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DISPERSAL OF *FENUSA DOHRNII* (HYMENOPTERA: TENTHREDINIDAE) FROM AN *ALNUS* SHORT-ROTATION FOREST PLANTATION

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ABSTRACT

The European alder leafminer, *Fenusa dohrnii*, is a defoliating insect pest of *Alnus* in short-rotation forest plantations. A 2-year study was performed to quantify movement from infested stands to uninfested areas. Sticky traps and potted monitor trees were installed at different locations within and at various distances from (0, 5, 10, and 20 m) an infested stand to measure adult flight and oviposition activity, respectively. Trap catch and oviposition activity fell off sharply with distance, few insects being trapped or eggs laid at distances of 5 m or greater from the infestation.

The genus *Alnus*, the alders, has been considered a promising group for biomass plantations because of its rapid growth and symbiotic nitrogen-fixing capabilities. Genetic improvement work with *Alnus* began at Iowa State University in 1976 with a range-wide collection of germplasm for European black alder, *A. glutinosa* Gaertn. (Hall et al. 1983). Selected populations of other *Alnus* species have been grown here as well.

In 1982, the European alder leafminer, *Fenusa dohrnii* (Tischbein) (Hymenoptera: Tenthredinidae), began developing as a pest in our local plantations (Hart et al. 1991). By 1985, much defoliation was obvious, prompting concern about the impact of the insect on the plantations and possible management measures. Because little was known about the insect in the north-central United States, a series of studies was initiated in 1986 to define the field biology and impact of the insect in the plantation environment.

Sustained yield from biomass plantations involves having all growth and coppice-regrowth stages of trees present at various proximities within the growing area. Tree growth and survivorship are especially sensitive to growing conditions, including defoliation effects, in the first 2 years after planting (Meridian Corporation, 1986). The ability of *F. dohrnii* to move from infested to uninfested, newly-planted stands can thus determine, in part, the impact that it may have on the plantations and how they should be designed.

When a plantation is cut, the first adult flight of European alder leafminer in the spring precedes most of the resprouting of stems and leaves on the cut alder stumps (Hart et al. 1991). This provides an opportunity to reduce the leafminer population significantly in the area for a time. Reinfestation, however, may occur from late-emerging insects and from adjacent uncut stands. Adult dispersal is therefore important in the reinfestation of harvested areas.

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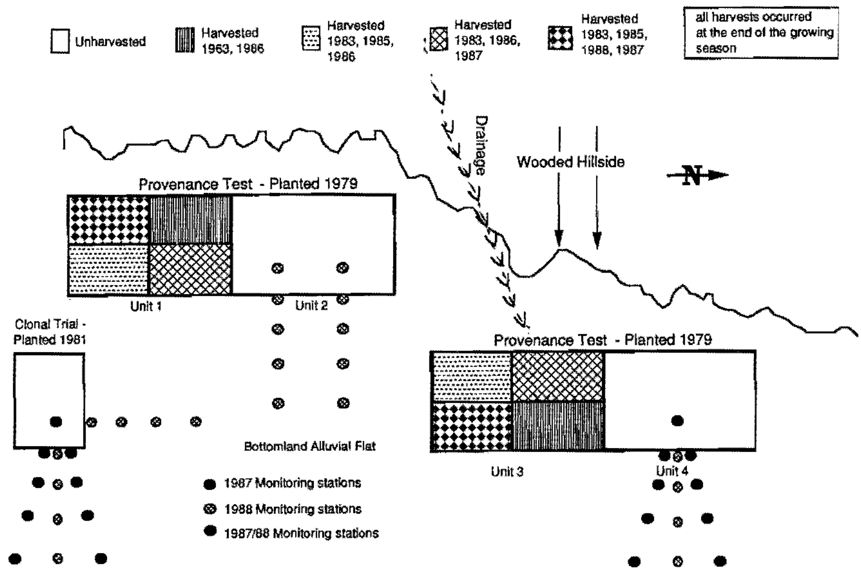

Figure 1. European alder leafminer sticky trap and monitor tree locations, *Alnus* plantation, Rhodes, Iowa, 1987, 1988.

