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Crop Profile for Highbush Blueberry in Canada, 2011

Prepared by:
Pesticide Risk Reduction Program
Pest Management Centre
Agriculture and Agri-Food Canada

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 pesticides or pest control techniques 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 highbush blueberry, 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.

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For inquiries regarding the contents of the profile, please contact:

Pesticide Risk Reduction Program
Pest Management Centre
Agriculture and Agri-Food Canada
Building 57, 960 Carling Ave
Ottawa, ON, Canada K1A 0C6
pmc.cla.info@agr.gc.ca

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General Production Information

The highbush blueberry, *Vaccinium corymbosum*, is a perennial, deciduous, woody shrub in the *Ericaceae* (heath) family. It was developed by selective breeding from the native lowbush blueberry by the USDA in the first half of the 20th century.

The health benefits of blueberries, particularly due to their high antioxidant levels, have positively influenced consumers and the market for blueberries has grown. Blueberries are good sources of Vitamins A and C. Highbush blueberries are consumed fresh or processed for whole-pack or crushed frozen product, pie filling, jam, jelly and syrup. About 50% of the highbush blueberry crop is sold for processing and 50% is sold for fresh market.

Table 1. National blueberry production statistics

Canadian production (2011)[1,2]	112,363 metric tonnes 38,413 hectares
Farm gate value (2011)[1,2]	$ 203 million
Domestic consumption (2009)[1,3]	0.78 kg/person
Highbush blueberry exports (2010)[4]	$56,279,007 (fresh)
	$58,564,795 (processed)

[1]Includes highbush and lowbush blueberries

[2]Source: Statistics Canada, *Fruit and Vegetable Production*, February 2012, Catalogue no. 22-003 X, vol. 80, no. 2

[3]Source: Agriculture and Agri-Food Canada, *A Snapshot of the Canadian Fruit Industry*, 2009. ISSN 1925-279X , AAFC No. 11390E (www.agr.gc.ca/fruit-industry)

[4]Source: Canada Brand - Canadien Blueberries (www.marquecanadabrand.agr.gc.ca/tools-utils/5318-eng.htm, accessed March 29, 2012)

Production Regions

British Columbia produces over 90% of the highbush blueberry crop in Canada. Other provinces that produce highbush blueberries include Ontario, Quebec and Nova Scotia. Over 99% of commercial blueberry production in British Columbia is located in the lower mainland region, with the remainder on Vancouver Island. In Nova Scotia, the bulk of the production is in the Annapolis Valley. There is also growing interest in production on the extensive peat bogs located in the mild, western end of the province and several test plantings have been established. In Ontario, most of the highbush blueberry production is concentrated in the south-western region of the province where mild winters provide a more ideal growing environment. Production in Quebec is located in the regions of Montérégie, Québec and Chaudière-Appalaches.

Table 2. Distribution of blueberry production in Canada, 2011[1,2]

Production regions	Cultivated area (hectares)[3]	Bearing area (hectares)	Percent national production (bearing area)
British Columbia	7,653	7,133	19%
Ontario	277	226	1%
Quebec	27,911	15,146	39%
New Brunswick	11,301	5,674	15%
Nova Scotia	17,562	7,672	20%
Prince Edward Island	4,899	2,398	6%
Newfoundland and Labrador	372	–	–
Canada	69,974	38,413	100%

[1]Source: Statistics Canada, *Fruit and Vegetable Production*, February 2012, Catalogue no. 22-003-X, vol. 80, no.2
[2]Includes highbush and lowbush blueberries
[3]Cultivated area includes bearing and non-bearing areas

The major and minor crop field trial regions were developed following extensive stakeholder consultation and have been harmonized between the Pest Management Regulatory Agency (PMRA) and the Environmental Protection Agency of the USA. The identified regions are used for experimental studies in support of residue chemistry data requirements for the registration of new pesticide uses. The regions are based on soil type and climate and 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/dir2010-01/index-eng.php).

Cultural Practices

Highbush blueberries are grown on a wide variety of soils ranging from muck (organic) to sandy loam, silt loam or clay loam. Highbush blueberries generally produce well in soils with a pH from 4.5 to 6.5. Minor iron deficiency symptoms can be observed at soil pH's greater than 6.5. Both overhead and trickle irrigation is used in blueberry production and varies with the region.

Perennial cover crops such as fescue are often established between the rows in blueberry fields. Sawdust mulches are used to aid in water conservation, maintain soil pH, increase organic matter in the soil, improve soil structure and help control annual weeds. Honeybee hives are placed in the fields while the crop is in bloom in April and May, for pollination. Blueberry varieties most commonly grown in BC are Bluecrop which matures mid-season and is suitable for both mechanical and hand harvesting, Duke which matures early and Elliott which is late maturing. In Quebec, more than 60% of the plantings are Patriot. Due to significant differences in weather where blueberries are grown in Ontario there are a large number of blueberry varieties grown. Varieties grown in Ontario include Bluecrop, Blueray, Duke, Patriot, Bluejay, Northland, Elliot, Nelson and Northblue. Bluecrop is presently planted in the greatest acreage. In Nova Scotia, all of the above varieties are planted to some extent but the major varieties in terms of acreage are Bluecrop, Jersey, Coville, Berkeley and Burlington. There is also a significant planting of the variety Brigitta.

Table 3. General highbush blueberry production schedule in Canada

Time of Year	Activity	Action
January and February: ALL PROV: Plants dormant	Plant care	BC: Pruning
		ON: Pruning perhaps in late February
		QC: No activity in the field.
	Disease management	BC: apply sprays for disease control
	Weed management	BC: weed control
March: BC: Buds start to swell; QC, ON & NS: Plants dormant	Plant care	BC: Planting
		ON & NS: Pruning
		QC: No activity.
	Disease management	BC & ON: spraying for disease control
	Weed management	BC & ON: weed control
Late March to Late April: BC: Leaf and flower bud break; QC: Slight bud break; ON & NS: Buds swell	Plant care	BC: Planting
		QC: Pruning
		ON: Pruning, planting
		NS: Pruning, spraying, weed control
	Soil care	BC: fertilizing
	Disease management	BC & ON: spraying for disease control
	Insect & mite management	BC & ON: spraying for insect control
Late April and May: BC: Blossoming; QC: bud break; ON & NS: Leaf and flower bud break; blossoming	Weed management	BC & ON: weed control
	Plant care	BC: Put out honeybees when flowering begins
		QC: Pruning.
		ON & NS: Put out honeybees when flowering begins; planting
	Soil care	QC: Begin fertilization.
		ON & NS: fertilizing
	Disease management	BC, ON & NS: spraying
	Insect & mite management	BC, ON & NS: spraying, if needed
	Weed management	BC, ON & NS: weed control
June: ALL PROV: Fruit development	Plant care	ALL: installing bird control devices
	Soil care	ALL: Fertilizing
	Disease management	ALL: spraying if needed
	Insect & mite management	ALL: spraying if needed
	Weed management	ALL: weed control

Time of Year	Activity	Action
July: ALL PROV: Fruit development and ripening	Plant care	ALL: Harvesting, irrigation if necessary, installing bird control devices
	Disease management	ALL: spraying as needed
	Insect & mite management	ALL: spraying as needed
	Weed management	ALL: spraying as needed
July to September: ALL PROV: Harvest	Plant care	ALL: Harvesting, irrigation if necessary, removing bird control devices
		QC: Foliar feeding if necessary.
	Disease management	ALL: spraying as needed
	Insect & mite management	ALL: spraying as needed
	Weed management	ALL: spraying as needed
September: ALL PROV: Post harvest growth	Plant care	ALL: Harvesting, irrigation if necessary, removing bird control devices
		QU: Fertilizing with sul-po-mag for winter hardening
	Disease management	ALL: spraying as needed
	Insect & mite management	ALL: spraying as needed
	Weed management	ALL: spraying as needed
October ALL PROV: Post harvest growth	Plant care	BC: Pruning
		QC: No pruning in October
		ON: apply sawdust mulch if needed
		NS: Harvesting, irrigation for frost protection
	Disease management	BC: spraying
	Insect & mite management	BC: spraying
	Weed management	BC & ON: weed control
November & December ALL PROV: Plants dormant	Plant care	BC: Apply sawdust mulch if needed
		ON & NS: Apply sawdust mulch if needed
	Soil care	
	Disease management	BC: spraying
	Insect & mite management	BC: spraying
	Weed management	BC: spraying

Abiotic Factors Limiting Production

Nutrients

Crops that are nitrogen deficient are reduced in size, have poor leaf colour and weak, stunted growth. Crops that have an excess of nitrogen show excessive vegetative growth, restricted flower bud formation and delayed fruit maturity. Heavy crop loads may induce temporary, nutrient deficiency levels in leaves.

Iron deficiency

Iron deficiency causes a yellowing of new leaves and often occurs when the soil pH is too high. Short term control of iron deficiencies is obtained through foliar sprays. Soil pH can be lowered with sulphur applications over several years. Most complete fertilizers available for blueberries contain enough boron, zinc, copper and other minor nutrients to prevent deficiencies.

Water

A uniform, adequate moisture supply is essential for good berry production. Under drought conditions, berry cracking can occur. The skin of the berry toughens and when water becomes available again, the berry swells rapidly, splitting the skin. Fruit may also shrivel under moisture stress. Poor drainage promotes the development of root rot in low-lying areas.

