Wheat Midge

The wheat midge (*Sitodiplosis mosellana*) is found around the world wherever wheat is grown. Significant damage to wheat crops has been reported in Alberta, Saskatchewan, Manitoba, Minnesota, North Dakota and several regions of British Columbia.

Most wheat varieties are susceptible to wheat midge, but a growing number of midge tolerant variety blends of wheat are now available. Although the midge also feeds on other members of the grass family including barley, couch grass, intermediate wheat grass and rye, levels on these plants are usually not serious enough to warrant control.

Damage

Feeding by larvae of wheat midge can reduce crop yields and lower the grade of the harvested grain.

Wheat midge may exist at low population levels for several years before it becomes a significant problem. But if conditions become favourable, populations can reach epidemic proportions quickly. Producers often mistake the symptoms of an infestation and report that frost or drought has reduced wheat yields or grain quality.

Crop damage occurs during the larval stage. After hatching, the midge larva feeds on the developing wheat kernel, causing it to shrivel, crack and become deformed. The damage to the crop is not readily apparent because there are no visible changes in colour, size, or shape of the affected wheat head. Damage can only be detected by inspecting the developing seed itself.

Damage to wheat kernels will vary within a single head. A few kernels may be aborted entirely. Others will not fully develop and will be so small and light, they will pass through the combine with the chaff during harvest. Still others may be only slightly damaged. Some may not be affected at all.

The loss of individual kernels will lower yield, whereas damaged kernels will reduce the grade of the harvested wheat. Standards established by the Canadian Grain Commission limit midge damage in No. 1 CWRS and No. 2 CWRS to two per cent and five per cent respectively before grade is affected.

Life Cycle and Identification

The insect passes through a four-stage life cycle.

Adult: The adult wheat midge is a very small, fragile orange fly about half the size of a mosquito, approximately 2-3 mm long (1/8 inch). Two black eyes cover much of its brown head. The midge has three pairs of legs which are long relative to its body size. Its wings are oval shaped, transparent and fringed with fine hairs.

Adult midge emerge from the pupal stage in late June or early July. During the day, adults remain within the crop canopy where conditions are humid. In the evening, females become active at the top of the wheat canopy, laying their eggs on the newly emerged heads of wheat. Female midge live for less than seven days and deposit an average of 80 eggs.

Figure 1. Adult wheat midge. Photo by Bob Lamb, AAFC

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Manitoba

Eggs: Most egg laying takes place from about 75 minutes before sunset to about 30 minutes after sunset when wind speeds are less than 10 km/h (6mph) and the air temperature is greater than 15°C (59°F). Eggs are laid singly or in clusters of three or four eggs under the glumes or in grooves on the wheat florets. The egg stage lasts four to seven days.

Larvae: Upon hatching, the small orange larvae feed on the surface of developing kernels. Frequently, there are three to four larvae per floret but in severe infestations, there may be as many as 26 larvae feeding on a single kernel.

Larvae feed and develop for about two to three weeks, by which time they grow to about 2 - 3 mm long (1/8 inch).

In dry conditions, larvae do not shed their last larval skin but shrink back inside it and stop developing. In this state, the larvae appear to be enclosed within a transparent envelope. The larvae can survive in this protected state for up to two months. When moisture conditions improve, the larvae become active, crawl off the wheat heads, find their way to the ground and bury themselves in the soil.

Figure 2. Wheat midge larvae feeding on developing wheat kernel.

Most larvae remain within the top 5 cm (2 inches) of soil but some may burrow 10 cm (4 inches) below the soil surface. The larvae spin round cocoons which are about haft the size of a Polish-type canola seed. Overwintering larvae may remain dormant until conditions are favourable for development, whether the following spring or several years later.

Pupae: Once temperature and soil conditions end the overwintering period, the larvae become active and move to the soil surface to pupate. Depending on the conditions, the larvae will pupate with or without a cocoon. Adult flies begin to emerge from the pupae in late June or early July. Emergence may continue for about six weeks. Weather conditions affect the wheat midge life cycle significantly. Moist soil conditions during May and June are required for larval development and pupation. Dry conditions may result in the larva remaining dormant for extended periods of time. Warm calm evenings during July are favourable for egg laying.

Figure 3. Canola seeds (top) and wheat midge cocoons (bottom).

Don't Confuse Wheat Midge with Lauxanids

Not every small fly in the crop will be a wheat midge. The wheat midge may be mistaken for another small fly that is common in wheat - the lauxanid.

At 2.5- 4 mm in length (1/10-1/6 inches), the lauxanid is a little larger than the midge. It is yellowish-brown compared to the predominantly orange colour of the wheat midge. The lauxanid may be observed during the day and early evening resting on the wheat leaves or on the awns. When disturbed during the day, it will fly above the crop canopy. At rest, its body will be oriented in the horizontal position or with its head pointed towards the ground.

