Crop Profile for Pear in 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 pear 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 pear, 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 pear, 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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Pears (*Pyrus* spp.), native to Europe and Asia, are members of the Rosaceae (rose) family. The European or common pear, *Pyrus communis* subsp. *communis* was introduced into North America in the 17th century and is the most commonly grown species in North America. In the 18th century, Jesuit Missionaries brought a pear variety to Canada from France, which was later called the 'Jesuit Pear'. It was distributed among French-speaking settlers in Ontario and the Northern United States and is known to carry important genetic material still sought after by breeders today.

Crop Production

Industry Overview

Pears produced in Canada are mainly consumed fresh or processed into other fruit products including juice, preserves, canned or frozen pears and also baby food.

Canadian pear production acreage has decreased since 2016; however, in 2019, pear production was valued at $10.7 million, an increase of $1.6 million since 2016. Imports of fresh and processed pears continue to exceed Canadian production levels and are valued at $120 million (Table 1).

Fire blight is still the most serious threat to pears. This bacterial disease not only reduces pear yields but also kills pear trees, and may be a significant factor in the decline in pear orchard acreage. Newer pear cultivars developed in Canada have increased resistance to fire blight compared to Bartlett pears.

Table 1. General production information, 2019

	Pear
Canadian production[1]	9,192 metric tonnes 830 hectares
Farm gate value[1]	$10.7 Million
Pears available in Canada[2]	1.83 kg/ person (fresh) 0.17 kg/ person (processed)

…continued

Table 1. General production information, 2019 (continued)

Exports[3]	Pear (fresh): $0.45 Million Pear (processed): $0.06 Million
Imports[3]	Pear (fresh): $107.4 Million Pear (processed): $12.6 Million

[1]Source: Statistics Canada. Table 32-10-0364-01 Area, production and farm gate value of marketed fruits. (Database accessed: 2020-08-27).
[2]Source: Statistics Canada. Table 32-10-0054-01 Food available in Canada. (Accessed: 2020-08-27).
[3]Source: Statistics Canada. Canadian International Merchandise Trade Database (Accessed: 2020-08-27). HS # 080830 - Fresh pears; HS # 200840 - Pears, nes, o/w prepared or preserved, whether or not sugared, sweetened or spirited.

Production Regions

Commercial pear production is located in the Okanagan and Kootenay Valleys of British Columbia, the Niagara Peninsula and Norfolk County of Ontario, the Annapolis Valley of Nova Scotia and the Montérégie region of Quebec.

In 2019, Ontario had the largest acreage with 465 ha of pear trees or 56% of the total national acreage, followed by British Columbia (245 ha or 30%), Quebec (64 ha or 8%) and Nova Scotia (45 ha or 5%) (Table 2). Interestingly, despite its smaller acreage, British Columbia had a larger volume of production (5,325 metric tonnes or 64%) compared to Ontario (3,329 metric tonnes or 40%) with farm gate values of $4.6 million and $5.3 million, respectively. The larger volume of production in British Columbia might be explained by a greater acreage of more productive high-density orchards in British Columbia compared to Ontario. Also, the larger farm gate value observed in Ontario, despite a lower production compared to British Columbia, might be attributable to a higher share of the more valuable fresh fruit market, whilst British Columbia produces a larger volume of pear on a smaller acreage for the less lucrative processing market.

Table 2. Distribution of pear production in Canada, 2019

Production Regions	Cultivated area[1,2] (national percentage)	Marketed production[1] (national percentage)	Farm gate value[1]
	Pear		
British Columbia	245 ha (30%)	5,325 metric tonnes (64%)	$4.6 Million
Ontario	465 ha (56%)	3,329 metric tonnes (40%)	$5.3 Million
Quebec	64 ha (8%)	289 metric tonnes (3%)	$0.5 Million
Nova Scotia	45 ha (5%)	205 metric tonnes (2%)	x
Canada	830 ha	9,192 metric tonnes	$10.7 Million

[1]Source: Statistics Canada. Table 32-10-0364-01 Area, production and farm gate value of marketed fruits (accessed: 2020-08-27).
[2]Cultivated area includes bearing and non-bearing area

Cultural Practices

Pear trees are long-lived and can produce fruit for over 100 years. Pears grow best in areas with mild winters and warm growing conditions. While pear trees can withstand temperatures of -25 °C without serious injury, temperatures below -30 °C can cause long-term damage. Trees fare best when planted in areas with little wind, a slight grade and a soil depth of at least one meter. Pear trees can grow in many types of soil; however, loam soils are considered to be ideal. Pears are sensitive to wet soil conditions, so good drainage is important. The flower buds and fruit are sensitive to frost. Planting pear trees on a slope helps to reduce the risk of frost damage and improves drainage. Generally, pear trees will not produce fruit unless they are pollinated with pollen from a complementary pollinating variety. That said, there are a few varieties that self-pollinate, such as the cultivar Duchess.

There has been an increase in plantings of new, fire blight resistant cultivars across Canada. Bartlett and Bosc remain the main fresh market cultivars with increases in plantings of Cold Snap and Bounty using the tall spindle training system. This training system results in higher yields per hectare but requires more pruning, tying and training. Bartlett remains the main processing cultivar; however, there is very little pear acreage grown for processing in Canada.

Table 3. Pear production and pest management schedule in Canada

Time of Year	Activity	Action
Winter-dormancy (December to late March)	Plant Care	Winter prune trees; apply nitrogen and zinc sulphate, as required; spray if needed.
	Soil Care	Prepare sites of new plantings; apply lime if needed.
	Disease Management	Prune off shoots that have white tips (mildew) and cankers. Remove and burn any fire blight infected material that remains in the orchard.
	Insect Management	Apply delayed dormant oil spray for pear psylla, scale and mite eggs. At pruning, check tops of trees for presence of scale insects.
	Other	Apply rodenticides, as needed.
Spring-green tip to fruit set (late March to May)	Plant Care	Finish pruning trees; plant and prune new trees; install tree supports and begin training new trees; apply foliar nutrients as needed; place bees in fields when blossom begins; irrigate as needed; begin fertigation in established stands, if used; apply post-bloom chemical thinners.
	Soil Care	Fertilize new trees; apply soil nutrients as needed.
	Disease Management	Monitor for scab, fire blight and powdery mildew infections; apply controls if needed.
	Insect Management	Apply delayed dormant oil spray for mite eggs reaching 13 mm (1/2 inch) in green to tight cluster; oil is also the preferred strategy for scale insect control and pear psylla deterrence; set out and monitor pheromone traps for moth pests (e.g. codling moth, oriental fruit moth) and begin monitoring for other insects; apply controls as needed.
	Weed Management	Monitor for weeds and apply controls if needed. Apply pre-emergent herbicides before June.
Summer – fruit growth (June to August)	Plant Care	Apply supplemental nutrient sprays as needed; irrigate as needed; begin fertigation of new trees, if used; hand thin fruit; apply calcium for bitter pit and other calcium deficiencies if needed; have leaf analyses performed; continue training young trees; apply growth regulator to prevent drop as needed; monitor fruit maturity; summer prune and sucker removal, if needed.
	Soil Care	Apply boron, if needed; take soil samples.
	Disease Management	Continue monitoring for scab and other diseases; prune out wood with cankers and fire blight; treat for pinpoint scab.
	Insect Management	Monitor and apply control measures for insect management.
	Weed Management	Monitor for weeds and apply controls if needed. Mow sod and maintain alleyways.
	Other	Monitor for bird damage and use control measures if needed.

