Organic Management of Swede Midge

Elisabeth A. Hodgdon & Yolanda H. Chen, Dept. of Plant & Soil Science, University of Vermont, Burlington, VT
Christine A. Hoepting, Cornell Cooperative Extension Vegetable Program, Albion, NY
Rebecca H. Hallett, School of Environmental Sciences, University of Guelph, Ontario, Canada

Revised March 2019

Figure 1. Adult female swede midge

Swede midge (*Contarinia nasturtii)* is a small (1/16" long) invasive fly (Fig. 1) that is a serious pest of Brassica (cruciferous) vegetable crops, including broccoli, cabbage, and kale. The insect was named for one of its hosts in Europe, the "swede," a type of forage turnip. Management of swede midge is particularly challenging because of its small size, hidden feeding behavior, low damage threshold, and life cycle consisting of multiple overlapping generations during the growing season. Small-scale organic growers with insufficient space for crop rotation to break the swede midge life cycle are especially at risk for economic losses from this pest.

Host crops and damage symptoms

All varieties of *Brassica oleracea* vegetables, including broccoli, cauliflower, Brussels sprouts, cabbage, collard greens, kale, and kohlrabi, are susceptible to swede midge damage. Canola, mustards, and Asian greens, including Chinese cabbage and bok choi (*B. rapa* and *B. napus*) are also host plants for swede midge. Midge larvae feed on the growing points of their host plants, resulting in scarred stems, deformed leaves, multiple shoots or heads, uneven development and complete loss of heads or crowns (Fig. 2)[1]. Unfortunately, injury similar to swede midge damage may be caused by several other factors, and it is not uncommon for swede midge damage to be misdiagnosed. For more information on swede midge diagnosis, visit the Swede Midge Information Center for the U.S. website listed under 'Additional Resources'.

Figure 2. Swede midge damage symptoms in Brassica crops: Uneven head development (A) and death of head (B) in broccoli, multiple heads of cabbage (C), distorted growing tip in kale (D), and scarring of kohlrabi (E).

Figure 3. Yellow larvae feeding on cauliflower

Life cycle

During their short 1-3 day lifespan, adults emerge from the soil, mate, and lay eggs within the newly developing leaves in the growing point of their host plants. Eggs hatch into small (~1/8") larvae that become yellow with age and are visible to the unaided eye (Fig. 3). Once larvae are hidden within the growing point, they are protected from contact with foliar insecticides. After feeding for 7-21 days, larvae jump off of the plant to the ground and develop into pupae, which reside in the top 0.5" of soil beneath their host plant[2]. In the fall, pupae remain in the soil and overwinter in cocoons, emerging as adults in May. Although most overwintering pupae emerge the following year, some may stay in the soil and emerge in the second or third spring.

Management strategies

The most important management strategy for controlling swede midge is to disrupt its life cycle. This can be accomplished in several ways.

Crop rotation

Wherever there is a Brassica crop infested by swede midge is where the midges will emerge the following spring, as they overwinter in the soil surrounding the plants on which they developed. To disrupt their life cycle, do not provide midges with a suitable host when they emerge from overwintering the next spring and early summer. Long and widely spaced rotations away from prior and adjacent Brassica vegetables can be very effective for limiting swede midge population growth. Rotate host crops as far away as possible from infested fields for as long as possible. At least one mile between adjacent or previous Brassica crops, with at least three years between Brassica crops in any given location, is suggested. If this is not possible, waiting until the majority of spring emergence is completed (May-June) before planting another Brassica in the same field helps to reduce swede midge pressure. Avoid using mustard, radishes, and other cover crops in the Brassicaceae family in infested areas, as these also serve as hosts of the swede midge.

Monitoring

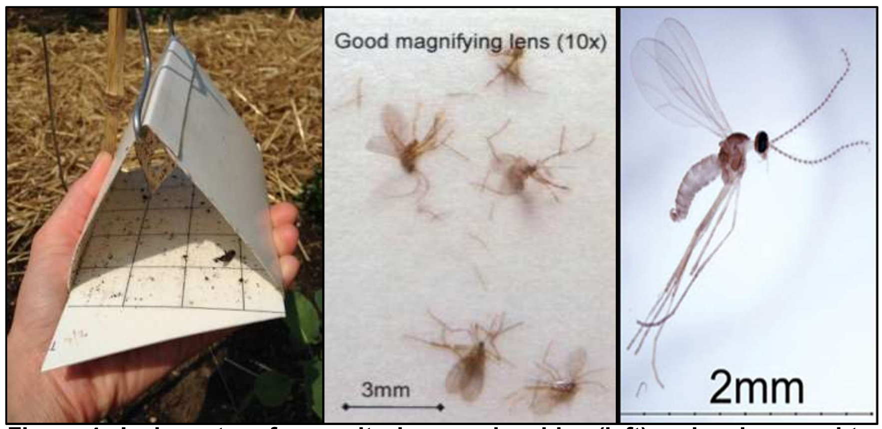

Figure 4. Jackson trap for monitoring swede midge (left) and males caught in trap (right). 2 mm = ~1/16"

