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Crop Profile for Pear in Canada, 2013

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Canada

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Preface

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

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

For detailed information on growing 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.

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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Contents

List of Tables and Figures

Crop Profile for Pear in Canada

Pears (*Pyrus spp.*) are members of the Rosaceae (rose) family. Pears are native to Europe and Asia and have been cultivated for thousands of years.

The European or common pear, *Pyrus communis* subsp. *communis* is the species most commonly grown in North America. Grown in Europe throughout the 15th to 20th centuries, many cultivars have been developed. This pear was introduced into North America during the 17th century by European settlers. In Nova Scotia, French settlers planted pears following the establishment of Port Royal in 1604.

Crop Production

Industry Overview

Pears produced in Canada are mainly utilized as fresh or processed fruit products. Fruit products include juice and pickled, canned or frozen pears and baby food. Pears are a source of Vitamin A and B, phosphorus and iodine.

Table 1. General production information

Canadian Production (2013)[1]	8,672 metric tonnes
	707 hectares
Farm gate value (2013)[1]	$8.0 million
Fresh fruit available in Canada 2013[2]	2.2 kg/ person
Exports (2013)[3]	pears (fresh) N/A
	10 metric tonnes (pears canned)
Imports (2013)[3]	70,710 metric tonnes (pears fresh)
	6,530 metric tonnes (pears canned)

[1]Statistics Canada. Table 001-0009 - Area, production and farm gate value of fresh and processed fruits, by province, annual CANSIM (database). (accessed: 2015-02-10)

[2]Statistics Canada. Table 002-0011- Food available in Canada CANSIM (database) (accessed 2015-02-10)

[3]Statistics Canada. Table 002-0010 - Supply and disposition of food in Canada CANSIM (database). (accessed: 2015-02-10)

Production Regions

Commercial pear production is located in the Okanagan and Kootenay Valleys of British Columbia, the Niagara Peninsula and Norfolk County of Ontario and south western Ontario and the Annapolis Valley of Nova Scotia. Ontario grows the largest acreage (971ha or 71% of the total national acreage), followed by British Columbia (304 ha or 22% of the total national acreage), Nova Scotia (75 ha or 5% of the total national acreage) and Quebec (24 ha or 2% of the total national acreage) (Source: Statistics Canada (2015) (Table 2)).

Table 2. Distribution of pear production in Canada (2013)

Production Regions	Cultivated Area 2013 (hectares)	Percent National Production
British Columbia	211	30%
Ontario	417	59%
Quebec	35	5%
New Brunswick	a[2]	a[2]
Nova Scotia	40	6%
Prince Edward Island	a[2]	a[2]
Canada	707	100%

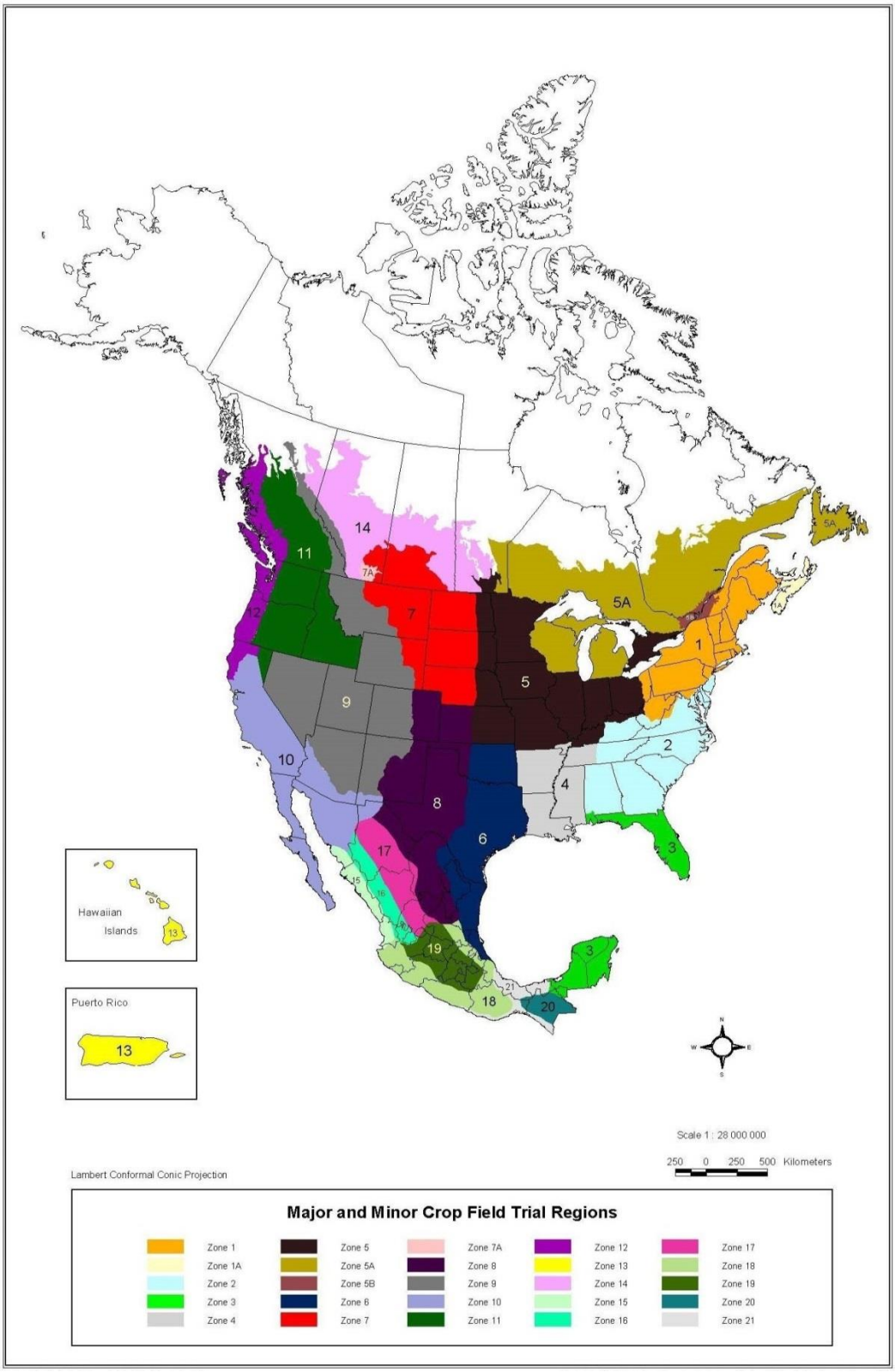
[1]Statistics Canada. Table 001-0009 - Area, production and farm gate value of fresh and processed fruits, by province, annual CANSIM (database) (accessed: 2015-02-10).

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

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

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

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



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

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 should be planted in areas with little wind, a slight grade and a soil depth of at least one meter. Pear trees grow in many types of soil however sandy loam and clay loam are preferred. Pears are sensitive to wet soil conditions, therefore 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 speaking, pears trees will not produce fruit unless they are pollinated by a complimentary pollinating variety however there are a few varieties that self-pollinate, such as the cultivar Duchess. Pear fruit is harvested by hand before ripening.

Clapp's Favorite, Bartlett, Flemish Beauty, Bosc and Anjou are the main pear cultivars grown in Canada. In Ontario, the main fresh market cultivars are Bartlett and Bosc and to a lesser extent Anjou. Bartlett is the main processing cultivar for canned fruit. Swiss Bartlett, French Bartlett, Clapp's Favourite, AC Harrow Crisp and AC Harrow Gold are also used for processing. Bosc pears are mainly grown in British Columbia.

