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MSU Extension Ag Alerts

Flea beetles and diamondback moth incidence reported on mustard *(General)*

Description: The crucifer flea beetle and diamondback moth have been reported on mustard in the Golden Triangle Areas of Montana (Collins, Knees, Dutton, Brady and Conrad). Both of these are pests on Brassica oilseed crops. Although larvae and adult flea beetles cause damage to the crop, adult beetles causes significant damage and yield losses, if not controlled. Larvae of diamondback moth feed on the leaves and bores into pods and eaten up the developing pods completely. For pest biology, ecology, thresholds, chemical control and other management option, please refer to attached alert documents.

Alert Period: 06/22/2017 - 07/31/2017

Submitted By: Gadi VP Reddy

Alert Documents:

Frost damage showing up in winter wheat heads and peas and some damage to anticipate *(Cropland Diseases)*

Description: Frost and wind damage common on wheat and pulses, clarification on fusarium head blight symptoms vs. frost, pictures of bacterial blights on cereals and pulses following hail, and a request for nice fresh samples when you send them in. --Mary Burrows, 599-9966, mburrows@montana.edu

Alert Period: 06/12/2017 - 06/26/2017

Submitted By: mary burrows

Alert Documents:

High level of cereal leaf beetle incidence in Choteau, MT *(Cropland*

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MONTANA STATE UNIVERSITY
College of AGRICULTURE & MONTANA AGRICULTURAL EXPERIMENT STATION

Western Triangle Agricultural Research Center

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Thursday, June 22, 2017

Flea beetles and diamondback moth incidence reported on mustard

Gadi V.P. Reddy
Western Triangle Agricultural Research Center, Montana State University, 9546 Old Shelby Rd., P. O. Box 656, Conrad, MT 59425, email: reddy@montana.edu

The crucifer flea beetle, *Phyllotreta cruciferae* and diamondback moth (*Plutella xylostella*) have been reported on mustard in the Golden Triangle Areas of Montana (Collins, Knees, Dutton, Brady and Conrad). Both of these are pests on *Brassica* oilseed crops. Although both larvae and adult flea beetles cause damage to the crop, adult beetles causes significant damage and yield losses, if not controlled. Larvae of diamondback moth feed on the leaves and bores into pods and eaten up the developing pods completely.

Figure-1: Canola flea beetle adult, *Phyllotreta cruciferae* (left) and damage to mustard (right)
(Photo credit: WTARC)

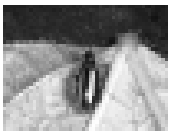
Figure-2: Larva of diamondback moth larva, *Plutella xylostella*
(Photo credit: WTARC)

For pest biology, ecology, thresholds, chemical control and other management option, please refer to attached alert documents.

Canola and Mustard XVI-5

Flea Beetles

Sue Blodgett & Greg Johnson



Flea beetle adult.

Identification (and life cycle/ seasonal history)

Overwintered adult flea beetles fly to volunteer rapeseed, canola or mustards when spring temperatures reach 68 ^{o}F. The shiny black beetles are 1/10 inch in length and have the characteristic of jumping from a plant when disturbed. Eggs are laid in the soil and hatch into larvae that feed on the roots of the canola/mustard plant. Larvae feed for 3-4 weeks, pupate and emerge as adults during July to early August. Emerging adults feed on any green plant tissue and then move to protected areas surrounding the field to overwinter. There is one generation per year.

Plant Response and Damage

Adult flea beetles can cause serious plant damage, seedling death and stand loss by feeding on the cotyledons and first true leaves of emerging seedlings. Adults feed on the underside of the leaf causing numerous small round holes or pits. Damage is most severe when plants are stressed, particularly during drought. Seedling canola plants cannot regrow if above ground plant parts are completely eaten. A systemic seed treatment such as imidacloprid is recommended. If a seed treatment is not used, then treat with an appropriate foliar insecticide when 25% of the cotyledons show severe pitting or tissue loss. Once plants have developed true leaves, damage may be tolerated except under extremely high beetle densities or drought conditions.

Management Approaches

Monitor newly emerged seedlings until plants are well established. Relatively low populations may cause damage when plants are newly emerged or during cold weather when plants are growing slowly.

Cultural Controls

Early planting and establishment of canola can prevent significant injury to young plants by flea beetles migrating to fields after the first true leaves are fully expanded. Remove weeds from field edges and control volunteer canola crops.

Check Prosper 400

Product List for Flea Beetles

Pesticide	**Product/Acre**	**Preharvest interval, Remarks**
Gaucho 600F	10.24 – 25.6 fl oz/cwt	Seed treatment. For use by commercial seed-treaters only.
Poncho 600	3.84 – 10.23 fl oz/cwt	Seed treatment. Rate depends on flea beetle pressure or where extended control is needed. All treated seed must be colored. Commercial treaters only. Replant restrictions.
Helix Xtra or Lite	23 oz/cwt.	Seed treatment. May be planted to wheat or canola as soon as necessary, other crops after 30 days.
Capture 2EC[R,1]	2.1 – 2.6 fl oz	35 days. 12 hr REI. Do not apply more than 5.12 oz /A /season. Do not make applications less than 14 days apart. See label for minimum gallonage.
Proaxis[R,1,2]	1.92 - 3.84 oz	7 days, 24 hr REI. Do not apply more than 0.72pt/A/season. See seasonal use rates for gamma and lambda cyhalothrin.
Pyrethrins[1]	2 – 16 oz (Evergreen EC 60-6) 4.5 – 18 oz (Pyganic EC 5.0)	0 Day, 12 hr REI . No less than 2 GPA by air or 10 GPA by ground. Buffer spray to pH 5.5 – 7.0.
Lambda-cyhaolthrin[R,1,2]	1.92-3.84 oz (Warrior with Zeon) 1.92-3.84 (Lambda T)	7 days, 24 hr REI. Avoid application when bees actively foraging by applying early morning or evening. Do not apply more than 0.72 pt/A /yr. See seasonal use rates for gamma and lambda cyhalothrin.