…continued

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

Fall – harvest period (September to November)	Plant Care	Harvest pears; irrigate as needed after harvest; remove dead, weak or diseased trees.
	Soil Care	Fumigate sites of new plantings as needed; take soil samples. Cover crops may offer an alternative to fumigation.
	Pest management	Fruit harvest assessment; examine cull fruit to help plan next year's pest control programs (e.g., any pest contributing to more than 2% of cull fruit requires a control strategy); apply rodenticides. Prune out, remove and burn shoots visibly affected by fire blight.

Abiotic Factors Limiting Production

Environment

Environmental conditions that affect pear growth include wind, shade and frost. High winds and excessive shade can adversely affect tree growth, fruit quality and production. Limb rubbing can downgrade fruit while hail and high winds can result in substantial losses. Late spring frost can destroy developing flower buds, whereas early autumn frost can damage fruit, rendering it unmarketable.

Harvest and Storage Conditions

Pears are harvested by hand for the fresh and processing markets. Pears are picked before they ripen, at the mature green stage. Harvesting and storage of immature fruit will result in shriveling and the failure of the fruit to ripen, while the storage of over mature fruit will result in internal breakdown. To increase the storage life of pears, they are typically stored at temperatures of -1 °C to -0.5 °C as quickly as possible after harvest. Delayed storage accelerates the ripening process. Pears can freeze at temperatures as high as -2.2 °C, rendering them unmarketable.

Pears are prone to damage during harvesting and packing. Fruit stems may wound the skin of adjacent fruit. Puncture wounds make the fruit extremely susceptible to decay and also fungal or bacterial infection. Undamaged pears are also susceptible to fungal and bacterial rots if stored for prolonged periods of time. Decay and infections can be reduced by improved packing house sanitation.

Diseases

Key issues

- Fire blight management continues to be a concern, even with the planting of newer fire blight resistant cultivars. It is important to maintain current antibiotic product registrations and evaluate new materials to maintain suitable resistance management.

- Additional research, development and commercialization of fire blight resistant rootstocks and pear varieties are required.

- Resistance to fungicides is an on-going concern. The registration of cost effective rotational fungicides is required for scab protection and improved fungicide resistance management.

- Additional products are required for the management of post-harvest diseases of pear.

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

Disease	British Columbia	Ontario
Fire blight		
Pear blossom blast		
Pear scab		
Powdery mildew		
Trellis rust		
Phacidiopycnis canker		
Phytophthora diseases		
Sooty blotch and flyspeck		
Sooty mold		
Pear stony pit		
Storage diseases		
Blue mold		
Gray mold		
Phacidiopycnis rot		

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 pressure.

Pest not present.

Data not reported.

[1]Source: Pear 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 pear production in Canada[1]

Practice / Pest		Fireblight	Pear scab	Powdery mildew	Pear blossom blast
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				
Monitoring	Scouting / spore trapping				
	Maintaining records to track diseases				
	Soil analysis for the presence of pathogens				

…continued

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

Practice / Pest		Fireblight	Pear scab	Powdery mildew	Pear blossom blast
Monitoring	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				
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: Pear stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2017, 2018 and 2019 production years.

Fire Blight *(Erwinia amylovora)*

Pest Information

Damage: Fire blight is one of the most destructive bacterial diseases of pear trees in North America. The disease can affect blossoms, shoots, limbs and fruit. Symptoms of fire blight vary with the part of the tree attacked, and the time during the growing season that infection occurs. As a result fire blight may be difficult to diagnose. Infected blossoms and shoots become wilted, shrivelled and brown and the infected shoots may develop a characteristic shepherd's crook. Infected fruitlets first appear water soaked and off-color then eventually turn brown to black and shrivel up. Fire blight can move from infected blossoms and shoots into branches and trunks, eventually giving rise to cankers, which can girdle the affected tissues.

Life Cycle: Fire blight overwinters in cankers that were formed on diseased branches the previous year. The bacterium becomes active in the spring as temperatures warm up and can seep from cankers in the form of an ooze. The bacteria within the ooze can be spread to healthy blossoms by rain splashing, pollinating insects and on pruning tools. Insects are attracted by the ooze of bacterial cells and can disseminate the bacteria from canker to flowers.

Pest Management

Cultural Controls: Cultural controls include removing infected wood (cankers) during dormancy and pruning out summer shoot infections, at least 30 to 40 cm below visible signs of infection. The sterilization of pruning tools with bleach or denatured alcohol between each cut will prevent spread of the bacterium via pruning. The removal of secondary blossoms, which are very susceptible to infection, and of hosts near pear orchards helps to reduce infection. Using nursery stock that is free from disease will minimize the potential of introducing fire blight into the orchard. Weekly monitoring will enable the early detection of the disease. Several epidemiological models (e.g., COUGARBLIGHT, MARYBLYT) predict the likelihood of blossom blight epidemics based on observed climatic conditions. The models can be used to aid decisions on the need for and timing of chemical applications. Following balanced fertilizer programs that include potassium and micronutrients and avoiding excessive nitrogen can minimize the growth of succulent shoots that are very susceptible to fire blight infection. Refer to *Table 5* for practices used by growers in Canada to manage fire blight.

Resistant cultivars: Seuri, Shinko, Singo, Kosui, Chojoro, Shinsui, Harrow Crisp, Harrow Gold, Harrow Delight, Harvest Queen and Harrow Sweet, Kieffer, Magness, Maxine, Moonglo, Old Home, Seckel, Starking Delicious and Warren are resistant to fire blight. Varieties that are more susceptible include: Hosui, Shinseiki, 20th Century Anjou, Barlett, Bosc, Cascade, Flemish Beauty, and Starkrimson.

Issues for Fire blight

1. Fire blight management continues to be a primary concern of pear growers, even with the availability of resistant cultivars. It is important to maintain current antibiotic product registrations. As well, there is a need for the evaluation of additional products (e.g., non-conventional products including biopesticides) for the management of fire blight in pear (and apple) orchards, as the potential for antibiotic resistance development is a concern.
2. Additional research, development and commercialization of fire blight resistant rootstocks and pear varieties are required.
3. It has become difficult to market new fire blight resistant cultivars. There is a need to improve marketing strategies to educate consumers on these new cultivars.
4. Predictive models need refining to more accurately predict fire blight infection events in resistant cultivars.

Pear Blossom Blast (*Pseudomonas syringae* pv. *syringae*)

Pest Information

Damage: Early stages can resemble fire blight. Black spots develop on leaves and fruits; blossoms and fruit buds become blackened and eventually die. Yield can be severely reduced.

Life Cycle: Infections are caused by *Pseudomonas syringae* pv. *syringae.* The bacterium can exist on the surface of plant tissues and are more prevalent during cool, wet, spring weather. Tissues injured by cold temperatures and frost in the spring are most susceptible to infection, although the disease can be active all season. Proteins produced by the bacterium facilitate ice crystal formation, rendering plant tissues more susceptible to freezing injury and predisposing them to invasion by the bacterium.

Pest Management

Cultural Controls: Blossom blast can best be prevented by reducing the potential for frost damage by establishing orchards on sites with good air drainage or through the use of wind machines. The removal of affected tissues by pruning will reduce the amount of inoculum in the orchard. Refer to *Table 5* for practices used by growers to manage pear blossom blast.

