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Effects of Sucrose Spray for Biological Control of the Alfalfa Weevil

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EFFECTS OF SUCROSE SPRAY FOR BIOLOGICAL CONTROL OF THE ALFALFA WEEVIL

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Abstract

The alfalfa weevil, *Hypera postica,* is the major pest of Colorado alfalfa, reducing both hay quality and crop yield. Parasitoid wasps (Ichneumonidae), and aphidophagous Coccinellidae are the primary biological control agents of alfalfa weevil in early season alfalfa. These agents often occur in numbers too low to prevent economic alfalfa weevil damage. Sucrose sprays have been used as artificial Homopteran honeydew to attract and retain Ichneumonidae, Chrysopidae, Coccinellidae and Syrphidae. In this study, we observed the effect of sucrose sprays on population densities of parasitoid wasps and general predators and monitored associated changes in populations of the alfalfa weevil.

Section 1.

Objectives and Hypothesis

Overall Objective.

The purpose of this study is to determine how applications of sucrose spray influence biological control of alfalfa weevil in Colorado alfalfa agroecosystems. It is hypothesized that an application of sucrose will arrest natural enemy movement within experimental plots thereby resulting in a numerical increase in these beneficial predators. Also, the number of alfalfa weevil larvae will be monitored in treated and untreated plots to determine the effect of treatment on pest population levels.

Objectives and Hypothesis.

I. Determine if applications of sucrose spray will influence:
   - A. General predator densities.
   - B. Parasitoid densities.

II. Determine effect of sucrose spray on the augmentation of natural enemies and their suppression of alfalfa weevil larval densities.

III. Compare costs and benefits of sucrose spray and conventional pesticide for management of alfalfa weevil.

Section 2.

Methods and Materials.

Experiment 1.

Experimental Design. The study was conducted in an alfalfa field on City of Boulder Open

Space lessee property (Steve Penner Farms 75th street and Baseline Road, Boulder, Colorado). In both 1994 and 1995, a randomized complete block design was used to test a single application of sucrose spray. Plots were laid out in the southern part of the field as two rows by six columns. Individual plots were square, measuring 21.35 m x 21.35 m (70 x 70 feet). To compensate for spatial variances of insects and plants and a south to north irrigation gradient, plots were blocked into four sets of three plots. Treatments were replicated four times.

Treatments. Sucrose spray consisted of a solution of 150 g of white beet sugar to 1 liter of water. Sugar and water were mixed on site immediately before application. Treatments were sprayed on each plot using a Honda™ FourTrax equipped with a 15 gallon holding tank and ten foot spray boom. The sprayer was calibrated to deliver 23.1 kilograms of sucrose per hectare. Treatment 1 was sprayed once with two liters of sucrose solution, and treatment 2 was sprayed once with two liters of water as a control. A third treatment was sprayed with the insecticide chlorpyrifos to evaluate yield differences. Chlorpyrifos was sprayed at a rate of 0.56 kilograms per hectare (1 pound per acre).

Measurements. Plots were sampled using a 37 cm diameter muslin sweep-net with a 180-degree sweeping motion (Luna and Ravilin 1992). After 10 sweeps, net contents were emptied into 1 quart Ziploc™ plastic bags and placed in an ice chest. Precount samples were taken from each plot 24 hours before treatment. Samples were taken on the 1st, 2nd, 4th, 7th day, and 15th day after application of sucrose. All samples were collected between 1100 and 1300 hours.

Experiment 2.

In 1995, a randomized complete block design was used to test multiple applications of sucrose spray. Plots were laid out 6 m north of the original plots in 8 columns by 2 rows. Individual plots were square, measuring 15.24 m x 15.24 m (50 x 50 feet). To compensate for spatial variances of insects and plants and a south to north irrigation gradient, plots were blocked into four sets of four plots. Treatments were replicated four times.

