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Crop Profile for Cranberry in Canada

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Canada

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Use of Information

Product trade names may be included and are meant as an aid for the reader, to facilitate the identification of products in general use. The use of these trade names does not imply endorsement of a particular product by the authors or any of the organizations represented in this publication.

Information on pesticides and pest control techniques are provided for information purposes only. No endorsement of any of the pesticides or pest control techniques discussed is implied.

Information contained in this publication is not intended to be used by growers as a production guide. Provincial publications should be consulted by growers for this information.

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Preface

National crop profiles are developed under the Pesticide Risk Reduction Program (PRRP), a joint program of Agriculture and Agri-Food Canada (AAFC) and the Pest Management Regulatory Agency (PMRA). The objective of the program is to reduce the risks to the environment and to human health from pesticide use in agriculture. To achieve this objective, the PRRP works with grower groups, industry and provinces to identify gaps in pest management and opportunities for pesticide risk reduction. This information is used to develop issue specific pesticide risk reduction strategies. The national crop profiles provide baseline information on crop production and pest management practices and document the pest management needs and issues faced by growers, information used in the development of risk reduction strategies.

Information contained in the crop profiles is developed through extensive consultation with stakeholders. Pest management information for major crop producing regions is collected by provincial focus groups through the "Canadian Expert Poll on Crop Protection", a software tool developed by the PMRA.

For detailed information on growing cranberry, the reader is referred to provincial crop production guides and provincial ministry websites listed in the Resources Section at the end of the profile.

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The large-fruited, American cranberry, *Vaccinium macrocarpon*, is a member of the heath (Ericaceae) family. Native to North America, commercial production of cranberry in Canada began in 1872 in Nova Scotia when William McNeil of Melverne Square in the Annapolis Valley planted a small cranberry patch at the end of a bog. Despite periods of expansion and decline, Nova Scotia has sustained a commercial cranberry industry until the present day. In recent years, production has also begun in the adjacent Atlantic provinces of New Brunswick, Prince Edward Island and Newfoundland, as well as in other provinces including Quebec, Ontario and British Columbia.

Crop Production

Industry Overview

General production information is presented in table 1.

Table 1. General Production Information

Canadian Production (2007)	79,163 metric tonnes 3,952 hectares (bearing)
Farm gate value (2007)	$ 73.5 million
Domestic consumption (2007)	0.70 kg/person (fresh)
Export (2007)[1]	$ 44.3 million
Imports (2007)[1]	$ 17.2 million
Source(s): Statistics Canada [1]Cranberries and bilberries	

Production Regions

There were 2,904 hectares of cranberries grown in Canada in 2005. The distribution of cranberry production is presented in Table 2. Major production areas include British Columbia (1,562 hectares) and Quebec (1,087 hectares).

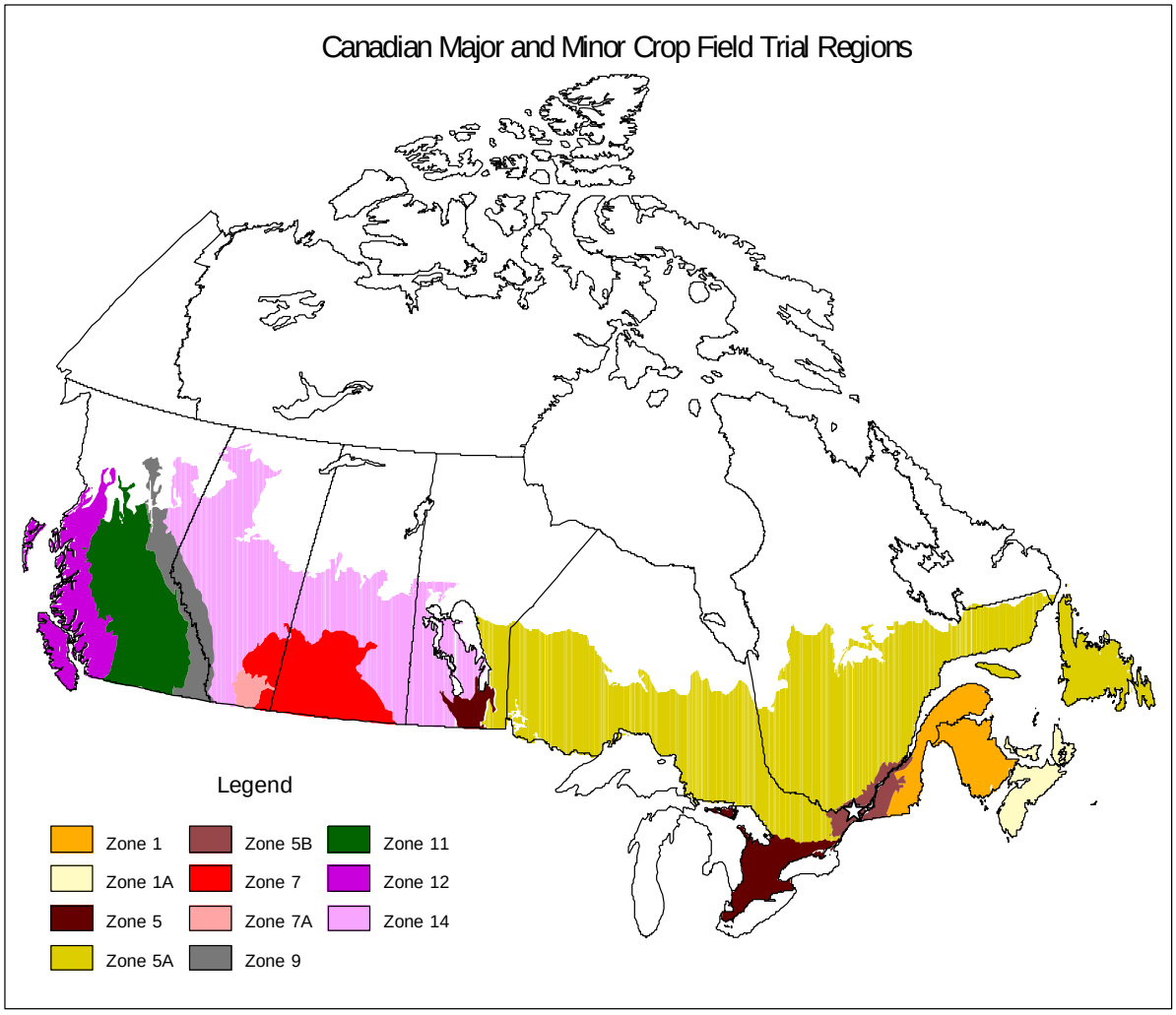
Table 2. Distribution of cranberry production in Canada

Production Regions	Bearing Area[2] 2007 (hectares)	Percent National Production
British Columbia	2,056	54%
Quebec	x	-
New Brunswick	x	-
Nova Scotia	x	-
Prince Edward Island	x	-
Canada	3,952	100%

Source: Statistics Canada; x suppressed to meet the confidentiality requirements of the *Statistics Act*

Figure 1. Common Zone Map: Canadian Major and Minor Field Trial Regions

The major and minor crop field trial regions were developed following extensive stakeholder consultation and have been harmonized between the Pest Management Regulatory Agency (PMRA) and the Environmental Protection Agency of the USA. The identified regions are used for experimental studies in support of residue chemistry data requirements for the registration of new pesticide uses. The regions are based on soil type and climate and do not correspond to plant hardiness zones. For additional information, please consult the PMRA Directive 98-02 Residue Chemistry Guidelines (www.hc-sc.gc.ca/cps-spc/pubs/pest/_pol-guide/dir98-02/index-eng.php).



Cultural Requirements

Commercial cranberry production differs from all other forms of small fruit production. The plant is a long-lived perennial that can be propagated vegetatively or by seed, although the former is preferred to retain cultivar purity in commercial plantings. The plant is a trailing, woody vine that produces runners from 0.3 to 1.8 m long, from which emerge numerous short (5 to 7.5 cm), vertical, upright branches known as “uprights”. The upright branches form terminal buds that give rise to the flowers which in turn give rise to the berries produced by the plant. Berries begin to ripen in late September and are harvested until late in the fall when freezing temperatures make the fruit unsuitable for use.

The cranberry is an evergreen plant with dark, glossy green leaves which become dull reddish brown during dormancy. Although evergreen, the cranberry is not truly hardy and depends on natural flooding to protect it from winter injury. In some areas of Canada, these conditions are simulated commercially by planting vines in well-engineered peat or sand beds that are located within 0.3 to 0.8 m of the water table. Surrounding the beds and sometimes through the beds, are ditches, dykes and other water control structures used to regulate water flow into or away from the beds. This careful regulation of water allows for flooding for frost protection, pest management, harvest and winter protection. The ability to flood and hold water on the bed surface is critical to the success of the commercial cranberry operation. The cranberry thrives best where the summers are cool. It is an acid loving crop requiring soil conditions with a pH between 4.0 and 5.5.

A new cranberry bed is established by “pressing in” hardwood cuttings obtained by pruning cranberry vines in mature beds or by using rooted cuttings or “plugs”. The first economic harvest is usually obtained by year three and maximum production by year five. The productivity of the crop is maximized by good nutritional management, renovation of the beds with new sand layers every 3 to 8 years, frost protection by flood or overhead irrigation and the use of integrated pest management practices. If these management practices are maintained, production in a cranberry bed can go on for many years. Many beds have been in production for over 100 years.

As a wetland species, cranberry has traditionally been grown on wetland (organic) soils. However, environmental concerns, coupled with increased demand for fruit in the early 1990s, forced expansion onto non-traditional “upland” sites on mineral soils. If these soils meet the pH, drainage and flood requirements of modern production systems, they are as productive as the more traditional peat bog developments.

The extensive use of water in modern cranberry production necessitates significant water holdings adjacent to the operations. This, coupled with a greater public concern over potential contamination of the water supply through the misuse of fertilizers and pesticides, has resulted in the cranberry industry being highly scrutinized and regulated in recent decades. Grower response to this has been exceptionally progressive and they are recognized leaders among agricultural commodities in the adoption of IPM strategies.