Resistant cultivars: Cultivars more susceptible to blossom blast include Bartlett, Anjou and Bosc.

Issues for Pear Blossom Blast

1. There is concern that the incidence of pear blossom blast may rise with the increase in planting of fire blight resistant pear cultivars and the decrease in fire blight sprays that provided incidental control of pear blossom blast.
2. There are no registered control products for blossom blast; therefore, there is a need to seek new registrations of bactericides against this disease.

Pear Scab *(Venturia pirina)*

Pest Information

Damage: Pear scab lesions can develop on leaves, fruit and shoots. Young lesions appear as velvety, pinpoint spots. Lesions on the fruit begin at the calyx end and spread to the sides of the fruit. As the lesions enlarge, they become dark brown to black and coalesce. Heavily infected fruit may become deformed, cracked and unmarketable. Heavily infected leaves and fruit may drop. Twig infections are common. They begin as brown, velvety spots but then develop into corky, cankered areas.

Life Cycle: Scab overwinters in fallen leaves and within corky lesions on twigs. In the spring, ascospores (sexual spores) are produced within fungal fruiting bodies in infected tissues, then they are released and give rise to new infections. Infection periods begin in the spring during the green tip stage of development. Conidia (asexual spores) are produced within new lesions and are spread by splashing rain and wind, resulting in secondary spread of the disease. Late season infections may develop into pinpoint scab in storage.

Pest Management

Cultural Controls: Monitoring for scab from bud break until mid to late July will help determine the necessity and timing of sprays. Pruning of infected twigs may also be beneficial. The removal of unmanaged, host trees near pear orchards will remove a source of inoculum of the disease. As well, the elimination of fallen leaves from the orchard and mowing of fallen leaves to facilitate decomposition will reduce a source of overwintering inoculum. Refer to *Table 5* for practices used by growers to manage pear scab.

Resistant cultivars: Cultivars are available that are less susceptible to scab. Flemish Beauty and Seckel are highly susceptible to the disease.

Issues for Pear Scab

1. The registration of cost effective rotational fungicides is required for scab protection and improved fungicide resistance management.

Fabraea Leaf and Fruit Spot (*Fabraea maculata*)

Pest Information

Damage: Fabraea leaf spot attacks petioles, leaves, shoots and fruits of pear. Early symptoms on leaves are tiny, round, purplish-black spots, which quickly enlarge to 3 to 6 mm in diameter. Spots coalesce and severely infected leaves fall prematurely. Premature defoliation can result in undersized fruit and a failure of fruit buds to set for the following year. Fruit lesions are larger than those on leaves and cause the fruit to crack and drop. Small, inconspicuous lesions

may develop on current season's shoots; however, these usually do not persist into the following growing season.

Life Cycle: The disease overwinters in infected leaf litter and first-year twig cankers. Conidia (asexual spores), produced in infected tissues, are spread by splashing water from rains or overhead irrigation. Wetting periods for infection may vary from eight to 12 hours at temperatures of 10 to 25 °C. The disease may advance rapidly in late summer as wind and rain distribute the conidia throughout the tree canopy. Foliage of all ages is susceptible to infection and under suitable conditions the disease can continue to spread throughout the season.

Pest Management

Cultural Controls: The elimination of fallen leaves from the orchard and mowing of fallen leaves to facilitate decomposition will reduce a source of overwintering disease. Disease levels in the orchard can be monitored by examining the lowest leaves on individual 'sample' trees.

Resistant cultivars: None available.

Issues for Fabraea Leaf and Fruit Spot

None identified.

Powdery Mildew *(Podosphaera leucotricha)*

Pest Information

Damage: Powdery mildew produces a white powdery growth on new shoots and developing fruit. On pears, powdery mildew leaves black and russeting marks on the surface of young fruit and may render the fruit unmarketable.

Life Cycle: Pear is infected by *Podosphaera leucotricha* spores that can spread from infected apple orchards or neighbouring apple blocks. The spores (conidia) are dispersed by air currents and are dispersed to other tissues, causing secondary spread. Powdery mildew is also favoured by moderate temperatures (10 to 25 °C) and high relative humidity. Unlike in apples, *P. leucotricha* does not overwinter in pear buds. In the spring, primary infections develop on blossoms, young leaves and fruits. Under suitable conditions, there can be several disease cycles during a season.

Pest Management

Cultural Controls: Pruning out twigs with white fungus growth is beneficial and provides better air circulation within the orchard. Avoiding areas with poor air circulation when establishing an orchard helps to minimize powdery mildew development. Refer to *Table 5* for practices used by growers to manage powdery mildew.

Resistant cultivars: None identified.

Issues for Powdery Mildew

None identified.

Trellis Rust (*Gymnosporangium sabinae or G. fuscum*)

Pest Information

Damage: Trellis rust causes bright yellow-orange spots on the surfaces of pear leaves, fruit and twigs. Within leaf spots, fruiting bodies develop on both upper and lower surfaces, with those of the lower surface becoming blister-like and eventually developing spores that infect juniper, the required second host, in the fall.

Life Cycle: Both pear and juniper hosts are required for the complete life cycle of trellis rust. Spores produced in gelatinous growths on juniper branches infect pear tissues resulting in the yellow-orange spots. In the fall, spores produced within leaf spots on pear are windblown to susceptible juniper hosts where they cause infection. The disease overwinters on juniper.

Pest Management

Cultural Controls: The removal of juniper hosts within 1 to 2 km of the orchard or pruning out of swellings and galls on juniper, will break the disease cycle.

Resistant cultivars: None identified.

Issues for Trellis Rust

1. There is a need for research on the biology, epidemiology and impact of trellis rust on pear.
2. There is a need for the registration of fungicides for the management of pear trellis rust, particularly for pear production in British Columbia.

Phytophthora Diseases: Crown, Root and Collar Rots (*Phytophthora* spp.)

Pest Information

Damage: Phytophthora spp. cause sunken cankers on the lower trunk and roots of pear. Cankered tissues develop an orange-brown decay with a distinct margin. Young trees with smaller root systems may be killed within a few weeks while larger trees decline over a number of years. Chronically affected trees exhibit purple discolouration of foliage in the fall and premature leaf drop.

Life Cycle: The disease is more prevalent under conditions of excessive soil moisture and poor drainage. Phytophthora persists in orchard soils and in infected plant tissue. Under suitable

moisture conditions, the fungus produces sporangia which give rise to motile zoospores which "swim" to susceptible tissues where they cause infection.

Pest Management

Cultural Controls: Avoiding planting sites with poorly drained soils and those prone to excessive wetness will reduce the chances of Phytophthora crown and root rot development.

Resistant cultivars: None identified.

Issues for Phytophthora Crown, Root and Collar Rots

None identified.

Sooty Blotch *(Gloeodes pomigena)* and Flyspeck *(Schizothyrium pomi)*

Pest Information

Damage: Sooty blotch and flyspeck cause losses by reducing fruit quality. Sooty blotch produces circular, olive green colonies with irregular margins on the surface of mature fruit, which may eventually cover a large proportion of individual fruits. Flyspeck produces circular groups of black shiny specks on the fruit surface.

Life Cycle: The sooty blotch fungus overwinters on infected twigs of apple and other woody plants. In the spring and early summer, spores are dispersed by rain to susceptible tissues. There are extensive secondary infections throughout the season. Flyspeck overwinters on twigs of a number of woody hosts outside the orchard. Ascospores (sexual spores) are released in the spring and cause primary infections on fruit and stem tissues. Conidia (asexual spores) produced in infected tissues are dispersed by air currents and cause secondary infections later in the season.

