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Economic Injury Levels for Western Bean Cutworm, *Loxagrotis albicosta* (Smith) (Lepidoptera: Noctuidae), Eggs and Larvae in Field Corn

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ABSTRACT: Yield losses caused by different densities of western bean cutworm, [*Loxagrotis albicosta* (Smith)], egg masses and young larvae in field corn [*Zea mays* (L.), Pioneer 3475] were studied in replicated field cages in Perkins County, Nebraska, during 1989 and 1990. Treatments consisted of four egg masses per plant, one egg mass per plant, ten young larvae per plant, three young larvae per plant and an uninfested caged check. Infestations were timed to correspond with the natural occurrence of western bean cutworms each year. Larval density at dent stage and total grain yield were measured. Linear regression equations were calculated to describe the relationship between larval density at dent stage and total yield. Yield losses during the two years averaged 3.7 bu/acre for each western bean cutworm larva per plant at dent stage. Average survival to mature larvae in the field cages during the two years was 3.3 ± 0.4% for eggs and 21.6 ± 2.1% for young larvae. Economic injury levels for western bean cutworm egg masses and young larvae are presented.

The western bean cutworm, *Loxagrotis albicosta* (Smith) (Lepidoptera: Noctuidae), is a native pest of dry edible beans and corn in the western United States (Blickenstaff and Jolley, 1982). It has been reported in Idaho, Kansas, Nebraska, Iowa, Utah, Colorado, Arizona, New Mexico, Texas, South Dakota, Wyoming, and Oklahoma.

Western bean cutworm larvae reduce corn yields by direct feeding in the ear causing loss of kernels, misshapen ears, and entry of fungi (Hagen, 1962). Yield losses of 30 to 40% in heavily-infested fields have been reported (Keith et al., 1970). A 3.9 bushel per acre loss was reported by Pilcher et al. (1990) when 1.1 mature larvae per ear (from an infestation of 6–10% of plants having at least one egg mass) were observed on 100 out of 200 ears. Another field with an infestation of 15% of the plants having at least one egg mass resulted in 49 larvae in 50 ears and a 15.4 bushel loss per acre.

No experimentally derived economic injury levels have been published for western bean cutworms in field corn based on egg or larval densities. Currently in Nebraska, treatment for western bean cutworm in field corn is suggested if 8% of the plants are infested with eggs or larvae and corn is at least 95% tasseled (Wright et al., 1992). The objective of this research was to determine the relationship between western bean cutworm egg and larval density and yield loss in field corn under Nebraska conditions (Appel, 1991).

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Table 1. Summary of experimental results on relationship between western bean cutworm density and corn yield loss.

Treatment	Eggs per cage (per 16 plants)	Larval density per plant at dent stage	Percent survival	Yield (bu/acre)
		1989		
0	–	–	–	144.6 ± 4.8
1 Egg mass per plant	1027 ± 52	2.0 ± 0.5	3.4 ± 1.0	143.5 ± 6.0
4 Egg masses per plant	3902 ± 65	6.9 ± 0.7	2.3 ± 0.5	118.4 ± 7.8
3 Larvae per plant	–	0.8 ± 0.2	25.0 ± 4.8	147.2 ± 5.8
10 Larvae per plant	–	1.9 ± 0.4	18.8 ± 4.3	133.8 ± 2.9
		1990		
0	–	–	–	117.9 ± 5.4
1 Egg mass per plant	885 ± 98	2.5 ± 0.3	4.6 ± 0.8	99.0 ± 7.9
4 Egg masses per plant	3635 ± 193	6.1 ± 1.2	2.5 ± 0.6	82.2 ± 3.7
3 Larvae per plant	–	0.8 ± 0.2	25.0 ± 4.8	108.9 ± 5.6
10 Larvae per plant	–	1.8 ± 0.3	17.5 ± 3.2	109.2 ± 6.8

Data reported are means ± standard error, $n = 4$, except for final larval density, where $n = 8$.

Materials and Methods

Research was conducted in commercial corn fields in Perkins County, near Grant, Nebraska. Fields are irrigated by center pivot and similar agronomic practices were used on all replications. Field corn [*Zea mays* (L.) 'Pioneer 3475'] was planted in 1989 and 1990 at 79,040 plants per hectare, with 0.76 m between rows. Saran fabric field cages (1.8 by 1.8 by 3.0 m high) were placed over corn plants before first generation European corn borer (*Ostrinia nubilalis* [Hubner]) flight began and these cages remained in place until plots were hand harvested. Corn was thinned by hand to 16 plants per cage.

Treatments consisted of one egg mass per plant, four egg masses per plant, three larvae per plant, ten larvae per plant and an uninfested caged check. Treatments were arranged in a randomized complete block design with four replicates.

On 20–21 July 1989 and 17 July 1990 western bean cutworm egg masses were removed from corn fields in the area by cutting a square of leaf tissue (approximately 2580 mm^2) around the egg mass. A 10× hand lens was used to count the number of eggs per mass. Egg masses were placed on the upper leaf surface of corn plants in cages. Each leaf square containing an egg mass had a 51 by 51 mm cloth screen placed over it and another 51 by 51 mm cloth screen placed on the under leaf surface. This "sandwich" was stapled to keep the egg masses attached to the corn plant. Observations indicated that the egg masses were not damaged by this procedure. No attempt was made to put equal numbers of total eggs in each replicated treatment, but the total number of eggs per cage was recorded (Table 1).