Temperature

Frost injury can be a problem. Frost injury predisposes blueberries to pseudomonas bacterial blight in the spring, and can be more severe if bacterial blight is already established.

Cold weather in the winter often causes freezing of stems not covered by snow. About one meter of snow cover is required to prevent winter injury. However, heavy snow and ice can damage branches and buds.

Diseases

Key Issues

- Effective controls to minimize the spread of blueberry scorch virus are available, but more research on disease diagnosis is needed.
- Alternative controls are required for the bacterial blight pathogen. Some strains have developed resistance to copper, the primary chemical used for control.
- Additional fungicides are required to manage resistance development in botrytis, anthracnose and phytophthora rots.
- New product registrations and reductions in pre-harvest intervals are needed for mummy berry control.
- New product registrations are needed for alternaria fruit rot control and resistance management.
- The presence of blueberry mosaic virus is increasing. The impact of this virus on plants needs to be determined.
- There are no fungicides registered for the control of godronia canker.
- New registrations are needed for resistance management in phomopsis canker, as well as more information on biology to best time pest control products.
- Root rots are difficult to diagnose and the main pathogens involved need to be determined.
- Blueberry shock ilarvirus (BlShV) is a cause for concern for blueberry growers as it is expected to spread rapidly. More research on disease diagnosis is needed.

Table 4. Occurrence of diseases in highbush blueberry production in Canada by province[1,2]

Disease	British Columbia	Ontario
Alternaria fruit rot		
Bacterial blight		
Blueberry anthracnose and ripe rot		
Blueberry mosaic virus, stunt, ringspot and shoestring viruses		
Blueberry scorch virus		
Blueberry shock ilarvirus		
Botrytis blight and fruit rot		
Botryosphaeria canker		
Godronia canker		
Phomopsis canker		
Crown gall		
Mummy berry		
Root and crown rot (oomycetes)		
Root and crown rot complex		

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: Highbush blueberry stakeholders in reporting provinces.

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

Table 5. Adoption of disease management practices for highbush blueberry in Canada[1]

Practice		Blueberry scorch	Mummy berry	Botrytis blight	Blueberry anthracnose	Bacterial blight	Godronia canker	Canker diseases[2]
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 / elimination of infected crop residues							
	tillage / cultivation							
	removal of other hosts (weeds / volunteers / wild plants)							
Monitoring	scouting - trapping							
	records to track diseases							
	soil analysis							
	weather monitoring for disease forecasting							
	grading out infected produce							
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							
	calendar spray							

Practice		Blueberry scorch	Mummy berry	Botrytis blight	Blueberry anthracnose	Bacterial blight	Godronia canker	Canker diseases[2]
Suppression	pesticide rotation for resistance management							
	soil amendments							
	biological pesticides							
	controlled atmosphere storage							
Crop specific practices	wind machines for frost protection, to reduce infection sites							

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

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

This practice is not applicable for the management of this pest

Information regarding the practice for this pest is unknown.

[1]Source: Highbush blueberry stakeholders in British Columbia.

[2]Phomopsis canker and botryosphaeria canker

Table 6. Fungicides and bactericides registered for disease management in highbush blueberry in Canada

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Target site[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
Agrobacterium radiobacter	biological	unknown	unknown	N/A	R	crown gall
Bacillus-subtilis	Bacillus subtilis and the fungicidal lipopeptides they produce	F6: lipids and membrane synthesis	microbial disrupters of pathogen cell membranes	44	R	grey mould, mummy berry, bacterial blight
boscalid	pyridine carboxamide	C2. respiration	complex II: succinate-dehydro-genase	7	R	grey mould, anthracnose (*Colletotrichum* spp.), *Phomopsis* spp.
captan	phthalimide	multi-site contact activity	multi-site contact activity	M4	R	fruit rot, mummy berry (*Monilinia vaccinii-corymbosa*)
chlorothalonil	chloronitrile (phthalonitrile)	multi-site contact activity	multi-site contact activity	M5	R	alternaria fruit rot, anthracnose fruit rot, phomopsis canker
copper (different salts)	inorganic	multi-site contact activity	multi-site contact activity	M1	R	bacterial blight
cyprodinil + fludioxonil	anilino-pyrimidine + phenylpyrrole	D1: amino acids and protein synthesis + E2: signal transduction	methionine biosynthesis (proposed) (cgs gene) + MAP/ histidine-kinase in osmotic signal transduction (os-2,HOG1)	9 + 12	R	anthracnose (*Colletotrichum acutatum*), botrytis fruit rot
fenhexamid	hydroxyanilide	G3: sterol biosynthesis in membranes	3-keto reductase, C4- demethylation (erg27)	17	R	grey mould

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Target site[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
ferbam	dithio-carbamate and relatives	multi-site contact activity	multi-site contact activity	M3	R	blossom blight, *Botrytis* spp. (general), twig blight
fluazinam	2,6-dinitroaniline	C5. respiration	uncouplers of oxidative phosphorylation	29	R	fruit anthracnose (*Colletotrichum gloeosporioides* and *C. acutatum*), phomopsis fruit rot, mummy berry (suppression)
fludioxonil + cyprodinil (see above)						
fosetyl-Al	ethyl phosphonate	unknown mode of action		33	R	phytophthora root rot (*Phytophthora cinnamomi*), anthracnose fruit rot (*Colletotrichum gloeosporiodes*), phomopsis canker (*Phomopsis vacinii*; suppression)
metalaxyl-M	acylalanine	A1: nucleic acids synthesis	RNA polymerase I	4	R	root rot (*Phytophthora cinnamoni*)
propiconazole	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	mummy berry
pyraclostrobin	methoxy-carbamate	C3. respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	anthracnose
triforine	piperazine	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	mummy berry

[1]Registrations confirmed on the PMRA Registered Products Database (www.hc-sc.gc.ca/cps-spc/pest/index-eng.php) March 13, 2012.

[2] Not all end use products containing this active ingredient may be registered for use on this crop. The information in these tables should not be relied upon for pesticide application decisions. Individual product labels must be consulted for up to date, accurate information concerning the use of these pesticides and specific registration details.

[3]Source: FRAC Code List: Fungicides sorted by mode of action (including FRAC code numbering) published by the Fungicide Resistance Action Committee (February 2011) (www.frac.info/frac/index.htm).

[4]PMRA re-evaluation status as of **March 31, 2011**: R – full registration, RE (yellow) – under re-evaluation, DI (red) – discontinued by registrant, PO (red) – being phased out as a result of re-evaluation.

[5] Please consult the pesticide label for a detailed listing of pests controlled by products containing each active ingredient. Information on registered pesticide uses is also available from the PMRA Registered Products Database (www.hc-sc.gc.ca/cps-spc/pest/index-eng.php).

Alternaria fruit rot (*Alternaria alternata* and other species)

Pest information

Damage: Fruit rot and leaf spot caused by *Alternaria* sp. is usually only a problem during cold, wet periods when fruit infections may occur. Infected fruit becomes soft with a flat, fuzzy greenish mould, containing many spores. Fruit can rot before and after harvest. Leaf spots are small (1-5mm wide) and light brown to grey with a brownish red border.

Life cycle: The fungi over-winter on the ground, on twigs and on debris. Spores produced in infected tissues in the spring, are dispersed to the fruit by wind and other means.

Pest management

Cultural controls: Cooling the fruit immediately after harvest and timely harvest to avoid over-ripening, will reduce fruit rot. The crop should be monitored for leaf infections in the spring and fruit infections at harvest, to determine the potential for fruit infections and disease the following spring.

Cultivar susceptibility: None identified.

Chemical controls: Fungicides registered for the control of alternaria fruit rot are listed in table 6. This disease may be kept in check by fungicides sprayed for botrytis.

Issues for alternaria fruit rot

1. New product registrations are needed for alternaria fruit rot control and resistance management.

Bacterial blight (*Pseudomonas syringae pv. syringa*)

Pest information

Damage: Bacterial blight can cause significant, economic damage in new plantings. Extensive lesions can result in stem girdling and death of young plants. When associated with late spring frosts, flower buds maybe killed. Symptoms first appear in late winter as water soaked lesions that range in size from several millimetres to the length of the entire branch. Only one-year old shoots are affected.

Life cycle: Pseudomonas over-winters on diseased twigs and spreads during cool, wet weather in the spring and fall. Infections occur through wounds, natural openings such as leaf scars or on frost or winter injured tissues.

Pest management

Cultural controls: Pruning diseased wood out before fall will remove a source of inoculum. Avoiding over application of nitrogen after the first of July is important to prevent overly vigorous growth which is very susceptible to fall infection. Field history, weather in the spring and the level of disease at winter pruning, can be used to forecast infection. Additional disease management practices are listed in table 5.

Cultivar susceptibility: None identified.

Chemical controls: Chemical controls available to control bacterial blight are listed in table 6.

Issues for bacterial blight

1. Some strains of the bacterium have demonstrated a degree of tolerance (resistance) to copper. Resistance management is a concern.

Blueberry anthracnose and ripe rot (*Colletotrichum gloeosporioides* and *C. acutatum*)

Pest information

Damage: Berries infected with anthracnose are unmarketable. Infected fruit develop pink mould growth.

