

Insect IPM in Organic Field Crops: Seedcorn Maggot

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The seedcorn maggot (SCM), *Delia platura*, is a soil insect pest of corn, soybean, and vegetable crops. Small grain or legume green cover crop incorporation, weed cultivation, and animal manure organic matter can increase attractiveness of fields to adult SCM flies at spring planting. However, conventional SCM management methods of synthetic insecticide seed treatment and cover crop or weed herbicide burn-down are incompatible with organic agriculture.

This publication addresses cultural control integrated pest management (IPM) strategies for SCM in corn and soybean. Planting crops during the “fly-free” period between SCM generations, when the insect population is entering its non-feeding pupal stage, can minimize SCM damage. This fact sheet provides information on SCM identification, life cycle, crop damage symptoms, and the use of insect degree days to forecast fly-free periods during the growing season.

Appearance

Eggs of the seedcorn maggot are white, oval-shaped, and approximately 0.04 inch (1 mm) long. The larvae are cream-colored, legless maggots with a tapered head and wedge-shaped anterior end (figure 1). Larvae complete three instars increasing in length from 0.03 inch (0.7 mm) to approximately 0.25 inch (7 mm) when full-grown. The pupae are light reddish brown, cylindrical capsules, 0.20 inch (5 mm) long by 0.06 inch (1.5 mm) wide, becoming darker brown prior to emergence as adults (figure 2).

Adult seedcorn maggot flies are dark gray and approximately 0.2 inch (5mm) long, about half the size of a common housefly. The thorax (middle section behind the head) is bulkier than the abdomen and covered with numerous bristles (figure 3). The wings are clear with distinct wing venation, and overlap the body when the fly is at rest.

Figure 1. Seedcorn maggot larvae



Figure 2. Seedcorn maggot pupae



Life cycle

Seedcorn maggots overwinter in the soil as pupae. Adult flies emerge in spring once the ground has thawed and sufficient heat units, or degree days, have accumulated for SCM to reach the adult stage. Estimating peak spring emergence, the point at which 50% of the adult fly population has emerged, is possible with an understanding of insect degree days (see below for explanation). Peak spring emergence of the overwintered generation will occur at 360 Fahrenheit degree days (base 39°F) or 200 Celsius degree days (base 3.9°C).

Figure 3. Seedcorn maggot adult fly



Female seedcorn maggot flies are attracted to fields with decaying organic matter associated with spring cover crop incorporation, weed cultivation, or animal manure application. After mating, females lay eggs in freshly plowed fields. Eggs are deposited at the soil surface, singly or in small clusters. Eggs are difficult to see in the soil, but this is not necessary for management purposes.

Eggs hatch within 2–4 days and develop through three larval instars. These occur entirely in the soil where the maggots burrow into seeds and feed on cotyledons (seed leaves) of germinating seeds. Maggots also feed on the hypocotyl of germinating soybeans. Larval development is followed by the non-feeding pupal stage, after which the next generation of adult flies emerges.

Seedcorn maggot has three generations in the upper midwestern United States. A complete life cycle, from egg to adult, generally requires about 3–4 weeks in Wisconsin, depending on temperature and location. The first generation occurs in spring when field corn and soybean seeds are most susceptible to SCM larval feeding damage. During subsequent generations, established corn and soybean stands are no longer vulnerable to SCM damage.

Figure 4. Seedcorn maggot larvae feeding on soybean seed



Damage

Seedcorn maggots feed below ground on seeds and germinating seedlings. The larvae penetrate seeds, leaving holes or scarring, and these can cause decay. Damaged seeds may fail to emerge. Crop stand loss can be widely distributed throughout the field and may require replant under heavy infestations. Damage to both corn and soybean can occur, but is usually more severe in soybean fields.

On soybean, maggots burrow into the seed (figure 4). If the seed germinates, maggots feed on the cotyledons causing brown feeding scars. Soybeans may emerge as characteristic “snakehead” seedlings with missing cotyledons (figure 5). On corn, all parts of the germinating seed are susceptible to feeding (figure 6).

Figure 5. Soybeans emerge with missing cotyledons as “snakehead” seedlings after seedcorn maggot have fed below ground on germinating seeds



Sarah Schramm

Because SCM larvae infest germinating seeds below ground, the likelihood of SCM crop stand damage increases with time between planting and seedling emergence. Crop stands are more susceptible to SCM damage under environmental conditions that delay emergence, such as cool spring temperatures and wet field conditions that cause soil surface crusting. A rotary hoe can be used to break up hard soil surfaces and help promote stand emergence. However, SCM damage may go unnoticed or be difficult to distinguish from problems caused by seedling fungal diseases or other soil insect pests.

