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Animal and Plant Health Inspection Service

Cooperating State Departments of Agriculture

May 21, 2007

# New Pest Response Guidelines

## Swede Midge

## *Contarinia nasturtii* (Kieffer)

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May 21, 2007

*New Pest Response Guidelines: Swede Midge* Contarinia nasturtii (*Kieffer*) was prepared by Susan E. Ellis, USDA–APHIS–PPQ–PDMP and edited by Patricia S. Michalak, USDA–APHIS–PPQ–Manuals Unit.

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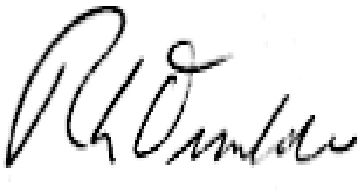

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Swede Midge

# Credits

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# Contents

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# Chapter 1

## *Introduction*

## Purpose

Use *New Pest Response Guidelines: Swede Midge* Contarinia nasturtii *(Kieffer)* as a guide when designing a program to detect, monitor, control, contain, or eradicate an infestation of this pest. If swede midge is detected in the United States, PPQ personnel will produce a site-specific action plan based on this document and the most recent research findings. Personnel of state departments of agriculture, and others concerned with developing local survey or control programs for this pest, should find this document useful.

PPQ developed this report through discussion, consultation, or agreement with staff at Animal and Plant Health Inspection Service (APHIS), Agricultural Research Service (ARS), and with university advisors.

## Pest Status

Swede midge is a pest of crucifers in Canada. In 2004 in Niagara County, NY, surveyors captured adult males in pheromone traps and found larvae on crucifer plants at one farm. In 2005, surveyors in the United States will continue to use pheromone traps to monitor the distribution of swede midge.

## Disclaimers and Document Comprehension

This document is not intended to be complete and exhaustive. It provides a foundation, based on available literature, to assist further work. Some key articles were not available at the time of writing, and not all specialists and members of the research community were consulted for their advice. For the most current information on this pest, consult with local agricultural experts, including personnel from USDA, Cooperative Extension Service, and state departments of agriculture. Conduct your own literature search and review Web sites frequently for updated information.

## Commercial Suppliers or Products

References to commercial suppliers or products should not be construed as an endorsement of the company or product by USDA.

## Contacts

When an emergency program for swede midge has been implemented, its success depends on the cooperation of many groups. The appropriate liaison and information officers should distribute news of program progress and developments to interested groups, including the following:

- Federal, state, county, and municipal agricultural officials
- Grower groups (such as specific commodity or industry groups)
- Commercial establishments
- Academic entities with agricultural interests
- Land-grant universities and Cooperative Extension Service
- State and local law enforcement officials
- Public health agencies
- Foreign agricultural interests
- National, state and local news media
- The public

## Initiating an Emergency Pest Response Program

An emergency pest response program or incident response consists of detection and delimitation, and may be followed by programs in regulation, containment, eradication or control.

If a newly detected exotic or imminent pest threat does not have a current *New Pest Response Guidelines* for reference, the New Pest Advisory Group (NPAG) will evaluate the pest. After assessing the risk to plant health in the United States and consulting with experts and regulatory personnel, NPAG will make a recommendation to PPQ management for a course of action.

Follow this sequence when initiating an emergency pest response program:

1. A new or reintroduced pest is discovered and reported.
2. The pest is examined and pre-identified by regional or area identifier (See "Chapter 3" on page 3-1).
3. Pest identity is confirmed by national taxonomic authority (See "Chapter 1" on page 1-1).
4. *New Pest Response Guidelines* are consulted or NPAG is assembled to evaluate the pest.

5. Depending on the urgency, official notifications are made to the National Plant Board, cooperators, or trading partners.
6. A delimiting survey is conducted at the sight of detection (See "Delimiting Survey" on page 4-4).
7. An Incident Assessment Team may be sent to evaluate the site.
8. Any of the following recommendations are made, based on the assessment of surveys, other data, and recommendations of the Incident Assessment Team and/or an NPAG (See "Regulatory Procedures" on page 5-1):
   - ❖ Take no action
   - ❖ Regulate the pest
   - ❖ Contain the pest
   - ❖ Suppress the pest
   - ❖ Eradicate the pest
9. State Departments of Agriculture are consulted.
10. If appropriate, a control strategy is selected.
11. A PPQ Deputy Administrator authorizes a response.
12. A command post is selected and the Incident Command System is implemented.
13. Further detection surveys are conducted (See "Survey Procedures" on page 4-1).
14. Field identification procedures are standardized (See "Chapter 1" on page 1-1).
15. Data reporting is standardized.
16. Environmental assessments are completed as necessary.
17. Treatment is applied for required pest generational time (See "Chapter 6" on page 6-1).
18. Environmental monitoring is conducted if appropriate.
19. Pest monitoring surveys are conducted to evaluate program success (See "Survey Procedures" on page 4-1).
20. Programs are designed for eradication, containment or long-term control of the pest.

## Support for Decision Making

The USDA–APHIS–PPQ Center for Plant Health, Science and Technology (CPHST) provides technical support to emergency pest response program directors concerning risk assessments, survey methods, control strategies, regulatory treatments, and other aspects of pest response programs.

## Safety

Safety of the public and program personnel has the highest priority. Safety officers and supervisors must enforce on-the-job safety procedures.

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Swede Midge

# Chapter 2

## *Pest Information*

## Classification

Use **Table 2-1** (below) as an aid to classification of swede midge.

**TABLE 2-1 Classification of Swede Midge**

| | |
|---|---|
| **Phylum** | Arthropoda |
| **Class** | Insecta |
| **Order** | Diptera |
| **Family** | Cecidomyiidae |
| **Species** | *Contarinia nasturtii* (Keiffer) |
| **Synonyms (CFIA 2002)** | *C. gallaica* Tavares 1916<br>*C. geisenheyneri* Rübsaamen 1917<br>*C. isatidis* Rübsaamen 1910<br>*C. perniciosa* Rübsaamen 1914<br>*C. pontevedrensis* Tavares 1916<br>*C. torquens* De Meijere 1906<br>*C. tudensis* Tavares 1916<br>*Diplosis nasturtii* Keiffer, 1888<br>*D. ruderalis* Kieffer, 1890 |
| **Common names** | swede midge, cabbage crown gall fly, cabbage gall midge, la cécidomyie du chou-fleur |
| **Related pest** | Hessian fly (*Mayetiola destructor* (Say))—an important pest of wheat |

## History

*Contarinia nasturtii* (Kieffer) is a Eurasian pest of crucifers, especially those grown in clay soil. It has been reported in Austria, Belgium, Czechoslovakia, Denmark, France, Germany, Great Britain, Ireland, Italy, the Netherlands, Norway, Portugal, Sicily, Sweden, and the Ukraine. Recent hot spots for swede midge infestations in Europe were centered in Belgium, Switzerland and areas of Germany (Baur 2004). Major losses were reported in northern Poland, France, Slovakia, the Netherlands, and other areas of Germany (Baur 2004). Minor losses occurred in Norway and Denmark (Baur 2004). Periodic outbreaks of swede midge in Great Britain have resulted in extensive damage to crucifers and rutabagas [swedes] (USDA 1962).

### Canada

In 2000, University of Guelph researchers discovered this pest was the cause of damage to broccoli crops in Ontario. Although losses had been observed since 1994, they were erroneously attributed to a deficiency of the nutrient molybdenum.

In 2001, the researchers surveyed cruciferous crops by supplying farmers in Quebec and Ontario with sticky cards. Farmers installed the cards in fields of crucifers, then returned the cards with specimens of the exotic swede midge (Friedlander 2003). Swede midge was found in nine municipalities in Ontario and one municipality in Québec.

Since 2001, intensive surveying has shown that swede midge is a pest in twelve Ontario municipalities and one Québec municipality (Pitblado et al. 2004). In 2004, broccoli farmers experienced yield losses of 85% due to swede midge damage.

Control measures were implemented by the Canadian Food Inspection Agency in 2002 (CFI 2002) and included the following:

- Quarantine on the infested areas in Ontario and Québec
- Restrictions on the movement of *Brassica* spp. plants out of the quarantine areas
- Swede midge certification program for growers
- Delimiting surveys in Ontario and Québec
- Detection surveys in other areas in Canada

### United States

In the United States, swede midge was detected in Niagara County, New York, in 2004. Surveyors captured adult males in pheromone traps and found larvae on crucifer plants at one farm. In 2005, surveyors will continue to use pheromone traps to monitor the distribution of swede midge.

## Damage to Host

Swede midge damage mimics common physiological and nutritional problems found in crucifers, including molybdenum deficiency, herbicide injury, genetic variability of seed, heat stress and frost damage (Callow and Fraser 2002). For example, nicking young plants while cultivating can result in multiple heads and the formation of scar tissue on crucifer stalks that resembles swede midge damage.

Plant feeding by flea beetles and tarnished plant bug can leave similar scar tissue and damage to growth points. In response to swede midge damage, flower buds may fail to open and may swell. The main stem may become deformed to the extent of forming an extra stem. Seedlings are unmarketable and will fail to produce a marketable head. If infested in the early stages of development, yield is severely reduced. Blind head, twisted shoots, galls and brown, corky scars are common symptoms of damage.

## Blind Head

Disrupted growth of the tissue at the terminal growing point is a typical symptom of infested broccoli or cauliflower plants (Figure 2-1 and Figure 2-2 below).

**FIGURE 2-1 Blind Head Symptom with Secondary Bacterial Infection on Cabbage; Courtesy of Ontario Ministry of Agriculture and Food**

**FIGURE 2-2 Blind Head Symptom on Broccoli; Courtesy of Ontario Ministry of Agriculture and Food**

## Twisted Shoots

Immature shoots may be twisted, swollen or otherwise distorted (Figure 2-3 and Figure 2-4 below).

**FIGURE 2-3 Twisted Shoot Symptom on *Brassica* spp.; Courtesy of Kim Riley, University of Guelph**

**FIGURE 2-4 Heart Leaves of Cabbage may be Crumpled and Exhibit a "Drawstring Effect;" Courtesy of Ontario Ministry of Agriculture and Food**

## Galls

Galls may form on plant stems in response to feeding by larvae (Figure 2-5 below).

**FIGURE 2-5 Gall Caused by Feeding of Swede Midge Larvae Inside Stem; Courtesy of Ontario Ministry of Agriculture**

### Brown, Corky Scars

As plants grow, tissue damaged by larvae becomes brown and corky (Figure 2-6 below).

**FIGURE 2-6 Brown, Corky Scarring on Broccoli Caused by Larval Feeding**

## Economic Impact and Host Range

In Canada, swede midge damage has accounted for up to 85% loss in market yield of Ontario cole crops. In some areas of Europe, swede midge infestations may account for 100% loss in a grower's crop, despite treatment with insecticides (Baur 2004). Agricultural scientists at Cornell University estimate that the state of New York, which leads the United States in production of cabbage, could lose a major portion of their $87 million annual crop in addition to the state's $6 million yield in non-cabbage cruciferous crops, should the swede midge become established there (Friedlander 2003).

