Haskap Production

and

Integrated Pest Management for Yukon Berry Crops

Update to the Yukon Crop Guide

Report to Government of Yukon, Director of Agriculture Branch,

Department of Energy, Mines and Resources

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1. Background

Small-scale berry production in Yukon has been ongoing for many years. Historically, producers have had the most success with raspberries, black currants, saskatoons, and strawberries (Yukon Crop Guide 1994). In recent years, however, berry acreage has increased with the development and availability of the haskap plant *(Lonicera caerulea)*. By the end of 2016, over 40,000 haskap plants have been planted in Yukon and at least 14 growers are reporting berries as available farm products (Yukon Agricultural Association 2016).

This update to the Yukon Crop Guide aims to provide Yukon berry producers with an introduction to Haskap production as well as a comprehensive guide to preventing, identifying, and managing any pest issues they may encounter in their berry crop agroecosystems using an Integrated Pest Management (IPM) approach. Yukon is fortunate to have few serious pests or disease issues affecting berry crops; however, climate change and the trend to warmer average annual temperatures may result in changes in pest populations and interaction with crop plants.

2. Haskap Production

The following are general guidelines for Haskap production in Canada. Local experience may differ.

2.1 About the Haskap

The Haskap plant *(Lonicera caerulea)* is a circumpolar species native to northern boreal forests of Europe, Asia, and North America. In general, it is a tidy, non-suckering, globe-shaped plant. Haskap berries are dark blue-purple in colour, dusty, and oblong with a flavour described as a mix between a raspberry and a blueberry. Though the berries appear similar to blueberries, haskap is more closely related to snowberry. The haskap plant is extremely cold-hardy, with selections released by the University of Saskatchewan able to withstand temperatures of -45C.

2.2 Haskap Development in Canada

In 2007, under the direction of Dr. Bob Bors, the University of Saskatchewan Fruit Program released its first haskap cultivars, Tundra and Borealis. Several other cold-hardy selections have since been released, and more releases are expected from 2017-2018. The cultivars developed by the U of S are crosses between Japanese, Russian and Kuril types. The U of S haskap breeding program aims to develop cultivars that are suited to mechanical harvesting. Visit the U of S Fruit Program page for more information at www.fruit.usask.ca/haskap.

2.3 University of Saskatchewan Cultivars

Below are the cultivars that have been developed through the U of S Fruit Program. Like many fruit species, haskaps require cross-pollination with an unrelated cultivar to bear fruit (see 'Honeybee', 'Aurora' and 'Boreal Beast' below). It is important that pollinator varieties selected for interplanting are not only genetically compatible with the main crop variety, but they must

also bloom at the same time or at least have a significant period of overlap. The U of S has a pollination cultivar compatibility chart that is available online (see "Useful Websites and Publications" at the end of this document). In an average year, haskaps can be expected to ripen 6 - 7 weeks after bloom time (Bors 2016). In Yukon, experience so far indicates that ripe fruit are typically available in July.

Table 1. University of Saskatchewan Haskap Cultivar Information

Cultivar	Fruit qualities	Bush habit/vigor	Early/mid/late producer	Mildew resistance	Other
Tundra	-large size -sweet/tart -firm -minimal bleed	-compact -4-5 feet mature	early	very high	-suitable for IQF (individually quick frozen) processing -suitable for mechanical harvest
Borealis	-large size -sweet/tangy -softer berry -bleeds slightly	-compact -4 feet mature	early	very high	-not suitable for mechanical harvest -best for u-pick operations
Indigo Gem	-medium size -sweet/tangy -firm	-compact -5-6 feet mature	early	less resistant	-high yields -suitable for mechanical harvesting
Indigo Treat	-medium size -sweet	-upright -4-5 feet mature	early	high	-very similar to Tundra
Indigo Yum					*difficult to propagate
Boreal Blizzard	-very large -excellent taste -firm	-upright, vigorous growth	mid	very high	-high yields
Boreal Beauty (2017)	-large -excellent taste -firm -heart or oval-shaped	-upright, vigorous growth -sturdy branches	late	very high	-later bloom and ripening -suitable for mechanical harvest -companion plant with Boreal Beast
Honeybee (pollinator)	-large -cylindrical -tart	-upright -vigorous	early	very high	-selected as companion for Borealis, Tundra and Indigo -not suitable for mechanical harvest

					-best for juice
Aurora (pollinator)	-large -sweet	-5 feet mature -upright	early	high	-selected as companion for Borealis -high yields
Boreal Beast (2017/18) (pollinator*)	-large -firm -excellent taste	-upright -vigorous	mid	very high	-later bloom and ripening -companion plant with Boreal Beauty

***Boreal Beast also displays qualities that would make for a good commercial selection**

2.4 Site Selection

Haskaps grow best in well-drained loam soil and can tolerate a wide range of soil pH, however a general guideline for haskaps is between 5 - 8. (Bors 2009). Soil testing and fertilizing is recommended prior to planting. Haskaps are susceptible to wind and sunburn (predominately on the leaves) and will benefit from being planted in protected areas. Plant in full to partial sun.

2.5 Planting and Establishment

Select cultivars that are most appropriate for your production plan – i.e. mechanical vs. hand harvesting, fresh vs. processed berries and so on. Plant haskaps at the same depth or slightly lower than the depth in the original pot. (Bors 2009). Haskaps take 3-4 seasons of establishment before they are productive enough to harvest. During this time, it is important to ensure the plants receive adequate irrigation so a healthy, deep root system can develop. Established bushes require less irrigation but should be monitored closely in dry regions like Yukon.

At 1m spacing (within row), most cultivars will grow into a hedge. If it is preferred that individual bushes are maintained, then the spacing can be increased to 1.3 m (Bors 2009). Pollinator cultivars must be planted near the main cultivar. There are several ways of inter-planting pollinator bushes with your main cultivar: for example, pollinator bushes may be planted within rows of your main cultivar, or alternating rows of the main cultivar and the pollinator cultivar may be more desirable – this depends on which cultivars you have selected. See the U of S Fruit Program website (www.fruit.usask.ca/haskap) for details.

2.6 Soil and Nutrient Management

Because the commercial haskap industry in Canada is relatively new, there are currently no established guidelines for nutrient management. Regular soil testing is recommended to assess availability of soil nutrients required for optimal plant growth. Avoid applying fertilizer after spring to avoid new growth being pushed too late in the year. Some local growers have had success applying fertilizer in late winter when snow is still present so that fertilizer can be incorporated with snowmelt. Haskaps appear to be sensitive to fertilizer burn, so use caution when applying fertilizers. Side-band application of fertilizer may be best for haskaps. See section 4.4.3 - Nutrient Deficiencies.

