January 2, 2007

Black Vine Weevil Trapping Methods

Final Report (REVISED) to the BC Landscape and Nursery Association 2006

Title: Evaluation of monitoring methods for black vine weevil in nursery ornamental production.

Researchers: Dr. Janice Elmhirst, Jaclyn D'Rozario and Seungho Lee, Elmhirst Diagnostics & Research, 5727 Riverside Street, Abbotsford, BC, V4X 1T6. Tel. 604-820-4075: cell: 604-832-9495; email: Janice.elmhirst@shaw.ca

Objectives:

1. Identify a cost-effective and practical trapping method for monitoring adult black vine weevils in ornamental nurseries and polyhouses.
2. Determine whether adult trapping can be used to time applications of predatory nematodes to reduce crop damage.

Pest: Black vine weevil: *Otiorhynchus sulcatus* Fabricius (Coleoptera: Curculionidae)

Location/Grower: N.A.T.S. Nursery, 32nd Ave., Langley, British Columbia

Background:

Black vine weevil (*Otiorhynchus sulcatus* F.) is the most common species of weevil affecting ornamental nursery stock in British Columbia. Black vine weevils overwinter as mature larvae, or occasionally as pupae or adults, in weedy hedgerows or within infested crops. Adults emerge in spring and summer (May to mid-July)[1,2] and crawl into polyhouses and outdoor nursery crop blocks. Adults feed on the foliage of some crops at night, causing leaf-notching, and hide in dark refuges during the day. Adults must feed for at least four weeks before they begin laying eggs at the base of host plants.[1] Egg-laying can continue until mid- September and adults can be found through to October-November.[1] Eggs hatch in about three weeks[2] and larvae begin feeding on roots.

A wide range of ornamental crops, including ferns, salal, euonymus, kinnikinnik, heather, rhododendron, cedar and yew, can be affected whether grown in plug flats, containers or in field soil.[1]

Chemical insecticides are generally timed to control adults in spring/summer, before egg-laying occurs.[1] However, chemical insecticides are not very effective against larvae in soil and in ornamental nursery crops, adult feeding is not always evident on crops where the adults lay eggs (J. Elmhirst, pers. obs.). In container-grown polyhouse crops, *Heterorhabditis* spp. predatory nematodes, such as *H. megidis* (NEMASYS H: Evergro/Westgro) and *H. bacteriophora* (LARVANEM, TERRANEM: Koppert Canada) can provide good control of root weevil larvae throughout most of the growing season in British Columbia. In crops under cover, there are only a few days or weeks in late fall/winter when the temperature of container potting media drops below 10^{o}C, the temperature below which these nematode species become less active. When applied and timed properly, black vine weevil larval mortality can be 90% or higher with predatory nematodes (J. Elmhirst, pers. obs.).

Adult weevil emergence and crop infestations can be spotty and unpredictable from season to season and year to year. Because adult weevil feeding damage is not always evident on leaves of some crops, infested crops often go undetected until larval feeding on roots causes the plants to die back, by which time large larvae are present and much of the root damage is already done. In addition, larger, late-instar larvae are more difficult to control with predatory nematodes.

A simple, inexpensive and practical way of predicting when and where adult weevils are entering polyhouses would allow growers to apply predatory nematodes preventively, before significant crop damage occurs.

Mating pheromones are not effective for black vine weevil because the adults are all female; aggregation pheromones have not been very successful either (S. Fitzpatrick, AAFC-PARC Agassiz, personal communication). Indicator trap crops, such as potted primula, cyclamen or strawberry can attract adults but need to be maintained and can be a source of other pests, such as mites, aphids and whiteflies, and roots need to be examined for larvae if adult feeding is not evident on leaves. Growers in the Netherlands often monitor spring adult activity by checking for feeding injury on *Euonymus fortunei*, a favourite host crop for the black vine weevil, but feeding damage is not always evident and the weevils may or may not enter nearby crops in high numbers.

