Crop Profile for Peach in Canada

Prepared by:

Pesticide Risk Reduction Program

Pest Management Centre

Agriculture and Agri-Food Canada

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This profile is based on a report prepared on contract (01B68-3-0041) by:

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The authors recognize the efforts of the Pest Management Regulatory Agency, provincial pest management representatives, industry specialists and growers in the gathering of information that was required, and the review and validation of the content of this publication.

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Information for many of the tables in this crop profile is incomplete. It has been collected and will be published in an updated version of the crop profile on this website in the near future.

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Crop Profile for Peach in Canada

Peach (*Prunus persica* var. *persica*) is native to China and was introduced into Europe 2,000 years ago and was first brought to North America in the 16th century by Spanish explorers.

The nectarine, *Prunus persica* is a closely related fruit, differing from peach genetically by a single recessive gene. Peaches are heterozygous for the recessive gene and occasionally mutate to nectarine, with nectarine being able to mutate to peach as well. Peach and nectarine trees do not differ in appearance, growth response, bearing habit or other general characteristics. Nectarines are distinguished from peaches by their absence of pubescence, smaller size, greater aroma and distinct flavour. Throughout this document, all descriptions, practices, growth stages and activities refer to both peaches and nectarines unless otherwise stated.

Peaches are high in Vitamin A, B, C and potassium and have many uses including canned or frozen slices for desert, fruit cup cocktails, sauces, drinks, jams, pie fillings and as food flavouring in products such as yogurt. However, the largest use by far is fresh consumption. A small portion of the consumer fresh product is home processed into canned fruit, jams and chutneys.

Since the 1700's, peaches and nectarines in Ontario and BC have been primarily grown for fresh consumption. Since the 1950s, Nova Scotia has also been producing peaches for the fresh market. The small volume of peaches grown in Nova Scotia is produced as a sideline to apple production. Integrated Fruit Production (IFP) guidelines developed by AAFC at Kentville, NS have been adopted by apple producers and will be carried over into peach production.

General Production Information

Canadian Production (2005)	22,478 metric tonnes 3,009 hectares
Farm gate value (2005)	$26.8 million
	0.66 kg/person (fresh peaches)
Domestic consumption (2003)	0.56 kg/person (fresh nectarines)
	0.94 kg/person (processed peaches)
Export (2001)	-
Imports (2001)	$83 million
Source(s): Statistics Canada	

Production Regions

Major production areas include Ontario (2550 ha or 81% of the national acreage) and British Columbia (575 ha or 18% of the national acreage). Small plantings also exist in NS (14 ha <1%).

Cultural Practices

Peaches grow best on sites that are protected from spring frosts with deep, well-drained, sandy loam soil. South facing slopes of about 4-8% allowing good air exchange and surface water

runoff during heavy rains and having the greatest exposure to the sun, are the preferred planting sites. Since peaches in Canada are grown at their northern limits of production, sites should be located within 3-4 km of a body of water, for temperature moderation to protect against frost and extreme cold during the winter. Properly designed wind breaks are also used to reduce winter damage and raise temperatures. Peach trees grown on standard Bailey rootstock normally produce commercial crops for 15-18 years. Once the orchard is removed, it is recommended that the soil be fumigated for nematodes. Soil tests are done in the fall and adjustments to nutrients or pH are applied in the spring. The ideal pH of soil is between 6 and 6.5.

Land preparation includes tile drainage, since peach trees cannot tolerate wet soils. Sites are ploughed in the fall, cultivated, limed and managed for weeds before planting. If the season permits, a fall green cover crop is planted to build up organic matter. Planting takes place in the spring (usually mid April) when soil temperatures rise and there is still good moisture in the soil. Trees are planted dormant and the buds break 2 weeks after. Before planting, crown or root galls are pruned off. Standard rootstocks are used and densities are normally 201 trees per acre (18 x 12 foot spacing). Trees are typically branched when planted, but are pruned to 4-5 feet high with about 6-10 shoots that are each 2-3 buds in length.

Proper pollination is essential for good fruit quality. Peaches are self-fertile and do not require a pollenizing variety to be located within the orchard. Peaches bear fruit on 1 year-old wood so heavy pruning is needed each year to produce a good crop.

Thinning of fruit must be done by hand. Thinning can improve the size of the remaining fruit and the crop load, as well as increase the amount of bloom that will occur the following season. In the United States, a chemical thinner is registered for use.

Leaf analysis is the most reliable method to determine tree nutrient needs. Nitrogen is applied in the late fall or early spring. Excess nitrogen leads to poor fruit colour and poor storage quality and should be avoided. Fertigation (the addition of fertilizer to irrigation water) is an area of growing interest and research in tree fruit production.

Weather networks in each province are used to monitor weather conditions. Irrigation is critical for peaches during the growing season (April-July). After harvest, trees should receive a thorough watering before being allowed to dry out for the winter. The weather networks help in the calculation of evapo-transpiration that can be used to develop schedules for irrigation using water balance methodology. Irrigation can be done with under-tree micro-sprinklers, overhead sprinklers or drip irrigation.

Fruit is hand picked to ensure fruit quality. Skilled workers need to climb 6-8 foot ladders to pick the fruit on mature trees.

Recent innovations in the production of peaches include an initiative of the B.C. Fruit Growers Association called “Growing with Care”. This is a program which aims to reduce pesticide use in the production of tree fruits generally through the area-wide adoption of Integrated Pest Management.

Production Issues

Peach production in Canada is affected by numerous abiotic and biotic factors. Abiotic factors include low winter temperatures and spring frosts, poorly drained soils, availability of water and

irrigation equipment and cost of labour. Biotic factors, often occurring in conjunction with abiotic factors, include bacterial, fungal and viral diseases, insects and mites, annual, biennial and perennial weeds and vertebrates.

Table 1. Canadian peach and nectarine production and pest management schedule

Time of year[2] (Growth stage)	Activity	Action[3]
November 15[2] – March (dormant)	Plant care	Prune trees.
	Disease management	Prune out branches with peach (cytospora) canker.
	Weed management	Monitor for weeds and apply controls if needed (BC).
	Other	Monitor for vertebrate pests and control as needed.
Early – mid April (swollen bud)	Insect and mite management	Spray for scale and European red mite; use of superior oil.
Mid – late April (bud burst 1/2 inch green tip)	Plant care	Fertilizer application (nitrogen and potash), pruning; irrigation.
	Disease management	Monitor for powdery mildew, peach leaf curl, coryneum blight and brown rot; apply controls as needed.
	Weed management	Herbicide application.
May 1 (pink) - mid May (pink - petal fall, first new leaves open)	Plant care	Pruning, cultivation, brush removal.
	Disease management	Monitor for powdery mildew, peach leaf curl, coryneum blight and brown rot; apply controls as needed.
	Insect and mite management	Monitor for peach twig borer, leafrollers, fruitworms, mites, aphids, lygus bugs and beneficials; apply controls as needed.
	Weed management	Monitor for weeds and apply controls as needed.
	Other	Monitor for vertebrate pests and control as needed.
May 20 (fruit set, shuck, fully expanded leaves)	Plant care	Pruning, brush removal, cultivation.
	Disease and insect management	Spray first cover; use of insecticide.
	Weed management	Herbicide application.
June 1 to mid August (shoot growth, fruit development and maturation, terminal buds set)	Plant care	Thinning crop, seeding cover crop; apply supplemental nutrient sprays as needed; irrigate as needed; thin peaches; do leaf analysis.
	Disease and insect management	Optional second cover.
	Insect and mite management	Monitor for peach tree borer, leafrollers, mites, aphids and other insects; apply controls as needed.
Mid August to end September (fruit matures; harvest)	Disease management	Treat harvested fruit for brown rot and rhizopus rot as needed.
	Other	Hand harvest, grading and packing, irrigation only if very dry, spray pre-pick for late varieties.
Late Sept. to Nov. (leaf senescence, harvest and postharvest care)	Plant care	Mowing; irrigate as needed after harvest; remove weak, dead and diseased trees; take soil samples for nutrient analyses; begin preparation of new sites for new plantings.
	Disease management	Apply post-harvest copper spray for coryneum blight and peach leaf curl.
	Weed management	Monitor for weeds and apply controls if needed.
	Other	Monitor for vertebrate pests and control as needed.

[1]The calendar of events as listed in Table 4 are for Ontario. For Nova Scotia, the dates for the events run 7 to 14 days behind those for Ontario. For British Columbia, the season is often 2-3 weeks ahead of Ontario.
[2]Dates are only averages and may vary depending upon weather conditions and site.

[3]Spray schedule will vary with temperature and precipitation.

[4]Adapted in part from the *Crop Profile for Peaches in British Columbia (2003)*

Abiotic Factors Limiting Production

Key Issues

- The nursery industry has a challenge in supplying virus free nursery peach trees. Elite mother blocks will be available by 2006-2007. Currently the industry is using Best Available (PPV tested trees from mother blocks).
- There is concern over the fact that minor use status is granted only on the crop for which data is generated. Peaches and nectarines are considered a minor crop. The industry is concerned that new reduced risk product registrations available outside of Canada will not be available to Canadian peach growers.
- All acreage requires irrigation. The lack of water results in yield losses. There is a concern that new Ontario provincial guidelines on both water and nutrient management may restrict production in the future.
- There is a need for research into orchard management, plant nutrition and alternative irrigation systems, as well as scion-rootstock interactions for tree size control.
- There is a need to evaluate productivity, adaptability and longevity of processing cultivars outside the traditional growing regions of the Niagara Peninsula and South-Western Ontario, especially in the areas north of Lake Erie where new plantations are anticipated. There is a need for winter hardy, processing peach cultivars for areas outside the traditional tender fruit growing areas.
- Research trials need to emphasize ecological benefits.

Temperature

Peaches and nectarines can be produced commercially in only a few locations, marking the northern margins of their hardiness zone. Like most tender fruits, they are at high-risk for crop failure due to extreme weather conditions. Fruit buds are easily killed by cold winter temperatures and spring frosts. Winter injury also compounds the problem of tree decline caused by biotic factors such as borers and canker. In British Columbia, wind machines have been used to reduce the threat of spring frost, but these are very expensive.

Soil

Peach trees must be planted in soils that provide very good water percolation. Planting on poorly drained soil may result in Phytophthora root rot, winter damage, low productivity or death of trees.