Swede midge is a pest of all cruciferous crops. In addition, the following weeds may be alternate hosts when cultivated crucifers are unavailable:

- Wild mustard (*Brassica* spp.)
- Wild radish (*Raphanus raphanistrum* L.)
- Shepherd's-purse (*Capsella bursa-pastoris* (L.) Medik.)
- Stinkweed
- Field peppergrass (*Lepidium campestre* (L.) R. Br.)
- Yellow rocket (*Barbarea vulgaris* R. Br.)

- Dog mustard (*Erucastrum gallicum* (Willd.) O. E. Schulz)

## Ecological Range

The swede midge may be capable of becoming established in USDA zones 4-8 (Figure 2-7 below).

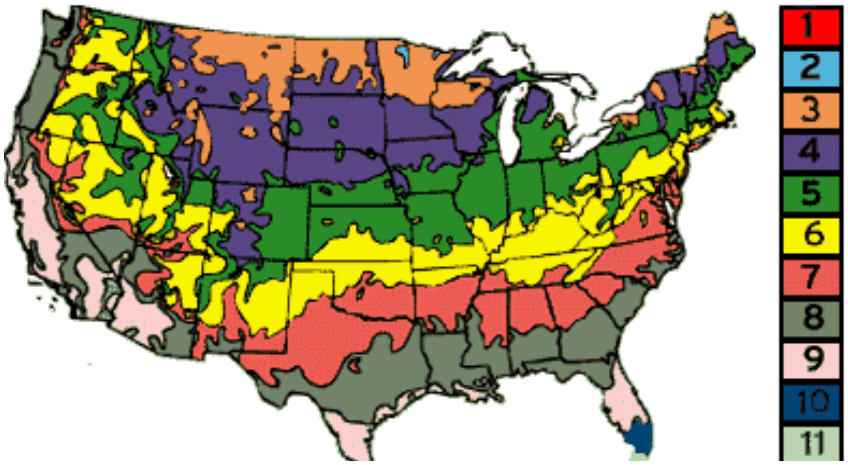


**FIGURE 2-7 USDA Plant Hardiness Zone Map**

## Life Cycle

The life cycle of the Swede midge includes egg, larval [maggot], pupal and adult [midge] stages (Figure 2-8 next page). Swede midge may produce three to five overlapping generations each year in Ontario

(Callow 2004; Hallet et al. 2001). First generation adults emerge in the second or third week of May; males may appear in pheromone traps earlier (Callow, pers.comm.).

The females of the second generation seek the first suitable plant on which to lay eggs. They are not strong fliers. Adults may live three or four days, making control of this life stage problematic.

Pre-pupae of the last generation of the season over-winter in their cocoons in the soil until the following spring when pupation resumes; some may overwinter a second season before emergence.

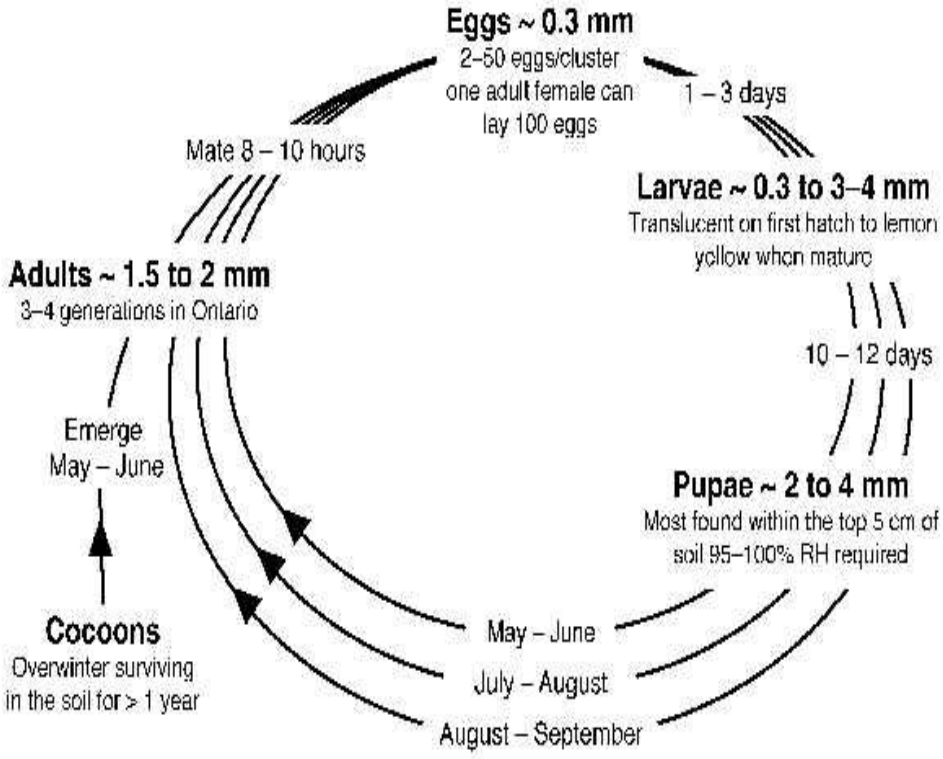


**FIGURE 2-8 Life Cycle of Swede Midge; Courtesy of Callow and Fraser (April 2003)**

## Eggs

Each female lays approximately 100 eggs in clusters or strings of approximately 15-20 eggs each on leaves or leaf stalks. Eggs hatch in about three days (**Figure 2-9** next page). With favorable temperatures and high humidity, eggs hatch within a few days (Readshaw 1965).

Diapause of eggs is unknown (Gagné 1989).

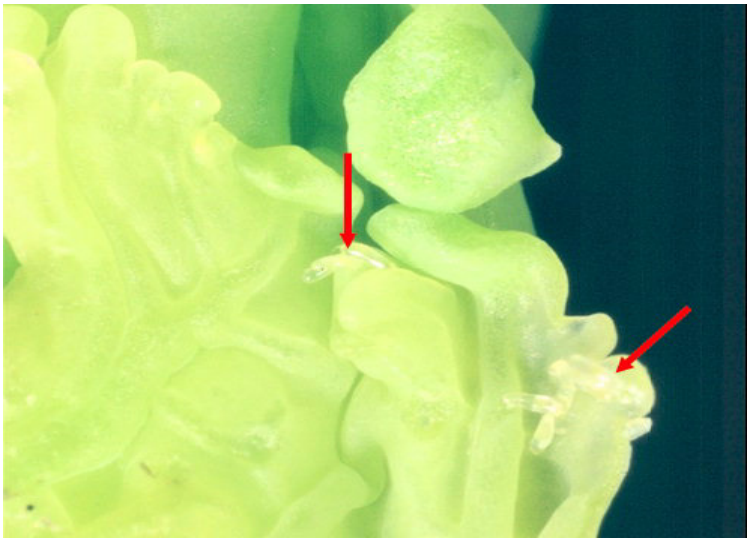

**FIGURE 2-9 Eggs of Swede Midge; Courtesy of Klaus Schrameyer, ALLB, Heilbronn**

## Larvae and Pupae

NOTICE

Temperatures discussed below are from European studies; in the United States, use only as a rough guideline for development. The Ontario Ministry of Agriculture and University of Guelph are currently evaluating the developmental responses of swede midge to temperature and humidity in North America.

Larvae (Figure 2-10 next page) require high humidity, adequate temperatures, protection from the elements, and abundant food. Rate of development depends on temperature. Readshaw (1965) found accelerated development of larvae when reared in vitro at constant temperatures of 20$^0$C/<15 days, and 25$^0$C/<10 days. Larvae reared in the field, with temperatures fluctuating between 15$^0$C and 20$^0$C, required between 15-20 days for development.

Upon hatching, larvae immediately begin feeding on the tender growing points of the host plant. Activity of larvae is highly dependent on adequate moisture. Larvae undergo a short dormancy in response to drought, resuming growth after a rainfall (Readshaw 1966). Irrigation may produce the same effect as rainfall.

Newly-hatched larvae submerge themselves in a watery environment of liquefied plant cells, salivary and excretory fluids. They probably produce bactericides and fungicides, since galls occupied by these larvae are free of such pathogens (Gagné 1965). Within three weeks—moisture and temperature permitting—the fully developed larvae drop to the ground, and spin cocoons in the upper five cm of the soil.

Larvae are gregarious when feeding, and grow rapidly under warm, moist conditions (Readshaw 1965). When mature, they flip to the ground, burrow into the soil and pupate or diapause (Readshaw 1961). Larvae spend approximately two days constructing their cocoons. Shape of cocoons varies. Larvae pupate in oval cocoons and diapause in spherical cocoons. Whether or not the larvae enter diapause depends on the seasonal effects of temperature, humidity, and especially, on day length (Readshaw 1965). Larvae may enter a moisture-dependent state of short-term dormancy or "quiescence" when pupating. Unlike diapause, moisture-deprivation is the sole reason for this delay in development (Readshaw 1965). Larvae can diapause for up to two years if conditions are unfavorable (Callow 20 2003).

**FIGURE 2-10 Mature Larvae of Swede Midge (at arrows); Courtesy of Ontario Ministry of Agriculture**

Temperature is a leading factor in the duration of the pupal phase. At $30^0$C, pupation may require between 5-10 days. At $10^0$C, pupation may require nearly 35 days (Readshaw 1965). Pupal development slows below $20^0$C.

If soil conditions in the top five cm of the soil are not sufficiently moist and warm, larvae may emerge from their cocoons and burrow up to 10-15 cm deeper into the soil. These larvae spin new, specialized cocoons and await more favorable conditions. When conditions improve, larvae move back up to the top five cm to complete the life cycle and emerge as adults. Larvae may diapause, or assume a quiescent state, in this way for two or more years (Readshaw 1966).

## Adults

Adults take flight as soon as their wings dry after emerging from soil (Figure 2-11). Males mate with virgin females who are at least 8 hours old. Females typically mate once (Gagné 1989). Males may mate with more than one female.

Adult swede midges live for three to four days (Fraser 2004). Adult males live for one or two days in natural conditions, although they can survive a few days longer in laboratory conditions; females die soon after they complete oviposition (Gagné 1989).

**FIGURE 2-11 Adult Swede Midge; Courtesy of Klaus Schrameyer, ALLB, Heibronn**

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Swede Midge

# Chapter 3

## *Identification*

## Importance

Accurate identification of the pest is pivotal to assessing its potential risk, developing a survey strategy, and determining the level and manner of control.

## Authorities

Qualified local personnel may perform pre-identification and screening of suspected swede midge specimens. Before survey and control activities are initiated in the United States, a USDA–APHIS–PPQ–National Identification Service (NIS)-recognized authority must verify the first detection of this pest.

