*Frankiniella occidentalis*)

Pest Information

Damage: Thrips feed on flowers and fruit. Damage often shows up in patches or where fruit touch each other, resulting in faint rings of scarring. Females lay their eggs in the ovary of cherry flowers, causing a dimple-like injury to form on mature fruit. As the fruit begins to colour, the dimple appears as a bright red spot against the yellow-green background, reducing the quality of the crop.

Life Cycle: Western flower thrips have a very wide host range; including many crop and weed species. Females insert eggs into leaf tissue. Development from egg to adult ranges from 10 to 30 days, depending on temperature. Once mature, females begin to lay eggs. The females

reproduce asexually (without mating). Consequently, increases in the thrips population can occur very rapidly, especially during periods of hot, dry weather. There are several overlapping generations per year. Overwintered adults migrate to flowers of various species and vegetables as overwintering sites dry down or are harvested (e.g., winter wheat, alfalfa).

Pest Management

Cultural Controls: Delaying mowing ground cover until after petal-fall stage will reduce thrips movement towards cherry trees and may reduce their damage. Heavy rainfall is also effective in knocking thrips off the plant for a short time.

Resistant Cultivars: None identified.

Issues for Western Flower Thrips

1. There are currently no effective chemical controls for western flower thrips or onion thrips on cherries during the blossom period. There is a need for effective controls (e.g., systemic insecticides) that are non-toxic to pollinators and have the ability to move to the tissues under the shuck where thrips feed.
2. Additional research is needed on the activity patterns of these insects in cherry orchards so that management strategies can be implemented.

Wasps, European Paper and others (*Polistes dominula*)

Pest Information

Damage: European paper wasp is a recent introduction in Western Canada. Wasps prey on other insects as host tree fruits (cherries, apples and grapes) ripen, and wasp workers attack and damage the fruit, creating channels across the surface of fruit, which render fruit unmarketable. Damage also provides a point of entry for infection from bacteria, yeast and fungi. Wasps may also be a nuisance to pickers and orchard workers.

Life Cycle: Fertilized queens overwinter in sheltered locations such as buildings, hollow trees or rock piles. They emerge in the spring to construct their nests and lay their eggs. Worker female larvae develop in 40 days under favorable conditions. In the fall, several queens are produced in each colony and leave to seek suitable overwintering sites.

Pest Management

Cultural Controls: Reducing the availability of nest-building sites will minimize the development of colonies. Trapping out queens using suitable traps or attractants in the spring can help to disrupt wasp colonies.

Resistant Cultivars: None identified.

Issues for Wasps, European Paper and Others

1. In British Columbia there is a need to find effective controls that will prevent fruit injury near harvest from wasps.

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.

- In British Columbia, there is a need for weed surveys to identify and determine the distribution of problem weeds.

- There is a need to investigate the long term effects of pre-emergent herbicides that have multi-season residual weed control. Growers are concerned that areas treated with these long lasting pre-emergent herbicides are compromised for future plantings.

Table 10. Occurrence of weeds in cherry production in Canada[1,2]

Weed	Sweet Cherry		Sour Cherry
	British Columbia	Ontario	Ontario
Annual broadleaf weeds			
Annual grass weeds			
Perennial broadleaf 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 pest 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 (British Columbia and Ontario). The data reflect the 2017, 2018 and 2019 production years.
[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

Table 11. Adoption of weed management practices in sweet cherry production in Canada[1]

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Avoidance	Varietal selection / use of competitive varieties				
	Planting / harvest date adjustment				
	Crop rotation				
	Choice of planting site				
	Optimizing fertilization for balanced crop growth				
	Use of weed-free propagative materials (seed, cuttings or transplants)				
	No till or low disturbance seeding to minimize weed seed germination				
	Use of physical barriers (e.g., mulches)				
Prevention	Equipment sanitation				
	Canopy management (thinning, pruning, row or plant spacing, etc.)				
	Manipulating seeding / planting depth				
	Irrigation management (timing, duration, amount) to maximize crop growth				
	Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds)				
	Weed management in non-crop lands				
	Weed management in non-crop years / the year prior to planting				
Monitoring	Scouting / field inspection				
	Maintaining records of weed incidence including herbicide resistant weeds				
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of weeds				

…continued

Table 11. Adoption of weed management practices in sweet cherry production in Canada[1] (continued)

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Decision making tools	Economic threshold				
	Crop specialist recommendation or advisory bulletin				
	Decision to treat based on observed presence of weed at susceptible stage of development				
	Decision to treat based on observed crop damage				
	Use of portable electronic devices in the field to access weed identification / management information				
Suppression	Use of diverse herbicide modes of action for resistance management				
	Soil amendments and green manuring involving soil incorporation as biofumigants to reduce weed populations				
	Use of biopesticides (microbial and non-conventional pesticides)				
	Release of arthropod biological control agents				
	Mechanical weed control (cultivation / tillage)				
	Manual weed control (hand pulling, hoeing, flaming)				
	Use of stale seedbed approach				
	Targeted pesticide applications (pre-emergent, banding, spot treatments, use of variable rate sprayers, etc.)				
	Selection of herbicides that are soft on beneficial insects, pollinators and other non-target organisms				

…continued

Table 11. Adoption of weed management practices in sweet cherry production in Canada[1] (continued)

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Specific Practices	Use of pre-emergent herbicides				

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: Cherry stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2017, 2018 and 2019 production years.

