

Leafy Spurge Control Using Flea Beetles

(*Aphthona* spp.)

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Figure 1. *Aphthona* species flea beetles are about the size of flax seed (about 0.10 inches long) and vary in color and shape depending on species. Shown are *A. flava* (copper to gold in color), *A. nigriscutis* (brown with a black dot) and *A. lacertosa* (black with brown femurs).



Leamy spurge is an exotic perennial weed that causes an estimated annual economic loss of \$23.2 million in North Dakota. Although leafy spurge can be successfully controlled with herbicides, treating large acreages is not cost-effective. In fact, approximately 40 percent of the leafy spurge infested rangeland has a carrying capacity below the herbicide cost break-even point. Using biological agents to control leafy spurge has become an economic alternative in many locations in the state.

Biological control of leafy spurge was initiated in the mid 1980s. To date, 12 species of insects have been released in North Dakota for control of leafy spurge, and eight have become established. Five of the eight established insects are flea beetles, (*Aphthona* spp.) which have reduced the leafy spurge density more than any other agent.

The first flea beetle released in North Dakota was *Aphthona flava* Guill in 1986 (Figure 1). This flea beetle has established only at a few sites in the state and occurs at densities too low to be effective. In 1988, a mixed population of *Aphthona czwalinae* Weise and *Aphthona lacertosa* Rosenhauer were released near Valley City, North Dakota. By 1995, the majority (greater than 90 percent) of this mixed population was *A. lacertosa* and will be referred to as such in this circular. Two additional flea beetles, *Aphthona cyparissiae* Koch and *Aphthona nigriscutis* Foudras, were released the following year. *Aphthona abdominalis* Duftschmid was released in 1992 but has not yet contributed to leafy spurge control in the state. *A. lacertosa* and *A. nigriscutis* were established in almost every county in North Dakota by 1996 and have become the major biocontrol agents used for leafy spurge control.



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Flea beetle life cycle

Aphthona spp. adults emerge from the soil in late spring to early summer (Figure 2). Following emergence, adults feed on leafy spurge leaf tissue and mate. Females begin laying egg clusters of three to 15 eggs almost immediately. Egg laying continues every three to five days throughout the adult life stage. *Aphthona* spp. females produce an average of 220 to 280 eggs over a lifetime. Eggs are yellow and laid on the soil surface or slightly below, near the leafy spurge stem base. Larvae emerge from eggs in 12 to 19 days. The longevity of *A. czwalinae*, *A. lacertosa* and *A. nigriscutis* will vary from year to year depending on weather conditions. A hot, dry spring and summer will shorten the time adults are present while a cool, wet season will lengthen it. Generally, adults live for 1.5 to two months in the field. Most leafy spurge flea beetles have a single generation, egg to adult, each year.

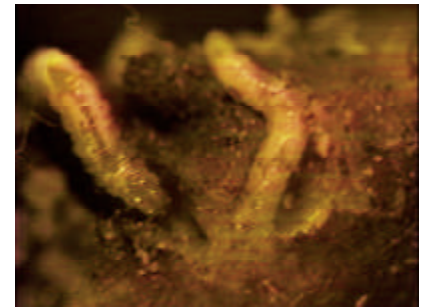
Flea beetles undergo three larval instars. First- and second-instar larvae feed on filamentous and larger leafy spurge roots, respectively. Third-instar larvae feed on the root crown (Figure 3). Flea beetles overwinter as second- and third-instar larvae in the soil. Larval feeding begins to decline when soil temperatures fall below 45 F and resume feeding when soil temperature warms in the spring to above 45 F.

Third-instar larvae feed for a number of weeks in early spring prior to pupation. Larvae pupate away from the root and emerge as adults. *Aphthona* spp. emerge in early to mid-June in North Dakota with the exception of *A. flava* which emerges two to three weeks later. Peak emergence occurs first in *A. nigriscutis* followed by *A. lacertosa*.

Although *Aphthona* spp. adults feed on leafy spurge foliage, the major damage to the plant occurs when the larvae feed on the roots. Larvae feed on both the fine feeder roots used by the plant to absorb water and nutrients and the storage tissue of the root crown. This feeding both destroys root tissue directly and causes the plant to be more susceptible to other methods of control, such as herbicides and infection from soil borne pathogens.



Figure 3. Larvae and holes from feeding damage in a leafy spurge root crown (top), and two larvae feeding in a leafy spurge root bud (right).



Where to release flea beetles

Research at North Dakota State University found flea beetle establishment was best on silt loam, silt clay loam, clay loam and clay soils with an organic matter content of 6 to 9.5 percent. Flea beetles were least productive in fine sand to loamy fine sand soils with an organic matter content of 1 to 3 percent. In addition, the release area needs to be well drained and not subject to frequent prolonged flooding or standing water, which will kill the larvae.

