E-1346

Diamondback Moth in Canola

Biology and Integrated Pest Management

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The diamondback moth, *Plutella xylostella* (Linnaeus), belongs to the order Lepidoptera and family Plutellidae. It is an important, occasional pest of canola in North Dakota. The immature stage, or larva, injures the leaves, buds, flowers and seed pods of canola. In the North Dakota, the severity of infestation varies considerably from year to year and depends on the numbers and seasonal timing of migrating moths. The most recent outbreaks occurred in 2001 and 2007, primarily in the north-central and northeastern regions of North Dakota.

Distribution

The distribution of the diamondback moth is worldwide, including North America, Europe, Southeast Asia and New Zealand. It was introduced into the United States in Illinois from Europe in 1854. The moth quickly spread to Florida and the Rocky Mountains in 1883 and to British Columbia by 1905. Currently, it is distributed throughout the United States wherever its host plants are grown.

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Figure 1. Diamondback moth adult. (Fauske, Department of Entomology, NDSU)

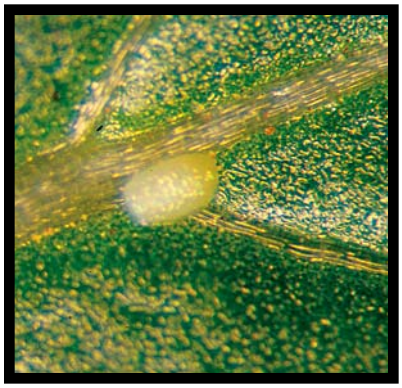

Figure 2. Diamondback moth egg. (Cranshaw, Colorado State University, Bugwood.org)

Figure 3. Diamondback moth larva. (Knodel, Department of Entomology, NDSU)

Figure 4. Diamondback moth pupae – newly formed (left) and old pupa (right). (Knodel, Department of Entomology, NDSU)

Identification

Adult (Figure 1)

The adult diamondback moth is a small gray or brown moth about ½ inch (12 to 15 millimeters) in length. At rest, wings are folded rooflike over its body. Light tan marks can be seen on the margin of the forewing. Male moths have three diamond-shaped markings on the back of the forewing when the wings are folded together, hence the name diamondback moth. Wing tips are fringed with long hairs.

Egg (Figure 2)

Eggs are laid singly or in small clusters of two to eight eggs on the underside of leaves or on stalks near terminal buds. Eggs are small, spherical and cream-colored. Eggs hatch after five to six days, depending on temperature.

Larva (Figure 3)

The newly hatched larva is light green and turns a darker green as it matures. Both ends of the larva are tapered slightly and the posterior end is forked. The body is covered with sparse erect black hairs. When the larvae are fully grown, they are about ½ inch (12 to 14 mm) long. When disturbed, larvae thrash backward violently and often drop from the plant, suspended on a strand of silk.

Pupa (Figure 4)

Mature larvae pupate within a loose, silken cocoon attached to the leaves, stems or pods. The cocoon is initially light green and gradually turns brown as the pupa matures. The yellowish pupa is ⅓ inch (7 to 9 mm) in length. The adult moth can be seen through the cocoon near the end of the pupal period.

Life Cycle (Figure 5)

Very few pupae survive the long, cold, harsh winters of North Dakota. Diamondback moths are generally weak fliers and usually fly within 6 feet (2 meters) of the ground. However, adults can be dispersed for hundreds of miles when swept up into strong upper-level winds that transport moths north each year. In North Dakota, migrating diamondback moths usually arrive in late May or early June. The complete life cycle takes about 32 days from eggs to adult, depending on daily temperatures. Moths can have three or more generations during a single growing season. Different generations often overlap, so all life stages (eggs, larvae, pupae and adults) can be found in the field at the same time.

Mated female moths lay their eggs on the underside of the leaves at night. Females lay eggs for about 10 days and lay an average of 150 eggs during their life. Eggs hatch after five to six days into pale, yellowish-green larvae (or caterpillars).

Larvae develop through four instars during a period of 21 to 30 days. The newly hatched larvae burrow into and mine inside the leaf for several days to a week. The larva exits the leaf and feeds externally for another seven to 14 days until it pupates. Pupation occurs in a silken cocoon and lasts about five to 15 days.