Cranberry beds are not cultivated but are rejuvenated periodically by the addition of 1 to 2.5 cm of coarse, sharp sand. This practice encourages new upright production and maintains the productivity of the beds. Although tolerant of flooded soils, good drainage is essential for optimum root growth and function during the growing season. For this reason, drainage controls are emphasized and consist of extensive ditching through and around the more traditional peat

bog developments. Under-drainage from below the plants tends to be favoured in upland developments on mineral soils.

Also, irrigation has become a standard feature of the modern cranberry operation, providing for the water needs of the crop during periods of water stress, for frost protection and in many cases for the addition of fertilizers and pesticides through “fertigation” and “chemigation” respectively.

The following table (table 3) describes production practices and worker activities for cranberry throughout the season.

Table 3. Canadian cranberry production and pest management schedule.

Time of Year	Activity	Action
winter-dormancy (December to late March)	Plant care	Apply winter flood, taking precautions to avoid oxygen deficiency injury (eg. snow removal, draining water under ice, etc); sanding for bed rejuvenation.
spring-flood removal to budbreak (late March to May)	Plant Care	Apply Sul-Po-Mag (K-Mag) for oxygen deficiency injury treatment, etc; apply sulfur for pH adjustment; pruning if required; introduce pollinators (honeybees, bumblebees, etc.) at 10% bloom if desired.
	Soil care	Apply sulfur or lime for pH adjustment
	Weed management	Monitor for weeds, apply pre-emergence herbicides before vines break dormancy; apply late water (if desired) for dewberry control.
	Disease Management	Application of late water for fruit rot reduction
	Insect Management	Application of late water for cranberry fruitworm and southern red mite reduction
summer – budbreak to berry maturity (May to late-September)	Plant Care	Apply granular and foliar nutrients as required; frost protect and irrigate as required; apply calcium-boron for optimum fruit set, if desired; conduct leaf analyses; monitor fruit maturity.
	Soil Care	Apply low rates of sulfur as required; take soil samples.
	Disease Management	Monitor for disease (upright dieback, fruit rot, etc.); apply fungicides as required.
	Insect Management	Monitor (sweep nets, pheromone traps, etc.) for cranberry fruitworm, blackheaded fireworm, cranberry tipworm, cranberry girdler, spanworms, false armyworm, cranberry blossomworm, fleabeetle, loopers, weevils, tussock moth, Spargonothis fruitworm, green fruitworm, grubs and beneficials; apply controls as needed; summer re-flood for grubs (loss of crop).
	Weed Management	Monitor and map weeds; apply controls if needed.
	Other	Monitor for other pests (muskrats, etc.); control as required.
fall – harvest period (September to November)	Plant Care	Harvest berries; irrigate as needed after harvest; remove trash piles; prune after harvest if desired; apply fall fertilizers.
	Soil Care	Apply sulfur or lime for pH adjustment.
	Disease Management	Remove trash piles after harvest.
	Insect Management	Fall flood after harvest for cranberry girdler and root weevil reduction.
	Weed management	Remove trash piles after harvest; apply pre-emergence weed controls, as required.

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

Abiotic Factors Limiting Production

Temperature extremes

Excessive heat (> 32˚C) in the summer months may result in sunscald and heat injury to berries. At temperatures below -1˚C, flowers and flower buds are damaged. Before budbreak, mixed terminal buds (containing flower buds) will tolerate temperatures of -4 ˚C, while fully dormant buds will tolerate temperatures as low as -18 ˚C. Young, vegetative growth exposed to frost turns brown and eventually falls off. Berries become progressively more cold tolerant as they mature. The white-berry stage is tolerant to -2 ˚C, while well-coloured fruit will withstand temperatures of -5 to -7 ˚C, depending on cultivar and maturity.

Other climatic factors

Summer droughts can negatively impact vine growth and fruit production. Hailstorms can cause severe injury to blossoms and buds, impacting fruit set and may also physically bruise or cut fruit, predisposing them to field and storage rots. Lightning can also strike and cause damage to cranberry beds. Lightening strikes kill plants both above and below ground, in wavy patterns that emanate from a central point, with damage usually coinciding with a metal sprinkler head.

Soil pH, salts and drainage

Cranberries are acid-loving plants that require a soil pH between 4.0 and 5.5 for optimum growth. Vine growth and yields will be poor in soils with a pH outside the desired range or in soils with poor drainage. Vines growing in poorly drained soils are susceptible to phytophthora root rot and salt injury. Although relatively tolerant to salt injury, vines can be injured from roadside run-off of salt and flooding from hurricane tides or seaside salt spray if drainage is insufficient to wash the salts out of the plant root zone. The regular sanding of cranberry beds reduces the buffering capacity of the soils, making the beds susceptible to rapid pH change if irrigated with water of pH below or above the desired range. Water pH is extremely important in cranberry production due to the extensive use of water for irrigation, frost protection and flooding.

Water availability

Large volumes of water are required for successful cranberry production. In the colder eastern and central provinces, beds are flooded to a depth of 0.25 to 1.0 meter to prevent cold temperature damage and desiccation. In the spring, water is used extensively for frost protection and during the growing season about 3 cm of water is used per week to irrigate the crop. Prior to

harvest, water is applied extensively for frost protection. The majority of beds are flooded to harvest the berries. Beds may also be periodically flooded for weed, disease and /or insect management (e.g. late water flood, summer flood, fall flood). The successful cranberry operation must have sufficient and reliable quantities of accessible water to meet the many needs of the crop.

Oxygen deficiency

Insufficient oxygen in winter flood water can severely injure cranberry plants and indirectly reduce subsequent yields. When sunlight is blocked from penetrating the ice layer (by sand, snow, etc.) plants begin to use more oxygen than they generate. When the oxygen content falls to below 40% of normal, injury will occur within two to three days.

General Production Issues

None identified.

Pest Management

Cranberry production in Canada is affected by many insects, plant diseases, weeds and is subject to damage from birds and mammals.

Cranberry production is relatively new in Quebec and many of the important diseases and pests in other cranberry growing regions of North America are not present.

The following disease, insect and mite and weeds sections provide detailed information on pests affecting cranberry. Pest management issues are presented at the beginning of each section. In each section, the issues are followed by a series of tables that provide information on pest occurrence, chemical controls and IPM practices as follows;

Tables 4, 8 and 12: Disease, insect or weed occurrence and severity and is presented on a provincial basis.

Tables 7, 11 and 15; Integrated pest management information is provided on an individual pest basis.

Tables 5, 9 and 13: List all registered fungicides, insecticides and herbicides for cranberry.

Tables 6, 10 and 14: List registered pesticides on a disease, insect or weed group basis, respectively and provide stakeholder comments on efficacy.

Further information for each pest is provided under individual pest write-ups following the tables in each section.

For detailed information on pest management and growing the crop in specific regions, the reader is referred to provincial crop production guides and provincial ministry websites listed in the Resources Section at the end of the profile.

Diseases

Key Issues

- The susceptibility of cranberry varieties to common diseases is unknown.
- There are insufficient reduced risk products available for the control of diseases such as fruit rots and red leaf spot.
- Cranberry fruit rot is a disease complex. With the narrow spectrum of activity of newer fungicides, it will become increasingly more important to know which rot species are present in a cranberry bog.
- There are insufficient reduced risk fungicides and cultural controls available for the control of cottonball, a disease with epidemic potential.
- Further research is required to more fully elaborate cultivar differences in susceptibility to phytophthora root and runner rot.

Table 4. Degree of occurrence of disease pests in Canadian cranberry production.

Diseases	Degree of occurrence		
	BC	QC	NB
Black Spot	DNR		
Cottonball	E		E
Fairy ring (*Psilocybe agrariella*)	DNR		
Fruit rot complex	E	E	E
Leaf spot *(Protoventuria myrtylli*)	DNR	E	E
Phytophthora root and runner rot			
Red gall	DNR		
Red leaf spot	E	E	E
Rose bloom	E	DNR	
Twig blight	DNR		E
Upright dieback	E		E
Virus	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

D – invasion expected or dispersing

Source(s): "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005); New Brunswick Department of Agriculture and Aquaculture.

Table 5. Adoption of disease pest management approaches for cranberry production in Canada

	Practice \ Pest	Fruit rot complex	Cottonball	Rose Bloom (Exobasidium)	Upright dieback	Proventuria leafspot
Avoidance	resistant varieties					
	use of late water					
	planting / harvest date adjustment					
	crop rotation					
	choice of planting site					
	use of disease-free seed or transplants					
	optimizing fertilization			available/used	available/used	
	reducing mechanical damage / insect damage				available/used	
	thinning / pruning				available/used	
Prevention	optimized drainage (ditching, tile drain, clean sand)					
	equipment or facility sanitation; use of sterile media					
	mowing / mulching / flaming					
	removal of alternative hosts					
	row or plant spacing (plant density)	available/used		available/used	available/used	
	seeding depth					
	water / irrigation management	available/used	available/used		available/used	
	crop residue removal / management	available/used	available/used	available/used	available/used	
	pruning out / elimination of infected plant material					
Monitoring	Scouting	available/used	available/used	available/used	available/used	available/used
	records to track pests	not available	not available	not available	not available	not available
	soil analysis				available/not used	
	weather monitoring for disease forecasting	not available	not available	not available	not available	not available
	grading out infected produce					
Decision Making Tools	economic thresholds	not available	not available	not available		not available
	weather/ weather based forecast/ predictive model	not available	not available	not available	not available	not available
	recommendation from crop specialist					
	first appearance of pest or pest life stage			available/used		
	observed crop damage		available/used			
	crop stage	available/used			available/used	
	calendar spray		available/used			
Suppression	biological pesticides	available/not used	available/not used	not available	available/not used	available/not used
	environmental management (eg. as in greenhouses)					
	pesticide rotation for resistance management					
	soil amendements					
	controlled atmosphere storage	available/used				

no information regarding the practice is available

available/used

available/not used

not available

Source(s): "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005).

Table 6. Disease control products registered for cranberry production in Canada.

