Crop Profile for Highbush Blueberry in Canada

Prepared by:

Pesticide Risk Reduction Program

Pest Management Centre

Agriculture and Agri-Food Canada

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Crop Profile for Highbush Blueberry in Canada

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.

General Production Information

Canadian Production (2005)	71,681 metric tonnes[1] 43,977 hectares[1]
Farm gate value (2005)	$137 million[1]
Domestic consumption (2004)	0.33 kg/person (fresh)
Exports (2005)	$51 million (fresh)
	$48 million (processed)
Imports (2005)	$38 million (fresh)
	$5.3 million (processed)
Source(s): Statistics Canada	

[1] includes low bush and high bush blueberries

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 la Montérégie, Québec and Chaudière-Appalaches.

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 blueberrry 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.

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.

Production Issues

Blueberries are affected by a wide variety of pests including fungal, bacterial and viral diseases, insects and birds. Production issues vary from region to region.

Blueberry maggot (*Rhagoletis mendax*) is the most important insect pest in Quebec. There is an obligatory quarantine for this pest. Abiotic factors leading to production problems include a shortage of labour, nutrient and water limitations and excesses and temperature extremes.

Table 1. Canadian highbush blueberry production and pest management schedule

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; QU, 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; QU: Faible débourrement; 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; QU: Débourrement; 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

Template adapted from BC Ministry of Agriculture, Food and Fisheries apple crop profile, July 2002.

Abiotic Factors Limiting Production

Key Issues

- Labour shortages are limiting blueberry 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

- An effective control method for blueberry scorch virus, is required. Insecticide applications to control the aphid vectors do not always provide adequate control.
- Alternative controls are required for *Pseudomonas syringae* pv. *syringae*, the bacterium responsible for bacterial blight. Some bacterial strains have developed resistance to copper, the primary chemical used for control.
- Additional fungicides are required for botrytis and anthracnose fruit rots. Emergency fungicide registrations have been required for three years for anthracnose management.
- There is no effective chemical control for godronia canker.
- Additional fungicides are required for the control of phytophthora root rot which is a problem on wet, heavy or compacted soils.
- Root rots are difficult to diagnose and the main pathogens involved need to be determined.
- The presence of Blueberry Mosaic Virus is increasing. The impact of this virus on plants needs to be determined.
- The cause and method of spread of premature fruit drop, which occurs only in the variety 'Bluecrop', needs to be determined.
- The effect of Blueberry Shock Ilavirus (BSIV) on yield needs to be determined.

Table 2. Degree of occurrence of disease pests in Canadian highbush blueberry production

	Degree of occurrence	
Major Diseases	**BC**	**QC**
Blueberry Scorch Carlavirus (BSCV)	E	DNR
Botrytis Blight / Gray Mould Fruit Rot	E	E
Blueberry Anthracnose and Ripe Rot	E	E
Bacterial Blight	E	DNR
Mummy Berry	E	E
Minor Diseases	**BC**	**QC**
Alternaria Fruit Rot	E	DNR
Blueberry Mosaic Viruse and others	E	E
Blueberry Shock Ilarvis Viris (BSIV)	E	DNR
Crown Gall	E	DNR
Godronia Canker	E	
Phomopsis Canker	E	E
Phytophthora Root and Crown Rot	E	DNR
Powdery mildew	DNR	E
Blueberry rust	DNR	E
Premature fruit drop	E	DNR

Widespread yearly occurrence with high pest pressure

Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure

Widespread yearly occurrence with low to moderate pest pressure

Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure

Pest not present

DNR - Data not reported

E – established

D – invasion expected or dispersing

Source(s): Crop Profile focus groups for British Columbia and Quebec (2005).

Major Diseases

Blueberry Scorch Carlavirus (BSCV)

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

Chemical Controls: Registered insecticides to control the aphid vector include imidacloprid and malathion.

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 planting stock will prevent the introduction of the disease into the field.

Alternative Controls: Lady beetles will provided 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.

Issues for Blueberry Scorch(Carlavirus)

1. Effective controls for aphids are needed to minimize the spread of blueberry scorch virus.
2. The two most common cultivars of highbush blueberry, 'Duke' and 'Bluecrop' are susceptible to the East Coast strain of the virus, which is the predominant strain in major production areas.

