Crop Profile for Raspberry in Canada

Prepared by:

Pesticide Risk Reduction Program

Pest Management Centre

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Raspberries (*Rubus* spp.) are members of the Rosaceae (rose) family. Although raspberry species produce fruit of various shades of red, black, yellow and purple, red raspberries (*Rubus idaeus*) form the majority of the commercial crop. Raspberries are consumed fresh, frozen, or processed in jam, juice, yogurt and wine. Individually quick-frozen (IQF) raspberries are the premium quality and priced product and consumer demand for this product type continues to grow. Red raspberries contain ellagic acid, a potent anti-carcinogenic and anti-mutagenic compound and are used in the formulation of a variety of natural anti-cancer products.

General Production Information

Canadian Production (2005)	3,178 metric tonnes[1]
Farm gate value	N/A
Domestic consumption (2005)	0.34 kg/person (processed)
Export (2005)	$7.7 million (fresh)
	$10.9 million (processed)
Imports (2005)	$40.0 million (fresh)
	$26.9 million (processed)
Source(s): Statistics Canada	

[1]Includes raspberries, blackberries, mulberries and loganberries

Production Regions

Raspberries are produced commercially in all provinces of Canada, but the majority of production is in BC (83%), followed by Quebec (10%) and Ontario (5%). The remaining 2% of Canadian raspberries are produced in the rest of the provinces. The majority of commercial production of raspberries in BC (99%) occurs in the BC Lower Mainland. Abbotsford, in the Lower Mainland, is known as the “Raspberry Capital of Canada”.

Almost all of the raspberries grown in BC (94%) are processed. However, most of the raspberries grown in other regions are sold for the fresh market. In Manitoba and Saskatchewan, there is interest in expanding the processing sector.

Cultural Practices

The Plant Material

In BC, only certified planting stock is used in order to reduce the risk of introducing nematodes, viruses, root rot and other pests and diseases. Certified, bare root planting stock is grown in Washington State by tissue culture. On the prairies, most bare root planting stock is obtained

from Nova Scotia. Ontario primarily uses bare root plants obtained from Ontario, Nova Scotia or Quebec certified growers.

Growers choose varieties based on fruit quality, disease resistance, harvest maturity time, suitability for hand or mechanical harvest and suitability for the fresh or processing market. 'Meeker' is the main variety grown in BC for processing. Other summer fruiting varieties grown in BC include Chilcotin, Malahat, Qualicum and Tulameen. Chilcotin has shown some resistance to the most common strains of Raspberry Bushy Dwarf Virus (RBDV) in the Pacific Northwest. Susceptibility to root rot, fruit rot, cane blight and crown gall differs among the other varieties. New varieties being evaluated in BC include Cowichan, Esquimalt, BC89-33-84 and Coho. Fall-fruiting varieties for fresh market sales in BC include Amity, Autumn Bliss, Caroline, Dinkum, Heritage, and Orus 534-10. These varieties have been developed primarily in Australia.

In Ontario a broad range of varieties are grown due to the diverse climate in the region. Red varieties include Boyne, Nova, Killarney, Titan, Tulameen, Qualicum, K81-6 and Chilcotin. Royalty is the dominant purple raspberry and primocane fruiting varieties include Autumn Britten, Autumn Bliss and Heritage. On the prairies, 'Boyne', a summer-fruiting variety, accounts for approximately 70-80% of plantings. Other varieties grown in Manitoba are K81-6, Kilarney, Nova and Souris. In the Maritimes, summer-fruiting varieties are predominantly grown with the main varieties planted being Nova, K81-6, Boyne, Algonquin, Festival, Regency and Royalty. A limited amount of the fall-bearing variety Heritage is also grown in several long-season sites. In Quebec, the main summer-fruiting varieties are Festival, Nova, Killarney and Boyne. These are harvested from mid-July to mid-August. The fall-fruiting varieties, Pathfinder and Automne Bliss, are harvested from mid-August to the end of September.

Crop Establishment

Raspberries do best on loam or sandy loam soils that are slightly acidic (pH 5.8 to 6.5). Raspberries can also be grown on sandy or gravelly soils, but careful management of water and nutrients is required as these soils do not hold water or nutrients well. Ontario raspberries are grown on a variety of soil types including clay soils. Drainage is important for optimum production, as poorly drained soils, or those with a hard pan that prevents good drainage, can lead to root rot resulting in poor yields and a shortened lifespan of the plantings. Although raspberry roots extend to about 1.2 metres in depth, the most active roots are in the first 30 cm (1 foot) of soil. Thus, roots are highly susceptible to over watering or flooding that reduces oxygen levels and to drought stress in dry periods. A sub-surface drainage system is necessary on fields with poor natural drainage. The most critical periods for irrigation are during the year of planting and from flowering to harvest. In dry years, continued irrigation after harvest is needed to maintain yields and crop growth for the following season. To help reduce soil erosion, grass is planted on drives, headlands and in areas where water runs into the field. Fall cover crops are planted on hilly sites.

Land preparation begins in the year before planting. Soil nutrient testing is done in the fall before planting so amendments can be added during field preparation. Soil pH is tested before planting and again every 3 to 4 years. If the pH is 5.5 or less, ground limestone is broadcast in the fall prior to fumigation or cover crop planting, or in the spring before planting. Soil sampling for wireworms is done the year before planting (especially if land has been under sod or pasture before) and plans for treatment implemented. Treatment includes cultivation and planting of cereal bait crops in strips, using insecticide-treated seed. Established perennial weeds are controlled with glyphosate herbicide.

Soil sampling for pathogenic nematodes is also carried out and, if nematodes are detected, the soil is prepared for fumigation in late August/early September of the year prior to planting. About two weeks after fumigation, the soil is aerated by shallow disking and left for another week. Any established perennial weeds are killed with herbicide, and a fall cover crop (a cereal such as barley) is planted to add organic matter, help control weeds and improve soil drainage. The cover crop is seeded prior to mid-September to ensure that the crop becomes well established. In the spring, the cover crop is disked into the soil in time to allow for decomposition before planting.

In BC, raspberries are often grown on raised beds or hilled after planting to improve drainage and reduce root rot. Approximately 50-65% of BC acreage is under overhead irrigation, but there is a growing trend toward the use of drip irrigation to reduce fruit rot. On the prairies, raspberries are grown mainly on raised beds with drip irrigation. In Ontario, raspberries are planted on raised beds to enhance drainage. Most (80% or more) irrigation systems are drip systems. In Atlantic Canada, the majority of plantings are on flat ground with overhead irrigation but there is a movement toward trickle irrigation and raised bed plantings on heavier soils. The latter is driven by the appearance of Phytophthora root rot in the region in recent years. In Quebec, drip irrigation is used, rather than overhead sprinklers, and the use of raised beds (30-60 cm high) is recommended to reduce black root rot caused by *Phytophthora* and other root-rotting fungi.

Annual cover crops of barley, oats or rye are commonly seeded in the fall before planting and between rows from August 15 to September 15, in BC. A perennial legume cover crop, such as white clover, which does not compete with raspberry plants for nutrients, may also be used.

In BC, planting takes place early in the spring, usually March to early April. In Quebec, new planting is done in spring (May) or fall (October). Plant spacing depends on the vigour and growth habit of the variety as well as cultivating and harvesting equipment. Most varieties are planted in rows 3 m apart, with 4,305 plants per hectare. Where narrow machinery and upright varieties are used, row spacing may be 2.7 m for 4,784 plants per hectare. Planting densities in eastern Canada are generally higher based on reduced vigor of cultivars. Most varieties are planted in rows 2.1-3.0 m apart, with plants spaced at 60 cm for a density of 5555-7937 plants per hectare.

Specialized Production Systems

A few growers in BC and Ontario are experimenting with growing raspberries in greenhouses to supply high quality fruit for winter markets. Ontario has also started to experiment with raspberries grown in high tunnels to extend the marketing season and to reduce the impact of fruit diseases. A recent trend in Ontario is to grow raspberries in a biennial growing system. Presently more than 20% of the Ontario raspberries are grown under this system. Biennial raspberry production differs from annual production in that a portion of the planting is only allowed to fruit every second year. Some growers refer to this as “alternate year mowing” as the fruiting canes are mowed after fruiting, once the plants are dormant. Biennial production takes alternate year mowing one step further. The biennial system employs the same technique of mowing dormant canes after they finish fruiting, but includes additional management practices. These practices include row width maintenance during the vegetative year of growth and more importantly the use of primocane suppression during the fruiting year. A trellis or support mechanism for the canes is necessary in this growing system.

A few BC growers apply nitrogen and other nutrients by injection in drip and trickle irrigation systems. Use of fertigation is increasing in Ontario.

Crop Rotation

Raspberries have a perennial crown and root system, with a biennial cane system. The average lifespan of a raspberry planting is 7 to 10 years. Raspberry fields are productive for about 7 to 10 years in BC, and for up to 12 years in Ontario and Quebec. Most BC growers do not rotate fields due to lack of suitable land. Occasionally a raspberry field will be put into production of a vegetable or other crop for one to two years before replanting, but most fields are killed in summer after the final harvest. If possible, fields which have been previously planted to strawberries or solanaceous crops, such as potato, are avoided to reduce the risk of Verticillium wilt. Crop rotation is used to avoid fields with a history of crown gall or dagger nematodes. Crop rotation for 2-5 years is recommended and normally followed when suitable land is available.

Production Issues

Raspberries are affected by a wide variety of pests including fungal, bacterial and viral diseases, insects, mites and pathogenic nematodes. Contamination of raspberries by weevils, fruitworms and caterpillars, Botrytis gray mold and Rhizopus soft rot are the main factors affecting grade. Crumbly berry caused by Raspberry Bushy Dwarf Virus (RBDV) and non-pathogenic factors are also a significant fruit quality problem, particularly in meeting IQF quality standards.

Contamination during mechanical harvesting can be a significant problem due to insects falling into fruit. There is zero tolerance for insects or insect parts in processed raspberry products and very low tolerance for moulds. Mould, insect contaminants or crumbly berry will cause fruit to be downgraded from IQF to juice or puree uses, resulting in a $0.30 to $0.40 reduction in the price per pound paid to producers. It is very difficult to wash raspberry fruit to remove insects or mould. Processors use low concentrations of chlorine in wash water and thorough inspection procedures to eliminate insect-contaminated or soft, mushy, or crumbly fruit.

Since raspberries are a long-term perennial crop, it can be difficult to estimate the impact of pest injury. Severe damage in one growing season not only causes direct injury, but also affects plant health, vigour and yield over the following years. Raspberries are also susceptible to post-harvest quality problems caused by insect and mould contamination at harvest. Contaminating insects may cause little direct plant injury but can be a significant factor in fruit quality – for instance, adult weevils may do little damage from foliar feeding, but contaminate fruit at harvest, resulting in significant economic loss to growers from down-graded quality or rejected fruit.

Another key issue affecting the Canadian raspberry industry is low commodity pricing. Low prices combined with high production costs for labour, fertilizer and pesticides and lack of pest control products in Canada has resulted in many raspberry producers operating at very thin or negative profit margins.