Regulatory status as of July 17, 2007				
Control 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]**
chlorothalonil (Bravo 500 Agricultural Fungicide)	chloronitrile (phthalonitrile)	Multi-site contact activity; M5	R	Fruit rots Upright dieback Twigleaf blight
copper oxychloride (Copper Spray Fungicide)	inorganic	Multi-site contact activity; M1	R	Fruit rot fungal complex Leaf blight Twig blight (*Phomopsis/ Diaporthe vaccinii*)
ferbam (Ferbam 76 WDG Fungicide)	dithiocarbamate and relatives	Multi-site contact activity; M3	R	Fruit rots
folpet (Folpan 50 WP (Folpet) Fungicide)	phthalimide	Multi-site activity; M4	R	Fruit rots
triforine (Funginex DC Fungicide)	piperazine	C14 - demethylation in sterol biosynthesis (*erg11/cyp51*); 3	R (BC use only)	Cottonball
propiconazole (Topas 250E Fungicide)	triazole	C14 - demethylation in sterol biosynthesis *(erg11/cyp51);* 3	R	Cottonball (*Monilinia oxycocci*)

[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: www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides: www.irac-online.org/Crop_Protection/MoA.asp#area223; Fungicides: 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). 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: www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php

[4] Please consult the product label on the PMRA web site (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php) for specific listing of pests controlled by each active ingredient.
Source: Pest Management Regulatory Agency

Table 7. Disease control products, classification and performance for cranberry production in Canada

Pests or Group of Pests targeted	Active ingredient[1,2]	Mode of Action/ Resistance group[3]	Stakeholder comments[5]	
			Performance of active ingredient according to recommended use[4,5]	Notes[5]
Cottonball	triforine (BC only)	3		
	propiconazole	3		
Fruit rots	chlorothalonil	M5	A	Used in Quebec as a preventative measure only on fruit under conventional production destined for the fresh market - the efficacy has not been evaluated. Lower residue tolerance in Canada (2ppm) vs. US (5 ppm).
	copper oxychloride	M1		
	ferbam	M3		Export restricitons may apply.
	folpet	M4		
Leaf blight	copper oxychloride	M1		
Twig blight (*Phomopsis/ Diaporthe vaccinii*)	copper oxychloride	M1		
Twigleaf blight	chlorothalonil	M5		
Upright dieback	chlorothalonil	M5	A^P	

[1]All active ingredients listed were registered for this use as of July 17, 2007 (refer Table 5).

[2] Please consult product labels on the PMRA web site (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php) for further information on pesticide use.

[3]The mode of action/ resistance group is 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: www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides: www.irac-online.org/Crop_Protection/MoA.asp#area223 ; Fungicides: www.frac.info/frac/index.htm

[4] Adequate (green) (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control); 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)

[5]Source: "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005).

Fruit rot complex – Early rot (*Phyllosticta vacinii*), End Rot (*Godronia cassandrae*), Viscid Rot (*Phomopsis vaccinii*), Botryosphaeria Fruit Rot and Berry Speckle (*Botryosphaeria vaccinii*), Ripe Rot (*Coleophoma empetri*), Black Rot (*Allantophomopsis lycopodina*), Yellow Rot (*Botrytis cinerea*) and Blotch Rot (*Physalospora vaccinii*)

Pest information

Damage: Fruit rots are caused by a collection of pathogens affecting the cranberry fruit, either before harvest when they are referred to as field rots or after harvest when they are referred to as storage rots. Affected berries are soft and become either tan or black in color and are unmarketable. Losses of 33% are commonly reported in untreated beds, but there is a potential for up to 100% fruit loss.

Life Cycle: The fungi that cause fruit rot are present in most bogs and overwinter in infected stems, leaves and persistent pedicels. Depending on the species, infections generally begin during bloom and early fruit set. However, infections may also occur at wound sites during water harvest. Some of these infections lead to classic rot symptoms immediately while others remain dormant within the berry until suitable conditions occur. Warm temperatures favour some rot species while cooler temperatures favour others.

Pest Management

Cultural Controls: Cultural practices that reduce fruit rot include sanding, drainage improvement, harvest trash removal, maintaining balanced growth through proper pruning and nitrogen management, use of "late water" (leaving flood waters on a bog later into the spring to avoid infection periods), minimizing berry bruising and injury by proper harvest equipment set-up, minimizing the length of time berries remain in the harvest flood water and maintaining optimum temperatures and humidity (2-4 ˚C, 90% humidity) during storage.

Resistant Cultivars: There are several varieties known to have resistance to field rot, including 'Black Veil', 'Foxboro' 'Howes', 'Matthews', 'Shaw's Success', 'Stevens' and 'Wilcox'.

Chemical Controls: Active ingredients registered for control of fruit rot in Canada are listed in Table 6.

Issues for Fruit Rot

1. Cranberry fruit rot is a disease complex. With the narrow spectrum of activity of newer fungicides, it will become increasingly more important to know which rot species are present in a cranberry bog.
2. There are insufficient reduced risk alternatives available for the control of fruit rots.

Cottonball (*Monilinia oxycocci)*

Pest information

Damage: Cottonball, caused by *Monilinia oxycocci,* results in tip blight of young succulent shoots and a fruit rot known as hard rot.

Life Cycle: Cottonball overwinters as sclerotia, often in the form of mummified berries, on or below the cranberry bed surface. The sclerotia are tolerant of winter flooding and germinate in early spring, with apothecia maturing around budbreak. Ascospore release is greatest over a 10-14 day period coinciding with new shoot growth, when shoots are very susceptible to infection. This disease develops under wet conditions with moderate temperatures. Conidia are produced in infected tissues and are released during a separate 10-14 day window coinciding with full bloom. Conidia release is favoured by warm temperatures, low relative humidity and high wind speed. Conidia only infect open flowers. After bloom, infected shoots desiccate and fall off. Infected berries remain on the plant where the disease progresses and eventually develops into the characteristic fruit rot. Sclerotia develop in 25-50% of infected berries by the end of the growing season. Berries that do not develop sclerotia decompose normally while those with sclerotia often float and may be disseminated by moving water.

Pest Management

Cultural Controls: The removal and destruction of mummified fruit at harvest reduces inoculum for infection the following season. Cottonball can be moved to new fields in imported vines from regions where the disease is problematic. Extreme care needs to be taken to prevent the introduction of this disease into new areas.

Resistant Cultivars: There has been very little evaluation of cultivars for resistance to cottonball and field reports have been inconsistent.

Chemical Controls: Beds with a history of cottonball can be effectively protected with fungicides.

Issues for Cottonball

1. There are insufficient reduced risk fungicides and cultural controls available for the control of cottonball, a disease with epidemic potential.

Rose Bloom (*Exobasidium oxycocci*)

Pest information

Damage: Rose bloom causes abnormal branching of uprights with fleshy, pink leaves that resemble miniature roses, resulting in a reduction of yield of affected shoots. Affected uprights are scattered throughout the beds and are visible from late April, through mid June. Affected tissues are initially pale green but become pink as they enlarge, eventually becoming powdery white when spores are produced on the surface of infected tissues. By mid-bloom the affected uprights harden and become dry and dark brown and withered.

Life Cycle: Basidiospores are produced on the surface of the affected shoots and are dispersed by wind to nearby, lateral buds. Newly infected buds do not show symptoms until the following spring.

Pest Management

Cultural Controls: None available.

Resistant Cultivars: None identified.

Chemical Controls: There are no fungicides registered for this disease.

Issues for Rose Bloom

None identified.

Red Gall (*Synchytrium vaccinii*)

Pest Information

Damage: Red gall forms on the surface of cranberry leaves, young stems, petioles, flowers and fruit. If galls are numerous, the affected tissue becomes misshapen and reddish in colour.

Life Cycle: Red gall overwinters as resting spores in the gall tissue. The method of proliferation is not known but it is suspected that zoospores are released in spring and swim to new cranberry growth where they cause infection. Host tissue proliferates in response to the infection and a gall is formed.

Pest Management

Cultural Controls: The spread of this disease depends on free water for zoospores to swim. Improving drainage and removing low-lying areas in beds so there is less standing water is beneficial. Early removal of winter flood water is also beneficial, as is the use of sprinklers rather than flooding for frost protection.

Resistant Cultivars: None identified.

Chemical Controls: There are no products registered in Canada on cranberry for control of red gall.

Issues for red gall

None identified.

Phytophthora Root and Runner Rot (*Phytophthora* spp.)

Pest information

Damage: Phytophthora root and runner rot affects the roots and underground runners of cranberries. The disease occurs most often in areas that have poor drainage and areas with prolonged periods of soil saturation or standing water during the growing season. Above ground symptoms are weak, unthrifty vines that have stunted, weak uprights with fewer and smaller leaves that turn red prematurely in late summer. Similarly, flower and fruit production is reduced and in advanced cases, discrete patches without vines develop in the beds. Underground symptoms include reduced numbers of fibrous feeder roots and frequent discoloration below the periderm in infected roots and runners. Where symptoms are severe, there can be significant yield reduction.

Life Cycle: The life cycle of this disease has not been fully elucidated. However, based on phytophthora species affecting other crop plants, it is surmised that the species affecting cranberry overwinter as mycelium, chlamydospores or oospores in infected plants, colonized plant debris or soil. Primary infection is likely on new, fibrous roots and from there progresses into the woody, underground runners. Saturated or flooded soil conditions promote sporangium production and zoospore release, the latter constituting the primary unit of infection. Disease spread within a bed is most likely through flowing water and disease spread between bogs or regions via vines with latent infections used to plant new beds.

Pest Management

Cultural Controls: Improving drainage by installing drains, ditches, etc. and removing low-lying areas in beds so there is less standing water is beneficial. Over watering should be avoided if this disease is present and additional fertilizer may be beneficial in promoting new root production in weak, diseased vines. Vines from infected beds should not be used to plant new beds.

Resistant Cultivars: Very little is known about the relative resistance of cranberry cultivars to this disease. Results from studies of artificially inoculated, greenhouse-grown plants have been inconsistent.