Water

For sustained production and mitigation of risk, all acreage requires irrigation. Erratic weather patterns in the last 10 years have resulted in a greater need for the industry to have access to water for irrigation. Where growers do not have access to water or have not invested in irrigation equipment, losses have resulted.

Labour

To ensure fruit quality, peaches must be hand picked for the fresh market. Skilled workers are required to climb 6 to 8 foot ladders to pick fruit. With labour prices increasing, profit margins for farmers are suffering.

Diseases

Key Issues

- There is a need for developing control strategies for bacterial spot. There are currently no products registered for the control of this disease in Canada.
- A diverse selection of chemical products and biopesticides must be available to prevent the development of pest resistance.
- There is a need to develop varieties resistant to common peach diseases, including plum pox virus. The use of gene transfer technology may be required.
- There is a need to develop rootstocks resistant to root lesion nematode.
- Plum Pox virus is the most significant threat to the survival of the Ontario and Nova Scotia peach industries. The virus has not been found in British Columbia. There is a need to continue research into the control of the disease. Phase II of the government supported eradication program is working towards eradication of virus by 2010. Tree removal and surveys will be completed per NAPPO (North American Plant Protection Organisation) standards.
- There is a need for the registration of products for the control of peach leaf curl.

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

	Degree of Occurrence	
Major Diseases	**BC**	**ON**
Plum Pox Virus		DNR
Brown Rot	E	**E**
Peach Leaf Curl	E	**E**
Bacterial Spot	DNR	**E**
Powdery Mildew	E	**E**
Coryneum Blight	E	DNR
Rhizopus Rot	E	DNR
Peach Canker (Cytospora canker)	E	**E**
Minor Diseases	**BC**	**ON**
X-Disease	DNR	DNR
Verticillium Wilt	DNR	DNR
Crown Gall	DNR	DNR
Phytophthora root and crown rot	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): Crop Profile for Peaches in British Columbia (2003); Crop Profile Focus Group (ON) 2004.

Major Diseases

Plum Pox Virus (Sharka) (PPV)

Pest Information

Damage: Commonly known as Sharka, plum pox is established as a devastating disease of stone fruit in Europe. It was first identified in Canada in Ontario and Nova Scotia in 2000. The virus has not been found in British Columbia. The disease infects peach, plum, nectarine, apricot, almond, cherry, and wild *Prunus* species. Symptoms are difficult to recognize and may appear on leaves or fruits, on a portion of a tree or on a single branch. Fruit infections may appear as chlorotic spots or rings and deformation with internal browning of flesh and pale rings or spots on the stones. Infected trees are not killed but become unproductive.

Life Cycle: The pathogen is spread in the nursery by grafting infected buds or scions. It is spread in the field by aphids. Natural root grafting is another means for its dissemination and suckers that grow from infected roots can also carry the virus. Some strains are transmitted by pollen and seeds. Long distance spread is via the movement of plant material such as nursery trees, bud wood or scion wood. It is not spread by mechanical means such as pruning.

Pest Management

Chemical Controls: There are no anti-virus treatments that can be applied to infected trees. Intensive insecticide programs controlling aphid vectors have not stopped the spread of PPV in Europe.

Cultural Controls: Planting only virus-free, certified nursery stock will prevent the introduction of the disease into new areas. Avoiding growing susceptible trees within a plum pox infected zone helps to prevent new infections. Annual testing of mother trees for the presence of plum pox by laboratory analysis (ELISA and PCR) of tissue samples and the elimination of infected trees, will help to maintain a virus-free orchard.

Alternative Controls: Control can be maintained by monitoring, sanitation and quarantine, to avoid introduction and prevent the movement of material out of an infected area. When the virus is detected, eradication should take place by removing infected trees. An AAFC supported program of sampling, testing and tree removal where necessary, is working towards eradication of the virus by 2010. Foliar oil sprays may reduce virus transmission by aphids, but are not economically practical.

Resistant Cultivars: No natural resistance has been found. Transgenic research is underway in Europe and the United States to produce in-plant protection through genetic modification. Collaborative research between various institutions and AAFC is planned.

Issues for Plum Pox Virus

1. Eradication of the disease in Ontario and Nova Scotia remains the main objective. However, the industry requires additional federal and provincial funding for compensation of lost production and for intensive surveys.
2. The nursery industry has a challenge in supplying virus free nursery peach trees. Elite mother blocks will be available by 2006-2007. Currently the industry is using Best Available (PPV tested trees from mother blocks.
3. There is a need to develop varieties resistant to plum pox virus.

Brown Rot (*Monilinia fructicola*)

Pest Information

Damage: The brown rot fungus causes blossom blight, shoot dieback, twig cankers and fruit rot. Infected blossoms wilt, shrivel and die. Developing or mature fruit may exhibit a brown spot that quickly develops as a soft dry rot of the entire fruit.

Life Cycle: *M. fructicola* mycelia over-winter in infected plant parts in orchards. As temperatures warm in spring, conidia are produced. The conidia are dispersed by wind and rain and cause new infections. Frost injured blossoms are more susceptible to infection. The amount of inoculum is an important factor affecting levels of infection. Nectarine is more susceptible than peach and both appear to be most susceptible from pink to the shuck-fall period and 2-3 weeks prior to picking.

Pest Management

Chemical Controls: All products are applied with airblast sprayers. A number of fungicides are registered for use, including captan, chorothalonil, cyprodinil, dicloran, fenbuconazole, fenhexamid, myclobutanil, propiconazole, pyraclostrobin, sulphur, thiophanate methyl and triforine. To date there have been no documented cases of resistance to the new group of demethylation (DMI) fungicides such as propiconazole (Topas), febuconazole (Indar) and myclobutanil (Nova) and triforine (Funginex).

Cultural Controls: Sanitation is essential. The following practices should minimize spore populations and reduce the likelihood of an epidemic: Removal of all remaining fruit from the tree after the final picking; fruit thinning carried out before pit hardening if possible; removal of infected blossoms and shoots as they occur; maintenance of a weed free herbicide strip in sod culture/high density systems to discourage the production of apothecia and spores; removal of abandoned blocks and wild susceptible hosts nearby. Best management practices should be employed to reduce post-harvest decay.

Alternative Controls: None identified.

Resistant Cultivars: Some varieties, like Babygold 5, 7, Veecling, and Harrow Diamond, are more susceptible than others. Sources of resistance for conventional breeding programs are available.

Issues for Brown Rot

1. There is a need for post-harvest treatments to control brown rot.
2. Resistance to pesticides is becoming a concern. Brown rot fungus resistance to benomyl (Benlate), (no longer registered) and thiophanate methyl has been observed.
3. There is a need to develop cost effective monitoring techniques and thresholds to time sprays. Although most fungicides work best as protectants, monitoring techniques to determine the risks of infection have not been developed to date because they are too labour intensive.

Peach Leaf Curl (*Taphrina deformans*)

Pest Information

Damage: The pathogen causes discolouration, curling and thickening of leaves. Affected leaves eventually wither and die and are replaced by healthy leaves. The repeated loss of leaves

weakens the tree. Severe early defoliation and dieback of foliage in the spring causes crop loss on nearly all peach and nectarine cultivars. The destructive potential of peach leaf curl is frequently underestimated, resulting in important control measures being forgotten or delayed.

Life Cycle: The fungus overwinters as spores on twigs. Buds are infected in the spring as they expand resulting in curled and thickened leaves. Leaves become less susceptible to infection as they mature. New spores are produced within infected tissues and remain on the branches and twigs until the following spring when they cause new infections. Affected leaves wither and die and eventually are replaced by new leaves.

Pest Management

Chemical Controls: The disease can be controlled with one well-timed fungicide application in the autumn (preferred) or in the spring before bud swell. Following the fall application, an additional spring application may be needed if rain has been heavy. Registered products contain ferbam, chlorothalonil, copper and sulphur.

Cultural Controls: When infection is severe, tree vigour should be maintained by thinning more fruit than normal, reducing drought stress with irrigation and applying extra nitrogen fertilizer.

Alternative Controls: Treatment is not effective once infection has occurred and symptoms appear. Monitoring during bloom is done to assess the effectiveness of the control program and to help plan for the next season. Young leaves should be monitored on sample trees for early foliar symptoms and to record incidence of disease.

Resistant Cultivars: All cultivars are susceptible to some degree. Redhaven and its derived cultivars are less susceptible.

Issues for Leaf Curl

1. There is a need to register products to replace those that may loose their registration. Ferbam and chlorothalonil are the only products registered that are effective under high disease pressure.

Peach Canker (cytospora canker, valsa canker, perennial canker) (*Leucostoma cincta* and *Leucostoma persoonii*)

Pest Information

Damage: Fungi that cause peach canker attack the inner bark of trees causing branch girdling, dieback, and death of trees. This disease is the major limiting factor in Ontario peach production.

Life Cycle: Although the causal fungi are found primarily on peach they can also cause canker and twig dieback on nectarine, plum, prune, sweet and sour cherry, wild black cherry, choke cherry, apricot and apple. Fruiting bodies develop in the cankers and release spores. The spores are spread to wounds by rain, insects, birds and pruning tools, where they cause new infections. In the late winter and early spring, cankers may expand due to the activity of the lesser peach tree borer. In the fall, the incidence of new cankers may be related to injury to twigs caused by the oriental fruit moth.

Pest Management

Chemical Controls: There are no products available that provide suitable control for the disease. The peach tree borer can be controlled using root and crown dips of endosulfan. Latex paint with thiram will help avoid injury caused by rodent feeding.

Cultural Controls: Proper site selection for new plantings is essential, with ideal sites having deep, well drained soil and good air drainage to minimize winter injury. Soil should be hilled or mulch should be placed at the base of the tree to drain water away and to prevent cold injury to the crown. New plantings should be reasonably isolated from sources of *Leucostoma* inoculum. Young trees should not be planted adjacent to older, heavily infected peach blocks and not down-wind of older blocks. Inter-planting young trees between older, diseased trees may appear economical, however the young trees are at much greater risk and have a shorter productive life than young trees planted in solid blocks. Disease free nursery stock should be used. Oriental fruit moth and peach tree borer should be controlled, even in the first few non-bearing years. Trees should be trained during the first season so that the branches develop wide crotch angles, necessary for long orchard life. Tissue in narrow crotch angles is susceptible to winter injury and invasion by borers. Rodent injury should be avoided by using wire or plastic guards. Late season application of nitrogen or late season cultivation should be avoided. Pruning cuts may provide entry points for the disease, however healed wounds are no longer susceptible to attack. As healing is temperature-dependent, pruning should be delayed until the first forecasts of warm, dry weather in late April or May.