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 (B.C.); spray if needed.
	Soil Care	Prepare sites of new plantings.
	Disease Management	Prune off shoots that have white tips (mildew) and cankers.
	Insect Management	Apply delayed dormant spray for aphids, 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; apply blossom thinning sprays; irrigate as needed; begin fertigation in established stands (B.C.); apply post-bloom chemical thinners.
	Soil Care	Fertilize new trees; apply soil nutrients as needed; apply lime if needed.
	Disease Management	Monitor for scab, fire blight and powdery mildew infections; apply controls if needed.
	Insect Management	Apply oil spray for mite eggs at 1/2 inch green to tight cluster; oil is also the number one strategy for scale insect control; set out and monitor pheromone traps for moth pests (e.g. codling moth, oriental fruit moth); begin monitoring for spring-feeding caterpillars, mullein bug, plum curculio, mites, aphids, leafhoppers and beneficial arthropods; apply controls as needed.
	Weed Management	Monitor for weeds and apply controls if needed.
Summer – fruit growth (June to August)	Plant Care	Apply supplemental nutrient sprays as needed; irrigate as needed; begin fertigation of new trees (B.C.); 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 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	Control codling moth as needed; continue monitoring for leafrollers, codling moth, apple maggot, mites, aphids, leafhoppers and beneficial organisms; begin monitoring for scales; apply controls as needed.
	Weed Management	Monitor for weeds and apply controls if needed.
	Other	Monitor for bird damage and use control measures if needed.
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, eg. any pest contributing to more than 2% of cull fruit requires a control strategy; apply rodenticides.

Pear producers in Canada make use of a number of plant growth regulators over the course of the annual crop production cycle described above. Table 4 presents a list of plant growth regulators registered in Canada and their uses.

Table 4. Plant growth regulators registered for pear production in Canada[1]

Active ingredient	Use
1-methylcyclopropene	post-harvest, delay of ripening and senescence in storage; reduction of superficial scald
1-naphtaleneacetamide	thinning
6 benziladenine	fruit thinning and sizing; enhanced return bloom
kaolin	protection against sunburn and heat stress

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of February 12, 2015. The product label is the final authority on product use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for application decisions and use.

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 market. 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 fungal and 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 packinghouse sanitation.

Diseases

Key issues

Integrated pest management (IPM)

- The potential loss of streptomycin as a control for fire blight is of concern to growers. Resistance to this bactericide has been reported in some areas.
- Studies are required to evaluate the efficacy of phosphorous acid materials in controlling fire blight.
- There is concern that blossom blast (*Pseudomonas syringae* pv. *syringae*) will become more prevalent now that fire blight resistant cultivars are in commercial use.

Emerging Issues

- Economic damage caused by trellis rust has not been reported, however the incidence of this disease is increasing in Ontario. There is a need for further investigations on the biology and potential for spread of this disease. There are currently no products registered for the control of pear trellis rust.

New disease management products and application technologies

- Alternative management products including new copper formulations that control or suppress fire blight are urgently required to help the industry remain competitive.
- There is a need to evaluate the efficacy of bactericides currently registered for fire blight against *Pseudomonas syringae* pv. *syringae*, the causal agent of blossom blast.
- There is a need to maintain registrations of materials with multi-site activity such as mancozeb and captan or register replacement materials with similar multi-site activity, for early season scab control.
- Additional products are required for the management of post-harvest diseases of pear.

Table 5. Occurrence of diseases in pear production in Canada

Disease	British Columbia	Ontario
Fire blight		
Pear blossom blast		
Pear scab		
Fabraea leaf spot		
Powdery mildew		
Trellis rust		
Phytophthora diseases		
Sooty blotch and flyspeck		
Pear stony pit		
Storage diseases		
Blue mould		
Grey mould		
Snow mould 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 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: Pear stakeholders in reporting provinces.

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

Table 6. Adoption of disease management practices in pear production in Canada

Practice / Pest		Fireblight	Pear scab	Powdery mildew	Blue mould (storage disease)
Avoidance	resistant varieties				
	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	optimizing fertilization				
	reducing mechanical damage or insect damage				
	thinning / pruning				
	use of disease-free seed, transplants				
Prevention	equipment sanitation				
	mowing / mulching / flaming				
	modification of plant density (row or plant spacing; seeding rate)				
	seeding / planting depth				
	water / irrigation management				
	end of season crop residue removal / management				
	pruning out / removal of infected material before harvest				
	tillage / cultivation				
	removal of other hosts (weeds / volunteers / wild plants)				
Monitoring	scouting / trapping				
	records to track diseases				
	soil analysis				
	weather monitoring for disease forecasting				
	use of portable electronic devices in the field to access pest identification / management information				
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	economic threshold				
	weather / weather-based forecast / predictive model				
	recommendation from crop specialist				
	first appearance of pest or pest life stage				
	observed crop damage				
	crop stage				

...continued

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

Practice / Pest		Fireblight	Pear scab	Powdery mildew	Blue mould (storage disease)
Suppression	pesticide rotation for resistance management				
	soil amendments				
	biological pesticides				
	controlled atmosphere storage				
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				
This practice is used to manage this pest by at least some growers.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					
Information regarding the practice for this pest is unknown.					

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

Table 7. Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
*Aureobasidium pullulans*DSM 14940 and DSM 14941	biological	unknown	unknown	N/A	R	fire blight
Bacillus subtilis QST 713	microbial: *Bacillus* spp. and the fungicidal lipopeptides they produce	F6: lipid and membrane synthesis	microbial disrupters of pathogen cell membranes	44	R	apple scab, pear scab, fire blight, powdery mildew
boscalid + pyraclostrobin	pyridine-carboxamide + methoxy-carbamate	C2: respiration + C3:repiration	complex II: succinate-dehydrogenase + complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	7 + 11	R + R	apple scab, pear scab, powdery mildew, flyspeck, sooty blotch, Brooks spot
captan	phthalimide	multi-site contact activity	multi-site contact activity	M4	RE	scab, sooty blotch
copper (different salts)	inorganic	multi-site contact activity	multi-site contact activity	M1	R	fire blight
cyprodinil + difenoconazole	anilino-pyrimidine + triazole	D1: amino acids and protein synthesis + G1:sterol biosynthesis in membranes	methionine biosynthesis (proposed) (cgs gene) + C14-demethylase in sterol biosynthesis (erg11/cyp51)	9 + 3	R + RES	apple scab, pear scab, Brooks fruit spot, cedar apple rust, quince rust, powdery mildew (suppression), flyspeck, sooty blotch
difenoconazole	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	RES	apple scab, pear scab, Brooks fruit spot, cedar apple rust, quince rust, powdery mildew (suppression), flyspeck, sooty blotch

...continued

Table 7. Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
dodine	guanidine	unknown mode of action	cell membrane disruption (proposed)	U12	R	apple scab, pear scab
ferbam	dithio-carbamate and relatives	multi-site contact activity	multi-site contact activity	M3	RE	pear scab, leaf blight, fruit spot, sooty blotch
fludioxonil	phenylpyrrole	E2: signal transduction	MAP/histidine-kinase in osmotic signal transduction (os-2, HOG1)	12	RE	blue mold, grey mould
fluxapyroxad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydro-genase	7	R	apple scab, pear scab, powdery mildew
garlic powder	not classified	unknown	unknown	N/A	R	pear scab (suppression)
kresoxim-methyl	oximino-acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	pear scab, powdery mildew
lime sulphur (calcium polysulphide)	inorganic	multi-site contact activity	multi-site contact activity	M2	R	pear scab, powdery mildew, general clean-up spray
methyl bromide (fumigant, pre-plant soil application)	alky halide[4]	miscellaneous non-specific (multi-site) inhibitor[4]	miscellaneous non-specific (multi-site) inhibitor[4]	8A[4]	PO	controls insects, nematodes, soilborne fungi and certain weeds
myclobutanil	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	pear scab, powdery mildew