Pest Management

Cultural Controls: Pruning to improve air circulation in the tree canopy will help reduce disease incidence and severity. Thinning of fruit will also help reduce the development of these diseases.

Resistant cultivars: None identified.

Issues for Sooty Blotch and Flyspeck

None identified.

Pear Stony Pit (unidentified virus)

Pest Information

Damage: The severity of symptoms varies with cultivar. Symptoms first appear as dark areas on fruit. The growth of infected fruit becomes restricted resulting in deformed fruit. Leaves may exhibit vein banding and mottling or scabby spots may develop on the bark of young trees.

Life Cycle: Transmission of the virus is through propagation, such as grafting, budding and cuttings.

Pest Management

Cultural Controls: Sanitation practices, including the use of virus-free planting and propagation stock, will reduce the chances of introduction and spread of the virus in the orchard. Removing trees showing virus symptoms will prevent other trees from becoming infected.

Resistant cultivars: Pear cultivars vary in their susceptibility to this disease with Bosc, Comice and Seckel being the most susceptible.

Issues for Stony Pit

1. Although stony pit is a minor concern for pear growers across the country, there is a need for virus-free propagation materials. It has been extremely difficult to ship pear trees and rootstocks between provinces and import from the United States.

Sooty Mold (*fungal complex*)

Pest Information

Damage: Sooty mould is caused by a complex of fungi. Damage includes a black, velvety coating of leaves, shoots and fruit where honeydew from sap feeding insects has been deposited. Damage severity increases with an increase in honeydew production.

Life Cycle: The fungi responsible for sooty mould survive and overwinter on the surface of all plant parts. In the spring, spores are spread to green tissue by air currents and rain. If honeydew from sap feeding insects (e.g., pear psylla) is present, the fungi will use it as a food source and turn surfaces black.

Pest Management

Cultural Controls: Control measures to minimize sap feeding insects such as pear psylla are key. Nitrogen applications at levels that do not promote excessive vegetative growth, and summer pruning to remove new growth will remove the favoured egg laying sites of adult psylla. Refer to *Table 5* for additional practices used by growers to manage pear psylla.

Resistant cultivars: None identified.

Issues for Sooty mould

1. Sooty mould is generally a secondary concern related to pear psylla infestations, which can affect the fruit finish (e.g., fruit skin appearance). If sucking insects are controlled, no sooty mould develops. There may be a future need to register commercial soap solutions for orchard application.

Phacidiopycnis Canker and Rot (*Potebniamyces pyri*; anamorph - *Phacidiopycnis pyri*)

Pest Information

Damage: Phacidiopycnis canker of pears is considered a weak bark pathogen, often associated with dead bark and cankers. The pathogen survives as conidia, and, under high relative humidity, mycelium. Conidia produced in cankers can infect fruit through general wounds, through the stem or through the calyx with symptoms developing once fruit are in storage. Early symptoms include water soaked areas that turn brown/black as the disease advances.

Life Cycle: Phacidiopycnis rot is an emerging postharvest disease of pear. Infections occur under warm, wet conditions (20 to 25 °C). The pathogen overwinters on infected orchard trees and is associated with cankers, dead bark and twig dieback.

Pest Management

Cultural Controls: Pre-harvest sanitation practices such as pruning will reduce the inoculum load and spread. Avoiding pruning during wet weather may reduce the chances of infection.

Resistant cultivars: None identified.

Issues for Phacidiopycnis canker and rot

1. The incidence of Phacidiopycnis canker is increasing in BC orchards. There is a need for the registration of fungicides for the management of this canker.
2. There is a need to register post-harvest products for the control of Phacidipycnis rot in pear.

Storage diseases: Blue Mold *(Penicillium expansum) and* Gray Mold *(Botrytis cinerea)*

Pest Information

Damage: Blue mold causes a soft, watery decay of pears in storage. There is a sharp line of demarcation between rotted and healthy tissues. Gray mold decay often begins at the calyx or stem ends of the fruit. Fruit with physical injury or that has been stored for prolonged periods, is more prone to decay.

Life Cycle: Blue mold infections can arise under suitable environmental conditions from spores on the surface of fruit or present in the packing house on decaying fruit. In the orchard, gray mold grows and sporulates on dead and dying plant tissues and can establish itself on the stem and calyx extremities of the pears at harvest. Dump water (water used to move pears during packing and grading) may become contaminated through soil, grass and crop debris in the harvest bins and result in fruit infections of snow mould rot and other pathogens. Under suitable conditions, infections may spread in storage through mycelial growth (gray mold and snow mould rot) and spore production. High humidity and delays in cooling fruit after harvest increase the chance of storage disease infections.

Pest Management

Cultural Controls: Careful handling, rapid cooling and prompt storage at harvest will help to minimize storage rots as the potential for infection is increased with wounding, high humidity and delays in cooling after harvest. The culling of damaged fruit prior to storage will reduce storage rot. Frequent changing of dump tank water (water used to move pears during packing and grading) is important as is following good sanitation measures in the handling and processing areas.

Resistant Cultivars: All pear varieties are susceptible.

Issues for Storage Diseases

None identified

Insects and Mites

Key issues

- Mealybugs are a vector of grapevine leafroll virus. Careful monitoring for virus vectoring insects (mealybugs and scale insects) is required in orchards within proximity to vineyards so that controls may be implemented, if necessary.

- Early detection methods are important to identify and track mite populations; however, action thresholds need to be established for each pest mite species observed in pear. Phenological growth stage, weather conditions, and miticide modes of action need to be considered when developing thresholds.

- Information on the toxicity of pest control products to beneficial predatory mites is required at time of registration, to enable best management practices to protect natural enemies.

- Unmanaged host trees on private and public properties, especially those close to commercial orchards, are of concern as they can be a reservoir for pests.

- No products are currently available for management of pear sawfly. There is a need for the registration of products that can be used at the petal fall stage.

- There has been an increase in plum curculio activity and pear injury from this pest in Ontario. There is a need to establish economic thresholds for plum curculio on pear. Additionally, apple curculio injury has been identified in a small number of pear orchards in Ontario and British Columbia. Research to determine the frequency, distribution and potential impact of apple curculio is needed.

- There is a need for the registration of new conventional and non-conventional products for the management of a number of pests including: pear blossom midge, pear psylla, Comstock mealybug, pear leaf blister mite, tarnished plant bug, plum curculio and twospotted spider mites. Depending on the target pest, products are needed pre- and post-bloom, offer short pre-harvest intervals and are non-toxic to pollinators.

Table 6. Occurrence of insect and mite pests in pear production in Canada[1,2]

Insect	British Columbia	Ontario
Plum Curculio		
Oriental Fruit Moth		
Codling moth		
Pear psylla		
Brown marmorated stinkbug		
Comstock mealybug		
Mites		
European red mite		
Pear rust mite		
Pearleaf blister mite		
Two spotted spider mite		
Mullein bug		
Tarnished plant bug		
Scale insects		
San Jose scale		
Pear sawfly (pear slug)		
Green fruitworm		
Japanese beetle		
Spring feeding caterpillar complex		
Red-banded leafroller		
Fruit tree leafroller		
Eyespotted bud moth		
European leafroller		
Two generation leafrollers		
Obliquebanded leafroller (OBLR)		
Threelined leafroller		

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 pressure.

