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Aphthona nigriscutis larval densities in Campbell County, South Dakota[1]

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Abstract:

Biological control of leafy spurge (*Euphorbia esula* L.) in drier areas of the northern Great Plains has focused on the use of *Aphthona nigriscutis* Foudras. Following release in 1990, *A. nigriscutis* became established at a site near Pollock, South Dakota. Larval densities were determined in transects at Pollock from 1995 to 1997. Most larvae were found within 7.6 cm of the soil surface. Densities of larvae varied among transects and years. Overall, larval densities increased from 1995 to 1996, but declined in 1997.

Keywords:

Aphthona nigriscutis, leafy spurge, *Euphorbia esula*, biological control.

Leafy spurge (*Euphorbia esula* L.) is a noxious perennial weed that infests more than one million ha of pasture and rangeland in the northern Great Plains (Pecora *et al*. 1992). Cattle (*Bos taurus*) often become ill after ingesting leafy spurge and learn to avoid infested areas. Conventional control methods (herbicides, grazing, and mowing) provide only temporary suppression, and repeated treatments are usually necessary. However, conventional treatments are not feasible in ecologically sensitive areas or on difficult terrain.

Several species of *Aphthona* flea beetles (Coleoptera: Chrysomelidae) have been introduced to North America for biological suppression of leafy spurge (Julien 1987). *Aphthona nigriscutis* Foudras prefers dry coarse soils and is established in many leafy spurge infested areas of the Great Plains (Clay and Scholes 1993). This species is univoltine and larvae overwinter in the soil. The larval stage causes the most damage to leafy spurge by feeding on roots and dramatic reductions in the size of leafy spurge infestations have been observed in some areas (Rees *et al*. 1996).

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Natural dispersal of *A. nigriscutis* is limited, especially if host plants are available (Fornasari 1996). In order to expedite the distribution of this biological control agent, adults are collected from established field sites and released to areas infested with leafy spurge. *Aphthona nigriscutis* adults were released at a site near Pollock, South Dakota in 1990 and have since become established. The Pollock site serves as an insectary from which *A. nigriscutis* is collected each year for distribution to other areas in the state of South Dakota. The objective of our research was to monitor *A. nigriscutis* population trends several years following introduction by determining the density of larvae in the soil.

Materials and methods

The study site was located near Pollock in north central South Dakota and is at the margins of dry subhumid and semi-arid regions (T128N, R79W, Sec. 21, NW 1/4, Campbell County). Approximate coverage of the leafy spurge infestation was determined by using a measuring wheel (Rolatape Corporation, Spokane, Washington). In 1995, two soil samples were collected from the surface to 15.0 cm depth by using a 10.5 cm diameter cup cutter (Standard Golf Company, Cedar Falls, Iowa) and were evaluated for particle size and pH.

In 1990, the original point of *A. nigriscutis* release had been marked with a metal post. In 1995, there were three large patches of leafy spurge in which transects were delineated (Fig. 1). The center point of Transect Two was placed within 0.25 miles of the metal post marker. The center point of Transect One was 18 miles south of the original point of *A. nigriscutis* release. Transect Three's center was 40 miles east of the original point of release. The distance between each point within transects was 2.5 miles.

Each spring, senescent leafy spurge plants were located at points in the transects and a cup cutter was used to extract soil and roots from the surface to 7.6 cm and 7.6 to 10.2 cm depth. Core samples were individually placed in 3.8 liter plastic bags. Each year, 13 core samples were taken from Transect One, 16 from Transect Two, and 13 from Transect Three. Core samples were collected on 22 May 1995, 19 April 1996, and 29 April 1997. In 1996 and 1997, samples were collected within 0.3 miles from each original (1995) transect point.

In the laboratory, soil core samples were broken into smaller fractions by hand. Leafy spurge roots were removed from samples and inspected for the presence of larvae. Soil was then sifted through a sieve (2 mm opening, No. 10 USA Standard Testing Sieve, Fisher Scientific Company). Larvae were visually located and removed from soil by using a microforceps. *Aphthona nigriscutis* larval identification was confirmed by comparison with laboratory reared specimens. Larval density data were analyzed by using the PROC CAT MOD procedure in SAS (SAS Institute 1989).