....continued

Table 7. Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Pantoea agglomerans C9-1	biological	unknown	unknown	N/A	R	fire blight (suppression)
Pantoea agglomerans strains E325 (NRRL B-21856) and C9-1	biological	unknown	unknown	N/A	R	fire blight (suppression)
penthiopyrad	pyrazole-4-carboxamide	C2 : respiration	complex II: succinate-dehydro-genase	7	R	apple scab, pear scab, powdery mildew, cedar apple rust
phosphites (mono and dibasic sodium, potassium and ammonium)	not classified	unknown	unknown	N/A	R	fly speck, sooty blotch
Pseudomonas fluorescens strain A506	biological	unknown	unknown	N/A	R	fire blight
Pseudomonas syringae strain ESC-10 (post-harvest)	biological	unknown	unknown	N/A	R	blue mold, grey mould, mucor rot
pyrimethanil	anilino-pyrimidine	D1: amino acids and protein synthesis	methionine biosynthesis (proposed) (cgs gene)	9	R	pear scab, apple scab
pyrimethanil (post-harvest)	anilino-pyrimidine	D1: amino acids and protein synthesis	methionine biosynthesis (proposed) (cgs gene)	9	R	grey mould, blue mold (suppression)

....continued

Table 7. Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
streptomycin	glucopyranosyl antibiotic	D4: amino acids and protein synthesis	protein synthesis	25	R	fire blight
sulphur	inorganic	multi-site contact activity	multi-site contact activity	M2	R	powdery mildew, scab
thiabendazole (post-harvest)	benzimidazole	B1: mitosis and cell division	ß-tubuline assembly in mitosis	1	R	*Penicillium* spp., *Botrytis cinerea*
thiophanate-methyl (British Columbia)	thiophanate	B1: mitosis and cell division	ß-tubuline assembly in mitosis	1	RE	apple scab, powdery mildew
thiophanate-methyl + captan	thiophanate + phthalimide	B1: mitosis and cell division + multi-site activity	ß-tubuline assembly in mitosis + multi-site activity	1 + M4	RE + RE	apple scab, powdery mildew
trifloxystrobin	oximino acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	powdery mildew, cedar apple rust, sooty blotch, fly speck, scab

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of December 11, 2014. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

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

[3]PMRA re-evaluation status: R - full registration RE (yellow) - under re-evaluation , RES (yellow) - under special review as published in PMRA re-evaluation note *REV2013-06, Special Review Initiation of 23 Active Ingredients*, RES* (yellow) - under re-evaluation and special review, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA as of December 30, 2014.

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

Fire Blight *(Erwinia amylovora)*

Pest Information

Damage: Fire blight is one of the most destructive diseases of pear trees in North America. The disease can affect blossoms, shoots, limbs and fruit. Symptoms vary with the part of the tree attacked and the time of the growing season infection occurs and as a result may be difficult to diagnose. Infected blossoms and shoots become wilted, shrivelled and brown and the infected shoots may develop a characteristic shepherds 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 on infected trees. The bacterium becomes active in the spring as temperatures warm up and can be spread to healthy blossoms by rain splashing, pollinating insects and on pruning tools. Following infection, the bacterium can move into vascular tissues and other succulent tissues.

Pest Management

Cultural Controls: Cultural controls include removing infected wood (cankers) during dormancy and pruning out summer shoot infections, at least 30 to 45 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 unmanaged hosts near pear orchards, which can be reservoirs of the disease, helps to reduce infection. Ensuring that nursery stock is free from disease minimizes the potential of introducing fire blight into the orchard. Weekly monitoring will enable the early detection of the disease. Following balanced fertilizer programs that include potassium and micronutrients and avoid excessive nitrogen can make a tree less susceptible to fire blight by minimizing the growth of succulent shoots that are very susceptible to fire blight infection. Disease prediction models, (eg. CougarBlight 2010). (http://county.wsu.edu/chelan-douglas/agriculture/treefruit/Pages/Cougar_Blight_2010.aspx) and Maryblyt (http://www.caf.wvu.edu/kearneysville/Maryblyt/)) are available for improved treatment decisions.

Resistant cultivars: AC Harrow Crisp, AC Harrow Gold, Harrow Delight, Harvest Queen and Harrow Sweet, released by AAFC, Harrow, are resistant to fire blight. Varieties that are more susceptible include: Anjou, Barlett, Bosc, Cascade and Starkrimson.

Chemical Controls: Products registered for fire blight management are listed in Table 7 Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada.

Issues for Fire Blight

1. The potential loss of streptomycin is of concern to growers. Resistance to this bactericide has been reported in some areas. Alternatives to streptomycin, including new copper formulations that control or suppress fire blight are urgently required to help the industry remain competitive. Studies are required to evaluate the efficacy of phosphorous acid materials on fire blight.

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

Pest Information

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

Life Cycle: Infections caused by bacteria that exist on the surface of plant tissues, 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.

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

Chemical Controls: Chemicals registered for the management of blossom blast are listed in Table 7 Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada.

Issues for pear blossom blast

1. There is concern that incidence of pear blossom blight has been suppressed by the use of bactericides for fire blight management, and that with the use of fire bight resistant pear cultivars and resulting decrease in need for sprays, pear blossom blight incidence may rise.
2. There is a need to evaluate efficacy of bactericides against this disease, and seek registrations where appropriate.

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 then 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. Late season infections may develop into pinpoint scab in storage.

Life Cycle: Scab overwinters in fallen leaves and within corky lesions on twigs. In the spring, ascospores (sexual spores) produced within fungal fruiting bodies in infected tissues, 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 and result in secondary spread of the disease.

Pest Management

Cultural Controls: Monitoring for scab from bud break until mid to late July will help determine the necessity and timing of sprays. Disking to cover leaf litter, where feasible, may reduce infection in the spring. 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.

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

Chemical Controls: Fungicides registered for pear scab, are listed in Table 7 Fungicides, bactericides and biofungicides registered for disease management in pear production in Canada.

Issues for Pear Scab

1. Resistance to systemic materials is of concern. There is a need for the continued registration of new classes of fungicides for early season scab management, including fungicides with multi-site activity, which are valuable resistance management tools. There is a need to maintain registrations of multi-site materials for early-season scab control.

Fabraea Leaf 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 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 8 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 the examination of the lowest leaves on individual ‘sample’ trees. One to ten infections and greater than ten infections per 20 leaves, represents moderate and high risk, respectively.

Resistant cultivars: None available.

Chemical Controls: There are no fungicides registered for the control of fabraea leaf spot. Fungicides applied to control pear scab will also provide control of fabraea leaf spot.

Issues for Fabraea Leaf Spot

1. Fabraea leaf spot has limited controls. The disease can spread through the orchard very quickly if trees are not adequately protected since foliage of all ages is susceptible to infection.

Powdery Mildew *(Podosphaera leucotricha)*

Pest Information

Damage: Powdery mildew produces a white powdery growth on new shoots and developing fruit. On fruit, the powdery growth eventually sloughs-off leaving black marks and russetting on the surface.