Life cycle: The fungus over-winters in infected twigs and spent fruit trusses and in the spring produces spores that are splashed onto the developing flowers and fruit. Infected fruit develop sunken lesions that ooze bright orange spores as the disease develops. Spores are spread by berry contact at harvest or via water. Fruit rot usually develops on ripe berries after harvest. Spores can also be spread on totes, flats and harvesting machines.

Pest management

Cultural controls: Practices that encourage rapid drying of the canopy such as pruning to allow good air circulation, avoiding overhead irrigation and irrigating during the early morning, will help to reduce anthracnose. Berries should be cooled as soon as possible after harvest. The crop should be monitored during harvest for disease. The movement of totes and flats between farms and moving unwashed harvesters from infected to healthy fields should be avoided.

Cultivar susceptibility: None identified.

Chemical controls: Fungicides registered for the control of anthracnose are listed in table 6.

Issues for blueberry anthracnose and ripe rot

1. Alternative fungicides are required for anthracnose and ripe rot control. Resistance management is a concern.

Blueberry mosaic virus, stunt, ringspot and shoestring viruses

Pest information

Damage: Virus diseases cause a variety of symptoms such as chlorotic mottling, reddish ringspots and deformities on foliage. Blueberry shoestring virus causes red streaking on flowers and current year and one year old canes and causes leaves to become strap-like and curled. Blueberry mosaic virus can reduce quality and quantity and delay ripening of fruit.

Life cycle: For some viruses such as blueberry mosaic virus, the method of spread is unknown. Ringspot viruses are spread by soilborne dagger nematodes. Blueberry shoestring virus is spread by aphids.

Pest management

Cultural controls: Only virus free planting stock should be used. Infected plants should be removed. Soil from areas for new plantings should be tested for the presence of dagger nematodes.

Cultivar susceptibility: None identified.

Chemical controls: None available.

Issues for blueberry mosaic virus, stunt, ringspot and shoestring viruses

1. The presence of blueberry mosaic virus is increasing. The impact of this virus on plants needs to be determined. More research on disease diagnosis needed.

Blueberry scorch virus (BlScV)

Pest information

Damage: There are at least two strains of the blueberry scorch virus, the Northwest strain and the East Coast strain. Symptoms develop one to two years after the bush is infected. Susceptible, infected plants have severely reduced yields and are characterized by the blighting of new shoots and blossoms in the spring. In some varieties, fruit production can drop by 85% three years following infection.

Life cycle: Aphids, primarily the blueberry aphid, are the main vectors of this virus. The disease can also be spread in infected planting stock.

Pest management

Cultural controls: Infected plants should be removed and destroyed and an aphid control program implemented. This practice does not provide complete control since infected plants are symptomless the first year of infection and can be overlooked. The planting of virus free stock will prevent the introduction of the disease into the field. Additional disease management practices are listed in table 5. Lady beetles will provide limited control of aphids.

Cultivar susceptibility: The cultivars ‘Duke’ and ‘Bluecrop’ do not develop symptoms when infected with the Northwest strain. The East Coast strain causes symptoms in all varieties except “Jersey”. Additional information on variety susceptibility is available.

Chemical controls: Insecticides registered to control the aphid vector are listed in table 9.

Issues for blueberry scorch virus

1. Effective controls to minimize the spread of blueberry scorch virus are available, but more research on disease diagnosis is needed.
2. Common cultivars of highbush blueberry are susceptible to several strains of BlScV, especially to the East Coast strain of the virus, which is the predominant strain in major production areas.

Blueberry shock virus (BlShV)

Pest information

Damage: Blueberry shock virus (BlShV) causes flowers and new shoots of affected plants to blight rapidly in the spring. Blueberries infected with shock virus display dramatic symptoms for one to four years, after which they appear to recover. However, the virus is still present in the plant, and the bush continues to serve as a source of viral inoculum. Laboratory testing (ELISA) is necessary for correct diagnosis. Plants showing suspicious symptoms should be tested, especially since symptoms strongly resemble blueberry scorch virus.

Life cycle: The virus spreads rapidly via pollen exchange.

Pest management

Cultural controls: To prevent the introduction of the virus into new areas, only certified, virus-free stock should be planted. If bees are rented for pollination, it must be ensured that they have not been in a field where the virus is present. New plantings must not be established next to virus-infected fields.

Cultivar susceptibility: None identified.

Chemical controls: None available.

Issues for BlShV

1. Shock virus is a cause for concern for blueberry growers as it is expected to spread rapidly. More research on disease diagnosis is needed.
2. The effect of BlShV on yield needs to be determined.

Botrytis blight and grey mould fruit rot (*Botrytis cinerea*)

Pest information

Damage: Botrytis attacks blossoms and fruit primarily but also will cause stem blight. Infected blossoms turn brown and wilt, while infected berries shrivel and soften. Gray sporulation is often visible around the site of infection. Losses due to this major post-harvest disease can be very high in wet years.

Life cycle: Botrytis cinerea is a common fungal organism. The fungus overwinters as mycelium or sclerotia in infected plant material. In the spring, numerous spores are produced in infected tissues and are wind dispersed to blossoms where primary infections occur. Wet weather favours infections. Senescing blossoms are especially susceptible to infection. Spores are spread to ripening fruit later in the season where they cause infections. Berries with minor or undetectable infections may be harvested and contaminate healthy berries in storage.

Pest management

Cultural controls: Cultural controls involve minimizing periods of wetness by managing irrigation and increasing air circulation through pruning and plant spacing. Infected tissues should be removed by pruning. Fruit should be cooled as quickly as possible after harvest. Weather and field history are good indicators for infection and should be used in conjunction with monitoring for blossom infections. Additional disease management practices are listed in table 5.

Cultivar susceptibility: None identified.
Chemical controls: Fungicides registered for the control of botrytis blight are listed in table 6.

Issues for botrytis blight

1. There is concern about the development of resistance in botrytis to commonly used fungicides. New product registrations are required with shorter pre-harvest intervals.

Godronia canker (*Godronia cassandrae – Fusicoccum putrefaciens*)

Pest information

Damage: Godronia canker is more prevalent in older plantings. The fungus infects only new wood. Lesions expand annually and may eventually girdle stems, causing wilting and death. The leaves of girdled stems become bright red and these red "flags" are readily visible in late summer.

Life cycle: The fungus over-winters as mycelium in stems and crowns of infected plants. Pycnidia develop in the previous season's cankers and release spores in wet weather. The spores are spread by water. Most infections occur from early March to July. Infections begin at leaf scars and wounds.

Pest management

Cultural controls: Cultural controls for godronia canker include pruning-out and destroying infected branches. Pruning will also promote good air movement around plants and facilitate foliar drying. Over-head irrigation should be avoided in infected fields, or timed for early morning, so plants can dry as quickly as possible to minimize infections and disease spread. Additional disease management practices are listed in table 5.

Cultivar susceptibility: 'Jersey', 'Pemberton', 'Earliblue' and 'Bluecrop' are highly susceptible to godronia canker, while 'Rubel' and 'Rancoccas' are resistant.

Chemical controls: None available.

Issues for godronia canker

1. There are no fungicides registered for control of this disease. More research on disease diagnosis is needed.

Phomopsis canker (*Phomopsis vaccinii*) and Botryosphaeria canker (*Botryosphaeria* spp.)

Pest information

Damage: Cankers caused by phomopsis develop on stems that are one to three years old. As cankers age, they become grey and flattened and eventually girdle the stem, resulting in a reddening and wilting of the leaves.

Life cycle: The fungus overwinters in infected stems. Conidia are produced in infected tissues and are spread by rain from blossom bud swell until late August. Wounds make a plant more susceptible to infection.

Pest management

Cultural controls: Infected branches should be pruned out and destroyed. Additional disease management practices are listed in table 5.

Cultivar susceptibility: None identified.

Chemical controls: Fungicides registered for the control of phomopsis canker are listed in table 6.

Issues for phomopsis canker

1. Phomopsis canker is a widespread problem, some varieties are more tolerant. New registrations of crop protection materials are needed for resistance management and more information on biology to best time pest control products are needed.

Crown gall (*Agrobacterium tumefaciens*)

Pest information

Damage: Crown gall causes dark brown, rough galls on the roots, crown, stems and branches of blueberry plants. Stems may be girdled and leaves above the infection may turn red, symptoms similar to godronia canker "flags". The symptoms are often worse following winters where cold injury has occurred.

Life cycle: The crown gall bacterium is soil borne. It enters plants through wounds and induces gall formation. Galls become woody and slough off exterior tissues that are infested with the crown gall organism, thereby returning it to the soil. *A. tumefaciens* can be introduced to new areas on infected nursery stock. The pathogen has a very broad host range.

Pest management

Cultural controls: Planting disease-free plants is important to prevent the introduction of the disease into the field. On established bushes, infected stems should be pruned out and destroyed and pruning shears disinfected between each cut. Weevils should also be controlled, as the crown gall organism can enter the blueberry plant through weevil feeding wounds. Dygall, a formulation of the naturally-occurring bacterium *Agrobacterium radiobacter* can prevent crown gall infection if applied to cuttings or plant roots before they are planted in infested soils.