Figure 6. Seedcorn maggot larvae feeding on corn seed



Cropping system perspective on seedcorn maggot

Since seedcorn maggot flies are attracted to lay eggs in fields with decaying organic matter, incorporation of a small grain or legume green manure cover crop in spring can increase potential for SCM damage (figure 7).

The risk of SCM problems in corn and soybean increases with tillage intensity and crop residue incorporation. No-till and minimum tillage attract the lowest densities of adult SCM flies. Populations increase moderately with chisel plowing where residue is incorporated in the process of inverting the soil. Plowed and disked fields are most attractive to flies.

Adult flies prefer fields in which legumes are incorporated prior to crop planting as compared to grass incorporation. Previous research in Ohio found significantly greater numbers of SCM adults in plots where alfalfa was incorporated prior to soybean planting, followed by rye, soybean residue, and corn residue. More SCM are found where live, green legume, or grass cover crops (rather than dead crop residue) has been incorporated into the soil. Soybean planted into a rolled or crimped winter rye cover crop may be attractive to adult flies as rye plant material begins to decompose, but it will be less attractive than when incorporated with greater soil disturbance.

Damage potential to corn, soybean, and vegetables is greater when a crop is planted within 17–21 days (2.5–3 weeks) of incorporating a living green cover crop, particularly if planting is done immediately or shortly after tillage.

Figure 7. Adult seedcorn maggot flies are attracted to lay eggs in fields where a green cover crop has been incorporated in spring shortly before corn or soybean planting.



Management

There is no economic threshold or rescue treatment option for SCM adults or larvae in the soil. Once larval feeding has occurred, it is too late to suppress further damage. This is true regardless of cropping system—conventional or organic. Accordingly, SCM management strategies must follow a preventive approach.

Incorporating grasses instead of legumes, practicing no-till or conservation tillage with minimal green crop residue incorporation, or waiting to plant for 2.5–3 weeks after cover crop incorporation will decrease attractiveness of fields to SCM flies. Planting into warm, dry soil promotes rapid emergence and shortens the time seeds are exposed to SCM larvae. However, one or more of these practices may be incompatible with a grower's organic system plan or under a given year's weather conditions. Therefore, an understanding of the SCM life cycle can be used to reduce the risk of damage.

A key cultural control is to plant during the fly-free window between SCM generations, when the population is nearing its non-feeding pupal stage. Determining the fly-free period and timing of the pupal stage in the field requires an understanding of insect degree days.

Insect degree days

Insect degree days measure heat unit accumulation required for insect development. Degree days are calculated on a daily basis, with each day's value added to the previous sum for a cumulative total. The date from which to begin degree day accumulation for a particular insect is referred to as the **biofix date**.

This event may be a calendar date for insects that overwinter in the local area, or an event such as peak pheromone trap catch for migratory insects.

Insect degree days are useful because insects develop through each life cycle stage incrementally, depending on temperature. Development is bounded by lower and upper developmental thresholds. The lower developmental threshold, or **base temperature**, is the temperature below which development stops. For example, SCM overwinters as pupae in the soil. It does not resume development in spring until air temperature meets and exceeds its lower developmental threshold, or base temperature, of 39°F (3.9°C). SCM degree days can then be calculated each day until enough heat units have accumulated for adult flies to emerge from the soil.

All insects require a certain number of heat units to develop from one life stage to the next. Heat unit requirements vary by insect species. This information is obtained through laboratory and field experiments. Insect development occurs faster at warmer temperatures and more slowly at cooler temperatures, within an optimal range between lower and upper developmental thresholds.

Calculating insect degree days

Progression through an insect's life cycle in the field can be estimated using temperature data from a weather station nearest the field or farm where IPM decisions are made. This information is accessible online and is unique to each state. Once you know the degree days required for a particular insect pest life cycle event (e.g., peak adult emergence, pupal development), you can estimate when these events will occur by calculating and accumulating degree days from the appropriate biofix date. The daily formula for calculating insect degree days (DD) is:

$$\text{DD} = (\text{maximum temperature} + \text{minimum temperature}/2) - \text{base temperature}$$

Each day's DD calculation is added to the previous sum for a running cumulative total. If the average daily temperature for a given day is less than the insect's base temperature, then zero insect degree days are accumulated for that day.

The UW-Extension Ag Weather website (www.soils.wisc.edu/uwex_agwx) provides thermal models and a degree day calculator (www.soils.wisc.edu/uwex_agwx/thermal_models/degree_days) for field and forage crop insect pests in Wisconsin and Minnesota, including alfalfa weevil, European corn borer, common stalk borer, and seedcorn maggot. This website allows users to access weather station air temperature data to conveniently check insect degree day accumulation for their location. This is useful when a field crop scouting and/or treatment action decision window is approaching.