2.7 Pruning

Minimal pruning is required, but on mature bushes it is recommended that older branches be removed in the late winter or early spring if bushes have become quite dense. Pruning helps to promote air circulation and can help reduce the incidence and severity of fungal diseases. It also allows for more even sunlight penetration and even ripening of fruit. It is recommended that no more than 25% of plant tissue be removed in a single year (Bors 2009).

3. What is Integrated Pest Management (IPM)?

IPM is a pest management approach that aims to manage crop pests in an economically and environmentally sustainable way.

An IPM program involves:

- an understanding of pest life cycle and behaviour
- systematic crop monitoring to assess pest occurrence, pest population levels, severity of pest damage to plants, as well as the presence of beneficial organisms
- the use of thresholds, where available, to make management decisions
- a 'toolbox' of pest management options
- the evaluation of the efficacy of any control measures taken.

3.1 Pest life cycle and behaviour

Perhaps the most important part of an IPM program is the understanding of the life cycle and behaviour of the pests in your field. This knowledge is necessary so that any needed control measures can be targeted and timed for optimal efficacy, and so effective monitoring for pests can take place - for example, whether the use of sweep nets, beat sheets, or examination of plant tissue is most appropriate to monitor for a given pest.

3.2 Systematic crop monitoring

Management decisions under an IPM approach are based on the pest presence, population levels, and crop injury levels in the field as opposed to the application of pesticides on a calendar date, often without knowledge of whether the pest is actually present in the field or at levels that are of economic concern (see 'Thresholds' below). Crop monitoring or scouting involves visiting the field at regular intervals and systematically sampling plants or sections of the field and recording this data (Figs. 1 and 2). It may also include insect traps that are checked at a regular interval. It is important that data is recorded in a consistent manner so that records can be compared year to year and the effectiveness of a given control measure can be assessed. Regular monitoring coupled with knowledge of life cycle and behaviour means that chemicals are used wisely and growers can minimize pesticide and labour costs.

Berry Monitoring Data Sheet

W = winged
LR = leafroller
SD = syrphid
LB = ladybird beetle
PA = parasitized aphid
E = eggs

Date: ____July 5 2016_____ Scout: __AB____ Field: __2014 haskap_____

Plant Stage: 50% ripe berry Row :__3___ From: __west___ Direction: __north___ Paces between samples: _20__

	APHIDS				CATER-PILLARS		SPIDER MITES				SAWFLY		DISEASES			BENEFICIALS			OTHER
Plant #	L	M	H	W	#	dmg	L	M	H	E	#	dmg	MILDEW (severity)	FRUIT ROT	DIEBACK	SD	LB	PA	
1	II	I	-	-	I	L	-	-	-	-	-	-	M	-	-	-	1 ad	1	Sunburn on leaves
2	-	I	-	-	-	-	-	-	-	-	-	-	M	-	-	-	-	-	
3	-	-	-	-	I	L	-	-	-	-	-	-	L	-	-	-	-	-	
4	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	-	
5	I	-	-	-	-	-	-	-	-	-	-	-	L	-	-	-	-	-	
6	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	-	-	-	
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Broken branches
8	I	I	-	-	-	-	I	-	-	-	-	-	M	-	-	-	-	1	
Total	5	3	0	0	2	2 L	1	0	0	0	0	0	3 L, 3 M	None observed	None observed	0	1 adult, eggs	2	

Aphid rating: Examine 10 shoot tips per bush and record # of low/mod/high tips. Low = 1-5 Med = 6-10 High = 11+
Disease ratings: Low (1-5 leaves) M (6-10 leaves) H (11+ leaves)

Figure 1. Sample data sheet for field monitoring.

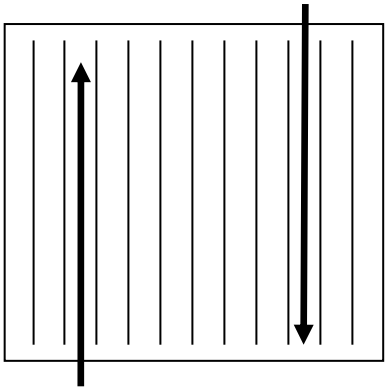


Figure 2: Monitoring a berry field. Sample the first bush at the end of your chosen row. Then move down the same row and continue to sample bushes a consistent number of paces apart (i.e. 20-30 paces for a total of 3-8 samples). If making more than one pass in a field, try to distance the two passes from each other by at least 3 or 4 rows. Record where you sampled in the field on the data sheet so that you can return to check on the same plant or area if needed and so you can alternate rows sampled from week to week.

3.3 Thresholds

IPM uses the concept of thresholds to make management decisions. There are two main types of thresholds used in IPM: the first is the Economic Injury Level (EIL), the second is the Action Threshold.

Economic Injury Level: Simply described, the EIL is reached when the economic loss that will be suffered as a result of pest injury to the crop is equal to the cost of applying a control measure (Hunt 2016). Prior to reaching this threshold, it is economically advantageous to the grower to "do nothing"; i.e. not apply a pesticide. The EIL is a theoretical concept and is not directly used to make management decisions; rather it helps to understand the Action Threshold.

Action Threshold: The Action Threshold is used so that the Economic Injury Level is not reached. The action threshold is the point at which control measures should be made in order to prevent economic crop loss from pest injury.

The development of specific thresholds in IPM is a complex process and is based on years of research and local experience. There are many pests for which thresholds do not exist, as well as instances where a well researched and widely accepted threshold may need to be adjusted in response to local observations on pest behaviour and population levels. You may develop your own "thresholds" on your farm based on years of observation. The take-home message of the concept of thresholds is that pest presence alone does not necessitate control measures, and that regular monitoring and data collection is key to making good management decisions

3.4 The IPM 'Toolbox'

IPM uses a combination of control options to manage pests. These include cultural controls, biological controls, chemical controls, and mechanical/physical controls.

Cultural Control: Cultural controls are mainly preventative and are those that involve changes to the way aspects of the farm are managed. For example, a cultural control method for rodents is mowing long grasses that may provide habitat for them near a crop site. Another example is keeping cull piles that may contain disease or insect pests far away from field sites.

Biological Control: Biological controls make use of natural enemies of crop pests – for example, ladybug larvae are voracious aphid predators. Biological controls can include introduction of natural enemies (i.e. field releases of predator mites that were reared in an insectary for control of spider mites); or encouragement of natural enemies (i.e. incorporating non-crop plants into the field that will attract parasitic wasps).

Mechanical/Physical Control: Mechanical or physical controls are those that prevent a pest from entering the crop ecosystem, suppress a pest, or kill a pest directly –for example, netting to keep birds out of a berry orchard, snap traps for rodents, or the use of plastic mulches to suppress weeds.

Chemical Control: Chemical control involves the use of pesticide products to control pests. In IPM, pesticides are used as a last resort only when deemed necessary through monitoring and data collection, and are used in combination with other control methods whenever possible. The most selective pesticides should be chosen whenever possible to avoid harm to non-target organisms.