For verification, contact NIS personnel at the following address:

Systematic Entomology Laboratory, USDA
U. S. National Museum of Natural History
Washington, DC. 20560-0168

## Pre-identification

Cecidomyiids are small flies (**Figure 3-12** and **Figure 3-13** below) with the following characters:

- Long, filiform antennae
- Reduced wing venation, and
- First tarsal segment much smaller than following segments

Host plant association is the only practical diagnostic tool in the field. Collect and process all small flies associated with known host plants if they resemble swede midge. Watch for small flies clinging to, hovering nearby, or laying eggs on known host plants. For information on processing midges, See "Processing Specimens" on page 3-7.

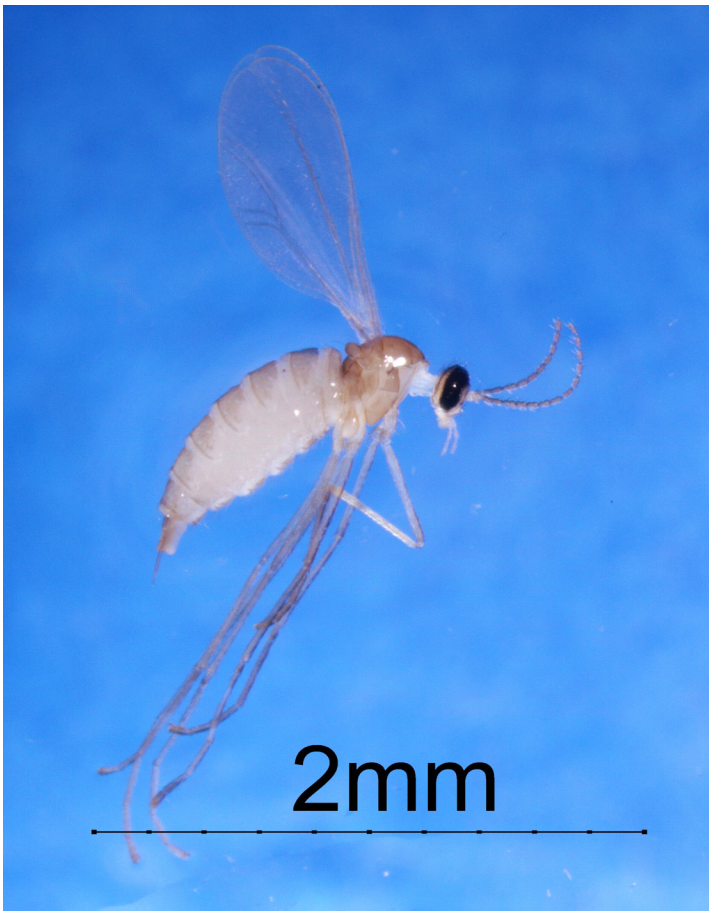


**FIGURE 3-12 Adult Stage of Female Swede Midge**


**FIGURE 3-13 Adult Stage of Male Swede Midge**

## Microscopic Identification

### Eggs

Use the following characters to identify eggs:

- Color is white.
- Size is 0.27 mm by 0.08 mm with a 0.06 pedicel (ARS).
- Batch size is 2-50 eggs (Readshaw 1965).

### Larvae

Use the following characters to identify first and second instar larvae:

- Legs are absent.
- Color is translucent (Gagné, pers. comm.).
- Length is between 0.3 mm to 4 mm.

Use the following characters to identify third (last) instar larvae:

- Color is pale lemon (Gagné, pers. comm.).
- Body length is 3-4 mm at maturity.

- During the last instar, larvae possess a sclerite—the sternal spatula—on the ventral side of the prothorax (Borror, et al. 1989) (Figure 3-14 and Figure 3-15 below).
- Third instar larvae are capable of jumping (ARS 1962).

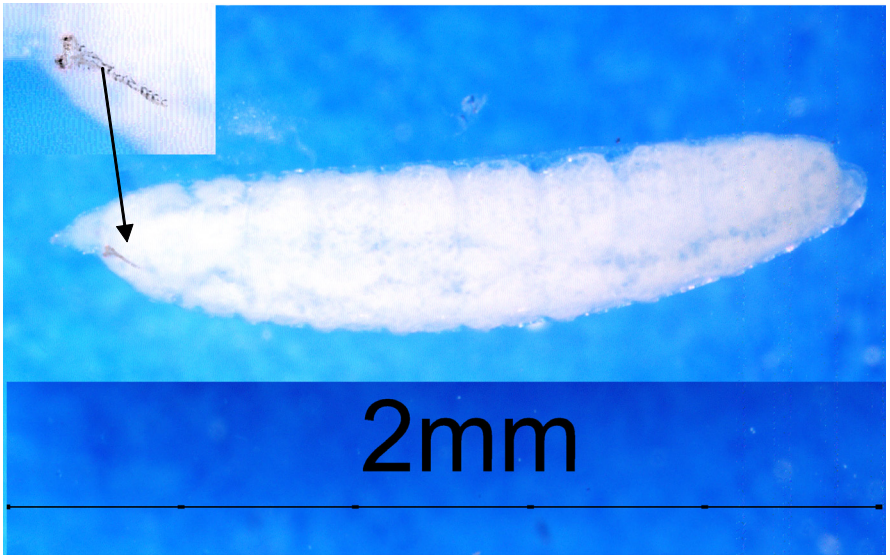


**FIGURE 3-14 Larva of Swede Midge; Sternal Spatula is Enhanced**

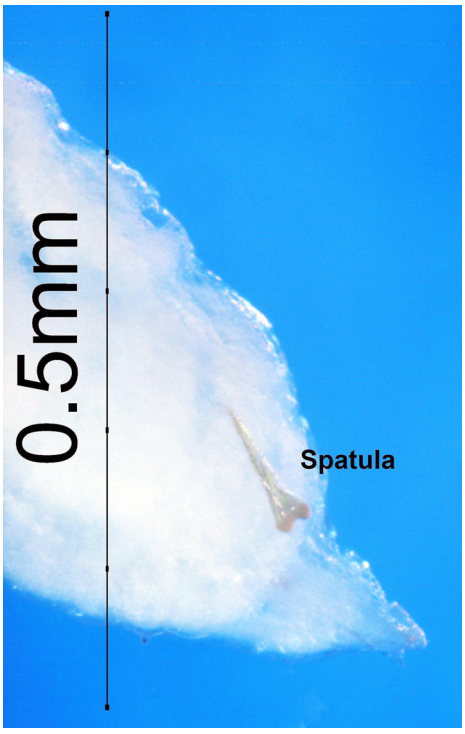


**FIGURE 3-15 Larval Stage of Swede Midge With Sternal Spatula**

## Pupae

Pupation takes place in an ovoid, silken cocoon 2 inches deep in soil near the host plant (Gagné 1989).

## Adults

Wing venation is a useful diagnostic tool for cecidomyiid flies; however, flies on sticky traps may be too damaged to identify correctly.

Use the following characters to identify adults:

- Wing venation is reduced (Figure 3-16 below).
  - Cross veins are absent.
  - Radial vein is straight or nearly so.
  - Cubital fork is present in middle third of wing.
- Antennae are long, filiform.
- Female antennal segments are cylindrical (Figure 3-17 below).
- Male antennae with 12 flagellum ears; each is divided into two separate nodes surrounded by a threadlike looped sensillum (Figure 3-18 below).
- First tarsal segment is much smaller than following segments (Figure 3-19 below).
- Mouthparts are haustellate, usually with a four-segmented palpus.

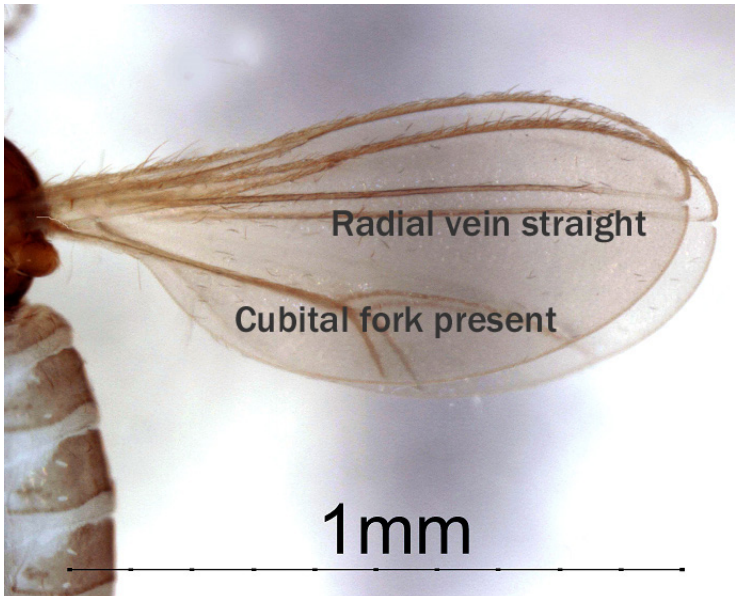


**FIGURE 3-16 Reduced Wing Venation Character of Swede Midge**

**FIGURE 3-17 Detail of antennae of female swede midge**


**FIGURE 3-18 Detail of antennae of male swede midge**

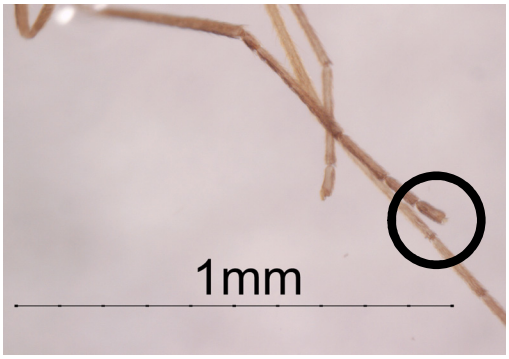


**FIGURE 3-19 Detail of first tarsal segment of swede midge**

## DNA Sequencing

DNA sequencing is a new method of identifying insects. According to Frey et al. (2004), DNA sequencing is a reliable method for identifying both European and North American swede midge, particularly if samples were collected from pheromone traps in areas where host plants are present. Working at Cornell University, Dr. Ping Wang and Anthony Shelton have refined this technique to rapidly identify swede midge adults (Shelton, pers. comm.).

## Similar Species

There are approximately 400 *Contarinia* spp. worldwide (Gagné 1989). Approximately 1,200 species in the family Cecidomyiidae reside in North America, with at least 59 *Contarinia* spp. described (Gagné 1989). Because many cecidomyiids are not yet described, this number is probably an underestimate (Gagné 1989). Most are host specific, and this may be the best way to perform an initial identification. The National Specialist must separate a *Contarinia nasturtii* specimen from other *Contarinia* spp. by comparative examination of its genitalia.

## Processing Specimens

### Labeling

Label samples with the following information:

- Location
- Host
- Date of sampling

- Survey method used to obtain the sample
- Name of sampler
- Temperature and habitat

## Collecting

### Larvae

Use three techniques to force larvae from plant tissue:

- Immerse swollen flower buds or other tissue in 70% alcohol.
- Place plant tissue into plastic bags in sunlight.
- Examine plant tissue microscopically.

