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Flea beetle (Coleoptera: Chrysomelidae) pilot study on leafy spurge (*Euphorbia esula*)

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Life cycle and impact of the plant

Leafy spurge (*Euphorbia esula* L.) is an aggressive, persistent, deep-rooting perennial plant of Eurasian origin. It has become dominant on rangelands and pastures, displacing useful forage plants in North America. Leafy spurge reproduces both by vegetative re-growth and the production of large quantities of seeds which are often distributed by birds, wildlife, man, and water. This plant is able to maintain high energy reserves through an extensive root system, ranging from a massive network of small roots near the soil surface, to deep penetrating tap roots. This ability to maintain high root reserves permits the plant to recover quickly from physical and most chemical damage.

In Europe, there are 105 native *Euphorbia* species which belong to the subgenus *Esula*, the group to which the target leafy spurge belongs. An additional 4 species belong to the subgenus *Chamaesyce.* In North America, 21 native species belong to the subgenus *Esula*, 26 species belong to the subgenus *Agaloma*, 3 species to *Poinsettia* and 57 species to *Chamaesyce.* Two species (*E. garberi* and *E. deltoides*) belonging to the subgenus *Chamaesyce*, currently have federal protection under the endangered or threatened species act.

In 1979, estimated losses in the United States, in terms of expenditures for controlling leafy spurge and loss of productivity at $10.5 million annually, while others reported that although the problem is most severe on undisturbed lands, it can reduce crop yields from 10 - 100% on cultivated cropland areas. Economist in North Dakota recently concluded that in North Dakota, one million acres of leafy spurge had depreciated land values by $137 million and had a total economic impact of $105 million in that state for 1989.

Life history and habits of the flea beetles

Adult flea beetles feed on leafy spurge leaves and bracts, while the larvae feed on the root hairs and yearling roots. Larval feeding damages the roots and reduces the plant's ability to take up nutrients and moisture. Moderately attacked plants show retarded flowering periods. Continued pressure by the flea beetles first reduces the average plant height and then, as the insect population increases further, plant density drops and native vegetation returns.

Most *Aphthona* flea beetle species have one generation per year on leafy spurge; adults are present between late June and early September when eggs are laid in the soil near leafy spurge roots. Larvae hatch and immediately begin to feed on leafy spurge roots. As they grow they move to larger roots where they feed both externally and internally. A portion of the leafy spurge control that has already been documented from flea beetle release sites may be due to the secondary invasion of soil borne plant pathogens. Mature larvae over winter in the soil and pupate in late spring or early summer.

The copper spurge flea beetle, *A. flava*, is amber colored, while the brown dot spurge flea beetle, *A. cyparissiae,* and the black dot spurge flea beetle, *A. nigriscutis*, are brown and can be separated by a black dot between the forward section of the two elytra on the latter species. Work by Peter Harris in Canada suggests that the black dot flea beetle prefers sandy soils with low humus content, while the brown dot flea beetle does better in higher humus and moisture content soils. Although these 3 species of flea beetles are similar in action, there are some characteristics which tend to separate them.

The Copper Flea Beetle was first released near Bozeman in 1985, and in North Dakota and Idaho in 1986. It established at 4 of the 8 Montana sites, and at a single North Dakota site. The brown dot flea beetle was first released in Montana in 1987 and established at 2 sites. Most 1989 releases of the black dot flea beetle appear to have established in 1990 in Idaho, Montana, Nebraska and North Dakota.

The pilot study

A large scale experiment was begun in 1990 to observe the various conditions which affect the efficiency of selected flea beetles to suppress leafy spurge. The first phase of the experiment had the following objectives:

1. To study the efficacy of various numbers and patterns of releases of *Aphthona nigriscutis* as to its effects on populations of the leafy spurge plant, flowering periods, growth patterns, and spurge density.
2. To study the effects and interactions of different associated plant communities on the efficacy of the beetle in suppressing populations of leafy spurge.
3. To study the effects of different leafy spurge densities on the efficacy of the beetle.
4. To study the direct and indirect effects of different soil types and composition on the efficacy of *A. nigriscutis.*
5. To determine factors that affect how fast *A. nigriscutis* populations can increase and expand.

6. To monitor the changes in plant community constituents, density, and biomass production as leafy spurge competition is reduced.
7. To determine the optimum size of release for *A. nigriscutis.* From this information, protocols for the sizes of future release for various *Aphthona* species may be established.
8. To determine the optimum period for releasing adults.
9. To locate detrimental factors for *A. nigriscutis* establishment, and population dynamics, and to investigate how best to avoid or manipulate such factors.
10. To compare efficiency of sweep sampling of the flea beetle on leafy spurge with D-VAC sampling.
11. To determine effectiveness of the beetle in relation to weather conditions, elevation, site conditions, etc.
12. To investigate the effect of host plant genetics (biotype) on the efficacy of *A. nigriscutis* against leafy spurge.

In addition to these objectives, effects of cattle grazing, and previous use of herbicides is also being evaluated.

This research was and is being conducted by the USDA/ARS in cooperation with Bureau of Land Management (BLM), U.S. Forest Service (USFS), USDA/APHIS, Resource Conservation and Development (RC&D), Agriculture Canada, and Montana State University (MSU). Six sites were selected in Colorado, Idaho, Montana, Nebraska and North Dakota.

In the first phase, from three (in Colorado and Idaho) to seven (Montana (2), Nebraska and North Dakota) treatments and duplicate checks were randomly assigned at each site, such that topography, vegetation, soil conditions, etc. were similar throughout the site study area, and particularly between each treatment and its check. Treatments are generally separated by a minimum of one kilometer and 200 to 300 meters separates a treatment and its check. Transects radiate outward from the center in each of 8 directions, north, northeast, east, southeast, south, southwest, west and northwest. Plant composition, canopy cover, spurge plant height, spurge density and number of flowering stems are sampled and recorded from each of the 1/10th meter north, east, west, and south test loci. The four remaining transects are used for clipping samples (biomass) at each 1/10 meter locus.

The second phase was established in 1992 with the addition of 3 new treatments at each of 3 of the sites (Montana, Nebraska, North Dakota). *Aphthona cyparissiae*, *A. flava* and *A. nigriscutis* were released to duplicate the original "treatment #4", such that the results can be compared to the original study.

At most locations, 1992 surveys of the 1990 releases revealed that flea beetles were established and effective in more than 66% of the plots. Depressed plant height, retarded flowering and diminishing plant populations are observed, but no insects have been recovered from any of the North Dakota plots, and many results are not as was expected indicating than we are either not measuring all of the appropriate parameters, or we are not giving the proper credit to the proper conditions.