Table 1. Canadian raspberry production and pest management schedule

Time of year/Plant Stage	Activity	Action
January Plants dormant	Plant care	Pruning of canes (BC)
February Plant tops dormant; roots becoming active (BC); Plants dormant (QC, ON)	Plant care	Top canes if necessary; Chop prunings; Set out new plantings (BC)
	Soil care	Perform spring soil test; Apply manure, if used; Incorporate manure and lime in sites of new plantings (BC)
	Weed management	Apply herbicide for weeds within rows (BC)
March Buds starting to swell and open (BC); Plants dormant (QC, ON)	Plant care	Finish all pruning and topping of canes; Finish chopping prunings; Continue with new plantings (BC) Hand pruning or mowing (ON)
	Disease management	If field has history of spur blight, apply pre-bloom fungicide; Apply delayed dormant spray for cane diseases and yellow rust; Apply a spray for bacterial blight control; Begin monitoring for *Phytophthora* root rot, spur blight, cane blight, and *Botrytis* cane wilt (BC)
	Insect & mite management	Drench crowns for crown borers, if needed; Begin monitoring for climbing cutworms and clay coloured weevils; Apply controls if needed (BC)
April New canes and fruiting laterals (BC); Buds start to swell and open, roots become active (QC, ON)	Plant care	Remove first flush of primocanes by "shoot burning" (BC) Apply granular fertilizer; Continue hand pruning or mowing (ON)
	Soil care	Apply commercial fertilizer; Fertilize new plantings, if necessary (BC, QC) Prepare land for planting and plant as soon as possible (ON)
	Disease management	Monitoring for root rot, spur blight, cane blight, and cane wilt; Begin monitoring for yellow rust; Apply copper for bacterial blight, if needed; Apply fungicide for yellow rust and root rot, if needed (BC, QC) Delayed dormant spray of lime sulphur for cane diseases (ON)
	Insect & mite management	Continue monitoring for climbing cutworms and clay coloured weevils; Monitoring for leafrollers and western raspberry fruitworm; If insecticides are needed, apply before bloom to protect bees; Treat for cutworms, if needed (BC) Pruning for bud moth control (QC) Drench crowns for crown borers, if needed; Begin monitoring for climbing cutworms and clay coloured weevils; Apply controls if needed (QC)
	Weed management	Begin cultivation between rows; Treat for quackgrass, if needed (BC) Apply pre-emergent herbicide (ON)
May Start of flowering (BC); New canes & fruiting laterals; Start flowering at end of May (QC); Bud swell and leafing out (ON)	Plant care	Apply foliar feed sprays (for micronutrients) if needed; Irrigate as needed; Put honeybees in field at the start of flowering (BC) Apply boron or magnesium as needed (QC) Put honeybees in field at the start of flowering (late may) (ON) Install post and wire trellises in new plantings; Observe and plan sites of any future plantings, and note whether fumigation for nematodes is necessary
	Disease management	Continue monitoring for yellow rust; Apply fungicide for yellow rust, if needed; Apply fungicide for spur blight, if needed; Apply copper for bacterial blight, if needed; Begin sprays for Botrytis fruit rot control (BC) Prune out canes affected by anthracnose and spur blight (QC) Delayed dormant spray of lime sulphur or ferbam for cane diseases (ON)
	Insect & mite management	Continue monitoring for clay coloured weevils, leafrollers, and western raspberry fruitworm; Begin monitoring for black vine weevil, mites, and predators; Apply insecticides if necessary, before bloom (BC) Prune out canes affected by mites and borers. (QC) Apply insecticides if necessary, for raspberry crown borer. Prebloom insecticides if necessary (ON)

Time of year/Plant Stage	Activity	Action
June Bloom to harvest	Plant care	Continue foliar feeding as required; Irrigate as needed. Begin harvest (BC) Primocane suppression in biennial systems (ON)
	Disease management	Monitor for cane wilt; Apply fungicide for cane wilt if needed; Continue fruit rot sprays, as needed (BC) Apply fungicides for fruit rot as needed (ON)
	Insect & mite management	Continue monitoring for leafrollers, western raspberry fruitworm, black vine weevil, mites, and predators; Apply sprays when needed, observing required PHI Monitor for sawfly, leafrollers and mites (ON)
Late June to early August Harvest	Plant care	Harvest and market fruit; Irrigate as necessary
	Disease management	Continue fruit rot sprays, as needed; Monitor primocanes for spur blight; Monitor for cane wilt and spot mould (fruit) during rainy seasons
	Insect & mite management	Continue monitoring for mites, and predators; Apply controls for leafrollers and cutworms if harvest contamination is a problem, observing required PHI (BC, QC)
August Harvest (QC); After harvest (BC)	Plant care	Irrigate to maintain growth in new canes; Apply foliar sprays, if needed. Apply foliar boron, if needed; Perform post-harvest nitrate tests (BC, QC)
	Soil care	Loosen soil that was compacted during harvest; Prepare soil for cover crop, if using
	Disease management	Remove floricanes to improve air circulation if cane wilt was problem at harvest; Use cultural controls if root rot was problem; Apply fungicide for spur blight, if needed
	Insect & mite management	Continue monitoring for mites and predators; Apply controls only if needed
September After harvest	Plant care	Irrigate as needed
	Soil care	Plant fall (cereal) cover crops; Loosen compacted soil to improve winter drainage; Install drainage in new fields, if required; Collect soil samples for fall nutrient analysis
	Disease management	Continue cultural controls for root rot, if needed; Fumigate for new plantings
	Insect & mite management	Continue monitoring for mites and predators; Apply controls if needed Apply insecticide for crown borer if needed (ON)
	Weed management	Mow or cultivate as needed
October Pre-dormancy	Plant care	Begin pruning floricanes
	Soil care	Collect soils samples for fall nutrient analysis
	Disease management	Apply fungicide for root rot control, if needed; Apply controls bacterial blight, if needed
	Insect & mite management	Apply spray for crown borer, if needed
	Weed management	Apply fall and early winter herbicides, if needed; Control high weeds and grass to discourage mice (BC, ON) Application of pre-emergence herbicides (QC)
November & December Plants becoming dormant	Plant care	Continue pruning floricanes; Begin to prune out weak or unwanted primocanes (BC) Mowing of fruiting canes in a biennial sytem can begin once plants dormant Begin to prune out weak or unwanted primocanes (ON)
	Weed management	Apply early winter herbicides, if needed (BC, QC) Apply pre-emergent herbicide if needed (ON)

Adapted from the Raspberry Crop Profile, BC Crop Profiles 2002-2004, BC Ministry of Agriculture, Food and Fisheries, March 2003. Source(s): Tracy Hueppelsheuser, BC Ministry of Agriculture, Food and Fisheries.

Abiotic Factors Limiting Production

Key Issues

- The major abiotic problems are high soil moisture contributing to root rot and crumbly berry (also caused by viruses).
- It is recommended that any fertility recommendations for crops in the guidelines and regulations of the proposed Nutrient Management Act be based on valid research.

Moisture

Water management is a critical factor in raspberry production. Poor drainage and periodic flooding are major contributing factors to Phytopththora root rot disease. However, coarse, sandy soils suitable for raspberry production can also dry out quickly in the summer. Drought can lead to stressed plants, resulting in small berries and reduced yields, while over-watering may result in leaching of nutrients and root rot. Drought stress has also been shown in other plants to increase susceptibility to Phytophthora root rot.

Soil Acidity

Soil pH below 5.5 leads to poor yields and growth. Poorly growing roots are less able to withstand root rot pathogens and root damaging insects.

Frost

Frost injury increases cane and shoot dieback from Pseudomonas bacterial blight and vice versa. Excess nitrogen in the fall increases frost injury and damage from Pseudomonas bacterial blight in the spring. Severe frosts can also kill new primocanes in spring. Frost damage can be very significant in some years in the BC Lower Mainland. Frost is normally not a problem in Ontario except for some areas in northern Ontario.

Nutrient Imbalance

Magnesium, boron, and calcium levels are often low in coarse, sandy soils. Magnesium deficiencies cause interveinal areas of leaves to become yellow and red,eventually resulting in leaf death, starting with older leaves. Symptoms of boron deficiency include uneven bud break in the spring, downward cupping of leaves, death of the terminal bud on new canes and crumbly fruit and narrowing of new leaves in late summer. Calcium deficiencies result in slow growth, dieback of the terminal growth and spotting of leaves. Purpling and reddening of new leaves often occurs in early spring in BC as the result of a phosphorus deficiency. This is more severe in cold, wet years, but the plants generally grow out of it as the weather warms up.

Diseases

Key Issues

- There is an urgent need for new, reduced-risk fungicides in raspberry production for control of Botrytis and cane diseases, spur blight, late yellow rust, fireblight, powdery mildew and cane anthracnose and fruit rot.
- There is a lack of effective control methods for Phytophthora root rot and the causal agent has shown an ability to adapt to resistant varieties. There is a need for research on the timing of *Phytophthora* spp. infection periods to better target fungicide applications, as well as on new fungicides and management methods for the disease.
- There is a need for a more intensive breeding program for resistance to Phytophthora root rot, spur blight, Raspberry Ringspot Virus (Tomato Ringspot Virus TRV) and Raspberry Bushy Dwarf virus (RBDV) in varieties with good processing fruit and mechanical harvest qualities
- Strains of the bacterial blight pathogen (*Pseudomonas syringae* pv. *syringae*), resistant to copper, exist in the BC Lower Mainland.
- There is an urgent need for effective treatments including biopesticides, for the control of crown gall. Crown gall is particularly critical in BC since fields remain infested for many years and there is a limited amount of suitable land for new plantings.
- There are no treatments available for control of Raspberry Ringspot Virus (Tomato Ringspot Virus (TRV), once the virus is established in a planting.
- Raspberry Leafspot (*Sphaerulina rubi*) is a relatively new disease of raspberry and research is required on it's impact and control.
- There is a need for a nematicide treatment that can be applied in the spring.
- One of the key limitations in raspberry production is lack of effective pest control products. Several pest control products available to foreign competitors are not registered in Canada.
- Low commodity prices and thin profit margins and increasing gas, tax and labour costs have made private IPM scouting increasingly unprofitable.
- There are no disease forecasting programs since favourable weather conditions for Botrytis exist in most years and preventive fungicide treatments are generally needed starting at bloom.

Table 2. Degree of occurrence of disease pests in Canadian raspberry production

	Degree of occurrence		
Major Diseases	**BC**	**ON**	**QC**
Botrytis fruit rot and cane blight and wilt	E	E	E
Phytophthora root rot	E	E	E
Spur blight	E	E	E
Anthracnose	E	E	E
Yellow rust	E	DNR	DNR
Late yellow rust	DNR	E	E
Fire blight	DNR	E	E
Raspberry Bushy Dwarf Virus (RBDV)	E[1]	DNR	E[1]
Raspberry leafspot (*Sphaerulina rubi*)	DNR	E	DNR
Lesser Diseases	**BC**	**ON**	**QC**
Cane blight	E	E	DNR
Bacterial blight	E	DNR	DNR
Crown Gall	E	E	E
Nematodes	DNR	DNR	DNR
Powdery mildew	DNR	DNR	DNR
Raspberry ringspot (Tomato ringspot virus (TRV))	E	E	E
Rhizopus fruit rot (watery berry)	DNR	DNR	DNR
Verticillium wilt	DNR	DNR	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; E[1]- Refer crop profile text.
D – invasion expected or dispersing

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

Major Diseases

Botrytis Fruit Rot, Cane Blight and Wilt *(Botrytis cinerea)*

Pest Information

Damage: This fungus infects blossoms and fruit resulting in mouldy and dried berries and also causes primocane lesions known as Botrytis cane blight and wilt. Cane wilt causes less economic crop loss than fruit rot. In wetter years, the disease can drastically reduce both fruit quality (grade) and marketable yield and even with fungicide use, losses can be up to 30%.

Life Cycle: B. cinerea overwinters as sclerotia on primocanes and as mycelia on dead leaves and mummified fruit. These overwintering structures produce spores in the spring which infect blossoms. The early blossom infections remain inactive (latent) until the fruit is nearly ripe. When conditions are favourable for fungal growth within the berry, the fungus sporulates on the berry surface, appearing as a distinctive grey mould. These spores contribute to secondary infection of fruit, primocanes and other green tissues. Infections are of most concern when they occur during fruit development and harvest. The infection and spread of the disease is favoured by high moisture and poor drying conditions.

Pest Management

Chemical Controls: Registered chemicals include boscalid, iprodione and fenhexamid. . Growers apply preventive sprays each year starting at 10% bloom as weather conditions are favourable for disease development in most years. In Quebec, the critical periods for application are at early and late bloom.