## Rearing

Adult specimens that were raised from eggs or larvae are easier to identify, compared with specimens collected from sticky traps. Consult with identifiers for instructions on artificially rearing insects. Facilities must meet the security standards for rearing of quarantined insects.

### Pupae

Rear pupae in a warm, moist environment and collect the adults that emerge. Pupae may also be submitted for identification.

## Preserving

### Larvae

Preserve larvae in 70% ethanol. Transfer larvae to fresh alcohol after several days.

### Adults

Sacrifice reared or captured adults by freezing.

## Shipping

Double-box and ship the specimens with at least 2 inches of padding around the sample (See "Processing Specimens" on page 9-2). Identification may be confirmed by digital images.

Include PPQ Form 391 (Specimens for Determination) (See "PPQ Form 391" on page A-1) marked **Urgent**. See the Airport Maritime Operations Manual for instructions on completing the form.

Send samples to the following address:

Leader, Taxonomic Services Unit
USDA, ARS, BA, PSI
Building 046, Room 101A
BARC-EAST Beltsville, MD 20705-2350

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Swede Midge

# Chapter 4

## *Survey Procedures*

## Introduction

The purpose of a survey is to determine the extent and means of pest spread. Surveys are also used to assess the effectiveness of treatments.

Pheromone trapping and visual inspection of plants are the best tools to use when searching for swede midge. Survey for adult and larval swede midge any time during the growing season while plants are actively growing. Survey for pupae in the soil during inactive periods.

Before initiating survey and control activities in the United States, a national authority recognized by USDA–APHIS–PPQ–National Identification Service must verify the identity of this pest (See "Authorities" on page 3-1).

There are three methods available to survey for swede midge, as follows:

- Detection survey
- Monitoring survey
- Delimiting survey

To determine which method to use, see Table 4-1 below.

**TABLE 4-1 Decision Table for Selecting Method of Survey**

| IF: | THEN use this method of survey: |
|---|---|
| You are uncertain that the pest is present OR<br>You have applied a control and need to measure its effectiveness | **Detection or monitoring survey (see Detection Survey and Monitoring Survey below).** Use visual inspection, sweep net sampling, and/or traps to capture specimens. Place traps or inspect plants at suspect locations. Submit suspect specimens to a specialist to confirm your identification. |
| You know the pest is present and you need to define its geographic location | **Delimiting survey (see Delimiting Survey below).** Use traps at specific locations and densities to capture specimens according to the plan outlined below. Submit suspect specimens to a specialist to confirm your identification. |

## Detection Survey

Use a detection survey to detect the presence of the pest. Conduct a detection survey by using a combination of survey tools, including pheromone trapping ("Trapping" on **page 4-7**), visual inspection of plants ("Visual Inspection" on **page 4-5**), or sweep net sampling of vegetation ("Sweep Netting" on **page 4-7**).

Positive results indicate that the pest is present. Negative results are valuable clues to pest movement, particularly when considered with positive trapping results from similar areas. Once you have detected the pest in an area, conduct a traceback investigation to determine the source of the investigation.

### Cooperative Agricultural Pest Survey Protocols

USDA–APHIS–Cooperative Agricultural Pest Survey (CAPS) (USDA 2005) committee has recommended the following detection survey protocols:

#### Survey Intensity

Twice each year, inspect host plants on farms in the detection survey area where cole crops are grown commercially. The first field inspection should coincide with feeding by first generation larvae. In areas adjacent to Ontario, where five generations of swede midge may overlap, best times to inspect are in early July and early to mid-August.

As the geographic survey area progresses south, adjustments must be made for temperature, moisture, and humidity. Use emergence traps or pheromone traps to detect emergence of adults. Damage to plants is apparent after larvae have been feeding for 4-5 days.

#### Block Priorities

Scout blocks in the following prioritized order:

1. Those in which a grower has noted damage.
2. Continuous cole crops (unrotated).
3. Border blocks (e.g., hedgerows, forest edges, next to buildings).
4. Plants 8 inches (20 cm) tall [or 14-leaf stage].

#### Symptoms

Look for the following symptoms of swede midge damage:

- Swollen or closed buds
- Crinkled central leaves
- Swollen, distorted shoots or leaf stalks
- Dead main shoot
- Development of secondary shoots

- Brown scarring (especially at petioles and stems where head originates)
- Rot in damaged areas
- In plants showing any of the above, yellowish larvae, no greater than 2—3 mm long

As swede midge population density increases, control becomes more difficult. In late-season crucifer plantings, scouting for damage symptoms and larvae should begin immediately.

### Cooperative Agricultural Pest Survey Sample Preparation

USDA–APHIS–Cooperative Agricultural Pest Survey committee (USDA 2005) has recommended the following procedures for collecting plant samples:

- Cut off young, developing primary or secondary shoots (axillary buds) that show damage.
- Select plants that are representative of the symptoms in the block, including all areas of the block (beyond stop points).
- Include all damaged plants reported by growers, even if not in the sample block.
- Include damaged plants that are growing in edge areas.
- Carefully place all shoots (without crushing tissue) from a single plot into a plastic resealable bag; hold samples at ambient temperature to encourage larvae to exit tissue.
- Use a soft bristle brush to transfer suspect larvae from plants to vials; add a small piece of host tissue and a few drops of water to prevent desiccation.
- Use a dissecting microscope to examine samples.
- Store samples in a refrigerator or cold room before shipping to identifier.
- Ship samples with ice packs; pack samples and ice separately.

## Monitoring Survey

Use a monitoring survey to evaluate the effectiveness of an action taken to contain, suppress or eradicate the pest. Use the same survey tools as used for detection and delimiting surveys.

## Delimiting Survey

Once you have detected the pest, use a delimiting survey to facilitate containment, suppression or eradication. Use the delimiting survey decision table (Table 4-2 below) and the sampling scheme (Figure 4-1 below) as guidelines when conducting a delimiting survey. You must tailor actual trap placement to local environments and distribution of the host.

**TABLE 4-2 Delimiting Survey Decision Table for Swede Midge**

| IF you find: | IN an area that is: | THEN take this action: | AND supplement with: |
|---|---|---|---|
| One or more adults | Apparently in the original infestation site | Initiate delimiting survey in 1 square mile area | |
| One or more any stage | Within a 1 square mile area | Extend delimiting survey to 9 square miles by adding 1 square mile blocks around original area | Visual survey of 100 hosts per square mile in the 9 square mile area |
| | Within a 6 square mile area | Extend delimiting survey to 25 square miles by extending survey area by 1 square mile blocks around 9 square mile area | Visual survey of 100 hosts per square mile in the 25 square mile area |

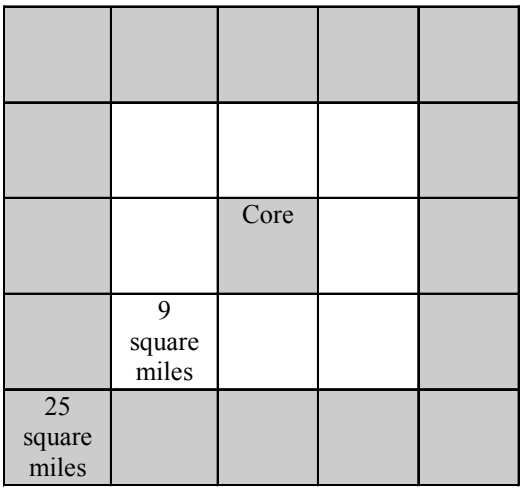


**FIGURE 4-1 Sampling scheme for swede midge**

## Traceback Investigation

Use a traceback investigation to locate the source of an introduction after swede midge has been detected. Traceback investigations help to determine if an isolated detection is spurious—for example, the midge was conveyed into an area by air currents—or if it is evidence of an established population. Typically, if a single adult midge is found in an area far removed from a port of entry, it is likely that it was transported to the site. The same is true for isolated detections during cool seasons.

Traceback investigations on commodities such as crucifer transplants involve examining commercial records, such as bills of sale, to determine the origin and route the potential host traveled. Infested seeds or commodities are not likely routes for transmission of the swede midge. Seedlings for transplant present the most significant risk, and growers' lots of seedlings can be traced back to route and origin through bills of lading and bills of sale.

Environmental traceback investigations involve examining wind field maps to plot the possible trajectories of the midge. Swede midges are weak fliers; however, it is possible that a swede midge could survive a wind-borne journey.

Computer generated atmospheric trajectory analyses are available to help identify potential sources of infestation and to trace the probable movement of plant pests with air masses. One such program is the Branching Atmospheric Trajectory (BAT) available from the National Climatic Center (See "Local Climate" on page 9-3).

## Survey Tools

Use the following tools, singly or combined, when surveying for swede midge.

### Visual Inspection

Inspect plants at equally spaced locations, unless damaged areas are noted (Figure 4-2 on page 4-6). Concentrate your search at field edges and areas sheltered from brisk air movement, since these areas are favored by the swede midge. Plants with deformed, yellowed or crinkled leaves; blind or double heads; erratic growth patterns; or exhibiting poor growth should receive priority in the survey.

At each sample location, inspect at least 10 plants from three adjoining rows (or at equivalent distances apart). Collect eggs and larvae with sufficient host material for rearing purposes, if necessary.

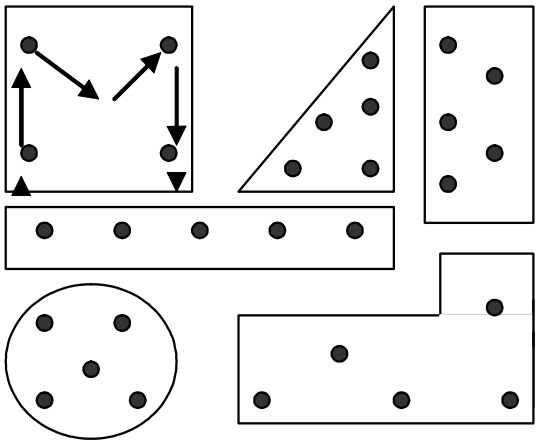

**FIGURE 4-2 Sampling Pattern for Visual Inspection of Plants**

Blind heads (Figure 2-1 on page 2-3), twisted shoots (Figure 2-3 on page 2-4), galls (Figure 2-5 on page 2-5) and brown, corky scars (Figure 2-6 on page 2-5) are common signs of damage. Look for translucent streaks or windows in the leaves, created by larvae as they mine leaves and feed on the dermal tissue.

In addition to the in-field survey, check borders, fencerows, and ditch banks for suitable wild or weedy hosts. If hosts are found, conduct a separate survey, particularly if it is in the core area.

Follow a similar sampling pattern for each field.

## Eggs

Due to their small size and translucence, microscopic examination of tissue-bearing eggs is necessary to detect eggs (Callow, pers.com.).

## Larvae

Nearly all larval instars are detectable by visual inspection of plants. Check actively-growing leaves for feeding signs and groups of young larvae. Infested leaves may appear to have rotted areas, since the larvae produce secretions that break down cellular tissue. Brown, corky scarring is the most definitive sign of feeding by swede midge larvae. Collect larvae by breaking off galled or distorted portions of plants and examining the tissue with a hand lens. If larvae are not readily found by visual inspection, immerse plant tissue in alcohol and agitate; larvae will quickly exit.