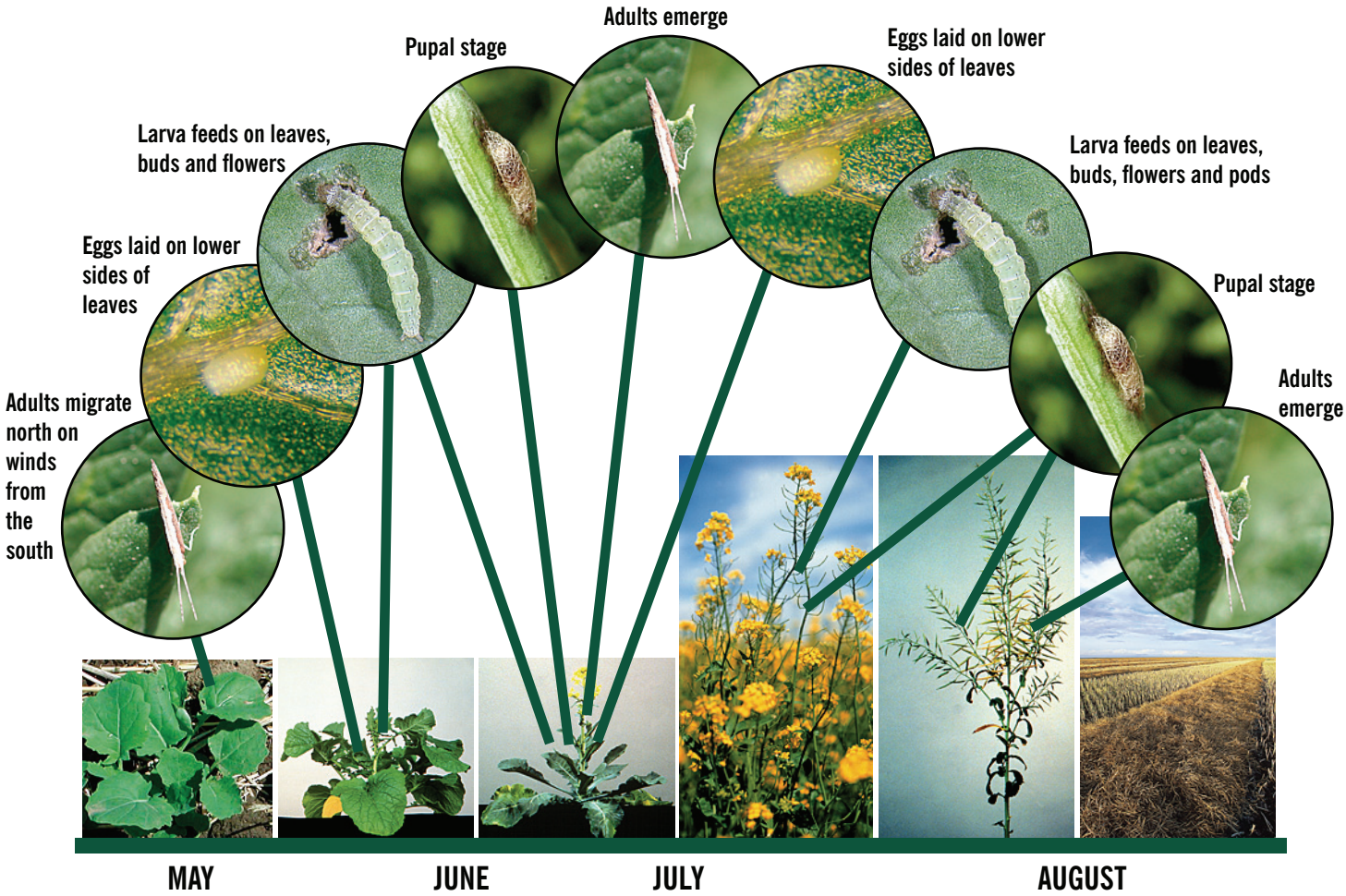

Figure 5. Life cycle of diamondback moth. (Adult moth – Cranshaw, Colorado State University, Bugwood.org)

Hosts

Diamondback moths are oligophagous insects that use several closely related host plants for oviposition and feeding. Larvae feed on cruficerous plants (Family Brassicaceae), including canola, leaf mustards, cabbage, broccoli, cauliflower, collards, brussels sprouts, horseradish, radish and turnips.