Alternative Controls: None identified.

Resistant Cultivars: There are no resistant varieties. There have been some attempts to identify resistance genes and utilize them in both conventional and biotech breeding programs, but to date this has been unsuccessful.

Issues for Peach Canker

1. There is concern over this disease in Ontario, as it is the major cause of decline and short life span of orchards.
2. There is a need to develop and register effective chemical controls and breed resistant varieties.

Bacterial Spot (*Xanthomonas pruni*)

Pest Information

Damage: Bacterial spot is a serious disease of peach, nectarine, apricot, and Shiro plum. The disease attacks the fruit, leaves and current season's twigs. It can severely devitalize trees by defoliation and reduces yield and quality of harvested fruit. Early season infections result in very deep lesions in the fruit flesh, while infections within 30 days of harvest result in circular, yellowish spots. Losses have been as high as 30% and in some cases affected peaches have been rejected by processors.

Life Cycle: Bacterial spot is of most concern in regions with annual rainfall greater than 50 cm. The disease overwinters in cankers on twigs. Bacteria are produced in the cankers in the spring and are spread by splashing rain to new leaves where they cause new infections. Frequent rainfall, winds and moderate temperatures favour infection. The bacteria multiply and are spread to developing fruit throughout the season when favourable conditions occur. The 3-week period following petal fall is critical for early-season fruit infection, and establishment of inoculum on new foliage. Rainfall during this period is favourable for infection.

Pest Management

Chemical Controls: There are no bactericides registered for stone fruits in Canada.

Cultural Controls: Wind breaks that prevent sand blasting of leaves and fruit can be helpful. New plantings should be located away from orchards of highly susceptible cultivars.

Alternative Controls: None available.

Resistant Cultivars: The most effective means of managing bacterial spot is the selection of more resistant cultivars. Varieties developed in the relatively humid areas of North America possess fair to good tolerance to the disease. Varieties developed in the drier areas are frequently too susceptible to the disease to be grown successfully in humid areas.

Issues for Bacterial Spot

1. Research is needed to support registrations, as there are presently no products registered in Canada for this disease. In the United States, copper formulations and antibiotics are registered. Plant elicitors such as Actigard must also be considered as methods of control.
2. There is concern that affected fruit may not be acceptable to processors, leaving no market for growers.

Powdery Mildew (*Sphaerotheca pannosa*)

Pest Information

Damage: Powdery mildew is increasing in importance in British Columbia and Ontario, but is a greater problem in nectarine and some fresh market peach in Ontario than in processing peach, which is less susceptible. The fungus attacks young shoots, leaves, and fruits. Under favourable weather conditions, the disease can reduce fruit quality, defacing the fruit with netting or white spots which increase in size until a large portion of the surface is covered. Skin eventually turns dark brown, with the surface becoming leathery and hard. As the fruit matures, it becomes more resistant to the fungus. The pathogen has the ability to affect a variety of woody ornamentals in addition to peach and nectarine. Another powdery mildew fungus, *Podosphaera clandestina*, which causes common mildew on cherry, also infects peach.

Life Cycle: Powdery mildew overwinters in infected buds and shoots. With the onset of growth in the spring, the fungus produces conidia which are dispersed by wind and rain to expanding leaves, shoots and young fruit where they cause new infections. Warm, humid weather conditions favour disease development. Conidia develop in the new infections and are dispersed by wind and rain to new infection sites.

Pest Management

Chemical Controls: Pesticides containing myclobutanil have been registered for powdery mildew control. Some fungicides applied for brown rot have also shown good activity against powdery mildew.

Cultural Controls: Practices that facilitate drying of the foliage, such as pruning to promote air circulation in the canopy and reduce relative humidity, will reduce the development of powdery mildew. Irrigation should be avoided late in the afternoon or evening. Peaches should not be planted adjacent to susceptible apple blocks.

Alternative Controls: None available.

Resistant Cultivars: The disease is effectively managed by avoiding peach cultivars susceptible to powdery mildew.

Issues for Powdery mildew

1. There is a need for the registration of alternative fungicide families for use in rotation in order to manage pathogen resistance.

Coryneum Blight (*Wilsonomyces carpophilus*)

Pest Information

Damage: The pathogen causes small spots on fruit, with symptoms being most severe when there is frequent wet weather at husk fall. Twigs can also be infected. Small spots that may become gummy also develop on twigs. Infections of bud tissues can result in bud death, blossom blight or shot hole symptoms on the leaves. Twig infections can result in girdling and dieback of the twig

Life Cycle: The pathogen overwinters in buds and twig cankers. Spores produced in infected tissues are spread by rain to new bud and twig tissues where they give rise to new infections.

Pest Management

Chemical Controls: In orchards where the disease is present, a rigorous three-year spring and fall spray program is needed to break the disease cycle. Fixed copper after harvest, before fall rains helps prevent the development of new twig cankers. Chemical control is particularly important when overhead irrigation is used.

Cultural Controls: Pruning of infected twigs should be done during dormancy. For irrigation, drip systems are preferred to overhead systems.

Alternative Controls: Other hosts of the pathogen, such as apricots and sweet cherry, should also be treated for the disease.

Resistant Cultivars: None identified

Issues for Coryneum Blight

None identified

Rhizopus Rot (*Rhizopus* spp.)

Pest Information

Damage: The disease causes a soft rot of harvested or over-ripe stone fruits. Lesions may be difficult to distinguish from early brown rot lesions. At warm temperatures the fungus rapidly advances, causing the loss of many peaches within the shipping container.

Life Cycle: Rotted fruit on the orchard floor allow for inoculum build up as the season progresses. In the early stages of fruit ripening, injuries such as those caused by insects, hail, or cracking are required for infection. After harvest, injuries are not required for infection on ripe fruit and Rhizopus rot can spread from fruit to fruit at contact points.

Pest Management

Chemical Controls: There are no fungicides registered for post-harvest use.

Cultural Controls: The fungus does not grow at temperatures below 4°C, so storing fruit at this temperature will stop the progress of the disease. Fruit should be carefully handled to avoid wounding. Storage containers, warehouses and hydro-cooling water should be kept clean. Dumping culled fruit should be avoided.

Alternative Controls: None identified.

Resistant Cultivars: None identified.

Issues for Rhizopus Rot

1. There is a need for the registration of pre-harvest fungicides, post-harvest fungicide dips and/or sprays, or impregnated fruit wrapping papers to help prevent the disease. Potential products include tebuconozole and fludioxonil (registered in the United States).

Minor diseases

X-Disease (Phytoplasma)

Pest Information

Damage: The disease affects peach, nectarine, sweet cherry, sour cherry, Japanese plum and wild chokecherry. Symptoms become apparent after about 2 months of growth. The leaves curl and develop spots. The spots later drop out, leaving tattered leaves with a "shot-hole" appearance. Infected leaves fall prematurely, until only a tuft of leaves remains at the tips of the shoots. Fruit produced on infected branches is small, lacks flavour and may shrivel and drop prematurely. Within 2-3 years of the initial infection, the entire tree may show symptoms, resulting in a rapid decline in productivity.

Life Cycle: X-Disease, once thought to be caused by a virus, is now known to be caused by a phytoplasma that lives in phloem cells. Wild choke cherry serves as a reservoir. The disease is transmitted to orchard plantings by several species of leafhopper that move into orchards late in the summer.

Pest Management

Chemical Controls: None available.

Cultural Controls: Eradication of choke cherry near stone fruit orchards may reduce the incidence of X-disease. A program to suppress re-establishment of choke cherry should be used. Infected cherry trees should be removed, particularly those on Mazzard rootstock.

Alternative Controls: None identified.

Resistant Cultivars: None identified.

Issues for X-Disease

None identified

Verticillium Wilt (*Verticillium dahliae*)

Pest Information

Damage: *Verticillium dahliae* invades the xylem and interferes with water transport within the tree, resulting in wilting of foliage and dieback of branches. Affected sapwood becomes dark stained and trees up to 4 years old often die. Mature trees develop dieback and reduced yields.

Life Cycle: *Verticillium dahliae* is a soil borne organism that infects the roots and invades the vascular system of the tree. The pathogen produces resistant structures (microsclerotia) that can survive in the soil for many years in the absence of hosts. The disease in fruit orchards tends to be worse where orchards are planted on land that was previously planted with

cantaloupe, peppers, tomatoes, potatoes, eggplant, and other crops susceptible to Verticillium wilt.

Pest Management

Chemical Controls: Inoculum levels can be reduced by fumigating the soil between plantings, but this may not be practical.

Cultural Controls: Growing several seasons of grass/green manure crops can reduce inoculum levels. Orchards should not be planted where susceptible crops have been planted previously. Maintenance of adequate soil fertility, soil moisture levels and other methods of reducing stress will help trees tolerate the disease.

Alternative Controls: None identified.

Resistant Cultivars: None identified.

Issues for Verticillium Wilt

None identified.

Crown Gall (*Agrobacterium tumefaciens*)

Pest Information

Damage: The pathogen induces the formation galls on the surface of roots or on the crown. The galls interfere with the normal flow of water and nutrients. Young trees may be killed while older trees suffer reduced growth and vigour.

Life Cycle: The pathogen affects a wide range of broadleaf, woody plants, including stone fruits. Bacteria are released into the soil when galls are wet or when older gall tissue disintegrates. The bacterium can survive in the soil for at least 1 year in the absence of host tissue. Established trees are infected only through wounds, such as those caused by growth cracks, pruning, damage from cultivation equipment or freezing injury. Seedlings can be infected during germination if planted into infested soil.

Pest Management

Chemical Controls: None available.

Cultural Controls: Site selection and using disease free planting stock is important. In the nursery, a sterile planting medium should be used.

Alternative Controls: *Agrobacterium radiobactor* may be used as a preventative treatment for crown gall.

Resistant Cultivars: None identified.

Issues for Crown Gall

Not identified

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

Pest Information

Damage: Phytopythora root and crown rot is characterized by a decay of the roots and crown tissues. Peach, apricot, nectarine and cherry can be seriously affected. The disease interferes with the uptake and translocation of water and nutrients. The disease may reduce growth and vigour or can progress rapidly resulting in death of the tree. The disease can severely affect the establishment of new plantings at some sites.