Pest not present.

Data not reported.

[1]Source: Pear 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 7. Adoption of insect and mite pest management practices in pear production in Canada[1]

Practice / Pest		Codling moth	Pear psylla	Spring feeding caterpillar complex	Mites	Obliquebanded leafroller
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 (eg. 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 7. Adoption of insect and mite pest management practices in pear production in Canada[1] (continued)

Practice / Pest		Codling moth	Pear psylla	Spring feeding caterpillar complex	Mites	Obliquebanded leafroller
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					
	Preservation or development of habitat to conserve or augment natural controls (e.g. preserve natural areas and hedgerows, adjust crop swathing height, etc.)					
	Mating disruption through the use of pheromones					
	Mating disruption throught the release of sterile insects					

…continued

Table 7. Adoption of insect and mite pest management practices in pear production in Canada[1] (continued)

Practice / Pest		Codling moth	Pear psylla	Spring feeding caterpillar complex	Mites	Obliquebanded leafroller
Suppression	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: Pear stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2017, 2018 and 2019 production years.

Plum Curculio *(Conotrachelus nenuphar)*

Pest Information

Damage: Plum curculio adults and larvae attack pears, damaging developing green tissues, blossoms and fruits. This insect can be very destructive if no controls are implemented. Females create feeding injuries next to each oviposition site, which develop into scar bumps on the fruits at harvest, making them unsuitable for fresh market sale.

Life Cycle: The adult plum curculio overwinters in debris, woodpiles and other protected sites adjacent to orchards. Adults fly into the orchards in the early spring. Emergence can be expected when three to four days of warm temperatures (above 16 °C) occur after a rain. Adults migrate to orchards from white bud to petal fall and feed on buds, flowers, leaves and young fruits. During this time, females lay eggs in cavities of the developing fruit. After egg hatch, the larvae feed inside the fruit until they are fully grown, then they drop to the ground to pupate. Second generation adults emerge in two to three weeks and return to the trees to feed on the fruit before seeking overwintering sites.

Pest Management

Cultural Controls: Infestations occur during early season and can be revealed with frequent monitoring through the use of traps, checking for visual feeding injury and by shaking branches to drop adults onto cloths for counting. Populations of plum curculio can be reduced through winter mortality and predation by insects.

Resistant cultivars: None available.

Issues for Plum Curculio

1. The proposed restriction of neonicotinoid insecticides will limit insecticide options for plum curculio beyond the 2020 growing season. Additional insecticides are needed for control and resistance management.
2. In recent years there has been an increase in plum curculio activity and associated injury on pears. There is a need to establish economic thresholds for this pest on pears.
3. Additionally, apple curculio injury has been identified in a small number of pear orchards in Ontario. This is not an identified pest of pear; research is needed to determine the frequency, distribution and potential impact of apple curculio on pear.

Oriental Fruit Moth (*Grapholita molesta*)

Pest Information

Damage: The primary hosts of the Oriental Fruit moth (OFM) are peaches, nectarines and apricots. Apples and pears are alternative hosts. The larvae attack pear fruit usually from mid-season through to harvest. Pear shoots are not usually attacked. Codling moth larvae and damage may be confused with that of the OFM.

Life Cycle: Late stage larvae overwinter on or near the host and pupate in the spring. There may be up to four generations of OFM per year.

Pest Management

Cultural Controls: Control strategies for OFM in nearby peach, apricot and nectarine orchards can reduce late season migration of this insect into pear orchards. The use of pheromones for mating disruption will help manage this insect. Predictive models can also help the timing of insecticides' applications. As the rate of development of oriental fruit moth differs between apples, pears and stone fruit, different degree day accumulation methods are also used for modelling.

Resistant cultivars: None available.

Issues for Oriental Fruit Moth

None identified.

Codling Moth *(Cydia pomonella)*

Pest Information

Damage: Codling moth can cause significant economic loss in pears. Larvae enter the fruit from the sides, stem and calyx ends, bore to the core and feed in the seed cavity.

Life Cycle: The codling moth overwinters as a late stage larva under bark scales and in crevices. The larvae pupate in the spring and adults emerge in May or June. Female moths lay eggs on the fruit or on leaves near the fruit. After hatching, the young larvae may feed on the fruit surface before tunnelling into the fruit to feed on the pulp and seeds. At maturity, the larvae leave the fruit to pupate. Second generation moths emerge in July and August and the cycle repeats.

Pest Management

Cultural Controls: Sanitation practices contribute greatly in managing this pest. Practices such as the removal of all unmanaged pear or apple trees within 100 m of the orchard and the removal and destruction of fallen fruit and infested fruit found at thinning and harvest, help reduce pest numbers. Bands of corrugated cardboard may be placed around tree trunks and scaffold limbs in early August to collect pupating larvae. These bands are destroyed after harvest. Pheromone baited traps are also used to monitor the population and determine the necessity and timing of treatments. In some areas (e.g., BC interior), codling moth populations can be maintained below economic thresholds by the release of sterile moths, or by combinations of sterile moth release and pheromone mating disruption. Refer to *Table 7* for practices used by growers in Canada to manage codling moth.

Resistant cultivars: Pear varieties vary in their susceptibility to codling moth injury.

Issues for codling moth

1. Registration of a pheromone mating disruption triple lure targeting codling moth, obliquebanded leafroller and eyespotted bud moth is needed in British Columbia.

Pear Psylla *(Cacopsylla pyricola)*

Pest Information

Damage: Pear psylla nymphs feed by sucking plant sap from tender tissues. Feeding can cause premature leaf drop, weaken fruit buds and reduce shoot growth. Heavy populations can cause significant crop loss and over time may result in tree mortality.

Life Cycle: Psylla overwinters as adults in protected places in and around the orchard. In early spring, the adults migrate to the pear trees and lay eggs on or near the buds. Later generation females lay their eggs on leaves of new shoots and suckers. Nymphs progress through five stages before becoming adults. Depending on weather conditions, psylla can have up to four overlapping generations per year. Psylla nymphs also excrete honeydew that supports the growth of sooty mould.

Pest Management

Cultural Controls: Nitrogen applications at levels that do not promote excessive vegetative growth, and summer pruning to remove new growth will remove the favoured egg laying sites of adult psylla. Monitoring involves the use of visual techniques including beating trays to dislodge adults and the examination of fruit spurs and branch tips for eggs or nymphs. Economic thresholds have been established. Many natural predatory insects feed on psylla, but these may not maintain the pest below economic levels. Refer to *Table 7* for additional practices used by growers to manage pear psylla.

Resistant cultivars: None available.

Issues for Pear Psylla

1. Further investigation is required on management approaches that conserve natural enemies of pear psylla in the orchard.
2. There continues to be a heavy reliance on neonicotinoids for control the summer generation of pear psylla. With the proposed restriction of neonicotinoids and concerns of resistance development, new insecticides, with different modes of action are required for responsible management of pear psylla.

Brown Marmorated Stinkbug (*Halyomorpha halys*)

Pest information

Damage: Brown marmorated stinkbug (BMSB) adults and nymphs can cause significant crop injury; injecting saliva with digestive juices into hosts and feeding on the liquefied plant tissues. Early season feeding can result in stunted fruit growth and late season feeding can cause dimpling marks on pears or sunken patches on the skin surface with very hard and pithy areas developing internally.