Cultural Controls: Increasing air circulation helps to suppress the disease. Biennial crop production and primocane suppression help improve air movement and thus reduce the incidence of Botrytis in Ontario.

Alternative Controls: Due to the microscopic nature of the bloom infections, monitoring for this disease is impractical.

Resistant Cultivars: There is little or no resistance to Botrytis among raspberry cultivars. 'Meeker' displays some field resistance in BC, but all cultivars are susceptible under favourable weather conditions for the disease.

Issues for Botrytis Fruit Rot and Cane Blight and Wilt

1. Control of Botrytis fruit rot and cane wilt depends primarily on captan. There are no cost-effective alternatives. Additional fungicides are needed as a resistance management tool, as well as to provide control in case captan and, a second fungicide, iprodione are lost.
2. There are no disease forecasting programs for *Botrytis* since favourable weather conditions exist in most years and preventive fungicide treatments are generally needed starting at bloom.

Phytophthora Root Rot *(Phytophthora fragariae var. rubi* and other species

Pest Information

Damage: Fruiting canes wither and dry in summer from spring and fall root infection. Primocanes are killed and eventually whole bushes die out. The disease increases in plantings from year to

year. *Phytophthora* spp. are favoured by wet soil conditions and can invade and kill root and crown tissue. This is a site specific disease related to soil type and drainage. It can be very serious in fields where it is present. In BC, Pythium causes similar damage to Phytophthora.

Life Cycle: The pathogens persist in the soil for many years by means of resistant spores. Mycelium in infected roots produces sporangia in spring and fall which release zoospores that move in water and infect new root tips in wet conditions. *P. fragariae* is a cool weather pathogen that infects roots at soil temperatures from about 1 to 12^{o}C. In irrigated fields, it is possible that infection from *P. cinnamomi* can occur later in warmer soils.

Pest Management

Chemical Controls: Registered chemicals include metalaxyl-m and fosetyl-al, but these are only partially effective.

Cultural Controls: Cultural practices to prevent infection include avoidance of fields with a history of the disease (as the fungus can survive in the soil for several years), improving soil drainage, ridging or planting into raised beds, cleaning cultivation equipment to avoid spread from infected to healthy fields, application of gypsum to increase calcium levels in the root zone and use of certified, disease-free root stock. In Ontario, control is focused on providing ideal drainage including the use of raised beds. Gypsum added to increase soil calcium levels may reduce infection and plant damage but further research is needed. Many BC growers plant on raised beds and try to incorporate manures and fertilizers to reduce root rot, but this does not control the disease effectively.

Alternative Controls: Fields can be scouted before or during harvest for symptoms.

Resistant Cultivars: 'Meeker' has some tolerance to root rot but there is no acceptable resistance in most cultivars and the disease has been increasing on 'Meeker' in recent years. Phytophthora is a problem in Ontario especially with the cultivar 'Titan'

Issues for Phytophthora Root Rot

1. There is a lack of effective control methods for Phytophthora root rot. The primary causal agent, *Phytophthora fragariae* var. *rubi*, has shown an ability to adapt to resistant varieties.
2. There is a need for epidemiological studies to determine the timing of *Phytophthora* spp. infection periods and improve the timing and efficacy of fungicide applications.
3. There is a need for new, reduced risk fungicides and alternative management tools for root rot.
4. More intensive breeding programs for resistance to Phytophthora root rot in raspberry cultivars with good processing fruit and mechanical harvest qualities are required.

Spur Blight (*Didymella applanata*)

Pest Information

Damage: Yield loss from this disease tends to be cumulative over the years. Cane and shoot infection causes dieback of leaves, shoots and fruiting spurs. The disease first appears in mid- to late summer as wedge-shaped lesions on leaves. As the disease progresses, infections travel down the leaf petiole and infect the cane at the nodes. Primocane lesions can damage buds once the infections reach the cane. Damaged buds are predisposed to winter injury, potentially reducing yield the next season.

Life Cycle: The fungus overwinters on infected primocanes and in the spring produces ascospores and conidia which can be wind-blown or rain-splashed and infect new primocanes. Release of conidia continues throughout the growing season during wet weather.

Pest Management

Chemical Controls: Registered fungicides include calcium polysulphide, captan and ferbam but these provide only some disease suppression.

Cultural Controls: None identified.

Alternative Controls: Scouting may be done to determine infection levels and the need for lime sulphur in dormant season or applications of captan or ferbam pre-bloom.

Resistant Cultivars: None available. Vigorous varieties are more susceptible.

Issues for Spur Blight

1. There are no effective control methods for Didymella spur blight in Canada. New, reduced risk fungicides need to be registered and alternative control methods need to be developed.

Anthracnose or cane spot (*Elsinoe veneta* and *Colletotrichum* spp.)

Pest Information

Damage: The first symptoms are small, purplish circular patches on the cane or petioles that enlarge and eventually girdle the canes, resulting in dieback of the canes and potential for uneven fruit ripening. Considerable cane injury may result from anthracnose in years when weather remains wet into late May or early June, but early infections are more damaging.

Life Cycle: In the fall, the disease spreads via spores produced in small black fruiting bodies. In the spring, splashing rain carries the spores to new shoots, leaves or fruit, where infection takes place. Both *E. veneta* and a *Colletotrichum* species resembling *C. gloeosporioides* have been associated with this disease in BC; *E. veneta* is the most common species in eastern Canada.

Pest Management

Chemical Controls: Registered fungicides include ferbam. Ferbam is applied early, pre-bloom or post-harvest.

Cultural Controls: Control includes pruning out infected canes after harvest and avoiding excessive nitrogen.

Alternative Controls: None identified.

Resistant Cultivars: 'Meeker' appears to have some resistance. The variety 'Qualicum' is more susceptible.

Issues for Anthracnose

1. Anthracnose causes very serious losses in Quebec, from both cane blight and fruit rot, and there are no effective control methods. The registration of reduced risk fungicides is required.

Yellow Rust (*Phragmidium rubi-idaei*)

Pest Information

Damage: The fungus infects floricane and primocane foliage. In some years, it causes significant premature leaf death, reducing plant vigour and increasing the likelihood of winter injury.

Life Cycle: The fungus overwinters in old primocane leaf debris trapped in bundles of canes where they are tied to the trellis wire. Spores released by the fungus in the spring cause the initial infection of floricane leaves. The first visible symptom of disease is the appearance of orange pustules on older leaves. Spores from these lesions lead to secondary spread of the disease and to the overwintering stage.

Pest Management

Chemical Controls: Registered fungicides include calcium polysulfide, ferbam and propiconazole.

Cultural Controls: In infected fields, it is recommended that leaves be removed from primocanes before they are tied up in the fall, or that cane tying be delayed until after leaves have dropped. At this time, leaves may be tilled into the soil. This sanitation practice is not always practical, but when done it is an important control.

Alternative Controls: Scouting in late April, early May and after harvest is recommended to assist in decisions on dormant or pre-bloom fungicide sprays and post-harvest cultural practices to reduce winter carryover. The level of disease symptoms (disease severity) may be used to decide whether dormant or pre-bloom fungicide treatment is warranted, but there are no precise thresholds.

Resistant Cultivars: None available. The variety 'Malahat' is more susceptible to this disease.

Issues for Yellow Rust

1. None identified.

Late Yellow Rust (*Pucciniastrum americanum*)

Pest Information

Damage: In Atlantic Canada and Quebec, late yellow rust is a significant problem which prevents cultivation of some raspberry varieties, such as 'Festival', which have good fresh market qualities. This rust can attack leaves causing premature leaf drop and greater susceptibility to winter injury. It attacks the fruit itself resulting in unsightly and unmarketable berries. Severe outbreaks usually occur at harvest (late July to mid-August) and are often linked to conditions favourable for the development of aecia on nearby white spruce earlier in the season.

Life Cycle: The late leaf rust fungus is not systemic. The fungus is heteroecious, attacking two different hosts at two different stages of its life cycle. The alternate host is white spruce (*Picea americanum*), on which it produces aeciospores. The spores produced on white spruce in mid-June and early July and are capable of infecting raspberry plants. Infected raspberry plants then produce urediniospores in early July on the underside of infected leaves and flowers, which continue to cause infections on the raspberry plant thorughout the growing season. In the fall, the fungus is capable of creating teliospores on infected raspberry leaves. These spores serve as the overwintering form of the fungus. The following year, these spores germinate and form basidiospores, which are capable of infecting white spruce needles during rainy periods from mid-May to early June. Since the disease can be found year after year in regions far from spruce trees, it is suspected that the fungus overwinters on infected raspberry canes as urediniospores or teliospores, which serve as the source of primary inoculum for new infections the next growing season in these regions.

Pest Management

Chemical Controls: Registered fungicides include calcium polysulfide and ferbam.

Cultural Controls: Growers have resorted to removing the alternate host (white spruce).

Alternative Controls: The level of disease symptoms at harvest may be used to decide whether dormant or pre-bloom fungicide treatment is warranted, but there are no precise thresholds.

Resistant Cultivars: Resistant cultivars are 'Nova' and 'K81-6'. 'Pathfinder' and 'Festival' are susceptible to late yellow rust.

Issues for Late Yellow Rust

1. There are no registered fungicides for late yellow rust.

Fire Blight *(Erwinia amylovora)*

Pest Information

Damage: Fire blight causes significant crop damage in some years on the prairies, where 'Boyne', a highly susceptible variety, is the most commonly grown variety. Fire blight of raspberry is caused by a bacterium similar, but not identical to, the bacterium that causes fire blight on apples and pears. Primocane tips and laterals of infected raspberry canes appear wilted, black and frequently curve downward in the form of a shepherd's crook. Infected fruit or flower clusters appear water-soaked and eventually turn black. Droplets of white or amber bacterial ooze may be excreted from the lesions of infected tissue. Infected berries become hard, dry and brown and remain attached to the pedicel.

Life Cycle: Insects such as tarnished plant bugs which have piercing, sucking mouthparts, earwigs and ants can spread the fire blight bacteria and facilitate infection. Ants efficiently spread the bacterium to healthy blossoms.

Pest Management

Chemical Controls: None available.

Cultural Controls: Overhead irrigation on susceptible varieties should be avoided as this practice can cause wounding of tissue and favours infection and spread of the bacteria to healthy plants. Infected canes should be pruned out and removed from the planting as soon as observed. Insects must be monitored and controlled if necessary. Resistant cultivars should be planted in areas of potential disease development.

Alternative Controls: None identified.

Resistant Cultivars: Heritage, Nova, and Royalty are resistant varieties, Ruby, Avon, Polana and Caroline are partially resistant and Boyne and K81–6 are susceptible varieties.

Issues for Fire Blight

1. There are no treatments registered for fireblight..

Raspberry Bushy Dwarf Virus (RBDV)

Pest Information

Damage: RBDV has become common in the BC Lower Mainland over the past five years resulting in loss of yield and fruit quality and a shortened lifespan of plantings. This virus, in spite of its name, does not cause bushy or dwarfed plants, but rather crumbly fruit. Once a plant is infected, it will carry the virus for life, and continue to produce a poor quality and low fruit yield. Yield and fruit quality losses are estimated at 20-30% in infected plantings. The disease is not common in other regions of Canada, but does occur in Quebec, where it is becoming a concern.

Life Cycle: The disease is spread by infected pollen.

Pest Management

Chemical Controls: None available.

Cultural Controls: The only methods to control RBDV are cultural means including planting certified stock and the use of resistant varieties, although spraying for vectors can reduce spread of the virus.

Alternative Controls: None available.

Resistant Cultivars: Willamette, Cowichan and Chilcotin are resistant, while Meeker is susceptible.

Issues for Raspberry Bushy Dwarf Virus

1. RBDV is a major factor in poor fruit quality and the only effective control is development of resistant varieties. There is a need for a more intensive breeding program for resistance to RBDV (as well as root rot and spur blight) in varieties with good processing fruit and mechanical harvest qualities.