Pheromone traps use lures containing the swede midge female pheromone to attract swede midge males. Because the traps only attract males, they are not effective for mass trapping to reduce swede midge populations, but are useful for monitoring. Monitoring swede midge activity can provide tremendous insight into the swede midge population dynamics on a farm as it relates to management practices and can aid in a grower's understanding of the nature of this seemingly invisible pest. However, monitoring swede midge requires skilled insect identification and time. If you are interested in monitoring for swede midge, visit the Swede Midge Information Center for the U.S. website listed under 'Additional Resources'. For help identifying swede midge in traps, preserve sticky cards in plastic bags and consult with your local extension professionals.

Post-crop destruction and tillage

Infested crops should be destroyed via tillage or chopping immediately after harvest to prevent continuing buildup of swede midge populations, otherwise swede midge will continue to develop on secondary side shoots produced once the main harvest is completed. Larvae have been found on these plant parts into late October, so the ability of side shoots to grow after harvest contributes to the overwintering population that will emerge to infest new crops the following year.

OMRI-approved insecticides

Because feeding larvae are protected within the bud, making contact with foliar insecticides is challenging. Adding a spreader-sticker adjuvant to the insecticide treatment can improve contact between sprays and the waxy leaves of Brassicas. Although systemic conventional insecticides are effective for swede midge management, no systemic organic insecticides are currently available. Field trials testing organic-approved insecticides have found minimal or inconsistent efficacy in protecting vegetable crops from swede midge damage. In Ontario, Canada, Evans and Hallett (2016) tested products containing azadirachtin, *Beauveria bassiana*, pyrethrin, and spinosad and found that all materials except *B. bassiana* provided crop protection in one year, but none of the materials improved crop yield in another study year[3]. In Europe, spinosad application provided 36% and 58% reduction of swede midge damage in broccoli and kohlrabi, respectively[4]. Of the products tested, spinosad and azadirachtin seem to be the most promising organic insecticides for swede midge management, but do not provide complete or consistent control.

Tolerant crop varieties

Crop	Susceptibility
B. oleracea	
Broccoli	*High*
Brussels sprouts	*Low/Moderate*
Cabbage	*Low*
Cauliflower	*High*
Collards	*Moderate*
Kale	*Moderate, 'Red Russian'* most susceptible
Kohlrabi	*High*
B. napus	
Turnip	*Low*
B. rapa	
Bok choi	*Low*
Mizuna	*Low*

Table 1. Swede midge vegetable crop hosts and susceptibility to economic damage [1]
Low = mildly susceptible or susceptible with little economic damage
Moderate = moderately susceptible
High = highly susceptible, frequent yield loss

To date, no field trials have demonstrated resistance to swede midge in commercially-available vegetable crop varieties. Broccoli appears to be the most preferred by swede midge and tends to suffer the most economical losses, in part because swede midge scarring within the head deems the produce unmarketable and because broccoli is susceptible through all growth stages. Cabbage is less susceptible to swede midge because once head formation has begun, leaves protect the growing point and the female cannot access it to lay her eggs. As a management strategy, some small-scale growers decide not to grow broccoli for a year or more to reduce swede midge populations to below economically-damaging levels.

Intercropping

Intercropping broccoli with several candidate vegetable, herb, and cover crop species was tested at the University of Vermont in both laboratory and field settings. None of the intercrop species tested provided crop protection from swede midge in field trials.

Biological control

No specialist predators, parasitoids, or other natural enemies have been found for swede midge, despite exploration in Europe for candidate species. Although some parasitoid wasps will utilize swede midge as hosts, low levels of parasitism and lack of specialization render them ineffective for managing swede midge and unsuitable as candidates for importation into the U.S[5]. Predatory nematodes applied to soil to manage pupae provided inconsistent reduction in emergence of swede midge adults in the field[6].

Insect exclusion netting

Figure 5. Insect exclusion netting for broccoli in a Cornell Cooperative Extension field trial

Insect exclusion netting (ProtekNet, 14' wide, 25 gram, Dubois Agrinovation) can provide 100% reduction of SM damage when used with plastic mulch and when care is taken to prevent openings in the netting. For broccoli, netting is placed over 4' hoops made of electrical conduit placed 4-6' apart over 3-4' wide beds and secured with clamps (Fig. 5). Although costly ($400/100', which includes $200 for reusable conduit, stakes and clamps), netting is an option for small-scale organic growers lacking adequate distance for crop rotations away from Brassicas. Netting in combination with mulch has been proven effective for weed control, ensuring that netting does not have to be removed for hand weeding operations. However, if midges get inside the netting by emergence from the soil within the enclosure or through a hole in the netting, they can cause damage to the crop. Studies have shown that a crop can be grown free of swede midge under netting in a field that is adjacent to midge emergence sites, provided that the bed itself is located on ground that has not produced an infested Brassica crop in at least three years. Using netting with mulch can create a warmer microclimate underneath the netting than in the open air, which can change the days to harvest for a crop and potentially cause heat stress. Netting may also help to exclude other pests, including flea beetles and caterpillars, but it is possible that other pests could be inadvertently enclosed within the netting. Scout for and remove pests on transplants before enclosing them under netting.