Life Cycle: Powdery mildew spreads to pear orchards from infected, neighbouring apple blocks. The spores are dispersed by air currents and are favoured by warm temperatures. In the spring, primary infections develop on blossoms, young leaves and fruit. Infected tissues give rise to the white powdery fungal growth with spores that are dispersed to other tissues and cause secondary spread. Under suitable conditions, there can be several disease cycles a season.

Pest Management

Cultural Controls: Pruning to provide good air circulation within the orchard and avoiding areas with poor air circulation when establishing an orchard help to minimize powdery mildew development.

Resistant cultivars: None identified.

Chemical Controls: Fungicides registered for the management of powdery mildew are listed in Table 7 Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada.

Issues for Powdery Mildew

None identified.

Trellis Rust (*Gymnosporangium sabine*)

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 the 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.

Chemical Controls: None available.

Issues for trellis rust

1. Economic damage caused by trellis rust has not been reported, however the incidence of this disease seems to be increasing in Ontario. There is a need for further investigation of the biology and potential for spread of this disease.
2. There are currently no products registered for the control of trellis rust.

Phytopthora Crown and Root Rot (*Phytophthor*a 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 phytopthora crown and root rot development.

Resistant cultivars: None identified.

Chemical Controls: There are no fungicides registered for phytophthora diseases on pear.

Issues for phytophthora crown and root rot

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 is extensive secondary spread 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 to reduce disease incidence and severity. Thinning of fruit will also help reduce the development of these diseases.

Resistant cultivars: None identified.

Chemical Controls: Fungicides applied to control other diseases will provide some control of sooty blotch. Fungicides registered for the management of sooty blotch and flyspeck are listed in Table 7 Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada.

Issues for sooty blotch and flyspeck

None identified.

Stony Pit (unidentified virus)

Pest Information

Damage: The severity of symptoms varies with cultivar. On susceptible cultivars such as Bosc, pits up to 6 mm deep develop in fruit. A stone-like mass develops at the base of each pit. Growth stops in the affected tissues and the continued development of other parts of the fruit results in fruit deformities. Leaves may exhibit vein banding and mottling and scabby spots may develop on the bark of young trees.

Life Cycle: Propagation methods such as grafting, budding and cuttings are known to transmit the disease, however the causal agent and its biology have not yet been determined.

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.

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

Chemical Controls: None available.

Issues for stony pit

None identified.

Storage rots: Blue Mould *(Penicillium expansum),* Grey Mould *(Botrytis cinerea)* and Snow Mould Rot *(*Low Temperature Basidiomycete (LTB))

Pest Information

Damage: Blue mould causes a soft, watery decay of pears in storage. There is a sharp line of demarcation between rotted and healthy tissues. Grey mould decay often begins at the calyx or stem ends of the fruit. Fruit infected by snow mould rot have dark brown spots of various sizes that are slightly sunken and sometimes have white mycelium near the centre of the lesion. Fruit with physical injury or that has been stored for prolonged periods, is more prone to decay.

Life Cycle: Blue mould spores on the surface of fruit cause infection under suitable environmental conditions, especially if the surface of the fruit has been injured. Spores may also be prevalent in the packing house on decaying fruit. Botrytis grows and sporulates on dead and dying plant tissues in the orchard and may be established on the stem and calyx end of the pears at harvest. Dump water (water used to move pears during packing and grading) may become contaminated through soil 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 (botrytis and LTB) and spore production. High humidity and delays in cooling fruit after harvest increase the chance of storage problems.

Pest Management

Cultural Controls: Careful handling, rapid cooling and prompt storage at harvest will help to minimize storage rots as the possibility of 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 good sanitation in the handling and processing area.

Resistant Cultivars: All pear varieties are susceptible.

Chemical Controls: Fungicides registered for the management of storage rots are listed in Table 7 Fungicides, bactericides and biopesticides registered for disease management in pear production in Canada.

Issues for storage rots

1. Alternative products to thiabendazole are required for post-harvest disease control.

Insects and Mites

Key issues

Integrated pest management

- With the loss of the broad-spectrum, organophosphate insecticides there is concern that previously minor pests, such as some spring feeding caterpillars and the Comstock mealybug (CMB), may increase in prevalence. There are concerns that the CMB may vector viruses in tree fruits and grapes. Therefore, there is a need for continued monitoring of these pests so that controls may be implemented if necessary.
- Early detection methods are required to monitor mite activity and to accurately time miticide applications.
- Information on the toxicity of pest control products to specific predatory mites is required by growers and advisors at time of registration, to enable best management practices to conserve natural enemies.
- Further investigation is required on management approaches that conserve natural enemies of pear psylla in the orchard.
- 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.

Emerging issues

- Neonicotinoid insecticides are the only registered products that effectively control plum curculio. With concerns about resistance development and the potential loss of these materials due to concerns of toxicity to bees, there is a need to register non-neonicotinoid products effective against this insect.
- The brown marmorated stinkbug (BMSB), a new pest in Ontario with the potential to feed on many fruit crops including pear, is of great concern. Careful monitoring of established colonies and the development of effective IPM strategies is urgently required.

New insect and mite pest management products and application technologies

- There is a need for the registration of new products in new chemical families for the management of a number of pests including: pear blossom midge, pear psylla, CMB, pear leaf blister mite, pear sawfly, tarnished plant bug and two spotted spider mites.
- Registered chemical controls are required for the BMSB. These controls must be harmonized with the US and not pose maximum residue limit (MRL) issues in foreign markets. In the interim, emergency use registrations are required in the event that the BMSB does move into commercial crops.
- There is a need for domestic products to be made available for homeowners to control populations that threaten nearby commercial host crops.

Table 8. Occurrence of insect and mite pests in pear production in Canada

Insect	British Columbia	Ontario
Pear Blossom Midge		
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		
European fruit scale		
Pear sawfly		
Fruitworms		
Green fruitworm		
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 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: Pear stakeholders in reporting provinces.

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

Table 9. Adoption of insect and mite pest management practices in pear production in Canada

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

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Table 9. Adoption of insect and mite pest management practices in pear production in Canada (continued)

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

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

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

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

Information regarding the practice for this pest is unknown.

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

Table 10. Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
abamectin	avermectin, milbemycin	chloride channel activator	6	R	two-spotted spider mite, McDaniel mite, European red mite, pear rust mite, yellow mite, pear psylla
acetamiprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	R	aphids, leafhoppers, tentiform leafminer, apple maggot, European apple sawfly, plum curculio, mullein bug, green fruitworm, oriental fruit moth, pear psylla, codling moth
Bacillus thuringiensis berliner ssp. *kurstaki* Strain HD-1	*Bacillus thuringiensis* and the insecticidal proteins they produce	microbial disruptors of insect midgut membranes	11A	R	obliquebanded leafroller, threelined leafroller, fruittree leafroller, European leafroller, cherry fruitworm, cranberry fruitworm, speckled green fruitworm, corn earworm, gypsy moth, eastern tent caterpillar, eyespotted bud moth, redbanded leafroller
carbaryl	carbamate	acetylcholinesterase (AChE) inhibitor	1A	RES*	apple maggot, eastern tent caterpillar, fruittree leafroller, green fruitworm, pearleaf blister mite, pear psylla, pear slug, plum curculio, redbanded leafroller (2nd brood), rust mites, tarnished plant bug, tentiform leafminer, woolly apple aphid, apple leafhopper, apple leafroller, redbanded leafroller (1rst brood), pistol casebearer, codling moth, mealybug, eyespotted bud moth
chlorantraniliprole	diamide	ryanodine receptor modulator	28	R	dogwood borer, Japanese beetle, apple maggot, white apple leafhopper, European apple sawfly, green fruitworm, threelined leafroller, obliquebanded leafroller, western tentiform leafminer, spotted tentiform leafminer, oriental fruit moth, codling moth