Figure 6. Leaf mines caused by the early instar larva. (Knodel, Department of Entomology, NDSU)

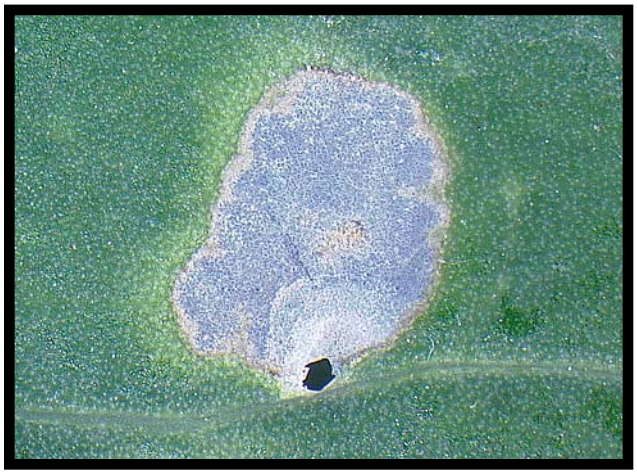

Figure 7. Leaf defoliation from young diamondback moth larva. (Knodel, Department of Entomology, NDSU)

Damage

Plant injury is caused entirely by larvae. The severity of diamondback moth infestations depends on the overwintering population in the southern states and how many moths migrate into North Dakota. The level of feeding injury varies greatly and depends on larval densities and plant growth stage. Larvae feed on the leaves, buds, flowers, seed pods, green outer layer of the stems and, occasionally, on the developing seeds. Larvae have two distinct feeding patterns:

1. Newly hatched larvae feed by internal leafmining (Figure 6).
2. Older larvae feed externally and cause leaf defoliation, aborted flowers, and chewed seed pods and stems.

Leaf feeding by young larvae results in a characteristic windowpane effect (Figure 7) and small, irregular-shaped holes. Mature larvae may eat the entire leaf, leaving only the veins. Foliar feeding often looks serious, but significant yield losses are not common unless plants are also under drought or heat stress. Larval feeding on flower buds and flowers causes flowers to abort (Figure 8). This injury is typically from larvae of the second generation and results in the most significant injury and subsequent yield loss.

Injury to canola by first-generation larvae generation is unusual, though significant defoliation has been observed on seedling canola when diamondback moths arrive in late May or early June. First-generation larvae typically are not controlled by insecticide seed treatments applied to canola seed, probably because the titer levels of insecticide within

the plant are below the toxic level by the time the moths arrive and the first larvae hatch. The second generation is usually present at blooming to early pod development when the crop is most susceptible to injury. Larval feeding during blooming to early pod development can cause delayed plant maturity, uneven crop development and significant yield reduction due to loss of flowers and pods. The third generation usually occurs too late in the season to cause plant injury, except in late-planted canola fields.

Detection and Monitoring

Sex pheromone traps are useful tools for detecting the flights of the adult diamondback moth. Researchers recommend that wing trap or delta trap styles with sticky inserts be used to capture adult moths. Pheromone traps should be suspended about 3 to 5 feet (1 to 1.5 meters) high at the field's edge (Figure 9). Traps indicate when moths have arrived in an area and give an indication of their relative numbers. High numbers of adults (>100 moths per week per trap) captured in the traps during bloom to early pod development provide an early warning that significant larval infestation may follow. Fields should be monitored for larvae then to assess the numbers of larvae present.

Diamondback moth larvae can be monitored in the field by pulling all plants from a 1-square-foot area. Beat collected plants onto a clean surface or into a white bucket and then count the number of larvae dislodged from plants. Larvae often will dangle from canola plants on a silk thread. Repeat this procedure in at least five locations in the field to obtain an average of the number of larvae per square foot.