Life Cycle: The disease is more of a problem on heavy, wet soils with poor drainage. The pathogen remains in soil as resting spores (oospores or chlamydospores). The fungus is carried from place to place on infected plants, in contaminated soil, or in surface water. In saturated soils the disease spreads by the production of mobile zoospores, which are able to move long distances in ground water and runoff. Under saturated soil conditions, the spores germinate and infect the roots and the bark of the crown. The fungus develops within the bark, cambium and young xylem tissue, killing the colonized host tissues as it advances.

Pest Management

Chemical Controls: None identified.

Cultural Controls: Sites that are well-drained and have sandy loam soil should be chosen. Trees can be planted on ridges. Irrigation should be managed so that prolonged periods of saturated soils are avoided.

Alternative Controls: None identified.

Resistant Cultivars: None identified.

Issues for Phytophthora Root Rot and Crown Rot

None identified

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

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
Agrobacterium radiobacter (Dygall)	Bactericide	Biological	RE	crown gall		Applied to seeds/seedlings in nursery only.
captan	phthalimide fungicides	M4	R	brown rot		
chlorothalonil	chloronitrile fungicides	M5	R	peach leaf curl		
				brown rot		
copper (copper oxychloride or copper sulphate)	inorganic fungicides	M1	R	peach leaf curl		Weakest product on leaf curl. Must use a minimum of 6 kg per ha. Not registered use, but has some bacterial action. Used as dormant spray as an eradicant. No PHI given on label becauses uses are for dormant time of application.
				coreneum blight (approved for this use only in BC)		
cyprodinil	analino-pyrimidine fungicides	9	RR	brown rot		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
dicloran	aromatic hydrocarbon fungicides	14	R	rhizopus		Orginally used as post-harvest treatment.
				brown rot		No longer registered for post harvest use. Not readily available in market place or used for pre-harvest use.
fenbuconazole (Indar 75 WP)	triazole fungicides	3	R	brown rot		
fenhexamid (Elevate 50 WDG)	hydroxyanilide fungicide	17	R	brown rot		
ferbam	dithiocarbamate fungicides	M3	R	peach leaf curl		
myclobutanil	triazole fungicides	3	R	brown rot		
				powdery mildew		Early fruit infections on nectarines and some susceptible varieties of peach.
propiconazol	triazole fungicides	3	R	brown rot		Re-entry : 4 hrs if certain protection
pyraclostrobin	methoxy-carbamate fungicides	11	R	brown rot		
sulphur	inorganic fungicides	M2	R	brown rot		
				leaf curl		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
thiophanate-methyl	thiophanate fungicides	1	RE	brown rot		Resistance to this product is wide spread and is a cross resistance with benomyl
triforine	piperazine fungicides	3	R	brown rot		not for use after petal fall

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

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

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

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

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

[6] Source(s): Crop Profile Focus Group (ON) 2004.

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

	Practice \ Pest	Plum pox virus	Bacterial spot	Brown Rot	Peach Leaf Curl	Powdery Mildew	Peah Canker
Prevention	tillage						
	removal of infected trees						
	residue removal / management						
	water management						
	equipment/ facility sanitation						
	row spacing / seeding depth						
	removal of alternative hosts (weeds/volunteers)						
Avoidance	resistant varieties						
	planting / harvest date adjustment						
	crop rotation						
	trap crops - perimeter spraying						
	use of disease-free seed/ transplant stock						
	optimizing fertilization						
	reducing mechanical damage / insect damage						
	site selection						
	thinning of fruit / pruning						
Monitoring	scouting - trapping						
	records to track pests						
	field mapping of weeds						
	soil analysis/ tissue analysis						
	weather monitoring for disease forecasting						
	grading out infected fruit						
Suppression	use of thresholds for application decisions						
	biological pesticides						
	pheromones						
	sterile mating technique						
	beneficial organisms & habitat management						
	pesticide rotation for resistance management						
	ground cover / physical barriers						
	controlled atmosphere storage						
	forecasting for applications						

no indication that the practice is available/used

available/used

available/not used

not available

Source(s): Crop Profile Focus Group (ON) 2004.

Insects and Mites

Key Issues

- There is a need for harmonization of the registration of products in Canada with that of the U.S.
- There is a need for research, development and registration of products for the control of pests for which there are currently no effective controls, including: the European earwig, Comstock mealy bug, Japanese beetle, ambrosia beetle, shothole borer and green peach aphid. [Pirimicarb (Pirimor) is registered for aphids but will no longer be available after 2007; crops treated cannot be exported to the USA as there is no residue tolerance.].
- Western Flower Thrips is a crop-limiting pest for nectarine production in BC. There are no registered pesticides in Canada. BC has sponsored a registration submission for spinosad for this use, and will submita registration package for imidacloprid soon.
- There is a need for research, development and the registration of new chemical pesticides to be used in rotation with existing products in order to manage resistance of pests including the Oriental fruit moth, European red mite, two-spotted spider mite, oblique banded leafroller, and tarnished plant bug.
- There is concern about organophosphate resistance that is now widespread among Oriental fruit moth populations. Alternatives need to be found before pest populations become resistant to synthetic pyrethroids.
- There is a need for a transition strategy to deal with the loss of organophosphate insecticides, particularly for early season control and restricted uses for problem pests, such as plum curculio, green peach aphid, Comstock mealy bug and Japanese beetle.
- There is concern about the impact on IPM programs of the loss of registration of organophosphate insecticides. Shifts in pest populations may occur following changes in insecticide use and may result in several pests becoming major problems.
- There is a need to pursue novel chemistries for mating disruption systems for lesser peach tree borer (occurs in the east), peach twig borer (occurs in BC), and leafrollers (two products are registered, one includes peaches but is no longer available, and the other does not include peaches but is available).
- There is concern about the potential development of resistance in insect populations to the synthetic pyrethroids and that there is insufficient new products in the “pipeline” to ensure effective control in future years.

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

	Degree of Occurrence	
Major Pests	**BC**	**ON**
Oriental fruit moth		E
European red mite	DNR	E
Tarnished plant bug	DNR	E
Plum Curculio		E
Green peach aphid	E	E
Peach tree borer	E	E
Peach twig borer	E	DNR
European earwig	E	DNR
Minor Pests	**BC**	**ON**
San Jose scale	DNR	E
Comstock mealy bug	DNR	DNR
Leafrollers	E	DNR
Peach silver mite	DNR	DNR
Lesser peach tree borer	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
DNR - Data not reported.
Pest not present
E – established
D – invasion expected or dispersing
Source(s): Crop Profile for Peaches in British Columbia; Crop Profile focus Group (ON) 2004.

Major Insects and Mites

Oriental Fruit Moth (*Grapholitha molesta*)

Pest Information

Damage: The Oriental fruit moth is the principal insect pest of peach and nectarine in Ontario. The pest is not a problem in B.C. or Nova Scotia. Other trees attacked include plum, apricot, pear and apple. The larvae enter the terminal at the base of young leaves, tunnelling toward the base of the shoot. Infested terminals wilt and die. Heavy twig infestations in nursery stock and new orchards adversely affect the shape of trees. The insect also attacks the fruit. During early fruit development, fruit infestations can cause fruit drop. Later infestations do not cause fruit drop, but entrance holes are visible.

Life Cycle: Full sized larvae form cocoons and overwinter in bark crevices or in dropped fruit in the orchard. The larvae pupate in the early spring, and the first adults are seen at the pink to early bloom stage of bud development. Excessive tree growth or high temperatures during late summer and fall can encourage the development of four full generations which cause losses to later maturing varieties.

Pest Management

Chemical Controls: First instar larvae are more susceptible to conventional insecticides than are adults or eggs. Chorpyrifos, cypermethrin, deltamethrin, cyhalothrin-lambda, azinphos-methyl, carbaryl, malathion, permethrin, phosalone and phosmet are registered.

Cultural Controls: Pruning to facilitate good spray penetration and adjusting irrigation schedules to avoid washing off insecticide residue after application will improve chemical control. The inter-planting of peach and nectarine with apple or pear should be avoided. All susceptible hosts within 2.2 km of the orchard should be removed.

Alternative Controls: The effectiveness of mating disruption with insect pheromones has been demonstrated in an area-wide project in the Niagara Peninsula of Ontario. The long-lived dispenser Isomate OFM Rosso provides season-long control, while the Isomate M 100 must be applied twice. The use of pheromone traps over the last 40 years has been useful in better timing insecticide sprays to control young hatching larvae. This approach has reduced insecticide use by 50%.

Due to the susceptibility of the fruit to pest larvae during the two weeks preceding harvest, protection is needed regardless of moth activity. The economic threshold for fruit moth injury in most commercial peach orchards is < 1% of the total crop at harvest.

Resistant Cultivars: None available.

Issues for Oriental fruit moth

1. There is concern over insecticide resistance, as populations of the pest began to show widespread resistance to organophosphates as early as 1994. Pyrethroid resistance has also been detected, although no control failure has been reported to date. There is a need to register alternatives to organophosphates before pest populations become resistant to pyrethroid insecticides.
2. Conventional insecticides are needed to support mating disruption technology (pheromones) in case an intervention is required. They are also important in sites where populations must be reduced so that mating disruption can be effective.

European Red Mite (*Panonychus ulmi*) and Two-Spotted Spider Mite (*Tetranychus urticae*)

Pest Information

Damage: Mites feed on leaves causing a characteristic leaf injury referred to as bronzing. Photosynthesis and the nitrogen content of leaves is reduced. Prolonged feeding causes tree stress and will reduce shoot growth and fruit bud set the following year. Fruit color, soluble solids, firmness, size and weight are all affected.

Life Cycle: European red mites overwinter as eggs on fruit spurs and buds. Overwintered eggs hatch by the end of the bloom period. The mites develop from egg, through three nymphal stages to adult, and produce 6-8 generations per year. Both adults and nymphs cause plant injury. Development is temperature dependent with development being faster during the hot summer months. A small population of 2-5 mites per leaf can explode to over 100 active mites per leaf in a short period of time.

