Grasshopper Biology and Management

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Each season grasshoppers are a threat to field crops, forage crops, pastures and rangeland in North Dakota.

The most severe infestations are likely to occur during seasons when the weather is hot and dry.

Scouting should begin in May and early June, and producers should be prepared to start management measures when young hopper populations reach threatening levels.

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Life Cycle

Figure 1. Grasshopper life cycle. (10KB b&w illustration)

Grasshopper eggs are laid beneath the soil surface in pod-like structures that the female deposits from her abdomen. Each egg pod consists of 20 to 120 elongated eggs securely cemented together; the whole mass is somewhat eggshaped and covered with soil. A female grasshopper produces from eight to 25 egg masses. The species of grasshoppers that cause major crop loss overwinter in the egg stage, although a few other noneconomic species overwinter as nymphs.

In the Northern Plains, grasshopper egg hatch normally begins in late April to early May. The peak hatch occurs about mid June and the hatch is usually nearing completion by late June. Cool and extremely dry springs may delay the hatch, allowing it to continue into July.

Young grasshoppers are referred to as nymphs. They are similar to adults in general appearance but are smaller and have wing pads instead of wings. There are usually five or six nymphal stages and the length of time from egg to adult is 40 to 60 days. Knowledge of grasshopper instar identification is useful because it gives a rough indication of how far the hatch has progressed.

Normally, once fourth and fifth instar grasshoppers are present, the hatch is winding down. More important, recognition of fifth instar hoppers indicates that the winged adult stage is soon to follow. Winged adults are much more mobile than the nymphal stages. Wingpads of first to third instar hoppers are borne saddle-like over the thorax. Wingpads of fourth and fifth instar hoppers are pointed backward over the abdomen and differ only in size. In the fourth instar they are relatively small and extend only to the first abdominal segment, while in the fifth instar they are large and extend past the second abdominal segment.

Adults of crop-damaging grasshopper species become numerous in mid July with egg laying activity usually beginning in late July and continuing into fall. Eggs are deposited in a variety of non-crop areas including ditches, fence rows, shelterbelts and weedy areas. They are also laid in cropped areas including late season crops, weedy fallow fields and headlands as well as in haylands and alfalfa. Migratory and clear winged grasshoppers frequently lay eggs in pastureland.

Damage

Weather is the main factor affecting grasshopper population levels (Figures 2 and 3). Outbreaks are usually preceded by several years of hot, dry summers and warm falls, allowing populations to increase slowly (Figure 4).

Figure 2. How weather affects grasshoppers.

Temperature Effects	Rainfall Effects
• High temperatures in summer - fall Early maturity of grasshoppers Long egg laying period • Warm spring Early hatch, followed by: <70^{o} -->No feeding, high mortality Warm and dry --> Good start for hoppers • Winter temperatures have little affect	• Cloudy, wet weather for 1+ weeks Promotes fungal pathogens of grasshoppers Prolonged wet period important • Heavy rains during emergence Kills young grasshoppers embeds young hoppers in soil physically wash them away • Extreme drought Poor egg hatch Hoppers starve from lack of food Low egg production by adults

Figure 3. Weather effects and their impact on grasshopper populations.

Decrease when . . .	Increase when . . .
• Warm early spring premature hatch IF get a cold snap --> poor development • Hot period in early spring... promotes hatching ...following by cloudy, wet weather favors the occurrence of disease • Cool summer and early fall delays the maturity of the grasshoppers shortens the time for egg laying	• Cool, wet weather in early spring prevents premature hatch insures adequate food supply • Warm and dry in late spring promotes uniform hatching time good weather conditions for feeding • Hot summer with adequate rainfall provides good food supply low incidence of disease • Late fall long egg laying period

Grasshopper damage to wheat and other cereal crops is generally concentrated near field margins. Individual plants will exhibit leaf stripping, beard loss after heading, head clipping, and kernels that have been fed upon or completely destroyed. When grasshopper populations are extremely high and food plants are scarce, grasshoppers migrate and will consume almost any plant they come upon. Row crop producers should be aware of the potential for grasshoppers to move into row crops after small grains have begun to dry down.