Botrytis Blight and Grey Mould Fruit Rot (Botrytis cinerea)

Pest Information

Damage: Botrytis blight attacks blossoms and fruit primarily but also will cause a 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

Chemical Controls: Registered chemicals include boscalid, ferbam and fenhexamid.

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.

Alternative Controls: Weather and field history are good indicators for infection and should be used in conjunction with monitoring for blossom infections.

Cultivar Susceptibility: None identified.

Issues for Botrytis

1. There is concern about the development of resistance in botrytis to commonly used fungicides. New product registrations are required.

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

Chemical Controls: Available chemicals include pyraclostrobin and chlorothalonil.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Blueberry Anthracnose and ripe rot

1. Alternative fungicides are required for anthracnose and ripe rot control.

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

Chemical Controls: Chemical controls available include copper oxychloride.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Bacterial Blight

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

Mummyberry (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 "mummyberries". Mummyberries germinate to produce apothecia at budbreak in the spring. The apothecia release ascospores that infect young, vegetative and floral buds, resulting in the 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 mummyberries.

Pest Management

Chemical Controls: Captan, triforine and propiconazole are registered as foliar sprays.

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, mummyberries and apothecia, should be monitored to predict the need and timing for sprays.

Alternative Controls: None identified.

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

Issues for Mummyberry

1 New product registrations are needed for mummyberry control.

Minor Diseases

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

Chemical Controls: Chlorothalonil is registered as a foliar spray. This disease may be kept in check by fungicides sprayed for botrytis.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Alternaria Fruit Rot

1. None identified.

Blueberry Mosaic Virus, Stunt, Ringspot and Shoestring Viruses

Pest Information

Damage: These virus diseases are not common in Canada. 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 straplike 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

Chemical Controls: None available.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

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.

Blueberry Shock Ilarvis Virus (BSIV)

Pest Information

Damage:. Blueberry Shock Ilarvis Viris (BSIV) 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

Chemical Controls: None available.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for BlueberryShock Ilarvis Virus

1. Shock virus is a cause for concern for blueberry growers as it is expected to spread rapidly.
2. The effect of Blueberry Shock Ilarvis Virus (BSIV) on yield needs to be determined.

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

Chemical Controls: None available.

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.

Alternative Controls: 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.

Issues for Crown Gall

1. None identified.

Godronia Canker (Godronia cassandrae – Fusicoccum putrefaciens)

Pest Information

Damage: Godronia canker is an important canker disease of blueberry across Canada. It 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

Chemical Controls: None available.

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.

Alternative Controls: None identified.

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

Issues for Godronia Canker

1. There are no fungicides registered for control of this disease.

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

Chemical Controls: Chlorothalonil and pyraclostrobin are registered for the control of phomopsis canker..

Cultural Controls: Infected branches should be pruned out and destroyed.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Phomopsis Canker

1. None identified.

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 commonly present 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

Chemical Controls: Metalaxyl–m can be applied as a soil drench.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Phytophthora root and crown rot

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

Table 3. Disease control products, classification and performance for Canadian highbush blueberry production

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
***Agrobacterium radiobacter* (Dygall)**	biological	N/A; N/A	RE	Crown gall		Pre-plant treatment used for cuttings.
boscalid (Lance WDG)	carboxamide fungicide	complex II in fungal respiration (succinate-dehydrogenase); 7	RR	Botrytis grey mould		
captan (Captan 80-WP, Maestro 80)	phthalimide fungicide	Multi-site activity; M4	R	RipeRot		Growers do not like applying these products at blossom if there is a risk of reduced pollination.
				Mummyberry	I	Not extensively used.
chlorothalonil (Bravo 500)	chloronitrile fungicide	Multi-site activity; M5	R	Alternaria fruit rot		
				Anthracnose		
				Phomopsis canker		
copper oxychloride (Copper Spray Fungicide)	inorganic fungicide	Multi-site activity; M1	R	Bacterial blight	A	Difficult to assess the performance. No evidence of of benefit of spring sprays but still used if cold and wet. Pest resistance in some fields.
fenhexamid (Elevate 50 WDG)	hydroxyanilide fungicide	3-keto reductase during C4 demethylation in sterol biosynthesis; 17	R	Botrytis blight		