Exclusion fencing

Although swede midge is deemed a poor flyer, tall fencing does not provide an effective barrier against swede midge, as wind can carry midges over the barrier.

Repellent plant essential oils

Plant essential oils applied to crops in foliar sprays can deter oviposition by pests and can be toxic to larvae. Several essential oils, including garlic, lemongrass, oregano, and thyme, showed promise for swede midge management in laboratory trials at the University of Vermont, however, field trials did not find garlic essential oil to be effective.

Pheromone mating disruption (PMD)

Pheromone mating disruption involves the release of large quantities of the female sex pheromone in the field to confuse males and prevent them from finding mates. When PMD is successful, midges will not mate and females will not lay their eggs within the host crop. Although PMD was demonstrated successfully in Europe for swede midge[7], swede midge pheromone synthesis is expensive. Trials are currently underway in Ontario, Canada to determine how to reduce pheromone input costs using reservoir-type dispensers on wire stakes (Fig. 6) set up within broccoli fields.

Figure 6. PMD pheromone dispenser

Conclusion

Small-scale organic farms are most at risk of economical losses caused by swede midge. Because organic vegetable farms tend to have a relatively small land base, sometimes less than two acres, there is simply not enough area for crop rotation to be effective. There are no OMRI-listed insecticides comparable to the very effective systemic insecticides available for conventional growers. Long and wide rotations and insect exclusion netting are the most effective means of managing swede midge until other control strategies are identified through research. Learn to recognize and accurately diagnose swede midge damage when it occurs on your farm.

References cited:

1. Hallett, R. H. Host plant susceptibility to the swede midge (Diptera: Cecidomyiidae). *J Econ Entomol* **100,** 1335–1343 (2007).
2. Chen, M. & Shelton, A. M. Impact of soil type, moisture, and depth on swede midge (Diptera: Cecidomyiidae) pupation and emergence. *Environ Entomol* **36,** 1349–1355 (2007).
3. Evans, B. G. & Hallett, R. H. Efficacy of Biopesticides for Management of the Swede Midge (Diptera: Cecidomyiidae). *J Econ Entomol* **109,** 2159–2167 (2016).
4. Wyss, E. & Daniel, C. The effect of exclusion fences on the colonization of broccoli and kohlrabi by the Swede midge, Contarinia nasturtii (Diptera: Cecidomyiidae). *Mitteilungen der Dtsch Gesellschaft fuer Allg und Angew Entomol* **14,** 387–390 (2004).
5. Abram, P. K. *et al.* Identity, distribution, and seasonal phenology of parasitoids of the swede midge, Contarinia nasturtii (Kieffer) (Diptera: Cecidomyiidae) in Europe. *Biol Control* **62,** 197–205 (2012).
6. Evans, B. G., Jordan, K. S., Brownbridge, M. & Hallett, R. H. Effect of temperature and host life stage on efficacy of soil entomopathogens against the swede midge (Diptera: Cecidomyiidae). *J Econ Entomol* **108,** 473–483 (2015).
7. Samietz, J., Baur, R. & Hillbur, Y. Potential of synthetic sex pheromone blend for mating disruption of the swede midge, Contarinia nasturtii. *J Chem Ecol* **38,** 1171–1177 (2012).

Photo credits: Figs. 1, 2d, 4 (left), and 6: Elisabeth Hodgdon. Figs. 2 a,b,e and 5: Christine Hoepting. Fig. 2c: Ontario Ministry of Agriculture, Food and Rural Affairs. Fig. 3: Paolo Filho. Fig. 4 (center): Agroscope, FAW Wadenswil. Fig. 4 (right): Susan Ellis.

This material is based upon work supported by the Vermont Specialty Crop Block Grant Program under subaward 02200-SCBGP-9-1 awarded to YCH, the National Institute of Food and Agriculture, U.S. Department of Agriculture, through Crop Protection and Pest Management (2014-70006-22525) and Northeast Integrated Pest Management (2013-34103-21431) grants awarded to YCH, and the Northeast Sustainable Agriculture Research and Education program under subaward numbers GNE16-121 and ONE15-237 awarded to EAH and CAH, respectively.