## Pupae

Find pupae by sieving soil collected from the top two inches beneath host plants.

**Adults**

Find adults in sheltered areas with little air movement, such as at field edges or near buildings. Use a sweep net or aspirator to collect specimens.

## Trapping

**Pheromone**

The pheromone trap is the best tool for detecting emergence of adults (Goodfellow 2004). Swedish and Swiss entomologists (Baur 2004) developed and tested a synthetic pheromone to trap male swede midges. The pheromone is available commercially as a lure in a Delta-style trap (See "Pest Management Supplies" on page 9-1). Suspend traps from stakes at a height of approximately 30 cm above the soil. The detection of males in pheromone traps must be followed-up with a visual survey to determine the presence of a viable population. For confirmation, look for larvae in tissue or adult females flying within the plant canopy.

**Light**

Researchers at the Ontario Ministry of Agriculture and Food developed an emergence trap that features a UV light and a sticky card positioned inside (Callow 2004) (Figure 4-3 below). The trap detects the emergence of swede midge adults from soil, while screening out large insects that might damage the midge specimens. Efficiency of the trap is unknown.

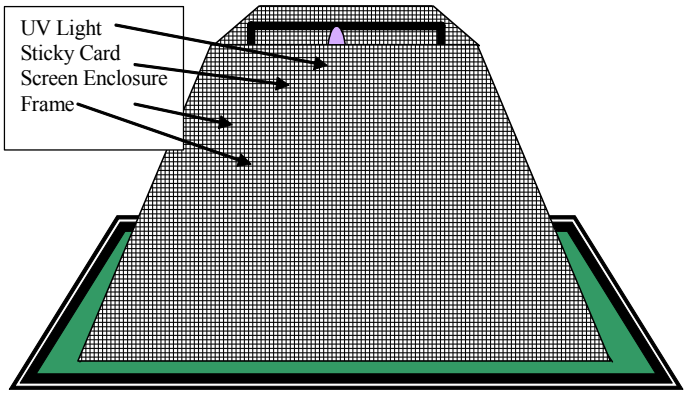


**FIGURE 4-3 Schematic of Light Trap Developed by Ontario Ministry of Agriculture and Food (Callow 2004)**

## Sweep Netting

Sweep net sampling may be a useful method for collecting large, late-instar larvae from the undersides of leaves. When disturbed, late-instar larvae will jump off the plant to the soil. Smaller larvae are imbedded in the galled tissue and difficult to collect using a sweep net. Since midges are easily broken, using an aspirator to collect adults directly into vials may yield better results. Perform sweeping in tandem with a visual survey, if necessary.

If sweeping for adults, great care is essential for capturing useful specimens. Adults are more likely to fly low to the ground than amid the canopies, so sweeping between the rows may yield more specimens. Adults are active at dawn and dusk and on cloudy, calm days. Sweeping around areas protected from air movement—such as near buildings, tree breaks, and hedgerows—will produce the best yield.

Rapid movement of the net in a long series of sweeps—a typical sample unit is 25 sweeps—is most effective. When sweeping foliage for larvae, lightly graze the surfaces of the leaves. When performing aerial sweeps for adults, move the net (with the mouth of the net at the leading edge), in a horizontal "figure-8" path, passing the handle from hand to hand at the body mid-point during the downstroke.

### Soil Survey


Soil samples collected from a regulated area require certification prior to removal from the area.

Use a soil survey to locate larvae and pupae in the soil. Swede midge larvae "jump" to the soil to pupate in cocoons, typically within the first 2-inches of soil beneath the host.

Take a minimum of four, 20-square inch, 2-inch deep samples of soil from under the host. You can use a golf-hole borer, soil corer, or an open-ended metal tube to obtain a sample. Place samples in containers and label them before transporting to the laboratory.

Place each soil sample into a 0.15-inch (4 mm) sieve and wash with water until all the lumps are broken and only solid objects remain in the sieve. Remove any solid objects; collect and hold larvae and pupae until emergence.

## Host Collection

Rear eggs and first to third instar larvae on host material to provide intact adults (i.e., undamaged by trap adhesives) for positive identification. Store hosts at the temperature and humidity that permit insect development to the adult stage. The rearing facility must meet the security standards for Biosecurity Level 3 quarantine insect-rearing facilities.

## Sentinel Plants

Plant cauliflower or Brussels sprouts as sentinel plants. Symptoms are more apparent on these crops, compared to deeply pigmented broccoli and cabbage (Baur 2004). The Ontario Ministry of Agriculture has found that Brussels sprouts tend to exhibit symptom of swede midge infestation more readily than cauliflower (Callow, pers. comm.).

## Orientation of Personnel

Experienced personnel will train their replacements. A training period of three working days should be sufficient for training.

## Records

Survey records and data recording formats should be standardized. Maintain survey records, noting the areas surveyed, sites trapped, dates, locations, and hosts.

Enter all data into the database of the National Agricultural Pest Information System (NAPIS).

5

Swede Midge

# Chapter 5

## *Regulatory Procedures*

## Instructions to Officers

Officers must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Comprehension is essential when explaining procedures to persons interested in moving articles affected by the quarantine and regulations. Only authorized treatments may be used in accordance with labeling restrictions.

Find instructions for regulatory treatments in the PPQ Treatment Manual.

## Issuing an Emergency Action Notification

An Emergency Action Notification may be issued pending positive identification and/or further instruction from the USDA–APHIS–PPQ Deputy Administrator.

If necessary, the Deputy Administrator will issue a letter directing PPQ field offices to initiate specific emergency action under the Plant Protection Act until emergency regulations can be published in the *Federal Register.*

The Plant Protection Act of 2000 provides for authority for emergency quarantine action. This provision is for interstate regulatory action only; intrastate regulatory action is provided under state authority. However, if the U.S. Secretary of Agriculture determines that an extraordinary emergency exists and that the measures taken by the state are inadequate, USDA can take intrastate regulatory action provided that the governor of the state has been consulted and a notice has been published in the *Federal Register.* If intrastate action cannot or will not be taken by a state, the PPQ may find it necessary to quarantine an entire state.

PPQ works in conjunction with state departments of agriculture to conduct surveys, enforce regulations, and take control actions. PPQ employees must have permission of the property owner before accessing private property. Under certain situations during a declared extraordinary emergency or if a warrant is obtained, PPQ can enter upon private property in the absence of owner permission. PPQ prefers works with the state to facilitate access when permission is denied, however each state government has varying authorities regarding accessing private property. A General Memorandum of Understanding

(MOU) exists between PPQ and each state that specifies various areas where PPQ and the state department of agriculture cooperate. For clarification, check with your State Plant Health Director (SPHD) or State Plant Regulatory Official (SPRO) in the affected state.

## Regulated Articles

Some regulated articles may present a risk of dissemination of swede midge. Persons in control or possession of the articles must be notified that the following articles are regulated:

- Cole crops in the regulated area
- Soil from within the drip area of host plants, regardless of the presence of a viable plant
- Transplants or seedlings for propagation of host plants
- Agricultural machinery that has been used in the cultivation or management of host crops
- Any other product, article, or means of conveyance of any type when an inspector determines that it presents a hazard of spread of the swede midge

## Quarantine Actions

Regulatory action may be required under the following circumstances:

- More than one adult fly is found in an area less than 100 square km within one estimated life cycle; **or**
- One mated female, or a larva, or a pupa are detected; **or**
- A single adult fly is detected that is determined to be associated with a current eradication project.

## Regulated Establishments

Field personnel will attempt to detect the pest within the regulated area at all establishments where regulated articles are sold, grown, handled, moved, or processed, including the following:

- Airports
- Ports of entry from Canada to the United States
- Landfill sites
- Processing plants

- Farmers' associations
- Produce and flea markets
- Nurseries
- Flower shops
- Establishments that handle regulated articles

Surveys may be set up at establishments deemed to be at risk by project personnel. Black light traps at establishments are set and serviced by survey personnel. Service traps weekly if catches of insects are high, or biweekly if trap catches are low. Replace black light traps with pheromone traps as the newer technology is developed.

## Application of Recommended Insecticides

The PPQ Treatment Manual and this document identify authorized insecticides, and describe methods, rates of application, and special application instructions ("Chapter 6" on **page 6-1**). Concurrence by PPQ is necessary before using any other pesticide or procedure for regulatory purposes.

## Approved Treatments for Regulatory Articles

Approved regulatory treatments for this pest are selected by program management and/or a Technical Advisory Committee in conjunction with the Center for Plant Health, Science, and Technology (CPHST). Find directions for utilizing the treatments in the **PPQ Treatment Manual**. Apply the following approved treatments before removing regulated articles from a quarantine area:

**Fumigation—**Application of an approved fumigant to destroyed hosts or soil as a treatment

**Sanitation—**Removal and destruction of leaves, flowers, stems, stalks, rotting tissue, vegetables, and other host material ("Host Destruction" on **page 6-4**)

**Insecticide treatment—**An approved treatment applied to above ground parts of hosts ("Application of Recommended Insecticides" on **page 6-5**)

**Soil Treatment—**An approved insecticide applied to the soil within the drip line of host plants; hold plants for one life cycle after treatment before certifying for movement

## Principal Activities

The degree of regulatory activity required depends, among many other factors, on the degree of the infestation. For example, safeguarding of stands throughout the regulated area may not be necessary if they are engaged in local retail activity only and the infestation is limited.

Principle activities for conducting a regulatory program to contain the swede midge include the following:

- Advise regulated industry(ies) of required treatment procedures.
- Supervise, monitor, and certify commodity treatments of commercial lots of regulated articles.
- Make regulatory visits as appropriate to the following:
  - Security and airline personnel
  - Vegetable stands
  - Local growers, packers, and processing plants
  - Farmer's associations, produce markets, and flea markets
  - Commercial haulers of regulated articles
  - Public transportation
  - Post offices
- Visit processing establishments.
- Monitor the movement of waste material to and from landfills to ensure adequate disposal of regulated articles.
- Monitor the movement of regulated articles through major airports and other transportation centers.
- Observe major highways and quarantine boundaries for movement of host materials.

## Removing Areas from Quarantine

Project managers will remove areas from quarantine requirements if the swede midge is declared eradicated. Eradication is assumed when sufficient time, equal to three seasons, has passed since the last specimen recovery. At minimum, two years must elapse after control activities have ceased. APHIS will publish a Notice of Quarantine Revocation in the *Federal Register* when areas are removed from quarantine requirements.

## Orientation of Personnel

Initially, program personnel will be limited to those already trained or experienced. Experienced individuals train their replacements. A training period of three days should be sufficient for the orderly transfer of these functions.

## Records

Maintain standardized records and database(s) in sufficient detail to carry out an effective, efficient, and responsible regulatory program.