Chemical Controls: There are no chemical controls registered for phytophthora on cranberry in Canada.

Issues for Phytophthora root and runner rot

1. Further research is required to more fully elaborate cultivar differences in susceptibility to phytophthora root and runner rot.

Upright dieback: (*Diaporthe vaccinii* (anamorph *Phomopsis vacinii*) and *Synchronoblastia crypta*)

Pest information

Damage: The visible symptoms of upright dieback include yellowing of the leaves which progresses to orange or bronze and eventually becomes brown as the upright dies. The incidence of the disease is generally greater in young, 1-3 year old beds where large patches of uprights can become infected. In well-established beds, infected uprights tend to be more scattered throughout the bed. Symptoms usually develop in early spring after the winter flood is removed. Roots of infected vines remain unaffected, but berries attached to affected uprights wither and desiccate as the upright dies. Normally, upright dieback does not cause significant economic loss, but in cases where greater than 20% of uprights are infected, crop loss can be significant. One of the fruit rots, viscid rot, is caused by the same species and therefore some fruit rot is often associated with upright dieback.

Life Cycle: Diaporthe vaccinii does not overwinter well in diseased vines and how it infects new tissue is not known. It is thought that ascospores are released from perithecia at the time of bud swell and form hyphae that penetrate the new tissue. The fungus can be isolated from visually healthy uprights suggesting infections may be symptomless for several weeks before environmental factors and stresses affecting the plant, favour expression. Dieback may occur at any time during the growing season, but is more likely to occur when vines are under stress from hot or dry conditions. It is not known whether ascospores are capable of infecting blossoms and fruit. Environmental conditions that favour infection by *Synchronoblastia crypta* parallel those of *D. vaccinii*. However, *S. crypta* is spread by conidia and infects uprights, blossoms and fruit.

Pest Management

Cultural Controls: Optimized fertility programs make vines more resistant to infection. Also, avoiding moisture stress through good irrigation management and the use of overhead irrigation for vine cooling during hot temperatures may inhibit the progression of infections. Avoiding other stresses such as oxygen deficiency and winter injury are also thought to help limit infection.

Resistant Cultivars: The cultivar ‘Franklin’ is thought to have some resistance to this disease, but more research is required.

Chemical Controls: A fungicide is registered for upright dieback control. For best results, application should be made both at bud-break and during bloom.

Issues for upright dieback

None identified.

Black Spot (*Mycosphaerella migromaculans*)

Pest information

Damage: Black spot is actually a secondary invader that colonizes stem lesions and leaf spots caused by *Exobasidium rostrupii*, the red leaf spot pathogen. Black lesions are formed on runners and uprights and often girdle the stem leading to defoliation and death of the tissue beyond the girdling point. This usually occurs in late August or September when it is too late in the season for lateral branches to set a mixed bud. As such, yield reduction is usually seen in the year following infection. Berries may also be attacked but the incidence is generally not considered to be economically important. Lesions do not lead to rotting in storage.

Life Cycle: The life cycle of this fungus is not fully understood, but it is believed to overwinter in stem lesions as immature perithecia. It is hypothesized that saprophytic growth of the fungus in the duff layer or bark of older runners, produces conidia that infect the host later in the summer when red leaf spot lesions are present. Like red leaf spot, black spot prefers cloudy, rainy or misty weather for infection and development, tending to be most common in shaded areas of the bog.

Pest Management

Cultural Controls: The cutting back of trees and shrubs surrounding the bog helps reduce shading and improves air movement and sun exposure, making conditions less favourable for the disease. Controlling red leaf spot disease should also control black leaf spot.

Resistant Cultivars: None identified.

Chemical Controls: There are no registered chemical controls for this disease.

Issues for black spot

None identified.

Red Leaf Spot (*Exobasidium rostrupii*)

Pest information

Damage: Young plantings are more susceptible to red leaf spot. Symptoms of red leaf spot are circular, bright red spots on the upper side of leaves and sometimes on young, green berries. Expanding spots often overlap and infected leaves are usually shed prematurely. The disease may also spread through leaf petioles to new stem growth where it can cause reddening and hypertrophy, sometimes resulting in tissue death. The most serious effect of the disease is the loss of vegetative and fruiting buds due to the death of young shoots. Black spot disease often develops on plants already affected by red leaf spot and some damage attributed to red leaf spot damage may actually be caused by black spot.

Life Cycle: The life cycle of this fungus is not fully understood, but it is thought to over-winter on diseased leaves and stems as a dormant mycelium. It is believed that this mycelium serves as the primary inoculum, infecting young leaves and stems in spring after growth resumes. The disease is favoured by high levels of moisture from rain, fog, poor drainage, etc. and is more prevalent in shaded areas where air circulation is poor. Excessive vine growth, in over-fertilized beds, also favours disease development.

Pest Management

Cultural Controls: Practices that improve air circulation and plant drying are favoured in controlling the disease. Over fertilization causing excessive vine growth should be avoided.

Resistant Cultivars: Greenhouse studies have reported little variation in disease susceptibility between cultivars tested, although the cultivars 'Ben Lear' and 'Stevens' exhibit more susceptibility in the field.

Chemical Controls: There are no registered controls for this disease in Canada.

Issues for red leaf spot

1. There are currently no fungicides registered for red leaf spot.

Twig Blight (*Lophodermium oxycocci* and *L. hypophyllum*)

Pest information

Damage: Twig blight can affect scattered uprights or large patches in the beds. In severe outbreaks entire beds can be blighted. In winter and early spring, the foliage on one-year old wood turns brown. As the disease progresses, the blighted leaves become bleached tan and then silvery gray. The disease kills only one-year old wood, though runners may also be affected. Vines are unable to compensate for the loss of fruit buds by increased fruit set or berry size and consequently, yield reduction is directly proportional to the percentage of uprights with mixed (fruiting) buds that have been blighted. In severe cases where the disease is untreated, up to 80% of uprights may be affected.

Life Cycle: The fungus overwinters as mycelium in infected leaves and twigs. Ascospores are released between June and August and are disseminated by wind to new leaves suitable for infection. Moisture is required for 4-28 hrs for spore release and may come from rain or irrigation. Moisture from fog or dew is insufficient to trigger spore release. Leaves on new upright growth are susceptible to new infections for only about 30 days each summer. New infections occur in the summer, but symptoms are not expressed until winter and early spring.

Pest Management

Cultural Controls: Removing trees causing shading is effective in reducing the incidence of twig blight in these areas. Efforts should be made to obtain twig blight free planting stock when planting new beds, as beds infected with the disease fill in very slowly without treatment.

Resistant Cultivars: The cultivars 'McFarlin', 'Stevens', 'Bergman' and 'Crowley' are known to be susceptible.

Chemical Controls: Chemical controls are based on the protection of new tissue with fungicides during the infection period.

Issues for twig blight

None identified.

Insects and Mites

Key Issues

- There are very few reduced risk alternatives to organophosphate insecticides registered for cranberry. Growers are concerned about the further restriction and possible loss of organophosphate insecticides, without suitable replacements.
- MRL's in export markets must be taken into account when registering new pesticides on cranberries in Canada, to ensure there are no conflicts.
- Effective management strategies that include biological controls and reduced risk pesticides are not available for pests such as cranberry fruitworm, blackheaded fireworm, cranberry tipworm and cranberry girdler.
- The refinement of pheromone-mediated mating disruption and biological control strategies for the blackheaded fireworm is required.
- Economic thresholds have not been established for the blueberry spanworm and other spanworms, the various species of root weevils and for the rusty tussock moth.
- There are no reduced risk insecticides available for the control of insects such as redheaded flea beetle, cranberry blossomworm, rusty tussock moth, speckled green fruitworm, false armyworm, root weevils and the blueberry spanworm and other spanworms.
- The olive spanworm (*Ematurga amitaria*) was identified for the first time in Quebec in 2004. There have been no monitoring techniques or economic thresholds established for this pest.
- There is a lack of information on the biology, distribution and potential impact of the cranberry tipworm. Action thresholds for treatment need to be determined.
- There are no biological or reduced risk products available for the cranberry fruitworm. There is an immediate need to replace the organophosphate insecticides currently registered for the control of this pest.
- There are no early detection methods available for the cranberry fruitworm.
- There is concern in many areas that conventional chemicals are becoming less effective against the sparganothis fruitworm. The development of environmentally friendly, alternative controls would improve the management of this insect.
- The economic threshold for damage caused by both flea beetle larvae and adults in cranberries needs further work.
- The registration of systemic insecticides could potentially reduce the frequency of pesticide applications currently used for the management of insects such as the cranberry blossomworm and false armyworm.
- There are no registered controls for the cranberry weevil in Canada and effective alternative control strategies have not been investigated.

Table 8. Degree of occurrence of insect pests in cranberry production in Canada

Pests	Degree of occurrence		
	BC	QC	NB
Big cranberry spanworm	DNR	E	DNR
Blackheaded fireworm	E	E	E
Blueberry spanworm	DNR	E	DNR
Cranberry blossomworm	DNR	E	DNR
Cranberry fruitworm	DNR	E	E
Cranberry girdler	E	E	E
Cranberry tipworm	E	E	E
Cranberry weevil	DNR	E	DNR
Dearness scale (*Rhizaspidiotus dearnessi*)	E	DNR	DNR
False armyworm	DNR	E	DNR
Green spanworm/ brown spanworm	DNR	E	DNR
Olive spanworm (*Ematurga amitaria*)	DNR	E	DNR
Sparganothis fruitworm	DNR	E	E
Redheaded flea beetle	DNR	E	DNR
Root weevils	E	E	DNR
Rusty tussock moth/ white marked tussock moth	DNR	E	DNR
Rusty tussock moth	E	E	E
Speckled green fruitworm	DNR	E	DNR
Widespread yearly occurrence with high pest pressure			
Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure			
Widespread yearly occurrence with low to moderate pest pressure			
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure			
Pest not present			
DNR - Data not reported.			
E – established			
D – invasion expected or dispersing			
Source(s): "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005); New Brunswick Department of Agriculture and Aquaculture.			

