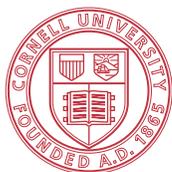


VEGETABLES



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Integrated Pest Management

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Organic Management of Swede Midge

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Figure 1. Adult female swede midge

Introduction

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 choy (*B. rapa* and *B. napus*) are also host plants for swede midge. Swede midge larvae feed on the growing points of their host plants, resulting in scarred stems, deformed leaves, multiple shoots or heads, uneven development and



Figure 3. Yellow larvae feeding on cauliflower

complete loss of heads or crowns (Fig. 2, Ref. 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'.

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). Swede midge larvae are hidden within the growing point where 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 (Ref. 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.



Figure 2. Swede midge damage symptoms in *Brassica* crops: Uneven head development (a) and death of head/blind head (b) in broccoli, multiple heads of cabbage (c), distorted growing tip in kale (d), and brown corky scarring of kohlrabi (e).

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

Swede midge emerge in the spring wherever there was a *Brassica* crop infested by swede midge the previous year, 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. 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 area helps to reduce swede midge pressure. Avoid using mustard, radishes, and other *Brassica* cover crops in infested areas, as these also serve as hosts of the swede midge.

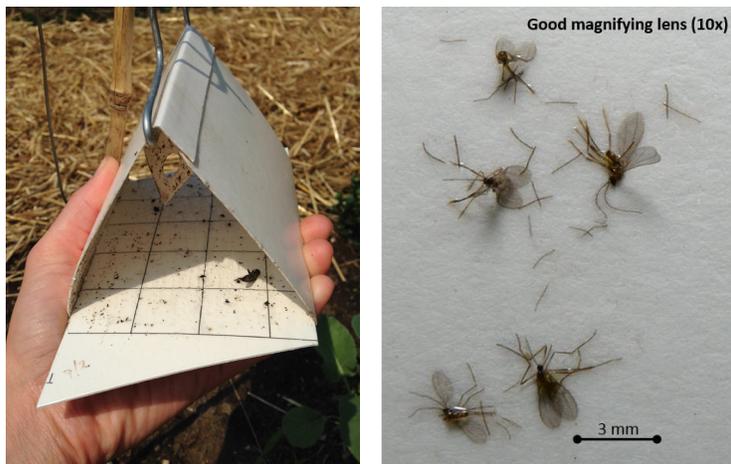


Figure 4. Jackson trap for monitoring swede midge (left) and males caught in trap (right). 2 mm = ~1/16"

Monitoring

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 damage 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 understanding 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 Monitoring and Identification section of the Swede Midge Information Center for the U.S. website listed under 'Additional Resources.'

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.

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 *Brassic*s. Although systemic conventional insecticides are effective for swede midge management, no systemic organic insecticides are currently available. Field trials in New York testing organic-approved insecticides have found that weekly applications of Surround (kaolin clay) starting immediately after transplanting and continuing until head formation has consistently been the most effective treatment. Trials were conducted under only moderate pressure so more research is needed to confirm these results. Growers in New York will need to have a 2ee label for this use. Azera (a.i. azadirachtin + pyrethrins) has also been effective in at least one trial in New York. 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 (Ref. 3). In Europe, spinosad application provided 36% and 58% reduction of swede midge damage in broccoli and kohlrabi, respectively (Ref. 4). Of the products tested, Surround, spinosad, and azadirachtin seem to be the most promising organic insecticides for swede midge management, but do not provide complete or consistent control.



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

Tolerant crop varieties	
Crop	Susceptibility
<i>B. oleracea</i>	
Broccoli	High
Brussels sprouts	Low/Moderate
Cabbage	Moderate
Cauliflower	High
Collards	High
Kale	Moderate, 'Red Russian' most susceptible
Kohlrabi	High
<i>B. napus</i>	
Turnip	Low
<i>B. rapa</i>	
Bok choy	Low
Mizuna	Low

Table 1. Swede midge vegetable crop hosts and susceptibility to economic damage

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 economic losses, in part because swede midge scarring within the head renders it 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 (Ref. 5). Predatory nematodes applied to soil to manage pupae provided inconsistent reduction in emergence of swede midge adults in the field (Ref. 6).

Insect exclusion netting

Insect exclusion netting (ProtekNet, 14' wide, 25 gram, Dubois Agrinovation) can provide 100% reduction of SM damage when used with plastic mulch 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 emerging 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, such as cabbage worms 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, our research has shown that tall (5') 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. Additional field trials are underway to test other essential oils.



Figure 6. PMD pheromone dispenser.

Pheromone mating disruption

Pheromone mating disruption (PMD) 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 (Ref. 7), swede midge pheromone synthesis is expensive. Trials are currently underway in Ontario, Canada to test lower cost pheromone blends using reservoir-type dispensers on wire stakes (Fig. 6) set up within broccoli fields.

Conclusion

Small-scale organic farms are at high risk of economic losses caused by swede midge. Because many organic vegetable farms tend to have a relatively small land base where 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 and implement a management strategy before populations build to high levels.

Additional Resources

Swede midge Information Center for the U.S. Cornell University.

<http://web.entomology.cornell.edu/shelton/swede-midge/>

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