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Table 10. Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
clothianidin	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	RES	brown marmorated stink bug, pear psylla, leafminers, plum curculio, aphids, leafhoppers, oriental fruit moth, codling moth, European apple sawfly
cyantraniliprole	diamide	ryanodine receptor modulator	28	R	European apple sawfly, white apple leafhopper, apple maggot, plum curculio, Japanese beetle, green peach aphid, rosy apple aphid, obliquebanded leafroller, threelined leafroller, fruittree leafroller, European leafroller, eyespotted bud moth, tufted apple bud moth, codling moth, oriental fruit moth, spotted tentiform leafminer, western tentiform leafminer
Cydia pomonella granulosis virus CMGv4	biological	unknown	N/A	R	codling moth
cypermethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	green fruitworm, plum curculio, tarnished plant bug, codling moth, pear psylla, fruittree leafroller, redbanded leafroller, obliquebanded leafroller, European leafroller, threelined leafroller
deltamethrine	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	oriental fruit moth, pear psylla
diazinon	organophosphate	acetylcholinesterase inhibitor	1B	PO (expiry date of use Dec. 31, 2016)	pear psylla, eye-spotted bud moth, tentiform leafminers, codling moth, apple maggot, aphids (rosy, apple, woolly), mites, mealybugs, scales (crowlers), stink bugs, pear leaf miner, blister mites, San Jose scale, green fruit worm, fruit tree leafroller

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Table 10. Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
dimethoate	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RE	tarnished plant bug, aphids, mites, pear psylla
flonicamid	flonicamid	modulator of chlordotonal organs	9C	R	aphids
imidacloprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	RES	mullein bug, tentiflorm leafminer, leafhopper, aphids
lambda-cyhalothrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	codling moth, pear psylla,
malathion	organophosphate	acetylcholinesterase inhibitors	1B	R	aphids, codling moth, fruittree leafroller, redbanded leafroller, mealybugs, pear psylla, (suppression), pear slugs, plum curculio, scale crawlers, spider mites, tent caterpillars, brown marmorated stink bug (suppression)
mancozeb	dithiocarbamate and relatives	multi-site contact activity	M3[4]	RE	pear psylla
methoxyfenozide	diacylhydrazine	ecdysone receptor agonists	18	R	obliquebanded leafroller, threelined leafroller
methyl bromide (fumigant, pre-plant soil application)	alky halide	miscellaneous non-specific (multi-site) inhibitor	8A	PO	controls insects, nematodes, soilborne fungi and certain weeds
mineral oil	not classified	unknown	N/A	R	San Jose scale, lecanium scale, pear psylla, European red mite, European fruit scale, oyster shell scale, pear blister mite,
permethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	pear psylla, codling moth, green fruitworm,

....continued

Table 10. Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
phosmet	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RE	obliquebanded leafroller, pear psylla, codling moth, redbanded leafroller, plum curculio, green fruitworm, rust mite, eastern tent caterpillar, elm spanworm, gypsy moth, Japanese beetle, spring cankerworm, European red mite, two spotted spider mite
spinetoram	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activator	5	R	plum curculio, apple maggot, spotted tentiform leafminer, western tentiform leafminer, obliquebanded leafroller, threelined leafroller, codling moth, oriental fruit moth, apple maggot, San Jose scale, green apple aphid, woolly apple aphid, rosy apple aphid,
spinosad	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activator	5	R	obliquebanded leafroller, threelined leafroller, fruit-tree leafroller, European leafroller, eyespotted budmoth
spirotetramat	tetronic and tetramic acid derivative	inhibitor of acetyl CoA carboxylase	23	R	mealybugs, San Jose scale, whiteflies, rosy apple aphid, apple aphid, pear psylla
sulfoxaflor	sulfoxaflor	nicotinic acetylcholine receptor (nAChR) agonist	4C	R	woolly apple aphid, rosy apple aphid, San Jose scale, green apple aphid, apple maggot, spotted tentriform leafminer, western tentiform leafminer, obliquebanded leafroller, threelined leafroller, codling moth, oriental fruit moth, plum curculio
tebufenozide	diacylhydrazine	ecdysone receptor agonists	18	R	codling moth, obliquebanded leafroller, threelined leafroller

....continued

Table 10. Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
thiacloprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	R	aphids, Japanese beetle, European apple sawfly, pear psylla, spotted tentiform leafminer, mullein bug, leafhoppers, codling moth, apple maggot, oriental fruit moth, plum curculio
thiamethoxam	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonist	4A	RES	brown marmorated stink bug, plum curculio, pear psylla

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of October 23, 2014. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

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

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

Table 11. Pheromone products registered on pear in Canada[1]

Product Name	Targeted Pests
Isomate-C Plus Codling Moth Pheromone	Codling moth
Isomate-CM/LR TT	Codling moth, obliquebanded leafroller, fruittree leafroller, threelined leafroller, European leafroller,
Isomate-CM/OFM TT	Codling moth, Oriental fruit moth, lesser apple worm
Isomate DWB	Dogwood borer
Isomate-M Rosso Oriental Fruit Moth Pheromone	Oriental fruit moth
Isomate-M100 Oriental Fruit Moth Pheromone	Oriental fruit moth
Isomate OFM-TT	Oriental fruit moth
Isomate-P Pheromone	Peach tree borer, apple clearwing moth

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all pheromone products registered as of February 12, 2015. The product label is the final authority on use and should be consulted for application information. The information in this table should not be relied upon for pheromone application decisions and use.

Pear Blossom Midge (*Contarinia pyrivora*)

Pest Information

Damage: The larvae feed on immature pear fruit causing swelling and premature dropping of fruit.

Life Cycle: The pear midge overwinters as a pupa in the soil. Adults emerge in early May and are present for a short period during which they lay eggs in flower buds. The flies disappear by the time of full bloom of Bartlett pears. After hatching, larvae feed on the developing fruit. There are usually numerous larvae in each fruit. In June and July, the full grown larvae exit from the fruit (on the tree or the ground), and burrow into the soil to pupate and overwinter. There is one generation per year.

Pest Management

Cultural Controls: The removal of infested fruitlets will help reduce populations of the midge.
Resistant cultivars: None available.
Chemical Controls: There are no registered chemical products available.

Issues for pear blossom midge

1. The occurrence of this pest is not widespread however once it becomes established at a particular location, damage appears annually. With the loss of the broad spectrum organophosphate materials, growers have no registered controls for this pest. There is a need to register effective control materials that are safe for pollinators for use immediately pre-bloom.

Green Fruitworms (Family: *Noctuidae*)

Pest Information

Damage: A number of fruitworms attack pear. Fruitworm larvae feed on flower parts and fruit. Feeding can result in large corky scars and indentations on the fruit.

Life Cycle: The various fruitworms overwinter as adults, pupae or eggs. Larvae feed in the early spring and 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.