3.5 Evaluation of the IPM Program

The final major component of an IPM program is the evaluation of the efficacy of any control measures taken. Good record keeping is crucial to track the effectiveness of the IPM program over the years.

4. Integrated Pest Management for Yukon Berry Crops

Not all berry crops are equally susceptible to the pests described below. See Table 4 at the end of this section for more information.

4.1 Vertebrate Pests

Bird netting over haskap. Photo credit: https://onspecialtycrops.wordpress.com

4.1.1 Birds

Damage: Birds will damage berries either by eating them completely or "pecking" and leaving large gouge marks. Haskaps are among the earliest available berries in the spring and therefore very attractive to birds.

Identification and life cycle: The main bird species causing damage to haskaps in Saskatchewan is cedar waxwing, which is present in Yukon but rare (Eckert 2015). The Bohemian waxwing is present in Yukon and is known to eat ornamental berries late in the year, but thus far there are no reports of crop loss from bohemian waxwings.

Many other bird species may attack berries, including robins, starlings, crows and sparrows. Local growers indicate that robins and sparrows are the most commonly observed birds in Yukon berry fields.

Monitoring: Walk the field and look for large gouges out of berries or missing berries.

Control options: *Mechanical/Physical control*: Good results have been reported out of Saskatchewan with the use of netting. The size of netting is important – too small and birds can get trapped, too large and they can pass through. A ½ inch netting is recommended (Bors 2009). Some local berry producers have had success using commercial bird netting (available at local retailers). Netting must be in place before berries are ripe.

Bird scare devices can be used in areas where damage has been observed. Types of scare devices are visual (kites that look like predatory birds, reflective tapes or streamers, and scarecrows) or noise (propane-fired cannons, recordings of predatory birds or loud noises such as motorbikes/quads ridden through fields). Visual scare devices are only effective if used with noise scare devices (BC Berries Production Guide 2016).

4.1.2 Rodents (voles/field mice)

Northern red-backed vole. Photo credit: Environment Yukon

Damage: Voles, also called field mice, damage plants by feeding on roots and bark, sometimes girdling and killing berry bushes. Extensive rodent tunneling can cause the soil to collapse under bushes. Anecdotal evidence suggests that haskaps are less susceptible to vole damage than other berry crops, but fields should still be monitored.

Identification and life cycle: Voles are small rodents with small ears, short bodies, and short tails. They are typically brownish in colour with grey undersides. Voles breed from June-September, and have extremely high reproductive rates. The Northern Red-backed vole is able to produce up to 6 young every 3 weeks (Environment Yukon 2015). Voles are active throughout the winter, tunneling under snow and feeding on plant roots. The population of voles is cyclical, and some years will see much higher numbers.

Monitoring: While walking down the row, look for holes and tunnels near the bases of plants. If a plant looks weak or stressed, give it a tug to see if the root system has been damaged by rodent feeding. It will pull up easily if the roots have been eaten. Make note of field areas with evidence of damage.

Control options: *Cultural control:* Keep grass and weeds in or near field sites under control to limit vole habitat. Minimize brush piles near fence lines, ditches and buildings. Some organic blueberry growers in BC and Oregon have found that the use of weed mat down the row serves as protection and habitat for rodents and has increased problems. Opening the weed mat occasionally to allow access to predators may help decrease rodent pressure (Strik 2015). *Biological control:* Foxes and birds of prey are both predators of voles. *Chemical control:* Use chemical control options as a last resort only. Commercial poisons and bait stations are available for rodents. Bait stations are designed to limit access to non-target animals and protect the bait from the weather. Place bait stations near areas with evidence of rodent activity. Keep away from areas that pets and children may access.

4.1.3 Other Wildlife (deer, elk, moose)

Damage: Yukon wildlife can damage berry crops by browsing on plant tissue and trampling and breaking branches. Damage may be severe, especially on young plants.

For more information about wildlife management and Yukon agriculture, contact the Agriculture Branch.

4.2 Insect and Mite Pests

4.2.1 Aphids

Aphid damage on currants. Photo credit: https://www.rhs.org.uk/advice/profile?PID=491

Damage: Aphids have piercing-sucking mouthparts that puncture plant tissue and suck out sap. They are particularly attracted to new, succulent shoot growth. Heavy infestations can result in sticky aphid "honeydew" (excrement) and associated sooty mold that can make fruit unmarketable. Aphids can be a concern in berry crops as they can vector (transmit) plant viruses through feeding. On currants, aphid feeding often causes distinct curling, red discolouration and blistering of infested leaves. Growth may be stunted and heavy infestation may affect yield.

Identification and life cycle: Aphids are small (2-3 mm) soft-bodied insects. Aphid colour depends on species and plant host, but they are often green to greenish-yellow. Winged aphids of some species are black. They are slow moving with long legs. Aphids are typically found on the underside of leaves feeding in colonies.

In the spring, overwintered eggs hatch and first generation aphids begin feeding and reproducing. These aphids reproduce using asexual reproduction, meaning females can produce live young without males. Aphids can reproduce very quickly and have many generations per year. Unwinged aphids are referred to as apteran. Crowding and deterioration of the food source results in the birth of winged male and female aphids. These aphids will disperse to new food sources and mate. Females will then produce eggs in preparation for winter, rather than live young (Flint 2013).

Monitoring: At each bush being sampled, examine 10 shoot tips. Look for clusters of small greenish-coloured insects on the underside of leaves and rate numbers from low to high (see sample data sheet in Fig.1). Record the number of shoot tips infested with aphids, including any winged aphids. Record the presence of any beneficial insects – i.e. ladybugs, ladybug eggs or larvae (Appendix I).

Control options: *Cultural control:* Avoid over-fertilization with nitrogen as this can result in excessive shoot growth that aphids favour. *Biological control:* There are many natural enemies of aphids. These include ladybug adults and larvae, syrphid (hover) fly larvae, and parasitic wasps that lay their eggs inside the body cavity of aphids, resulting in an aphid "mummy" – the desiccated body of the aphid that remains once the parasitic wasp has completed its development inside (Appendix I). In many cases these beneficial insects are able to keep aphid populations at an acceptable level. Incorporating plants such as alyssum, carrot, phacelia, yarrow, coreopsis, dill

and rudbeckia into the farm design can help to attract natural enemies. *Chemical control:* Use chemical control options as a last resort only. There are many products registered for aphid control. Spray when aphid numbers are increasing and beneficial insects are not present. See Table 2.

4.2.2 Caterpillars

Cutworm larvae. Photo credit: http://www.gov.mb.ca/agriculture/crops/insects/printcutworms-field-crops.html

Leafroller larvae found in saskatoons, Dawson City

Damage: Caterpillars can damage berry plants by feeding on new leaf and blossom tissue as well as by webbing flower/berry clusters together. Flower and/or berry clusters are often contaminated by caterpillar frass (excrement). Leafroller caterpillars will roll leaves up around themselves and feed and eventually pupate inside. Occasionally caterpillars can be harvest contaminants. Cutworms are a type of caterpillar that live at soil level and eat large sections out of leaves or completely shear off new seedlings. Cutworms are more likely to cause damage in raspberry and strawberry plantings.