In contrast, the midge is not active during the day. Wheat midge tends to flutter from plant to plant and assumes a vertical position with its head pointed skyward when resting on the plants.

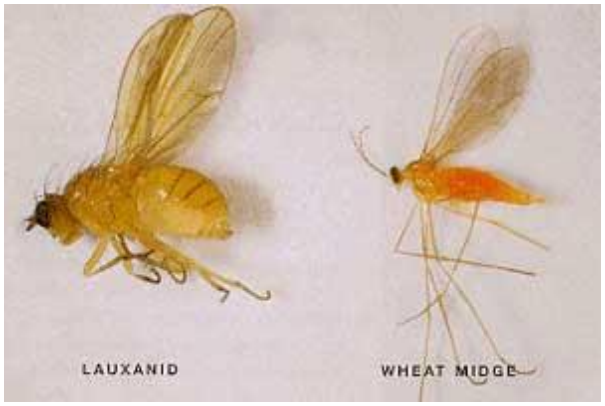

Figure 4. Lauxanid, *Camtoprosopella borealis* (left) and wheat midge (right).

Table 1. Differences between the Lauxanid, *Camtoprosopella borealis* and wheat midge

Characteristics	Lauxanid (left)	Wheat Midge (right)
Size	2.5 - 4 mm (1/10-1/6 inch)	2 - 3 mm (1/12-1/8 inch)
Colour	yellowish-brown	orange, brown head, black eyes
Active period	day and evening	evening only
Movement habits	will fly above the canopy when disturbed during day	tends to flutter from plant to plant in the evening
Stationary habits	sits on plant in horizontal position or pointing down	sits with head pointing up

Monitoring

Estimating emergence of Wheat Midge and its key parasitoid

Emergence of wheat midge can be estimated by measuring the accumulated temperature units, known as degree-days, above a base temperature needed for the development of the insect. For wheat midge, a base temperature of 5 degrees Celsius is used.

Table 2. Accumulated degree-days needed for 10%, 50% and 90% emergence of adult wheat midge.

Percent Emergence	Accumulated degree-days (base 5)
10	693
50	784
90	874

Emergence of wheat midge may be erratic and delayed in areas that receive less than 20 mm rainfall in May. Emergence may be 1 to 7 days earlier than expected at sites receiving 20 to 30 mm of rain in May. Conversely, emergence may be 2 to 8 days later than expected at sites receiving more than 145 mm rain in May and June.

The peak period of flight of adult wheat midge is mid-July in Manitoba. The first 10% and 50% of flight usually occurs around July 9 and July 16 respectively. A large proportion of the wheat midge flight occurs in the second and third weeks in July. Emergence of adults may occur earlier in the southern part of Manitoba than the more northern wheat growing areas of Manitoba. In a warm, dry year, early seeded wheat may head in the latter part of June, finish flowering at the beginning of July, and escape infestation completely.

There may be 50% emergence of *Macroglenes penetrans*, the main parasitoid of wheat midge, after 823 degree-days, at a base temperature of 5 degrees Celsius.

Adult Counts:

Stage of wheat to monitor: Wheat heads are most susceptible to damage when egg laying occurs during heading, Zadoks growth stages 51 (ear just visible) to 59 (ear fully emerged). Damage declines dramatically when

egg-laying occurs after anthers are visible. Therefore, fields should be inspected frequently from the time wheat heads emerge from the boot leaf until anthers are visible on the heads. Figure 5 shows a wheat head with anthers (left) and without (right).

Time of Day to Monitor: Field inspection should be carried out between from about 75 minutes prior to sunset until about 30 minutes after sunset, when female midge are most active. Females are more active when the temperature is above 15°C (59°F) and wind speed is less than 10 km/h (6 mph).

What to Count: Midge populations can be estimated by counting the number of adults present on four or five wheat heads.

Inspect the field in at least three or four locations. Midge densities and plant growth stages at the edge and centre of fields may be very different. The highest densities are often next to fields where wheat was grown in previous years or in low spots where soil moisture is favourable to midge development.

Figure 5. Wheat heads with anthers (left) and without (right).

Monitoring Using Sticky Traps

Another option for monitoring wheat midge in spring wheat, particularly in fields that may be hard to access for frequent monitoring in the evenings during susceptible stages, is using yellow sticky traps. With this method yellow sticky cards (75 X 125 mm) are put on stakes and placed at the height of the wheat spikes. Traps are placed in the field when wheat spikes begin to emerge and collected after 3 evenings in the field. Ten traps placed at 10-m intervals provide an effective sampling size. Depending on the value of the wheat, three or 4 wheat midge per 10 traps is considered the action threshold.

Pheromone for male wheat midge

A pheromone lure has been developed that is attractive to males of wheat midge. However, these lures may be ineffective for monitoring of wheat midge when wheat is grown in rotation with a non-host crop. Emergence and mating of wheat midge will occur in fields that were in wheat the previous year. This is followed by dispersal of the female wheat midge, but not male wheat midge, to the current year's wheat to lay eggs. Thus catch of male wheat midge in the traps may be highly influenced by proximity to a field where wheat was grown the previous year, and not account for the different dispersal behaviour of the female wheat midge.