Chemical Controls: Insecticides registered for control of green fruitworms are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for fruitworms

None identified

Plum Curculio *(Conotrachelus nenuphar)*

Pest Information

Damage: Both the adults and larvae of this weevil attack pears, damaging developing green tissues, blossoms and fruit. Plum curculio can be very destructive if no controls are implemented. This insect is a significant pest especially where plantings are adjacent to woodlots and fields.

Life Cycle: The adult insect overwinters in debris, in woodpiles and other protected sites adjacent to orchards. Adults fly into the orchards in the early spring to feed on the buds, flowers, leaves and young fruit. During this time females lay eggs in cavities in the developing fruit. Characteristic crescent-shaped cuts are made next to each cavity. After the eggs hatch, the larvae develop in the fruit for 10 to 16 days, then 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: Early season, frequent monitoring through the use of traps, checking for feeding injury visually and by shaking branches to drop adults onto cloths for counting, will reveal infestations. Populations of plum curculio can be reduced through winter mortality and predation by insects.

Resistant cultivars: None available.

Chemical Controls: Insecticides registered for control of plum curculios are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for Plum curculio

1. Neonicotinoid insecticides are the only registered products that effectively control plum curculio. With concerns about resistance development and the potential loss of these materials due to concerns of toxicity to bees, there is a need for the registration of non-neonicotinoid products that are effective against this insect.

Oriental Fruit Moth (OFM) (*Grapholita molesta*)

Pest Information

Damage: The primary hosts of the 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 per year.

Pest Management

Cultural Controls: Control strategies for OFM in nearby peach, apricot and nectarine orchards can impact late season migration of this insect to pear orchards. The use of pheromones for mating disruption will help control this insect.

Resistant cultivars: None available.

Chemical Controls: Insecticides registered for control of OFM are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

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 late stage larvae 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 itself.

Pest Management

Cultural Controls: Sanitation practices contribute greatly in managing this pest. Practices such as the removal of all unmanaged apple or pear 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 should be destroyed after harvest. The orchard and surrounding areas should be kept free of wooden structures if possible. There are

many predators and parasites that feed on codling moth but these rarely provide sufficient control to prevent significant economic loss. Mating disruption can be achieved using sex pheromones. Pheromone baited traps are also used to monitor the population and determine the necessity and timing of treatments. In British Columbia, 2 or more moths/trap/week over two consecutive weeks, during first brood flight, is the threshold.

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

Chemical Controls: Insecticides registered for the control of codling moth are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for codling moth

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

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. Psylla nymphs also excrete honeydew that supports the growth of sooty mould.

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.

Pest Management

Cultural Controls: Nitrogen applications at levels that do not promote excessive succulent growth and summer pruning to remove new growth, will remove the favoured egg laying sites of adult psylla. Monitoring for this insect 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. However, natural predators usually do not provide adequate control of pear psylla.

Resistant cultivars: None available.

Chemical Controls: Insecticides registered for the control of psylla are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for pear psylla

1. Further investigation is required on management approaches that conserve natural enemies of pear psylla in the orchard.
2. New insecticides, in classes other than the neonicotinoids are required for the management of pear psylla.

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

Pest information

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

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. The BMSB overwinters as adults. In the spring, adults mate and lay eggs on host plants. Adults are long-lived and females may lay several hundred eggs over an extended period of time. In the fall, the adults move back to protected overwintering sites. They have frequently entered structures in the fall where they are a nuisance pest.

Pest Management

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

Resistant cultivars: None available.

Chemical controls: Pesticides registered for the management of brown marmorated stink bug are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for brown marmorated stinkbug

1. The BMSB and its potential for damage are of great concern to growers. Careful monitoring of established colonies and the development of effective IPM strategies is urgently required.
2. Registered chemical controls are required for this insect. It is important that these controls be harmonized with the United States and not pose MRL issues in foreign markets. In the interim, emergency use permits are required in the event that this insect does move into commercial crops.
3. There is a need for domestic products to be made available for homeowners to control populations that threaten nearby commercial host crops.

Comstock Mealybug (CMB) (*Pseudococcus comstocki*)

Pest Information

Damage: Mealybugs feed by sucking plant sap from leaves and fruit. The insect secretes honeydew that supports the growth of unsightly sooty moulds.

Life Cycle: The mealybug overwinters as eggs that hatch in early spring. Nymphs are present until early summer at which time adult females and males emerge. After mating, eggs are laid back on the host. A second generation of adults lays overwintering eggs.

Pest Management

Cultural Controls: Mealybug populations can be monitored by visual examination of the shoots.

Resistant cultivars: None available

Chemical Controls: Insecticides registered for control of the CMB are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

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 for the control of this pest is required.
3. There are concerns that the CMB may be a vector of virus diseases in tree fruits and grapes. Careful monitoring is required so that controls may be implemented if 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 the leaves and fruit. The pearleaf blister mite causes reddish, russetted spots and fruit deformities. Spider mites cause 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. 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 and during hot weather a generation can be completed in as little two weeks.

Pest Management

Cultural Controls: The removal of trash 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 chances of spread of infestations, pears should not be planted in close proximity to 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 predatory mites can keep the mites in check.

Resistant cultivars: None identified.

Chemical Controls: Insecticides registered for control of mites are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for mites

1. Information on the toxicity of products to specific predatory mite species is required by growers and advisors, at time of registration, to enable best management decisions to conserve natural enemies.
2. Two spotted spider mites develop resistance to pesticides relatively quickly. The continued development of new active ingredients in new chemical families is required for resistance management. Additional products are required for pear leaf blister mite.
3. Early detection methods are required to monitor mite activity and to accurately time miticide application when necessary.

European Red Mite *(Panonychus ulmi)*

Pest Information

Damage: Heavy feeding by mites results in a blackening of the foliage. Size, color and fruit set may be affected if mite populations are high for a long period of time.

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 a larval stage and two nymphal stages before becoming adults. Following mating, eggs are laid on the foliage.There may be 6 to 8 overlapping generations per year, depending on temperature. Populations begin to decline in late summer when the overwintering eggs are produced.

Pest Management

Cultural Controls: Maintaining good weed control in the orchard will help to reduce mite numbers. Avoiding the planting of pears near other host trees such as cherry, apple, plum and peach will help to reduce the chances 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 species weekly can ensure that treatments are applied only when warranted. Some predatory mites can keep the mites in check.

Resistant cultivars: None available.

Chemical Controls: Insecticides registered for control of European red mite are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for European red mites

1. Information on the toxicity of products to specific predatory mite species is required by growers and advisors at time of registration, to enable best management decisions to conserve natural enemies. 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 (TPB) (*Lygus lineolaris*) and Other Plant Bugs

Pest Information

Damage: Among the several species of plant bugs that attack pears, the TPB is the most serious. TPBs feed by sucking plant sap. Feeding on fruit buds and immature fruit can result in aborted fruit buds and in "dimpling" of the fruit.

Life Cycle: TPB overwinters as an adult in weeds and under debris and in protected areas such as woodlots and fence rows. The overwintering adult becomes active very early in the spring, attacking the buds of early developing fruit. 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 the 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 TPB.

Resistant cultivars: None available.

Chemical Controls: Insecticides registered for control of TPB are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for tarnished and other plant bugs

1. There is a need for the registration of additional pesticides for the control of TPB.

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

Pest Information

Damage: Scale insects injure pears by sucking moisture from plant tissues. Heavy infestations cause a decrease in plant vigour. Heavy infestations of San Jose scale "crust over" twigs and can cause dieback. Feeding by San Jose scale also causes spotting of fruit. Feeding by the European fruit scale can cause distorted growth and a reduction in tree vigour.