Since adult weevils crawl and don't fly, several trapping methods have been reported to be effective monitoring tools. The EXOTIOR™ Black Vine Weevil trap (AgBio, Inc.) contains a dried apple lure plus an electrostatically-charged powder and a glue board that prevents weevils from exiting: this was the most effective trap in a 2005 study in Oregon.[3] Flat, grooved boards placed face-down on soil, or bunched burlap sacking are known to trap adults, as will sticky boards laid at openings to polyhouses or between overwintering sites and crop blocks. Another method reported in the literature is a simple pit-fall trap consisting of a 16 oz plastic drink cup buried in the soil and coated with grease or oil on the inside rim; or with a second greased cup placed inside the first; a cover can be added to prevent rain or irrigation water from entering the trap. In addition, barrier strips of aluminum or hard plastic, coated with non-stick Teflon spray, oil, or sticky glue, can prevent adults from entering a crop; or can be used to guide insects toward a pit-fall or other trapping device.

This trial compared the cost, effectiveness, practicality and ease of use of various trapping methods for monitoring adult black vine weevils at a commercial nursery in the BC Lower Mainland in spring and fall 2006. In addition to monitoring, the effectiveness of trapping as a direct method for reducing crop damage from weevils was assessed.

Methodology:

It was originally planned to test the traps at more than one nursery. However, because of the cost of traps and difficulty in locating suitable sites, only one site was selected: the new N.A.T.S. Nursery site established in 2004 on 32nd Ave., south-east of Langley. This location afforded a uniform environment to test and compare the effectiveness of the different weevil traps “in situ”. Polyhouses containing various container-grown crops were located in a row, numbered east (#4) to west (#34), approximately one metre apart, with entrances facing north and south. A weedy hedgerow with trees and shrubs extended uniformly for approximately 150 metres along the south side of the nursery, opposite the south entrance to the polyhouses. A uniform, five-metre-wide strip of *Gaultheria shallon* (salal) in one-gallon containers on ground cloth was located between the hedgerow and the south entrance to the polyhouses, separated from the polyhouses by a two-metre-wide gravel driveway. The salal crop was divided into six sections, east to west and not previously weevil-infested. A site map is presented in Appendix I.

Perimeter Traps: Perimeter traps to monitor for new adult weevils moving into the nursery were placed on May 8 and checked weekly from May 15 to Oct. 24. Traps were situated at the north base of the weedy, southern hedgerow and spaced five to 10 metres apart in a randomized design with six replicates per treatment (three replicates of the EXOTIOR™ traps). Yellow, 15 cm (6 in.) wide, double-sided HopperFinder sticky tape, (Terralink Horticulture Ltd.) was applied to the wooden base plate at the north and south entrances to polyhouses #8 to 23 on May 9 and #33-34 on June 6 and changed every 14 days or when the tape had become too dirty and was no longer “sticky” to the touch.

Weevil Lures: In mid-June, from communiation with individual nursery growers, it was learned that Dr. John Borden, Pherotech International Inc., was conducting a project for the BC Landscape and Nursery Association also, to evaluate the effectiveness of five different chemical attractant lures developed in the Netherlands for black vine weevil. Although Dr. Borden had installed traps at another nursery site already, he agreed that it seemed a good opportunity to compare the baited lure traps to the various traps being tested in this project, too. On June 28, Dr. Borden donated 12 Vernon Beetle traps to this project, which were placed along the southern hedgerow, interspersed randomly with the other traps. Six traps containing the test lures (lures 1 through 5 with the sixth trap containing a combination of all five lures) were placed next to six Vernon traps containing no lure. These traps were monitored by Elmhirst Diagnostics and Research.

In addition, Dr. Borden placed Vernon Beetle traps containing the experimental lures, both singly and in combination, along the north end of the polyhouses, along with some EXOTIOR™ traps: these traps were monitored by Pherotech staff.

When the first, tiny weevil larvae were seen in the outdoor salal crop on August 30, it was suspected that late adult weevils might be moving into the nursery from other locations, such as berry fields, and laying eggs. At my request, Dr. Borden provided another six Vernon traps, each with the combined five lures, which were placed along the south hedgerow on September 8.

Indoor Polyhouse Traps: In the previous year (2005) weevil feeding damage to roots had been observed by nursery staff in House #12 (on *Athyrium* & *Dryopteris* ferns); House #18 (on *Cornus nuttallii* and *Gaultheria procumbens*) and in House #33 (on *Lysichiton americanus* and *Leptarrhena pyrolifilia*). Black vine weevil adults and larvae carried over from 2005 were observed in these crops in late May 2006. Adults could be found under the containers during the day, but only *Cornus nuttallii* showed leaf notching from adult weevil feeding. On June 6, Exotior™, burlap and board traps were placed in Houses #12, 18 and 33 to see if any of the black vine weevil adults would move from the infested crops into the traps.