Table 9. Adoption of insect pest management approaches for cranberry production in Canada

	Practice \ Pest	Cranberry fruitworm	Black-headed fireworm	Cranberry girdler	Blueberry spanworm	Tussock moths	False armyworm, cranberry blossomworm, speckled green fruitworm	Root weevils	Cranberry tipworm
Avoidance	resistant varieties								
	use of late water								
	planting / harvest date adjustment								
	optimizing fertilization								
	reducing mechanical damage								
	thinning / pruning								
	trap crops / perimeter spraying								
	Repellents								
Prevention	optimized drainage (ditching, tile drain, clean sand)								
	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								
Monitoring	scouting – trapping								
	records to track pests								
	soil analysis								
	weather monitoring for degree day modelling								
	grading out infected produce								
Decision making tools	economic thresholds								
	weather/ weather based forecast/ predictive model								
	recommendation from crop specialist								
	first appearance of pest or pest life stage								
	observed crop damage								
	crop stage								
	calendar spray								
Suppression	biological pesticides								
	pesticide rotation for resistance management								
	soil amendments								
	controlled atmosphere storage								
	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(s): "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005).

Table 10. Insect control products registered for cranberry production in Canada

Regulatory status as of July 17, 2007				
Control 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]**
acephate (Orthene 75% Soluble Powder Systemic Insecticide)	Organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	RE	Blackheaded fireworm
azinphos-methyl (Guthion)	Organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	PO (Last date of use Dec 31, 2012).	Cranberry fruitworm Sparganothis fruitworm Tipworm Fireworm
***Bacillus thuringiensis* var. *kurstaki* (Bioprotec 3P Dry Flowable, Dipel WP)**	B.t. subsp. kurstaki	Microbial disruptor of insect mid-gut membranes (includes transgenic crops expressing Bt toxins); 11B2	RR & RE	Green spanworm Brown spanworm
carbaryl (Sevin SL Carbaryl Insecticide Liquid Suspension)	Carbamate insecticide	Acetylcholine esterase inhibitors; 1A	RE	Cranberry fruitworm Climbing cutworm Blunt-nosed cranberry leafhopper Fireworm
diazinon (Diazinon 50 W Insecticide)	Organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	RE	Blackheaded fireworm Sparganothis fruitworm Cranberry fruitworm
malathion (Malathion 85E)	Organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	RE	Blackheaded fireworm Cranberry fruitworm Leafhoppers Meadow spittle bugs (nymphs)
phosmet (Imidan 50-WP Instapak Insecticide WP)	Organophosphate insecticide	Acetylcholine esterase inhibitors; 1B	RE	Blackheaded fireworm
potassium salts of fatty acids (Neudosan Commercial)	Insecticide, acaricide	N/A	R	Aphids Mealy bugs Mites Scale insects
tebufenozide (Confirm 240F Agricultural Insecticide)	Diacylhydrazine insecticide	Ecdysone agonists / moulting disruptors; 18A	RR	Blackheaded fireworm Sparganothis fruitworm

[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: www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides: www.irac-online.org/Crop_Protection/MoA.asp#area223 ; Fungicides: 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). 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: www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php

[4] Please consult the product label on the PMRA web site (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php) for specific listing of pests controlled by each active ingredient. Source: Pest Management Regulatory Agency

Table 11. Insect control products, classification and performance for cranberry production in Canada

Pests or Group of Pests targeted	Active ingredient[1,2]	Resistance group[3]	Stakeholder comments[5]	
			Performance of active ingredient according to recommended use[4,5]	Notes[5]
aphids	potasium salts of fatty acids	N/ A		
blackheaded fireworm	acephate	1B		
	diazinon	1B	A	Easy to use; very effective; can be applied via chemigation.
	malathion	1B		
	phosmet	1B		
	tebufenozide	18A	A[P]	Not used frequently; research is required to determine the best way to use this product; opinions vary as to it's efficacy; low toxicity to pollinators.
fireworms	azinphos methyl (until Dec. 31, 2012)	1B		
	carbaryl	1A		
climbing cutworm	carbaryl	1A		
fruitworm, cranberry	azinphos methyl (until Dec. 31, 2012)	1B		
	diazinon	1B	A	Easy to use; very effective.
	malathion	1B		
fruitworm, sparganothis	azinphos methyl (until Dec. 31, 2012)	1B		
	tebufenozide	18A	A[P]	Product has low toxicity to pollinators
leafhopper, blunt-nosed cranberry	carbaryl	1A		
leafhoppers	malathion	1B		

Pests or Group of Pests targeted	Active ingredient[1,2]	Resistance group[3]	Stakeholder comments[5]	
			Performance of active ingredient according to recommended use[4,5]	Notes[5]
mealy bugs	potassium salts of fatty acids	N/ A		
mites	potassium salts of fatty acids	N/ A		
scale insects	potassium salts of fatty acids	N/ A		
spanworm, brown	*Bacillus thuringiensis* var. *kurstaki*	11B2		
spanworm, green	*Bacillus thuringiensis* var. *kurstaki*	11B2		
tipworm	azinphos methyl (until Dec. 31, 2012)	1B		

[1]All active ingredients listed were registered for this use as of July 17, 2007 (refer Table 9).

[2] Please consult product labels on the PMRA web site (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php) for further information on pesticide use.

[3]The mode of action/ resistance group is 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: www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm; Insecticides: www.irac-online.org/Crop_Protection/MoA.asp#area223 ; Fungicides: www.frac.info/frac/index.htm

[4] Adequate (green) (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control); 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)

[5]Source: "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005).

Cranberry Fruitworm (*Acrobasis vaccinii*)

Pest information

Damage: Cranberry fruitworm damage is caused by larvae burrowing into berries, feeding on seeds and pulp and leaving behind frass in the hollowed out berries. One larva may tunnel through 5-8 berries. Infested berries turn prematurely red and eventually wither, giving rise to their being called "raisins".

Life Cycle: Cranberry fruitworms overwinter as larvae inside cocoons in the soil and pupate in the spring. From mid-June to late July, the brownish grey moths emerge. The moths are primarily active at night. Egg laying coincides with berry set. Females lay up to 50 eggs, one per berry at the calyx end. Eggs hatch in 5-10 days and young larvae bore into the fruit and seal the opening with silk, making it quite inconspicuous. Caterpillars feed on berries from July to September before dropping to the ground to build an overwintering cocoon in the soil.

Pest Management

Cultural Controls: A late water flood can be extremely effective in controlling cranberry fruitworm, thereby eliminating the need for chemicals under ideal conditions. However, scouting for eggs should continue following the late water flood to verify the effectiveness of the treatment and to ensure that new moths have not flown in from outside the bog to lay eggs. Monitoring for cranberry fruitworm can be accomplished with pheromone traps placed in the cranberry bog, although a correlation between trap catch and egg-laying has not been established.

Resistant Cultivars: None identified.

Chemical Controls: A number of insecticides are registered for cranberry fruitworm control.

Issues for Cranberry Fruitworm

1. There are no biological or reduced risk products available for control of the cranberry fruitworm. There is an immediate need to replace the organophosphate pesticides currently registered for this pest.
2. There are no early detection methods available for the cranberry fruitworm.

Blackheaded Fireworm (BHF) *(Rhopobota naevana)*

Pest information

Damage: Spring damage is caused by first generation larvae that feed on leaves from the previous season, before moving on to feed on expanding terminal buds and new leaves, the latter directly reducing yield. Summer damage is caused by second generation larvae feeding on new leaves, flowers and fruit. Damage to fruit is very similar to that of cranberry fruitworm except that blackheaded fireworms do not seal their holes with silk. Blackheaded fireworm larvae also produce characteristic "tents" by webbing together several leaves at the tip of an upright or even several uprights.

Life Cycle: BHF overwinters as eggs on the underside of cranberry leaves. They hatch over a 3-6 week period beginning in May. Larvae feed for 2-3 weeks after which they drop to the trash layer where they pupate, emerging as adult moths in June. Adult moths begin laying eggs on leaf undersides only 24 hours after emergence. Some of these eggs overwinter but most hatch

in July into second generation larvae that feed on leaves, flowers and fruit. Following pupation, second generation adults emerge in August through September and produce overwintering eggs.

Pest Management

Cultural Controls: First generation larvae may be controlled by re-flooding beds for a period of 10 hours. Re-flooding for second generation larval control is not recommended as blossoms and newly set berries will be killed. Larvae can be monitored by sweep netting before terminal buds begin to swell or by counting the number of fireworm "tents" and checking the size of the larvae. If first generation larvae are successfully controlled, treatment for the more damaging second generation should not be required. Monitoring for the emergence of first generation adults using pheromone baited traps is also highly recommended. The use of chemical controls may be reduced or eliminated through the use of pheromone mating disruption. A biological control is also commercially available for BHF control. *Trichogramma sibericum* is a parasitic wasp that attacks and parasitizes BHF eggs. It is most effective in reducing high fireworm populations and works well as a companion treatment to mating disruption.

Resistant Cultivars: None identified.

Chemical Controls: If there is a history of infestation and larvae exceed thresholds, insecticides may be applied.

Issues for Blackheaded Fireworm

1. There are insufficient reduced risk pesticides available for the management of the blackheaded fireworm.
2. The blackheaded fireworm is difficult to manage. The timing of treatments is critical. The development of effective monitoring techniques and timing of controls would facilitate the management of this pest.
3. The refinement of pheromone-mediated mating disruption and biological control strategies is required.

Cranberry Girdler (*Chrysoteuchia topiara*)

Pest information

Damage: Larvae of the cranberry girdler feed on the bark and wood of roots and runners causing girdling. This damage becomes more visible in late fall when leaves turn brown and in spring when the damaged plants have lost their leaves altogether.

Life Cycle: The cranberry girdler over-winters as a larva inside a cocoon in the trash layer on the bed surface. Pupae complete their development in the spring and adult moths emerge in late June and are present until August. Female moths lay eggs in plant debris on the bed surface. Following egg hatch, caterpillars actively feed from August to September. There is only one generation per year.