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
ferbam (Ferbam 76WDG)	dithiocarbamate fungicide	Multi-site activity; M3	R	Botrytis blight		
metalaxyl-m (Ridomil Gold 480EC)	acylalanine fungicide	RNA polymerase I; 4	RE/RR	Phytophthora root rot	A^P	Difficult to assess performance of this product. Treatment needs to be combined with cultural controls. PHI is 80 days so application has to be done in the spring.
propiconazole (Topas 250E, Propiconazole 250E)	triazole fungicide	C14-demethylation in sterol biosynthesis; 3	RE	Mummyberry	A^P	Has poorer performance than triforine but costs less. Both fungicides have systemic action which stops disease progression.
pyraclostrobin (Cabrio EG)	methoxy-carbamates fungicide	Complex III of fungal respiration: ubiquinol oxidase, Qo site; 11	R	Anthracnose	A^P	Used in the fall to eliminate anthracnose infections on the stems. Is the only product available for this use.
				Phomopsis canker		
triforine (Funginex DC Fungicide)	piperazine fungicide	C14-demethylation in sterol biosynthesis; 3	R	Mummyberry	A^P - A	There have been shortages of supply in the past. No US residue tolerance. Usually alternated with Topas. Expensive. Has systemic action which stops disease progression.

[1] Common trade name(s), if provided in brackets, are for the purpose of product identification only. No endorsement of any product in particular is implied.
[2]The classification and the mode of action group are based on the classification presented in the Pest Management Regulatory Agency Regulatory Directive DIR99-06, Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action. The document is under revision and up-to-date information can be found on the following web sites: Herbicides:http://www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides:http://www.irac-online.org/documents/moa/MoAv5_1.pdf ; Fungicides:http://www.frac.info/frac/index.htm

[3] R-full registration (non-reduced risk), RE-under re-evaluation (yellow), DI (red) -discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA, BI-biological, RR-reduced risk (green), OP-organophosphate replacement, NR-not registered. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Individual product labels should be consulted for up to date accurate information concerning specific registration details. The information in these tables should not be relied upon for pesticide application decisions. Consult individual product labels for specific registration details. The following website can be consulted for more information on pesticide registrations: http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp

[4] Please consult the product label on the PMRA web site (http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp) for specific listing of pests controlled by each active ingredient.

[5] A – Adequate (green) (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control), A^p – Provisionally Adequate (yellow) (the PCP, while having the ability to provide acceptable control, possesses qualities which may make it unsustainable for some or all uses), I – Inadequate (red) (the PCP, according to recommended use, does not maintain disease below economic threshold OR provides unacceptable control)

[6] Sources: Crop profile focus groups for British Columbia and Quebec (2005).

Table 4. Availability and use of disease pest management approaches for Canadian highbush blueberry production

	Practice \ Pest	Blueberry Scorch Carlavirus	Botrytis Blight / Grey Mould Fruit Rot	Blueberry Anthracnose and Ripe Rot	Mummy berry	Godronia canker	Rust (*Pucciniastrum goeppertianum*)	Foliar viruses	Powdery mildew
Prevention	equipment or facility sanitation; use of sterile media								
	mowing / mulching / flaming								
	removal of alternative hosts								
	row or plant spacing (plant density)								
	seeding depth								
	water / irrigation management								
	crop residue removal / management								
	pruning out / elimination of infected plant material								
Avoidance	resistant varieties								
	planting / harvest date adjustment								
	crop rotation								
	choice of planting site								
	use of disease-free seed or transplants								
	optimizing fertilization								
	reducing mechanical damage / insect damage								
	thinning / pruning								
Monitoring	scouting								
	records to track pests								
	soil analysis								
	weather monitoring for disease forecasting								
	grading out infected produce								
Decision Making Tools	use of thresholds for application decisions								
	forecasting models for treatment decisions								
Suppression	biological pesticides								
	environmental management (eg. as in greenhouses)								
	pesticide rotation for resistance management								
	soil ammendements								
	controlled atmosphere storage								

no information regarding the practice is available

available/used

available/not used

not available

Source(s): Crop profile focus groups for British Columbia and Quebec (2005).

Insects and Mites

Key Issues

- 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 which is increasing in importance.
- There is concern about the blueberry gall midge which is damaging to slower growing varieties such as ‘Duke’.
- There are no products registered for the control of plum curculio.