Identification and life cycle: Caterpillars are the larval stage of moths and butterflies. Size and markings will vary by species. Several different species of caterpillar may be found in berry fields in Yukon. Leafroller caterpillars will exhibit similar behavior (webbing and rolling leaves or flower/berry clusters together and feeding within).

Depending on species and climate, caterpillars will overwinter as eggs or as late life stage larvae in hibernacula (overwintering cocoons) in protected places, such as under bark or in tree crotches. Overwintered eggs hatch in the spring as temperatures warm and larvae will feed on plant tissue until they pupate. Caterpillars generally have 1-3 generations per year depending on species; however only 1-2 generations are likely in Yukon. Adult moths are generally non-descript and dull in colour.

Monitoring: At each sample, look for rolled-up leaves or flowers or berry clusters that have been webbed together. Use the tip of a pencil to gently pry open the cluster in order to find the

caterpillar feeding inside. Frass and webbing is often more obvious than the caterpillar itself. Caterpillar frass looks like small black or brown pellets. When disturbed, the caterpillar will often wiggle vigorously and may drop to the ground before it can be observed. Record numbers of caterpillars and/or damage found.

Control options: *Cultural control:* Keep weeds and grasses in or near field sites under control as this will limit habitat for caterpillars. *Biological control:* Natural enemies such as parasitic wasps can help to suppress caterpillar populations. Incorporating plants such as alyssum, carrot, phacelia, yarrow, coreopsis, dill and rudbeckia into the farm design can help to attract natural enemies. *Chemical control:* Use chemical control options as a last resort only. There are many products registered for caterpillar control. Sprays are most effective when larvae are small. See Table 2.

4.2.3 Lygus bug/ Tarnished plant bug

Lygus bug adult. Photo credit: http://www.insectsofalberta.com/plantbug_3.htm

Damage: Lygus bugs are a common pest of many plant species. Both adults and late-instar nymphs damage plants by piercing plant tissue and feeding on juices from leaves, flowers and fruit. Feeding on flowers can result in no fruit development ("blind" blossoms), and feeding on developing berries can result in misshapen fruit.

Identification and life cycle: Lygus nymphs are small (2-4 mm) green soft-bodied insects and are often mistaken for aphids, however, unlike aphids, they run very quickly when disturbed. Adults are shield-shaped and are green to brown in colour with a distinct light-coloured triangle at the top of their back. They can be up to 6 mm in size, also move quickly, and are able to fly.

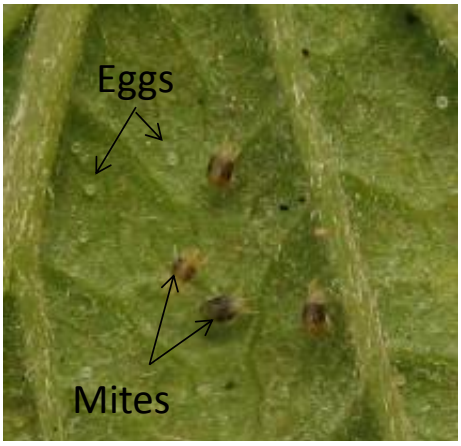
Adult lygus overwinter in plant debris on the soil surface and other protected areas in or around fields. They emerge in spring following snow melt and begin feeding on new plant growth and laying eggs. Nymphs progress through several instars before reaching adulthood.

Monitoring: Lygus nymphs and adults can be difficult to detect because they move away quickly when disturbed. They are most often found feeding in flower clusters. It can be helpful to use a light-coloured container (i.e. a margarine or yogurt tub) to catch lygus by shaking/tapping the flower clusters over top of it and dislodging any nymphs or adults that might be feeding within. In saskatoons, lygus feeding damage to developing flowers often resembles winter injury (Spencer et al 2013).

Control options: *Cultural control:* Good weed management on field borders can help to minimize lygus populations in your field. Control weeds before adults are observed, as they will fly into fields looking for new food sources once weeds are mowed or dried out. Likewise, harvesting of neighbouring hay fields may mean movement of lygus into berry fields.

Biological control: Parasitic wasps have been known to attack lygus. Incorporating plants such as alyssum, carrot, phacelia, yarrow, coreopsis, dill and rudbeckia into the farm can help to attract natural enemies such as parasitic wasps. *Chemical control:* Use chemical control options as a last resort only. Sprays are most effective when targeted at young nymphs. See Table 2.

4.2.4 Mites



Two-spotted spider mites. Photo Credit: Carolyn Teasdale, E.S. Cropconsult Ltd.

Damage: There are many different species of mites that are crop pests. Spider mites are common, and have rasping-sucking mouthparts and cause damage by puncturing plant cells and sucking out juices. Heavy spider mite infestations can cause whitish stippling and bronzing of leaves and eventual leaf drop. Webbing over leaves and berries may also be seen in cases of severe infestation. Yield may be affected.

Identification and life cycle: Spider mites are very small (<1 mm) members of the arachnid family. Adults have eight legs and oval bodies and are generally light yellow to light brown in colour, though colour and markings vary by species. They are typically found feeding on the undersides of leaves in colonies. Spider mite eggs are round, very small, light-coloured and glossy and are often found alongside adult spider mites. Overwintering female spider mites are bright orange-red.

Spider mites can overwinter under bark or leaf litter in protected areas and begin to feed and reproduce as temperatures increase in the spring. Spider mites can reproduce rapidly in periods of warm weather and thrive in warm, dry, dusty conditions. Infestations will often be most pronounced along roadways where dust has been kicked up onto neighbouring plants. There are multiple generations per season.

Monitoring: It is easiest to see spider mites with the aid of a 10X power magnifying hand lens. Walk down an outer as well as an inner row of your field and inspect the underside of 10 leaf shoots for mites at each sample. Look for leaf stippling, bronzing or curling as well as any leaf drop. Record any observed mites and note if eggs are also present - many eggs and a period of warm weather will often mean a rapid increase in mite populations. Also look for mite predators (see *Biological control* below).

Control options: *Cultural control:* If spider mites have been a problem in previous years, limit dusty conditions near berry fields by watering down pathways or roadways. Adequate irrigation is important as water-stressed plants are less able to tolerate spider mite feeding.
Biological control: Natural predators, namely predator mites, are often able to keep spider mite populations down on their own. It can be difficult to tell spider mites apart from predator mites, but predator mites are often fast-moving and can be seen running across the undersides of leaves

whereas spider mites move relatively slowly. *Mechanical/Physical control:* Spraying plants down with water occasionally can help to suppress spider mites. Try to ensure that water hits the undersides of leaves (UC IPM 2011). *Chemical control:* Use chemical control options as a last resort only. See Table 2. Take care reading labels as some products are registered for post-harvest use only.