Pest Management

Cultural Controls: Regular sanding and sanding of "hot spots" reduces cranberry girdler damage. A six day, post-harvest flood also is beneficial but may reduce the next season's crop. Cranberry girdlers may be monitored with pheromone traps. Beds can also be

monitored for signs of larval damage in August and September when damage is most visible. Entomopathogenic nematodes (*Steinernema carpocapsae*) may be applied to control larvae in mid to late August.

Resistant Cultivars: None identified.

Chemical Controls: There are no insecticides available for the control of cranberry girdler.

Issues for Cranberry Girdler

1. There are no chemical treatments available for the cranberry girdler.

Cranberry Tipworm (*Dasineura oxycoccana*)

Pest information

Damage: Cranberry tipworm larvae feed on the terminal growth of new shoots and often cause lateral branching if the growth point is injured. The larvae also feed on the new leaves by rasping the upper surface causing colour loss and leaf cupping. Eventually the leaves turn brown and drop off. Plants recover well from early season injury but damage to developing buds in August directly reduces yield.

Life Cycle: Cranberry tipworms have two to three generations during the growing season. First generation females mate and begin laying eggs in late May. Eggs are usually laid on the leaf surface near the base of terminal leaves. Larvae hatch and begin to feed on leaves. There are three larval instars followed by pupation in a cupped leaf at the shoot tip. The next generation adults emerge soon after. Pupae of the final generation drop to the bed surface when the leaves turn brown and overwinter in the trash layer. The life cycle from egg to adult takes only 2-4 weeks.

Pest Management

Cultural Controls: Re-sanding reduces the emergence of adult flies in spring by covering and smothering overwintering pupae.

Resistant Cultivars: Cranberry tipworm reportedly prefers the variety ‘Early Black’, followed by ‘Howes’. The variety ‘Stevens’ seems to be the least preferred among cultivars.

Chemical Controls: Refer to Table 10 for chemical control of cranberry tipworm.

Issues for Cranberry Tipworm

1. There is a lack of information available on the biology, distribution and potential impact of the cranberry tipworm. Action thresholds for treatment need to be determined.
2. There are no reduced risk insecticides available for the control of the cranberry tipworm.

Blueberry Spanworm (*Macaria argillacearia* (syn. *Itame argillacearia*)) and Green Spanworm (*M. sulphurea*)

Pest information

Damage: Damage is caused by the larvae that feed on buds beginning at budbreak and then on new leaves and flower blossoms. Damaged areas are evident by their darker colour in the bog, a result of loss of the lighter green, new growth, leaving the older, darker green leaves.

Life Cycle: Blueberry and green spanworms are among the earliest caterpillars to be seen in spring. They overwinter as eggs in the leaf trash at the bed surface and hatch in early May

(blueberry spanworm) to mid-May to early June (green spanworm). The caterpillars feed voraciously until pupating in the plant debris. Adults emerge in late June for blueberry spanworm and early July to August for green spanworm. Eggs are laid singly or in small clusters in the trash layer at the bed surface, through late July and August.

Pest Management

Cultural Controls: Sanding is helpful for managing spanworms. Spanworms are less common in new fields due to more regular sanding. *Bacillus thuringiensis* can be used effectively for spanworm control. Monitoring is done effectively by net sweeping for larvae.

Resistant Cultivars: None identified.

Chemical Controls: There are no chemicals registered specifically for blueberry spanworm control.

Issues for Spanworm

1. Economic thresholds have not been established for the blueberry spanworm.
2. There are insufficient reduced risk insecticides available for the control of the blueberry spanworm.

Sparganothis Fruitworm (*Sparganothis sulfureana*)

Pest information

Damage: Two generations of larvae of the sparganothis fruitworm cause damage. The first generation selectively feeds on flower buds, indirectly reducing yield. The second generation larvae have a direct impact on yield as they feed selectively on fruit, hollowing out the contents.

Life Cycle: There are two generations per year. The sparganothis fruitworm overwinters as a young larva in the trash layer at the bed surface and resumes activity at budbreak. At this time it feeds on buds and as it gets older, webs together uprights and feeds on leaves within the protective web. Adults emerge in mid-June and lay eggs in masses of 20-50 eggs on the upper side of cranberry leaves or on weeds. The second generation caterpillars emerge by late July and feed on leaves and fruit. Second generation adults are present by early August and actively lay eggs until the end of September. Eggs hatch and young larvae overwinter.

Pest Management

Cultural Controls: Flooding is ineffective in controlling the larvae. Second generation moths can be monitored with pheromone traps.

Resistant Cultivars: None identified.

Chemical Controls: Chemical insecticides registered for sparganothis fruitworm control are listed in Table 10.

Issues for Sparganothis fruitworm

1. There is concern in many areas that conventional chemicals are becoming less effective against the sparganothis fruitworm. The development of environmentally friendly, alternative controls would improve the management of this insect.

False Armyworm (*Xylena nupera*)

Pest information

Damage: Larvae of the false armyworm feed during the day on the inner part of terminal buds, and when older and larger, feed voraciously on new leaves and flower blossoms. As a cutworm species, false armyworms characteristically chew and "cut-off" leaves and buds when they are feeding.

Life Cycle: There is only one generation of false armyworm per season and it begins with an overwintering adult that becomes active in April. Females lay eggs in masses of about 100 on the stems or lower surfaces of leaves. Eggs hatch in late May making these caterpillars among the first to be seen in the cranberry marsh. Young larvae feed during the day on buds (before new growth) but as they get older become nocturnal, feeding aggressively on new leaves and flower blossoms. In late June, the mature caterpillars burrow into the soil for a 2-6 week dormancy period. Pupation follows with adults emerging in mid-August.

Pest Management

Cultural Controls: Late water is reported to reduce false armyworm populations. *Bacillus thuringiensis* can be used effectively. The action threshold for treatment is 4.5 larvae per 25 sweeps.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for False Armyworm

1. The registration of systemic insecticides potentially could reduce the frequency of pesticide applications required for the control of the false armyworm.
2. There are no reduced risk chemical controls available for the control of false armyworm.

Cranberry Blossomworm (*Epiglaea apiata*)

Pest information

Damage: Cranberry blossomworm is also a cutworm. Cranberry blossomworm larvae skeletonize the older leaves and bore into buds and "cut-off" flower blossoms.

Life Cycle: Cranberry blossomworm overwinters as eggs in the leaf trash on the bed surface. The eggs hatch in mid-May and the larvae begin to feed on leaves and buds. The larvae mature by July and enter a 2-4 week dormancy period in the trash layer before burrowing into the soil and pupating. Moths emerge in September and are active through to November, laying eggs singly in the plant debris at the bed surface.

Pest Management

Cultural Controls: Late water is reported to reduce cranberry blossomworm populations. Also, sanding may be beneficial as overwintering eggs are buried by this operation. *Bacillus thuringiensis* can be used effectively. The action threshold is 4.5 larvae per 25 sweeps.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for Cranberry Blossomworm

1. There are no reduced risk chemical controls registered for the cranberry blossomworm.

Redheaded Flea Beetle (*Systena frontalis*)

Pest information

Damage: Adult flea beetles feed on leaves of cranberry and weeds within the bog. This impacts bud development for the coming year. There is also some feeding by larvae on plant roots but the impact of this feeding has not been quantified.

Life Cycle: There is one generation per year of this pest. Flea beetles overwinter as eggs and sometimes as adults. Eggs begin hatching in late May and larvae feed on plant roots. Adults emerge from the soil from mid-July to August and feed on plant leaves, impacting bud development for the following year. Eggs that overwinter are laid in the soil from August until September.

Pest Management

Cultural Controls: None identified.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for Redheaded Flea Beetle

1. The economic threshold for damage caused by both flea beetle larvae and adults in cranberries requires further work.
2. There are no reduced risk insecticides available for the control of flea beetles.

Minor Spanworms: (Big cranberry spanworm (*Eutrapela clemataria)* spiny looper (*Phigalia titea*) and stout spanworm (*Lycia ursaria*))

Pest information

Damage: Although these species are less common than blueberry and green spanworms, when they do occur they can do serious damage. They are voracious feeders and can defoliate the cranberry bed, often in localized areas. Infestations of the big cranberry spanworm and stout spanworm can be particularly damaging as the larvae of these species are large, up to 60 mm in length at maturity.

Life Cycle: Each of these spanworms has one generation per year, overwintering as pupae in a cocoon in the soil. Moths emerge at varying times, laying egg masses of 150-600 eggs, depending on species. Caterpillars feed on buds, leaves and blossoms before pupating, to repeat their life cycle.

Pest Management

Cultural Controls: Spanworms are less common in new fields due to more regular sanding. Sanding is thought to be a helpful cultural practice in managing this pest. *Bacillus thuringiensis* can be used effectively for spanworm control if applied when larvae are small (less than 6 mm in length). Populations can be monitored by net sweeping for larvae.

Resistant Cultivars: None identified.

Chemical Controls: There are no chemicals registered specifically for the control of these spanworms.

Issues for Spanworm

1. Species specific action thresholds for treatment have not been determined for minor spanworms.
2. There is a lack of chemical controls specifically labelled for treatment of spanworm infestations.

Cranberry Weevil (*Anthonomus musculus*)

Pest information

Damage: Both larvae and adult weevils damage cranberry. Adults bore holes in flower blossoms during oviposition, often causing the flower to drop and loss of a potential fruit. They also bore holes in terminal buds, causing browning which resembles frost injury when the bud develops. The larvae feed on the developing flower blossom. Adult weevils emerge in summer and bore holes in the developing fruit, reducing yield directly.

Life Cycle: Adults overwinter in flooded fields or on adjacent dykes and margins of beds. After the winter flood is removed, the adults become active and feed first on old leaves and buds, and then on new leaves and blossoms as the plant develops. Female weevils lay their eggs singly in flower blossoms and after hatching, larvae feed in the flower. Pupation also occurs in the flowers and adults emerge about the time fruit are forming. They feed on leaves, fruit and new buds through July and August before migrating to the soil surface where they overwinter in the trash layer.