Pest Management

Chemical Controls: Registered products include dormant oil, clofentazine, pyridaben, dicofol, diazinon, phosalone and formetanate hydrochloride. With the adoption of an IPM program for peach in Ontario over 20 years ago, mites became a minor pest of peach/nectarine. Since the development of resistance in populations of Oriental fruit moth to insecticides, growers have been forced to use products that are harsh on beneficials. This has had an impact on mite predators, causing their populations to decline and causing three main mite species to become frequent pests. The use of sulfur fungicides is harsh on predators and may increase mite populations. Regular monitoring is essential during the summer. A threshold of 10-15 mites per leaf should be used.

Cultural Controls: The creation of dust particles in the air should be avoided. Water stress should be avoided by following an irrigation schedule. Annual pruning opens up the tree allowing good air flow and spray penetration. Mite populations are highest in orchards located beside greenhouses or clover sod cover crops.

Alternative Controls: Nature provides the most effective control of pest mite populations with the presence of predator mites. The main predatory mites are of the family Phytoseiidae with the most abundant species being *Typhlodromus pyri*, *Ambleyseius fallacis* and *Typhlodromus caudiglans*. The use of harsh chemical pesticides which are toxic to beneficial species can reduce the effectiveness of these alternative controls

Resistant Cultivars: None available.

Issues for European Red Mite and Two-Spotted Spider Mite

1. Resistance of mites to miticides is a serious concern in Ontario. European red mite resistance to dicofol is widespread in the province. Additional miticides are needed for proper product rotation.
2. There is a need to register alternative reduced-risk products before older products are removed from the market.

Tarnished Plant Bug (*Lygus lineolaris*)

Pest Information

Damage: The pest attacks buds, flowers and fruit, making it an important direct pest present throughout the growing season. The insect feeds by piercing the plant and sucking sap. Prior

to shuck split, feeding injury causes bud, flower or fruit drop. Very little fruit drop is seen between shuck split to shuck fall. Prior to pit hardening young fruit becomes deeply injured and deformed. As the fruit matures after pit hardening, additional injury can appear.

Life Cycle: The tarnished plant bug is a general feeder found on many wild and cultivated plants throughout North America. Adults and nymphs may be found on many herbaceous plants, especially legumes, however only adults are found on peaches and nectarines. Resident populations overwinter and subsequent generations develop on ground cover in the orchard. Migratory populations overwinter outside the orchard, with summer generations developing on alternative hosts outside the orchard. Migratory populations migrate to orchard blocks when food sources dry up and hot, humid conditions encourage dispersal.

Pest Management

Chemical Controls: Pyrethroid insecticides give the best control. Border sprays are warranted when 2% of fruit collected from the edge of the orchard is damaged. For both migratory and resident populations, complete block sprays are needed when injury reaches 2-5% throughout the block. The use of mating disruption for control of the Oriental fruit moth, and resultant decrease in the use of pyrethroids to control OFM has lead to an increase in the potential impact of tarnished plant bug. Registered insecticides include: azinphos-methyl, cyhalothrin-lambda, cypermethrin and phosmet.

Cultural Controls: Fruit injury and populations within the tree are influenced by ground cover management and the presence of alternate host crops, such as alfalfa. The use of cover crop species that are not hosts to TPB and a trap crop strip which is an alternate host to TBP are effective tools in managing the pest.

Alternative Controls: Mass releases of parasitic insects have the potential of providing biological control, but their establishment in Canada is not well known. There are no economic action thresholds based on tarnished plant bug monitoring. Ground cover sampling can be used to predict the necessity of insecticide sprays.

Resistant Cultivars: Some varieties incur less damage, but the reasons are unknown.

Issues for Tarnished Plant Bug

1. There is a need for further research on alternative products and biological controls to be used in rotation with existing products to manage the resistance of pests.
2. There is a concern that the pest has the potential of becoming a major disruptive pest in blocks where mating disruption technology is applied.

Plum Curculio (*Conotrachelus nenuphar*)

Pest Information

Damage: The plum curculio is one of the most important insect pests of tree fruits. Hosts include peach, nectarine, plum, apple, cherry, apricot, pear and quince. It is generally distributed over the eastern United States and in Canada, east of the Rocky Mountains. Over-wintering adult beetles attack fruit soon after it forms, eating holes through the skin and feeding on the pulp next to the pit. Adults cause the formation of bumps on the fruit by feeding. Females cause crescent-shaped scars when laying eggs and larvae cause internal injuries as they burrow through the fruit, causing most of the infested fruits to drop during June.

Life Cycle: The pest survives on wild plum, hawthorn and native crab-apple. Eggs are laid on young fruit. Larvae develop within the fruit and drop to the soil to pupate. Adults emerge in July and August and feed on developing fruit throughout the rest of the season. Beetles are

more active on warm, damp, cloudy days and in the centre of thick, heavy trees that provide the appropriate micro-climate. Temperature is the most important factor affecting development, particularly early in the spring.

Pest Management

Chemical Controls: Petal-fall sprays and the first and second cover sprays are directed at the adult and the egg-laying period. Sprays are applied at the first sign of new injury, targeting the adult stage of the beetle, which is difficult to control. Azinphos-methyl is the only effective registered insecticide and is only effective for 3-5 days. Re-application may be required if new damage is observed. Field trials with the use of mating disruption for Oriental fruit moth and removal of insecticides has allowed the resurgence and establishment of plum curculio populations causing significant damage. Other registered insecticides include: malathion, permethrin, phosalone, phosmet, azinphos-methyl and carbaryl.

Cultural Controls: Wild, susceptible hosts should be removed around the orchard blocks.

Alternative Controls: New trap monitoring methods have been developed that give advanced warning to migration into the orchard and injury of fruit. Research is underway to determine if aggregating pheromones mediate movement.

Resistant Cultivars: Nectarine, plum and apricot fruit are more attractive than peach, but there are no resistant cultivars.

Issues for Plum Curculio

1. There is a need for replacements to azinphos-methyl, the only effective, registered pest control product.
2. Research is needed to determine how new trap monitoring methods can be used effectively to aid in early warning and timing of sprays.

Green Peach Aphid (*Myzus persicae*)

Pest Information

Damage: Aphids feed primarily on the underside of leaves which causes them to curl, become distorted and yellow and drop prematurely. Feeding may also occur on flowers and fruit resulting in distortion and drop. Peach fruit is not usually attractive for direct aphid feeding. Cool, cloudy weather in May and June prevents aphids from developing wings and migrating to other hosts, which can lead to substantial stress and stunting of leaves of nectarine and peach, as well as direct damage to nectarine fruit. Aphid feeding results in excretion of honeydew which supports the growth of a black sooty fungus that causes spotting of leaves and fruit. This aphid may also serve as a vector of virus diseases such as plum pox.

Life Cycle: The green peach aphid, native to Europe, is an invasive pest of peach and nectarine throughout North America and has a diverse host range of plants, including all stone fruits and many ornamental shrubs and vegetables. The insect overwinters as eggs on peach and nectarine. The eggs hatch in the spring as females which develop through nymphal stages to adults. Subsequent generations develop without mating (parthenogenesis) and bear live young. Through the summer, aphids migrate to other hosts. In the fall they return to peaches where they mate, lay overwintering eggs and die.

Pest Management

Chemical Controls: This pest is difficult to control because it has developed resistance to many pesticides. The resurgence of this aphid on stone fruit in the 1980's is attributed to the destruction of natural predators with pesticides and resistance to chlorinated hydrocarbon and organophosphate insecticides. However, the regular use of dormant oil to control European red mite and pyrethroids sprays in summer to control Oriental fruit moth has helped keep resident populations low. Pirimicarb is the only effective registered product, but its use is restricted to use only before petal fall. Other registered insecticides include: cyhalothrin-lambda, diazinon and endosulfan.

Cultural Controls: Over fertilization of nitrogen can lead to high populations of aphids. Avoiding excessive growth with balanced fertilization and irrigation is important.

Alternative Controls: Thresholds, based on the number of colonies per tree or the percentage of infested shoots, have been established for insecticide treatments of bearing trees. Predators and parasites include ladybird beetles, lacewings, syrphid fly larvae and chalcid wasps.

Resistant Cultivars: Nectarines are more susceptible than peaches, as the pubescence of peach fruit discourages aphid feeding.

Issues for Green Peach Aphid

1. There is concern over this pest because it is the major vector for the Plum Pox Virus. Chemical control of the aphid may be required when populations are high until the virus is eradicated.
2. There is concern that the adoption of mating disruption controls for the Oriental fruit moth may result in the resurgence of aphid pests and cause the spread of the plum pox virus.
3. There is concern over the a wide host range for the aphid and its ability to migrate to or remain resident within orchards.
4. Reduced-risk chemical controls are needed to control the aphid and prevent direct fruit damage to nectarines.

Peach Tree Borer (*Synanthedon exitiosa*)

Pest Information

Damage: The borer has been reported in all fruit-growing areas of Canada and the United States. Serious damage may also occur to cultivated cherry, plum, apricot, nectarine and ornamental shrubs. Larvae feed on the cambium, growing tissues and the inner bark of the tree. Most of the larval activity is confined to the trunk area, from a few inches above ground line to few inches below. Larval feeding may completely girdle and kill young trees. Older trees are less likely to be girdled but are often severely injured, making them susceptible to attack by other insects and diseases.

Life Cycle: The adult clear wing moths, present from mid to late summer, lay eggs on the lower trunk and in cracks in soil near peach trees. Following hatching, the larvae bore into the lower trunk and begin to feed. The larvae overwinter in feeding tunnels and complete their feeding in the spring.

Pest Management

Chemical Controls: Protection for one or two years can be provided to newly planted trees by dipping the trunk and roots in endosulfan before planting. Based on adult counting in pheromone traps, trunks of established trees may be sprayed with endosulfan (the only registered product, aside from the mating disruption pheromone) for at least 2 consecutive years.

Cultural Controls: Painting trunks of young trees with white latex paint reduces their attractiveness to adult peach borers. Other hosts from surrounding orchard blocks should be removed and wood from orchard trees that have been cut should be removed from the orchard.

Alternative Controls: Pheromone traps are used to time sprays; in British Columbia, well defined thresholds have been worked out. For small plantings, organic blocks or single trees, placing a metal, cone-shaped collar around the base of the tree before eggs are laid prevents larvae from boring into the tree base. Larvae can also be killed in tunnels by probing with a wire or by opening the tunnels to find and destroy them. In 2002, Isomate-P was registered in Canada as a control method based on mating disruption for peach tree borer.

Resistant Cultivars: None identified.