6

Swede Midge

# Chapter 6

## *Control Procedures*

## Introduction

Consider all possible methods of control—cultural or chemical—before beginning a program. Swede midge is most effectively controlled with cultural methods (**See "Application of Cultural Controls" on page 6-3**). Your goal is to manage or eradicate the pest while avoiding or minimizing effects on the environment.

### Laws Pertaining to Pesticide Use

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes the Environmental Protection Agency (EPA) to regulate pesticides. All persons using and applying pesticides should understand the laws pertaining to pesticide use and application. The following are provisions of FIFRA that are most pertinent to emergency pest control programs:

- Restricted use pesticides must be applied by a certified applicator.
- Use of any pesticide inconsistent with the label is prohibited.
- Violations can result in heavy fines and/or imprisonment.

States may register pesticides on a limited basis for local needs according to the following Sections:

- **Section 18**—EPA administrators may exempt federal or state agencies from FIFRA if it is determined that emergency conditions exist that require such exemptions.
- **Section 24**—A state may provide registration for additional uses of federally registered pesticides formulated for distribution and use within that state to meet special local needs in accordance with the purposes of this act.

For additional information concerning exemptions, see the Emergency Programs Manual, Section 14. Contact Environmental Services staff to assure that any pesticide being considered as part of an eradication program conforms to pesticide use requirements. Obtain all required environmental documentation before beginning.

### Environmental Monitoring

Environmental monitoring is an important consideration in all programs. Contact Environmental Services staff to learn if environmental monitoring is required. Environmental Services staff may evaluate environmental impact by monitoring the following:

- Water, to detect insecticide levels resulting from direct application, leaching, and runoff
- Soil, to determine insecticide levels and residues
- Foliage, to identify residues
- Non-target organisms before, during and after applications and post treatments, to determine impact of pesticides

### Treatment Duration

Continue eradication measures for at least two life cycles of the swede midge. Monitor the success of the program for at least one life cycle after the termination of eradication measures.

### Orientation of Personnel

Experienced personnel will train their replacements. A training period of three days should be sufficient for training.

### Records

Program personnel must maintain records and maps noting the locations of all detections, the number and type of treatments, and the materials and formulations used in each treated area.

## Define the Treatment Area

Use the decision table (Table 6-1 below) to define the treatment area.

**TABLE 6-1 Decision Table to Define Treatment Area**

| IF this number of midges: | ARE detected in an area of this size: | THEN treatment will commence and extend: |
|---|---|---|
| 1—5 gravid females, larvae or pupae | Less than 6 square miles | 200 yards beyond the detection |
| 2—5 males or virgin females | | |
| 6 or more any stage | Greater than 6 square miles | 2 1/2 miles beyond the detection |

## Treatment Options

Once established in a field, swede midge is difficult to eradicate (Callow 2003). Direct treatments at the first generation, to eliminate successive generations. Treatment may include the following options:

- Application of cultural controls (**See "Application of Cultural Controls" on page 6-3**)
- Application of recommended insecticides (**See "Application of Recommended Insecticides" on page 6-5**)

Prescribe treatments after considering the following:

- Results of detection and delimiting surveys (**See "Chapter 4" on page 4-1**)
- Local conditions
- Pest development and emergence
- Current information available about the pest and insecticides

## Application of Cultural Controls

Crop rotation is the most effective method of control against this pest. You should combine crop rotation with sanitation and other cultural methods. The use of some cultural controls may be subject to obtaining environmental documentation under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). Check with the program manager to make sure documentation is complete.

### International Swede Midge Task Force Recommendations

The International Swede Midge Task Force (**See "Miscellaneous" on page 9-3**) has recommended the following management practices to control swede midge.

#### Crop Rotation

Crop rotation has been used to successfully control swede midge (Kikkert and Hoepting 2002). Growers of susceptible crops should rotate to non-host crops for four to five years. Swede midge larvae may remain in a resting state in soil for up to two years (Callow and Fraser 2003). Rotate host crops at least 200 m from a previous planting of crucifers, especially if weed hosts grow within 200 m of the infested field (Baur 2004).

If destruction of weed hosts is combined with crop rotation, host crops may be planted in the field after a minimum of two years.

**Field Selection**

Plant in isolated areas. Planting a crop upwind from the previous crop may also reduce the likelihood of infestation. Without a host crop, the swede midge female will be unable to find a suitable host for egg-laying.

**Host Destruction**

Plow under debris to a depth of 5 cm or greater to destroy larvae and pupae (Kikkert and Hoepting 2002; Callow and Fraser 2003; Maisonueve 2004).

**Trap Crops**

Plant the following trap crops to attract swede midge adults, then destroy the crop by disking after oviposition: immature crucifers (Theunissen et al 1997); Gai Lan (Chinese Broccoli); cauliflower (Baur 2004).

**Cultivar Selection**

When possible, select plant cultivars that tolerate swede midge damage. Hallett and Callow (2004) reported the following susceptibilities to swede midge[1]:

**Most susceptible—**Broccoli cultivar 'Paragon'; Asian crucifers Gail Lan and Tsoi sim

**Least susceptible—**Broccoli cultivars 'Everest', 'Triathlon', 'Regal'; Asian crucifers Tah tsai and giant red mustard

**Transplant Production and Handling**

Use caution when transporting plants, soil, or equipment out of swede midge infested areas. Know the source of your transplants. In 2004, most transplants from Canada were grown in Kent County, which remained swede midge-free. Canadian growers of greenhouse transplants in infested counties follow a swede midge certification procedure.

**Planting and Harvest Dates**

To reduce swede midge damage and limit population growth, establish early season crops before swede midge adults begin to emerge in early May. By the time swede midge population density increases to damaging levels in mid-July, early-planted crops will have grown beyond the susceptible stage. Likewise, avoid late season crops to reduce the size of overwintering midges. This strategy is ineffective when growing long-season crucifers such as Brussels sprouts.

**Weed Control**

Control weeds, especially crucifers (Callow and Fraser 2003; Hallett and Callow 2004) (**See "Economic Impact and Host Range" on page 2-6**). If destruction of weed hosts is combined with crop rotation, host crops may grown in a field after a minimum of two years. In

1 All cultivars were susceptible to swede midge damage at high pest population densities.

preliminary investigations, Robinson (2004) reported that control of cruciferous weeds using the herbicide Muster® (ethametsulfuron-methyl) may help to control swede midge.

**Soil Cultivation**

Chop infested residue and plow deeply to disrupt the swede midge life cycle. Most swede midge overwinter in the top 5 cm of soil. Emergence may be spread over two seasons, giving the midge two opportunities to become established. Population density of swede midge tends to build gradually in fields, especially in unrotated crucifers.

**Greenhouse Sanitation**

Inspect all transplants prior to planting. When hardening off young seedlings outdoors, cover with a fine netting or floating row cover to prevent egg-laying by adults.

**Composting**

Do not collect infested residue in cull piles. Compost crop residues at high temperatures (between 140 and 160 degrees Fahrenheit) to kill swede midge and other insect pests.

**Barriers**

Cover field crops with netting (Kikkert and Hoepting 2002; Callow and Fraser 2003). Install net fences between host and non-host crops (Baur 2004).

## Application of Recommended Insecticides


With the exception of Assail® 70 WP, the insecticides mentioned below are **not** currently registered in the United States for use against swede midge. Please review "Laws Pertaining to Pesticide Use" on **page 6-1** for more information. The following are guidelines developed by researchers to control swede midge with insecticides in Canada. The insecticides will likely be effective in the United States, once they are registered. For updates on their status, contact the registrants or distributors of each product.

At the initiation of a program to control swede midge, evaluate registered insecticides. Baur (2004) reported that, over the course of the growing season, broad-spectrum insecticides are ineffective, uneconomical, and deleterious to Integrated Pest Management (IPM) programs.

Insecticides must be synchronized with life cycles of the pest to be effective. The adult stage of this pest lives four days or less. Timing is critical. Use pheromone trapping to effectively schedule the insecticide application. Insecticides are best used for suppressing initial detections of adults.

The following neo-nicotinal insecticides were most successful for control of swede midge adults in Canada:

- Acetamiprid (Assail® 70 WP, Tristar® 70 WSP)
- Imidacloprid (Gaucho®, Poncho®)
- Clothianidin

## Assail® 70 WP

**TABLE 6-2 Assail® 70 WP Data**

| | |
|---|---|
| **Trade name** | Assail® 70 WP (Label/MSDS) |
| **Similar to** | Tristar® 70 WSP |
| **Active ingredient** | Acetamiprid |
| **Usage** | Outdoor ovicide/larvicide |
| **Status** | Registered for use in New York only |
| **Registrant** | Nippon Soda |
| **Distributor** | Ceraxagri |
| **Representative** | Jeff Huether |
| **Telephone** | 315-789-0645 |
| **Website** | www.cerexagri.com |

Canadian researchers (2002) found that the acetamiprid Assail® 70 WP (in Canada) is an effective ovicide/larvicide.

## Tristar® 70 WSP

**TABLE 6-3 Tristar ®70 WSP Data**

| | |
|---|---|
| **Trade name** | Tristar® 70 WSP (Label/MSDS) |
| **Similar to** | Assail® 70 WP |
| **Active ingredient** | Acetamiprid |
| **Usage** | Ovicide/larvicide for emergency use in greenhouses |
| **Status** | Not currently registered in United States |
| **Registrant** | Nippon Soda |
| **Distributor** | Cleary Chemical |
| **Representative** | John Wruble |
| **Telephone** | 212-490-0351 |

**TABLE 6-3 Tristar ®70 WSP Data**

| | |
|---|---|
| **E-mail** | j.wruble@nissoamerica.com |

## Admire® 2F

**TABLE 6-4 Admire® 2F Data**

| | |
|---|---|
| **Trade name** | Admire® 2F |
| **Active ingredient** | Imidacloprid |
| **Usage** | Drench for seedlings |
| **Status** | Potential insecticide not currently registered against swede midge |
| **Registrant** | Bayer Crop Science US |
| **Distributor** | Bayer Crop Science US |
| **Representative** | David Rogers |
| **Telephone** | Office 919-549-2738 or Cellular 919-622-0860 |

## Gaucho®

**TABLE 6-5 Gaucho® Data**

| | |
|---|---|
| **Trade name** | Gaucho® (Label) |
| **Active ingredient** | Imidacloprid |
| **Usage** | Drench for seedlings |
| **Status** | Registered for use in New York, but not currently registered against swede midge |
| **Registrant** | Gustafson |
| **Distributor** | Gustafson |

## Poncho®

**TABLE 6-6 Poncho® Data**

| | |
|---|---|
| **Trade name** | Poncho® (Label) |
| **Active ingredient** | Imidacloprid |
| **Usage** | Drench for seedlings |
| **Status** | Registered for use in New York, but not currently registered against swede midge |
| **Registrant** | Gustafson |
| **Distributor** | Gustafson |

## Warrior® T

**TABLE 6-7 Warrior® T Data**

| | |
|---|---|
| **Trade name** | Warrior ®T (Label) |
| **Chemical same** | Matador® 120 EC |
| **Active ingredient** | Lambda-cychalothrin |
| **Usage** | Outdoor adulticide; direct contact is essential |
| **Status** | Not currently registered in United States |
| **Registrant** | Syngenta US Corporation |
| **Distributor** | Syngenta US Corporation |
| **Representative** | Keith Rynell |

Hallett (2004) reported that the lambda-cychalothrin insecticides Matador® 120 EC and Warrior® T are most effective as foliar sprays against moderate populations of adults. These insecticides are effective at suppressing 50-70% of adult midge activity (Pitblado et al. 2004). However, at high population levels, even systemic products do not seem very effective due to the overlapping generations of this pest. Fifty percent—70% control appears to have little effect. Lambda-cychalothrin treatments are best applied at dusk on adults, and are **not** appropriate for larval control.