Treatments. Sucrose spray consisted of a solution of 150 g of white beet sugar to 1 liter of water. Sugar and water were mixed on site immediately before application. Treatments were sprayed on each plot using a Honda™ FourTrax equipped with a 15 gallon holding tank and fifeteen foot spray boom. The sprayer was calibrated to deliver 23.1 kilograms of sucrose per hectare. Treatment 1 was sprayed once with sucrose solution, treatment 2 was sprayed twice with sucrose solution, treatment 3 was sprayed 3 times with sucrose solution, and treatment 4 was sprayed with water. Treatments were made every 7 days.

Measurements. Plots were sampled using a 37 cm diameter muslin sweep-net with a 180-degree sweeping motion (Luna and Ravilin 1992). After 10 sweeps, net contents were emptied into 1 quart Ziploc™ plastic bags and placed in an ice chest. Precount samples were taken from each plot before treatment. Samples were taken on the 1st, 2nd, 4th, and 7th day after application of sucrose. All samples were collected between 1100 and 1300 hours.

Objective IA.

Determine effect of sucrose spray on general predator densities.

Adult and immature natural enemies were counted and recorded. Natural enemies included: damsel bugs, minute pirate bugs, green lacewings, and Lady beetles.

Objective IB.

Determine effect of sucrose spray on parasitoid densities.

On day 7, alfalfa weevil larvae were collected from each plot using a sweep net and reared in the lab to determine larval parasitism rates. Five hundred third and fourth instar alfalfa weevil larvae from each plot were placed in paper bags with a small quantity of alfalfa. The paper bags were placed in a growth chamber set on a 12 hour photoperiod. Temperature ranged between 21.1°C during light periods and 17.1°C during dark periods. Larvae were fed untreated alfalfa foliage each day. After two weeks, the bags were placed in a freezer and later examined for evidence of parasitism. Adult alfalfa weevil, alfalfa weevil larvae, and dead alfalfa weevil larvae were counted. Adult hymenopterous parasites and cocoons were counted and identified to species.

Objective II.

Determine effect of sucrose spray on the augmentation of natural enemies and their suppression of alfalfa weevil larval densities.

Plots were sampled using a 37 cm diameter muslin sweep-net with a 180-degree sweeping motion (Luna and Ravilin 1992). After 10 sweeps, net contents were emptied into 1 quart Ziploc™ plastic bags and placed in an ice chest. Later, alfalfa weevil larvae and adults were counted and densities were determined by larvae or adults per sweep.

Objective III.

Compare costs and benefits of sucrose spray and conventional pesticide for management of the alfalfa weevil.

A 1-meter diameter plastic hoop was randomly tossed into plots to determine sample areas. Two yield samples were collected from each plot. Clipped alfalfa forage samples were weighed in the field at harvest. Samples were then placed in a drying oven at 60° C. After two days, samples were weighed and dry weights were recorded.

Section 3.

Results

Experiment 1.

Objective IA.

General predators. Profile plots indicate that lady beetle numbers increased from moderate to high numbers per sweep after treatment with sucrose (fig. 1).

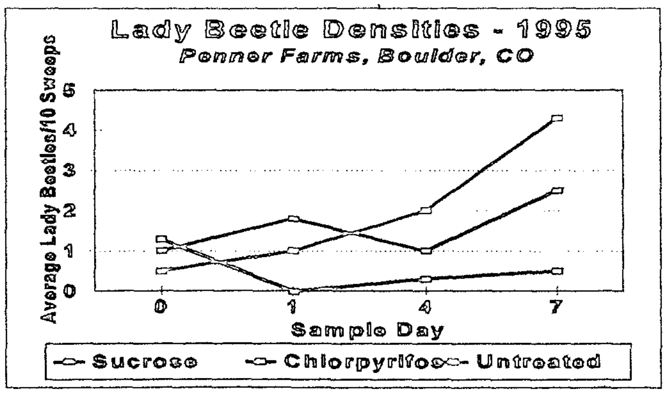

Figure 1. Lady beetle densities for experiment 1.

Objective IB.

Parasitoids. Plots sprayed with sucrose averaged 9.3% parasitism while control plots averaged 7.4%.

Objective II.