In 1989 egg masses were removed from corn in growth stages V18 to R1 (Ritchie et al., 1986) and placed on corn in the field cages at growth stages VT to R1. In 1990 eggs were removed from corn at growth stage V18 to VT and placed on corn at the same growth stages.

First and second instar western bean cutworms were removed from corn fields on 26 July 1989 and 1990 by pulling the tassel of infested plants. Some larvae (1989) were obtained from eggs that were kept in a plastic container until hatch

Table 2. Economic injury levels (larvae per plant) for western bean cutworms in corn at dent stage.

Corn value ($) per bu	Control costs ($) per acre					
	6	8	10	12	14	16
2.00	0.81	1.08	1.35	1.62	1.89	2.16
2.10	0.77	1.03	1.29	1.54	1.80	2.06
2.20	0.74	0.98	1.23	1.47	1.72	1.97
2.30	0.70	0.94	1.18	1.41	1.65	1.88
2.40	0.68	0.90	1.13	1.35	1.58	1.80
2.50	0.65	0.86	1.08	1.30	1.51	1.73
2.60	0.62	0.83	1.04	1.25	1.46	1.66

had occurred. Larvae were transferred from tassels to emerging silks of corn in the field cages (early R1) by camel's hair brush.

When the corn was just before stage R5 (dent), two corn plants per cage were removed and the number of larvae per plant was recorded to estimate the final density per plant of western bean cutworm larvae in each cage.

Corn was not harvested until observations showed that cutworms had left the ear. Each plot was hand harvested. Corn was shelled in a Haban husker-sheller operated at 2200 rpm. Samples were weighed and the weight was corrected to 15.0% moisture.

STATISTICAL ANALYSES: Linear regressions were used to describe the relationship between final western bean cutworm larval densities and yield for each year. Analyses of variance were used to test for effects of density and year on egg and larval survival. All results are reported as mean ± standard error.

Results and Discussion

YIELD LOSS PER LARVA: In both years there were significant linear regressions of western bean cutworm larval density (per plant) measured at dent stage (X) and yield (bu/acre) (Y). In 1989, $Y = 146.1(\pm 2.76) - 3.66(\pm 0.74)X$ ($F = 24.365$, 1, 34 d.f., $P < 0.01$) and in 1990, $Y = 110.9(\pm 2.94) - 3.67(\pm 0.81)X$ ($F = 20.419$, 1, 34 d.f., $P < 0.01$). The slopes of the regressions were not significantly different between years and averaged −3.7 bu/acre yield for each western bean cutworm larva per plant at dent stage.

ECONOMIC INJURY LEVELS: Economic injury levels (Pedigo, 1989) (EILs) were calculated for western bean cutworm larval densities in dent stage corn as:

$$\text{EIL} = \text{control costs}/(\text{commodity value} \times \text{yield loss per larva})$$

EIL's for various combinations of control costs ($/acre) and commodity value ($/bu) were calculated using 3.7 bu/acre yield loss for each western bean cutworm larva per plant at dent stage (Table 2).

EGG AND LARVAL SURVIVAL: Survival of eggs and young larvae compared with larval densities measured at the dent stage did not differ significantly with initial density or with year ($P > 0.05$). Egg-larval survival averaged 3.3 ± 0.4% and young larval survival averaged 21.6 ± 2.1%.

Caution should be used in applying the data from this study to field conditions because our study was conducted in field cages which excluded natural enemies and probably influenced the microclimate that the eggs and larvae experienced.

Also, mortality of western bean cutworm larvae has been reported to be variable between years. Hirnyck (1983) reported that natural mortality of western bean cutworm larvae ranged from 56.5–98.5% during a two year study under uncaged field conditions in Nebraska.

In 1990, cages treated with four egg masses per plant had considerable migration out of the field cages by first and second instar larvae. Inspection of the corn plants immediately surrounding the field cages two weeks after egg hatch showed three to seven larvae per ear. These larvae most likely came from the field cages, since further examination of corn plants one row from plants adjacent to field cages showed no larvae and examination of corn plants in the same row showed no larvae further than ca. 1.5 m from the field cage borders. There was no evidence of migration of larvae out of the field cages from any other treatments.

IMPLICATIONS FOR MANAGEMENT: Treatment decisions for western bean cutworms must be made soon after egg hatch. The economic injury levels developed in this research must be combined with data on expected egg and larval survival to produce a practical economic injury level. Using the average survival data from this study, predicted numbers of eggs per plant or small larvae per plant producing an EIL can be calculated. For example, assuming control costs were $8 per acre, and corn value was $2 per bushel, the economic injury level would be 1.08 larvae per plant at dent stage (Table 2). Assuming 3.3% egg-larval survival and 21.6% larval survival, this would be equal to 32.7 eggs or 5.0 larvae per plant at the time that treatment decisions must be made. The average number of eggs per egg mass in this study was 61.6 (1989) and 56.5 (1990) (Table 1). Based on these data, 32.7 eggs per plant would be equivalent to 0.5–0.6 egg masses per plant.

The nominal economic threshold currently used in Nebraska is 8% of plants infested with eggs or larvae (Wright et al., 1992). This research has demonstrated a relationship between larval density at dent stage and yield loss, and developed economic injury levels based on that relationship. There are no published data on the relationship between western bean cutworm egg and larval density and the percentage of plants infested. This prevents us from comparing our results with current practice.

Additional research is needed to measure *L. albicosta* egg and larval survival under uncaged field conditions and to understand the spatial dispersion patterns of western bean cutworm egg masses and larvae in field corn.

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