## Spinosad

Spinosad was ineffective for control of swede midge in Canada. However, studies are in progress to determine the effectiveness of spinosad as a seed treatment. Seed treatments may provide 5—9 weeks of control (Baur 2004).

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Swede Midge

# Chapter 7

## *Environmental Concerns*

## Introduction

Environmental Services (ES) is a unit of APHIS Policy and Program Development Staff. ES manages the preparation of environmental documentation, such as environmental impact statements and environmental assessments, to aid in program operational decisions. ES also coordinates pesticide registration and approvals for APHIS pest control and eradication programs, ensuring that registrations and approvals meet program use needs and conform to pesticide use requirements.

## Disclaimer

All uses of pesticides must be registered or approved by appropriate federal, state, and/or tribal agencies before application. Pesticide labels may not reflect all state or local restrictions. Read and abide by the label, including labeling that has been approved for the particular state or locality. Comply with all federal, state, tribal, and local laws and regulations relating to the use of the pesticide. APHIS program staffs are responsible for their compliance with applicable environmental regulations.

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Swede Midge

# Chapter 8

## *Pathways*

## Introduction

During the period 1985—2003, 941 interceptions of *Contarinia* spp. were reported (USDA Port Identification Network Database 1985—2003). Interceptions were **not** identified to species, **nor** were they intercepted on identified hosts of *Contarinia nasturtii*. Seventeen interceptions originated in Europe. Of these, two were on unidentified plant hosts, and one was intercepted from soil.

Prior to 1985, one specimen of *Contarinia* spp. was intercepted in 1962 (USDA 1962).

These data are inconclusive concerning the species, but indicate that this insect may pose very little risk in travel, commerce, or cargo pathways. Or, it may reflect the difficulty of detecting this small fly during inspections.

### Natural

Natural spread appears to be the most likely pathway for introduction of this pest in the U. S.

The presence of *Contarinia nasturtii* in Quebec and southern Ontario and the proximity of these areas to New York make this a pest of some concern. Prevailing westerly winds sweeping across Ontario into New York could easily carry this pest.

### Commerce

In 2003, Canada imposed a quarantine of host material used by *Contarinia nasturtii.* Because damage is apparent by the time crops are harvested, commerce in the fresh vegetable market is an unlikely pathway.

Nursery stock may pose more of a risk. The Canadian Food Inspection Agency (CFIA) has a certification program and interim rule (Interim Phytosanitary Requirements to Prevent the Entry and Spread of Swede Midge) to ensure that seedlings and transplant stock are free of swede midge prior to export.

### Travel

Conclusive data, concerning the risk of *Contarinia nasturtii* entering the United States by travel, are absent.

## Countries of Origin

Canada is the most likely source of natural spread of *Contarinia nasturtii* to the U. S.

## Destinations

In 2004 in Niagara County, NY, surveyors captured adult males in pheromone traps and found larvae on crucifer plants at one farm. In 2005, surveyors in the United States will continue to use pheromone traps to monitor the distribution of swede midge.

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Swede Midge

# Chapter 9

## *Resources*

## Beneficial Organisms

*Suppliers of Beneficial Organisms in North America.* A free 32-page booklet available online (http://www.cdpr.ca.gov/docs/ipminov/bensuppl.htm) or from the following address:

California Environmental Protection Agency
Department of Pesticide Regulation
Environmental Monitoring and Pest Management Branch
1020 N. Street, Room 61
Sacramento, CA 95814-5604
Telephone (916) 324-4100

Association of Natural Biocontrol Producers
10202 Cowan Heights Drive
Santa Ana, CA 92705
Telephone (714) 544-8295
http://www.anbp.org/

Weedon, C.R., A.M. Shelton, Y. Li, and M.P. Hoffmann. Biological Control: A Guide to Natural Enemies in North America. Cornell University. http://www.nysaes.cornell.edu/ent/biocontrol/

*Biological Control Virtual Information Center.* Center for IPM. North Carolina State University. http://cipm.ncsu.edu/ent/biocontrol/

## Pest Management Supplies

Peter Witzgall
PheroNet
SLU Box 44
23053 Alnarp Sweden
Telephone 46 40 415307
http://www.phero.net

# Processing Specimens

## Microscope Slide Box Mailers

BioQuip Products, Inc.
2321 Gladwick Street
Rancho Dominguez, CA 90220
Phone: (310) 667-8800
Fax: (310) 667-8808
http://www.bioquip.com/
Item: #6105A

Carolina Biological Supply Co.
2700 York Road
Burlington, NC 27215-3398
Telephone: (800) 334-555
http://www.carolina.com/
Item: #63-4422

Ted Pella, Inc.
P.O. Box 492477,
Redding, CA 96049-2477
Telephone: (530) 243-2200; (800) 237-3526
Fax: (530) 243-376
E-mail: sales@tedpella.com
http://www.tedpella.com/
Item: #22518, #2109, #2114

# USDA–APHIS–Environmental Services and Monitoring

Susan J. O'Toole
USDA–APHIS–PPQ
Environmental Services
4700 River Road
Riverdale, MD 20737
Telephone (301) 734-5861

Ronald Berger
USDA–APHIS–PPQ
Environmental Monitoring
4700 River Road
Riverdale, MD 20737
Telephone (301) 734-7175

## Insect Development

University of California Statewide Integrated Pest Management Program 2003 (http://www.ipm.ucdavis.edu/WEATHER/ddconcepts.html#Using or http://www.ipm.ucdavis.edu/MODELS/DDU/)

## Local Climate

- National Oceanic and Atmospheric Administration (NOAA Home Page)
- National Climatic Center
- U.S. Department of Commerce
- Local Cooperative Extension Service
- Private, state, university, or industry sources

## Miscellaneous

### International Swede Midge Task Force

The Swede Midge Task Force is an informal group of specialists workings in the fields of pest control and regulation, that commenced after meetings at the Ontario Fruit and Vegetable Growers Trade Show in 2003. Members include the following:

- Kristen Callow, Hannah Fraser and Graeme Murphy (OMAF)
- Danielle Roy (MAPAQ)
- Dr. Rebecca Hallett and Dr. Ron Pitblado (University of Guelph)
- Louise Dumouchel (CFIA)
- Dr. Tony Shelton (Cornell University)
- Dr. Julie Kikkert and Christy Hoepting (Cornell Cooperative Extension)
- Susan Ellis (USDA/APHIS)
- Dr. Robert Baur (Swiss Federal Research Station for Horticulture)

A

Swede Midge

# Appendix A

## PPQ Form 391

This report is authorized by law (7 U.S.C. 147a). While you are not required to respond your cooperation is needed to make an accurate record of plant pest conditions. *See reverse for additional OMB information.*

**FORM APPROVED**
**OMB NO. 0579-0010**

**U.S. DEPARTMENT OF AGRICULTURE**
**ANIMAL AND PLANT HEALTH INSPECTION SERVICE**

## SPECIMENS FOR DETERMINATION

Instructions: Type or print information requested. Press hard and print legibly when handwritten. Item 1 - assign number for each collection beginning with year, followed by collector's initials and collector's number. Example (collector, John J. Dingle): 83-JJD-001.
Pest Data Section – Complete Items 14, 15 and 16 or 19 or 20 and 21 as applicable. Complete Items 17 and 18 if a trap was used.

*FOR IIBIII USE*
LOT NO.
PRIORITY

1. COLLECTION NUMBER
2. DATE — MO | DA | YR
3. SUBMITTING AGENCY — ☐ State Cooperator ☐ PPQ ☐ Other _____

**SENDER AND ORIGIN**
4. NAME OF SENDER
6. ADDRESS OF SENDER
ZIP

**INTERCEPTION SITE**
5. TYPE OF PROPERTY *(Farm, Feedmill, Nursery, etc.)*
7. NAME AND ADDRESS OF PROPERTY OR OWNER
COUNTRY/ COUNTY

**PURPOSE**
8. REASON FOR IDENTIFICATION *("x" ALL Applicable Items)*

A. ☐ Biological Control (Target Pest Name )
B. ☐ Damaging Crops/Plants
C. ☐ Suspected Pest of Regulatory Concern *(Explain in* REMARKS*)*
D. ☐ Stored Product Pest
E. ☐ Livestock, Domestic Animal Pest
F. ☐ Possible Immigrant *(Explain in* REMARKS*)*
G. ☐ Survey *(Explain in* REMARKS*)*
H. ☐ Other *(Explain in* REMARKS*)*

9. IF PROMPT OR URGENT IDENTIFICATION IS REQUESTED, PLEASE PROVIDE A BRIEF EXPLANATION UNDER "REMARKS".

**HOST DATA**
10. HOST INFORMATION
**NAME OF HOST** *(Scientific name when possible)*
11. QUANTITY OF HOST
NUMBER OF ACRES/PLANTS
PLANTS AFFECTED *(Insert figure and indicate* ☐ Number ☐ Percent*):*

12. PLANT DISTRIBUTION
☐ LIMITED
☐ SCATTERED
☐ WIDESPREAD

13. PLANT PARTS AFFECTED
☐ Leaves, Upper Surface ☐ Leaves, Lower Surface ☐ Petiole ☐ Stem
☐ Trunk/Bark ☐ Branches ☐ Growing Tips ☐ Roots
☐ Bulbs, Tubers, Corms ☐ Buds ☐ Flowers ☐ Fruits or Nuts
☐ Seeds

**PEST DATA**
14. PEST DISTRIBUTION
☐ FEW ☐ COMMON ☐ ABUNDANT ☐ EXTREME

15. ☐ INSECTS ☐ NEMATODES ☐ MOLLUSKS

| NUMBER SUBMITTED | LARVAE | PUPAE | ADULTS | CAST SKINS | EGGS | NYMPHS | JUVS. | CYSTS |
|---|---|---|---|---|---|---|---|---|
| ALIVE | | | | | | | | |
| DEAD | | | | | | | | |