Larval Development: Predictions Based on Degree Day Models and Perimeter Adult Weevil Trap Catch: A degree-day model (Son & Lewis, 2005), based on the model of Briere, et al. (1999) for black vine weevil in strawberry fields suggests that 505 dgree days at a base temperature of 6.7 °C are needed from the time the adult black vine weevil first emerges to when it begins laying eggs.[4] Three weeks are generally needed for eggs to hatch, depending on soil temperature[1], although the development time of the weevil can vary within a week depending on the host crop it has been feeding on, also (Dr. Fitzpatrick, AAFC-PARC, Agassiz, pers. comm.). To test the degree-day model, 505 degree-days at base 6.7 °C were calculated from weather data recorded at Environment Canada's Cloverdale East site, the closest location to the Langley nursery, from the earliest date of the first adult black vine weevil caught in perimeter traps (June 15) to the first predicted egg laying date according to the formula: (Max.-Min. Temp. °C divided by 2) – Min. Threshold Temp. 6.7 °C.[6] Egg hatch three weeks later was compared to the date of the first observation of small weevil larvae (< 2 mm long) in the salal crop. The one-gallon salal (*G. shallon*) crop opposite the south hedgerow was examined weekly for new weevil larve in the root-balls from Aug. 30 (when first young larvae < 2 mm long were observed) to Oct. 16. Approximately 800 pots were examined each week: the plant root ball was removed from the container and the exterior of the root-ball checked for larvae and larval tunnels, the size of larvae was recorded, then the plant replaced.

Polyhouse Infestation: On Sept. 25-26 a survey of each polyhouse and crop was conducted. In each polyhouse, 10 plants from each crop species on both the east and west sides of the house were removed from the pot and the root zone examined for weevil larvae. The crop species and presence/absence of root weevil larvae was recorded (Appendix II).

Treatments: Perimeter traps placed in weedy hedgerow and at polyhouse entrances.

	Type of Trap	Number of Traps	Date Installed
1.	Yellow Sticky Tape (S & N polyhouse entrances)	16 x 2: Houses 8-23 2 x 2: Houses 33-34	May 9 June 6
2.	Pitfall Traps (Unitrap) + Aluminum Guide Strips	6	May 9
3.	Cup Pitfall Traps + Lids	6	May 9
4.	Grooved Boards	6	May 9
5.	Exotior™ Traps + Apple Lure[1]	3	May 9
6.	Burlap Sacking	6	May 9
7.	Vernon Beetle Traps + & - Pherotech Lures	6 + lure; 6 – lure	June 28
8.	Vernon Beetle Traps + Pherotech Lures: late emerging adults	6 traps + lures	Sept. 8

[1]Lure changed every 14 days.

Treatments: Indoor traps placed in polyhouses with adult weevils.

	Type of Trap	Total Number of Traps	Date Installed
1.	Exotior Traps + dried apple lure[1]	3	June 6
2.	Grooved Boards	6	June 6
3.	Burlap Sacking	6	June 6

[1]Lure changed every 14 days.

1. Pitfall Traps: A Unitrap (Pherotech International), a hard plastic green funnel trap with a rounded edge and a raised, detachable lid, generally used for Lepidoptera, was buried in the ground with the rim of the trap parallel to the ground. These were placed 5-10 metres apart along the weedy hedgerow located at the south side of the nursery greenhouses (polyhouses). An aluminum strip (15 cm high x 140 cm long) was stuck into the ground behind and extending on either side of each trap to direct insects into the pitfall.

2. Cup Pitfall Traps: A 16 oz. plastic drink cup was buried in the ground near each pitfall trap and covered with a plastic plate suspended on wires pushed into the ground. The inside rim of the cup was coated with vaseline to prevent insects from crawling out.

3. Grooved Boards: Several 0.5 cm wide grooves were cut 15 cm apart on one side of a 20 x 140 cm board. Six were placed "grooved-side down" along the hedgerow on the south side and 6 more were placed in greenhouses #12, 14, 17, 18, 22, 33.

4. Burlap Sacking: Burlap was draped over a stake and gathered at the bottom to provide an attractive area for the adult black vine weevil to take refuge during the day. Six were arranged along the south hedgerow and six placed in greenhouses #12, 14, 17, 18, 22, 33.