If internet access is unavailable, the degree day formula above can be calculated by hand each day, and degree days can be accumulated from the biofix date. Daily maximum and minimum temperatures can be obtained from a local newspaper or on-farm air temperature devices.

Determine SCM peak adult emergence

For growers to adjust planting dates to match the SCM fly-free period, it is first necessary to determine when 50% of the population has emerged as flies. The majority of eggs will be laid in the soil during this period of peak fly activity. From the biofix date of peak adult emergence, SCM egg and larval development times are known and can be used to estimate when SCM will enter the pupal stage in the soil.

Three methods have been suggested by previous research to determine SCM adult emergence peak(s):

1. Calculate SCM degree days beginning January 1. Peak adult emergence of first generation occurs at 360 Fahrenheit degree days (FDD) (base 39°F) or 200 Celsius degree days (CDD) (base 3.9°C) (table 1).
2. Assume peak adult emergence occurs at the date of spring tillage since adult SCM flies will be attracted to freshly plowed fields with decomposing plant organic matter.
3. Set yellow pan traps filled with soapy water around field edges. Check weekly during spring, and identify and count SCM flies to determine adult emergence peak(s).

Plant during the fly-free window

By calculating SCM degree days, growers can avoid planting field corn, soybean, and later crops such as sweet corn or vegetables during peak adult emergence when risk of SCM damage to untreated seeds is highest (table 1).

From the date of first-generation peak adult emergence, an additional 450 FDD (250 CDD) can be accumulated to predict when first-generation larvae will enter the pupal stage. The egg stage requires 54 FDD (30 CDD) and the three larval stages require 367 FDD (204 CDD). In addition, a minimum of 65 FDD (36 CDD) is required between adult emergence and egg laying. Therefore, approximately 450 FDD (250 CDD) after peak adult emergence, developing SCM larvae should have reached the pupal stage, further minimizing the risk of injury to developing seeds. Accounting for peak adult emergence, egg laying, egg and larval stages, this represents a seasonal accumulation, from January 1, of approximately 846 FDD (470 CDD).

Another important aspect of the cultural control approach to SCM management is knowledge of field history, including previous cropping practices and SCM problems. This will help guide future management improvements. Keeping records of how well weather station insect degree day data has targeted the fly-free window will allow growers to make necessary modifications to fit a particular location or microclimate.

Table 1. Seasonal accumulation of seedcorn maggot degree days from January 1 biofix date to adult emergence peaks for first, second, and third generation flies

	First generation	Second generation	Third generation
Fahrenheit degree days (FDD)	360	1,080	1,800
Celsius degree days (CDD)	200	600	1,000

UW-Extension Ag Weather

The UW-Extension Ag Weather website offers weather, sun, water, and degree day thermal model data tools to assist growers and others in agriculture in making informed decisions about management practices.
www.soils.wisc.edu/uwex_agwx.

Degree day calculator

This calculator on the UW-Extension Ag Weather website allows you to input your Wisconsin or Minnesota location, method of calculation, and appropriate biofix dates.
www.soils.wisc.edu/uwex_agwx/thermal_models/degree_days

Each model in UW-Extension’s Ag Weather database gives degree days in Fahrenheit units. Be sure to use the Fahrenheit scale when using this degree day calculator. It takes nine Fahrenheit degree days (FDD) to make five Celsius degree days (CDD). $CDD = 5/9 (FDD)$ and $FDD = 9/5 (CDD)$.



Seedcorn maggot degree days can be calculated on the degree day calculator website as follows:

1. First, select the latitude and longitude location nearest the farm or field for which you wish to calculate seedcorn maggot degree days.
2. Next, choose the degree day calculation parameters required.
Note: These parameters are usually specific for a particular crop or insect pest. Make sure you are using the correct ones for your particular situation.

Pest	Method	Base temp	Upper temp	Biofix
Seedcorn maggot	Sine	39°F	84°F	Jan. 1

The biofix is the date from which to begin calculating degree days. Use January 1 to predict adult emergence peaks for each generation (table 1). Avoid planting untreated seed to recently tilled fields during peak fly emergence.

The date of first generation peak adult emergence can then be used as a biofix from which to accumulate approximately 450 additional FDD (250 additional CDD) to predict when first generation larvae will enter the pupal stage.

3. Choose your data output format:
 - a. Choose your end date. The website end date will default to the most recent date for which weather station data are available.
 - b. If you select “seven-day summary page,” the value on the bottom right corner of the displayed output table will be the total accumulation of FDD beginning from the biofix start date, but only displaying the last seven days.
 - c. If you select “as text, for selected time period, ready for downloading,” the value on the bottom right corner of the last row of displayed output will be the total accumulation of FDD beginning from the biofix start date.
4. Click the “submit” button to obtain your results.

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