[1] *Label allows chemigation,*
[2] *Generic active ingredient, several formulations available, see labels for rates*
[R] *Restricted use pesticide*

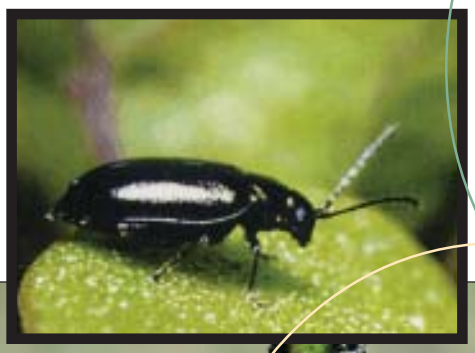
Categories: Canola, Mustard, Insects, Flea beetles

Date: 06/06/2006

E-1234

Crucifer Flea Beetle

Biology and Integrated Pest Management in Canola



Janet J. Knodel, Crop Protection Extension Specialist
North Central Research Extension Center

Denise L. Olson, Research Entomologist

Canola is an important oilseed crop in the northern Great Plains of the United States and Canada. Canola adds crop diversity to the cropping rotation systems in the region. Production has increased in the United States and Canada in response to the pest problems and low commodity prices of small grains and increased market demand by health conscious consumers for its high quality edible oil.

The crucifer flea beetle, *Phyllotreta cruciferae* Goeze, and the striped flea beetle, *Phyllotreta striolata* (F.) (Coleoptera: Chrysomelidae), are the most serious insect pests of canola. Both species were introduced from Eurasia. *Phyllotreta cruciferae* has become the dominant flea beetle pest of oilseed *Brassica* (canola). Adult flea beetles emerge in the spring and feed on the cotyledons and true leaves. When they emerge in large numbers, they can quickly devastate a seedling canola field; therefore, timely detection and management of this pest is important. Flea beetle damage to oilseed *Brassica* crops exceeds $300 million annually in North America.

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota 58105
SEPTEMBER 2002

Figure 1. Adult crucifer flea beetle, *Phyllotreta cruciferae Goeze.*

Figure 2. Adult striped flea beetle, *Phyllotreta striolata (F.).*

Figure 3. Flea beetle egg.

Figure 4. Flea beetle larva.

Figure 5. Flea beetle pupa.

Distribution

The crucifer flea beetle was introduced into North America in the 1920s and is now distributed across southern Canada and the northern Great Plains of the United States, including North Dakota, South Dakota, Montana, northwestern Minnesota, Manitoba, Saskatchewan, Alberta, British Columbia, Ontario, Quebec, and New Brunswick. The crucifer flea beetle is the most common and destructive flea beetle attacking canola.

In North America, the striped flea beetle was reported from "Carolina" in 1801 and is now widespread across Canada, United States, Mexico, and South America.

Identification

Adult

Crucifer flea beetle (Figure 1): The adult is a small, oval-shaped, blackish beetle with a bright blue sheen on the elytra, measuring about 1/32 to 1/8 in. (2-3 mm) in length. Flea beetles have enlarged hind femora (thighs) on their hind legs, which they use to jump quickly when disturbed. Their name, flea beetle, arose from this behavior.

Striped flea beetle (Figure 2): Adults are similar in size and shape to the crucifer flea beetle, but they are black with two yellow strips on their wing covers.

Eggs (Figure 3)

Eggs are yellow, oval, and about 0.38-0.46 mm long by 0.18-0.25 mm wide, and deposited singly or in groups of three or four adjacent to the host plant's roots.

Larvae (Figure 4)

Larvae are small approximately 1/8 in. or 3 mm, whitish, slender, cylindrical worms. They have tiny legs and a brown head and anal plate.

Pupae (Figure 5)

Pupae are similar in size to the adult and white in color except for the black eyes and the free body appendages, which are visible later in the pupal development.

Life Cycle (Figure 6)

Crucifer flea beetles have a single generation in the northern Great Plains. They overwinter as adults in the leaf litter of shelterbelts or grassy areas and are rarely found in canola stubble. Beetles emerge when temperatures warm up to 57°F (14°C) in early spring. They feed on volunteer canola and weeds, such as wild mustard, and move to newly planted canola as it emerges. Depending on the temperature, it may take up to three weeks for the adults to leave their overwintering sites. The striped flea beetle adults usually emerge before the crucifer flea beetle. Warm, dry, and calm weather promotes flea beetle flight and feeding throughout the field, while simultaneously slowing canola growth. In contrast, cool, rainy, and windy conditions reduce flight activity, and flea beetles walk or hop leading to concentrations in the field margins. Females oviposit up to 25 eggs in the soil in June. The overwintered adults continue to remain active until late June and begin to die off in early July. Larvae hatch from the eggs in about 12 days and feed on the secondary roots of the plant. No major effects on plant vigor from larval root feeding have been noted in North Dakota. However, a yield loss of 5% from larval densities of 1/sq. in. (0.16/sq. cm) has been recorded in Manitoba. Larvae pass through three instars and complete their development in 25 to 34 days by forming small earthen puparium. The pupal stage lasts for about seven to nine days, usually in early to mid-July. The new generation of adults emerge from the puparium beginning in late July until early September and feed on the epidermis of green foliage and pods of canola, mustard, and cruciferous weeds (Figure 7). The crop is usually mature enough that feeding damage is minimal. In early fall beetles move to overwintering sites.