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. 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. The European fruit scale has one generation per year.

Pest Management

Cultural Controls: Pruning out heavily infested branches and avoiding long pruning stubs that interfere with spray coverage will help to control scale populations.

Resistant cultivars: None identified.

Chemical Controls: Insecticides registered for control of scale insects are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

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 Others

Pest Information

Damage: Caterpillars feed on young developing leaves and bore into buds early in the spring. Larvae of some species web and roll terminal leaves, where they hide when not feeding. Leaf feeding, when severe, can reduce photosynthetic activity. Early season feeding results in large corky scars and indentations on the fruit, which often drop prematurely.

Life cycle: Spring feeding caterpillar species develop through a number of stages: egg, larva, pupa to the 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.

Resistant cultivars: None available.

Chemical controls: Insecticides registered for the control of the various caterpillar species are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues spring feeding caterpillars

1. With the loss of broad-spectrum organophosphate insecticides and reduced applications of early season insecticides, there is a concern that incidence of spring feeding caterpillars species may rise in future years. The incidence of these species should be monitored closely to determine if controls are necessary.

Eyespotted Bud Moth (*Spilonota ocellana*)

Pest Information

Damage: The eyespotted bud moth is a pest of apple, blackberry, cherry, peach, pear, quince, oak, raspberry, plum and other trees. Larvae feed on leaves and the surface of developing fruit.

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 adult moths emerge in late June and July. Following mating, the female moths lay eggs on the foliage. Larvae hatch and begin to feed. Summer feeding damage is similar to leafroller and fruitworm damage, but is not as severe.

Pest Management

Cultural Controls: Adults can be monitored with pheromone traps. Pruning to open up the canopy and allow better spray penetration will aid in control. Removal of infestations on host trees in the vicinity of the orchard will eliminate reservoirs of the pest. 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.

Chemical Controls: Insecticides registered for control of eye-spotted bud moth are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for Eyespotted Bud Moth

None identified.

Two Generation Leafrollers: Obliquebanded Leafroller (OBLR) (*Choristoneura rosaceana*) and Threelined Leafroller *(Pandemis limitata)*

Pest Information

Damage: The leafrollers feed on flowers, fruit and foliage. Early spring feeding results in small holes and corky scarring on fruit. Feeding by the second generation results in "grooved" damage on fruit and greater scarring of fruit.

Life Cycle: There are two generations per year. Adult moths lay 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, they resume feeding.

Pest Management

Cultural Controls: Pruning to open up the tree canopy and improve spray penetration is helpful in the control of leafrollers. Populations can be monitored by visual inspection of trees, the use of beating trays and with the use of pheromone traps. Control of the spring generation will minimize problems due to the second generation.

Resistant cultivars: None identified.

Chemical Controls: Insecticides registered for the control of two generation leafrollers are listed in Table 10 Insecticides and bioinsecticides registered for the management of insect and mite pests in pear production in Canada.

Issues for two generation leafrollers

None identified.

Pear Sawfly *(Hoplocampa brevis)*

Pest Information

Damage: Larvae feed in young fruitlets resulting in cavities and premature fruit drop.

Life Cycle: There is one generation per year. Eggs are laid in flower buds in the spring. After hatching, larvae feed in young fruit which drop to the orchard floor. Larvae exit the fruit and burrow into the soil. Pupation occurs in the spring.

Pest Management

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

Issues for pear sawfly

1. Pear sawfly has become a concern in select pear blocks in Ontario. Currently there are no products registered for control of this pest now that azinphos-methyl has been removed from the system. There is a need to register materials that can be used at the petal fall stage of development that are effective against pear sawfly.

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

Table 12. Occurrence of weeds in pear production in Canada

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

[1]Source: Pear stakeholders in reporting provinces.

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

Table 13. Adoption of weed management practices in pear production in Canada

Practice / Pest		Annual broadleaf weeds	Perennial broadleaf weeds	Annual grass weeds	Perennial grass weeds
Avoidance	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	optimizing fertilization				
	use of weed-free seed				
Prevention	equipment sanitation				
	mowing / mulching / flaming				
	modification of plant density (row or plant spacing; seeding)				
	seeding / planting depth				
	water / irrigation management				
	weed management in non-crop lands				
	weed management in non-crop years				
	tillage / cultivation				
Monitoring	scouting / field inspection				
	field mapping of weeds / record of resistant weeds				
	soil analysis				
	use of portable electronic devices in the field to access pest identification / management information				
	use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	economic threshold				
	weather / weather-based forecast / predictive model				
	recommendation from crop specialist				
	first appearance of weed or weed growth stage				
	observed crop damage				
	crop stage				

...continued

Table 13. Adoption of weed management practices in pear production in Canada (continued)

Practice / Pest		Annual broadleaf weeds	Perennial broadleaf weeds	Annual grass weeds	Perennial grass weeds
Suppression	pesticide rotation for resistance management				
	soil amendments				
	biological pesticides				
	arthropod biological control agents				
	habitat / environment management				
	ground cover / physical barriers				
	mechanical weed control				
	targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				
This practice is used to manage this pest by at least some growers.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					
Information regarding the practice for this pest is unknown.					

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

Table 14. Herbicides and bioherbicides registered for weed management in pear production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Fumigant, pre-plant soil application					
methyl bromide	alky halide[4]	miscellaneous non-specific (multi-site) inhibitor[4]	8A[4]	PO	insects, nematodes, soil borne fungi and certain weeds
Newly planted trees/ first year trees					
bentazon (bendioxide)	benzothiadiazinone	inhibition of photosynthesis at photosystem II	6	R	broadleaf weeds, yellow nutsedge, cleavers, stork's bill, volunteer canola
metribuzin	triazinone	inhibition of photosynthesis at photosystem II	5	R	annual grasses and broadleaf weeds
s-metolachlor and R- enantiomer	chloroacetamide	inhibition of VLCFA (inhibition of cell division)	15	R	annual grasses and broadleaf weeds
terbacil	uracil	inhibition of photosynthesis at photosystem II	5	R	annual weeds
trifluralin (before transplanting)	dinitroaniline	microtubule assembly inhibition	3	RES	most annual grasses and many broadleaved weeds

....continued

Table 14. Herbicides and bioherbicides registered for weed management in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Established/ bearing trees					
2,4-D	phenoxy-carboxylic-acid	action like indole acetic acid (synthetic auxins)	4	RES	broadleaf weeds
dichlobenil	nitrile	inhibition of cell wall (cellulose) synthesis	20	RES	many annual grasses, broadleaf weeds and certain perennial weeds
fluazifop-P-butyl	aryloxyphenoxy-propionate 'FOP'	inhibition of acetyl CoA carboxylase (ACCase)	1	RES	grass weeds
flumioxazin	N-phenylphthalimide	inhibition of protoporphyrinogen oxidase (PPO)	14	R	redroot pigweed, green pigweed, common ragweed, common lamb's quarters, green foxtail, hairy nightshade, dandelion, eastern black nightshade, kochia, Canada fleabane
glufosinate ammonium	phosphinic acid	inhibition of glutamine synthetase	10	R	common chickweed, green foxtail, lamb's-quarters, stinkweed, wild mustard, redroot pigweed, danadelion, oak-leaved goosefoot, wild buckwheat
glyphosate	glycine	inhibition of EPSP synthase	9	RE	annual and perennial weeds
indaziflam	alkylazine	cellulose biosynthsis inhibitor	29	R	annual grass and broadleaf weeds
linuron (trees established more than 10 years)	urea	inhibition of photosynthesis at photosystem II	7	RES*	most annual weeds,seedlings of dandelion, plantain and sowthistle