Minor Diseases

Cane Blight (*Leptosphaeria coniothyrium*)

Pest Information

Damage: This fungus is not common, but has a serious impact when it does occur. The fungus remains in the vicinity of the wound, but toxins produced by the fungus move up the cane, killing vascular tissue and buds. In infected canes, a reddish streaking lesion can be seen when the epidermis above the primocane wounds is scraped off. Symptoms may be confused with spur blight, anthracnose or Botrytis cane wilt.

Life Cycle: The fungus overwinters on old cane stubble and infection is favoured by wet conditions during the harvest period. Physical damage to the surface of the primocanes (usually from machine-harvesting) allows the fungus to enter the vascular tissue.

Pest Management

Chemical Controls: Calcium polysulphide is registered for the control of this disease.

Cultural Controls: The disease can be controlled by pruning out infected canes. Reducing damage from harvesting machinery, mowing equipment and trellising are also important cultural controls. Most growers adjust catcher plates to minimize primocane damage during mechanical harvest, thereby reducing the likelihood of infection.

Alternative Controls: Examination of suspect primocanes in the fall and early spring is recommended to confirm the presence of this disease. There are no precise thresholds.

Resistant Cultivars: None available.

Issues for Cane Blight

1. None identified.

Bacterial Blight (*Pseudomonas syringae* pv. *syringae*)

Pest Information

Damage: Bacterial blight rarely causes significant injury on raspberries, but can cause shoot dieback in early spring and can augment frost damage. The disease is more severe in some

years when warm weather is followed by a spring frost, as cool, wet weather favours infection. Losses from the disease are highly variable from year to year depending on weather conditions.

Life Cycle: Bacterial blight can occur in the spring, when temperatures are just above 0°C, until about mid-May, when there is a sudden wilting and blackening of new shoots, cane tips, laterals and leaves. However, the most serious phase is believed to occur in the fall in fields that are actively growing later than normal. These fields are susceptible to infection of the cambium layer under the bark. This damage is usually not noticed until spring and can be confused with spur blight or winter injury. The bacterium survives on leaf surfaces, in healthy buds and on weeds. It spreads through splashing rain, wind, insects and infected planting stock.

Pest Management

Chemical Controls: Registered fungicides include copper based compounds such as copper oxychloride and copper sulphate. Copper bactericides are only partially effective due to disease resistance and lack of persistence and are rarely applied.

Cultural Controls: Growers prune out infected canes and try to avoid excess nitrogen in the fall which leads to softer, more susceptible shoots.

Alternative Controls: None identified.

Resistant Cultivars: None available.

Issues for Bacterial Blight

1. Strains of the bacterium resistant to copper exist in the BC Lower Mainland.

Crown Gall (*Agrobacterium tumefaciens*)

Pest Information

Damage: This bacterial disease can cause significant reductions of yield,. The pathogen causes woody swellings on the roots, crowns or canes at ground level. Infected raspberry plants have short, weak fruiting canes with leaves that yellow and dry out in warm weather. Root and crown galls reduce nutrient uptake, resulting in yield loss and early decline of plantings. The long term impact can be greater since fields remain infested for many years and the disease will affect a new crop when fields are replanted.. This disease causes more damage under dry conditions. A related disease, caused by *Agrobacterium rubi*, attacks fruiting stems in Quebec and often is eliminated by pruning out of old stems.

Life Cycle: The bacterium can be introduced in infected planting stock and can carry over for many years in infested field soil. It enters the plant through wounds created by insects or mechanical damage.

Pest Management

Chemical Controls: None available.

Cultural Controls: Introduction of the bacterium can be prevented by carefully checking planting stock for galls and using only certified planting stock. Growers remove plants as they decline and re-plant. Long rotations are practiced in Ontario where crown gall is found. Also, more tolerant cultivars are planted. Other cultural controls include disinfecting pruning shears and minimizing plant injury.

Alternative Controls: An antagonistic bacterium (*Agrobacterium radiobacter*), available in a spray known as Dygall, may reduce the level of crown gall bacteria when applied to cuttings

or roots before planting in infested soils. However, because of the high cost and limited effectiveness, it is seldom used. This product is registered for nursery cuttings only.

Resistant Cultivars: Resistant or tolerant varieties include 'Willamette' and 'Meeker'. 'Meeker' can be susceptible to crown gall in nurseries but usually does not become infected under field conditions. 'Qualicum' is susceptible.

Issues for Crown Gall

1. Biopesticides are needed to control this pest (in Ontario).
2. There is an urgent need for effective fungicide treatments.
3. Crown gall is particularly critical in BC since fields remain infested for many years and there is a limited amount of suitable land for new plantings.

Nematodes - Root Lesion (*Pratylenchus* spp.), Dagger (*Xiphinema* spp.), Sting *(Belonolaimus* spp.*)*

Pest Information

Damage: Crop loss occurs from early decline of plantings and gradual loss of vigour. The sandy soils where raspberries are grown are highly favourable for pathogenic nematodes. If left uncontrolled, root lesion nematodes will shorten the productive life span of an established field by 2 to 3 years. Root lesion nematodes weaken plants and reduce their ability to overcome other pest damage or stress. Nematode damage to roots may increase susceptibility to root rot organisms, but no study has been done on this specific linkage. Dagger nematodes (*Xiphinema* spp.) transmit raspberry (tomato) ringspot virus. Only a small percentage of fields in the Abbotsford area (5%), are infested with dagger nematodes but the damage is severe where it occurs because of ringspot virus transmission. In Ontario and Quebec, the most common nematode pest is the root lesion nematode but the presence of dagger nematode is a concern as a vector for ringspot virus. The impact of nematodes on a vigorous field is less pronounced than on a weak field. Damage may occur at lower nematode densities if plants are also stressed by root rotting diseases, insects or other factors.

Life Cycle: Plant-feeding nematodes can progress from the egg stage to egg-laying adults in as little as 21 to 28 days during warm summer months. Nematodes are believed to survive from season to season primarily as an egg in the soil. Second stage juvenile nematodes enter roots to feed. Males eventually leave the roots, while females remain embedded within roots where they lay their eggs into a jelly like mass that extends out through the root surface and into the soil.

Pest Management

Chemical Controls: Registered nematicides include chloropicrin (used as a soil fumigant) and oxamyl (used as post-plant treatment).

Cultural Controls: Cultural methods to reduce root lesion nematode include good weed control and long rotations out of raspberries. However, this pest has a wide host range. Rotation is practiced in Ontario as an alternative to fumigation in areas where suitable land is available. Included in the rotational practices is the growing of non-nematode host crops or the growing of nematode-suppressing cover crops and the addition of soil amendments including manure. Keeping fields fallow and weed-free for 1 year prior to planting raspberries will reduce but not eliminate nematode populations. Planting stock certified to be free from tomato ringspot virus on land that is free from dagger nematodes is advised, but meeting both these

conditions may be difficult. Both the vector nematode and the virus have a wide host range. Where dagger nematodes transmit ringspot virus, the only control is roguing out infected plants.

Alternative Controls: Soil samples, to monitor for root lesion and dagger nematodes are collected before field planting to aid in site selection and to determine pre-plant fumigation needs. Economic injury levels based on laboratory analysis are well-established for root lesion nematodes. Due to their ability to transmit viruses, the threshold for dagger nematodes is very low.

Resistant Cultivars: None available.

Issues for Nematodes

1. There is a need for a nematicide treatment that can be applied in the spring.

Powdery Mildew (*Sphaerotheca macularis*)

Pest Information

Damage: This pest has a wide variety of hosts, including raspberries, strawberries, currants, gooseberries and weeds. Damage includes a fungal coating on the fruit and fruit discolouration, cracking and rotting and renders the fruit unmarketable. Severely infected plants may be stunted. The white/grey powdery growth first appears on leaves, green shoots and fruit and later becomes brown with black specks (fungal fruiting bodies).

Life Cycle: The fruiting bodies overwinter on fallen leaves and fruit. New leaves and fruit are infected every year in late spring, when bloom begins. Infection is caused by airborne spores and is favoured by warm, humid weather and late-season dew and fog.

Pest Management

Chemical Controls: Registered fungicides include thiophanate methyl.

Cultural Controls: Bushes are pruned and weeds are controlled to promote good air circulation. In the fall, cultivation between rows will bury infected leaves.

Alternative Controls: Leaves are checked for the first signs of white powdery growth before and during bloom.

Resistant Cultivars: Some resistant cultivars are available.

Issues for Powdery Mildew

1. There is a need to register new fungicides for the effective control of powdery mildew.

Raspberry Ringspot (Tomato Ringspot Virus, TRV)

Pest Information

Damage: Raspberry ringspot virus causes reduced yield and vigour. This virus stunts raspberry plants and causes crumbly fruit, thus impacting both yield and fruit quality. Some varieties may also show leaf symptoms, such as mottling, yellowing, ringspots, mosaic patterns or curling. The disease is present in light soils only.

Life Cycle: This virus is spread by dagger nematodes (*Xiphinema americanum*).

Pest Management

Chemical Controls:
Cultural Controls: Control of weeds, which are a host to nematode populations that may harbour the virus, is important. Soil should be tested for nematodes and certified planting stock should be used. At low levels of infection, infected plants and adjacent plants should be removed.
Alternative Controls: None identified.
Resistant Cultivars: None available. The variety 'Meeker' is susceptible to ringspot virus.

Issues for Raspberry Ringspot Virus

1. There are no treatments available for control of Raspberry Ringspot Virus, once the virus is established in a planting.

Rhizopus Fruit Rot (watery berry) (*Rhizopus* spp.)

Pest Information

Damage: Fruit infected with *Rhizopus* softens rapidly and collapses. This disease will occur after harvest, as well as on ripe fruit in the field in warm weather.
Life Cycle:

Pest Management

Chemical Controls: Registered fungicides include captan and thiophanate methyl.
Cultural Controls: None identified.
Alternative Controls: None identified.
Resistant Cultivars: None available.

Issues for Rhizopus Fruit Rot

1. None identified.

Verticillium Wilt (*Verticillium dahliae* and *V. albo-atrum*)

Pest Information

Damage: Both *Verticillium dahliae* and *V. albo-atrum* can infect raspberries causing a condition called "bluestem" and resulting in stunted growth, nutrient deficiency symptoms, wilted canes and poor production in the second or third year and later years.
Life Cycle: These pathogens are soil-borne and enter through the roots from where they move upwards in the vascular system and block water and nutrient movement. *V. albo-atrum* does not persist in soil for more than one season, but *V. dahliae* produces microsclerotia which can survive and remain infective in soil for many years. Both pathogens have a very wide host range.

Pest Management

Chemical Controls: Pre-plant soil fumigants applied for nematode suppression will also help to suppress Verticillium wilt temporarily.
Cultural Controls: Raspberries should not be planted where strawberries or potatoes and other solanaceous crops have been grown in the past if *Verticillium dahliae* has been present.
Alternative Controls: None identified.
Resistant Cultivars: Some varietal resistance is known.

Issues for Verticillium Wilt

1. None identified.

Table 3. Disease control products, classification and performance for Canadian raspberry 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	I	This product is not believed not to be effective against the strain of crown gall affecting raspberries.
boscalid (Lance WDG)	carboxamide fungicide	complex II in fungal respiration (succinate-dehydrogenase); 7	RR	Botrytis grey mould	A	Resistance is a concern with repeated use. Short pre-harvest interval. New product and growers are not familiar with it.
captan (Captan 80W, Maestro 80 DF)	phthalimide fungicide	Multi-site activity; M4	R	Rhizopus fruit rot		
				Spur blight	A^P - A	Inexpensive fungicide used in rotation. Long residual activity. Long pre-harvest interval. No documented resistance. Leaves residues on fruit.Not to be used once the fruit starts ripening as it will cause spotting.
copper oxychloride (Copper Spray Fungicide)	inorganic fungicide	Multi-site activity; M1	R	Bacterial blight		Usually only treated in fall raspberries.