Figure 6. Life cycle of the Crucifer flea beetle.

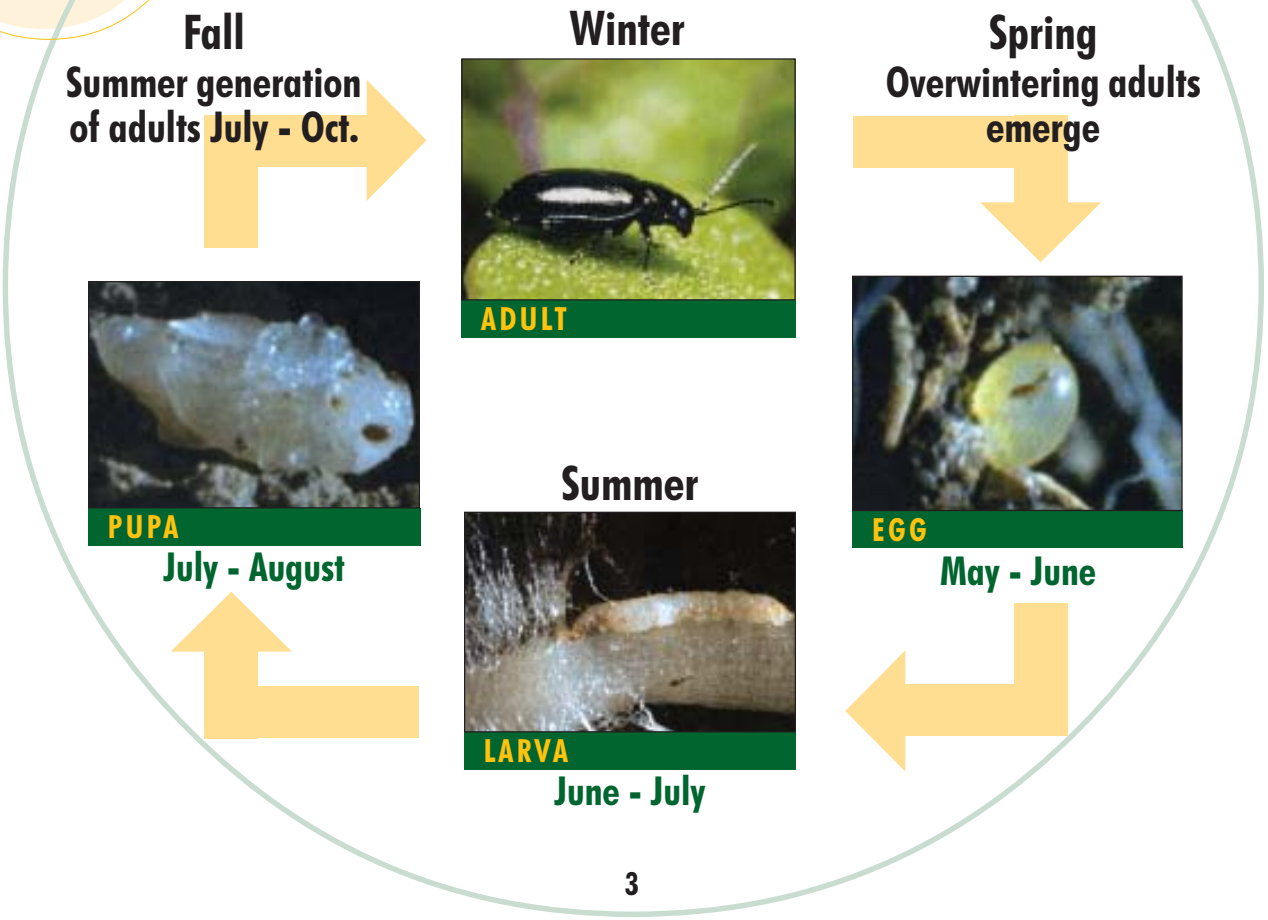


Figure 7. The new generation of flea beetles feeding on the green foliage and pods of canola in mid-July until early September.

Hosts

The crucifer flea beetle has a narrow host range restricted to plants primarily in the mustard family (Cruciferae). Other plant families attacked are the caper family (Capparidaceae), the nasturtium family (Tropaeolaceae), and the marshflower family (Limnanthaceae). Interestingly, all of the flea beetles prefer plant families that produce mustard oil (or allyl isothiocyanate), which is a known aggregation pheromone of the crucifer flea beetle. The most-preferred hosts are in the genus *Brassica* (Cruciferae), which include the major agricultural host attacked by flea beetle, oil rapeseed or Argentine canola *(B. napus)* and Polish canola *(B. rapa/campestris)*. Mustard (*Brassica* spp.) and crambe *(Crambe abyssinica)* are also susceptible to flea beetle attack but not preferred over canola. Other hosts that flea beetles will attack in the garden setting are cabbage, turnip, cauliflower, kale, Brussel sprouts, horseradish, and radish. Some weeds attacked in the cruciferous group are flixweed, field pennycress, peppergrass, and wild mustard.