Table 5. Degree of occurrence of insect pests in Canadian highbush blueberry production

	Degree of occurrence	
Major pests	**BC**	**QC**
Blueberry Aphids	E	DNR
Blueberry Maggot / Fruit Fly	DNR	E
White Grubs	DNR	DNR
Minor Pests	BC	**QC**
Loopers	E	DNR
Blueberry Leaf Tier and Leafrollers	E	DNR
Western Tent Caterpillar / Fall Webworm	E	DNR
Sawflies	E	DNR
Scales	E	DNR
Weevils	E	DNR
Blueberry gall midge	E	DNR
Cranberry, cherry and other fruitworms	DNR	E
Plum Curculio	DNR	E
Two Spotted Spider Mite	DNR	DNR
Blueberry Thrips	DNR	DNR
Calyx contaminants	DNR	DNR
Ants	DNR	E
Earwigs	DNR	E
Slugs	DNR	E
Widespread yearly occurrence with high pest pressure		
Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure		
Widespread yearly occurrence with low to moderate pest pressure		
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure		
Pest not present		
E – established		
D – invasion expected or dispersing		

Source(s): Crop Profile focus groups for British Columbia and Quebec (2005).

Major Insects and Mites

Aphids: Blueberry aphids *(Ericaphis fimbriata)* (BC) 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

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 include malathion and imidacloprid (BC only).

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, insecticide applications are not generally applied for aphids as natural enemies usually provide adequate control. Dormant oil reduces the number of over-wintering eggs.

Alternative Controls: 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.

Issues for Blueberry Aphid

1. Effective controls for aphids are needed to minimize the spread of blueberry scorch virus. Imidacloprid has received an emergency registration for aphid control in scorch-infected fields (in BC), in the past.

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

Chemical Controls: Registered pesticides include azinphos-methyl, carbaryl, dimethoate, malathion and phosmet.

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.

Alternative Controls: 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.

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.

White Grubs (European chafer (Rhizotrogus majalis), Japanese beetle (Poppillia 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

Chemical Controls: None identified.

Cultural Controls: Sites should be checked for the presence of white grubs prior to planting.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified .

Issues for White Grubs

1. An effective control for white grubs is required.

Minor Insects and Mites

Loopers: Bruce's Spanworm (*Operophthera bruceata*) and Winter Moth (*O. brumata*)

Pest Information

Damage: Bruce's 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

Chemical Controls: Deltamethrin and carbaryl are registered for the control of spanworm and winter moth.

Cultural Controls: None identified.

Alternative Controls:. *Bacillus thuringiensis* var. *kurstaki* is effective as a foliar spray.

Cultivar Susceptibility: None identified.

Issues for winter moth and spanworm

1. New reduced risk products for loopers 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, Croecia curvelana, 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 oblique banded 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 adult blueberry leaf tier moth 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

Chemical Controls: Unless leafroller or leaftier larval numbers are very high, chemical controls are not necessary. Registered insecticides include deltamethrin, malathion, carbaryl and phosmet.

Cultural Controls: Pruning and weeding plantings helps to reduce numbers by removing over-wintering sites.

Alternative Controls: 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.

Issues for

1. New "reduced risk" products for leafroller and leaf tier larval control 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 coccoons, 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 and drop to the soil to pupate.

Pest Management

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

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.

Alternative Controls: Bacillus thuringiensis var. *kurstaki* applied during the growing season to control leafrollers will also control young tent caterpillars.

Cultivar Susceptibility: None identified.

Issues for Western Tent Caterpillars and Fall Webworm

1.

1. None identified.

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

Pest Information

Damage: Sawflies rarely cause significant damage to blueberries. 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 egg 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

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

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

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

Chemical Controls: Dormant oil and carbaryl are registered for the control of scales.

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

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Scales

1. 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

Chemical Controls: Malathion is registered for the control of strawberry root weevils (in BC only).

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.

Alternative Controls: 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.

Issues for Weevils

1. The presence of weevils is increasing in highbush blueberry and there are no effective controls.

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

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

Cultural Controls: None identified.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Blueberry gall midge

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

Cranberry Fruit Worm (*Acrobasis vaccinii*) and Cherry Fruit Worm (*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

Chemical Controls: Azinphos-methyl, carbaryl and malathion are registered for the control of fruit worms.

Cultural Controls: None identified.

Alternative Controls: 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.

Issues for Cranberry Fruitworm and Cherry Fruit Worm

1. Only organophosphate or organochlorine insecticides are registered for the control of this pest; reduced risk products are required.