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**
copper sulphate (Copper 53W, Basicop Fungicide WP)	inorganic fungicide	Multi-site activity; M1	R	Bacterial blight		Copper based products are registered for control of bacterial blight caused by *Pseudomonas syringae* but are not registered for fireblight caused by *Erwinia amylovora*. In Québec, only *Erwinia amylovora* is present.
fenhexamid (Elevate 50 WDG)	hydroxyanilide fungicide	3-keto reductase during C4 demethylation in sterol biosynthesis; 17	R	Botrytis grey mould	A	Short pre-harvest interval. Resistance can be an issue with repeated use. High cost and is used as a last resort. Many growers (Ontario) consider the efficacy of Elevate, Rovral and Lance to be roughly equivalent. The product is not well known in some areas.
ferbam (Ferbam 76WDG)	dithiocarbamates and relatives fungicide	Multi-site activity; M3	R	Anthracnose	A^P	Less restrictive timing of application. The product leaves a residue.
				Spur blight	I - A^P	No residue tolerance in Japan. Research is required to confirm the efficacy against spur blight.It is strongly recommended that this product be applied early in the season for best results against this disease.
				Yellow rust		
				Late yellow rust		

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**
fosetyl-al (Aliette WP Systemic Fungicide)	ethyl phosphonate fungicide	Unknown; 33	R	Phytophthora root rot	A	Good rotation for Ridomil. Resistance could be of concern with repeated use. Soil type and drainage is a major factor with this disease. Heavier soils are more prone to infection. Cannot apply in the spring if there are no leaves.
iprodione (Rovral WDG)	dicarboximide fungicide	NADH cytochrome c reductase in lipid peroxidation (proposed); 2	R	Botrytis grey mould	A	Has localized systemic activity and curative effects. Resistance is beginning to develop.
sulphide sulphur; calcium polysulphide (Lime sulphur, Wilson Professional Lime Sulfur)	inorganic insecticide, fungicide, acaricide	Multi-site activity; M2	R (re-evaluation complete)	Cane blight	A^P	
				Spur blight	A^P	Phytotoxic. Difficult to apply. The window of application is narrow, a function of temperature. Young shoots can be damaged if application occurs after bud swell. This product is also an acaricide. Bordeau mixture may be used very early in the season and for renovation.
				Yellow rust		
				Late yellow rust		

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**
metalaxyl-m (Ridomil Gold 480EC)	acylalanine fungicide	RNA polymerase I; 4	RE/RR	Phytophthora root rot	I - A	Long pre-harvest interval. Advantage: applied by drip irrigation. Sometimes difficult to get the product down into the soil. Difficult to apply in the fall due to field conditions. Best used in conjunction with Aliette. Provides inadequate control in Ontario.
propiconazole (Topas 250E)	triazole fungicide	C14-demethylation in sterol biosynthesis; 3	RE	Yellow rust	A^P	Need more research on this pathogen, it's life cycle and the efficacy of treatments. New registration, limited data.
thiophanate-methyl (Senator 70WP)	thiophante fungicide	mitosis: beta-tubuline assembly; 1	RE	Rhizopus fruit rot		
				Powdery mildew		

[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, Ontario and Quebec (2005).

Table 4. Availability and use of disease pest management practices for Canadian raspberry production

	Practice \ Pest	Botrytis fruit rot, cane blight and wilt	Phytopthora root rot	Spur blight	Cane blight	Anthracnose	Yellow rust	Fireblight	Raspberry Leafspot
Prevention	equipment or facility sanitation; use of sterile media								
	mowing / mulching / flaming								
	removal of alternative or wild 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								
	pesticide rotation for resistance management								
	controlled atmosphere storage								

no information regarding the practice is available

available/used

available/not used

not available

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

Insects and Mites

Key Issues

- There is an urgent need for new, reduced-risk insecticides in raspberries to match those available in the US, for weevil control and pre-harvest insect clean-up for mechanical harvesting. Only organophosphate insecticides, such as diazinon, malathion and azinphos-methyl are registered for the control of weevils, fruitworms and crown borer in Canada. Moreover, pre-harvest intervals for insecticides available in Canada are too long to permit a "clean-up" spray before harvest.
- There is a critical need for an effective pre-harvest, adult miticide with a pre-harvest interval (PHI) of less than 7 days.
- Registration of new, reduced-risk products are needed for sawflies, leafrollers, cutworms and tarnished plant bugs..
- Harmonization of pesticide registration is crucial for continued access to the U.S. market as differing MRL's between the U.S. and Canada are affecting trade and are expected to have an increasingly negative impact on Canadian exports.
- There are no products registered for the control of sap beetles.
- There is a need for research to determine the impact and economic threshold of tarnished plant bug on raspberries.
- The raspberry cane borer (*Oberea bimaculata*) can be a problem in raspberry plantings. It is a problem in wild raspberries. Pruning decreases the population and is important especially in border rows, however the insect still persists. There are no pesticides registered for control of the raspberry cane borer.
- Insecticides with novel chemistry are needed for application close to harvest for caterpillars.
- An IPM approach to managing caterpillars needs to be developed.
- There is a need for the registration of reduced risk pesticides for the control of raspberry fruitworm and western raspberry fruitworm.
- There is a need to evaluate the usefulness in Canada, of a plant-derived phero-chemical (attractant) being assessed in Washington State, as a monitoring and decision-making tool, for timing insecticide treatment for fruitworms.
- Ants are an occasional pest of low importance. Their nests sometimes interfere with mowers. They are present on fruit at harvest which is undesirable to the consumer. An IPM approach to this pest needs to be developed.
- There is a need to develop IPM approaches for the control of occasional pests such as crickets, white grubs and Japanese beetles, chrysomèles des raciness (root weevils(?), raspberry cane maggot , wasps that are attracted to ripe fruit and Asian lady beetles (present in the fall).
- Monitoring for the raspberry crown borer is difficult as current techniques are destructive and involve digging up the plant. This pest is very devastating and is not readily recognized until significant crop losses have occurred.
- Demonstration projects are required to show growers the effective use of beneficial organisms for mite control.

Table 5. Degree of occurrence of insect pests in Canadian raspberry production

	Degree of occurrence		
Major pests	**BC**	**ON**	**QC**
Weevils (black vine weevil, Clay coloured weevil and obscure weevil	E	DNR	DNR
Strawberry bud (clipper) weevil	DNR	DNR	E
Caterpillars - Oblique banded leafroller, Cabbage looper, Bruce's spanworm, winter moth and alfalfa looper	E	E	E
Climbing cutworms - Bertha armyworm and variegated cutworm	E	DNR	DNR
Raspberry fruitworm and western raspberry fruitworm	E	E	E
Raspberry crown borer (*Pennisetia marginata*)	E	E	E
Red necked cane borer (*Agrilus ruficolis*)	DNR	E	E
Raspberry cane borer (*Oberea bimaculata*)	DNR	E	E
Spider mites - two spotted, yellow and McDaniel mite	E	E	E
Raspberry sawfly	DNR	E	DNR
Minor Pests	**BC**	**ON**	**QC**
Harvest contaminants	DNR	DNR	DNR
Raspberry cane maggot	DNR	DNR	E
Tarnished plant bug	DNR	E	E
Sap beetles	DNR	E	E
Leafhoppers	E	E	DNR
Aphids	E	DNR	DNR
Ants	DNR	DNR	E
White grubs / Japanese beetle	DNR	DNR	E
Wasps	DNR	DNR	E
Asian lady beetle	DNR	DNR	E
Root worm	DNR	DNR	E
Crickets	DNR	DNR	E
European earwigs	E	DNR	DNR
Wireworms	E	DNR	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			
E – established			
D – invasion expected or dispersing			

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

Major Insects and Mites

Weevils: Black Vine Weevil (*Otiorhynchus sulcatus*), Clay Coloured Weevil (*Otiorhynchus singularis*), Obscure Weevil (*Sciopithes obscurus*) and Strawberry Bud (*clipper*) Weevil (*Anthonomus signatus*)

Pest Information

Damage: Weevils are currently the most consistent and problematic fruit-contaminating insects on raspberries when the adult stage coincides with harvest. Damage from the strawberry bud weevil results when females sever buds from the pedicel, preventing fruit formation.

Life Cycle: Black vine weevils overwinter as grubs, feeding on roots in the top 5 to 20 cm of soil. They pupate in April and emerge from the soil as adults during May and early June. These adults are active on foliage at night during June and July, feeding on above-ground plant parts. Newly emerged adults begin laying eggs in late June prior to the onset of harvest. The life cycle of the obscure weevil is similar to that of the black vine weevil. Adult clay coloured weevils begin emerging from the soil in mid-March. These beetles feed on developing buds and new shoots, with peak damage occurring in April. Strawberry bud weevil has one generation per year, with overwintering adults emerging early in the season from ground litter in wooded areas. They migrate to berry fields in late April. Females puncture unopened buds with their long beaks and deposit a single egg into the bud. Larvae develop in the buds, reaching maturity in 3-4 weeks. Adults emerge in June, feed on flower pollen and then enter estavation in mid-summer, remaining inactive the rest of the season.

Pest Management

Chemical Controls: Registered insecticides include carbaryl (BC only), carbofuran (BC only) and malathion.

Cultural Controls: None identified.

Alternative Controls: Monitoring for adults is done using a beating tray in late March through April for the clay coloured weevil and from mid-May through late June for the black vine and obscure weevils. Monitoring is used to identify the species that are present and provide an estimate of population density before and after treatment.

Resistant Cultivars: None identified.

Issues for Root Weevils

1. The only insecticides registered for weevil control in Canada are broad-spectrum and will also kill beneficial insects, including pollinators.

Caterpillars: Obliquebanded Leafroller (*Choristoneura rosaceana*), Leaftiers and Loopers: Cabbage looper (*Trichoplusia ni*), Bruce spanworm (*Operophtera bruceata*), winter moth (*O. brumata*) and Alfalfa looper (*Autographa californica*)

Pest Information

Damage: Caterpillars feed on foliage and contaminate fruit. The timing of the life cycles of these insects varies from year to year depending on weather conditions. There are more than 25

species of caterpillars that may attack raspberries, but the obliquebanded leafroller (OBLR) is the most common in BC. OBLR is also a problem in Niagara and other isolated areas of Ontario. The larvae of this pest feed on raspberry foliage during April and May. The foliar damage is rarely economically important, but the larvae of the second generation can contaminate hand-picked and machine-harvested fruit in July and August if not controlled prior to harvest. There is little information available on the impact of this pest in Quebec.

Life Cycle: The OBLR overwinters as a larva, usually within protected old foliage or cane bundles in the field. In the spring the larvae move to feed on developing foliage, pupate and emerge as adult moths.

Pest Management

Chemical Controls: Registered insecticides include carbaryl and malathion Early spring applications of insecticides are often made for overwintering OBLR if larvae appear in late April, when weather is too cool for *Bacillus thuringiensis* (Bt) to be effective.

Cultural Controls: None identified.

Alternative Controls: Bacillus thuringiensis (Bt) *var. kurstaki* (foliar spray) and *Trichogramma minutum* (cards with eggs of this parasitic wasp) are available for control of these insects Parasitoids are also important contributors to the biological control of leafrollers and cutworms. Pheromone traps are used to monitor adult moth flights, however there is no established correlation between the number of adults caught and the resultant economic damage

Resistant Cultivars: None available.

Issues for Caterpillars

1. Insecticides with novel chemistry are needed for application close to harvest.
2. An IPM approach for the control of caterpillars needs to be developed.

Climbing Cutworms: Bertha Armyworm (*Mamestra configurata*) and Variegated Cutworm (*Peridroma saucia*)

Pest Information

Damage: Major fruit contamination occurs in years when the larval stage coincides with harvest (from late June to early August). Variegated cutworm larvae are present from April to October. They feed on buds and new growth early in the season and can be a significant contaminant at harvest.