Issues for Peach Tree Borer

1. There is a need to register alternatives to endosulfan that can be used in support of mating disruption programs before the registered product is removed from the market.

Peach Twig Borer (*Anarsia lineatella*)

Pest Information

Damage: The peach twig borer is unique to B.C. The larvae tunnel into buds and new shoots causing them to wilt and die. Larvae of later generations feed on fruit, creating entry holes near the stem. A gummy exudate is produced on damaged fruit and twigs. Host trees include peach, nectarine, apricot, plum and prune.

Life Cycle: The pest has two generations each year with a partial third generation in some years. The larvae over-winter on host trees. They feed from March to early May, pupate and emerge as adults in May and June. Eggs are laid on leaves, fruit or twigs, egg hatch occurs in late September, and larvae of the second generation feed for a short time before seeking over-wintering sites.

Pest Management

Chemical Controls: Thresholds have been established for chemical treatments based on the number of moths caught per trap in a week during the first and the second generation. Available insecticides include azinphos methyl, carbaryl, deltamethrin, diazinon, endosulfan, calcium polysulfide, phosalone and phosmet.

Cultural Controls: None identified.

Alternative Controls: The bacterium *Bacillus thuringiensis* subsp. *kurstaki* will control this pest, if applied before the young larvae tunnel into twigs, buds or fruit. The flight of male moths can be monitored through the use of pheromone traps to help time sprays to control larvae. Sprays can also be timed based on the visual examination of developing shoots, buds and fruit.

Resistant Cultivars: None identified.

Issues for Peach Twig Borer

1. There is a need to pursue novel chemistries for mating disruption systems for the peach twig borer.

European Earwig (*Forficula auricularia*)

Pest Information

Damage: Earwigs damage peaches by boring into damaged, ripening and over ripened fruit. This feeding damage increases the risk of brown rot infection by wind-borne or water-borne spores. Earwigs may also transfer spores directly as they feed.

Life Cycle: Earwigs have one generation per year: adult earwigs overwinter in the soil, eggs are laid in the soil in the spring,, then earwig nymphs hatch and begin to feed on a variety of materials. Earwigs are very sensitive to sunlight so they hide during the day in sheltered cracks and crevices.

Pest Management

Chemical Controls: Foliar sprays applied against other pests will control earwigs. Baits and sprays applied to the tree base provide protection for less than 1 day. Registered insecticides include carbaryl.

Cultural Controls: Debris and weeds should be removed from the base of trees.

Alternative Controls: Earwigs can be kept out of trees by wrapping a smooth part of the trunk with an adhesive tape and applying Tanglefoot® or Stickum® to the strip before activity is first noticed. Small boxes stuffed with crumpled paper or rolls of newspaper can be set on the ground to capture earwigs. Tucking newspapers, covered with plastic bags to keep them dry, into limb crotches is a useful way of monitoring them.

Resistant Cultivars: None identified.

Issues for European Earwig

1. There is a need for the registration of reduced risk products for the control of European earwigs.

Minor Insects and Mites

San Jose Scale (*Quadraspidiotus perniciosus*)

Pest Information

Damage: The pest causes direct injury to the fruit and injures the host tree by sap feeding, reducing tree vigour and causing limbs to die. Historical records reveal that high numbers of scale insects were a cause of tree mortality for various tender fruit crops (peaches, nectarines, plums and cherries) in the past.

Life Cycle: The insect may have two to three generations per year. The first nymphal stage overwinters on the bark. This stage matures by full bloom the following spring. Mating occurs in late May or early June and females bear live young or crawlers. The scale crawlers find a suitable feeding site, usually in the upper branches and settle down to feed. As they grow they secrete a protective scale under which they live.

Pest Management

Chemical Controls: Dormant oil every few years can help prevent the build-up of damaging population levels. Where fruit injury is detected, the use of oil in 2 or 3 consecutive seasons is needed. The elimination of dormant oil sprays may lead to flair-ups of scale populations. Registered insecticides include: azinphos-methyl, carbaryl, diazinon and calcium polysulfide.

Cultural Controls: Annual pruning should be done to open up the tree and allow for good air flow and spray penetration. Poor pruning resulting in poor spray penetration and may lead to high populations of scale insect in the upper centre of the canopy

Alternative Controls: There are no economic thresholds for scale insects on fruit, with most growers applying controls the next spring if fruit injury is seen at harvest.
Resistant Cultivars: None identified.

Issues for San Jose Scale

1. There is concern that the pest may become a major pest problem if mating disruption of Oriental fruit moth is used on a large scale and organophosphate and pyrethroid insecticides are removed from the cropping system.

Comstock Mealybug (*Pseudococcus comstocki*)

Pest Information

Damage: Fruit hosts of the Comstock mealybug include peach, pear and apple and it is also a pest of several ornamental plants such as catalpa, mulberry, and pine. It was first recognized as a fruit pest in the 1930s and has been a sporadic problem in Ontario on stone fruit and pear. The pest poses major economic concerns for the peach and pear processing industry. Because peaches or pears are made into puree or canned mechanically, infestations can potentially result in unacceptable contamination of the finished product. It may also slow the packing line as hand labour needs to be used. Honeydew secreted by the crawlers is a substrate for sooty moulds growing on the fruit surface. These moulds result in a downgrading of the fresh fruit and are an additional cause of economic loss.
Life Cycle: This pest overwinters in the egg stage in protected areas on the bark and near pruning wounds and sometime as nymphs and adult females. The eggs hatch from mid April to May and crawlers feed on terminal growth and lower leaf surfaces. The insect progresses through three instars prior to pupation and development into the adult stage. Mating occurs in the spring.

Pest Management

Chemical Controls: There are no insecticides registered for the control of this pest.
Cultural Controls: Good pruning practices should be used to open up the canopy to ensure good spray coverage.
Alternative Controls: Harvest assessments and routine monitoring provide advanced warning and determine the need to apply controls.
Resistant Cultivars: None identified

Issues for Comstock Mealybug

1. There is concern that this pest may become more important as organophosphate insecticides are lost and more pest-specific products are registered.
2. There is a need for the registration of replacement products for the control of this pest.

Oblique-Banded Leafroller (*Choristoneura rosaceana*) and other leafroller species

Pest Information

Damage: Larvae do not tunnel into the fruit, but rather cause serious injury by webbing a nearby leaf to the surface of the fruit and eating the skin of the fruit. Since the early 1980's the pest had increased its geographical range, as well as its host range to include apple, pear, plum, apricot, and sweet cherry. With the adoption of pyrethroid insecticides to combat Oriental

fruit moth's resistance to the organophosphates, the leafroller has become a minor pest in peach. The adoption of varieties less prone to split pit has also helped control the leafroller. In B.C., other leafroller pests include the single-generation fruit tree leafroller and European leafroller and the two-generation threelined leafroller.

Life Cycle: The oblique banded leaf roller overwinters as larvae (second or third instars). In spring, larvae fed on leaves and flower buds in the spring and fruit after petal fall. Larvae develop through 6 instars. Eggs are laid on the underside of leaves. There are two generations per year. Populations of over-wintering larvae are usually low and only occasionally cause economic damage.

Pest Management

Chemical Controls: Pyrethroid sprays applied for Oriental fruit moth provide adequate control. Treatments for peach twig borer commonly control the pest in B.C. Registered insecticides include: azinphos-methyl, carbaryl, phosmet and spinosad.

Cultural Controls: Fertilization and irrigation should not be done before the pit hardening stage. Fruit prone to split pits should not be thinned too much early in the season. Where possible, blocks of sweet cherries, apples and pears should be isolated from peach to avoid migration of larvae.

Alternative Controls: The bacteria *Bacillus thuringiensis* subsp. *kurstaki* and spinosad provide organic alternatives, but are short-lived products and are expensive to use. In hot seasons, viral infections of larvae can provide good control, but this usually occurs after some fruit have been damaged. Monitoring populations in other nearby crops and the use of pheromone trap monitoring for the application of insecticides is effective.

Resistant Cultivars: It is recommended not to grow varieties prone to developing split-pits.

Issues for Leafrollers

1. Pest resistance to both organophosphate and pyrethroid insecticides has been well documented in apple and pear. There is concern that these populations may migrate to or develop in stone fruit orchards.
2. Alternative IPM-friendly, cost-effective products are required to support both IPM and advanced mating disruption programs.

Peach Silver Mite (*Aculus cornutus*)

Pest Information

Damage: The peach silver mite feeds on the lower leaf surface and tends to congregate around the leaf mid-rib. High populations (200 to 300 per leaf) can bronze the lower surface, causing the leaves to curl and turn silvery green and may adversely affect fruit quality. Combined with drought stress, peach silver mite can impact fruit size on late maturing varieties, decrease fruit buds and reduce tree winter hardiness. The mite is primarily found on peach and nectarine, but occasionally attacks plum and prune. With the advent of pyrethroid use to control Oriental fruit moth, peach silver mite has become a widespread pest.

Life Cycle: Their appearance and biology are very similar to apple rust mite. The pest overwinters under bud scales and has several generations per year.

Pest Management

Chemical Controls: Growers tend to tolerate the pest and do not apply special control sprays unless populations are very high. The pest is actually beneficial in low numbers because they

are an important food source for predatory mites when other pest mites are at low numbers. Registered insecticides include carbaryl and endosulfan.

Cultural Controls: The creation of dust particles in the air should be avoided. Water stress should be avoided by following an irrigation schedule. Annual pruning opens up the tree allowing good air flow and spray penetration. Mite populations are highest in orchards located beside greenhouses or clover sod cover crops.

Alternative Controls: Nature provides the most effective control of pest mite populations with the predator mites. The main predatory mites are of the family Phytoseiidae and the most abundant species are *Typhlodromus pyri*, *Ambleyseius fallacis* and *Typhlodromus caudiglans*. Regular monitoring is essential during the summer. Trees with a heavy infestation of peach silver mite late in the season should be irrigated post-harvest if drought conditions are present into September.

Resistant Cultivars: None

Issues for Peach Silver Mite

1. There is concern over the difficulty in detecting the silver mite before symptoms are present.

Lesser Peach Tree Borer (*Synanthedon pictipes*)

Pest Information

Damage: The lesser peach tree borer attacks peach, plum, sweet cherry, tart cherry, apricot and nectarine. Wild crop hosts include wild black cherry, wild red cherry, beach plum, wild plum and Juneberry. The borer attacks the bark of trunks and branches previously injured by pruning, canker diseases or other insects. Larvae feed on the bark at the margins of the injured area, enlarging the wounded area often girdling and killing the branch. Trees infested by the borer have increased susceptibility to perennial canker.