Crop Damage

The greatest crop loss occurs during the spring when flea beetle feed on cotyledons and first true leaves during the first two weeks after emergence. Leaf tissue of the cotyledons die around adult flea beetle feeding sites producing a shot-hole appearance and necrosis (Figure 8). Under severe pressure in North Dakota, flea beetles have been recorded attacking the growing point (meristem tissue), killing the plant.

Adult feeding on young seedlings results in reduced crop stands and plant growth, delayed maturity, and lower seed yield. When flea beetle populations are large and warm, sunny, dry, calm conditions favor feeding, fields can be infested quickly and canola seedlings die.

Figure 8. Canola seedling damage, pitting caused by flea beetle feeding (top) and undamaged seedling (bottom).

Stand losses may result in having to reseed the field. Less severe infestations may result in stunted plants, uneven stands and maturation, and harvest problems. When weather conditions are cool, wet, and windy, flea beetles may creep slowly into the field and concentrate feeding on the field edges. Spring feeding activity occurs from May through June.

During the summer months, the larvae feed on the secondary root hairs, but only a negligible effect on yield loss or vigor has been observed. The summer generation of adult flea beetles emerge after mid-July and feed on developing pods (Figure 7). Usually the upper or younger pods and later seeded crops are most impacted. This feeding damage results in poor seed fill, premature pod drying, shriveled seeds, or pod shattering, and provides an entry point for fungal growth within pods in damp weather.

Integrated Pest Management

In the spring, overwintering flea beetle adults emerge, locate, feed on, and damage emerging canola plants. To effectively manage flea beetles and other pests of canola, producers should use an Integrated Pest Management (IPM) program. An IPM approach uses multiple strategies to control flea beetles, minimizes inputs, conserves the natural enemies of pests, and reduces the negative impacts of pesticides on the environment. This type of approach is also the most economical. Canola fields should be monitored on a regular basis to determine the level of infestation and damage.

Monitoring and Field Sampling

Flea beetles overwinter as adults and become active during early spring. Field monitoring for flea beetle activity should begin in newly emerged canola fields during May and June when air temperatures reach 57°F (14°C). Commercial, 4x6 in. yellow sticky traps (Figure 10) can be used for monitoring population levels, but they do not indicate the need for control actions. Assess the canola field for presence of flea beetles and their feeding damage during the first 14 days after crop emergence, or until plants have reached the 4-leaf stage. Fields should be checked daily to identify damage as it develops and to make timely management decision. Beetles are most active during sunny, warm, calm and dry weather conditions, so avoid monitoring for flea beetles when conditions are cool, windy, and damp.

The amount of defoliation should be used as a guide to determine the need for management action. Injury occurs first at the field edges, particularly where a shelterbelt/grassy area borders a field. The beetles readily fly when temperatures exceed 64°F (17.8°C) and will move quickly into the field's interior. To determine the extent and distribution of damage, start at the field margins and walk into the field, selecting plants at various random intervals. Estimate percent defoliation for each plant selected. **The economic threshold for a foliar application is when an average of 25% of the surface area of cotyledons and first true leaves has been injured (Figure 9) and beetles are present.** If leaf damage is less than 25% and the crop is actively growing, the crop can usually recover. **Watch fields closely in hot, dry weather, when flea populations can rapidly increase.**

Foliar treatments must be made quickly if damage exceeds 25% defoliation. Under high beetle pressure and feeding damage, a delay of one to two days can result in loss of entire fields. If damage is limited to only the edge, spraying only part of the field may

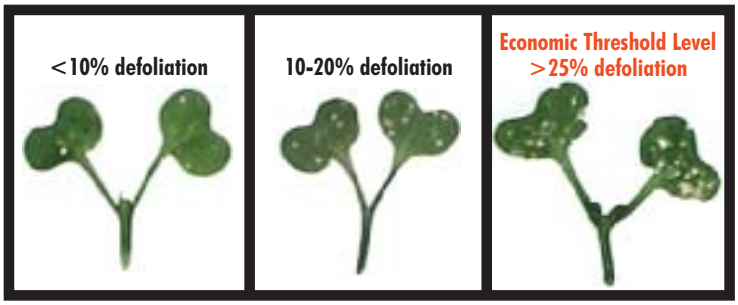


Figure 9. Examples of defoliation with 25% defoliation on canola cotyledons being an economic threshold level.