16. SAMPLING METHOD
17. TYPE OF TRAP AND LURE
18. TRAP NUMBER

19. PLANT PATHOLOGY – PLANT SYMPTOMS *("X" one and describe symptoms)*
☐ ISOLATED ☐ GENERAL

20. WEED DENSITY
☐ FEW ☐ SPOTTY ☐ GENERAL

21. WEED GROWTH STAGE
☐ SEEDLING ☐ VEGETATIVE ☐ FLOWERING/FRUITING ☐ MATURE

22. REMARKS

23. TENTATIVE DETERMINATION

24. DETERMINATION AND NOTES *(Not for Field Use)*

*FOR IIBIII USE*
DATE RECEIVED
NO.
LABEL
SORTED
PREPARED
DATE ACCEPTED
RR

SIGNATURE
DATE

**PPQ FORM 391** *Previous editions are obsolete.*
**(AUG 02)**

This is a 6-Part form. Copies must be disseminated as follows:
☐ PART 1 – PPQ ☐ PART 2 – RETURN TO SUBMITTER AFTER IDENTIFICATION ☐ PART 3 – IIBIII OR FINAL IDENTIFIER
☐ PART 4 – INTERMEDIATE IDENTIFIER ☐ PART 5 – INTERMEDIATE IDENTIFIER ☐ PART 6 – RETAINED BY SUBMITTER

**FIGURE A-1 Example of PPQ Form 391, page 1**

***OMB Information***
According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0579-0010. The time required to complete this information collection is estimated to average .25 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

**Instructions**
Use PPQ Form 391, Specimens for Determination, for domestic collections (warehouse inspections, local and individual collecting, special survey programs, export certification).

| BLOCK | INSTRUCTIONS |
|---|---|
| 1 | 1. Assign a number for each collection beginning the year, followed by the collector's initials and collector's number<br>**EXAMPLE** In 2001, Brian K. Long collected his first specimen for determination of the year. His first collection number is 01-BLK-001<br>2. Enter the collection number |
| 2 | Enter date |
| 3 | Check block to indicate Agency submitting specimens for identification |
| 4 | Enter name of sender |
| 5 | Enter type of property specimen obtained from (farm, nursery, feedmill, etc.) |
| 6 | Enter address |
| 7 | Enter name and address of property owner |
| 8A-8L | Check all appropriate blocks |
| 9 | Leave Blank |
| 10 | Enter scientific name of host, if possible |
| 11 | Enter quantity of host and plants affected |
| 12 | Check block to indicate distribution of plant |
| 13 | Check appropriate blocks to indicate plant parts affected |
| 14 | Check block to indicate pest distribution |
| 15 | • Check appropriate block to indicate type of specimen<br>• Enter number specimens submitted under appropriate column |
| 16 | Enter sampling method |
| 17 | Enter type of trap and lure |
| 18 | Enter trap number |
| 19 | Enter X in block to indicate isolated or general plant symptoms |
| 20 | Enter X in appropriate block for weed density |
| 21 | Enter X in appropriate block for weed growth stage |
| 22 | Provide a brief explanation if Prompt or URGENT identification is requested |
| 23 | Enter a tentative determination if you made one |
| 24 | Leave blank |

**Distribution of PPQ Form 391**
Distribute PPQ Form 391 as follows:
1. Send Original along with the sample to your Area Identifier.
2. Retain and file a copy for your records.

**TABLE 1-1 Example of PPQ Form 391, page 2**

B

Swede Midge

# Appendix B

## Mounting Specimens

The following is an excerpt from Gagné (1989):

> A dissecting microscope should allow one to distinguish among some genera of cecidomyiids. For detailed study of larvae or adults, however, the specimens will need to be mounted on microscope slides for study under a compound microscope, preferably one with phase contrast. If a slide has to be made, it is best to make a good-quality, permanent one. This means that all the muscles should be dissolved.
>
> To dissolve the muscles of a larvae, first prick it once or twice with a fine insect pin. Then place the specimen in a small crucible with a solution of sodium hydroxide. It can be heated quickly on a hot plate or left in a solution for a longer period of time at room temperature. If a hot plate is used, allow the solution to boil gently for a minute or so. When the specimen is cleared, remove it with an eye dropper and place it in a porcelain spot plate. With fine forceps transfer the larva to a drop of acetic acid for a minute to neutralize the sodium hydroxide, and then transfer it successively to 70% alcohol, 95% alcohol, and creosote or clove oil, leaving it in each liquid for about 5 minutes. Specimens can be kept in creosote or clove oil overnight if necessary. Then transfer the larva to a drop of Canada balsam on a slide and lay a cover slip on it. Attach a label to each end of the slide: one label to record the host, other collection data, and the mounting medium, and the other to record the identification.
>
> Adults are more difficult to prepare. Taking a specimen from alcohol, first remove the wings and place them directly into the creosote. Puncture the abdomen with a fine insect pin and place the body in the sodium hydroxide solution. When the specimen is cleared, follow the same process as for a larva. The wings can be mounted under one cover slip, the rest of the body under the other. Once on the cover slip in the drop of balsam, the head can be removed from the body and placed so that it can be seen in frontal view. If the specimen is a male, the terminalia should also be disconnected from the body and placed dorsoventrally. The remainder of the body is mounted laterally. When several specimens are available, it is a good idea to mount some with the head and terminalia still attached. Pupal skins can be mounted without clearing in the same way as wings, but they should be stored in alcohol long enough so that no air remains in the leg or antennal sheaths. A little practice is required to get the Canada balsam just thick enough so that the specimen is not distorted and yet not so thick that one cannot use the high power microscope objectives. An easier, alternate mounting medium is Euparal, which is miscible with 70%

alcohol. With Euparal, two steps can be skipped, the 95% alcohol and the creosote. The optical properties of Euparal are adequate for most work.

Specimens stored in alcohol deteriorate with time, so mount an adequate sample on slides as soon as possible after collecting or rearing. Because many species are strikingly marked with colored scales that are lost when immersed in liquid, it is best to pin a series on double mounts or on card points. Most adults shrivel slightly, but the scale or color pattern will preserve well. Larvae and pupae can also be mounted on card points for long-term storage. These should be kept the same way and with the same care as for any pinned specimens. More general guidelines for preparing and maintaining a collection are given in Steyskal et al. (1987).

# Glossary

**APHIS**. Animal and Plant Health Inspection Service.

**ARS**. Agricultural Research Service.

**aerial treatment.** Delivery of insecticide to a treatment area by aircraft.

**array**. Arrangement of traps in a one square mile (1 $mi^2$) area.

**array sequence**. Layout of traps (arrays) from the core area outward to the perimeter (buffer areas).

**BARC.** Beltsville Agricultural Research Center.

**block.** Unit (e.g., 1 square mile area) of a detection survey in which all survey activities are conducted.

**buffer area**. Area that is beyond the core block of a survey and1-2 miles from the perimeter of a regulated area; or in an extended survey, 50 miles from the core of a regulated area.

**CPHST.** Center for Plant Health, Science and Technology.

**cold treatment**. Exposure of a host product to cold temperatures lethal to a target pest beyond the pests' ability to endure.

**commercial production area**. Area where host material is grown for commercial distribution.

**confirmed detection**. Positive identification by a recognized expert in the taxonomy of a life form (specimen).

**core area.** Area of 1 square mile surrounding a confirmed detection.

**crepuscular**. Organism that is active in twilight hours.

**degree days**. Measure of physiological time using the accumulation of heat units (degrees) above an insect's developmental threshold for a 24-hour period.

**delimiting survey**. Determination of the extent of an infestation (e.g., distribution, density) in an area where an exotic species has been detected.

**delta trap.** Five-sided insect trap, configured with three lateral sides arranged triangularly, equipped with a lure (i.e., pheromone), a baffled edge, and an adhesive surface inside to capture and secure attracted insects.

**detection**. Collection of any life stage of an exotic species.

**detection survey**. Activity conducted in a susceptible area not known to be infested with an exotic species to determine its presence.

**developmental threshold**. Minimum and/or maximum temperatures that support physiological development for a species.

**diurnal.** Active during the day.

**eclosion.** Insect emergence from the previous life stage.

**epicenter**. Initial site of an infestation.

**exotic species.** Organism or pest species not native to or historically resident in North America.

**fumigation.** Application of an approved insecticidal chemical that enters the target pest's tracheal system in volatile form.

**generation**. The offspring of a parent population that move through the life cycle together.

**ground spray.** Insecticide delivered in droplet form, from equipment positioned on the ground or at the vegetation level.

**host**. Species that provides food, shelter or reproductive requirements for another organism.

**host collection/holding**. Collection and retention of infested host material for the purposes of determining characteristics of a pest's use of the material.

**ICS**. Incident Command System is a system for managing emergencies.

**infestation**. Collection of:

- Two or more of an exotic species
- A pupa, larva, or a mated female from an area, or
- The detection of a single adult associated with a current infestation

**infested area**. Area surrounding a single detection site or a group of sites. The standard designated area of 2.5 miles is used, unless biotic or abiotic factors dictate adjustment of this area.

**light trap**. Survey device that lures insects through radiating light in wavelengths attractive to the target pest, then captures the attracted insects, usually in a an escape-proof container or one containing an insecticide.

**migratory species**. Species in which individuals habitually move from place to place especially in search of mates or oviposition sites.

**monitoring/evaluation survey**. Conducting visual and/or trapping surveys in an area that has been treated with insecticide to evaluate the effectiveness of the treatment.

**NPAG.** New Pest Advisory Group.

**NPB**. National Plant Board is an organization of the plant pest regulatory agencies of each of the states and Commonwealth of Puerto Rico.

**natural enemies.** Living organisms found in a natural community that kill, weaken, or inhibit the biological potential of a pest species.

**nocturnal**. Active at night.

**non-migratory species.** Species in which individuals typically do not move far from the area of their birthplace.

**PPQ**. Plant Protection and Quarantine.

**parasite**. Lives on the host (frequently the adult stage) at one or multiple life stages; parasites kill or debilitate the host.

**parasitoid**. Parasitoids live on the host (often an immature stage) when immature, but are free-living as adults; parasitoids always kill the host. Insects that parasitize arthropods are parasitoids.

**regulated area**. Area that extends at least 2 1/2 miles in any direction from the epicenter of an infestation.

**regulated articles**. All known or suspected hosts of a confirmed infestation of an exotic species, including soil and any other suspected product or article.

**regulatory survey**. Trapping or detection program conducted around establishments where regulated articles are sold, handled, processed or moved.

**sex pheromone.** Chemical substance that is secreted by an insect to attract or to advertise reproductive competence to opposite sex insects (usually) of the same species.

**soil treatment.** Application of an approved insecticide to the soil of nursery stock or within the drip line of host plants.

**sweep netting.** Survey method in which a mesh net suspended around a hoop is swept through the air or around vegetation to collect insects.

**trap survey**. Determination of the presence of a pest through the use of randomly or strategically placed devices that capture insects (sometimes aided by an attractant). These traps are maintained and serviced on a schedule dictated by the goal of the survey.

**visual survey**. Examination of areas for eggs, larvae, pupae, cocoons, or other evidence that a particular insect species is present.

**wing trap.** Disposable, adhesive-coated capture device used primarily for surveying flying insects.

**urban/residential area**. Area containing a number of multiple- or single-family dwellings.

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