Pest Management

Cultural Controls: None available.

Resistant Cultivars: None identified.

Chemical Controls: There are no chemicals registered specifically for this weevil in Canada.

Issues for Cranberry Weevil

1. There are no registered controls for this pest in Canada and effective alternative control strategies have not been investigated.

Root Weevils: (Black Vine Weevil (*Otiorhynchus sulcatus*), Strawberry Root Weevil (*O. ovatus*) and Claycoloured Weevil (*O. singularis*))

Pest information

Damage: Root weevil larvae feed voraciously on the cranberry roots and bark, often causing girdling injury similar to that caused by cranberry girdler, except that there is no frass left at the feeding sites. Wilting and browning develops on above ground parts of the plants and shows in late spring, becoming more severe as the season progresses. Weevils are killed by flooding during harvest so this pest is generally only a problem in beds that are dry harvested.

Life Cycle: Larvae overwinter in cranberry soils and pupate in early spring. Adults emerge from pupal cells in late May through June depending on location. Adult weevils feed on leaves for 4-6 weeks before egg-laying begins and lay eggs at the soil level. The eggs hatch 2-3 weeks

later into legless, white grubs that feed on cranberry roots and root bark. Temperature permitting, they feed continuously until they pupate the following spring.

Pest Management

Cultural Controls: Wet-harvesting is effective in reducing root weevil populations. Alternatively, a 10-14 day fall flood as soon as possible after harvest is effective. Winter flooding also reduces populations. Adults are best monitored by net sweeping. Leaf notching is also indicative of the presence of adult weevils. Monitor in spring by pulling areas of dying vines, looking for the white C-shaped grubs in the soil below. If found, entomopathogenic nematodes may be applied when the soil temperature is above 13 ˚C.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for Root Weevil

1. Management options for root weevils are limited. There are no chemical controls specifically registered for root weevils.
2. Species specific action thresholds for the treatment of root weevils have not been determined.

Rusty Tussock Moth (*Orgyia antiqua*)

Pest information

Damage: Rusty tussock moth larvae feed on buds, leaves and flower blossoms. Infestations tend to be localized, with defoliated areas appearing as dark areas in the cranberry bed.

Life Cycle: There is one generation per year. The rusty tussock moth overwinters as eggs that are laid in masses on the cocoon from which the female moth emerged. Eggs hatch in late spring and larvae feed on buds, leaves and flower blossoms. The insect pupates in cocoons on cranberry stems from which moths emerge in August and September.

Pest Management

Cultural Controls: Rusty tussock moth larvae are relatively small (25-35 mm at maturity) and can be controlled with *Bacillus thuringiensis* if it is applied when larvae are young and less than 6 mm in length. Monitoring can be done by net sweeping for larvae. Flooding and sanding are potential cultural controls for the rusty tussock moth.

Resistant Cultivars: None identified.

Chemical Controls: None available.

Issues for Rusty Tussock Moth

1. There are no chemicals specifically labelled for rusty tussock moth control.
2. Specific action thresholds for treatment have not been determined for the rusty tussock moth.

Speckled Green Fruitworm (*Orthosia hibisci*)

Pest information

Damage: Feeding by larvae of the speckled green fruitworm can cause serious damage to leaves, buds and blossoms. The larvae are known to be particularly voracious as they approach maturity.

Life Cycle: There is only one generation per year of this pest. It over-winters as pupae in the soil, with adult moths emerging from late April to early May. They are active at night, laying eggs in irregular masses beginning shortly after their emergence. Larvae hatch from the eggs in mid-May and may be present in beds until late August.

Pest Management

Cultural Controls: There are no cultural controls reported specifically for speckled green fruitworm, although late water flooding is reported to be effective against related species such as false armyworm and cranberry blossomworm. *Bacillus thuringiensis* is effective if applied before the larvae are 12 mm long. "Late water" may potentially be an effective cultural management approach for the speckled green fruitworm.

Resistant Cultivars: None identified.

Chemical Controls: There are no pesticides specifically registered for speckled green fruitworm.

Issues for speckled green fruitworm

1. There are insufficient insecticides registered for the control of the speckled green fruitworm.

Weeds

Key Issues

- There are only a limited number of broad spectrum herbicides available to control the wide range of perennial weeds present in cranberry production.
- Silverweed can be particularly hard to control if it becomes established due to its growth habit and moderate tolerance to presently used herbicides.
- The effectiveness of acetic acid (vinegar) as a post-emergent treatment (application by injection into the soil) for the control of perennial broadleaf and grass weeds is not well understood.

Table 12. Degree of occurrence of weed pests in cranberry production in Canada

	Degree of occurrence		
Weeds	**BC**	**QC**	**Atlantic Provinces**
Annual grasses	E	E	DNR
Perennial grasses	DNR	E	DNR
Annual broadleaf weeds	E	E	DNR
Perennial broadleaf weeds	E	E	DNR
Legumes	DNR	E	DNR
Vetch	E	DNR	DNR
Sedges and rushes	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

DNR – data not reported

E – established

D – invasion expected or dispersing

Sources: "Canadian Expert Poll Focus Groups" for British Columbia and Quebec (2005).

Table 13. Adoption of weed pest management approaches for cranberry production in Canada

	Practice \ Pest	annual grasses	annual broadleaf	perennial grasses	Perennial broadleaf	Legumes
Avoidance	use of late water					
	thinning / pruning					
	crop rotation					
	choice of planting site					
	optimizing fertilization					
Prevention	optimizing drainage (ditching, tile drain, clean sand)					
	residue removal/ management					
	equipment sanitation					
	mowing / mulching / flaming					
	row or plant spacing (plant density)					
	water / irrigation management					
	weed management on non-crop lands					
	weed management in non-crop years					
	tillage / cultivation					
Monitoring	Scouting					
	records to track pests					
	field mapping of weeds / records of resistant weeds					
	soil analysis					
	grading of grain / produce for weed contamination					
	visual field inspection					
	grading out infected produce					
Decision Making Tools	economic threshold					
	weather/ weather based forecast/predictive model					
	recommendation from crop specialist					
	first appearance of pest or pest life stage					
	observed crop damage					
	crop stage					
	calendar spray					
Suppression	biological pesticides					
	habitat / environment management					
	pesticide rotation for resistance management					
	soil amendments					
	ground cover / physical barriers					
	inter-row cultivation					
	mechanical weed control					

no information regarding the practice is available

available/used

available/not used

not available

Sources: "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005).

Table 14. Weed control products registered for cranberry production in Canada

Regulatory status as of July 17, 2007				
Control 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]**
2,4-D (Nufarm 2,4-D Amine 500 Liquid Herbicide)	Phenoxy carboxylic acid herbicide	Action like indole acetic acid (synthetic auxins); 4	RE	Annual broadleaf weeds Perennial broadleaf weeds
clopyralid (Lontrel 360 Herbicide)	Pyridine carboxylic acid herbicide	Action like indole acetic acid (synthetic auxins); 4	R	Vetch (*Vicia* spp)
dichlobenil (Casoron G-2 Granular Herbicide)	Nitrile herbicide	Inhibition of cell wall synthesis; 20	R	Annual and perennial weeds
napropamide (Devrinol 10G Selective Herbicide Granular)	Acetamide herbicide	Inhibition of VLCFAS; 15	RE	Annual grasses
fluazifop-p-butyl (Venture L)	Aryloxyphenoxy-propionate herbicide	inhibitors of acetyl CoA carboxylase (ACCase); 1	R (non-bearing cranberries)	Annual grasses and quackgrass
glyphosate (Roundup Transorb Liquid Herbicide)	Glycine herbicide	Inhibition of EPSP synthase; 9	R	Annual and perennial weeds
sethoxydim (Poast Ultra Liquid Emusifiable Herbicide)	Cyclohexanedione herbicide	inhibitors of acetyl CoA carboxylase (ACCase); 1	RE	Annual grasses Quackgrass
mineral oil (Guardsman Agricultural Weedkiller No.1)	N/A	N/A	R	Annual and perennial weeds, sedges and bracken fern

[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: www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm ; Insecticides: www.irac-online.org/Crop_Protection/MoA.asp#area223; Fungicides: 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). 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: www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php

[4] Please consult the product label on the PMRA web site (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php) for specific listing of pests controlled by each active ingredient.

Source: Pest Management Regulatory Agency

Table 15. Weed control products, classification and performance for cranberry production in Canada.

Pests or Group of Pests targeted	Active ingredient[1,2]	Type of Treatment	Mode of Action/ Resistance group[3]	Stakeholder comments[5]	
				Performance of active ingredient according to recommended use[4,5]	Notes[5]
annual broadleaf weeds	2,4-D	post-emergence	4		Used infrequently.
annual grasses	napropamide	pre-emergence	15	A^P - A	Used only in new plantings. Effectiveness declines on organic soils.
	sethoxydim	post-emergence	1	A	Approximately 10 days are required for activity to become apparent so additional, unnecessary applications may be used.
annual and perennial weeds	dichlobenil	pre-emergence	20	A^P	Used only on established plantings every second or third year. Product is very phytotoxic to cranberries. Applications are made in the spring when the plants are dormant.
	glyphosate	post-emergence	9	A	Product is harsh on cranberries and can be only applied as a wipe and therefore is not effective on weeds below the canopy.
annual grasses and quackgrass	fluazifop-p-butyl (in non-bearing cranberries)	post-emergence	1		
annual and perennial weeds, sedges and bracken fern	mineral oil	post-emergence	N/ A		Used as a spot treatment.
perennial broadleaf weeds	2,4-D	post-emergence	4	A^P	

Pests or Group of Pests targeted	Active ingredient[1,2]	Type of Treatment	Mode of Action/ Resistance group[3]	Stakeholder comments[5]	
				Performance of active ingredient according to recommended use[4,5]	Notes[5]
quackgrass	sethoxydim	post-emergence	1	I	Label rate may be too weak to be effective; a reduction in the PHI to enable treatments later in the season, may improve efficacy.
vetch *(Vicia* sp.)	clopyralid	post-emergence, wipe treatment	4	A^P	Phytotoxic, especially to new, developing tissue.