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

Chemical Controls: Insecticide sprays for other pests will also provide some control.
Cultural Controls: Management of immature stages in the soil is an important factor in reducing curculio populations.
Alternative Controls: Some naturally occurring parasites will prey upon eggs and larvae, but rates of parasitization are usually low.
Cultivar Susceptibility: None identified.

Issues for Plum Curculio

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

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.
Life Cycle:

Pest Management

Chemical Controls: Malathion is registered as a foliar spray
Cultural Controls: None identified.
Alternative 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.

Issues for Two-spotted Spider Mite

1. None Identified.

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

Chemical Controls: Registered chemicals include permethrin.
Cultural Controls: None identified.
Alternative Controls:. None identified.
Cultivar Susceptibility: None identified.

Issues for Blueberry thrips

1. None identified.

Calyx Contaminents

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

Life Cycle:

Pest Management

Chemical Controls: None identified.
Cultural Controls: None identified.
Alternative Controls: None Identified.
Cultivar Susceptibility: None identified.

Issues for Calyx Contaminants

1. None identified.

Table 6. Insect control products, classification and performance for Canadian highbush blueberry production

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
***Bacillus thuringiensis (Bt)*subsp. *kurstaki* (Bioprotec, Dipel 2X DF, Foray 48BA)**	*Bt* subspecies *kurstaki* insecticide	Microbial disruptors of insect mid-gut membranes (includes transgenic crops expressing *Bacillus thuringiensis* toxins); 11B2	RE (RR)	white marked tussock moth		
				cranberry fruitworm and cherry fruitworm (highbush only)		
carbaryl (Sevin XLS Plus)	carbamate insecticide and acaricide	Acetylcholine esterase inhibitors; 1A	RE	blueberry maggot	A	Used only if the fly is detected during harvest.Pre-harvest interval is 2 days.Toxic to beneficials.
				climbing cutworms		
				leafrollers		
				loopers (Bruce's spanworm)		
				leaf hoppers		
				spittle bugs		
				fruitworms	A^P	Contact insecticide with short persistance.
				Lecanium scale		
deltamethrin (Decis 5 EC)	pyrethroid insecticide	sodium channel modulators; 3	R	Bruce's spanworm	A	Inexpensive.Toxic to bees.
				leaf tier		

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
dimethoate (Dimethoate, Cygon 480-AG, Lagon)	organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	RE	blueberry maggot	A	Pre-harvest interval is long (15 days). Used only as a preventative treatment.
Petro Canada Spray Oil 13E	mineral oil insecticide and acaricide	N/A	R	Lecanium scale	-	-
imidacloprid (Admire 240)	neonicotinoids insecticide	Nicotinic acetylcholine receptor agonists / antagonists; 4A	R (BC only?)	Blueberry aphid and other known aphid vectors of blueberry scorch virus	A	Need good coverage for good performance.
malathion (Malathion 25W, 85E)	organophosphate insecticide and acaricide	Acetylcholine esterase inhibitors; 1B	RE	aphids		
				blueberry maggot	A	Used only if the fly is detected during harvest. Relatively "soft" on benficials. Pre-harvest interval is short (1 day).
				cranberry and cherry fruitworm	A[P]	Contact insecticide with short persistance.
				leafrollers		
				leafhoppers		
				mites		
				rose chafers		
				strawberry weevil adults (BC only)	I	Registered for use on strawberry weevil adults but product is not readily available. Recommended temperature of 20 degrees is not suitable for when product is needed, evenings in June.

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
permethrin (Ambush 300EC, Pounce)	pyrethroid insecticide	sodium channel modulators; 3	R (eastern Canada only)	thrips		
phosmet (Imidan 50-WP Instapak)	organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	RE	leafrollers		
				blueberry spanworm		
				blueberry maggot	A^P	Is used as a preventative treatment. Pre-harvest interval is 15 days for low bush.

[1] Common trade name(s), if provided in brackets, are for the purpose of product identification only. No endorsement of any product in particular is implied.