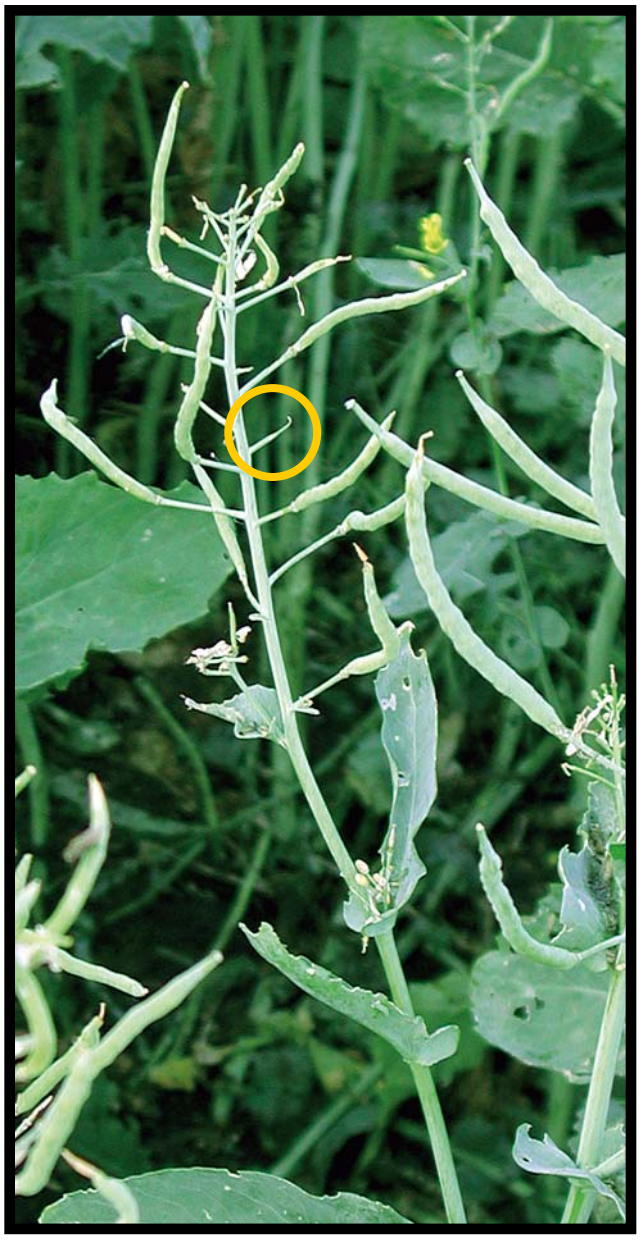

Figure 8. Aborted flowers caused by larval feeding injury during flowering. (Knodel, Department of Entomology, NDSU)

Figure 9. Sex pheromone trap for monitoring diamondback moth. (Knodel, Department of Entomology, NDSU)

Economic Threshold

For the early flowering stage, insecticide applications may be justified at larval densities of 10 to 15 larvae per square foot (or one to two larvae per plant). The economic threshold for canola at the pod stage increases to 20 to 30 larvae per square foot (or two to three larvae per plant). The best pest management practices for profitable yields while preventing losses from diamondback moth on canola include early monitoring of adults and larvae, and limiting use of insecticides to only those fields that reach economic thresholds.

Economic Threshold

Early flowering:
10 to 15 larvae per square foot

Pod stage:
20 to 30 larvae per square foot

Pest Management

1. Natural Control — Weather

A number of natural factors can affect populations of diamondback moths negatively. For example, heavy rainfalls can drown many larvae of the first or second generations. Humid conditions associated with rainfall can favor the development of lethal fungal diseases, such as *Entomophthorales*. In addition, cool, windy weather reduces adult activity and females often die before they lay all of their eggs.

2. Biological Control

Various parasitoid wasps — [*Diadegma insulare* (Cresson), *Microplitis plutellae* (Muesebeck), and *Diadromus subtilicornis (Gravenhorst)*] — and predaceous arthropods, such as ground beetles, true bugs, syrphid fly larvae, lacewing larvae and spiders,,can be important factors in controlling diamondback moth populations. In addition, *Entomophthorales* fungi play an important role in controlling moth populations. Disease outbreaks typically occur later in the growing season when diamondback moth populations are larger and weather conditions are more favorable for the fungi to develop.

3. Chemical Control

Despite a number of natural control factors and biological agents that suppress diamondback moth populations, the only effective way of controlling a severe infestation by diamondback moth is to apply an insecticide. Insecticides that are registered in canola and labeled for diamondback moth control are listed in the "North Dakota Field Crop Insect Management Guide," publication E-1143, at

www.ag.ndsu.edu/pubs/plantsci/pests/e1143w1.htm.

Selection of a suitable insecticide will depend on the environmental conditions, the presence of other insect pests and natural enemies, the number of days until harvest, the presence of pollinating insects and the cost of the insecticide. To protect pollinators, minimize insecticide applications to flowering canola, spray when pollinators are less active (during early morning or late evening hours), and select an insecticide with a lower toxicity level to pollinators.

For more information on this and other topics, see: www.ag.ndsu.edu

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