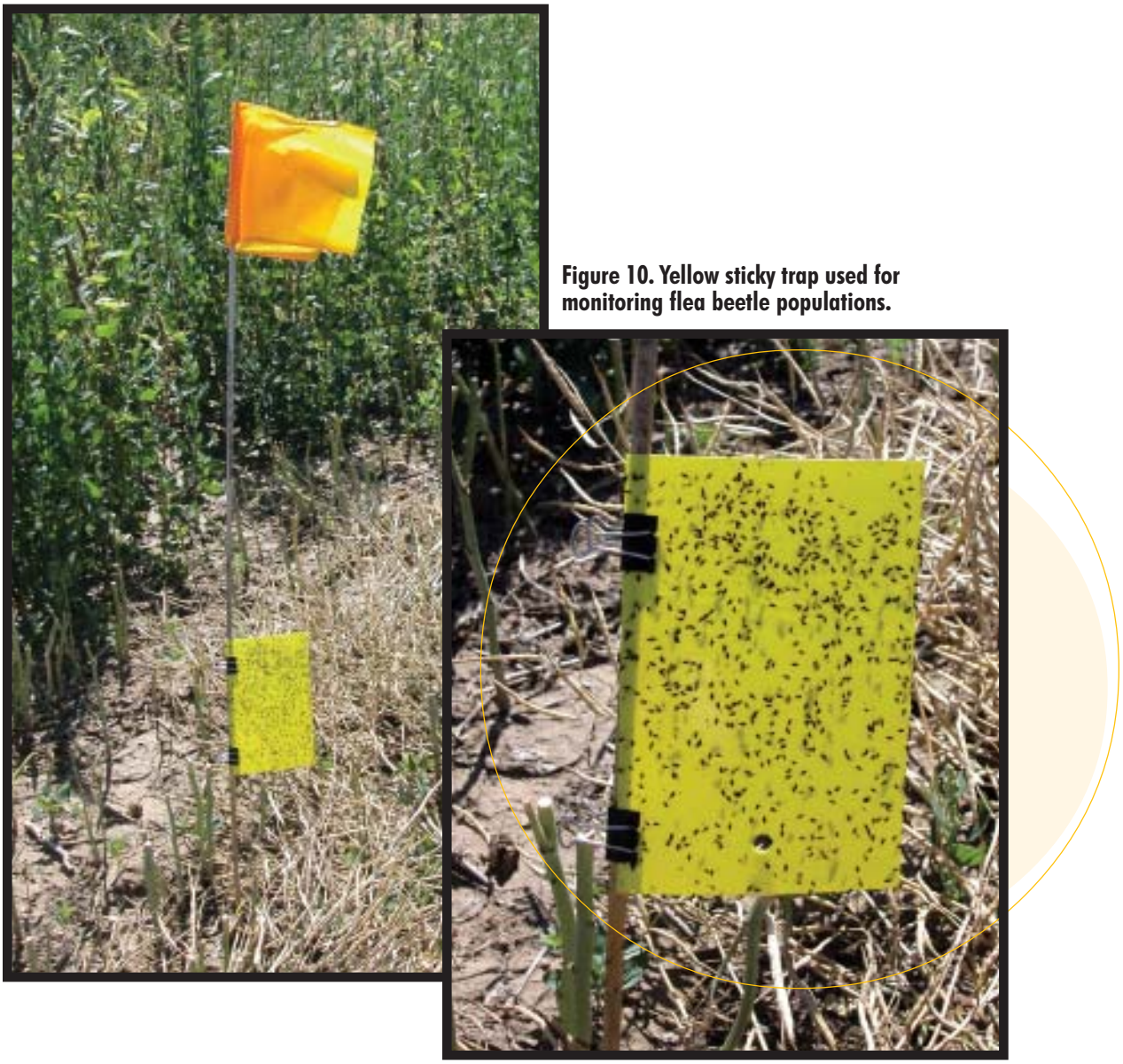


Figure 10. Yellow sticky trap used for monitoring flea beetle populations.

reduce flea beetle numbers. Apply insecticides during the sunny, warm part of the day when beetles are actively feeding on the plants. Canola plants that have reached the 4-leaf vegetative growth stage or beyond can tolerate more feeding damage, unless flea beetles are damaging the growing point. During years when flea beetles are abundant through June, a yield loss of about 10% can be common even when the crop is protected with insecticidal seed treatments. Under these conditions a later foliar treatment (21 days after planting) may be necessary to protect the crop from re-infestation.

The summer generation of adults emerging in late July and August will feed on the leaves, stems, and pods of the maturing crop, but usually does not cause economic damage. Control may be necessary in late maturing fields where large and increasing numbers of adults may congregate and feed on green pods.

Monitor the summer adult populations in late July and August to determine the need for protecting next year's canola crop. If the flea beetle population is abundant in canola swaths, consider a seed treatment for the following production season.

Economic Threshold

Seedling: 25% defoliation of cotyledons and first true leaves

Cultural Control

Planting Date

Canola planted early from April to mid-May reduces the risk of heat and drought stress during flowering and produces higher seed yields than canola planted from late May to early June. Early seeding with good quality seed into a shallow, firm seed bed also reduces the risk of feeding injury by flea beetles to canola seedlings. Planting early and shallow helps seedlings emerge earlier, so plants are larger and can tolerate more feeding by the time flea beetle populations are large. Increased seeding rates may also help reduce flea beetle impact by reducing overall damage per plant with more plants per unit area. In Canada, canola planted in wider row spacings of 7.8-11.8 in. (20-30 cm) resulted in decreased feeding damage per plant than narrower row spacings of 4 in. (10 cm). Later planted canola may not always avoid invasion of the flea beetle because of repeated migrations into the crop. Flea beetles continue to fly actively throughout May and June. Trap data of flea beetles in the north central region of North Dakota indicate that flight activity fluctuates throughout May and June, perhaps caused by favorable or unfavorable weather conditions.