Life Cycle: The seasonal activity of BMSB differs from other stink bugs, with feeding in tree tops and outer rows in mid-June, and fruit discoloration noticeable by the end of June. BMSB can spread through natural means and is also a "hitchhiker" in cargo and vehicles. It overwinters as adults in structures, emerging in the spring to mate and lay eggs on a range of host plants including tree fruit, berries, grapes, ornamentals, grain crops, tomatoes, peppers and sweet corn. Adults are long-lived and females may lay several hundred eggs over an extended period of time. In the fall, the adults move back to protected overwintering sites, which may include structures, where they are a nuisance pest.

Pest Management

Cultural Controls: Monitoring for the BMSB may be done through aggregation pheromones and 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. The potential for damage by BMSB is of great concern to growers. Careful monitoring of established colonies and the development of effective IPM strategies is required.
2. Additional control products, which offer excellent efficacy and short pre-harvest intervals, are required as the seven to 10 day period just prior to harvest is when the majority of BMSB damage occurs. The continued harmonization of pesticide registrations between Canada and the United States is very important to ensure Canadian growers remain competitive.
3. Behavioural research studies are required to determine the relationship with other host plants location with proximity of pear growing areas; it has been suggested that BMSB presence in pears is dependant on the orchard proximity to alternate tree hosts.
4. There is a need for domestic products to be made available for homeowners to control BMSB populations that threaten nearby commercial host crops.

Comstock Mealybug (*Pseudococcus comstocki*)

Pest Information

Damage: Comstock mealybugs (CMB) are sap-feeders which assemble on leaves or fruits. Feeding along fruit stems may result in fruit drop. The insect secretes honeydew that supports the growth of unsightly sooty moulds.

Life Cycle: The CMB overwinters as eggs that hatch from mid-April to May up until the petal fall stage. Nymphs are present until early summer at which time adult females and males emerge. After mating, eggs are laid on the host. A second summer-generation of adults lay eggs in mid-summer and again in late summer, with these latter eggs overwintering.

Pest Management

Cultural Controls: The removal of trash in and around the pear orchard will eliminate overwintering sites. Comstock mealybug can be monitored by visual examination of crawlers' activity on the terminal growth of the shoots. The presence of ants may also be an indicator of the presence of CMB since honeydew attracts ants.

Resistant cultivars: None available

Issues for Comstock Mealybug

1. There are concerns that the CMB may become more prevalent now that the use of broad-spectrum materials, such as organophosphate insecticides, is limited.
2. The registration of replacement products are required to control CMB.
3. There has been confirmation that mealybugs are vectors of grapevine leafroll virus. Careful monitoring is required in orchards within proximity to vineyards so controls can be implemented when necessary.

Mites: Pear Rust Mite *(Epitrimerus pyri)*, Pearleaf Blister Mite *(Eriophyes pyri)*, Two-Spotted Spider Mite *(Tetranychus urticae)*

Pest Information

Damage: Size, color and fruit set may be affected if mite populations are high for a long period of time. The pear rust mite causes smooth russeting on leaves and fruits. The pearleaf blister mite causes reddish, russeted spots and fruit deformities. The two-spotted spider mite causes leaf blackening and drop.

Life Cycle: Pear rust mite and the pearleaf blister mite overwinter at the base of buds, under bud scales and leaf scars or in bark crevices on branches and twigs. When the buds open, the rust and blister mites move to the flowers and leaves. At petal fall, the mites move to the fruit. Rust mites have several generations during the spring and summer months. The two spotted spider mite overwinters as adult females in bark crevices or in litter on the ground. This mite has many overlapping generations per year; during hot weather a generation can be completed in as little two weeks.

Pest Management

Cultural Controls: The removal of crop debris in and around the orchard will eliminate overwintering sites of the mites. Monitoring the orchard for mites on a weekly basis will help determine if treatments are necessary. Maintaining good weed control in the orchard and keeping the floor of the orchard clean will help to reduce mite numbers. To reduce the chance of spread of infestations, pears should not be planted near other host crops such as cherry, apple, plum and peach. The removal of unmanaged host trees in the vicinity of the orchard will remove a source of infestation. Some beneficial predatory mites can keep the mites in check. Refer to *Table 7* for practices used by growers to manage mites.

Resistant cultivars: None identified.

Issues for Mites

1. Information on the toxicity of pesticides to specific predatory mite species is required by growers and advisors when compounds are registered, to enable best management decisions to conserve natural enemies.
2. With limited management products available, additional miticides with activity against all life stages and quick knockdown are needed for proper resistance management.
3. Early detection methods are important to identify and track mite populations; however, action thresholds need to be established for each mite species observed in pear. Phenological growth stage, weather conditions, and miticide modes of action need to be considered when developing thresholds.
4. Pear leaf blister mite continues to be an annual pest in Ontario. Economic losses are minimal; however, there are limited products available for control. Additional materials are required for use during the immediate post-bloom period. Trace blooms may be present during the application window, so materials with low toxicity to pollinators are critical.

European Red Mite *(Panonychus ulmi)*

Pest Information

Damage: Feeding by European red mites (ERM) results in a stippling and bronzing of foliage. Severe infestations may result in leaf necrosis, burn and defoliation of pear trees. Size, color and fruit set may be affected if mite populations are high for a long period of time. Yields can also decrease the year after a severe attack. Pears can suffer damage from even a small population of ERM.

Life Cycle: The European red mite overwinters as eggs on rough bark around buds. The eggs hatch in the spring throughout the bloom period and the immature mites move to the leaves to feed. The immature mites develop through larval stages and two additional nymphal stages before becoming adults. Following mating, eggs are laid on the foliage. There may be six to eight overlapping generations per year, depending on temperature. Populations begin to decline in late summer when the overwintering eggs are laid.

Pest Management

Cultural Controls: Maintaining good weed control in the orchard will help reduce mite numbers. Avoiding planting pears near other host trees such as cherry, apple, plum and peach will help to reduce the chance of an infestation. The removal of unmanaged host trees in the vicinity of the orchard will remove a source of infestation. Monitoring for pest mites and beneficial predatory mite species, which can help keep pest mites in check weekly, can ensure that treatments are applied only when needed. Refer to *Table 7* for practices used by growers to manage mites.

Resistant cultivars: None available.

Issues for European Red Mites

1. Information on the toxicity of pesticides to specific predatory mite species is required by growers and advisors when compounds are first registered, to enable best management decisions to conserve populations of natural enemies.
2. European red mites are known to develop resistance to pesticides relatively quickly. There is a need for the continued development of new products in new chemical families for resistance management.

Tarnished Plant Bug (*Lygus lineolaris*)

Pest Information

Damage: Among the several species of plant bugs that attack pears, the tarnished plant bug is the most serious. It feeds by sucking plant sap on fruit buds and immature fruit which can result in aborted fruit buds and in a "dimpling" formation of the fruit.

Life Cycle: The tarnished plant bug overwinters as an adult in weeds and under debris and also in protected areas such as woodlots and fence rows. The overwintering adult becomes active very early in the spring, attacking buds of early developing fruits. Eggs are laid in the foliage of the host plants. The eggs hatch, and nymphs feed on the host plant causing injury similar to that of adults. There may be three to five generations per year.

Pest Management

Cultural Controls: The elimination of debris and the control of weeds in the vicinity of the orchard will make the area less attractive to the tarnished plant bug.