Life Cycle: The pest overwinters as larvae under the bark. After a short period of feeding in the spring, mature larvae move to the bark surface where they pupate and eventually emerge as adult moths. Following mating, female moths lay eggs back on injured bark tissues. Following hatch, the larvae enter the bark and begin to feed. There is one generation and sometimes a partial second generation per year. The rate of development of this pest is highly temperature dependent.

Pest Management

Chemical Controls: Endosulfan remains the most effective product. Young trees may be dipped in endosulfan at planting.

Cultural Controls: Painting trunks of young trees up to the age of 4-5 years with white latex paint reduces the attraction of adults to these trees.

Alternative Controls: Storing of wood from orchard trees that have been cut should be avoided since the wood could be a source of continued infestation. There is some scientific evidence that Isomate P is effective at controlling this pest by means of mating disruption. In B.C., thresholds based on the number of moths caught per trap per week have been established for chemical treatments. The bacterium *Bacillus thuringiensis* var. *kurstaki* is effective if applied before young larvae tunnel into twigs, buds and fruit.

Resistant Cultivars: None identified.

Issues for Lesser Peach Tree Borer

1. There is a need to register alternatives to endosulfan that can be used in support of mating disruption programs before the registered product is removed from the market.

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

Regulatory Status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
azinphos-methyl (Guthion 50WP, Sniper)	organophosphate insecticides	1B[1]	DI (available until Dec. 31, 2006)	leafrollers (oblique banded, *Platynota flavedana*, red banded)		resistance in Ontario
				Oriental fruit moth		resistance in Ontario
				peach twig borer		
				plum curculio		
				scales (cottony peach, Forbes, San Jose, terrapin, walnut, white peach)		
				tarnished plant bug		
Bacillus thuringiensis subsp. *Kurstaki (*Dipel WP*)*	*B.t.* subsp. *kurstaki*	11B2	RR & RE	leafrollers (fruittree, European, oblique banded, three-lined)		
carbaryl (Sevin Brand XLR Plus)	carbamate insecticides	1A[1]	RE	European earwig		
				leafrollers (fruittree, redbanded)		
				Oriental fruit moth		
				peach twig borer		
				peach silver mite		
				plum curculio		
				scales		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
Chlorpyriphos (Lorsban 50 W)	organophosphate insecticides	1B[1]	RE	Oriental fruit moth		Registered for first generation.
clofentezine (Apollo SC)	clofentezine	10A	RR	Mites (European red, two spotted)		Do not use past petal fall
cyhalothrin-lambda (Matador 120 EC)	pyrethroid insecticides	3	R	green peach aphid		
				Oriental fruit moth		This product is used as a second or third spray for control or plant bugs and Oriental fruit moth.
				tarnished plant bug		
cypermethrin (Cymbush 250 EC)	pyrethroid insecticides	3	R	Oriental fruit moth		
				tarnished plant bug		
deltamethrin (Decis 2.5 EC)	pyrethroid insecticides	3	R	peach twig borer		
				Oriental fruit moth		This product is used as a second or third spray for the control of Oriental fruit moth.
diazinon (Diazinon 50W)	organophosphate insecticides	1B[1]	RE	green peach aphid		
				peach twig borer		
				San Jose scale		
				two spotted spider mite		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
dicofol (Kelthane 50 W)	unclassified	Unknown mode of action	R	Mites (European red, two-spotted, peach silver)		
mineral oil (Superior Oil)	Mineral oil		R	European red mite		
				San Jose scale		Use product according to label, as doramant/delayed dormant early in season.
endosulfan (Thioex 50W, Thiodan 50WP, Thiodan 4EC)	cyclodiene organochlorine insecticides	2A[1]	RE	aphids		
				Tree borers (peach tree, lesser peach tree)		
				peach twig borer		As a pre-plant treatment, new trees are treated 100%.
				peach silver mite		
formetanate hydrochloride (Carzol SP)	carbamate miticides	1A[1]	RE	Mites (European red, two-spotted spider)		
Isomate M – 100 Oriental Fruit Moth Pheromone (Z-8-Dodecen-1-yl Acetate ; E-8-Dodecen-1-yl Acetate; Z-8 Dodecen-1-ol)	biological	N/A	R	Oriental fruit moth		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
Isomate-P Pheromone (Z,Z – 3, 13 Octadecadien-1-yl Acetate; E,Z – 3, 13 Octadecadien-1-yl Acetate)	biological	N/A	R	peach tree borer		
calcium polysulfide (Lime Sulphur)	inorganic insecticides	M	R	San Jose scale		
				peach twig borer		
malathion	organophosphate insecticides	1B[1]	RE	Oriental fruit moth		
				plum curculio		
permethrin (Ambush 500 EC)	pyrethroid insecticides	3	R	plum curculio		
				Oriental fruit moth		This product is used as the second or third spray for control of plant bugs and Oriental fruit moth.
				plant bug		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
phosalone (Zolone Flo Insecticide)	organophosphate insecticides	1B[1]	RE	European red mite		
				Oriental fruit moth		
				peach twig borer		
				plum curculio		
phosmet (Imidan 50 WP Instapak)	organophosphate insecticides	1B[1]	RE	oblique banded leafroller		
				Oriental fruit moth		
				peach twig borer		
				plum curculio		
				tarnished plant bug		
pirimicarb (Pirimor 50 DF)	carbamate insecticides	1A[1]	DI (available until Dec 31, 2009)	green peach aphid		
pyridaben (Pyramite)	METI miticides	21	R	European red mite (Ontario only)		More effective miticides are urgently needed. This product is used in summer.
				two-spotted spider mite (Ontario only)		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
spinosad (Success 480 SC)	spinosyn insecticides	5	RR	leafrollers (oblique banded, three-lined, fruittree, European)		Pesticide residues must be dry before re-entering treated area.

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

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

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

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

	Practice \ Pest	Oriental fruit moth	European red mite	Tarnished plant bug	Plum Curculio	Green peach aphid	Peach Tree Bborer
Prevention	tillage						
	residue removal						
	water management						
	equipment sanitation						
	row spacing / seeding depth						
	removal of alternative hosts (weeds/volunteers)						
Avoidance	resistant varieties						
	planting / harvest date adjustment						
	crop rotation						
	trap crops - perimeter spraying						
	use of pest-free seed						
	optimizing fertilization						
	reducing mechanical damage						
	tininning of fruit/ thinning of canopy						
	site selection						
	physical barriers						
Monitoring	scouting - trapping						
	records to track pests						
	field mapping of weeds						
	soil analysis						
	weather monitoring for disease forecasting						
	grading out infected apples						
Suppression	use of thresholds for application decisions						
	biological pesticides						
	pheromones/ mating disruption						
	sterile mating technique						
	beneficial organisms & habitat management						
	pesticide rotation for resistance management						
	ground cover / physical barriers						
	forecasting for applications						

no indication that the practice is available/used

available/used

available/not used

not available

Source(s): Crop Profile Focus Group (ON) 2004.

Weeds

Key Issues

- There is concern that heavy reliance on glyphosate herbicides will lead to resistance in marestail (Canada fleabane) and other plant species. There is a 'weed shift' occurring in BC orchards as a result of reliance on glyphosate. Weed species that are tolerant to glyphosate are becoming more prevalent.
- There is a need for new herbicide technologies to be registered to increase the number of products used in rotation to limit resistance development.
- There is concern that the heavy reliance on glyphosate has led to the build-up of residues in trees. This needs to be verified. Low level residues may cause sub-lethal effects on the trees.
- Reduced risk replacements are required for soil-applied, residual herbicides with harsh environmental profiles(toxicity to soil biota, leaching, ground water contamination and soil persistence).
- There is a need for research to support the development of integrated weed management in peaches.
- There is a need for weed surveys, the testing of integrated management methods, long term rotations and predictive models.
- There is a need for research on the critical period of weed control (weed free period) in peaches.
- There is a need for research on innovative methods such as flaming, mulch application, low cost production of mulches and testing of cultivators including assessing environmental impacts.
- The development of new, selective chemicals and biopesticides for weed control is required.
- There is a need to survey for new weed species and to screen herbicides for control of these new pests.

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

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

Widespread yearly occurrence with high pest pressure
Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure
Widespread yearly occurrence with low to moderate pest pressure
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure
DNR - Data not reported.
Pest not present
E – established
D – invasion expected or dispersing
Source(s): Crop Profile for Peaches in British Columbia (2003); Crop Profile Focus Group (ON) 2004.

Major Weeds

Weeds

Pest Information

Major weeds:

Annual broadleaf weeds: buttercup (*Ranunculus* sp.), yellow rocket (*Barbarbea vulgaris*), wild carrot (*Daucus carota*), burdock (*Arctium* sp.) and peppergrass (*Lepidium virginicum*)
Perennial broadleaf weeds: thistle (*Cirsium* sp.), dandelion (*Taraxacum officinale*), poison ivy (*Rhus radicans*), plantain (*Plantago* sp.), milkweed (*Asclepias* sp.), creeping Charlie (*Glechoma hederacea*), wild grape (*Vitis* sp.), bindweed (*Convolvulus* sp.), vetch (*Vicia* sp.) and perennial nightshade (*Solanum* sp.).
Perennial grasses: quack grass (*Elytrigia repens*)

Damage: A 50% reduction in tree trunk diameter may occur in areas where weeds are not controlled. Crop loss can be very high. Newly planted trees do not compete well with large annual weeds. New trees will lose a year's growth if competition is intensive and can be killed if water or nutrients are a limiting factor. Losses on larger trees result from smaller fruit due to competition and in reduced fruit bud set for the next season. Losses can be as high as 50% depending on the rootstocks and weeds involved. Perennial weeds that have been established for several years can become very large and consequently be very competitive.

Life Cycle: Most arable land is infested with weed seeds at all times. For new peach planting, the critical stage for control is during May and June. For bearing trees, the critical stage for control is from bud-break until 30 days after bloom. The critical weed-free period means that no yield reduction will result if the crop is kept free of weeds during this time. Weeds

emerging after that period will not affect yield, however control efforts at that time help make harvest more efficient and reduce weed problems in subsequent years.