Initial releases have been most successful on south-facing slopes, although good success has been achieved on western and eastern slopes as well. On north facing slopes, *Aphthona* spp. requires a longer period to establish at high enough numbers to control leafy spurge. Flea beetles establish best in moderate densities of leafy spurge (60 to 90 stems per square yard) with minimal grass cover and thatch. Establishment in dense leafy spurge stands is often difficult. Release flea beetles on the margins of dense infestations and allow the insect to work into denser stands as the population builds.

Research data is lacking and/or has given inconsistent results concerning the best species to release in a specific area. What is known at this time is that *A. lacertosa* is more widely adopted to the North Dakota climate and will tolerate a wider range of temperature and moisture conditions than other *Aphthona* spp. *A. nigriscutis* generally has done better on higher, drier sites with low to moderate stands of leafy spurge. Releasing a mixture of both species in the same location is the best way to determine which *Aphthona* spp. is best suited for a particular area.

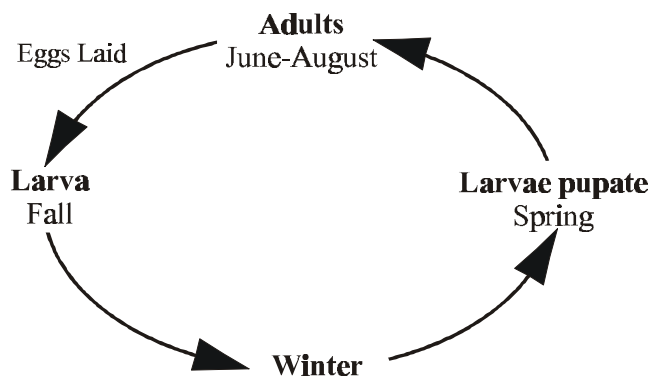


Figure 2. General flea beetle life cycle in North Dakota. All species except *Aphthona adominalis* have one generation per year and over winter as larvae in the soil. *A. adominalis* can average 3 to 4 generations per year, but has not yet established in the state.

When to collect and release flea beetles

Aphthona spp. flea beetles generally are distributed through the North Dakota Weed Control Association. Contact the local county weed officer for date, time, and location of flea beetle collection and redistribution programs in your area. Flea beetles are generally collected and redistributed from mid-June to early July. Total accumulated growing degree days (AGDD) for sunflower can be used as a guide to determine when to begin scouting for adult flea beetles. Begin scouting for adult flea beetles when the AGDD approaches 1,000 (Figure 4). Likewise, the flea beetle population and egg laying by females begins to decline when the AGDD reaches 1,600 or more.

Another method to determine when the flea beetle population is near peak abundance is using plant phenology. Growth patterns by various plant species can be used as ‘indicators’ of seasonal abundance of leafy spurge flea beetles. *Aphthona* spp. are often near peak levels when the prairie wild rose is flowering and strawberries are ready to be picked in family gardens in North Dakota.

The best time to collect flea beetles for redistribution is from 10 a.m. to 3 p.m. when the air temperature is greater than 70 F, there is little or no wind, and the skies are generally sunny. Leafy spurge should be dry before collecting flea beetles because wet conditions will make sweeping difficult and reduces the adult survival during transportation.

To determine if a population has increased enough for redistribution, sweep five times using a standard insect sweep net covering an area of 10 square feet and count the number of flea beetles in the net (Figure 5). If flea beetles are too numerous to count individually, remove excess trash and non-flea beetle insects and pour net contents into a graduated container. Every 10 ml of flea beetles is approximately 1,000 individuals. Redistribute flea beetles to other leafy spurge infestations when 500 to 1,000 beetles per five minute sweeping period are collected. Over-harvest of beetles is not possible because many flea beetles fall to the ground prior to being swept or are on the soil surface laying eggs.

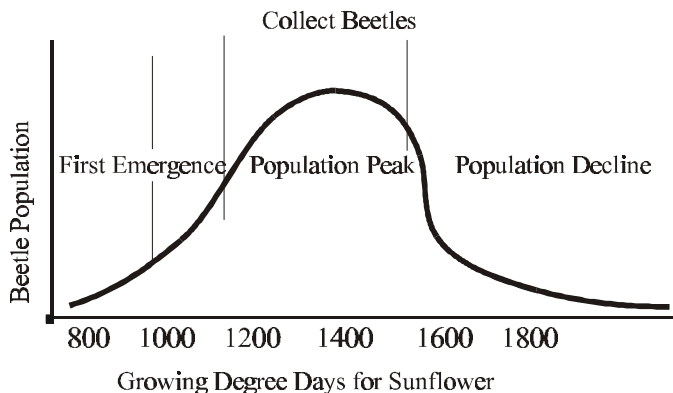


Figure 4. Begin to scout and move adult flea beetles when the growing degree days for sunflower approach 1000 to 1200. The peak emergence of *Aphthona* spp. flea beetles also corresponds to the flowering of the prairie wild rose and the ripening of garden strawberries in North Dakota.



Figure 5. Sweep for *Aphthona* flea beetles on warm sunny days. The sweeping motion should be in an arc from left to right over the top two thirds of the leafy spurge plant. Avoid hitting rocks and soil.