[2]The classification and the mode of action group are based on the classification presented in the Pest Management Regulatory Agency Regulatory Directive DIR99-06, Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action. The document is under revision and up-to-date information can be found on the following web sites: Herbicides:http://www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides:http://www.irac-online.org/documents/moa/MoAv5_1.pdf ; Fungicides:http://www.frac.info/frac/index.htm

[3] R-full registration (non-reduced risk), RE-under re-evaluation (yellow), DI (red) -discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA, BI-biological, RR-reduced risk (green), OP-organophosphate replacement, NR-not registered. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Individual product labels should be consulted for up to date accurate information concerning specific registration details. The information in these tables should not be relied upon for pesticide application decisions. Consult individual product labels for specific registration details. The following website can be consulted for more information on pesticide registrations: http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp

[4] Please consult the product label on the PMRA web site (http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp) for specific listing of pests controlled by each active ingredient.

[5] A – Adequate (green) (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control), A^p – Provisionally Adequate (yellow) (the PCP, while having the ability to provide acceptable control, possesses qualities which may make it unsustainable for some or all uses), I – Inadequate (red) (the PCP, according to recommended use, does not maintain disease below economic threshold OR provides unacceptable control)

[6]Sources: Crop profile focus groups for British Columbia and Quebec (2005).

Table 7. Availability and use of insect pest management approaches for Canadian highbush blueberry production

	Practice \ Pest	Blueberry maggot / Fruit Fly	Plum curculio	Lesser appleworm	Cranberry fruitworm
Prevention	equipment sanitation				
	mowing / mulching / flaming				
	removal of alternative hosts (weeds/volunteers)				
	row or plant spacing				
	seeding depth				
	water / irrigation management				
	crop residue removal / management				
	pruning out / removal of infested material				
Avoidance	resistant varieties				
	planting / harvest date adjustment				
	crop rotation				
	choice of planting site				
	use of pest-free seed				
	optimizing fertilization				
	reducing mechanical damage				
	thinning / pruning				
	trap crops / perimeter spraying				
	repellents				
Monitoring	scouting - trapping				
	records to track pests				
	soil analysis				
	weather monitoring for degree day modelling				
	grading out infected produce				
Decision Making Tools	forecasting / degree day modelling for treatment decisions				
	use of thresholds for treatment decisions				
Suppression	biological pesticides				
	environmental management (eg. as in greenhouses)				
	pesticide rotation for resistance management				
	soil ammendments				
	controlled atmosphere storage				
	ground cover / physical barriers				
	pheromones (eg. mating disruption)				
	sterile mating technique				
	beneficial organisms and habitat management				
	trapping				

Weeds

Key Issues

- None identified.

Table 8. Degree of occurrence of weed pests in Canadian highbush blueberry production.

	Degree of occurrence	
Weed	**BC**	**QC**
Annual grasses	E	E
Annual broadleaf weeds	E	E
Perennial grasses	E	E
Perennial broadleaf weeds	E	E

Widespread yearly occurrence with high pest pressure
Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure
Widespread yearly occurrence with low to moderate pest pressure
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure
Pest not present
E – established
D – invasion expected or dispersing

Sources: Crop Profile focus groups for British Columbia and Quebec (2005).

Major and Minor Weeds

Annual and 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

Chemical Controls:

Registered a**nnual grass herbicides** include**:** paraquat, dichlobenil, fluazifop-p-butyl, sethoxydim, glyphosate, napropamide, simazine, terbacil and hexazinone.

Registered a**nnual broadleaf herbicides** include: bentazon, paraquat, dichlobenil, glyphosate, hexazinone, napropamide, simazine and terbacil.

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.

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 include “companion grass” (a blend of perennial dwarf ryegrass and fescue), buckwheat, pearl millet or Sudan grass are seeded the year before blueberry planting.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for annual weeds

1. The registration of additional herbicides is required for the control of problem annual broadleaf and grass weeds, particularly annual bluegrass and chickweed.

Perennial Broadleaf and Grass Weeds

Pest Information

Perennial grass weeds include: Quackgrass (*Eltrigia repens*).

Perennial broadleaf weeds include: 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 include: horsetail (*Equisetum* sp.).

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

Chemical Controls:

Registered perennial grass herbicides include**:** dichlobenil, glyphosate, hexazinone, sethoxydim and terbacil. (Bentazon is registered for yellow nutsedge).

Registered perennial broadleaf herbicides include**:** dichlobenil, hexazinone, terbacil clopyralid and glyphosate.

Herbicides are not used in new plantings until the plants have been established in the field for six months to one year.

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.

Alternative Controls: None identified.

Cultivar Susceptibility: None identified.