5. Exotior™ Black Vine Weevil Traps: AgBio Inc.,Westminter, CO, USA: A rectangular hard plastic trap with lid that is set on the soil or other surface, containing an electrostatically-charged powder, a dried apple lure and a sticky board. Three were placed along the south hedgerow and three in weevil-infested polyhouses #12, 18 and 33. The dried apple lure was changed once every 14 days as instructed by company.

6. Yellow Sticky Tape: 15 cm wide, double-sticky-sided "HopperFinder" tape (Terralink Horticulture Ltd.) was placed along the wooden base of polyhouse doorway entrances at the south and north ends of greenhouses #8 to 23 and #33-34. Black vine weevils were already present in Houses #12, 18 and 33 from the previous year.

7. Vernon Beetle Traps with Pherotech Lures: June 28: Twelve Vernon Beetle Traps plus experimental weevil lures were donated to the trial by Dr. John Borden, Pherotech International, Delta, BC. On June 28, six traps with test lures: one with each lure and one with a combination of all five lures; and six traps with no lures were placed approximately five metres apart along the south hedgerow in a randomized pattern, interspersed with the other traps.

Pherotech Traps: On June 28, Dr. Borden placed additional Vernon traps with lures and EXOTIOR™ traps at the edge of the outdoor nursery crops located at the north end of the polyhouses; these traps were monitored by Pherotech staff.

8. Vernon Beetle Traps with Pherotech Lures: Six traps containing the five experimental lures provided by Pherotech (one with each lure and one with all five lures) were installed along the south hedgerow on Sept. 8, randomly among the other traps.

Results:
The number of adult black vine weevils caught in permeter traps per date is presented in Table 1 and the number of black vine weevil adults trapped indoors, in previously infested houses, is presented in Table 2.

Perimeter Black Vine Weevil Catch: One adult black vine weevil was caught on the yellow sticky tape at the south entrance to House 16 on June 15 and another was caught in the burlap sacking along the south hedgerow opposite House 15-16 on June 27 (Table 1). In addition, one adult black vine weevil was caught on July 27 in Dr. John Borden's EXOTIOR™ traps located at the north end of the polyhouses.[5] No black vine weevils were caught in any of the other perimeter traps.

Other Weevil Species: A few small, brown weevils, tentatively identified by Dr. Sheila Fitzpatrick at AAFC-PARC, Agassiz as a *Sidona* species, were caught on yellow sticky tape from May to early August and two were caught in an EXOTIOR™ trap on July 11th. (Table 3). No weevils were caught in the Vernon Beetle Traps installed on June 6, with or without the experimental lures, identical to the results of Dr. Borden, Pherotech[5].

In the survey of all polyhouse crops on Sept. 25-26 (10 pots examined per crop species on both the east and west side of each polyhouse), new weevil larvae were found only in Houses 15 and 16 (in *Hedera helix* and *Dryopteris expansa*) opposite where the yellow sticky tape and burlap trap in the south hedgerow opposite had caught one adult weevil on June 15 and 27, respectively, and in House 26 (in *Euonymus radicans* and *Mahonia aquifolium* where no traps were located.

Young black vine weevil larvae (< 2 mm long) were first seen on August 30 in the one-gallon container-grown salal crop located between the southern hedgerow and the polyhouses. Large weevil larvae (8-10 mm long) were observed in this crop on Sept. 19 and Oct. 16.

Degree-Day Model Predictions: The first adult weevil was observed on the yellow sticky tape on June 15. It is generally estimated that adult weevils must feed for four weeks before egg-laying, but this is influenced by temperature. Using the 505 degree-day model with a base temperature of 6.7 ^{o}C (Son & Lewis)[4] for predicting the onset of weevil egg laying from adult emergence, and daily weather data from the Environment Canada 'Cloverdale East' weather station closest to the nursery, the time from the first adult black vine weevil trap catch to predicted egg laying was calculated to be July 26 (Figure 1). Egg hatch is reported to take about three weeks.[1] When young (< 2 mm) larvae were first observed on Aug. 30, they probably had already been growing and feeding on plant roots for at least one to two weeks (Dr. S. Fitzpatrick, AAFC-PARC, Agassiz, pers. comm.). Thus, the first observation of young (< 2 mm) weevil larvae in the salal crop on August 30, was predicted quite well by the 505 degree-day model (Figure 1). This is about one month earlier than when large weevil larvae generally are first observed in infested and damaged nursery crops and when predatory nematode treatments are generally applied.