Once collected, the flea beetles should be transported in paper bags or containers (Figure 6). Do not use plastic containers because moisture condensing on the plastic can drown the insects. Add some leafy spurge to the container and place in a cooler containing blue ice. Do not allow the containers or cooler to sit in the sun. Flea beetles should be released as soon as possible after collection. Releasing the same day as collection is ideal; however, insects can survive several days when refrigerated at 40 to 45 F. The more similar collection and release environments are, the sooner the flea beetles are likely to become established and begin to control leafy spurge.

At least 1,000 or more insects should be released per location. Often new populations are started with several thousand insects (Figure 7). The higher the release number, the faster a population increases. Do not scatter the adults over a large area. *Aphthona* flea beetles are very gregarious, and males and females need to be in close proximity. Multiple releases in a large area are better than a single large release. Flea beetle establishment often increases when release points are scattered over a wide area of terrain. It is important to place a permanent marker such as a steel fence post at each release site so the population can be monitored in subsequent years. Adult flea beetles are susceptible to insecticides, so avoid wide-scale spraying near a flea beetle population, especially from June through mid-August.

A successful release should result in 50 or more flea beetles in five sweeps the summer following release. If densities are less than 50 flea beetles per five sweeps, then re-infest the site with additional flea beetles of the same and/or different species.



Figure 6. Once *Aphthona* are collected, remove as much trash as possible and place into paper cartons or bags. Keep the containers in the shade and transport the insects in coolers with blue ice. Flea beetle sorters may be used during mass redistributions. Consult your local APHIS representative or weed control officer for availability.

Limitations to biological control

Although flea beetles have become established throughout North Dakota, they have not been successful in all environments. To date, approximately 30 percent of the releases have established and the leafy spurge stem density has been reduced. In another 30 percent of the releases, the insects have become established but the population density is too low to be effective. In the remaining releases, flea beetles have not established.

If a flea beetle population becomes established but does not control leafy spurge, perhaps a second release of the same and/or different species will improve control. However, if the insect population does not increase after multiple releases, the site may not be suitable for *Aphthona* spp. to control leafy spurge. Each *Aphthona* spp. requires a slightly different type of habitat for survival. Also, *Aphthona* spp. generally will not establish at sites with excess moisture, long periods of shade, very sandy soil, high leafy spurge density, or poor snow cover in the winter. Of these problems only the density of the leafy spurge stand can be altered. Herbicide application in the fall and sheep or goat grazing from mid-May until mid-August will reduce the leafy spurge density and both methods are compatible with flea beetles.

Unlike herbicides, biological control agents do not provide predictable, consistent levels of leafy spurge control. Often *Aphthona* spp. take several years to become established and then require several more years to reduce a leafy spurge stand. Wide-scale rapid reduction of leafy spurge infestations are so far the exception, not the rule. Biological control of leafy spurge with flea beetles is not a “quick fix” and a land manager must practice patience when using this control method.

Integrating biological control with other control methods

Several options are available for leafy spurge control besides biological control agents, including the use of herbicides, grazing, seeding competitive grasses, and cultivation. Before beginning a leafy spurge control program, consider the best options suited for the situation and utilize more than one. Most successful control programs have used multiple control methods combined over several years.

Herbicides should be used to control leafy spurge patches as they become established and around the perimeter of larger infestations to keep them from spreading while biological control agents become established. Research at North Dakota State University has shown that a fall application of Tordon (picloram) plus 2,4-D at 1 quart plus 1 quart per acre (0.5 + 1 pound per acre) from early September to mid-October on leafy spurge with an established flea beetle population provided increased control compared to using either flea beetles or herbicides alone. Also, herbicides applied to dense leafy spurge infestations will open the canopy and may allow the biological control agents to establish in an otherwise unsuitable environment.

Grazing by sheep or goats after mid-August can increase leafy spurge control with *Aphthona* flea beetles. Grazing removes excess trash from the soil surface, providing a more suitable environment for egg and larvae survival. Fire may also be used to reduce cover, but avoid using a controlled burn until after mid-August when egg laying has been completed.



Figure 7. The larger the initial release number of adult *Aphthona* flea beetles, the more likely the population will establish and begin to control leafy spurge.

Additional sources

For more detailed information concerning IPM, biological, and other control methods for leafy spurge consult the following references:
Integrated Pest Management of Leafy Spurge, NDSU Ext. Service Circular W-866R, 1995.
Leafy Spurge Identification and Control, NDSU Ext. Service Circular W-765R, 1998.
Controlling Leafy Spurge Using Goats and Sheep, NDSU Ext. Service Circular R-1093, 1995.
Biological Control of Leafy Spurge, USDA-ARS TEAM Leafy Spurge, Sidney, MT. Download at <http://www.team.ars.usda.gov/>.
How to Raise Leafy Spurge Flea Beetles, North Dakota Dept. of Ag, Bismarck, ND, video.
 Photos 1a and 1b courtesy of Bob Richard, USDA-APHIS PPQ, Bozeman, MT, all others are by Rodney G. Lym.



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