Planting Systems

Use of different cropping systems such as no-till, minimum till, or fall dormant seeding, may offer an alternative to the traditional chemical control of flea beetles on canola. Since flea beetles are more active during sunny and warm days, it has been suggested that the different cropping systems may provide a less desirable, cooler micro-environment for flea beetle activity. Often, flea beetle populations are lower in no-till fields compared to conventional tillage fields. Dormant seeded canola may germinate, emerge, and reach the 4-leaf stage before significant numbers of flea beetles emerge from overwintering sites. Only 4% of the dormant-seeded fields in the north central region of North Dakota during 1999-2000 were sprayed with a foliar insecticide for flea beetle control, compared to 25% of the spring-seeded fields, according to a canola grower survey.

Crop Rotation

Since flea beetles are strong flyers and disperse over wide areas from overwintering sites, crop rotation is not an effective means of managing flea beetles. However, crop rotation is very important in reducing the level of canola diseases like blackleg and sclerotinia.

Plant Resistance

Although some of the larger-seeded varieties are more resistant to flea beetle damage due to their large seedling size, no canola varieties exhibit sufficient resistance to protect against flea beetle feeding damage.

Biological Control

Predators known to feed on flea beetles include lacewing larvae *(Chrysopa carnea),* big-eyed bugs *(Geocoris bullatus),* the two-lined collops *(Collops vittatus),* the western damsel bug *(Nabis alternatus)* and the northern field cricket *(Gryllus pennsylvanicus).* Parasitic wasps, like *Microtonus vittate,* are known to attack crucifer flea beetles, but the rate of parasitization is very low. Unfortunately, flea beetle populations emerge during a narrow window in the spring, and natural enemies usually do not have enough time to negatively impact flea beetle populations.

Insecticide Control

When flea beetle populations are large the previous fall, a seed treatment with a systemic insecticide should be applied as a preventive tactic. About 60-70% of canola seed in North Dakota is treated with an insecticide-fungicide. Treatments provide protection against flea beetles for about seven-14 days after seedling emergence. Flea beetles can still reduce yield of canola grown from treated seed by 8-10% when beetle populations are large and canola is past the protection period.

Foliar applied insecticides are effective when beetle populations have reached an economic threshold level and treatments are timed properly. Insecticides registered for flea beetle management in North Dakota as of 2002 are listed in the table below. Please check with the current *Field Crop Insect Management Guide* for updated insecticide registrations. Insecticide users must READ, UNDERSTAND, and FOLLOW ALL LABEL DIRECTIONS.

Registered Flea Beetle Insecticides

Insecticide	Dosage in Lb Ai/acre	Product Per Acre	Restrictions on Use
Capture 2 EC *RUP*	0.033 to 0.04	1.3 to 2.6 fl oz	Reduced rate is issued as a state 2 (ee) label. Apply in a minimum of 2 gals. of finished spray per acre by air or in a minimum of 10 gals. per acre by ground. When applying by air, 1 to 2 quarts of emulsified oil may be substituted for 1 to 2 qts of water in the finished spray. Do not apply within 35 days of harvest.
Ethyl-methyl parathion 6-3 *RUP*	0.5	0.66 pt	Aerial application only, using a minimum of 3 gallons of water per acre. Do not apply within 28 days of harvest. Do not enter treated fields for 3 days after application. Fields must be posted.
Gaucho		10.7 - 21.3 oz per hundred-weight of seed	For use in commercial seed treaters only. Not for use in hopper-box, slurry-box or other seed treatment applications at, or immediately before, planting.
thiamethoxam Helix (10.3% active) Helix Xtra (20.7% active)		23 fl oz per hundredweight of seed	For use in commercial seed treaters only. Contains 3 fungicides to protect against diseases. There is a 30 day plant back restriction.
Methyl parathion 8EC *RUP*	0.5	0.5 pt	Aerial application only, using a minimum of 3 gallons water per acre. Do not apply within 25 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.

RUP - Restricted use pesticide

Additional Sources

Canola Connection, Canola Council of Canada, http://www.canola_council.org/

Canola Production, NDSU Ext. Service Circular A-686, 1998, http://www.ext.nodak.edu/extpubs/plantsci/crops/a686w.htm

Northern Canola Growers Association, http://www.northerncanola.com/default.asp

2002 Field Crop Insect Management Recommendations, NDSU Ext. Service, Circular E-1143, http://www.ext.nodak.edu/extpubs/plantsci/pests/e1143w1.htm

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

E-1234

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Canola and Mustard XVI-8

Diamondback Moth

Sue Blodgett & Greg Johnson

Diamondback moth (DBM) cannot overwinter most years in the northern latitudes. Monitoring adult migration into northern canola production regions is important to determine the presence of this insect.

Identification (and Life cycle/seasonal history)

Moths are small, 1/3 inch in length, gray-brown colored insects with the folded wings flaring outward and upward toward their tips. Males have a row of three diamond-shaped yellow spots visible where the wings meet when the insect is at rest. Eggs are laid singly on canola or mustard foliage. Larva is a small, spindle-shaped, pale-green colored caterpillar that reaches about 1/3 inch in length. The tail end has a forked appearance. DBM larvae are distinguished by their violent wriggling, often dropping from foliage while suspended by a silken thread. Larvae feed on foliage but in dry years they may move to the reproductive parts of the plant and feed on buds, blooms and pods. Larva numbers are especially vulnerable to rainfall and humid conditions. Dry weather will cause leaf drop and cause larva to move to the reproductive portions of the plant. There are typically 2 generations per year, their importance as a pest is dependent on moth migration population, timing and conditions.