Issues for Perennial Broadleaf and Grass Weeds

1. The registration of new chemicals for the control of dandelion and perennial grasses is required.

Table 9. Weed control products, classification and performance for Canadian highbush blueberry production

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
bentazon (Basagran Liquid herbicide)	Benzothiadiazinone	6	RE	Broad leaf weeds		
				Yellow nutsedge		
clopyralid (Lontrel 360)	pyridine carboxylic acid herbicide	Action like indoleacetic acid (synthetic auxins); 4	R	Vetch, red and white clover	A^P	Provides control of weeds not controlled by other herbicides. Has a narrow spectrum of activity.
dichlobenil (Casoron G-4)	nitrile herbicide	Inhibition of cell wall (cellulose) synthesis; 20	R	Annual grass and broadleaf weeds, perennial grass and broadleaf weeds		Product is expensive. Possible accumulation in the soil.
fluazifop-p-butyl (Venture L)	aryloxyphenoxy propionate herbicide	Inhibitors of acetyl CoA carboxylase (ACCase); 1	R	Annual grass		
glyphosate (Roundup Ultra Max)	glycine herbicide	Inhibition of EPSP synthase; 9	R	All weeds		Can damage the crop. Use banded application or spot treatment. Used to suppress perennial weeds.
				Broad leaf weeds and perennial grasses	A	
hexazinone (Velpar L)	Triazinone herbicide	Inhibition of photosynthesis at photosystem II; 5	RE	Annual grass and broadleaf, perennial grass and broadleaf		

Regulatory Status as of May 31, 2006					Stakeholder Comments[6]	
Active ingredient / organism (product)[1]	**Classification[2]**	**Mode of action – resistance group[2]**	**PMRA status of active ingredient[3]**	**Pests or group of pests targeted[4]**	**Performance of product according to recommended use[5]**	**Notes**
paraquat (Gramaxone)	bipyridyliums herbicide	Photosystem-I-electron diversion; 22	R	Annual grass and broadleaf weeds		Does less damage to the crop than Roundup but more is expensive than Roundup.
sethoxydim (Poast Ultra)	cyclohexanedione herbicide	Inhibitors of acetyl CoA carboxylase (ACCase); 1	R	Annual grass, quackgrass		
simazine (Princep Nine T)	triazine herbicide	Inhibition of photosynthesis at photosystem II; 5	R	Annual grass and broadleaf		
terbacil (Sinbar Herbicide)	uracil herbicide	Inhibition of photosynthesis at photosystem II; 5	R	Annual grass and broadleaf weeds, perennial grass and broadleaf weeds	A	Applied very early in the spring. The duration of efficacy is less than that of Casoron.

[1] Common trade name(s), if provided in brackets, are for the purpose of product identification only. No endorsement of any product in particular is implied.

[2]The classification and the mode of action group are based on the classification presented in the Pest Management Regulatory Agency Regulatory Directive DIR99-06, Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action. The document is under revision and up-to-date information can be found on the following web sites: Herbicides:http://www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides:http://www.irac-online.org/documents/moa/MoAv5_1.pdf ; Fungicides:http://www.frac.info/frac/index.htm

[3] R-full registration (non-reduced risk), RE-under re-evaluation (yellow), DI (red) -discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA, BI-biological, RR-reduced risk (green), OP-organophosphate replacement, NR-not registered. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Individual product labels should be consulted for up to date accurate information concerning specific registration details. The information in these tables should not be relied upon for pesticide application decisions. Consult individual product labels for specific registration details. The following website can be consulted for more information on pesticide registrations: http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp

[4] Please consult the product label on the PMRA web site (http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp) for specific listing of pests controlled by each active ingredient.

[5] A – Adequate (green) (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control), A^p – Provisionally Adequate (yellow) (the PCP, while having the ability to provide acceptable control, possesses qualities which may make it unsustainable for some or all uses), I – Inadequate (red) (the PCP, according to recommended use, does not maintain disease below economic threshold OR provides unacceptable control)

[6]Sources: Crop profile focus groups for British Columbia and Quebec (2005).