Because only the adult stage of the leafminer is capable of significant interplant movement, a study was designed to quantify adult movement from known infested stands to uninfested areas. The major objectives of this study were: (1) to determine the distances that the insect can migrate in significant numbers from infested stands to uninfested areas and (2) to use this information to project practical planting distances from such infested areas.

MATERIALS AND METHODS

The research was performed in central Iowa at the Iowa State University Rhodes Experimental Farm. The plantation site lies in a narrow stream valley, surrounded by low, forested hills. The site is well-buffered from the prevailing winds, which in the growing season are mostly from the southeast. The first alders were planted at this location in 1979, with additional plantings added each year as needed by the breeding and selection program.

In 1987, two infested, unharvested plantings were selected as European alder leafminer source areas (Fig. 1). Four replications were established, two at Unit 4 of the 1979 provenance test plantings and two at the 1981 clonal trial plantings. Each replication was organized along a transect line away from a planting into an open, grassy field. For each area, a single monitor station was established within the planting. Each replication also consisted of monitor stations at the edge of the planting and at 5, 10, and 20 m from the edge of the planting. Adult presence and activity were measured at different heights at each station by two different methods: (1) yellow sticky traps to attract and capture insects that flew into the area; (2) potted trees of susceptible *A. glutinosa* selections to measure oviposition activity in the area.

For the first week of the study, the sticky traps consisted of 15 cm by 3 m PVC pipe, painted yellow and coated with Tangle Trap® (The Tanglefoot Co., Grand Rapids, MI); trap catch was measured for each 0.5-m section to a height of 3.0 m. Because the large surface area created logistical problems in counting and cleaning, the traps were replaced after 1 week with Pherocon® AM (Trece, Inc.,Salinas, CA) cards. The flattened cards were centered on and stapled to wooden standards at six 0.5-m heights above ground level, from 0.5 to 3.0 m. Leafminers were counted on and removed weekly from the central 8 by 20 cm section of each trap. Adult activity was measured as the number of trapped adults/cm^2/day.

To monitor oviposition activity at each station, greenhouse-grown potted trees, 45 to 60 cm tall, from two leafminer-susceptible *A. glutinosa* selections, SN-5 and SN-53 (Hall and Nyong'o 1987), were set out at two heights, ground level and 2.5 m. For each height, a potted tree from each selection was set into a beige plastic tub, watered from below, and replaced weekly. Four newly expanded leaves, those highly preferred for oviposition (Hart et al. 1991), were taken from each tree as it was removed from the field. Leaves were taken to the laboratory where egg counts and leaf area were measured. Female activity was defined as eggs/cm^2/day.

Under the climatic conditions of the central Iowa *Alnus* plantations, three generations of the leafminer occur each year (Hart et al. 1991). In 1987, monitor stations were established from 30 June through 28 July and from 11 August through 22 September to include the second and third adult activity periods.

In 1988, the study was modified and expanded to include five replications. Three unharvested plantings were selected as leafminer-infested sources (Fig. 1). One replication was established at Unit 4 of the 1979 provenance test plantings, two at Unit 2 of the 1979 provenance test plantings, and two at the 1981 clonal trial planting. Each replication consisted of a transect line established into an open area away from a planting. Separate within-planting monitor stations were established for replications 1, 2, and 3; replications 4 and 5 shared a common within-planting monitor station. Transect stations were established at the edge and at distances from the edge as in 1987. Adult presence and activity again were measured at each station with sticky traps and potted trees.

The sticky traps were stapled to wooden standards and centered at three heights above ground level, 0.5, 1.5, and 3.0 m. Weekly, during each adult activity period, trap catches were counted from the central 8 by 20 cm section and the traps cleaned.