Table 12. Adoption of weed management practices in sour cherry production in Canada[1]

	Practice / Pest	Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Avoidance	Varietal selection / use of competitive varieties				
	Planting / harvest date adjustment				
	Crop rotation				
	Choice of planting site				
	Optimizing fertilization for balanced crop growth				
	Use of weed-free propagative materials (seed, cuttings or transplants)				
	No till or low disturbance seeding to minimize weed seed germination				
	Use of physical barriers (e.g., mulches)				
Prevention	Equipment sanitation				
	Canopy management (thinning, pruning, row or plant spacing, etc.)				
	Manipulating seeding / planting depth				
	Irrigation management (timing, duration, amount) to maximize crop growth				
	Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds)				
	Weed management in non-crop lands				
	Weed management in non-crop years / the year prior to planting				
Monitoring	Scouting / field inspection				
	Maintaining records of weed incidence including herbicide resistant weeds				
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of weeds				

…continued

Table 13. Adoption of weed management practices in sour cherry production in Canada[1] (continued)

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Decision making tools	Economic threshold				
	Crop specialist recommendation or advisory bulletin				
	Decision to treat based on observed presence of weed at susceptible stage of development				
	Decision to treat based on observed crop damage				
	Use of portable electronic devices in the field to access weed identification / management information				
Suppression	Use of diverse herbicide modes of action for resistance management				
	Soil amendments and green manuring involving soil incorporation as biofumigants to reduce weed populations				
	Use of biopesticides (microbial and non-conventional pesticides)				
	Release of arthropod biological control agents				
	Mechanical weed control (cultivation / tillage)				
	Manual weed control (hand pulling, hoeing, flaming)				
	Use of stale seedbed approach				
	Targeted pesticide applications (pre-emergent, banding, spot treatments, use of variable rate sprayers, etc.)				
	Selection of herbicides that are soft on beneficial insects, pollinators and other non-target organisms				

…continued

Table 14. Adoption of weed management practices in sour cherry production in Canada[1] (continued)

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: Cherry stakeholders in reporting province (Ontario); the data reflect the 2017, 2018 and 2019 production years.

Annual and Perennial Weeds

Pest Information

Damage: Weeds compete with orchard trees for moisture and nutrients. A range 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 and flower in the spring, form seeds and then die. Perennial weeds live for many years, and 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. Refer to *Tables 11* and *12* for practices used by growers in Canada for weed management.

Issues for Annual and Perennial 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. In British Columbia, 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 (e.g., flaming, mulch application, use of cultivators) need further study. Methods for low cost production of mulches are also required.
5. There is a need to investigate the long term effects of pre-emergent herbicides that have multi-season residual weed control. Growers are concerned that areas treated with long lasting pre-emergent herbicides are compromised for future plantings.

Resources

Integrated Pest Management/ Integrated Crop Management Resources for Production of Sweet and Sour Cherries in Canada

British Columbia Ministry of Agriculture. *Tree Fruits Information on identification and management of insect and mite pests and plant diseases of tree fruit crops in British Columbia*: *Insects and Mites*. https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/tree-fruits

British Columbia Ministry of Agriculture and British Columbia Fruit Growers' Association. 2010. *Integrated Fruit Production Guide for Commercial Tree Fruit Growers, Interior of British Columbia*. British Columbia Central Branch Library. Branch Call Number: 634.05 T78. https://vpl.bibliocommons.com/item/show/1127085038_integrated_fruit_production_guide_for_commercial_tree_fruit_growers

British Columbia Ministry of Agriculture. BC Tree Fruit Production Guide: *Cherry Management Schedule*. https://www.bctfpg.ca/horticulture/crop-management/

British Columbia Ministry of Agriculture. BC Tree Fruit Production Guide: *Cherry Spray Schedule*.https://www.bctfpg.ca/pesticides/spray-schedules/cherries/

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

Ontario Ministry of Agriculture, Food and Rural Affairs. Publication 360D, Fruit Crop Protection Guides. 2020. http://www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm

Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture and Lands www.gov.bc.ca	Adrian Arts Adrian.Arts@gov.bc.ca	Caroline Bédard Caroline.bedard@gov.bc.ca
Saskatchewan	Saskatchewan Agriculture www.agriculture.gov.sk.ca	Forrest Scharf forrest.scharf@gov.sk.ca	Carter Peru carter.peru@gov.sk.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca/english/index.html	Kathryn Carter kathryn.carter@ontario.ca	Jim Chaput jim.chaput@ontario.ca

National and Provincial Cherry and Fruit Grower Organizations

BC Cherry Association: http://www.bccherry.com

British Columbia Fruit Growers Association: www.bcfga.com

BC Tree Fruits; http://www.bctree.com

Canadian Cherry Producers Inc.: www.cherryproducers.ca

Canadian Federation of Agriculture: https://www.cfa-fca.ca/

Canadian Horticultural Council: http://www.hortcouncil.ca

Canadian Organic Growers: https://www.cog.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 reporting province is provided in Tables 4, 7 and 10 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 pressure 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="13">Present</td><td rowspan="10">Data available</td><td>Frequency</td><td>Distribution</td><td>Pressure</td><td></td></tr>
<tr><td rowspan="5">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="5">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>Blue</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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