Resistant cultivars: None available.

Issues for Tarnished Plant Bug

1. There are limited control options for tarnished plant bug. There is a need for the registration of additional pesticides for control of *Lygus spp*. as damage to pear has been observed in British Columbia orchards.

2. The development of improved monitoring practices for more accurate timing of control measures is required.

Scale Insects: San Jose (*Quadraspidiotus perniciosus*) and European Fruit Scale (*Parthenolecanium corni*)

Pest Information

Damage: Scale insects injure pear by sucking moisture from plant tissues. Heavy infestations cause distorted growth and a decrease in the vigour of young trees, with severe infestations capable of killing tree limbs or a whole tree in two or three years. Heavy infestations of San Jose scale can "crust over" twigs and cause dieback. Feeding by San Jose scale causes fruit spotting and severe infestations may result in small, deformed fruit.

Life Cycle: The immature stages of both scales overwinter on bark. The scales mature in the spring and adults emerge at full bloom to petal-fall stages. The females bear live young (crawlers) that move to new feeding sites and begin feeding and forming a shell. There are two to three generations per year of the San Jose scale and one generation per year of the European fruit scale.

Pest Management

Cultural Controls: Pruning heavily infested branches and avoiding long pruning stubs that interfere with spray coverage will help to control scale populations. If injuries are observed at harvest, a control measure may be warranted the following spring.

Resistant cultivars: None identified.

Issues for Scale Insects

None identified.

Spring Feeding Caterpillar Complex: Red-banded Leafroller (*Argyrotaenia velutiana*), Fruit Tree Leafroller (*Archips argyrospila*), European Leafroller (*Archips rosana*), and Other Leafrollers

Pest Information

Damage: Leafrollers feed on young developing leaves and bore into buds during early spring. Early season feeding causes corky scars and fruit indentation. Fruit can also drop prematurely. Larvae of some species web and roll terminal leaves, where they hide when not feeding. Leaf feeding, when severe, can reduce photosynthetic activity.

Life cycle: Spring feeding leafroller species develop through a number of stages: egg, larva, pupa to become adult butterfly or moth. The timing of the life stages differs amongst species with some species overwintering as eggs and others as larvae or pupae.

Pest management

Cultural controls: Egg masses can be removed during winter pruning. Monitoring involving the visual observation of feeding activity on terminal growth and flower petals is done in some areas. Economic thresholds exist in some provinces. Refer to *Table 7* for practices used by growers to manage spring feeding caterpillars.

Resistant cultivars: None available.

Issues for Spring Feeding Leafrollers

1. Registration of a pheromone mating disruption triple lure targeting codling moth, obliquebanded leafroller and eyespotted bud moth is needed in British Columbia.

Eyespotted Bud Moth (*Spilonota ocellana*)

Pest Information

Damage: The eyespotted bud moth has many hosts, and is a pest of pear, apple, blackberry, cherry, peach, quince, oak, raspberry, plum and other trees. Larvae feed on leaves and the surface of developing fruit. Summer feeding damage is similar to leafroller and fruitworm damage, but is not as severe.

Life Cycle: There are one or two generations per year. Immature larvae overwinter in cocoons attached to the bark of twigs and branches. In the spring, the larvae leave the cocoons and enter leaf and blossom buds. Spring larval feeding may completely destroy blossoms. The larvae pupate within "nests" made of leaves and blossoms and the adult moths emerge in late June and July. Following mating, the female moths lay eggs on the foliage. Larvae hatch and begin to feed.

Pest Management

Cultural Controls: Adults can be monitored with pheromone traps. Pruning to open up the canopy and allow better spray penetration will improve control. Removal of infestations on host trees in the vicinity of the orchard will eliminate potential pest reservoirs. It is important to control the spring generation of the bud moth to reduce the need to control the summer generation which causes economic damage.

Resistant cultivars: None identified.

Issues for Eyespotted Bud Moth

1. Registration of a pheromone mating disruption triple lure targeting codling moth, obliquebanded leafroller and eyespotted bud moth is needed in British Columbia.

Two-Generation Leafrollers: Obliquebanded Leafroller (*Choristoneura rosaceana*) and Three-lined Leafroller *(Pandemis limitata)*

Pest Information

Damage: These leafrollers feed on flowers, fruit and foliage. First generation larvae feed on young fruit resulting in shallow grooves in the fruit skin. Second generation larvae cause small pin holes which are susceptible to infection with rot pathogens leading to storage loss.

Life Cycle: These species have two generations per year, and more than five instars within each generation. Adult moths start laying eggs on the upper leaf surfaces in the spring. Following hatching, larvae feed on developing fruit and leaves and when fully grown, pupate within rolled leaves and emerge as adults. Second generation larvae are present in late summer. Larvae overwinter in protected places on the bark. In the spring, the larvae resume feeding.

Pest Management

Cultural Controls: Pruning to open up the tree canopy and improve spray penetration is helpful in the control of leafrollers. Thinning fruits to reduce fruit crowding or touching can help reduce preferred feeding spots. Populations can be monitored by visual tree inspections, with the use of beating trays and pheromone traps. Control of the spring generation will minimize problems encountered with the second generation. The distribution of mating disruption pheromone, especially on the edge of orchards, help to reduce population levels of the two-generation leafrollers. Refer to *Table 7* for practices used by growers to manage obliquebanded leafroller.

Resistant cultivars: None identified.

Issues for Obliquebanded Leafrollers

1. Registration of a pheromone mating disruption triple lure targeting codling moth, obliquebanded leafroller and eyespotted bud moth is needed in British Columbia.

Pear Sawfly or Pear Slug *(Hoplocampa brevis)*

Pest Information

Damage: Larvae feed on the upper surface of pear leaves removing the photosynthetic layer. High populations can defoliate pear trees.

Life Cycle: There are two generations per year in the British Columbia Interior and one generation per year in Ontario. Eggs are laid in flower buds during the spring. After hatching, larvae feed in young fruit that drop to the orchard floor. Larvae resemble small, black and elongated slugs, hence its common name. Pear sawfly overwinters as a pupa in a cocoon buried deep in the soil.

Pest Management

Cultural Controls: None available.
Resistant cultivars: None available.

Issues for Pear Sawfly

1. Pear sawfly has become a concern in select pear blocks in British Columbia and Ontario. Currently there are no products registered for the control of this pest. There is a need to register materials that can be used at the petal fall stage of development.

Green Fruitworms (Family: *Noctuidae*)

Pest Information

Damage: A number of fruitworm species can attack pear. Fruitworm larvae feed on flower buds and blossoms causing petal fall drop and fruit abortion. Feeding can result in large corky scars and indentations or fruit distortion.
Life Cycle: The various fruitworms overwinter as adults, pupae or eggs. *Othosia hibisci*, the speckled green fruitworm, which is common in Ontario, begins emerging in early spring and lay its eggs on newly formed leaves. After hatching, larvae feed on leaves and forming fruit until early summer, then drop to the soil to pupate. There is one generation per year.

Pest Management

Cultural Controls: In the spring, fruit buds, blossom clusters and terminal leaves can be monitored for larvae by visual examination. During bloom, limb taps may be used to count larvae and determine whether treatments are necessary.
Resistant cultivars: None identified.

Issues for Green Fruitworms

None identified.