Life Cycle: Bertha armyworms lay their eggs in masses of 50 to 500 eggs on the undersides of raspberry leaves. Peak larval emergence varies between July and September, depending on environmental conditions. Bertha armyworms lay their eggs early in the growing season, but in some years egg laying may occur at the same time as the oblique banded leafroller.

Pest Management

Chemical Controls: Registered insecticides include carbaryl.

Cultural Controls: None identified.

Alternative Controls: Bertha armyworms have several natural enemies, including a virus and a parasitic wasp (*Trichogramma minutum*). *Trichogramma* applied to control leafrollers will also control Bertha armyworms, as the wasp parasitizes the eggs of both species. Pheromone traps are sometimes used for monitoring cutworm moths.

Resistant Cultivars: None available.

Issues for Climbing Cutworms

1. Bt is not effective on cutworms and no pyrethroids are registered for use in raspberries in Canada. The registration of reduced risk products, such as those available in the US, is required.

Raspberry Fruitworm (*Byturus unicolor*) and Western Raspberry Fruitworm (*Byturus bakeri*)

Pest Information

Damage: Raspberry fruitworm is not an important pest for most raspberry producers, but has the potential to become a very significant fruit contaminant if not controlled. Adult beetles feed on new leaves and flower buds in May, but the main injury is caused by larvae which feed on the receptacle inside the fruit. There is a very low tolerance for this pest because of the effect on fruit quality and most fields across Canada are infested to some extent.

Life Cycle: Overwintering fruitworm beetles emerge from the soil during April and May. These beetles feed on fruit buds and unfolding leaves in the early spring, mate and then lay eggs on flower buds and inside opening flowers. The emerging larvae move into the centre of the developing fruits where they feed for 30 days or more. Once inside the fruit, they are protected from insecticidal sprays.

Pest Management

Chemical Controls: Registered insecticides include carbaryl, diazinon and malathion. The raspberry fruitworm may be indirectly controlled by malathion applications for the strawberry bud (clipper) weevil.

Cultural Controls: None identified.

Alternative Controls: Adult populations are monitored by scouting through direct examination of the earliest open flowers and/or with a beating tray from mid-April through early bloom. When scouting indicates the presence of the insect in a field, a pre-bloom insecticide is applied to control adults prior to egg laying and before bees are introduced for pollination.

Resistant Cultivars: None available.

Issues for Raspberry Fruitworm and Western Raspberry Fruitworm

1. Diazinon and malathion are the only pre-bloom insecticides registered in Canada and are fairly effective in minimizing damage. However, these insecticides are toxic to bees and there is a short window for control of adults before egg-laying. Malathion is only effective at temperatures above 21^{o}C. There is a need for the registration of reduced risk pesticides for the control of raspberry fruitworm and western raspberry fruitworm.

2. A plant-derived phero-chemical (attractant) is being assessed in Washington State as a monitoring and decision-making tool for timing insecticide treatment. Its potential as a mass-trapping device has not yet been determined, and research is needed to confirm its usefulness in Canada.

Raspberry Crown Borer (*Pennisetia marginata*)

Pest Information

Damage: Raspberry crown borer has a 2-year life cycle and is considered more problematic in older, established plantings. Feeding damage in canes and crowns can weaken plants and kill infested canes. Infested areas often have uneven bud break in the spring and spindly canes,

which break off at ground level. Populations of borers can increase rapidly in infested fields, shortening the lifespan of plantings. Without insecticides, estimated yield loss could be up to 50%..

Life Cycle: Adult moths are present from late July through early October. Newly hatched caterpillars crawl down to the base of the canes and form an overwintering cell beside the cane. They begin to feed in early March on cane buds around the plant crown and then burrow into canes.

Pest Management

Chemical Controls: Registered compounds include diazinon. Due to its 2-year life cycle, these pests must be treated for two consecutive seasons to achieve control.

Cultural Controls: Weak areas within a field can be checked for evidence of this insect during pruning or cane tying. Infested canes or canes with galls are pruned out close to the crown, immediately after harvest or when setting canes on wires.

Alternative Controls: None identified.

Resistant Cultivars: None available.

Issues for Raspberry Crown Borer

1. The effectiveness of insecticides is poor because larvae reside inside canes and crowns. There is a need to develop alternative management methods.
2. Monitoring for the raspberry crown borer is difficult as current techniques are destructive and involve digging up the plant. This pest is very devastating and is not readily recognized until significant crop losses have occurred.

Red-necked Cane Borer (*Agrilus ruficolis*)

Pest Information

Damage: The adult feeds along leaf margins from May through early August. Eggs hatch into larvae and tunnel up and down the cane in a spiral pattern. Infested canes develop galls at the site of the tunnelling. This can cause canes to break near the swellings, while unbroken canes can wither and die. Swollen canes are usually first observed in July and August.

Life Cycle: Females deposit eggs on the bark of new growth near the bottom of the cane in May and June. Larvae reach full size in the fall and overwinter in the canes, pupating in the spring.

Pest Management

Chemical Controls:

Cultural Controls:

Alternative Controls:

Resistant Cultivars:

Issues for Red-necked Cane Borer

1. None identified

Raspberry Cane Borer (*Oberea bimaculata*)

Pest Information

Damage:.

Life Cycle:

Pest Management

Chemical Controls:
Cultural Controls:
Alternative Controls:
Resistant Cultivars:

Issues for Raspberry Cane Borer

1. None identified

Spider Mites: Two Spotted Spider Mite (*Tetranychus urticae*), Yellow Spider Mite (*Eotetranychus carpini borealis*) and McDaniel spider mite (*T. mcdanieli*).

Pest Information

Damage: Mites are a significant pest of raspberries across Canada. Several mites attack raspberries, but two spotted and yellow spider mites are the most common species that damage raspberry in most provinces. Both species feed on the underside of leaves. Populations are higher in the fall. Feeding damage reduces plant vigour and may cause leaves to drop prematurely, contributing to the potential for winter injury and subsequent yield loss. If uncontrolled, excessive defoliation during and after harvest from two spotted mite feeding damage can reduce yield by 25% the following season. Foliar symptoms associated with spider mite feeding differ between the species. This helps in identifying the mite species present. In Quebec, the McDaniel spider mite is the most common species.

Life Cycle: Spider mites overwinter as adult females in the soil in raspberry fields and begin to colonize the plants in early summer, moving upward on the canes. Populations usually increase through June and July with potential for rapid increase after harvest in mid to late August. In September, populations decline as a result of predation by natural enemies and migration of overwintering females from the raspberry plants to overwintering sites.

Pest Management

Chemical Controls: Registered pesticides for mites include abamectin, clofentizene, dicofol pyridaben and insecticidal soap. Clofentezine, pyridaben and insecticidal soap are the most commonly used miticides.

Cultural Controls: Good farming practices (e.g. irrigation, proper fertilization) help maintain vigorous plantings and reduce the impact of spider mite feeding. Most growers rely on the degree of foliar damage, vigour of the field and time of the year to determine the need for spray programs. Approximate treatment thresholds are 75 yellow mites or 25 two-spotted mites per leaflet prior to September 1st, although thresholds may vary depending on the levels of natural enemies.

Alternative Controls: Predators play a major role in suppressing spider mites, but generally do not maintain population levels below economic injury thresholds. The most dependable, naturally-occurring spider mite enemy is the predatory mite, *Amblyseius fallacis* . It is currently used in 6-10 % of the area growing raspberry in Quebec where its introduction is done according to the threshold 2- 5 spider mites per foliole on fruiting canes before harvest (generally mid to late June). These predatory mites provide good control, as good as other products and

there are no problems with resistance. This is a biological control and the presence of the predator is recurring. In BC, adult *A. fallacis* are sometimes released into new fields or into "hotspots" of established fields. The abundance of this predatory mite is considered when making a treatment decision. Other spider mite predators include the minute pirate bug *(Orius tristicolor)* and a small black lady beetle (*Stethorus punctillum*) known as the "spider mite destroyer". *Stethorus* is a significant natural predator in BC and can also be introduced. In other growing regions, other naturally-occuring predatory mite and *Stethorus* species aid in managing phytophagous mites.

Resistant Cultivars: None available.

Issues for Spider Mites

1. There is a critical need for a pre-harvest, adult miticide in Canada. Available miticides have limited utility due to pest resistance (dicofol) or post-harvest labels (Agri-mek and Pyramite) only, since most mite damage to the crop occurs earlier. Apollo only kills the egg stage and is quite expensive.
2. Demonstration projects are required to show growers the effective use of beneficial organisms for mite control.

Raspberry Sawfly (*Monophadnoides geniculatus*)

Pest Information

Damage: The raspberry sawfly is a sporadic pest in all provinces, but most damaging on the Prairies. Large infestations can result in defoliation and loss of the crop and occur in all provinces in some years. Larvae feed on leaves causing large holes or skeletonizing.

Life Cycle: Mature larvae overwinter in a cocoon in the soil. Adult sawflies lay eggs on leaves in May and June. Larval feeding can continue through to November in BC.

Pest Management

Chemical Controls: Registered insecticides include diazinon. Controls timed for raspberry fruitworm will generally provide control of sawfly larvae as well.

Cultural Controls: None identified.

Alternative Controls: None available.

Resistant Cultivars: None available.

Issues for Raspberry Sawfly

1. The registration of reduced risk products for raspberry sawfly is required

Minor Insects and Mites

Harvest Contaminants

Pest Information

Damage: Insects can be detrimental to raspberry production either by directly damaging the plant or by contaminating the harvested product. Innocuous or beneficial insects may become pests when they are shaken off with the raspberries during machine harvesting, becoming harvest contaminants. In addition to the contaminants described below, other organisms that

can contaminate crops include raspberry aphids *(Amphorophora agathonica, Aphis rubicola),* European earwigs *(Forficula auricularia),* various stink bugs (Family: Pentatomidae), lygus bugs (Family: Miridae), spiders, slugs and snails and ants. Fruit contamination can result in the crop being rejected.

Life Cycle:

Pest Management

Chemical Controls: The use of a clean-up insecticide spray just prior to harvest is an essential practice for machine-harvest.

Cultural Controls: Some insects can be removed by hand on the machine belt and the sorting belt in the processing plant. Harvesters are equipped with air suction fans, which help remove some plant and insect debris.

Alternative Controls: None identified.

Resistant Cultivars: None available.

Issues for Harvest Contaminants

1. Ants are an occasional pest of low importance. Their nests sometimes interfere with mowers. They are present on fruit at harvest which is undesirable to the consumer. IPM approaches for this pest need to be developed.

Raspberry Cane maggot (*Pegomya rubivora*)

Pest Information

Damage: The raspberry cane maggot adult closely resembles a small housefly. Newly hatched maggots bore into the pith, and then turn outward and girdle the stem, causing the shoot to wilt and die. The maggots also bore down to the base of the plant, where it pupates and overwinters. This pest usually occurs earlier in the season than the cane borer and seldom causes serious injury to raspberry.

Life Cycle: P. rubivora lays eggs in the tips of shoots in early spring. When mature, the maggot bores down to the base of the plant to pupate and overwinter.

Pest Management

Chemical Controls: None available.

Cultural Controls: None identified.

Alternative Controls: None identified.

Resistant Cultivars: None available.

Issues for Cane Maggot

1. None identified.

Tarnished Plant Bug (*Lygus lineolaris* and other *Lygus* spp.)

Pest Information

Damage: Adults and nymphs feed on flowers and foliage by sucking sap.

Life Cycle: Adult bugs overwinter under plant debris.

Pest Management

Chemical Controls: None available although this pest is partially controlled by the application of malathion against the strawberry bud (clipper) weevil.
Cultural Controls: None identified.
Alternative Controls: The biological control agent *Beauvaria bassiana* is currently under development for control of this pest.
Resistant Cultivars: None available.

Issues for Tarnished Plant Bug

1. Registration of new control products are needed for tarnished plant bug and lygus bugs.
2. There is a need for research to determine the impact of tarnished plant bug on raspberries and the economic threshold for tarnished plant bug.