Plant Response and Damage

The larvae feed on plant foliage, chewing irregular holes in the leaves. Dry weather will cause lower leaves to drop and larva to move to the reproductive portions of the plant. Seedpod damage can lead to development of undersized, poor quality seed. Foliar damage by DBM larvae looks bad, but significant yield losses are not common. However, damage is much worse when plants are drought or heat stressed. Pod damage is likely to occur if lower foliage is damaged by drought or other insects.

Management Strategies

This insect is well documented for multiple resistance to many classes of insecticides.

In North Dakota treatment is recommended when larvae counts reach 25-30 per square foot and there is significant evidence of damage to flowers and/or pods.

Check confirm, GF-120, Spintor

Product List for Diamondback Moth, Loopers

Pesticide	Product/Acre	Preharvest Interval, Remarks

Bacillus thuringiensis[1]	0.25-1.5 lbs(Deliver) 0.12 – 1.5 lbs (JavelinWG)	0 days to harvest. 4 hrs REI. Apply at first sign of newly hatched larvae. Reapply as necessary to maintain control.
Capture 2EC[R,1]	2.1 – 2.6 fl oz	35 days. 12 hr REI. Do not apply more than 5.12 oz /A /season. Do not make applications less than 14 days apart. See label for minimum gallonage.
Proaxis[R,1,2]	1.92 - 3.84 oz	7 days, 24 hr REI. Do not apply more than 0.72pt/A/season. See seasonal use rates for gamma and lambda cyhalothrin.
Lambda-cyhaolthrin[R,1,2]	1.92-3.84 oz (Warrior with Zeon) 1.92-3.84 (Lambda T)	7 days, 24 hr REI. Avoid application when bees actively foraging by applying early morning or evening. Do not apply more than 0.72 pt/A /yr. See seasonal use rates for gamma and lambda cyhalothrin.
Pyrethrins[1]	2 – 16 oz (Evergreen EC 60-6) 4.5 – 18 oz (Pyganic EC 5.0)	0 Day, 12 hr REI . No less than 2 GPA by air or 10 GPA by ground. Buffer spray to pH 5.5 – 7.0.

[1] *Label allows chemigation,*
[2] *Generic active ingredient, several formulations available, see labels for rates*
[R] *Restricted use pesticide*

Categories: Canola, Mustard, Insects, Diamondback moth, Loopers

Date: 06/06/2006

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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JANUARY 2008

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

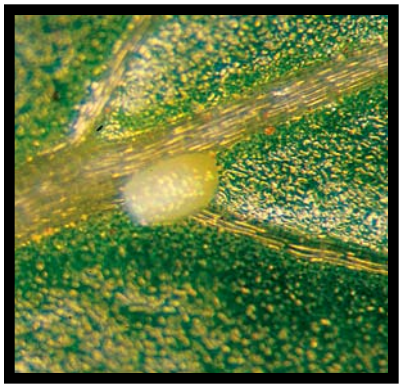

Figure 2. Diamondback moth egg. (Cranshaw, Colorado State University, Bugwood.org)

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.