Natural Enemies

Natural enemies including parasites, predators, and diseases help to control grasshopper populations. All grasshopper

stages are attacked by some type of natural enemy.

Parasites of grasshoppers include insects, nematodes, or mites which live in or on grasshoppers or their eggs for an extended period of time. They either consume or weaken grasshoppers, resulting in death or weakened populations. Some insects, such as wasp-like members of the family Scelionidae, parasitize the egg stage. Other insects attack the nymphal and adult stages of grasshoppers. These include flesh flies, tachinid flies, and tangle-veined flies. The adults of these flies lay eggs on, in, or near grasshoppers. When these eggs hatch, the resulting larvae feed on the grasshoppers. Nematodes, also called threadworms or hairworms, feed coiled up inside grasshoppers. This parasite often causes death, sterility, or reduced vigor of the insect. Small red mites are often seen as external parasites of grasshoppers but are generally not effective in reducing populations.

Predators of grasshoppers include arthropods, birds, and mammals. Egg predators include crickets, ground beetles, and the larvae of blister beetles and bee flies. Spiders, wasps, robber flies, rodents, and birds eat nymphal and adult grasshoppers. In the 1920s and 1930s, flocks of turkeys and chickens were often recommended for grasshopper control. The effectiveness of this technique is questionable and reportedly led to other problems. The fowl often became "crop-bound" and required special treatment to eliminate grasshopper wings and other indigestible parts. Claims were also made that a diet of grasshoppers tainted the birds' flesh.

Grasshoppers are susceptible to a large array of natural diseases caused by bacteria, viruses, protozoans, and fungi. Out of these four groups, three of them (viruses, protozoans, and fungi) are currently being studied in an attempt to develop applied biological control techniques. Research continues on several groups of entomopoxviruses that infect grasshoppers.

Figure 4. How grasshopper outbreaks develop

Outbreaks develop when . . .
there are several years of GRADUAL increase followed by an unusually FAVORABLE year

Low point . . .
ONE grasshopper per square yard

Favorable year . . .
TWO grasshoppers per square yard

Another . . .
FOUR grasshoppers per square yard (not enough to injure crops . . . yet)

Another . . .
EIGHT grasshoppers per square yard (now there is some injury)

One more . . .
24+ grasshoppers per square yard - outbreak with severe injury

Protozoans have been extensively studied for grasshopper control. The protozoan *Nosema locustae* is being commercially produced and marketed under various trade names such as Semaspore®. This organism is generally sold mixed with a bait. The grasshoppers ingest the spores and a certain percentage become infected. Infection can lead to death but more often causes reduced vigor and decreases egg-laying activity. This disease can be transmitted transovarially ("through the eggs") to offspring. It has been shown, in some cases, to cause a small reduction in grasshopper populations after several weeks, but it is not a good choice where immediate control is necessary.

A naturally-occurring fungus disease called *Entomophaga grylli* (commonly referred to as "summit disease") also attacks grasshoppers. Insects infected with this disease exhibit characteristic symptoms which are easy to recognize in the field. Shortly before death, grasshoppers crawl to the tops of the plants and die with their heads pointing upward and their legs wrapped tightly around the stalks.

Grasshoppers become infected from spores which stick to the bodies as they seek food. These spores germinate and penetrate the insect cuticle. The fungus then multiplies in the blood and grows on internal organs. At about the time the grasshopper dies, its body is full of several million resting spores. As the cadaver disintegrates, these resting spores are disseminated on the ground, germinate, and produce more sticky spores, thus spreading the disease (see Figure 5). This disease is capable of causing high mortality in grasshopper populations, but these epizootics (outbreaks) are usually sporadic and localized and generally occur late in the season after economic damage has occurred.

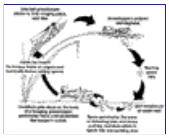

Figure 5. Life cycle of *Entomophaga grylli* fungus involves the death of a grasshopper. (11KB b&w illustration)

Research on this fungus has led to a better understanding of how the disease operates. Although moisture is required for the disease to spread, recent research suggests that it may not be as limiting a factor as once thought. Several strains of the disease occur worldwide and current research is focusing on the introduction of new strains into North American grasshopper populations.

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