4.2.5 Sawfly

Saskatoon sawfly adult. Photo credit: http://saskatoonberryinstitute.org/grower-information/saskatoon-sawfly/

Pear sawfly larvae on saskatoons, Dawson City

Currant sawfly larvae and damage. Photo credit: http://sites.udel.edu/ornamentals/files/2011/05/imported-currantworm-larvae.jpg

Damage: At this time it is not clear which species of sawfly are most common pests of berry crops in Yukon; however, pear sawfly and currant sawfly have been observed. *Saskatoons:* Pear sawfly larvae have been observed on saskatoons in Yukon. Pear sawfly larvae feed on the surface of leaves, leaving papery translucent holes (UC IPM 2012). Saskatoon sawfly lays its eggs in the developing fruit. Larval feeding in the fruit causes it to rot and/or drop off (Spencer et al 2013). *Currants/Gooseberries:* Currant sawfly larvae are voracious eaters and can eat large holes in leaves or even completely skeletonize leaves. Damage often occurs very quickly. Plants will appear healthy one day and can have noticeable feeding damage the next. Newly hatched currant sawfly larvae typically eat small holes in the centre of leaves, and older larvae typically eat from the edges of leaves inward. Leaves are attacked from the centre of the plant outward. Picking leaves off that only have one or two small holes from early larval feeding can stop dispersal to neighbouring leaves. Red currants and gooseberries are more commonly attacked by sawfly while black currants are rarely a host. Wild gooseberries may serve as a host plant.

Identification and life cycle: *Saskatoons:* Adults are thick-waisted wasps with clear wings. Mature Saskatoon sawfly larvae are cream to yellowish in colour (Spencer et al 2013). Mature pear sawfly larvae are yellow-green. Immature pear sawfly larvae often resemble slugs as they have a shiny green-black coating (UC IPM 2012).

Larvae of both species overwinter in the soil as pupae and adults emerge in spring, mate, and then move to new plant tissue to lay eggs. Saskatoon sawfly eggs are laid in developing berries

and larvae feed within. Pear sawfly eggs are laid under the leaf tissue. One or two generations may occur in Yukon.

Currants/Gooseberries: Adults are thick-waisted wasps with clear wings. Eggs are laid on the underside of leaves. Currant sawfly larvae are greenish in colour with small black spots and many legs. Larvae often feed in groups, and many may be observed on a single leaf.

Larvae overwinter in the soil as pupae. Adults emerge in spring and lay eggs on new plant tissue. Eggs hatch as temperatures warm, and larvae will begin feeding on the host plant. One or two generations may occur in Yukon.

Monitoring: *Saskatoons:* Once plants have leafed out, look for evidence of feeding damage on leaves. At green berry, examine berry clusters for evidence of dropped or damaged fruit. Record severity of any feeding damage observed. *Currants/Gooseberries:* At each sample, pick off and examine several leaves, focusing on the inner and lower part of the plant. Look for eggs or small larvae feeding on leaves. Record the location of any sawfly larvae or suspected damage in the field. Monitor at least once a week for sawfly larvae in currants and gooseberries. They are easy to miss and damage can occur very quickly.

Control options: *Mechanical/Physical control:* If low levels of sawfly larvae are found in a small orchard setting, affected leaves can be plucked off and the insect killed (crushed, dropped into a container of soapy water, thrown in a burning barrel, etc.). The publication "Identifying and Controlling Pests in Alaska" (University of Alaska Fairbanks 1997) suggests covering plants to prevent egg laying but this will only be effective if there has not been a previous infestation. A strong stream of water directed at the leaves may also be effective in knocking off larvae. *Biological control:* Parasitic wasps are known to attack sawfly larvae. Incorporating plants such as alyssum, carrot, phacelia, yarrow, coreopsis, dill and rudbeckia into the farm design can help to attract natural enemies. *Chemical control:* Use chemical control options as a last resort only. *Currants:* In fields with a history of sawfly, sprays should be applied as soon as feeding damage is observed. See Table 2.

4.2.6 Root Weevils

Strawberry root weevil adult. Photo credit: http://bugguide.net/node/view/78324/bgpage

Root weevil feeding damage and frass in strawberry roots. Photo credit: http://www.omafra.gov.on.ca/IPM/english/strawberries/insects/root-weevil.html

Characteristic c-shaped notches in leaves from adult weevil feeding. Photo credit: http://www.omafra.gov.on.ca/IPM/english/strawberries/insects/root-weevil.html

Damage: Root weevils damage berry crops mainly through larval feeding on roots. Plants will show general decline and failure to thrive as root systems become damaged. Adult root weevils also feed on plant foliage, eating characteristic "c" shaped notches out of the edges of leaves, which generally does not affect plant health but can be an aesthetic issue in a nursery setting. Some early-emerging species may also feed on developing buds, which can affect yield. Adult weevils in raspberries can cause leaf "flagging" by eating notches out of stems, causing the leaf to dangle.

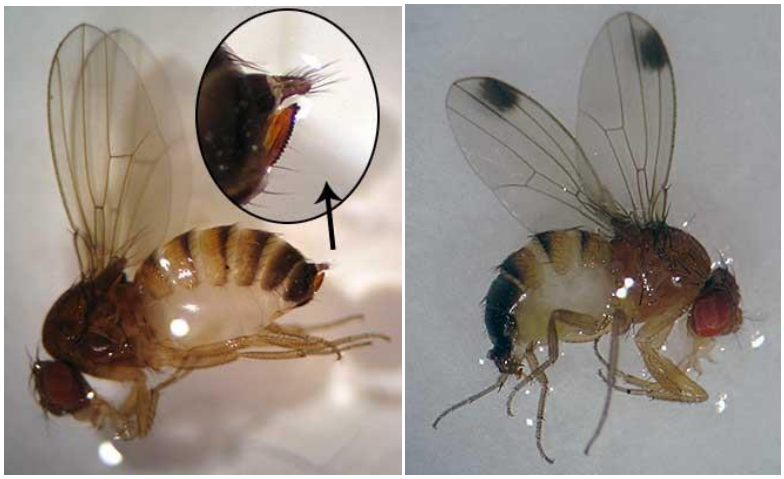
Identification and life cycle: Adult weevils are beetles with distinctive long snouts and elbowed antennae. Some species of weevil can fly but most weevils that are crop pests are flightless. Size and colour will vary by species. Larvae are white-to-cream coloured and legless, and may have a tan-coloured head capsule. They often curl into a c-shape when disturbed.

Most species of weevils have one generation per year. Larvae overwinter beneath the soil near plant roots and pupate in the summer. Adult emergence and egg laying occurs over several weeks. Eggs laid by adult weevils then hatch into larvae, which feed on plant roots throughout the remainder of the summer and fall. Adult weevils rarely overwinter.