....continued

Table 14. Herbicides and bioherbicides registered for weed management in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Established/ bearing trees (continued)					
metribuzin	triazinone	inhibition of photosynthesis at photosystem II	5	R	annual grasses and broadleaf weeds
napropamide	acetamide	inhibition of cell division (Inhibition of	15	R	germinating anuual grass and broadleaf weeds
paraquat	bipyridylium	photosystem-I-electron diversion	22	RES	many grasses and broadleaf weeds
propyzamide (pronamide)	benzamide	microtubule assembly inhibition	3	R	quackgrass and annual grasses
sethoxydim	cyclohexanedione 'DIM'	inhibition of acetyl CoA carboxylase [ACCase]	1	R	annual grasses and quackgrass
simazine plus related active triazines	triazine	inhibition of photosynthesis at photosystem II	5	RES	certain broadleaf weeds and annual grasses
s-metolachlor and R-enantiomer	chloroacetamide	inhibition of VLCFAs [Inhibition of cell division]	15	R	annual grasses and broadleaf weeds

....continued

Table 14. Herbicides and bioherbicides registered for weed management in pear production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation status[3]	Targeted Pests[1]
Hooded sprayer applications					
carfentrazone-ethyl	triazolinone	inhibition of protoporphyrinogen oxidase	14	R	broadleaf weeds

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of January 18, 2015. The product label is the final authority on pesticide use and should be consulted for application information. Not all end use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

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

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

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

Annual, 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 vigour. 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 of 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 seeding. Perennial weeds can become very large and be 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 for 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. Annual weed seeds 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. The plants die at the end of the second growing season. Perennial grass and broadleaf weeds can live for many years. Perennials spread effectively through seed production, root expansion and other vegetative means. Tillage practices can break up the underground root systems and aid in the spread of perennial weeds. The critical stage for damage is early in the growing season, as 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 2-3 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 the pear crop.

Chemical Controls: Some pear varieties may be sensitive to certain herbicides. Herbicides registered for weed control in pear are listed in Table 14 Herbicides and bioherbicides registered for weed management in pear production in Canada.

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.
2. There is a need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings in all tree fruit commodities.
3. There is a need for testing of non-chemical methods of weed control such as flaming, cultivation and the use of mulches, long term rotations and predictive models. 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 control of these new pests.

Vertebrate Pests

Mice, Voles and Pocket Gophers

Mice and voles feed on the bark and roots of pear trees during the winter months or when food is scarce. Young pear trees may be girdled, resulting in death of the tree. Pocket gopher damage tends to be restricted to root feeding. Removing straw, weeds and sod from a 60 cm diameter area around the base of tree trunks, regularly mowing sod, removing dropped pears, applying white latex paint and thiram protectants on trunks during winter and using wire mesh around trees are all good rodent management techniques. Predators such as shrews, skunks, weasels, dogs, foxes, coyotes, owls, hawks and snakes will help keep rodents away. Rodenticides may also be used to control rodents.

Deer

Deer feed on buds, spurs, shoots and leaves of pear trees. They have also been known to break branches and remove bark by antler rubbing. The severity of damage depends on the location of the orchard and local deer populations. If trees sustain significant damage at an early age (four years and younger), they may never develop into commercially productive plants. Deer browsing can be reduced by the construction of wire or electric fences around the perimeter of the orchard or the use of chemical repellents.

Resources

IPM/ICM resources for production of Pear in Canada

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

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

British Columbia Ministry of Agriculture, Food and Fisheries. *2010 Integrated Fruit Production Guide for Commercial Tree Fruit Growers, Interior of British Columbia.* British Columbia Fruit Growers Association. www.agf.gov.bc.ca/cropprot/prodguide.htm

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

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

Ontario Ministry of Agriculture and Food. *Guide to Fruit Production*, 2014-15, 2015 Supplement. Publication 360S. January 2015. 16 pp.
www.omafra.gov.on.ca/english/crops/pub360/sup/pub360sup.pdf

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

Perennia. *Orchard Management Schedule, A guide to insect, mite and disease management in apple and pear orchards in Nova Scotia, 2013-14* Bill Craig, Ed. Kentville, Nova Scotia.
http://perennia.ca/Pest%20Management%20Guides/Fruits/2013/Orchard%20Management%20Schedule%202013-14.pdf

Perennia. *Fruit Production* (production and pest management publications)
www.perennia.ca/fruit.php

Tree Fruit Field Guide to Insect, Mite, and Disease Pests and Natural Enemies of Eastern North America, 2006. NRAES. (ISBN: 978-1-933395-02-9). 238p
www.craaq.qc.ca/Publications-du-craaq/r?q=tree%20fruit%20field%20guide

Provincial Crop Specialists and Provincial Minor Use Coordinators.

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture www.gov.bc.ca/agri	Jim Campbell, Industry Specialist - Tree Fruit and Grapes, jim.g.campbell@gov.bc.ca	Caroline Bedard caroline.bedard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture and Food www.omafra.gov.on.ca	Leslie Huffman, Apple Specialist, leslie.huffman@ontario.ca	Jim Chaput jim.chaput@ontario.ca
		Kristy Grigg-McGuffin, Pome Fruit IPM Specialist, kristy.grigg-mcguffin@ontario.ca	
Quebec	Ministére d'Agriculture, Pêcheries et Alimentation du Québec www.mapaq.gouv.qc.ca	N/A	Luc Urbain luc.urbain@mapaq.gouv.qc.ca
Nova Scotia	Nova Scotia Department of Agriculture (www.novascotia.ca/agri/)	N/A	Jason Sproule sprouljm@gov.ns.ca
	Perennia www.perennia.ca	Chris Duyvelshoff Horticulture Crops Specialist cduyvelshoff@perennia.ca	

National and Provincial Fruit Grower Organizations

British Columbia Fruit Growers Association: www.bcfga.com

Canadian Horticultural Council: www.hortcouncil.ca

Norfolk Fruit Growers Association: www.nfga.ca

Nova Scotia Fruit Growers Association: www.nsapples.com

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

Appendix 1

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

Information on the occurrence of disease, insect and mite and weed pests in each province is provided in Tables 4, 7 and 11 of the crop profile, respectively. The colour coding of the cells in these tables is based on three pieces of information, namely pest distribution, frequency and importance in each province as presented in the following chart.

<table>
<tr><th>Presence</th><th colspan="4">Occurrence information</th><th>Colour Code</th></tr>
<tr><td rowspan="12">Present</td><td rowspan="10">Data available</td><td>Frequency</td><td>Distribution</td><td>Pressure</td><td></td></tr>
<tr><td rowspan="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></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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British Columbia Ministry of Agriculture. *Tree Fruit Insect Pests and Diseases.* www.agf.gov.bc.ca/cropprot/tfipm/treefruitipm.htm

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Ontario Ministry of Agriculture and Food and Rural Affairs. 2011. *Pear Production in Ontario*. Agdex 215. October 2011. www.omafra.gov.on.ca/english/crops/facts/11-047.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Scale Insect Pests of Tree Fruit*. 1990 (reviewed December 2014). www.omafra.gov.on.ca/english/crops/facts/90-120.htm

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United States Department of Agriculture. Crop Profile for Pears in New York. 2000. Available at: http://pmep.cce.cornell.edu/fqpa/crop-profiles/pear.html

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