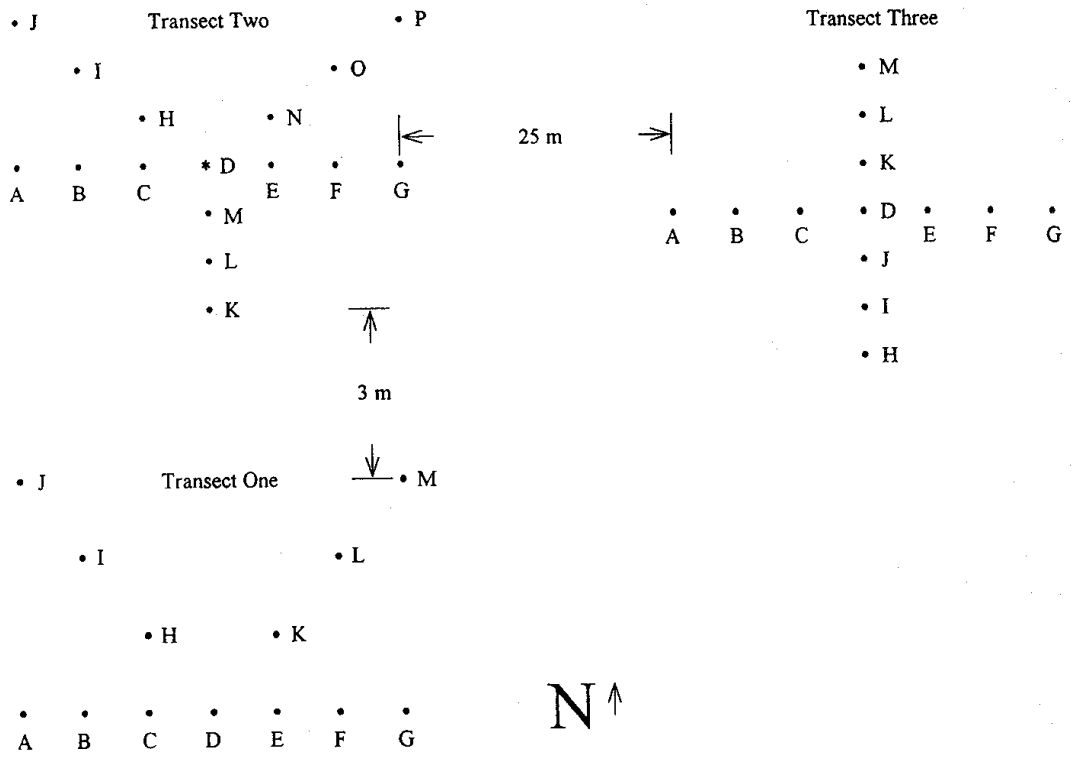

Figure 1. Layout of transects in leafy spurge patches at the Pollock, South Dakota study site. Transect point "D"(*) in Transect Two is the original point of *Aphthona nigriscutis* release in 1990. The distance between each transect point is 2.5 miles. Figure is not to scale.

Results and discussion

The leafy spurge infestation at the Pollock site covered about 20 ha. Soil classification was Sully silt loam with a pH of 7.4. Soil was comprised of 20.8% sand, 61.9% silt, and 17.3% clay.

Results from 1995 sampling suggested that most larvae reside close to the soil surface. In that year, 42 larvae were found in core samples collected from surface to 7.6 cm depth. Only three larvae were found in one core sample taken from 7.6 to 10.2 cm depth. Consequently, soil core samples were not taken from 7.6 to 10.2 cm depth in 1996 and 1997.

Live leafy spurge was abundant at the site during the three years of the study, but there was no clear pattern of *A. nigriscutis* population expansion. Instead, larval densities fluctuated among transects and years. In 1995, Transect Three contained significantly (X^2= 81.14, df = 4, P = 0.0010) fewer larvae than the other two transects (Table 1). However, this transect contained the highest density of larvae in 1996. In 1997, significantly ($P < 0.05$) more larvae were located in Transect One than in Transects Two and Three. Only one larva was found in all of the soil cores collected within Transect Two in 1997.

Root size is an important factor in larval development and may account for variability in larval densities among transects and years. Clay and Brinkman (1998) reported that first-instar *A. nigriscutis* larvae must locate 1 to 4 mm diameter leafy spurge roots within 48 hours for survival. In 1995, larval densities were relatively high within Transect Two, but subsequently declined in 1996 and 1997. The high concentrations of larvae in 1995 may have reduced the number of desirable sized roots available for the succeeding generations of larvae. According to Rees *et al*. (1996), *Aphthona* spp. larvae can impact a leafy spurge infestation by reducing lateral roots, yet new shoots can grow from the large taproots. This may explain why larval densities were lower in Transect Two even though leafy spurge was present within this transect in 1996 and 1997.

Overall, mean larval densities for the three transects (combined) increased from 1631.6 $\pm$ 513.2 per m^3 in 1995 to 2855.3 $\pm$ 1105.3 m^3 in 1996. In 1997, mean larval densities at the Pollock site declined by 66%.

The goal of a weed biological control program is to establish populations of biological control agents, which suppress weed infestations. As the weed infestation is reduced, carrying capacity restricts expansion of the biological control agent population. This may have occurred at the Pollock site in 1997; however, there may have also been high larval mortality due to harsh winter weather conditions. Although larval densities at Pollock were relatively low in 1997, about 100,000 adults were collected for distribution. In 1998, only about one-third that number of adults could be collected for distribution (Amy Mesman, pers. comm.).

Table 1. Density of *Aphthona nigriscutis* larvae (mean number per m^3 $\pm$ SEM) in transects at the Pollock, South Dakota site.

Transect	1995	1996	1997
One	1631.6 ± 1158.0	1526.3 ± 486.8	2460.5 ± 1171.1
Two	2750.0 ± 921.1	1144.7 ± 447.4	92.1 ± 92.1
Three	236.8 ± 157.9	6315.8 ± 3407.9	697.4 ± 276.3
Site Mean	1631.6 ± 513.2	2855.3 ± 1105.3	973.7 ± 394.7

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