Cultivar susceptibility: None identified.

Chemical controls: None available.

Issues for crown gall

None identified.

Mummy berry (*Monilinia vacinii-corymbosi*)

Pest information

Damage: Infections of *Monilinia vacinii-corymbosi* occur on new flowers and shoots and on berries. Symptoms in the spring include drooping of developing leaves and shoots. The disease causes berries to discolour, dry out and drop before harvest.

Life cycle: M. vacinii-corymbosi overwinters in mummified fruit from the previous season called "mummy berries". Mummy berries germinate to produce apothecia at bud break in the spring. The apothecia release ascospores that infect young, vegetative and floral buds, resulting in primary infections. Infected tissues subsequently give rise to conidia which are the means of secondary spread of the disease. Conidia are spread by wind and pollinating insects to young fruit. The fruit develop into hardened masses of fungal tissues known as the mummy berries.

Pest management

Cultural controls: Cultural controls are aimed at burying or destroying the mummified fruit and apothecia. Shallow cultivation is done in the fall. In the early spring, apothecia are destroyed by raking or cultivating the soil around the base of the bushes. Rotovating or frequent harrowing after raking also destroys apothecia and helps bury mummies. Straw, wood chips and sawdust mulch is also used to bury mummies. Since disease is most severe in low-lying, moist areas or beside windbreaks where air circulation is poor, creating openings in windbreaks may reduce infections, but may result in increased winter injury. Bud development and the presence of primary infections, mummy berries and apothecia, should be monitored to predict the need and timing for sprays. Additional disease management practices are listed in table 5.

Cultivar susceptibility: 'Rancoccas', 'Weymouth', 'Earliblue' and 'Northland' are among the most susceptible varieties. There are no varieties available with adequate resistance to this disease.

Chemical controls: Fungicides registered for the control of mummy berry are listed in table 6.

Issues for mummy berry

1. New product registrations and reductions in pre-harvest intervals are needed for mummy berry control.

Phytophthora root and crown rot (*Phytophthora cinnamomi* and other species)

Pest information

Damage: Phytophthora destroys the plant roots and eventually causes crown death. In severe cases, the plant may die. Leaves of infected plants become yellow or scorched and stunted. Symptoms can resemble nutrient deficiencies, godronia canker or crown gall. This disease is often seen in patches corresponding to areas where the soil is poorly drained.

Life cycle: Phytophthora spp. are common in low-lying, poorly drained areas of blueberry fields. Moist conditions, combined with warm temperatures between 20 and 32°C, encourage the growth of this fungus. The fungus spreads by motile zoospores and attacks stressed roots.

Pest management

Cultural controls: Good drainage will prevent phytophthora root rot. In new plantings, subsurface drainage should be installed where needed and deep planting of nursery stock avoided. In established plantings, irrigation must be managed carefully to avoid excessive soil moisture and drought stress. Other stresses such as fertilizer or herbicide burn should also be avoided. Any plants with root rot should be removed from the field.

Cultivar susceptibility: None identified.

Chemical controls: Refer to table 6 for fungicides registered for the control of phytophthora root and crown rot.

Issues for Phytophthora root and crown rot

1. Alternatives to metalaxyl are required for resistance management.
2. Root rots are difficult to diagnose and the main pathogens involved need to be determined.

Insects and Mites

Key Issues

- Spotted wing drosophila can cause significant crop losses in blueberry. Effective management strategies and chemical controls, with short pre-harvest intervals, are urgently needed.
- Effective controls for aphids are needed to minimize the spread of blueberry scorch virus. Resistance management is a concern.
- New resistance management tools are needed for the blueberry maggot, white grubs, cranberry fruit worm and cherry fruit worm.
- There are no effective controls for weevils, which are an increasing problem in highbush blueberry.
- There are no products registered for the control of the blueberry gall midge or the plum curculio.
- New reduced risk products are required for loopers, blueberry leaf tier, leafrollers, western tent caterpillar, fall webworm, sawflies and scales.
- There is a need for miticides with short days to harvest intervals to be registered for control of two spotted spider mite.

Table 7. Occurrence of insect and mite pests in highbush blueberry production in Canada by province[1,2]

Insect	British Columbia	Ontario
Aphids (general)		
Blueberry aphid		
Blueberry gall midge (Cranberry tip worm)		
Blueberry maggot		
Calyx Contaminants		
Cherry fruitworm		
Cranberry fruitworm		
White grubs		
Spring feeding caterpillar complex[3]		
Summer feeding caterpillar complex[4]		
Fall webworm		
Scale insects		
Spotted wing drosophila		
Weevils		
Two spotted spider mite		

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: Highbush blueberry stakeholders in reporting provinces.

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

[3]Includes: Bruce spanworm, winter moth, obliquebanded leafroller and eye spotted bud moth.

[4]Includes: European leafroller, blueberry leaf tier and flag-leaf leafroller.

Table 8. Adoption of insect and mite pest management practices for highbush blueberry in Canada[1]

Practice		Aphids	Blueberry gall midge	Fruitworms[2]	Spring feeding caterpillars	Summer feeding caterpillars	Spotted wing drosophila	Weevils
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							
	crop residue removal / management							
	pruning out / removal of infested material							
	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							
	grading out infected produce							
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							
	calendar spray							

Practice		Aphids	Blueberry gall midge	Fruitworms[2]	Spring feeding caterpillars	Summer feeding caterpillars	Spotted wing drosophila	Weevils
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							

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

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

This practice is not applicable for the management of this pest

Information regarding the practice for this pest is unknown.

[1]Source: Highbush blueberry stakeholders in British Columbia.

[2]Cherry fruitworm and cranberry fruitworm

Table 9. Insecticides and miticides registered for pest management in highbush blueberry in Canada

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
acetamiprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonists	4A	R	blueberry maggot, blueberry spanworm (suppression only), blueberry flea beetle, cherry fruitworm, cranberry fruitworm, strawberry rootworm (adults), thrips
acetamiprid (bushberry group 13-07B)	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonists	4A	R	aphids
Bacillus thuringiensis subsp. *Kurstaki*	*Bacillus thuringiensis* or *Bacillus sphaericus* and the insecticidal proteins they produce	microbial disruptors of insect midgut membranes	11	R	cranberry fruitworm, cherry fruitworm, fruit-tree leafroller, European leafroller, obliquebanded leafroller, three-lined leafroller
carbaryl	carbamate	acetylcholinesterase inhibitors	1A	R	blueberry maggot, Bruce spanworm, cranberry fruitworm, lecanium scale, leafrollers
deltamethrin	pyrethroid, pyrethrin	sodium channel modulators	3A	R	leaf tier, Bruce spanworm
deltamethrin + imidacloprid	pyrethroid, pyrethrin + neonicotinoid	sodium channel modulators + nicotinic acetylcholine receptor (nAChR) agonists	3A + 4A	R	blueberry aphid
dimethoate	organophosphate	acetylcholinesterase inhibitors	1B	RE	blueberry maggot
imidacloprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonists	4A	R	blueberry aphid and other aphids that vector scorch (BC only), European chafer (ON & QC), Japanese beetle (ON & QC)

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
malathion	organophosphate	acetylcholinesterase inhibitors	1B	R	aphids, blueberry maggot, cherry fruitworm, cranberry fruitworm, leafhoppers, leafrollers, rose chafer, thrips, spider mites, strawberry root weevil adults (BC only)
mineral oil	inorganic insecticide	N/A	N/A	R	scale insects (such as lecanium scale) and general clean-up
mineral oil + lime sulphur	inorganic pesticide	N/A	N/A + M	R	scale insects (such as lecanium scale) and general clean-up
novaluron (crop group 13-07B bushberries)	benzoylurea	inhibitors of chitin biosynthesis, type 0	15	R	cherry fruitworm, cranberry fruitworm
phosmet	organophosphate	acetylcholinesterase inhibitors	1B	RE	blueberry maggot, blueberry spanworm
pymetrozine	pymetrozine	selective homopteran feeding blockers	9B	R	blueberry aphid and other known vectors of blueberry scorch virus
spinetoram	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activators	5	R	blueberry flea beetle, blueberry spanworm (suppression)
spinosad	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric activators	5	R	blueberry maggot, oblique banded leafroller, spanworm, winter moth
thiamethoxam	neonicotinoid	nicotinic acetylcholine receptor (nAChR) agonists	4A	R	weevils (*Otiorhyncus sulcatus*), weevils (*Sciopithes obscurus*)
trichlorfon	organophosphate	acetylcholinesterase inhibitors	1B	R	blueberry case beetle, blueberry flea beetle, blueberry sawfly, blueberry spanworm, currant spanworm, whitemarked tussock moth

[1]Registrations confirmed on the PMRA Registered Products Database (www.hc-sc.gc.ca/cps-spc/pest/index-eng.php) March 13, 2012.

[2] Not all end use products containing this active ingredient may be registered for use on this crop. The information in these tables should not be relied upon for pesticide application decisions. Individual product labels must be consulted for up to date, accurate information concerning the use of these pesticides and specific registration details.

[3]Source: IRAC MoA Classification Scheme (Volume 7.1, issued June 2011) published by the Insecticide Resistance Action Committee (IRAC) International MoA Working Group (www.irac-online.org).