For each transect, trees were placed on platforms at the height of the prevailing foliage within and at the edge of the planting; at each of the outlying stations the trees were placed on the ground to simulate the location of newly planted trees. Two trees, 45 to 60 cm tall, one each from SN-5 and SN-53, were used in 1988. Trees again were placed in beige plastic tubs, watered from below, and replaced weekly. Two newly expanded leaves were taken from each tree as it was removed from the field. Leaves were taken to the laboratory and examined for oviposition density.

In 1988, monitor stations were established from 13 May to 3 June, from 14 June to 5 July, and from 26 July to 13 September to include the first, second, and third adult activity periods, respectively.

The data were analyzed by PROC GLM from the Statistical Analysis System (SAS Institute 1985a, b). When analysis indicated a significant difference ($P < 0.05$) for a given variable, the Duncan's option was used as the mean separation procedure.

RESULTS

Leafminer populations were quite high during the first adult activity period in 1988 and during the second adult activity period in both 1987 and 1988 (Hart et al. 1991), producing sufficiently measurable numbers for comparisons among locations

Table 1. European alder leafminer trap-catch density by sampling date.

1987			1988		
Date	N	EAL/cm²/day[a]	Date	N	EAL/cm²/day[a]
July 14	108	0.0084 A	June 21	72	0.0193 A
July 9	108	0.0069 B	June 28	72	0.0187 A
Aug 18	108	0.0026 C	July 5	72	0.0074 B
July 28	108	0.0011 D	May 20	72	0.0048 C
July 21	108	0.0011 D	May 27	72	0.0031 C
Sept 1	108	0.0005 DE	June 3	72	0.0005 D
Sept 22	107	0.0004 DE	Aug 2	72	0.0002 D
Sept 15	102	0.0001 E	Aug 9	72	0.0002 D
Aug 27	108	0.0001 E	Aug 30	59	0.0001 E
Sept 8	102	0.0001 E	Aug 23	64	0.0001 E
			Aug 16	72	0.0000 E
			Sept 13	69	0.0000 E
			Sept 6	72	0.0000 E

[a]Means followed by same letter are not significantly different. DNMRT

Table 2. European alder leafminer trap-catch density by trap location.

1987			1988		
Trap Location	N	EAL/cm²/day[a]	Trap Location	N	EAL/cm²/day[a]
Edge	48	0.0233 A	Within	60	0.3054 A
Within	24	0.0171 B	Edge	75	0.1027 B
5 m out	48	0.0013 C	5 m out	75	0.0072 C
10 m out	48	0.0010 C	10 m out	75	0.0024 C
20 m out	48	0.0003 C	20 m out	75	0.0017 C

[a]Means followed by same letter are not significantly different. DNMRT

and heights (Table 1). In both years, leafminer populations were so low during the third adult activity period that valid comparisons could not be made.

Sticky Traps. Trap catch fell off significantly with distance from the infested area (1987: $F = 262.49$, df = 4, 186, $P < 0.0001$; 1988: $F = 69.25$, df = 4, 345, $P < 0.0001$), and insects rarely were captured on traps at stations beyond 5 m (Table 2). Trap height had a significant effect on trap catch in 1987 (F 345 = 14.26, df = 5, 186, $P < 0.0001$), but not in 1988 (Table 3). For those locations with high trap catches, the higher traps closest to the tree canopy level tended to have the greatest density (Fig. 2).

Potted Trees. Because oviposition preference by seed source was not significant

Table 3. European alder leafminer density by trap height.