Monitoring: It is easiest to monitor for weevil adults. Destructive sampling is usually necessary to find weevil larvae. Bushes will need to be dug up with root ball intact and thoroughly examined for weevil larvae and signs of feeding damage. Reddish, sawdust-like frass is indicative of root weevil feeding. Adult weevils are most active at night and rest in the soil beneath bushes during the day. Timing of peak adult emergence can be estimated by looking for an increase in leaf notching. It may be possible to find adult weevils in the soil during the day but this is time consuming and difficult. It is easier to monitor for weevils at night by shaking branches over a white surface, i.e. a tablecloth or similar. Walk down a row in an area of the field where leaf notching has been observed and shake several plants over a white cloth laid on the soil beneath bushes. Record numbers of adult weevils found and make note of field areas with notching.

Control options: *Cultural control:* Plant stock that is free of weevils. *Biological control:* Entomopathogenic nematodes are available for field application (via drip irrigation or soil drench) for suppression of weevil larvae; however commercially available nematode species have limited cold tolerance and short shelf life and may not be suitable for use in Yukon. *Chemical control:* Use chemical control options as a last resort only. Registered pesticides target the adult life stage, therefore careful monitoring is needed to estimate timing of adult emergence. See Table 2.

4.2.7 Spotted Wing Drosophila *(Drosophila suzukii)* (not yet detected in Yukon)



Left: Female SWD with saw-like ovipositor highlighted. Right: Male SWD. Photo Credit: Sheila Fitzpatrick, Agriculture & Agri-Food Canada, Pacific Agri-Food Research Centre, Agassiz

Note: It is unlikely that Spotted Wing Drosophila (SWD) is currently present in Yukon; however, it has dispersed widely across North America since 2009. To date, SWD has been detected in all provinces in Canada (Agriculture and Agri-Food Canada 2016) and as of 2016, SWD have been detected in all regions in Alberta (Spencer 2016). It is thought that SWD have most likely been introduced into Alberta via summer travellers from BC bringing fruit across the border, however it cannot be ruled out that wind dispersal plays a part in SWD movement into new areas (Alberta Agriculture and Forestry 2016).

Damage: Spotted Wing Drosophila (SWD) is an invasive species of vinegar fly native to Southeast Asia. It has become a major pest of the soft fruit and stone fruit industry in North America in recent years. Unlike the common fruit fly, *Drosophila melanogaster*, SWD is attracted to ripe, healthy fruit on the plant as well as decaying fruit. Female SWD lay their eggs inside ripe fruit and subsequent larval feeding within causes the fruit to become soft, leaky and unmarketable.

Identification and life cycle: SWD is a small (2-3 mm) golden tan- to-brown coloured fly with clear wings. SWD is named for the distinct dark spot at the tip of each wing on males. Female SWD have specialized ovipositors that they use to cut through the skin of ripe fruit and lay their eggs inside. Larval feeding and pupation occurs within the berry.

Experience in other regions has shown that several generations occur over the summer and that populations build into the fall until temperatures start to decrease and available food sources diminish. In colder climates in Canada, SWD likely does not overwinter but is re-introduced each year.

Monitoring: *Adults*: Most research and monitoring has been conducted using a lidded plastic container baited with apple cider vinegar hung within the plant canopy. *Larvae*: When berry

clusters are examined for other pests, soft leaky fruit may be noticed. These fruits can be gently pulled open to find a small (2-3 mm) clear–to-whitish larva feeding inside.

Salt or sugar float-out tests are also useful for detecting SWD larvae in fruit. Ripe berries are collected in a Ziploc bag, gently crushed, and a solution of water and sugar or salt is added to the bag. Any larvae within the berries will float out to the top of the liquid (Dreves 2014).

Control options: *Cultural control:* Currently, management of SWD is heavily reliant on chemical controls but there are cultural practices that can help reduce the risk to fruit. Picking early, often and cleanly (minimizing fruit on the ground and not leaving older fruit hanging) is recommended. Cooling harvested berries immediately after picking can help to slow the development of larvae and eggs in fruit, or kill them. Raspberries are particularly susceptible to SWD infestation. Because haskaps fruit so early in the season, berries may be mostly harvested by the time potential SWD populations would begin to build; however, SWD larvae have been observed anecdotally in haskap fruit in BC (E. Gerbrandt, pers. comm. 2016).

4.2.8 Chemical Control Options for Berry Insect and Mite Pests

As pesticide use is limited in the Yukon, chemical control options have been summarized in the table below rather than discussed in-text. Chemical control options should only be used as a last resort. Options vary by berry crop. Pesticide use is not recommended during flowering, as most products are harmful to bees and other pollinators. It is important to read the label carefully and choose the most appropriate pesticide for life stage of the pest as well as crop stage. Consider days-to-harvest (also known as the PHI, pre-harvest interval) and re-entry intervals for farm workers. Follow any environmental or personal safety guidelines. It is important to rotate the use of products from different pesticide groups whenever possible in order to slow the development of pest resistance. Only use pesticide products for the specific pests and plants that they were developed for, as outlined and listed on the product label.

Table 2. Registered Insecticide and Miticides for Pests in Berry Crops in Yukon

	Products registered by berry crop **Products approved for use in organics in green. Always check with your certifying body before applying a product.**			
Pest	**Raspberries**	**Currants and Gooseberries**	**Saskatoons**	**Haskaps**
Spider mites	-Apollo SC -Acramite 50WS -Kanemite 15 SC -Agri-mek 1.9% EC -Pyramite 75 WP/Nexter	Malathion	none	none
Caterpillars	-Capture 240 EC -Delegate WG -Intrepid 240F -Success 480 SC -Entrust 80w -DiPel WP -Sevin XLR Plus	-Dipel 2XDF -Altacor -Exirel -Success 480 EC -Entrust 80W	-Success 480 EC -Entrust 80W	-Success 480 EC -Entrust 80W
Aphids	-Admire 240F or Alias 240SC -Assail 70WP -Diazinon 500E -Diazinon 50W -Movento 240SC -PyGanic EC1.4	-Malathion 25W -Diazinon 500EC -Assail 70WP -Exirel -Sivanto Prime	none	none
Sawfly	None specifically registered; products as applied for other pests may help to suppress	-Diazinon 500EC	none	none
Lygus/TPB	None specifically registered; products as applied for other pests may help to suppress	None	none	none
Weevils	Capture 240EC Actara 25WG Malathion 85E	-Exirel -Actara 25G	none	none

4.3 Diseases

4.3.1 Mildew

Early mildew leaf infection on haskap. Photo credit: http://www.omafra.gov.on.ca/CropOp/en/spec_fruit/berries/hask.html

Damage: *Haskap:* Mildew leaf infections can cause leaf browning and curling, and severely infected plants may be stunted. Experience so far in Saskatchewan shows that haskap fruit does not seem to be adversely affected by mildew, but no long-term studies have been conducted yet assessing the impact of mildew infections on yield (Bors et al 2012). *Currants:* When currant fruit is infected by mildew, it can be small and cracked. Leaf infections first appear as white powdery growth and then progress to brown lesions. Black currants are especially susceptible to powdery mildew, but newer cultivars are more resistant.