[4]PMRA re-evaluation status as of **March 31, 2011**: R – full registration, RE (yellow) – under re-evaluation, DI (red) – discontinued by registrant, PO (red) – being phased out as a result of re-evaluation.

[5]Please consult the pesticide label for a detailed listing of pests controlled by products containing each active ingredient. Information on registered pesticide uses is also available from the PMRA Registered Products Database (www.hc-sc.gc.ca/cps-spc/pest/index-eng.php).

Aphids: blueberry aphids (*Ericaphis fimbriata*) and other species

Pest information

Damage: Aphids feed on new shoots by sucking plant sap. Feeding by high populations may slow plant growth or make the fruit unmarketable because of honeydew and associated sooty mould. However, the main impact of aphids is as vectors of blueberry scorch virus.

Life cycle: Aphids over-winter as eggs on the plants. The eggs hatch about May and young, wingless aphids (nymphs) begin to feed on blossoms and growing shoots. Aphids reproduce parthenogenetically.

Pest management

Cultural controls: High nitrogen applications that can stimulate excessive growth that favours the build-up of aphid populations should be avoided. In fields at low risk of viral infection, insecticides are not generally applied for aphids as natural enemies usually provide adequate control. Dormant oil reduces the number of over-wintering eggs. Additional practices for the management of aphids are listed in table 8. A number of native, beneficial insects feed on or parasitize aphids including ladybeetles (*Hippodamia convergens)*, lacewings (Neuroptera), syrphid fly larvae (*Episyrphus balteatus)* and small parasitic wasps (*Aphelinus mali)*.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides are applied in fields where scorch virus is present or in fields that have a high risk of becoming infected. Registered insecticides are listed in table 9.

Issues for blueberry aphid

1. Effective controls for aphids are needed to minimize the spread of blueberry scorch virus. Resistance management is a concern.
2. Imidacloprid has received an emergency registration for aphid control in scorch-infected fields (in BC), in the past and a full registration is needed. It has been effective; however there is a need for new materials for resistance management.

Blueberry gall midge (cranberry tip worm) (*Dasineura oxycoccana*)

Pest information

Damage: The blueberry gall midge lays its eggs on the growing tips of plants. The larvae feed on the growing tips and this may cause unwanted branching of new growth. This is particularly a problem in young plantings, as affected young plants may be slower to reach suitable height for machine harvesting.

Life cycle: There can be several generations per year. The adult is a small fly that lays its eggs on the growing tips of plants. The maggot-like larvae are orange and reach 2 mm in length.

Pest management

Cultural controls: Practices used for the management of gall midge are listed in table 8.

Cultivar susceptibility: None identified.

Chemical controls: There are no sprays registered for the control of this pest, however sprays directed towards other pests may provide some control.

Issues for blueberry gall midge

1. There are no products registered for control of the blueberry gall midge which is increasing in importance.

Blueberry maggot (blueberry fruit fly) - (*Rhagoletis mendax*)

Pest information

Damage: Blueberry maggot is one of the most serious blueberry pests. Larvae develop within the fruit making it unmarketable. If left uncontrolled, almost 100% of the fruit in a field may be infested. There is zero tolerance for blueberry maggots in most fresh markets. The movement of blueberry plants, fresh fruit and soil from areas known to be infested is prohibited under the federal Plant Protection Act. Fresh fruit from infested regions cannot be moved into BC (currently free of the pest) unless it has been fumigated with methyl bromide.

Life cycle: The adult is a medium-sized fly that inserts its eggs directly into ripening fruit. The larvae feed and develop within the fruit. Adult flight and egg-laying activities coincide with fruit development. Infested berries usually drop prematurely. Larvae exit the fruit and pupate in the soil, where they overwinter. There is one generation per year.

Pest management

Cultural controls: Cultural controls include completely harvesting the crop, eliminating all crop debris, pruning fields to eliminate oviposition sites and controlling weeds that provide shelter for adult flies. Yellow sticky boards (ammonium carbonate bait) and pheromone traps are used to monitor for the presence of blueberry maggot adults and predict the timing of sprays.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for the control of blueberry maggot are listed in table 9.

Issues for blueberry maggot

1. There is the concern that blueberry maggot will spread to production areas currently not infested, where it could have a very serious impact on the crop. There is a need for new materials for resistance management.

Calyx contaminants

Pest information

Damage: The major contaminants of blueberry calyxes are the egg sacs of spiders and pupae of lacewings and syrphid flies. Contaminants usually appear as a white, “furry” mat in the calyx end of the fruit. Spiders and lacewing and syrphid larvae, consume or parasitize other insect pests and are considered beneficial.

Pest management

Cultural controls: None identified.
Cultivar susceptibility: None identified.
Chemical controls: None available.

Issues for calyx contaminants

None identified.

Fruitworms: Cranberry fruitworm (*Acrobasis vaccinii*) and cherry fruitworm (*Grapholitha packardii*)

Pest information

Damage: Both the cranberry fruitworm and the cherry fruitworm feed on blueberry fruit. The cranberry fruitworm feeds by webbing fruit together, damaging several berries. The cherry fruitworm feeds within the fruit with one larva damaging one to two berries.

Life cycle: The cranberry fruitworm overwinters as mature larvae in a cocoon in weeds and soil debris. Mature larvae of the cherry fruitworm over winter under bark. The adults of both insects emerge in late spring following pupation and lay eggs directly on the fruit. The cherry fruitworm adult also lays its eggs on the leaves around blossom time. Once the eggs hatch, the larvae feed within the berries and are well hidden. Both species of moths have one generation per year.

Pest management

Cultural controls: Practices used to manage fruitworms are listed in table 8. *Bacillus thuringiensis* is registered for the control of fruitworms. Pheromone traps are used to monitor adult activity and time insecticide sprays. Fruit and leaves should be monitored for eggs beginning in mid-May. There are no economic thresholds available. Treatments are timed when the first larvae are found entering the fruit.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for fruitworms on highbush blueberries are listed in table 9.

Issues for cranberry fruitworm and cherry fruitworm

1. There is a need for new materials for resistance management.

Plum curculio (*Conotrachelus nenuphar*)

Pest information

Damage: Preferred hosts of the plum curculio include peaches and plums, although adults will feed and reproduce on many other fruits including cherries, blueberries and apple. Adults injure fruit through direct feeding and egg laying activities. Larvae feed within the fruit causing premature ripening and drop.

Life cycle: Adult plum curculios overwinter in leaf litter. In the spring as fruit begins to develop, adults feed and lay eggs on fruit. Larvae develop within the fruit and at maturity drop to the soil to pupate.

Pest management

Cultural controls: Management of immature stages in the soil is an important factor in reducing curculio populations. Some naturally occurring parasites will prey upon eggs and larvae, but rates of parasitism are usually low.

Cultivar susceptibility: None identified.

Chemical controls: Insecticide sprays for other pests will also provide some control.

Issues for plum curculio

1. There are no products registered for the control of plum curculio.

Spotted wing Drosophila (SWD) (*Drosophila suzukii*)

Pest information

Damage: Spotted wing drosophila was first identified in BC in 2009 and in Ontario in 2010. SWD resemble common fruit flies but males have black spots on the end of each wing. Females do not have spots, but have a serrated ovipositor that enables them to lay eggs in thick skinned fruit. SWD can attack many berries and stone fruit. Unlike other fruit flies, female SWD have the ability to lay eggs in ripening fruit that is still on the plant, rather than overripe, fallen or decaying fruit. Feeding by larvae within the fruit turns the flesh of the fruit brown and soft. Damage can provide an entry site for infection by secondary fungal and bacterial pathogens, causing further deterioration of the fruit. This injury results in unmarketable fruit and economic loss to growers.

Life cycle: SWD overwinter as adult flies. The flies become active in the spring when they mate and lay eggs in susceptible fruit. After hatching, larvae feed internally within fruit. Pupation takes place within or outside the fruit. There can be multiple, overlapping generations in a year. The insect can be dispersed by wind or moved into new areas through the movement of infested fruit.

Pest management

Cultural controls: Sanitation practices such as the removal of over-ripe and fallen fruit, the elimination of old fruit in processing areas and equipment and the removal of nearby, wild, alternate hosts, will help to reduce the SDW population. Flies should be monitored through the use of apple cider vinegar baited traps. Earlier fruiting hosts in the vicinity of the blueberry field must be monitored for signs of SWD attack. Practices used for the management of SWD are listed in table 8.

Cultivar susceptibility: None identified.

Chemical controls: When flies are present, fruit must be protected from attack from the development of first colour until harvest is complete.

Issues for spotted wing drosophila

1. Spotted wing drosophila can cause significant crop losses in blueberry. Effective management strategies and chemical controls, with short pre-harvest intervals, are urgently needed.

Loopers: Bruce spanworm (*Operophthera bruceata*) and winter moth (*O. brumata*)

Pest information

Damage: The Bruce spanworm and winter moth are present at the same time, do similar damage and are controlled by the same chemicals; however, Bruce spanworm is the species of concern (BC). These early-season caterpillars feed on developing blossoms and leaves and can cause complete defoliation and significant yield loss if infestations are severe.