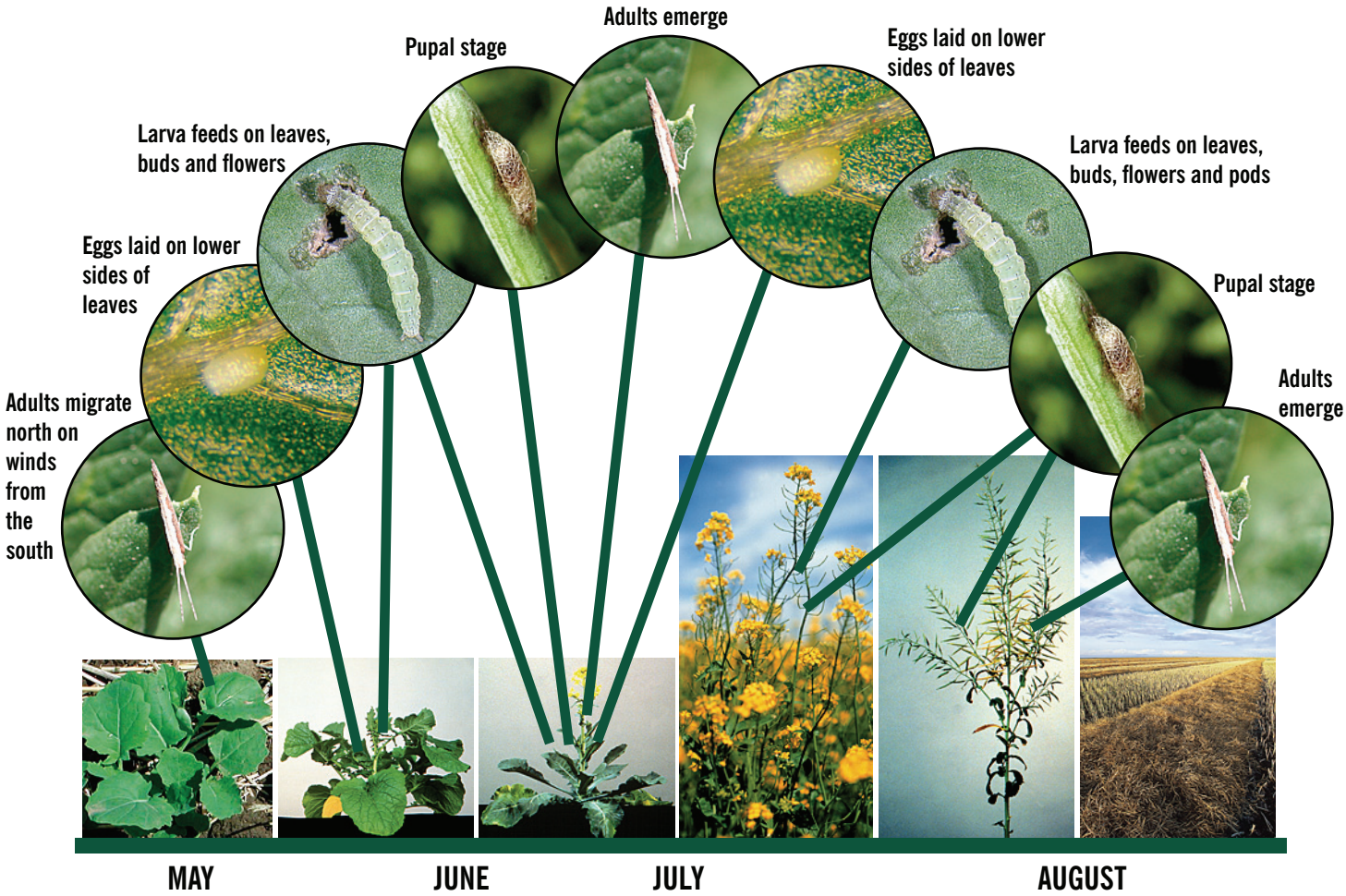

Figure 5. Life cycle of diamondback moth. (Adult moth – Cranshaw, Colorado State University, Bugwood.org)

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)

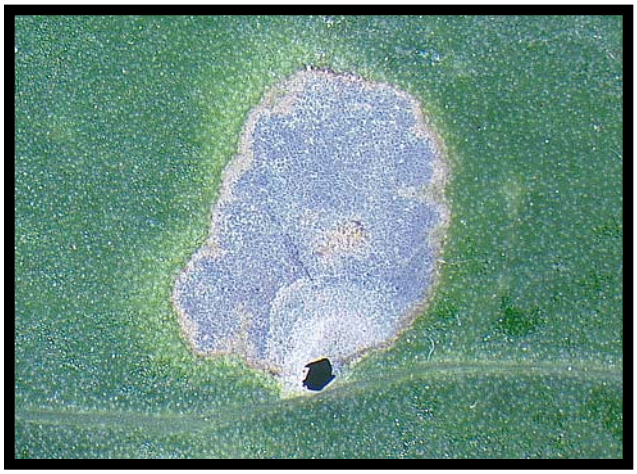

Figure 7. Leaf defoliation from young diamondback moth larva. (Knodel, Department of Entomology, NDSU)

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.

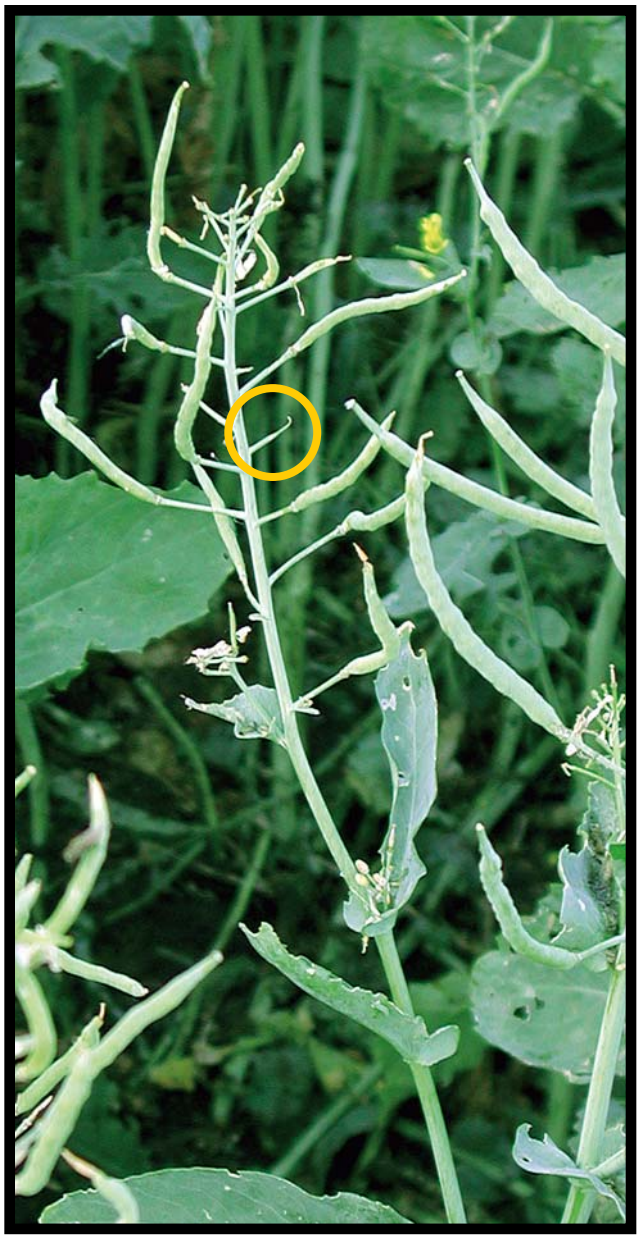

Figure 8. Aborted flowers caused by larval feeding injury during flowering. (Knodel, Department of Entomology, NDSU)

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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