Raspberry Bud Moth (*Lampronia rubiella*)

Pest Information

Damage: The raspberry bud moth is a sporadic pest in the Maritimes.
Life Cycle:

Pest Management

Chemical Controls: None available.
Cultural Controls: None identified.
Alternative Controls: None identified.
Resistant Cultivars: None available.

Issues for Raspberry Bud Moth

1. None identified.

Sap Beetles (Coleoptera: Nitidulidae)

Pest Information

Damage: Sap beetles are a sporadic fruit contaminant in eastern Canada. They are more prevalent near fields of field and sweet corn. They bore into the fruit, devour portions and lay eggs. When disturbed, they fall to the ground and seek cover. The beetles have been implicated in the transmission of rot pathogens.
Life Cycle: Adult beetles are attracted to overripe or decaying fruit. The pest is not attracted to undamaged ripe raspberries, but any damage to fruit may cause sap beetles to attack.

Pest Management

Chemical Controls: None available.
Cultural Controls: Harvest ripe fruit and follow recommended crop production practices.
Alternative Controls: None identified.
Resistant Cultivars: None available.

Issues for Sap Beetles

1. There are no pesticides registered for the control of sap beetles.

Leafhoppers

Pest Information

Damage: Leafhoppers are occasional pests but are generally controlled by insecticide sprays for other insects. Both nymphs and adults feed on the underside of leaves and suck sap from the leaves, causing white flecks or spots on the upper leaf surfaces.

Life Cycle: There are two generations of leafhoppers each year. Most of the population overwinters as eggs laid under the bark of the canes. In early May, first generation nymphs hatch and feed for a few weeks. Second generation nymphs hatch in late July and early August, mature and lay the overwintering eggs.

Pest Management

Chemical Controls: Registered insecticides include carbaryl.

Cultural Controls: None identified.

Alternative Controls: Monitor the underside of leaves for nymphs, beginning in early May.

Resistant Cultivars: None available.

Issues for Leafhoppers

1. None identified.

Aphids : Small Raspberry Aphid (*Aphis rubicola* Oestlund) and the Large Raspberry Aphid (*Amphorophora agathonica* Hottes)

Pest Information

Damage: Aphids are occasional pests, but are generally controlled by insecticide sprays for other insects. They rarely do any direct damage, but they are contaminants in machine harvested fruit and also transmit some viral diseases. They are usually found in colonies on new shoot growth, buds, undersides of leaves and near flower and fruit clusters. Early detection is important for effective and economical control.

Life Cycle: Aphids overwinter as eggs and hatch in May. Young aphids mature to be winged or wingless females, which give birth to living young during the summer. The winged form can fly and spread over great distances, while the wingless form remains where it was born. Males are produced only in the fall and mate with females who then lay overwintering eggs. Development time and the number of generations depends on the host crop and weather conditions.

Pest Management

Chemical Controls: Registered insecticides include abamectin, carbaryl, diazinon and insecticidal soap.

Cultural Controls: None identified.

Alternative Controls: Aphids are controlled by a number of native predators and parasites including ladybird beetles, lacewings and syrphid larvae. However, insecticides used to control other pests may kill these beneficials.

Resistant Cultivars: None identified.

Issues for Aphids

1. None identified.

Thrips (Thysanoptera)

Pest Information

Damage: Thrips feed on all cane fruits but seldom cause extensive damage. However, their presence in the fruit can render berries unmarketable. Thrips will attack in the spring, but are most abundant in July and August when the weather is hot and dry.

Life Cycle: Thrips overwinter in the soil at the base of canes.

Pest Management

Chemical Controls: Registered products include diazinon.

Cultural Controls: None identified.

Alternative Controls: None identified.

Resistant Cultivars: None available.

Issues for Thrips

1. None identified.

Straw-Coloured Tortrix Moth (*Clepsis spectrana*)

Pest Information

Damage: Larvae damage raspberry canes and fruit and are occasional fruit contaminants. This moth attacks a variety of fruit crops, including raspberry, strawberry, currant and occasionally cranberry, as well as white spruce and white cedar.

Life Cycle: Adults are nocturnal and readily attracted to lights. They fly from March until August. Larvae found in March have overwintered from the previous year.

Pest Management

Chemical Controls: Registered insecticides include malathion.

Cultural Controls: None identified.

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

Resistant Cultivars: None available.

Issues for Tortrix Moth

1. None identified.

Scales

Pest Information

Damage: San Jose scale and other scale insects are occasional pests of raspberry canes. They feed on plant sap with their long threadlike mouthparts. Feeding slowly reduces plant vigour. Heavy infestation results in poor growth and dieback. Occasionally infected hosts will die.

Life Cycle: Scales are small, immobile and have no visible legs or antennae. Eggs are protected by the scale of the mother insect until they hatch. Eggs hatch in late May or June, with 2 generations possible per year. After a short time feeding, the insect molts, losing their legs and antennae. The skin that has been removed is incorporated into the scale, which now forms over the body of the insect composed of thin threads of wax that were excreted from the body wall. Females molt twice during their life and remain under the scale the entire

time. Males, after molting twice, assume an adult two-winged form. Adult males seek out females and mate, but do not feed. After mating, adult females continue to feed and produce eggs.

Pest Management

Chemical Controls: Dormant oil + Lime sulphur are used as foliar sprays in the dormant season if necessary.
Cultural Controls: None identified.
Alternative Controls: None identified.
Resistant Cultivars: None available.

Issues for Scales

1. None identified.

Slugs

Pest Information

Damage: In BC, slugs are a significant problem in some years. Damage is from fruit feeding and contamination of fruit at harvest. Slugs are not generally a problem in Ontario or other provinces.
Life Cycle:

Pest Management

Chemical Controls:
Cultural Control:
Alternative Controls:

Table 6. Insect control products, classification and performance for Canadian raspberry 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**
abamectin (Agri-mek 1.9% EC)	avermectin insecticide and acaricide	Chloride channel activators; Interferes with the GABA nerve receptor of insects.; 6	R	Aphids		
				Two spotted spider Mites-	A	Has a negative effect on pollinators. This product is new to raspberry growers and can only be used post harvest. It needs to be made available for pre-harvest use. Excellent product that also controls other pests such as leafhoppers.
***Bacillus thuringiensis berliner* subsp. *kurstaki* (Bioprotec, Dipel WP, Foray)**	B.t. subsp. Kurstaki insecticide	Microbial disruptors of insect mid-gut membranes (includes transgenic crops expressing Bacillus thuringiensis toxins); 11B2	RE (RR)	Loopers	A^P	Broken down by sunlight, shortlived. Short pre-harvest interval.Resistance a concern with repeated use.
				Oblique banded leafroller		

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**
carbaryl (Sevin XLR Plus)	carbamate insecticide and acaricide	Acetylcholine esterase inhibitors; A1	RE	Blackberry leafminer		
				Japanese beetle		
				Leafrollers		
				Rose stem girdler		
				Aphids, including spotted wing raspberry aphid		
				Fruitworms		
				Spittlebugs		
				Bud or root weevils (BC only)		
				Climbing cutworm		
				Leafhoppers		
carbofuran (Furadan 480F)	carbamate insecticide	Acetylcholine esterase inhibitors; 1A	RE	Bud or Root weevils (BC only)		
clofentezine (Apollo SC)	clofentezine acaricide	Compounds of unknown or non-specific site of action (mite growth inhibitors); 10A	RR	two-spotted spider mites	A	Controls eggs and young larvae so timing is critical. Thorough coverage is essential. A good miticide. Not toxic to predators. PHI is too long. Often mite populations do not take off until harvest starts.

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
diazinon (Diazinon 50W)	organophosphate insecticide and acaricide	Acetylcholine esterase inhibitors; 1B	RE	Aphids		
				Borers (raspberry crown borer)	I - A	Only registered for spring application
				Leafhoppers		
				Raspberry sawfly	A^P	It is the only product labelled for control. There is concern about the potential loss of this product and other OP's through re-evaluation.
				Thrips		
				Fruitworms, including raspberry fruitworm and western raspberry fruitworm	A	-
1,3- dichloropropene; chloropicrin (Telone C-17 Liquid)	N/A; chloropicrin nematicide and fungicide	N/A; compounds of unknown or non-specific mode of action (fumigants); N/A; 8A	RE;R	Nematodes	A	Used only as a preplant treatment in the year of planting. Very toxic to all organisms.
dicofol (Kelthane 50W)	dicofol acaricide	Compounds with unknown mode of action; unc	R	Two spotted spider mites	A to A^P	Is moderately effective with a manageable pre-harvest interval. Is the most inexpensive product. Can be used prior to harvest. Resistance has been noted on other crops. Toxic to predators. Active only on adult mites.

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**
insecticidal soap (Safer's)	insecticide and acaricide	N/A	R	Aphids	-	-
				Whitefly	-	-
				Spider mites	I	Short pre-harvest interval. Used for biological control. It is important to have good coverage of foliage. Do not apply during sunny weather.
malathion (Malathion 25W)	organophosphate insecticide and acaricide	Acetylcholine esterase inhibitors; 1B	RE	Leafrollers	A^P	Not a real great product but because of its short harvest interval it is used frequently.
				Caterpillars	A^P	
				Sap beetles	A^P	
				Rose chafer	A^P	
				Adult bud weevils	A^P	
				Raspberry fruitworm and western raspberry fruitworm	A to A^P	Compatible with mite predators. Treatments for fruitworms are not necessary if malathion has been applied twice for the strawberry bud clipper weevil.
				Adult root weevils	A	The only product registered. Soft on predator mites. Malathion applications also control tarnished plant bug.
oxamyl (Vydate L)	carbamate nematicide, insecticide, acaricide	Acetylcholine esterase inhibitors: 1A	RE	Root lesion nematodes	A^P	Used post harvest. Is difficult to get enough water to get the the product down into the root zone.

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**
pyridaben (Pyramite)	METI acaricide and insecticide	Mitochondreal complete I electron transport inhibitors; 21	R	Mites	A^p to I	Not registered for preharvest treatment. Coverage important.

[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, Ontario and Quebec (2005).

Table 7. Availability and use of insect and mite pest management practices for Canadian raspberry production

	Practice \ Pest	Weevils	Caterpillars	Raspberry Sawfly	Raspberry Fruitworms	Raspbery Crown Borer	Raspberry cane borer	Mites	leafhoppers	Sap beetles	Tarnished Plant Bug
Prevention	equipment sanitation										
	mowing / mulching / flaming										
	removal of alternative hosts (weeds/volunteers)										
	row or plant spacing										
	water / irrigation management										
	crop residue removal / management										
	pruning out / removal of infested material										
	planting / harvest date adjustment										
	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										
	weather monitoring for degree day modelling										
	grading out infected produce										
Decision Making Tools	forecasting / degree day modelling										
	use of thresholds for treatment decisions										
Suppression	biological pesticides										
	pesticide rotation for resistance management										
	ground cover / physical barriers										
	pheromones (eg. mating disruption)										
	sterile mating technique										
	beneficial organisms and habitat management										
	trapping										

no information regarding the practice is available

available/used

available/not used

not available

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

Weeds

Key Issues

- Alternative, residual herbicides are needed for annual weeds such as annual bluegrass *(Poa annua*) and chickweed.
- An alternative residual herbicide is needed for perennial weeds such as creeping yellow cress (*Rorippa sylvestris*) and yellow nutsedge (*Cyperus esculentus*).
- An IPM approach for the management of annual and perennial grass weeds need to be developed.

Table 8. Degree of occurrence of weed pests in Canadian raspberry production

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

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

Major and Minor Weeds

Damage: Raspberries achieve maximum production when they have an undisturbed, competition-free strip in the planted row. Various species of weeds compete with raspberry plants for water and nutrients. In addition, weeds interfere with harvesting efficiency and reduce air movement, thus increasing the likelihood of cane, fruit and foliar diseases. Weeds are also hosts to nematode species, a number of which vector viruses.