Table 10. Availability and use of weed pest management approaches for Canadian highbush blueberry

	Practice \ Pest	grasses	broadleaf weeds
Prevention	equipment sanitation		
	mowing / mulching / flaming		
	row or plant spacing (plant density)		
	seeding depth		
	water / irrigation management		
	weed management on non-crop lands		
	weed management in non-crop years		
	tillage / cultivation		
Avoidance	planting / harvest date adjustment		
	crop rotation		
	choice of planting site		
	use of weed-free seed		
	optimizing fertilization		
Monitoring	scouting		
	field mapping of weeds / records of resistant weeds		
	soil analysis		
	grading of grain / produce for weed contamination		
	visual field inspection		
	grading out infected produce		
Decision Making Tools	use of thresholds for treatment decisions		
Suppression	biological pesticides		
	habitat / environment management		
	pesticide rotation for resistance management		
	soil ammendments		
	ground cover / physical barriers		
	inter-row cultivation		
	mechanical weed control		

no information regarding the practice is available

available/used

available/not used

not available

Source(s): Crop profile focus groups for British Columbia and Quebec (2005).

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. Metaldehyde bait (Deadline MP)can be applied or ferric phosphate (Sluggo or Safer's Slug Bait*.)* 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.

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IPM / ICM resources for production of highbush blueberry in Canada

Internet resources:

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

BC Blueberry Council:
www.bcblueberry.com

BC Ministry of Agriculture, Food and Fisheries, Berry Information
www.agf.gov.bc.ca/berries

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

North American Blueberry Council
www.blueberry.org

Nova Scotia Agriculture and Fisheries
www.gov.ns.ca/nsaf/home.htm

Ontario Ministry of Agriculture and Food
www.gov.on.ca/OMAFRA/english/index.html

Prince-Edward Island Agriculture, Fisheries, Aquaculture and Forestry
www.gov.pe.ca/af/index.php3

Québec Agriculture, Pêcheries et Alimentation www.agr.gouv.qc.ca/index.htm

Réseau d'avertissement phytosanitaire du Québec
www.agr.gouv.qc.ca/dgpar/rap/titre.htm

Saskatchewan Agriculture, Food and Rural Revitalization
www.agr.gov.sk.ca/default.asp

Non-internet resources:

BC Blueberry Council, PO Box 8000, Abbotsford, BC V2S 6H1, Tel. 604-864-2117; Fax 604-864-2197

BC Ministry of Agriculture, Food and Fisheries & Plant Diagnostic Laboratory
1767 Angus Campbell Rd., Abbotsford, BC V3G 2M3, Tel. 604-556-3001; Fax: 604-556-3117

Lower Mainland Horticultural Improvement Association
1767 Angus Campbell Road, Abbotsford, BC V3G 2M3, Tel. 604-556-3001;
Fax 604-556-3030

Ontario Highbush Blueberry Association. Tel: (519) 692-5373

Table 11. Research contacts related to pest management in Canadian highbush blueberry production

Name	Organization	Pest type	Specific pests	Type of research
D. Raworth	AAFC- Agassiz	Virus/aphid	Blueberry scorch virus; Blueberry aphid	Aphid vector management
Z. Punja; S. Rose	Simon Fraser University	Disease	Blueberry anthracnose	Timing of infection and forecasting; biofungicides
J. S. Mann	ES Crop Consulting,	Insect	Blueberry	Survey to examine

	BC		midge	pest levels, life history, varietal susceptibility
J. Elmhirst, J. S. Mann & D. Henderson	Elmhirst Diagnostics and Research and ES Crop Consult, BC	Insect	Blueberry midge; Blueberry aphid	Assessment of chemical controls for midge; aternatives to imidacloprid (Admire) for aphid control
A. Buonassissi and K. Ng	BCMAFF and private consultant	Disease	Bacterial blight	Evaluation of biological controls for bacterial blight and frost protection
Sanderson K., Holmstrom D., Ivany J., Sanderson B.	AAFC Research Branch, Crops and Livestock Research Centre, NS	Crop systems		Production management practices for vegetables, small fruit and alternative crops in Atlantic Canada
Hoyle J.	Nova Scotia Agricultural College	Nutrient	Salt	Investigation of the effects of salt on agricultural crops
Chuck Mouritzen	Southwest Crop Consulting	Weeds		
Janice Elmhirst	Elmhirst Diagnostics and Research	Disease/insect		
Deborah Henderson	E.S. Crop Consult Ltd.	Disease/insect		
Jasbir S. Mann	E.S. Crop Consult Ltd.	Insect		
Ken Ng	Ng Research and Consulting			
Kevin Schooley	KS Consulting			
Rick Delbridge	Delbridge Disease Management	Disease		