Table 1. Perimeter Traps: Number of adult black vine weevils caught in hedgerow traps at south end of polyhouses per date, 2006.

Traps	May	June 15	June 27	July	Aug.	Sept.	Oct.
Yellow Sticky Tape	0	1	0	0	0	0	0
Pitfall Traps	0	0	0	0	0	0	0
Cup Traps	0	0	0	0	0	0	0
Grooved Boards	0	0	0	0	0	0	0
Exotior Traps	0	0	0	0	0	0	0
Burlap Sacking	0	0	1	0	0	0	0
Vernon Traps	0	0	0	0	0	0	0

Table 2: Polyhouse Traps: Number of adult black vine weevils caught in 2006 within polyhouses infested from previous year, per date.[1]

Traps	May	June 12	July 04	July 25	Aug. 29	Sept.	Oct.
Yellow Sticky Tape	0	0	0	0	0	0	0
Grooved Boards	0	0	0	0	0	0	0
Exotior Traps H. 12	0	0	0	0	0	0	0
Exotior Traps H. 18	0	0	0	0	0	0	0
Exotior Traps H. 33	0	1	2	1	1	0	0
Burlap Sacking	0	0	0	0	0	0	0

[1]Crops infested in House 33 = *Lysichiton* & *Leptarrhena;* House 12 = *Athyrium* & *Dryopteris* ferns; House 18 = *Cornus nuttallii* & *Gaultheria procumbens.*

Table 3: Perimeter Traps: Number of *Sidona* sp. (tentative I.D.) adult weevils caught in south hedgerow traps opposite Houses #12-16, per date, 2006.

Traps	May 15	June 06	June 20	July 11	Aug. 08	Sept.	Oct.
Yellow Sticky Tape	1	1	1	0	1	0	0
Pitfall Traps	0	0	0	0	0	0	0
Cup Traps	0	0	0	0	0	0	0
Grooved Boards	0	0	0	0	0	0	0
Exotior Traps	0	0	0	2	0	0	0
Burlap Sacking	0	0	0	0	0	0	0
Vernon Traps	0	0	0	0	0	0	0

Conclusions:

The primary weevil species detected in the polyhouses was the black vine weevil, *Otiorhynchyus sulcatus*. Adults of a small, brown weevil, tentatively identified by Dr. Sheila Fitzpatrick, AAFC-PARC, Agassiz as a *Sidona* species was trapped on yellow sticky tape and in the Exotior™ traps, but was not seen in any of the crops. Dr.

Fitzpatrick suspects that larvae of this species may feed on ornamental crops, but the amount of damage it causes is unknown.

Black vine weevil larvae were found in roots of *Cornus nuttallii, Athyrium* and *Dryopteris* ferns, *Hedera helix*, *Euonymus radicans*, *Mahonia aquifolium*, *Lysichiton americanus, Leptarrhena pyrolifolia, Gaultheria procumbens, Gaultheria shallon* and *Rhododendron macrophyllum.* Leaf notching was most visible on *Cornus nuttallii* and *Rhododendron macrophyllum*.

Although the number of adult black vine weevils caught in the traps was far too small to make any definite conclusions about the effectiveness of traps as a monitoring method, there was a coincidence between the adults trapped on yellow sticky tape on June 15 in House 15 and the adult trapped in burlap opposite Houses 15-16 on June 27, and the occurrence of new weevil larvae in September in Houses 15 (in *Hedera helix*) and 16 (in *Dryopteris expansa*). The only other new weevil infestion in 2006 occurred in House 26 (in *Euonymus radicans* and *Mahonia aquifolium*), where no perimeter traps or yellow sticky tape was placed.

None of the traps were effective in detecting adult weevil infestions within already-infested crops. Within infested crops, when adult black vine weevils were already present and observed under container pots during the day, they were not lured out into traps. The Exotior™ trap caught a few adult weevils in only one of the three infested houses, House 33, where the weevils were infesting *Lysichiton americanus* (skunk cabbage) and *Leptarrhena pyrolifolia* (leather-leaved saxifrage); perhaps, in these cases, a few of the adult weevils preferred the apple baited-trap to the host crop.