[1]All active ingredients listed have been registered for this use as of July 17, 2007 (refer Table13).

[2] Please consult product labels on the PMRA web site (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php) for further information on pesticide use.

[3]The mode of action/ resistance group is 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: www.plantprotection.org/HRAC/Bindex.cfm?doc=moa2002.htm; Insecticides: www.irac-online.org/Crop_Protection/MoA.asp#area223; Fungicides: www.frac.info/frac/index.htm

[4] Adequate (green) (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control); 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)

[5]Source: "Canadian Expert Poll on Crop Protection" focus groups for British Columbia and Quebec (2005).

Annual and Biennial Weeds

Pest Information

Damage: Grasses and broadleaf weeds compete for light, water and nutrients with the cranberry cuttings. If not controlled effectively, they will reduce establishment and expansion of the cranberry and significantly reduce the yield potential of the bog for future years. Annual grasses also cause significant problems because of their fast growth and ability to compete for necessary resources. Additionally, grass weeds are very tolerant to extremes in moisture and temperature once established. With limited soil disturbance to stimulate germination and a dense stand, annual weed germination is limited. Decreased health of cranberry plants due to abiotic or biotic factors such as ice damage or insects can allow for bare areas to develop and annual weeds can become re-established.

Life Cycle: Annual grass and broadleaf weeds complete their life cycle from seed germination to new seed production, in a single season. Spring annuals germinate in the early spring and produce seed in the summer or fall of the same year. Winter annuals grow to the rosette stage in the fall and mature and produce seed early the following year. Annual weeds produce large numbers of seeds by which they easily spread. Most arable land is infested with annual weed seeds at all times and some weed seeds can remain viable in the soil for many years, germinating when conditions are suitable. Biennial weeds are plants that germinate in the spring, producing a rosette of leaves and remain vegetative during the first summer. They overwinter as rosettes and in the next season, flower and produce seed. The plant dies at the end of the second growing season.

Pest Management

Cultural Controls: A primary preventative measure to control weeds is bog preparation. Using weed free materials and preparing the bog before establishment is critical. Once a bog has been established and good density is achieved, annual weeds become less of a problem.

Resistant Cultivars: None available.

Chemical Controls: Refer Table 14.for registered annual weed control products. If applied at the proper time, these products can achieve good control of most annual weeds.

Issues for Annual and Biennial Weeds

1. There are insufficient, post-dormancy herbicides available for the control of late germinating annuals.

Perennial Weeds

Pest Information

Damage: Certain perennial weeds such as woody perennials can greatly affect yield, yield quality and harvest efficiency, if not controlled. Perennials like goldenrod and silverweed can choke out cranberry plants, reducing density and vigour.

Life Cycle: Perennial grass and broadleaf weeds can live for many years. They are generally established from root systems, although many will also spread by seeds. Perennials usually flower and produce seeds every year as well as expand their root system, so can spread effectively by both methods. Tillage practices can break up the underground root systems and aid in the spread of perennial weeds. The critical stage for crop damage is early in the growing season, as for other groups of weeds.

Pest Management

Cultural Controls: Hand weeding as well as cutting and removing of weeds is an option with small perennial weeds that are established in limited areas. Maintaining a healthy crop that competes well will also reduce weed establishment.

Chemical Controls: Refer Table 14: many perennial weeds can be difficult to control once established in a bog. Pre-plant and pre-emergent chemicals at establishment can be critical. Herbicides used as a spot teatment or with a weed wiper are very important tools to manage established perennials.

Issues for Perennial Weeds

1. Effective post dormancy control products for woody perennials and aggressive herbaceous perennials like silverweed and goldenrod are required.

Vertebrate Pests

Muskrats

Pest information

Damage: Muskrats dig into cranberry beds looking for succulent roots. This destroys plants and makes the bed surface uneven. Also they build dens in the side of dams which reduces the stability and is a concern for safety when heavier machinery travels over these weakened areas. Dams have been known to let go due to muskrat damage.

Life Cycle: Muskrats are extremely prolific. Mating occurs 1-2 times per year and the gestation period is only 25-30 days. Litter sizes are typically 4-7 in number. Muskrat habitat includes streams, ponds and marshes, anywhere where there is slow moving water and muddy stream beds.

Pest Management

Controlling weed populations in the bog and trapping and removing animals will reduce problems due to muskrats. Muskrats do not like crown vetch when it is planted along berms, however this may lead to weed control issues in the bog itself.

Issues for Muskrats

1. Methods for controlling muskrats are required.

Birds – Water fowl

Pest information

Damage: Birds can feed on cranberry in the fall and also cause some damage when nesting in the bogs in the spring and early summer. Large groups of migratory birds may cause physical damage to the plants by digging for food in the bogs.

Life Cycle: Depending on bird species, migratory birds can nest in bogs in the spring. They also may stop in bogs in large numbers when on their migratory routes.

Pest Management

Minimizing insect and weed pests will reduce potential food sources for birds. Propane scare guns and netting above bogs may also deter birds.

Issues for Birds

1. None identified.

Resources

IPM / ICM resources for production of cranberry in Canada

Eastern Canada Cranberry IPM Manual
www.pmra-arla.gc.ca/english/pdf/spm/ipmcranberries-e.pdf

Integrated Pest Management for Cranberries in Western Canada
www.bccranberrygrowers.com/ipm/

Provincial Cranberry Crop Specialists and Provincial Minor Use Coordinators

Province	Ministry	Fruit or Berry Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture and Lands	Mark Sweeney (mark.sweeney@gov.bc.ca)	Caroline Bédard (caroline.bedard@gov.bc.ca)
Ontario	Ontario Ministry of Agriculture and Food	Pam Fisher (pam.fisher@ontario.ca)	Jim Chaput (jim.chaput@ontario.ca)
Quebec	Ministére d'Agriculture, Pêcheries et Alimentation du Québec	Luc Urbain (Luc.urbain@mapaq.gouv.qc.ca); Joseph Savard (Joseph.savard@mapaq.gouv.qc.ca)	Marie Garon (marie.garon@mapaq.gouv.qc.ca)
New Brunswick	New Brunswick Department of Agriculture and Aquaculture	Roger Tremblay (roger.tremblay@gnb.ca)	Kelvin Lynch (kelvin.lynch@gnb.ca)
Nova Scotia	Nova Scotia Department of Agriculture and Fisheries	John Lewis (j.lewis@agrapoint.ca)	Lorne Crozier (crozielm@gov.ns.ca)
Prince Edward Island	Prince Edward Island Department of Agriculture, Fisheries and Aquaculture	Chris Jordan (cwjordan@gov.pe.ca)	Brian Beaton (bwbeaton@gov.pe.ca)

National and Provincial Cranberry Grower Organizations

L'association des producteurs de canneberges du Québec
www.producteurscanneberge.com

British Columbia Cranberry Growers Association
#130, 32160 South Fraser Way
Abbotsford, BC V2T 1W5
www.bccranberrygrowers.com

Canadian Horticulture Council
www.hortcouncil.ca/chcmain.htm

Horticulture Nova Scotia

Kentville Agricultural Centre, Blair House
Kentville, NS B4N 1J5
www.hortns.com

New Brunswick Cranberry Growers Association (Tel: (506) 368-2342)

Nova Scotia Cranberry Growers Association
R.R. 31, 497 Hwy 201
Lawrencetown, NS B0S 1M0
Contact: Anne Taylor (902) 584-3341

Prince Edward Island Cranberry Growers Association
Belfast, RR # 1, PE C0A 1A0
Tel: (902) 584-3341

Research contacts for cranberry in Canada

Name	Organization	Pest type	Type of research
Bernier, D.	ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ)	Weeds	
Brookes, V.	Agriculture and Agri-Food Canada (AAFC), Agassiz, BC	All	Pesticide Risk Reduction and Minor Use
Dixon, P.	AAFC – St. John's, NL	Insects	Use of forecasting, monitoring, biological controls and biorational products (eg. pheromones) in IPM.
Fitzpatrick, S.M.	AAFC, Agassiz, BC	Insects	Behavioural ecology, pheromone communication and IPM
Lacroix, M.	MAPAQ	Diseases	Plant Pathology in small fruits and vegetables
Letendre, M.	MAPAQ	Various	Bio-controls and pesticides
MacKenzie, K	AAFC - Kentville, NS	Insects	
Neron, R.	MAPAQ	Weeds	IPM and weed management
Roy, M.	MAPAQ	Insects	IPM and insect management
Sampson, M.G.	Nova Scotia Agriculture College	Weeds	Herbicide screening and weed management systems

References

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1999 Maine Cranberry Pest Management. From 1999 Cranberry Chart Book. University of Massachusetts Extension and Cranberry Experiment Station. University of Maine Cooperative Extension. April 1999.

Cranberry Chart Book: Management Guide for Massachussets. University of Massachusetts Cooperative Extension Service

Profile of the Canadian Cranberry Industry. Jeremy Hughs. Agriculture and Agri-Food Canada. February 2005.

British Columbia Cranberry Growers Association IPM Guide (Diseases)
www.bccranberrygrowers.com/ipm/diseases.htm

PMRA EDDENet - Search ELSE
http://pr-rp.pmra-arla.gc.ca/portal/page?_pageid=34,17551&_dad=portal&_schema=PORTAL

PMRA Regulatory Directive DIR99-06 Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action.
www.pmra-arla.gc.ca/english/pdf/dir/dir9906-e.pdf

Compendium of Pesticide Common Names
www.alanwood.net/pesticides/

Eastern Canada Cranberry IPM Manual
www.pmra-arla.gc.ca/english/pdf/spm/ipmcranberries-e.pdf

Cranberry Pest Management in Wisconsin 2005

www.hort.wisc.edu/cran/mgt_articles/articles_pest_mgt/A3276.pdf

University Of Massachusetts Cranberry IPM Program
www.umass.edu/cranberry/services/ipm.shtml