Chemical fallow kills weeds between rows, prevents dust build-up and provides a better surface for workers and machinery. Herbicides, such as Goal (BC only) and Ignite used for cane burning also help to control weeds within the rows. Weeds within the rows are usually managed with directed, banded herbicide applications, either pre- or post-emergence, as well as primocane suppression materials (cane burning) usually applied once in the early spring. In Quebec, the areas between the rows are seeded to grass and mowed to avoid high growth.

Annual Grasses and Broadleaves

Pest Information

Life Cycle: Winter annuals are weeds that germinate in the fall and overwinter in a vegetative state, flower in the spring, form seeds and then die. Control measures usually include contact application of herbicides. Summer annual weeds germinate in the spring, flower and fruit in the summer or fall, dying before the onset of winter. Control measures include pre-plant incorporated (PPI) applications of herbicides, as well as pre-emergence or post-emergence applications.

Pest Management

Chemical Controls: Please refer to table 9 (below) for a detailed listing of registered herbicides. Chemical fallow kills weeds between rows, prevents dust build-up and provides a better surface for workers and machinery. Herbicides, such as Goal (BC only) and Ignite used for cane burning also help to control weeds within the rows. Weeds within the rows are usually managed with directed, banded herbicide applications, either pre- or post-emergence, as well as primocane suppression materials (cane burning) usually applied once in the early spring. In Quebec, the areas between the rows are seeded to grass and mowed to avoid high growth.

Cultural Controls: Growers rely on a combination of chemical and cultural practices to manage weeds in raspberry fields. Cultural controls include mechanical weeding, hand weeding, cover cropping and mulching. Weeds between the rows are managed primarily by regular, frequent, shallow cultivation during the growing season and/or use of perennial or annual cover crops. Cover crops (e.g., Wheeler rye in BC) are grown between rows to reduce weed competition, as well as to protect from leaching and erosion. Cultivation is performed routinely during the growing season, but care is taken to avoid excessive frequency since it can destroy soil structure, lead to soil compaction and increase root stress. The dust produced by tillage can also lead to an increase in mite populations. Shallow tillage between rows using a rotary-type cultivator is the standard method for summer weed control in BC, but in Ontario tillage is not a common practice and most growers rely on residual herbicides. Crop rotation is generally not practiced in BC due to lack of suitable land. The old raspberry crop

is burned down with herbicides after the final harvest in late summer and the field is ploughed up and prepared for the new planting the following spring. Crop rotation is more common in Ontario. Habitat management, which involves managing weeds in headlands and other non-productive areas and preventing weeds from setting seed on crop land can gradually decrease the reservoir of weed seeds in raspberry fields. Weeds are controlled in areas immediately around fields primarily by maintaining year-round sod, which is mowed regularly during the growing season.

Alternative Controls: It is recommended that growers take note of shifts in predominant weed species which indicate development of resistance and the need to select alternative weed management strategies or materials.

Issues for Annual Weeds

1. Alternative, residual herbicides are needed for annual bluegrass and chickweed

Perennial Grasses and Broadleaves

Perennial weeds: Creeping yellow cress (*Rorippa sylvestris*), yellow nut sedge (*Cyperus esculentus*), curled dock (Rumex crispus), quack grass (*Elytrigia repens*), Canada thistle (*Cirsium arvense*) and field horsetail (*Equisetum arvense*).

Pest Information

Life Cycle: Perennial weeds form rhizomes, rootstocks or tubers that survive when above ground parts of the plant are killed. This makes them difficult to control, especially when the perennial structures are able to escape soil fumigation. If infestations become established, the basic approach to controlling perennial weeds is to destroy as much of the plant as possible between crops and prevent the re-growth from producing food reserves. Simple perennials regenerate each year from a root or crown structure and reproduce by sexual means only. Creeping perennials regenerate from roots, shoots and other structures and can reproduce both asexually (vegetatively) and sexually. Broken root pieces can result in the formation of a new plant. This group of weeds is usually the most difficult to control. Contact herbicides are best for both simple and creeping weed types.

If soil fumigation is not an option, avoid fields infested with any perennial weeds. Deep ploughing to thoroughly invert the soil is an effective cultural control for nutsedge infestations.

Pest Management

Chemical Controls: Please refer to table 9 below for a detailed listing of registered herbicides. Pre-plant soil fumigants applied for nematode control also help to suppress perennial (and annual) weeds

Cultural Controls: The best strategy for controlling perennials is to avoid infested fields and prevent establishment of weed infestations. Prevention can be done by removing seedlings during hand weeding operations and following strict sanitation procedures to avoid spreading perennial roots, tubers or rhizomes. Prior to planting new fields, perennial weeds are controlled by cultivation and glyphosate herbicide. Deep ploughing to thoroughly invert the soil is an effective cultural control for nutsedge infestations There is no control method for perennial weeds in summer except hand-weeding between rows. Casoron provides residual control for the first year after planting. Habitat management through controlling weeds in headlands and other non-productive areas and preventing weeds from setting seed on crop land, can gradually decrease the reservoir of weed seeds in fields.

Alternative Controls: Integrate cultural and chemical practices for thorough weed management.

Issues for Weeds

1. An alternative residual herbicide is needed for control of perennial weeds such as creeping yellow cress and yellow nutsedge.

Table 9. Weed control products, classification and performance for Canadian raspberry 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**
2,4-D (Estemine 2,4 D, Marks 2,4-D DMA 470)	phenoxy carboxylic acid herbicide	Action like indoleacetic acid (synthetic auxin); 4	RE	Broadleaf weeds	A^P	Phytotoxic to young primocanes.
dichlobenil (Casoron G-2 granular)	nitrile herbicide	Inhibition of cell wall (cellulose) synthesis; 20	R (Re-evaluation done)	Annual broadleaf weeds	A	Considered harsh on plantings after several years of application. Higher costing; residual. Delays primocane emergence.
				Annual grasses	A	
				Perennial broadleaf weeds	A^P - A	
				Perennial grasses	A^P - A	
fluazifop-p-butyl (Venture L)	aryloxyphenoxy-propionate herbicide	Inhibitors of acetyl CoA carboxylase (ACCase); 1	R	Annual grasses	A^P to A	Works best on actively growing grasses.Timing is important.
				Perennial grasses	A^P to A	Works best on actively growing grasses.Timing is important.
glufosinate ammonium (Ignite 15 SN)	phosphinic acid herbicide	Inhibition of glutamine synthetase; 10	R	Annual broadleaf weeds	A	Used primarily to as a primocane suppression tool that also provides control of emerged annual weeds. Does not control perennial weeds.
				First primocanes	A^P	
glyphosate (Roundup, Touchdown)	glycine herbicide	Inhibition of EPSP synthase; 9	R	All weeds		Used prior to planting only.

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**
napropamide (Devrinol 10-G Selective, Devrinol 50 DF)	acetamide herbicide	Inhibition of VLCFAs; 15	R	Annual broadleaf weeds	A^P	Subject to UV breakdown if not incorporated by water. Great crop safety. Narrow spectrum of actiivity.
				Annual grasses	A^P	
oxyfluorfen (Goal 2XL)	diphenylether herbicide	Inhibitors of protoporphyrinogen oxidase (PPO); 14	RE/ R (BC only)	First primocanes	A	Can be hard on plants. Goal works better in cold, wet weather.
paraquat (Gramoxone Liquid Herbicide with Wetting Agent)	bipyridylium herbicide	Photosystem-I-electron diversion; 22	R (Re-evaluation done)	Annual broadleaf weeds	A	Only effective on emerged annual weeds.
				Annual grasses	A	
				Perennial broadleaf weeds	A	Fast-acting, contact herbicide.
				Perennial grasses	A	
sethoxydim (Poast Ultra)	cyclohexanedione herbicide	Inhibitors of acetyl CoA carboxylase (ACCase); 1	R	Annual grasses	A	Only works on emerged grasses.
				Quackgrass		
simazine plus related active triazines (Simadex Simazine Flowable, Simazine 80W)	triazine herbicide	Inhibition of photosynthesis at photosystem II; 5	R	Annual grasses	A^P to A	
				Annual broadleaf weeds	A^P to A	Long residual with problems with triazine resistant weeds. Limited weed control spectrum. Inexpensive.

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**
terbacil (Sinbar Herbicide WP)	uracil herbicide	Inhibition of photosynthesis at photosystem II; 5	R (Re-evaluation done)	Annual grasses		
				Annual broadleaf weeds		

[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, Ontario and Quebec (2005).

Table 10. Availability and use of weed pest management practices for Canadian raspberry production

	Practice \ Pest	annual grass	annual broadleaf	perennial grass	perennial broadleaf
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				
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: Crop profile focus groups for British Columbia, Ontario and Quebec (2005).

Vertebrate Pests

Field mice occasionally kill plants by chewing on crowns and stripping bark. Deer and porcupines cause considerable damage in isolated plantings in Atlantic Canada by direct feeding on both primocanes and floricanes. Deer are becoming a significant problem in Ontario. Fencing gardens can help keep deer out. Birds feed on ripe fruit, but generally damage is minor.

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Alberta Agriculture, Food and Rural Development: www1.agric.gov.ab.ca/app21/rtw/index.jsp

BCMAFF Berry Information: www.agf.gov.bc.ca/berries/

BC Ministry of Agriculture, Food and Fisheries: www.agf.gov.bc.ca

BC Raspberry Industry Development Council/Raspberry Growers Association: raspberrycouncil@direct.ca

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

Government of Newfoundland and Labrador Forest Resources and Agrifoods: www.gov.nf.ca/fra/

Grading Standards Frozen Raspberries: http://laws.justice.gc.ca/en/C-0.4/C.R.C.-c.291/26587.html

Manitoba Agriculture, Food and Rural Initiatives; www.gov.mb.ca/agriculture/crops/insects/index.html

New Brunswick Agriculture, Fisheries and Aquaculture; www.gnb.ca/0027/index-e.asp

Northwest Berry and Grape: berrygrape.oregonstate.edu/

Northwest Berry Infonet: berrygrape.oregonstate.edu/

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

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

Name	Organization	Pest type	Specific pests	Type of research
Braun, G	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Pathology		
Fox GC	University of Guelph, Ontario Agricultural College			Economic Feasibility of Growing Raspberries in Protective Structures
Hicklenton, P.R.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Plant Physiologist		
Hildebrand, P.D.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Pathology		
Jamieson, A.R.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Fruit breeding		
Javorek, S.K.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Entomology		
Jensen, K.I.N.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Weed science		
MacKenzie, K.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Entomology		
McRae, K.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Statistics		
Privé, J.-P.	Atlantic Food and Horticulture Research Centre, Bouctouche, NB, AAFC	Fruit crop physiology		

Rochon D, French C, Sanfacon H, Bernardy M	Research Branch, Pacific Agri-Food Research Centre (Summerland), AAFC	Virus disease		Plant virus disease control
Smith, R.F.	Atlantic Food and Horticulture Research Centre, Kentville NS, AAFC	Entomology		Development of IPM technology for Integrated Fruit Production
Starner, V, O'Neill, G	Joint Canada-USA IR-4	Disease		Research on azoxystrobin
Sullivan A	University of Guelph, Ontario Agricultural College			Berry crop management
Sullivan A, Strommer J	University of Guelph, Ontario Agricultural College	Cultivar selection		Berry crop breeding and genetic transformation
Trottier Y-L, Simard C	Canadian Food Inspection Agency, St-Hyacinthe Laboratory	Viral diseases		Development, optimization and validation of molecular methods for the detection of enteric viruses in bottled water and berries
Vrain T, Lane W, Wiersma P	Research Branch, Pacific Agri-Food Research Centre (Summerland), AAFC			Genetic regulation and engineering of horticultural crops
Warman PR	Nova Scotia Agricultural College			Comparison of MSW compost and fertilizer for raspberry production and soil fertility
Zandstra JW	University of Guelph, Ontario Agricultural College	Cultivar selection		Management and Variety Evaluation of Fruit Crops in South-western Ontario