Burlap sacking appeared to be as good as any method for trapping adult black vine weevils entering the ornamental nursery – one adult black vine weevil was caught in the six perimeter sack traps in June. Burlap was both economical and easy to install and monitor. The EXOTIOR™ traps, at approximately $40 U.S. each plus a $10 "service pack", did not perform better than burlap (only one weevil was caught in an EXOTIOR trap by Dr. Borden much later on July 27). No weevils were observed under grooved boards, or in Unitrap or plastic cup pitfall traps. The yellow sticky tape (6 x 1500' Hopperfinder tape) caught one weevil in June too, at a cost of about 8 cents per foot, but was messy and time-intensive to apply, and had to be changed every two to three weeks.

Starting from the date the first adult weevil was caught and using daily temperature data from the Environment Canada weather station, and allowing three weeks from laying to egg hatch, the date when the first young weevil larvae appeared in a new crop could be predicted within one week, using the 505 degree-day and 6.7 ^{o}C base-line model (Son and Lewis).[4] Mr. Seungho Lee a SFU Co-op student working at Elmhirst Diagnostics & Research has developed an EXCEL worksheet that allows temperature data from the nearest Env. Canada weather station available on the internet to be cut and pasted into EXCEL and degree days calculated automatically from any start date.

Beneficial nematodes (*Heterorhabditis* spp.) are very effective in killing black vine weevil larvae in nursery crops, but most growers apply them in late September or early October, when large larvae are seen and most crop damage has already occurred.

This trial suggests that predatory nematodes should be applied much earlier to weevil-susceptible crops; starting in mid-to late August, with a subsequent application in September to kill late-hatching larvae.

It is recommended that the degree-day model be tested and verified in 2007 at more than one nursey location, using a larger number of burlap traps.

References:

1. DeAngelis, J. D. and G. Garth, 1997. "Root Weevils in the Nursery and Landscape: Identification and Control", EC 1485, January, 1997, Oregon State University Extension Service.
2. Author unidentified. 2000. Root Weevils and their Relatives, HYG-2069-95. "Root Weevils Coleoptera: Curculionidae, Strawberry root weevil *Otiorhynchus ovatus*, Black vine weevil *O. sulcatus*". Modified from Ralph E. Berry. 1998©. Insects and Mites of Economic Importance in the Northwest. 2nd Ed. 221 pp. http://ohioline.osu.edu/hyg-fact/2000/2069.html.
3. Bruck, D. J., J. R. Fisher and D. L. Edwards. 2005. "Monitoring strategies for improving weevil management: results from the first year of a multi-year trial". USDA-Agricultural Research Service, Horticultural Crops Research laboratory, Corvallis, OR, USA, 97330-5098.
4. Son, Y. and E. E. Lewis. 2005. Effects of temperature on the reproductive life history of the black vine weevil, *Otiorhynchus sulcatus*. The Netherlands Entomological Society, *Entomologia Experimentalis et Applicata*: 114:15-24.
5. Borden, J. H., E. Kovacs, A. L. Birmingham, J.-P. Lafontaine and C. Stafford. 2006. "Toward a Lure-Based Trapping System for Root Weevils", Pherotech International Inc., Report submitted to the BC Landscape and Nursery Association, Oct. 13, 2006.
6. Author unidentified. 2004. Integrated Pest Management: "Degree-day Calculation." University of Illinois Extension, University of Illinois at Urbana, U.S.A. http://ipm.uiuc.edu/degreedays/calculation.html

Acknowlegements:

Many thanks to Dr. John Borden and the staff at Pherotech International Inc. in Delta, BC for donating the Vernon Beetle Traps and experimental lures; Dr. Sheila Fitzpatrick, AAFC-PARC, Agassiz for weevil identification and advice on weevil biology; Dr. Jasbir Mann, D. M. Crop Consulting & Diagnostics Ltd. for donating the Unitraps; Rod Nataros and the staff of N.A.T.S. Nursery, particularly Shailesh Patel, IPM manager, who notified us whenever he saw weevils in a crop throughout the summer and provided historical data on weevil infestations and nematode treatments at the nursery; the Simon Fraser University Biology Co-op Work Program through which Jaclyn D'Rozario and Seungho Lee were hired; Chelsey Haselhan, a SFU Co-op student who assisted in setting up and monitoring the traps and sticky tape; and the BC Landscape and Nursery Association and the BC Investment Agriculture Foundation for funding this work.