Identification and life cycle: Mildew is usually seen first on leaves, where it appears as a whitish-grey powdery growth in early stages of infection. Later stages of leaf infection cause browning and leaf curling.

Mildew fruiting bodies overwinter on infected leaves or fruit from the previous season. Spores are windblown onto new plant tissue in the spring. Mildew is often more severe in warm, humid conditions, i.e. greenhouses. So far, mildew seems to develop later in the season on haskap (after harvest) so this disease has not been a serious concern for most producers.

Monitoring: At each sample, look for whitish-grey patches of growth on the leaves – this is the early stage of the infection and less obvious. As these patches develop they will turn brown and may cause the leaves to curl. Leaves infected by powdery mildew may also have sunburn as leaf curling exposes the underside of the leaves to the sun. Record areas of the field with symptoms and assess severity.

Control options:

Cultural control: Plant mildew-resistant varieties – most haskap varieties released by the University of Saskatchewan have tested well for resistance (Bors et al 2012). Some newer Scottish varieties of currants are more resistant to mildew. Selective pruning helps to encourage good air circulation and limit disease development. *Chemical control:* Use chemical control options as a last resort only. Registered products are preventative and are only effective if applied before the development of disease. See Table 3.

4.3.2 Fruit rots

Botrytis infection on raspberry at green berry stage. Photo credit: Carolyn Teasdale, E.S. Cropsconsult Ltd.

Damage: Infected green berries may have underdeveloped purplish, hard or sunken areas. Ripe berries may be covered in a fuzzy mould of varying colours or become leaky and mushy. Infected blossoms may shrivel and dry up. Fruit rot is often not noticed until post-harvest, where it can easily spread from infected to healthy berries.

Identification and life cycle: There are many different fruit rot pathogens that have the potential to infect blossoms and/or berries. Mould on ripe berries may appear as whitish, grey or green fuzzy growth depending on the pathogen. Infected green berries may be hard and underdeveloped. Infected flowers may shrivel up and fail to produce fruit.

Fruit rot pathogens overwinter on previous year's wood/canes or in debris at the base of plants and begin to sporulate in the spring, spreading to new plant tissues. Occasionally the fruiting bodies of some pathogens can be observed on canes in early spring as black dots or patches. Infection is favoured by periods of cool weather and high humidity, and greater rates of infection may occur if bloom coincides with rainy weather.

Monitoring: *Blossom*: At each sample, look for dried, brown or shrivelled blossoms. *Green berry*: At each sample, look for underdeveloped or shrunken berries. *Harvest*: look for soft, leaky or moldy berries.

Control options: *Cultural control:* Pruning can help to limit favourable conditions for disease development by encouraging good air circulation. Cooling berries as soon as possible after harvest can help to limit the spread of disease. *Chemical control:* Use chemical control options as a last resort only. Registered products are preventative and are most effective if applied before the development of disease. Sprays should be applied at regular intervals starting at bloom until harvest. Most labels recommend a spray interval of 7-14 days. Shorten the spray interval if wet weather is in the forecast. See Table 3.

4.3.3 Saskatoon Juniper Rust

Saskatoon-juniper rust infection on berries. Photo credit: http://www.okanaganlakebc.ca/community/personal/all/food.htm

Damage: Initial infection appears as yellow spots and swelling on leaves and berries. Later infection causes distinct spiky growths on berries and leaves.

Identification and life cycle: Saskatoon-juniper rust is caused by a pathogen that affects wild junipers. The rust first develops on neighbouring juniper plants as woody galls which then grow "horns" after summer rains. These horns release spores that can infect saskatoons. The rust that develops on saskatoons can then re-infect junipers (St. Pierre 2006).

Monitoring: Look for raised yellow spots on leaves while walking your field. Later, look for distinct spiky growths protruding from berries and leaves. Record areas with damage and assess severity.

Control options: *Cultural control:* Avoid locating saskatoon orchards near wild stands of juniper – the spores are able to travel up to 2 km. Plant resistant varieties when possible. *Chemical control:* Use chemical control options as a last resort only. Registered control products are preventative. Spray timings vary depending on product. See Table 3.

4.3.4 Haskap collar injury/infection and dieback

Injury to base of haskap plant, Whitehorse area

Damage: In summer 2016, some mature haskap plants started to show signs of general decline in the Dawson City and Whitehorse areas. The variety most affected appears to be Tundra. Plants are noticeably weaker compared to neighbouring healthy bushes, with discoloured or dying leaves, and overall poor leaf growth. Plants were examined by Agriculture Branch staff and private consultants and the damage appears to be related to large cracks/wounds near the base of the plant. Roots appear healthy. At this time, it is not known what is causing this damage – it is possible the wounds are caused by winter injury, which may have then enabled a pathogen to infect the plant at the site of the damage.

Monitoring: Walk your field and look for weak, stressed looking bushes with leaf discolouration. Affected plants are clearly noticeable next to healthy bushes. Search for an opening or wound at the base of the plant – you may have to dig some dirt away. Record areas of the field with damaged plants and make note of the variety affected.

Control options: None at this time.

4.3.5 Chemical Control Options for Berry Diseases

As pesticide use is limited in the Yukon, chemical control options have been summarized in the table below rather than discussed in-text. Chemical control options should only be used as a last resort. Options vary by berry crop. Pesticide use is generally not recommended during flowering as products may be harmful to bees and other pollinators. If preventative fungicides are necessary during bloom, try to spray at night when bees are less likely to be active. It is important to read the label carefully and choose the most appropriate pesticide for life stage of the pest as well as crop stage. Consider days-to-harvest (also known as the PHI, pre-harvest interval) and re-entry intervals for farm workers. Follow any environmental or personal safety guidelines. It is important to rotate the use of products from different pesticide groups whenever possible to slow the development of pest resistance. Only use pesticide products for the specific pests and plants that they were developed for, as outlined and listed on the product label.