Mullein Bug (Campylomma verbasci)

Pest Information

Damage: The mullein bug has two major hosts, apple and mullein plants but is also known to feed on pear, rose, potato and corn. Feeding damage results in pustules on young fruitlets, which results in distorted fruit as the fruit matures.
Life Cycle: Mullein bugs have two to three generations per year. The insects overwinter as eggs in the bark of young wood of apple and pear trees and hatch during the bloom and petal fall period. Mullein bug nymphs feed on the sap of leaves and young fruitlets, or become

predacious several weeks after petal fall. Adults move to mullein plants to feed throughout the summer, but return to apple and pear in the late fall for egg-laying.

Pest Management

Cultural Controls: Monitoring is done using trapping boards/beating trays. Thresholds will vary based on variety susceptibility. Removal of host crops (e.g., mullein plants) in and around the orchard will help reduce overall population.

Resistant cultivars: None identified.

Issues for Mullein Bug

1. There are limited control options for mullein bug; there is a need for the registration of additional pesticides
2. The development of improved monitoring practices for more accurate timing of control measures is required.

Weeds

Key Issues

- There is a need for registration of broad-spectrum contact herbicides with different modes of action in order to slow the development of glyphosate tolerance within weed populations, and to mitigate the impacts of resistant weed species including Canada fleabane and thistle.

- There is an urgent need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings in all tree fruit commodities.

- There is a need for testing of predictive models and of non-chemical methods for weed control such as flaming, rolling, cultivation and the use of mulches, and long-term rotations. Assessments need to include efficacy, economics and environmental impacts of these methods.

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

Table 8. Occurrence of weeds in pear production in Canada[1,2]

Weed	British Columbia	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 not present.

Data not reported.

[1]Source: Pear 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 9. Adoption of weed management practices in pear 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 9. Adoption of weed management practices in pear 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 (banding, spot treatments, use of variable rate sprayers, etc.)				
	Selection of herbicides 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: Pear stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2017, 2018 and 2019 production years.

Annual, Biennial and Perennial Broadleaf and Grass Weeds

Pest Information

Damage: Crop losses can be very high if weeds are not controlled. Broadleaf weeds compete with the crop for light, water and nutrients. If not controlled, they will reduce sapling vigour and tree vitality. Grasses also cause significant problems in pear production because of their fast growth and ability to compete for necessary resources. Additionally, grass weeds are very tolerant to extremes in moisture and temperature, once established. They can be very difficult to eliminate and require control prior to seed-set due to their prolific seedling. Perennial weeds can become very large and very competitive, especially if they have been established for several years. Young trees compete poorly with weeds for moisture and nutrients. Weeds near tree trunks provide shelter to rodents that can girdle the tree by stripping the bark.

Life Cycle: Annual weeds complete their life cycle in one year, going from seed germination, through vegetative growth and flowering to new seed production. Winter annuals begin their growth and produce a vegetative rosette in the fall. They flower and produce their seeds early the following year. Annual weeds survive and spread through the production of large numbers of seeds which are present at all times in most arable land. Some weed seeds can remain viable in the soil for many years, germinating when conditions are suitable. Biennial weeds are plants that germinate in the spring and remain vegetative during the first summer. They overwinter as rosettes and flower the second summer and produce seeds. These weeds die at the end of the second growing season. Perennial grass and broadleaf weeds can live for many years. Perennials spread effectively through seed germination, root expansion and other vegetative means. Tillage practices can break up the underground root systems and promote the spread of perennial weeds. The critical stage of perennial weeds for damage is early in the growing season, as it is for annual weeds.

Pest Management

Cultural Controls: Good weed control in a pear orchard is critical during the first five to six years of growth. Controlling serious weed problems, including perennial weeds, prior to orchard establishment is important. Weeds along roadsides, ditches and fence lines can be controlled by mowing. Cleaning soil and debris from equipment when leaving each field will reduce the spread of weeds between fields. Tilling prior to planting and cultivation after planting can help reduce weeds. Monitoring for annual weeds during the first two to three weeks after weed emergence, is important if post emergence controls are to be applied. Mulches, mowing and cover crops will also help to control weeds. Many perennial weeds cannot be effectively controlled once established in a pear orchard. Refer to *Table 9* for practices used by growers in Canada for weed management.

Issues for Weeds

1. There is a need for registration of broad-spectrum contact herbicides with different modes of action in order to slow the development of glyphosate tolerance within weed populations, and to mitigate the impacts of resistant weed species including Canada fleabane and thistle.
2. There is a need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings.
3. There is a need for testing of predictive models and of non-chemical methods of weed control such as flaming, cultivation, mulches, and long-term rotations. Assessments need to include efficacy, economics and environmental impacts of these methods.
4. The development of new, selective herbicides and bio-herbicides is required.
5. There is a need to survey for new weed species and to screen herbicides for the control of these new pests.
6. There is a need to investigate the long term effects of pre-emergent herbicides that have multi-season residual weed control. There is concern among the grower community that areas treated with these long lasting pre-emergent herbicides are compromised for future plantings.

Resources

Integrated Pest Management/ Integrated Crop Management Resources for Production of Pear 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. BC Tree Fruit Production Guide: Integrated Pest Management. https://www.bctfpg.ca/ifp-organics/integrated-pest-management/

Ontario Ministry of Agriculture, Food and Rural Affairs. Publication 360D, Fruit Crop Protection Guides. 2020-2021. http://www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm

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

Perennia. Tree Fruits. https://www.perennia.ca/portfolio-items/tree-fruits/?portfolioCats=87

Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture www.gov.bc.ca/agri	Adrian Arts Adrian.Arts@gov.bc.ca	Caroline Bédard Caroline.Bedard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs. www.omafra.gov.on.ca	Amanda Green amanda.green@ontario.ca	Jim Chaput jim.chaput@ontario.ca
Quebec	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec www.mapaq.gouv.qc.ca	Pierre-Olivier Martel pierre-olivier.martel@mapaq.gouv.qc.ca	Mathieu Coté mathieu.cote@mapaq.gouv.qc.ca
Nova Scotia	Nova Scotia Department of Agriculture www.novascotia.ca/agri/ Perennia www.perennia.ca	Michelle Cortens mcortens@perennia.ca	Jason Sproule sprouljm@gov.ns.ca

National and Provincial Fruit Grower Organizations

British Columbia Fruit Growers Association: www.bcfga.com

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

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

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

Canadian Organic Growers: https://www.cog.ca/

Nova Scotia Fruit Growers' Association: www.nsfga.com

Ontario Fruit and Vegetable Growers Association: www.ofvga.org

Ontario Tender Fruit Growers: http://www.ontariotenderfruit.ca/

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, 6 and 8 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="11">Present</td><td rowspan="9">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="6">**Sporadic** - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">**Widespread -** as above</td><td>**High** - see above</td><td>Orange</td></tr>
<tr><td>**Moderate** - see above</td><td>Yellow</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="3">**Localized** - as above</td><td>**High** - see above</td><td>Yellow</td></tr>
<tr><td>**Moderate** -see above</td><td>White</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data **not** available</td><td colspan="3">**Not of concern:** The pest is present in commercial crop growing areas of the province but is causing no significant damage. Little is known about its population distribution and frequency in this province; however, it is not of concern.</td><td>White</td></tr>
<tr><td colspan="3">**Is of concern:** The pest is present in commercial crop growing areas of the province. Little is known about its population distribution and frequency of outbreaks in this province and due to its potential to cause economic damage, is of concern.</td><td>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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