Life cycle: Eggs hatch in the early spring and larvae feed from late March to early June, then drop to the soil and pupate. Moths emerge in the late fall and lay eggs, the overwintering stage, in crevices and under bark of host plants.

Pest management

Cultural controls: Management practices for these insects are listed in table 8. *Bacillus thuringiensis* var. *kurstaki* is effective as a foliar spray.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for the control of spanworm and winter moth are listed in table 9.

Issues for winter moth and spanworm

1. New reduced risk products are required.

Blueberry leaf tier (*Croesia curvalana*) and leafrollers: oblique banded leafroller (*Choristoneura rosaceana*) and flag-leaf leafroller – (*Cheimophila salicellum*)

Pest information

Other species - European leafrollers *(Archips rosanus)*, *Pandemis cerasana*, and *Badebicia urticana*) and the eye-spotted budmoth *(Spilonota ocellana)* are incidental leafroller pests that occur throughout the summer.

Damage: These insects feed on foliage, buds, flowers and berries throughout the season. Damage due to the flag-leaf leafroller is clearly visible as tents and red "flags" late in the season. Damage to the fruit itself is minimal, but leafrollers may fall into picking pails and contaminate the harvested berries. Several species of leafrollers are present in Ontario but normally blueberry is not a preferred host.

Life cycle: Obliquebanded leafroller moths lay 150 or more eggs on leaves and the resultant larvae may cause significant damage. The obliquebanded leafroller has two generations per

year, while the other species go through one to three generations. Generations overlap between these and other species, so larvae may be found continuously in the field from flowering to harvest. The blueberry leaf tier overwinters as eggs that are laid in leaf litter around the base of the plants. Newly hatched larvae burrow into developing flower buds to feed. Older larvae feed on leaves and flowers and can cause defoliation if populations are high.

Pest management

Cultural controls: Pruning and weeding plantings helps to reduce numbers by removing over-wintering sites. Additional practices for the management of these insects are listed in table 8. Natural parasites, predators and spiders usually keep leafroller populations below economic thresholds. *Bacillus thuringiensis* var. *kurstaki* is also registered**.** Adult leaf tier moths can be monitored using pheromone traps.

Cultivar susceptibility: None identified.

Chemical controls: Unless leafroller or leaftier larval numbers are very high, chemical controls are not necessary. Insecticides registered for these pests are listed in table 9.

Issues for blueberry leaf tier and leafrollers

1. New reduced risk products are required.

Western tent caterpillar (*Malacosoma* spp.) and fall webworm (*Hyphantria cunea*)

Pest information

Damage: Larvae feed in colonies on the foliage. The larvae live in a messy web shelter built around a portion of the bush and can interfere with picking. Western tent caterpillars make tents from May to June, whereas the fall webworm has tents from mid-July to mid-September.

Life cycle: Western tent caterpillars over-winter as egg masses on one-year-old wood. Upon hatching, larvae feed on foliage. At maturity, larvae spin silken cocoons, in which they pupate. Adult moths emerge 7 -10 days later and after mating, lay overwintering eggs. The fall webworm over-winters as pupae in debris on the ground or in the soil. Adult moths emerge in the spring and lay eggs on the underside of foliage. Larvae feed within silken tents at the ends of branches and at maturity, drop to the soil to pupate.

Pest management

Cultural controls: Twigs with tent caterpillar egg masses should be pruned out during the dormant season. Tents containing the caterpillars should be pruned out and destroyed while tents are small. *Bacillus thuringiensis* var. *kurstaki* applied during the growing season to control leafrollers will also control young tent caterpillars.

Cultivar susceptibility: None identified.

Chemical controls: There are no insecticides registered. Insecticides applied to kill other insects will also control young tent caterpillars.

Issues for western tent caterpillars and fall webworm

1. New reduced risk products are required.

Blueberry sawfly (*Neopareophora* sp.) and other sawflies (*Pristophora* sp.)

Pest information

Damage: Sawfly larvae, which are gregarious feeders, chew the buds and flowers and feed on the underside of older leaves, often leaving the upper layer and veins intact. Sawfly damage appears as brown patches on leaves.

Life cycle: Sawfly larvae usually appear early in the season and mature and disappear by mid-bloom. A second generation appears in late summer. The blueberry sawfly adult lays its eggs in the young whorls of foliage in the spring. After hatching, larvae feed within the leaf whorls, killing new leaves. At maturity, the larvae spin cocoons in the leaf litter under the blueberry shrubs, where they spend the winter.

Pest management

Cultural controls: Clean cultivation reduces numbers of sawflies. If damage is noticed close to the end of harvest or after harvest, no control is necessary.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides applied for caterpillar and aphid control help to keep sawflies in check.

Issues for sawflies

1. The registration of reduced risk pesticides is required for sawfly control.

Scales: *Quadraspidiotus* spp., *Lecanium* spp. and others

Pest information

Damage: Scales suck plant sap and reduce plant vigour and terminal growth. Scales also secrete honeydew, which promotes the growth of sooty moulds that can make fruit unsuitable for the fresh market.

Life cycle: Overwintering scales complete their development by late spring or early summer. After mating, eggs are laid under the female scales in May or June. The eggs hatch in late June to early July and the young crawlers move to the underside of leaves. After feeding for 4 – 6 weeks, they return to the stems and twigs to over-winter. The scales continue to feed until early fall.

Pest management

Cultural controls: Heavily infested branches should be pruned out and destroyed.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for the control of scale insects are listed in table 9.

Issues for scales

1. The registration of reduced risk pesticides is required for scales.

Two-spotted spider mite (*Tetranychus urticae*)

Pest information

Damage: Lightly infested leaves become speckled; heavily infested leaves become bronzed and covered with webbing. Injured leaves may fall. Healthy, well-maintained shrubs will tolerate higher mite populations than those that are weak or are under stress.

Pest management

Cultural controls: Predator mites such as *Amblyseius fallacis,* are very effective at controlling pest mite populations. Chemicals applied for controlling other pests and diseases may upset the ratio of plant-feeding to predatory mites, reducing the effect of biological control.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for the control of mites are listed in table 9.

Issues for two-spotted spider mite

1. There is a need for miticides with short days to harvest intervals to be registered for control of two spotted spider mite.

Blueberry thrips (*Frankliniella vaccini* and *Catinathrips kainos*)

Pest information

Damage: Thrips feed on leaves and are found between curled leaves. Damaged leaves do not unfold properly, become tightly curled and develop a reddish colour. Infestations occur in localized areas.

Life cycle: Adult female thrips emerge from their overwintering sites in the soil and lay eggs on developing foliage. Eggs hatch and the larvae feed on the foliage until midsummer when they drop to the soil to pupate. Adults of the second generation emerge in late summer and eventually return to the soil to overwinter.

Pest management

Cultural controls: None identified.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for the control of thrips are listed in table 9.

Issues for blueberry thrips

None identified.

Weevils: black vine weevil *(Otiorynchus sulcatus),* obscure weevil *(Sciopithes obscurus),* strawberry root weevil *(O. ovatus)* and other species

Pest information

Damage: Weevil larvae feed on roots, rootlets and the basal crown area and are harmful to young plants. Adults feed at night on the leaves and cause notching on the leaf edges. Affected bushes may become stunted, yield poorly and may die. Black vine weevils are the most common weevil in blueberries.

Life cycle: The weevils do not fly, but are strong walkers and invade new plantings in July and August. Larvae and adults over-winter in soil and emerge in large numbers in late June. Adult beetles begin to lay their eggs in or on the soil in June and continue until mid-September. Immediately following hatch, the larvae work through the soil and begin feeding on roots.

Pest management

Cultural controls: To prevent the introduction of weevils to a field, only stock that is free of weevils should be planted. In infested fields, a non-host crop such as a cereal cover crop should be grown for 12-16 months before planting blueberries. Weevils should be controlled in vegetation and ornamentals adjacent to the blueberry field. Additional practices used in the management of weevils are listed in table 8. Blueberries should be monitored for weevils in early May and early July especially if bushes are close to older plantings or weedy headlands.

Cultivar susceptibility: None identified.

Chemical controls: Insecticides registered for the control of weevils are listed in table 9.

Issues for weevils

1. The presence of weevils is increasing in highbush blueberry and there are no effective controls.
2. Alternative weevil products are necessary. There are no products available to control the larval stage.

White grubs: European chafer (*Rhizotrogus majalis*), Japanese beetle (*Popillia japonica*) and June beetle (*Phyllophaga* sp.)

Pest information

Damage: The larval stage of European chafers, Japanese beetles and June beetles, commonly called white grubs, feed on the roots of blueberry. Although losses in productivity due to white grub feeding are hard to measure, they can ultimately affect the planting for many years. Damage in the early years of the planting can be particularly devastating. Chronic, sub-lethal levels of white grub feeding injury can result in an annual 50-80% crop loss on affected bushes. It is assumed that plants damaged by white grubs will eventually recover although this may take a number of years. Adult Japanese beetles feed on foliage and fruit beginning prior to harvest and can be a fruit contaminant.

Life cycle: Adult beetles lay their eggs in soil in close proximity to host plants. After hatching, larvae begin feeding on roots. The insects overwinter as larvae in the soil. Adult beetles

emerge in the spring and summer and following mating, lay their eggs back in the soil. There is one generation per year of European chafer and Japanese beetles, although it takes three years for June beetles to complete their life cycle.