Alfalfa weevil larvae. Profile plots indicate that alfalfa weevil populations were slightly higher in precounts of sucrose plots than in control plots (fig. 2). Day 1 samples indicate slightly fewer larvae in sucrose plots. However, by day four density trends are reversed. Day 2 samples were not taken due to weather.

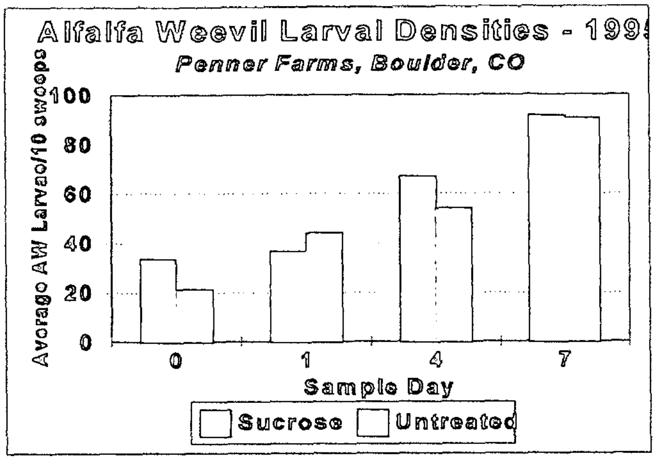

Figure 2. Alfalfa weevil larval densities for experiment 1.

Objective III.

Dry weight yield. Sucrose plots appeared to have lower dry weights than either chlorpyrifos or control plots (table 1). It is not known if these are significant differences.

Treatment	Sucrose	Chlorpyrifos	Control
Dry weight (g)	95.9	127.6	111.0

Table 1. Average dry weights of yield samples for experiment 1.

Experiment 2.

Objective IA.

General predators. General predator data for experiment 2 is still being processed at this time.

Objective IB.

Parasitoids. Parasitism data for experiment 2 is still being processed at this time.

Objective II.

Alfalfa weevil larvae. Larval data for experiment 2 is still being processed at this time.

Objective III.

Dry weight yield. Plots treated with sucrose spray on multiple occasions had successively higher dry weights with each additional treatment (table 2). It is not known if these are significant differences.

Treatment	Control	1 x	2 x	3 x
Dry Weight (g)	73.5	89.7	97.9	99.3

Table 2. Average dry weight of yield samples for experiment 2.

Section 4.

Discussion

Studies of food spray use usually involves only predator responses. This study went one step further by examining effects on prey populations. Results indicate that even though alfalfa weevil populations were slightly lower in sucrose treated plots there was not a significant difference. One possible reason for this is that the application of sucrose was incorrectly timed. An earlier application may have a greater effect on population levels. Another factor is weather. The spring of 1995 was characterized by copious amounts of rain. This affects both the life cycle of the insects as well as the persistence of the treatments.

Section 5.

Anticipated Value

Alfalfa, *Medicago sativa*, is the third most important crop in Colorado after wheat and corn and the most important cultivated forage crop (Colorado Agricultural Statistics 1993). Roughly 850,000 acres of alfalfa were harvested in Colorado in 1993, with a value of more than $239 million (Ag Update 1994). Alfalfa weevil, *Hypera postica*, larvae burrow into the leaf terminals causing the leaves to appear ragged. Without chemical treatment, spring populations of alfalfa weevil, can result in a 30% yield reduction in the first cutting (Doyle, Bradbury, Brase, & Peairs 1993). Insecticides such as carbofuran, chlorpyrifos, parathion, and permethrin are the principle means of controlling alfalfa weevil populations in Colorado alfalfa production, based on statistics compiled by the Colorado Pesticide Use Survey (Bohmont 1991).

In addition to losses associated with quality and quantity, chemical control of alfalfa weevil raises environmental and regulatory concerns. Insecticides applied for the control of alfalfa weevil can affect non-target organisms including human, avian species, and beneficial insects. Integrated pest management (IPM) guidelines are designed to provide cost effective and environmentally sound management of pests, thus addressing the needs and concerns of both agriculture and the community. One component of IPM which meets the criteria of effectively managing the pest, insuring environmental responsibility, and addressing public concerns is to employ biological control by natural enemies.

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