1987			1988		
Trap Height (m)	N	EAL/cm²/day[a]	Trap Height (m)	N	EAL/cm²/day[a]
3.0	36	0.0121 A	3.0	120	0.0836 A
2.5	36	0.0090 B			
2.0	36	0.0076 BC			
1.5	36	0.0069 C	1.5	120	0.0767 A
1.0	36	0.0067 C			
0.5	36	0.0036 D	0.5	120	0.0636 A

[a]Means followed by same letter are not significantly different. DNMRT

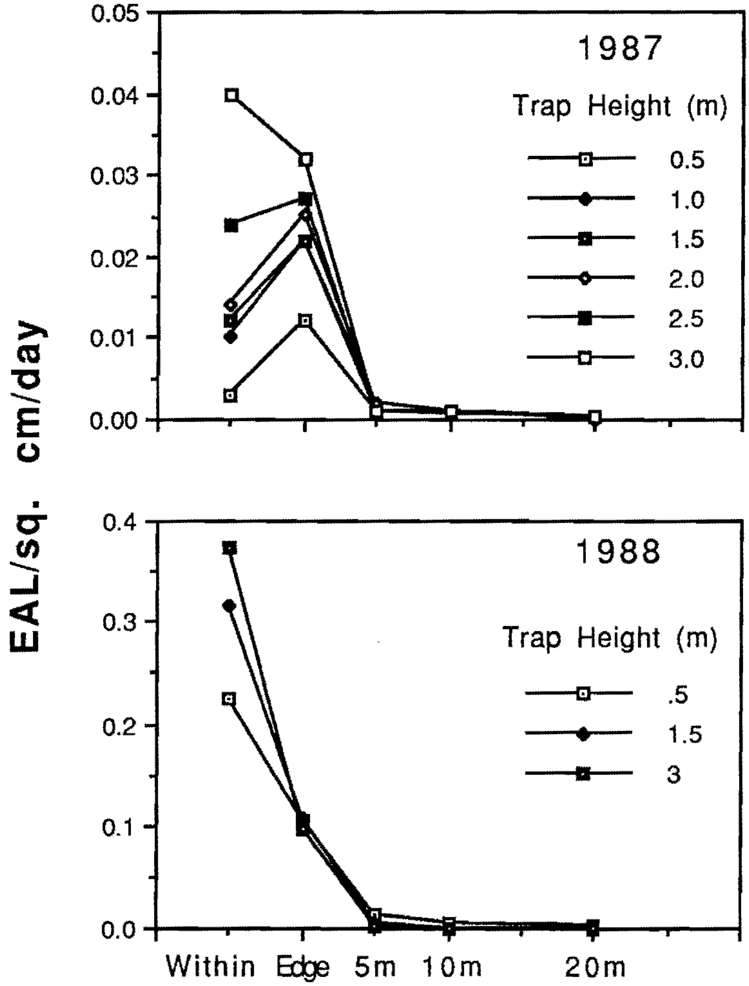

Figure 2. Effects of sticky trap height and position on trap catch density relative to infested areas, Rhodes, Iowa, 1987,1988.

(Hart et al. 1991), data from the two selections were pooled for further analyses. Oviposition density followed the same trend as sticky trap catches, but did not fall off quite as sharply with distance (1987: $F = 27.86$, df $= 4, 31$, $P < 0.0001$; 1988: $F = 10.92$, df $= 4, 229$, $P < 0.0001$) (Table 4).

The small amount of adult activity outside the infested area implies that new plantings at distances of 10 m or greater from infested areas should have 1 to 2 years of relatively low infestations, an important factor in the establishment of new trees. The less drastic decrease in oviposition density with distance from the population

Table 4. European alder leafminer oviposition density by tree location.

1987			1988		
Tree Location	N	Eggs/cm^2/day[a]	Tree Location	N	Eggs/cm^2/day[a]
Within	4	0.2022 A	Within	40	0.0979 A
Edge	8	0.1864 A	Edge	49	0.0500 B
5 m out	8	0.0329 B	5 m out	51	0.0072 C
20 m out	8	0.0190 B	20 m out	49	0.0062 C
10 m out	8	0.0029 B	10 m out	49	0.0031 C

[a]Means followed by same letter are not significantly different. DNMRT

source, compared with that of trap-catch density, however, suggests that a host-finding mechanism may be involved in dispersal.

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