Pest management

Cultural controls: Sites should be checked for the presence of white grubs prior to planting.
Cultivar susceptibility: None identified.
Chemical controls: Insecticides registered for the control of white grubs are listed in table 9.

Issues for white grubs

1. An effective control for white grubs is required. Additional tools for resistance management are needed.

Weeds

Key Issue

- The registration of additional herbicides is required for the control of many annual and perennial weeds.

Table 10. Occurrence of weeds in highbush blueberry production in Canada by province[1,2]

Pest	British Columbia	Ontario
Annual broadleaf weeds		
Annual grass weeds		
Perennial broadleaf weeds		
Perennial grass weeds		
Widespread yearly occurrence with high pest pressure.		
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.		
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high 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: Highbush blueberry stakeholders in reporting provinces.

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

Table 11. Adoption of weed management practices for highbush blueberry in Canada[1]

Practice		Annual grass weeds	Annual broadleaf weeds	Perennial grass weeds	Perennial broadleaf weeds
Avoidance	use of weed-free seed				
	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	optimizing fertilization				
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				
	grading of grain / produce for weed contamination				
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				
	calendar spray				
Suppression	pesticide rotation for resistance management				
	soil amendments				
	biological pesticides				
	arthropod biological control agents				
	habitat / environment management				
	ground cover / physical barriers				
	mechanical weed control				

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

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

This practice is not applicable for the management of this pest

Information regarding the practice for this pest is unknown.

[1]Source: Highbush blueberry stakeholders in British Columbia.

Table 12. Herbicides registered for weed management in highbush blueberry in Canada

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
bentazon (bendioxide)	benzothiadiazinone	Inhibition of photosynthesis at photosystem II	6	R	yellow nutsedge (directed spray only)
carfentrazone-ethyl	triazolinone	Inhibition of protoporphyrinogen oxidase (PPO)	14	R	lamb's-quarters, morning glory, eastern black nightshade, redroot pigweed, velvetleaf, tall waterhemp, round-leaved mallow, hairy nightshade, field pennycress, prostrate pigweed, smooth pigweed, tumble pigweed, common purslane, Pennsylvania smartweed (seedling), tansy mustard, carpetweed, cocklebur, jimsonweed, kochia, volunteer canola, glyphosate-tolerant volunteer canola, burclover, prickly lettuce, Venice mallow, corn spurry
clethodim	cyclohexanedione 'DIM'	Inhibition of acetyl CoA carboxylase (ACCase)	1	RE	wild oats, volunteer cereals (wheat, barley, oats), foxtail (green, yellow), Persian darnel, crabgrass (smooth and large), proso millet, witchgrass, fall panicum, barnyard grass, volunteer corn, volunteer canary grass, quackgrass (suppression)
clopyralid	pyridine carboxylic acid	Action like indole acetic acid (synthetic auxins)	4	RE	vetch, red clover, white clover
dichlobenil	nitrile	inhibition of cell wall (cellulose) synthesis	20	R	blue aster, loosestrife, horsetail, knotweed, plantain, smartweed, grasses, certain sedges and juncus species, bracken fern
fluazifop-P-butyl	aryloxyphenoxy-propionate 'FOP'	Inhibition of acetyl CoA carboxylase (ACCase)	1	RE	grasses, volunteer corn, Johnson grass, Persian darnel, barnyard grass, volunteer spring wheat and spring barley, wild oats, wild proso millet, crabgrass, fall panicum, old witchgrass, foxtail (green, yellow and giant), quackgrass (suppression), wirestem muhly

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
glufosinate ammonium	phosphinic acid	Inhibition of glutamine synthetase	10	R	common chickweed, green foxtail, lamb's-quarters, stinkweed, wild mustard, redroot pigweed, dandelion, oak-leaved goosefoot, wild buckwheat
glyphosate	glycine herbicide	Inhibition of EPSP synthase	9	R	annual and perennial weeds; quackgrass
flumioxazin	N-phenylphthalimide	Inhibition of protoporphyrinogen oxidase (PPO)	14	R	redroot pigweed, green pigweed, common ragweed, lamb's-quarters, green foxtail, hairy nightshade, dandelion, eastern black nightshade
mesotrione	triketone	Bleaching:Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	27	R	annual weeds, lamb's-quarters, redroot pigweed, velvetleaf, wild mustard, common ragweed (suppression), eastern black nightshade
metribuzin	triazinone	Inhibition of photosynthesis at photosystem II	5	R	annual broadleaf weeds
napropamide	acetamide	Inhibition of cell division (inhibition of very long chain fatty acids)	15	R	annual grasses: annual bluegrass, barnyard grass, foxtail, large crabgrass, sandbur, wild oats annual broadleaf weeds: chickweed, prostrate knotweed, small-flowered mallow (from seed), purslane, annual sow-thistle, stork's-bill, groundsel, lamb's-quarters, pineapple weed, prickly lettuce, redroot pigweed
s-metolachlor	chloroacetamide	Inhibition of cell division (inhibition of very long chain fatty acids)	15	R	American nightshade, fall panicum, eastern black nightshade, foxtail (green, yellow, giant), crabgrass (smooth, hairy), old witchgrass, barnyard grass, redroot pigweed (suppression only)

Active ingredient[1,2]	Classification[3]	Mode of action[3]	Resistance group[3]	Re-evaluation status[4]	Targeted pests[5]
sethoxydim	cyclohexanedione 'DIM'	Inhibition of acetyl CoA carboxylase (ACCase)	1	R	barnyard grass, large crabgrass, fall panicum, foxtail (green/yellow; wild millet), proso millet, volunteer corn, witchgrass, quackgrass, foxtail barley (suppression), Persian darnel
simazine	triazine	Inhibition of photosynthesis at photosystem II	5	R	lady's-thumb, volunteer clovers, lamb's-quarters (susceptible biotypes), barnyard grass, purslane, crabgrass, ragweed (susceptible biotypes), wild oats, wild buckwheat, yellow foxtail, smartweed, perennial species starting from seed
terbacil	uracil	Inhibition of photosynthesis at photosystem II	5	R	grasses and certain weeds including sheep sorrel, buttercup, sedges, plantain, lady's-thumb, fireweed, ragweed, wild radish, fall dandelion

[1]Registrations confirmed on the PMRA Registered Products Database (www.hc-sc.gc.ca/cps-spc/pest/index-eng.php) March 14, 2012.

[2] Not all end use products containing this active ingredient may be registered for use on this crop. The information in these tables should not be relied upon for pesticide application decisions. Individual product labels must be consulted for up to date, accurate information concerning the use of these pesticides and specific registration details.

[3]Source: Herbicide Resistance Action Committee, Classification of Herbicides According to Site of Action (January 2005) at: www.hracglobal.com/

[4]PMRA re-evaluation status as of **March 31, 2011**: R – full registration, RE (yellow) – under re-evaluation, DI (red) – discontinued by registrant, PO (red) – being phased out as a result of re-evaluation.

[5]Please consult the pesticide label for a detailed listing of pests controlled by products containing each active ingredient. Information on registered pesticide uses is also available from the PMRA Registered Products Database (www.hc-sc.gc.ca/cps-spc/pest/index-eng.php).

Annual grass and broadleaf weeds

Annual grass weeds: annual bluegrass (*Poa annua*), wild oats (*Avena fatua*) and barnyard grass (Echinocloa *crusgalli*).
Annual broadleaf weeds: sow thistle (*Sonchus oleraceus*), groundsel (*Senecio vulgaris*), purslane (*Portulaca oleracea*), chickweed and triazine resistant weeds.

Pest information

Damage: Weeds compete with blueberries for nutrients, water and light and serve as alternate hosts for insects and diseases. They also interfere with irrigation and harvest operations and flowering weeds compete with the crop for bee visitations.

Life cycle: **Summer annual** weeds germinate in the spring, flower and fruit in the summer or fall and die before the onset of winter. **Winter annuals** are weeds that germinate in the fall, over winter in a vegetative state and flower in the spring, form seeds and then die.

Pest management

Cultural controls: By managing weeds in headlands and other non-productive areas and by preventing them from setting seed on crop land, growers can gradually decrease the reservoir of weed seeds in their fields. A weed-free strip about one metre wide should be maintained within the rows in established fields. Other cultural controls include mechanical weeding, hand weeding, cover cropping and mulching. Tillage must be shallow to avoid pruning the blueberry roots. Mulches include sawdust, wood shavings, grass clippings, weed-free hay, clean straw and chicken manure. Sawdust mulch helps to suppress annual weeds. Cover crops are grown between rows to reduce weed competition, as well as to protect from leaching and erosion. Common cover crops including "companion grass" (a blend of perennial dwarf ryegrass and fescue), buckwheat, pearl millet or Sudan grass are seeded the year before blueberry planting. Practices used in the management of annual weeds are listed in table 11.

Cultivar susceptibility: None identified.

Chemical controls: Herbicides registered for the control of annual weeds are listed in table 12. Herbicides are not used in new plantings until the plants have been established in the field for six months to one year. Pre-plant soil fumigants for nematodes also help to suppress annual weeds. Blueberries have shallow roots and may be damaged by excessive herbicide applications.