Table 3. Registered Fungicides for Berry Crops in Canada

	Products registered by berry crop **Products approved for use in organics in green. Always check with your certifying body before applying a product.**			
Pest	**Raspberries**	**Currants and Gooseberries**	**Saskatoons**	**Haskaps**
Powdery Mildew	n/a	-Bordeaux mixture 8-8-100 -Sulphur 80% DF -Microscopic Sulphur WP -Pristine WG -Nova Gooseberries only: -Lime Sulphur -Mettle 125ME	-Nova	none
Fruit rots*	-Serenade Max -Timorex Gold -Lime Sulphur -Captan 80WDG -Maestro 80 DF -Senator 70WP -Rovral -Cantus WDG -Sercadis -Luna Tranquility -Pristine WG -Scala -Switch 62.5WG -Tanos 50DF -Elevate 50 WDG	-Serenade Max -Inspire Super -Lance/Cantus WDG -Sercadis -Pristine WG -Switch 62.5 -Elevate 50WDG	-Kumulus DF -Funginex -Jade/Topas/Mission -Serenade Max	none
Saskatoon-juniper rust	n/a	n/a	-Funginex -Jade/Topas/Mission -Pristine	n/a

*Note: there are many products registered for fruit rots in Canada. Most of the products included here are registered for **botrytis**. Many of these products will have some activity against other fruit rot pathogens, check labels for more information.

Table 4. Susceptibility of Yukon Berry Crops to Pests

	Berry Crop			
Pest	**Haskaps**	**Raspberries**	**Currants/ Gooseberries**	**Saskatoons**
Vertebrates				
Birds	2	1	1	1
Rodents	1	1	1	1
Deer/Elk/Moose	2	2	2	2
Insects/Mites				
Aphids	1	1	1	1
Caterpillars	1	1	1	1
Lygus Bug	1	1	1	1
Mites	1	2	1	1
Sawfly	0	1	2	2
Root Weevils	1	1	1	1
Spotted Wing Drosophila	1 (in other regions)	2 (in other regions)	1 (in other regions)	1 (in other regions)
Diseases				
Mildew	1	1	1	0
Fruit rots	1	2	1	1
Saskatoon Juniper Rust	0	0	0	1
Haskap collar injury/dieback	1	0	0	0

Number Key:

0 = not expected to be a crop pest 1 = occasional crop pest 2 = significant crop pest

4.4 Physiological Disorders/Mechanical Damage

4.4.1 Sunburn or windburn

Sunburn to underside of haskap leaf, Whitehorse area

Sun and wind can sometimes cause damage to leaves, particularly on younger berry plants. Sunburn may occur if there are sunny days following several cloudy or overcast days. Wind can worsen sunburn as the leaves flutter and twist in the wind, exposing the underside to the sun. Sunburnt leaves will have uneven brown patches that are most obvious on the underside but may also be visible on the upper leaf surface. Wind may also cause leaves to distort and/or turn brown and can exacerbate water stress. Locate fields near shelterbelts to help minimize wind damage. The Yukon Crop Guide includes information on shelterbelt design and composition.

4.4.2 Winter injury

Winter injury on berries can present in several ways. Tips can be killed if freezing temperatures occur before the plant has gone dormant in the fall. Freeze/thaw cycles can be very damaging to perennial plants, causing breakage of roots and splitting of trunks. Late frosts can result in damage to developing flower buds, although haskap flowers are very tolerant of late season cold temperatures. To check for winter damage in flower buds, cut the buds in half. Brown or black discolouration can be observed inside. These buds are unlikely to develop into berries.

4.4.3 Nutrient deficiencies

Nutrient deficiencies can present as plant stunting, poor yield, or leaf discolouration, distortion, or necrosis. Symptoms may be a result of macronutrient or micronutrient deficiencies, or both. Nutrient availability is related to many different factors, such as soil pH, texture, and organic matter content. Historically, Yukon soils have been deficient in nitrogen, particularly on newly cleared land (Yukon Crop Guide 1994). If you suspect a nutrient deficiency, soil samples can be submitted to Agriculture Branch. Regular soil testing enables fertilizer inputs to be planned according to soil content and plant need.

4.4.4 Herbicide injury

Berry crops can be very sensitive to herbicide exposure. Plant injury may result from accidental direct contact with herbicides or from herbicide drift from application in adjacent areas. Herbicide injury symptoms vary depending on the plant affected as well as the mode of action of the herbicide. Leaves may be twisted, stunted or otherwise distorted, or show symptoms similar to nutrient deficiency (discolouration and necrosis). Monitor the development of any suspected herbicide injury and refer to spray records to confirm.

Appendix I - Gallery of Natural Enemies

Syrphid flies: Aphid predator (larval stage)

L to R: Syrphid eggs, larva and adult. Photo credit: Marjolaine Dessureault, E.S. Cropconsult Ltd.

Adult: Small fly often mistaken for a wasp. Dark and light coloured stripes on abdomen. Hovers in place during flight; hence the common name hover fly.

Larvae: Translucent greenish body; no discernible head or eyes. Up to ~1 cm in length. Voracious aphid predator. Moves head rapidly to search for aphids.

Eggs: Small, white pill-shaped eggs often laid among aphid colonies.

Ladybugs: Aphid predator (both adult and larval stages)

Ladybug larvae and eggs
Photo credit: Marjolaine Dessureault
E.S. Cropconsult Ltd.

Adult ladybug on haskap

Adult: Small round beetle with distinct markings on back. Typically red, white and black.

Larvae: Often described as alligator-like. Black, often with red markings.

Eggs: Orange to yellow, rocket shaped, laid upright in groups among aphid colonies.

Parasitic wasps: Aphid and caterpillar predator

Apteran aphids and winged aphid alongside parasitized aphids or "aphid mummies". Photo credit: Carolyn Teasdale, E.S. Cropconsult Ltd.

Adult: Varies by species, but small, dark coloured wasps. Some have long ovipositors that enable egg laying inside the body of the host.

Larvae: Larvae develop within the body of insect host. Aphids that have been parasitized by wasps turn silvery tan in colour and dry out as the wasp larvae feeds and develops within. They are often stuck to the underside of leaves.

Eggs: Eggs are laid within body of host.

Other generalist predators: Ground beetles, spiders, dragonflies

Useful Websites and Publications

Alberta Saskatoon Berry Production Manual by Robert Spencer, Linda Matthews, Bob Bors and Clarence Peters (2013). Digital version can be accessed online. Hard copies can also be purchased.

University of Saskatchewan Fruit Program - Haskaps: www.fruit.usask.ca/haskap.html

-**Mildew and Sunburn in Haskap** by Dr. Bob Bors, Linda Sawchuk and Jill Thomson

-**Growing Haskap in Canada** by Dr. Bob Bors

-**Haskap Compatibility, Flowering and Ripening Charts for U of SK Varieties** by Dr. Bob Bors

BC Berries Production Guide: http://productionguide.agrifoodbc.ca/guides/14

Biobest Side Effect Manual: http://www.biobestgroup.com/en/side-effect-manual

This website gives toxicity ratings against beneficial insects for commonly used pesticides.

Health Canada Pesticide Label Search: http://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php

Pesticide label information can also be accessed on your mobile device. See above website for information.

Yukon Agriculture Branch: http://www.emr.gov.yk.ca/agriculture/index.html

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