Economic Threshold

When maintaining optimal grade is important, the suggested threshold is 1 adult midge per 8 to 10 wheat heads during the susceptible stage.

When yield is the only consideration, the suggested threshold is 1 adult midge for each four or five heads.

Pest Management

Biological, cultural and chemical controls affect wheat midge populations.

Biological Control

Parasitoids: Wheat midge populations are often held in check by a small, 1-2 mm (1/25-1/12 inch) long parasitic wasp called *Macroglenes penetrans*. This small wasp emerges from its pupa about the same time as its host and lays its eggs inside the eggs of the wheat midge. The wasp egg and the midge egg hatch about the same time and the tiny wasp grows slowly inside the midge larva. It remains dormant within the midge larva over winter.

In the spring, the parasite grows rapidly, destroying the midge larva. Under natural conditions, this parasitic wasp controls about 40 percent of the over-wintering population of wheat midge each year.

Figure 6. ***Macroglenes penetrans***

Predators: Ground beetles (Carabidae) will feed on larvae of wheat midge when they are in the soil. Studies in Saskatchewan found 14 species of ground beetles feeding on wheat midge larvae, and estimated daily predation ranged from less than one to 86 wheat midge larvae per m^2.

Cultural Control

Crop Rotation: Continuous wheat cropping should be avoided because this practice favours the buildup of midge populations.

When wheat midge populations are high in the soil of a particular field, it is best to switch from wheat and plant crops that are not susceptible to midge, such as oilseeds and pulse crops. Cereal crops such as barley, oats and annual canary grass can also be grown with little or no risk of damage.

Seeding Date and Rate: For spring wheat varieties, damage from a wheat midge infestation can be minimized by selecting early maturing varieties, increasing seeding rates to two bushels per acre and seeding as early as possible. By seeding early maturing varieties early, the crop may head and flower before peak adult midge populations occur.

Midge Tolerant Wheat

As of June 2023 there were 40 variety blends of wheat with midge tolerance, in 8 different classes of wheat (CWRS, CPSR, Durum, CWSP, CWSWS, CNHR, CWES, CWHWS). Midge tolerant wheat is sold as variety blends because 10% of a susceptible variety is mixed in with the midge tolerant variety to reduce the risk of wheat midge developing resistance to the resistant wheat variety.

The CWRS variety Waskada, although a refuge variety for some variety blends, is less susceptible to damage because of either oviposition deterrence or poor establishment on the seed.

The following website on midge tolerant wheat has a list of midge tolerant wheat varieties, and information on these varieties: https://midgetolerantwheat.ca/

Chemical Control

Stage of Crop: An insecticide application would be economical if the economic threshold has been reached after the ears have become visible, but before the crop has flowered. Application during the advanced stages of flowering is discouraged because plants in this growth stage are no longer susceptible to attack and the insecticide will have a negative impact on parasitoids of wheat midge.

Time of Day: All insecticides should be applied in the evening when female wheat midge are most active at the top of the crop canopy. However, early morning applications may also produce acceptable results.

Registered Insecticides:

Table 3. Insecticides registered for wheat midge on wheat in Canada.

Insecticide	Rate (L / ha)	Rate (L / acre)	Preharvest Interval (days)
[1]**Chlorpyrifos -** Lorsban, Pyrinex, Warhawk, Sharphos	0.83 - 1 L	0.336 - 0.405 L	60
Dimethoate - Cygon, Lagon	1 L	0.40 L	35

[1]Retailers are no longer allowed to sell chlorpyrifos (Lorsban, Pyrinex, Warhawk, Sharphos), as of December 2022. Producers have until December 2023 to apply remaining product before the product is officially unregistered and unusable for application.

Dimethoate is applied with ground or aerial equipment and provides effective contact control of adults and some residual control. It does not control eggs. Application should be made within 24 hours of reaching the action threshold - while the adults are still active. If adult midge persist, a second application may be required, provided the crop has not started to flower.

Chlorpyrifos effectively control both adults and eggs. Because these insecticides control eggs, they do not have to be applied within 24 hours of having reached the action threshold as is the case with dimethoate. In fact, application should be delayed up to four days after the recommended action threshold has been reached to allow the emergence of the maximum number of wheat heads from the boot.

Before deciding to apply insecticides for wheat midge, consider:

- Levels of wheat midge adults present (are they above the economic threshold),
- Distribution of wheat midge in field (are levels higher in some locations of the field),
- The stage of the crop. If the crop has flowered, spraying will not be economical and could reduce levels of parasitoids.

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For more information contact: John Gavloski, Entomologist, Manitoba Agriculture, Carman, Manitoba, Canada, 204-750-0594.