Issues for annual weeds

1. The registration of additional herbicides is required for the control of many annual weeds.

Perennial broadleaf and grass weeds

Perennial grass weeds: Quackgrass (*Eltrigia repens*).
Perennial broadleaf weeds: Canada thistle (*Cirsium arvense*), buttercup (*Ranunculus* sp.), dandelion (*Taraxacum officinale*), common sheep sorrel (*Rumex acetosella*), golden rod (*Solidago. canadensis*), Canada fleabane (*Erigeron canadensis*) and vetch (*Vicia cracca*).
Other perennial weeds: horsetail (*Equisetum* sp.).

Pest information

Damage: Weeds compete with blueberries for nutrients, water and light and serve as alternate hosts for insects and diseases. They also interfere with irrigation and harvest operations and flowering weeds compete with the crop for bee visitations.

Life cycle: Perennial weeds live for many years and re-grow each spring from rhizomes, rootstocks or tubers. They also flower and produce seed. Simple perennials regenerate each year from roots or crowns and reproduce by flowering and seed production only. Creeping perennials regenerate from roots, shoots and other structures and can reproduce both vegetatively and through flowering.

Pest management

Cultural controls: Perennial weeds must be controlled before planting and fields infested with perennial weeds must be avoided. Herbicides and cultural practices used in rotational crops will also help to manage perennial weeds in blueberries. Serious perennial infestations require persistent control for many years. By managing weeds in headlands and other non-productive areas and by preventing them from setting seed on crop land, growers can gradually decrease the reservoir of weed seeds in their fields. Strict sanitation procedures must be followed to avoid spreading perennial roots, tubers or rhizomes, in soil and water and on field equipment. Practices used in the management of perennial weeds are listed in table 11.

Cultivar susceptibility: None identified.

Chemical controls: Herbicides registered for the control of perennial weeds are listed in table 12. Herbicides are not used in new plantings until the plants have been established in the field for six months to one year.

Issues for perennial broadleaf and grass weeds

1. The registration of new herbicides is required for the control of perennial weeds.

Vertebrate Pests

Birds (starlings, crows, robins, songbirds and blackbirds)

Pest information

Damage: Birds have become a significant concern to the industry, not only because they eat approximately 5% of the annual crop, but also because the use of noise-making devices, the primary control for birds, has created an urban-rural conflict. In Quebec, birds are a major concern for producers, with losses reaching 25 – 40%. The amount of bird damage is variable and unpredictable. Starlings are the most common bird pests of BC blueberry fields and crows are also a major concern in some areas. Blackbirds are the major avian pest in Ontario. As the berries ripen, incoming flocks of starlings eat the fruit before it is harvested. Starlings will learn the locations of good feeding sites and return repeatedly to the same field. Loss due to robins and songbirds is generally less because they do not flock in large groups and they tend to eat berries that have already fallen to the ground, although crop losses can still be significant in some fields.

Cultural controls: In most blueberry fields, a variety of physical control methods are used to deter birds including netting over the bushes, visual scare devices (scarecrows, balloons, streamers, flash tape, model predators) and noisemakers (propane cannons, distress calls and predator calls). Netting is the most effective way to keep birds out of the field however it is not always cost-effective. Visual scaring devices are only effective when used with noise scaring devices. Eliminating bird populations from the field must obviously be a last resort. Large, baited traps can be used to capture starlings although it is questionable whether this is effective. The use of predatory birds such as falcons has been successful on a small number of farms in Ontario to minimize bird nesting and feeding on blueberries.

Beavers

Beavers occasionally cause serious feeding damage to blueberry bushes and their dams can result in flooding of berry fields. Removal or partial removal of beaver dams may be an effective, temporary solution to lower the water levels of fields. However for permanent protection, the beavers must be trapped and removed from the area.

Field mice

Field mouse numbers can fluctuate widely, but when numerous, they can cause severe damage. Mouse injury is often associated with high grass and weed growth beside or within blueberry plantings. Field mice cause damage by gnawing the stems and roots. Below ground injury is not noticeable until the plants fall over or fail to leaf-out normally.

Poison baits containing chlorophacinone or zinc phosphide may be used if preventative control measures are ineffective. Covered bait stations are used to protect bait from weather and prevent accidental poisoning of other animals.

Slugs and snails

Snails and slugs cause problems when they are present on bushes, as they can contaminate harvested fruit. Berries harbouring contaminants can be downgraded or rejected by buyers. Snails climb into the blueberry bushes and eat moss and lichens on their branches. Occasionally they eat the leaves and berries. Their protective shells allow them to stay in the bushes during the day. Snails can end up in the fruit, particularly with mechanical harvesting. Snails that are the same size as blueberries cannot be removed mechanically.

Weed control is important, and if slug and snail populations are high, they should be controlled before they climb into the plants. Baits may be used to eliminate slugs and snails.

Deer

Deer populations in Ontario have been increasing steadily and damage from winter and spring grazing has become a concern. Deer are a pest in areas outside the Annapolis Valley, the main growing area in Nova Scotia.

Resources

IPM / ICM resources for production of highbush blueberry in Canada

Agri-Réseau, Quebec (www.agrireseau.qc.ca)

British Columbia Ministry of Agriculture and Lands, berry information (www.agf.gov.bc.ca/berries)

2012-2013 Berry Production Guide, Beneficial management Practices for BC Berry Growers British Columbia Ministry of Agriculture and Lands (www.smartfarmbc.ca)

Centre de Référence en Agriculture et Agroalimentaire du Québec (CRAAQ) (www.craaq.qc.ca)

Guide to Fruit Production, 2012-13, Publication 360. Ontario Ministry of Agriculture, Food and rural Affairs (www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm)

Ontario Ministry of Agriculture, Food and Rural Affairs, berry information (http://www.omafra.gov.on.ca/english/crops/hort/berry.html)

Provincial Small Fruit Crop Specialists and Provincial Minor Use Coordinators

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture and Lands www.gov.bc.ca/agri/	Mark Sweeney mark.sweeney@gov.bc.ca	Caroline Bédard caroline.bédard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca/	Pam Fisher pam.fisher@ontario.ca	Jim Chaput jim.chaput@ontario.ca

National and Provincial Fruit Grower Organizations

BC Blueberry Council (www.bcblueberry.com)

North American Blueberry Council (www.nabcblues.org)

Ontario Highbush Blueberry Association. Tel: (519) 738-6086

Ontario Berry Growers Association (http://ontarioberries.com/)

Appendix 1

Definition of terms and colour coding for pest occurrence tables 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 10 of the crop profile, respectively. The colour coding of the cells in these tables is based on three pieces of information, namely pest distribution, frequency and 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="9">Data available</td><td>Frequency</td><td>Distribution</td><td>Importance</td><td></td></tr>
<tr><td rowspan="5">**Yearly** - Pest is present 2 or more years out of 3 in a given region of the province.</td><td rowspan="3">**widespread** - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.</td><td>**High** - If present, potential for spread and crop loss is high and controls must be implemented even for small populations</td><td>Red</td></tr>
<tr><td>**Moderate** - If present, potential for spread and crop loss is moderate: pest situation must be monitored and controls may be implemented.</td><td>Orange</td></tr>
<tr><td>**Low** - If present, the pest causes low or negligible crop damage and controls need not be implemented</td><td>Yellow</td></tr>
<tr><td rowspan="3">**localized** - The pest is established as localized populations and is found only in scattered or limited areas of the province.</td><td>**High** - see above</td><td>Orange</td></tr>
<tr><td>**Moderate** - see above</td><td>White</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="6">**Sporadic** - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">**widespread** - as above</td><td>**High** - see above</td><td>Orange</td></tr>
<tr><td>**Moderate** - see above</td><td>Yellow</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="3">**localized** - as above</td><td>**High** - see above</td><td>Yellow</td></tr>
<tr><td>**Moderate** -see above</td><td>White</td></tr>
<tr><td>**Low** - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data **not** available</td><td colspan="4">**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="4">**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>

References

A Snapshot of the Canadian Fruit Industry 2009. Agriculture and Agri-food Canada, December 2010, revised June 2011. ISSN 1925-279X AAFC No. 11390. Electronic version available at www.agr.gc.ca/fruit-industry

Bristow, P.R., R.R. Martin, and G.E. Windom. 2000. *Transmission, Field Spread, Cultivar Response and Impact on Yield in Highbush Blueberry Infected with Blueberry Scorch Virus.* Phytopathology. 90: 474-479.

British Columbia Ministry of Agriculture, Food and Fisheries. 2003. *Crop Profile for Highbush Blueberries in British Columbia*. BC Ministry of Agriculture, Food and Fisheries.

BC Lower Mainland Horticultural Improvement Association. 2001, 2002, 2003. *LMHIA Short Course Proceedings*. BC Lower Mainland Horticultural Improvement Association.

British Columbia Ministry of Agriculture, Food and Fisheries. *BC Farm Products A-Z: blueberries*. British Columbia Ministry of Agriculture, Food and Fisheries. Available at: http://www.agf.gov.bc.ca/aboutind/products/plant/blueberry.htm .

University of Vermont, Extension. Brattleboro, VT. USA *Health and History of Highbush Blueberries.* Available at: http://www.uvm.edu/vtvegandberry/factsheets/blueberrie.html