Annual grasses and annual broadleaves: Annual weeds complete their life cycle, from seed germination, through vegetative growth and flowering, to seed production, in one year. Many weeds in fruit crops are winter annuals, plants that begin their growth in the fall, produce a rosette of leaves in the fall and flower the second year. Spring annual weeds germinate in the early spring, grow during May-June and produce seeds in the summer for the next year. Annual weeds are very successful at reproducing by seed. They produce large numbers of seeds and some weed seeds remain viable in the soil for many years, germinating when conditions are right.

Biennial weeds: Biennial weeds germinate in the spring and remain vegetative during the first summer. They over-winter as rosettes and then in the second growing season, they bolt, sending up a flower stock on which seeds are produced. The original plants die at the end of the second growing season. Biennial weeds reproduce only through seeds produced every other year.

Perennial grasses and perennial broadleaf weeds: Perennials are plants that live for many years. They spread through the expansion of various types of root systems, seeds and vegetative means.

Pest Management

Chemical Controls: For non-bearing trees there are many pre-emergent herbicide options, including terbacil, trifluralin, s-metolachlor and metribuzin. For escapes, post-emergent products such as sethoxydim, fluazifop-p-butyl, paraquat and glyphosate, can be used. All products are ground applied using booms with various types of hoods to avoid drift into the tree canopy "Enviromist" technology (fine droplet size with ultra low volumes of water applied in an enclosed hood to avoid drift and contact with non-targets) may also be used for spray application. Spot treatment, combined with hand weeding is essential to prevent the establishment of new weed species and resistant biotypes. Perennial weeds are usually controlled when they are actively growing, but are still shorter than the lower part of the tree canopy. With these weeds, systemic herbicides such as glyphosate or amitrole should be considered in the pre-plant year when there are no crop restrictions. Repeated applications and cultivations may be needed to control certain species. Critical control stage information has helped growers determine what periods of time the planting strip must remain weed free. Application of 2-3 pre-emergent and/or post emergent products are required over this critical period of 2-3 months.

Cultural Controls: The management of surrounding fields, ditch and road areas by regular cultivation, fallowing and/or mowing to prevent flowering of weeds helps keep the seed bank of weeds lower in the soil. The use of a clean, seed–free source of mulch and manure prevents the introduction of additional seeds and new species. A green manure crop planted the year before, combined with fallow periods, can stimulate weed seed germination and deplete the weed seed bank in the soil. Site preparation may also involve planting a green manure crop the previous year such as rye-grass or Sudan grass and using non selective herbicides for broadleaf weeds such as 2,4-D in the green manure cropping system. Biodegradable plastic mulch or straw mulch can be used to cover the soil. Establishing sod cover the year before planting and then planting into the sod that has been killed before planting will reduce the need for herbicides in the year of planting. Weed whippers and mowers that cut close to the trees without injury are helpful, but mowing on its own will not completely eliminate weed competition. The establishment of a vigorous sod growth between

tree rows will reduce weed pressure. Hand removal of new weed species or resistant biotypes may be an important method of stopping them from becoming established.

Alternative Controls: None available.

Resistant Cultivars: None available.

Issues for Weeds

See key issues section.

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

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
2,4-D	Phenoxy carboxylic acids	4	RE	annual broadleaf		
				perennial broadleaf		
dichlobenil (Casoron)	Nitrile herbicides	20	R (Re-evaluation complete)	annual broadleaf		
				annual grasses		
				perennial broadleaf		
				perenial grasses		
fluazifop-p-butyl (Venture)	Aryloxyphenoxy propionates herbicides	1	R	annual grasses		
				quackgrass		
glufosinate ammonium (Ignite 15 SN)	phosphinic acid	10	R	annual broadleaf		
				annual grasses		
				perennial broadleaf		
glyphosate	Glycines	9	R	annual grasses		
				annual broadleaf		
				perennial broadleaf		
				perennial grasses		
linuron (Afolan F)	Ureas	7	R	annual broadleaf		
				annual grasses		
metribuzin (Lexone DF, Sencor 500F)	triazinone herbicides	5	R (Re-evaluation complete)	annual broadleaf		
				annual grasses		
napropamide (Devrinol)	Acetamide	15	R	annual broadleaf		
				annual grasses		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
paraquat (Gramoxone)	bipyridylium herbicide	22	R (Re-evaluation complete)	annual broadleaf		
				annual grasses		
				perennial broadleaf		
				perennial grasses		
sethoxydim (Poast)	Cyclohexanediones	1	R	annual grasses		
				perennial grasses		
simazine	triazine herbicide	5	R	annual broadleaf		
				annual grasses		
				perennial seedlings		
s-metolachlor (Dual Magnum)	chloroacetamides herbicides	15	RR	annual grasses		
terbacil (Sinbar WP)	uracil herbicides	5	R (Re-evaluation complete)	annual broadleaf		
				annual grasses		

Regulatory status as of May 8, 2006					Stakeholder comments [6]	
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]**	**Performance of product according to recommended use[5]**	**Notes**
trifluralin (Treflan)	dinitroaniline herbicides	3	RE	annual broadleaf		
				annual grasses		

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

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

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

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

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

[6] Source(s): Crop Profile Focus Group (ON) 2004.

Table 10. Availability and use of weed pest management approaches for Canadian peach production

	Practice \ Pest	annual grass	annual broadleaf	perennial grass	perennial broadleaf
Prevention	tillage				
	residue removal				
	water management				
	equipment sanitation				
	row spacing / seeding depth				
	weed management in non-crop areas				
	mowing / mulching / flaming/ cover crops				
Avoidance	resistant varieties				
	planting / harvest date adjustment				
	crop rotation				
	trap crops - perimeter spraying				
	use of weed free soil ammendments				
	optimizing fertilization				
	reducing mechanical damage				
	thinning of fruit				
Monitoring	scouting - trapping				
	records to track pests				
	field mapping of weeds				
	soil analysis				
	weather monitoring for disease forecasting				
	grading out infected fruit				
Suppression	use of thresholds for application decisions				
	biological pesticides				
	pheromones				
	sterile mating technique				
	beneficial organisms & habitat management				
	pesticide rotation for resistance management				
	ground cover / physical barriers				
	forecasting for applications				

no indication that the practice is available/used

available/used

available/not used

not available

Source(s): Crop Profile Focus Group (ON) 2004.

Vertebrate Pests

Vertebrate pests include deer, birds, rabbits, mice (voles), woodchucks (groundhogs) and bears. Damage includes direct feeding on fruit, injury to trees by feeding on buds or broken tree limbs, girdling by eating the bark, tunnelling into the ground and eating the roots, as well as a possible bacterial contamination of fruit by bird droppings and subsequent food safety issues.

Chemical control, in the form of rodenticide baits, is an option for mice. Registered products include diphacinone, chlorophacinone, zinc phosphide and strychnine. Repellents to keep deer and bear away include ammonium soaps and putrescent whole egg solids.

The control of most vertebrates is based on a combination of cultural practices and preventative techniques in a season-long management strategy to reduce economic losses. Keeping orchard grass short and herbicide strips free of weeds will reduce damage by mice. Mowing of the orchard sod also makes it easier for predators such as foxes and hawks to hunt voles. Removing straw, weeds and sod from around the base of trunks reduces habitat for rodents and discourages mouse establishment. Picking up fruit that has fallen to the ground in the fall discourages deer and rabbits. Wire mesh tree guards will help prevent voles from girdling trees. Yellow tapes or streamers act as a visual repellent for birds and can be used in conjunction with noisemakers, such as cracker or whistler shells, propane exploders or electronic alarms. Broadcasting of distress calls and the use of scarecrows and predator models, such as hawk-shaped kites, will repel birds. Woodchucks and rabbits can be controlled by live trapping or shooting. Hunting at certain times of the year can help control deer. Woven wire fencing or electric fencing, will help keep deer and bears out of orchards.

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West Virginia University, Index of Fruit Disease: http://www.caf.wvu.edu/kearneysville/wvufarm8.html

The Plant Disease Diagnostic Clinic at Cornell University http://plantclinic.cornell.edu/FactSheets/cytospora/cytospora.htm

IPM / ICM resources for production of peach in Canada

The Ontario Ministry of Agriculture and Food has several publications and factsheets available discussing IPM:

Fruit Production Recommendations 2004-2005 (Publication 360); Publication 360 Supplement 2005

Tender Fruit IPM Workshop (March 1998)

OMAF Factsheets, Newsletter Articles, Web Articles by subject category: Source: http://www.gov.on.ca/OMAFRA/english/crops/hort/tender_fruit.html

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

Name	Organization	Pest type	Specific pests	Type of research
McFadden-Smith, W.	McSmith Agr Services	Pathology	Brown rot, Bacterial Spot	Applied Research, Disease models, epidemiology and efficacy of biologicals alternatives and fungicides.
Philip, H.	BCMAFF	Insect		entomologist for tree fruit
Pogoda, M.	Agriculture and Agri-Food Canada	Insect	tarnished plant bug, plum curculio, oriental fruit moth, mites, oblique banded leafroller, aphids	Research Entomology, GLP Residue, Efficacy Trials
Pree, D.J.	Agriculture and Agri-Food Canada	Insect	tarnished plant bug, oriental fruit moth, mites, oblique banded leafroller, aphids	Research Entomology
Rochon, D. French, C. Sanfacon, H. Bernardy, M.	Agriculture and Agri-Food Canada, Reesearch branch, Pacific Agri-Food Research Centre (Summerland)	Disease, virus	Several	Plant virus disease control
Sholberg, P.	Pacific Agri-Food Research Centre, AAFC (Summerland)	Disease	Brown Rot, Powdery mildew, Rhizopus	plant pathology
Stobbs, L.	Agriculture and Agri-Food Canada	Virus	plum pox	Research Virology
Subramanian, J.	University of Guelph, Ontario Agricultural College	Abiotic		Genetic improvement of tree fruit crops (Prunus spp) through conventional and biotechnological approaches
Svircev, A.	Agriculture and Agri-Food Canada	Pathology	Plum Pox, Peach Canker	Basic Research
Vrain, T. Lane, W. Wiersma, P.	Agriculture and Agri-Food Canada, Reesearch branch, Pacific Agri-Food Research Centre (Summerland)	Insect, nematode, abiotic	Several	Genetic regulation and engineering of horticultural crops, with emphasis on tree fruits and small fruit crops