A Study of Habitat Preference for the Aestivation of the Alfalfa Weevil Hyper Postica (Curculionidae: Coleoftera)

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A STUDY OF HABITAT PREFERENCE FOR THE AESTIVATION OF THE
ALFALFA WEEVIL HYPER POSTICA (CURCULIONIDAE: COLEOPTERA)

by

Donald D. Myers

A thesis
submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Biology

Western Michigan University
Kalamazoo, Michigan
December 1981
Habitat preference for the aestivation of Hyper postica was researched by the sampling of field borders. Sampling methods included soil and vegetative litter collection, sweeping of borders with an insect net and emergence trapping of wooded and grass habitat. Fields were swept once a week to determine if H. postica returned to the field before the winter season. The methods resulted in the following findings: Weevils do not aestivate in the top eleven centimeters of soil and vegetative litter. Data from sweepings indicated that weevils prefer areas that include alfalfa and grasses. Results of observations implied that there is a direct relationship between population density of weevils and density of vegetation if the vegetation includes alfalfa and grasses. Emergence traps support the data that shows weevils select sites that include alfalfa and grasses. Field sweepings indicated that weevils began to return to the field in late August.
ACKNOWLEDGEMENTS

I would like to thank Dr. Joseph Engemann, Dr. Richard Brewer and Dr. David Cowan for their contributions as members of my graduate committee. For the use of their fields, I would like to thank Mr. Dan Yeck, Mr. Glen Walter, Mr. John O'Donnel and Mr. Robert Callender. A special thank you goes to my wife, Denise Myers, for her help in proof reading and drawing the illustrations for the final draft. Finally I would like to thank Sally Myers for her help in proof reading the final draft.

Donald D. Myers
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Western Michigan University M.A. 1981

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CHAPTER I

INTRODUCTION

The Problem

Destruction of many acres of Medicago sativa (alfalfa) has been recorded throughout the world. Most of these worldwide losses have been caused by a weevil from the order Coleoptera, Hyper postica. The capabilities for field decimation by H. postica have made it necessary to identify this pest and to study its behavior and life cycle. Since much of the weevil's life cycle occurs in the field borders, this study is concerned with the selection of borders by H. postica. That selection was determined by sweeping, taking soil samples and emergence traps. Although the prime concern of this study is the selection of aestivation sites, it should be understood that much of the behavior of the weevil is affected by weather and climate.

Its Significance

Large economic losses have been inflicted by the alfalfa weevil, Hyper postica, to the alfalfa crops around the world. Economic losses from H. postica have been observed in Asia, Europe, South America, Central America

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and North America (Yakhoutov 1974). The consequences of infestation have been described by growers as a yellowing of green leaves (Yakhoutov 1974) or a skeletonizing of leaves and crowns. As a result of this damage, farmers have crop losses ranging from the loss of nutritional value and productivity and to the complete destruction of a field. Consequently *H. postica* is known as a devastating alfalfa pest. The purpose of this study was to gain more knowledge of the life cycle of this pest.

Identification

A pest with the capabilities for such destruction should be recognized by people working with alfalfa. Identifying characteristics of *H. postica* are described in the following material. Ruppel and Stehr (1974) depicted the eggs as being small and yellow to brown in color. Depending on the time of oviposition, the eggs can be located in dead or living stems of alfalfa. A legless, white larvae with a black head eventually emerges from an egg. Larvae are described as being wrinkled and about 9.5 millimeters long. By the fourth instar, the larvae has become grass green with a prominent white stripe down the middle of its back. After the larval stage, the weevil spins a rough-textured silky cocoon with a white silky shine. This cocoon measures from 5.5 to 8 millimeters long and 3.5 to 6 millimeters wide. Cocoons can be
located at the base of *M. sativa* or *Lamium amplexicaule* (henbit). Adults emerge from the cocoon with a typical weevil snout and a broad black band that extends from the anterior portion of the thorax to the middle of the back. Adults are from 3 to 5 millimeters long and range in color from brown to grey (Ruppel and Stehr 1974). The main characteristics for identification of *H. postica* are distinctive measurements and markings during larval, pupal and adult stages.

**Life Cycle**

Identification of this pest is important, but a knowledge of its behavior is necessary to use appropriate control methods. Understanding the weevil's life patterns allow the growers to adjust and maximally protect their crops. This knowledge has been used to let the farmer apply controls more successfully with the minimum of crop damage and expense. Improper implementation of weevil control because of the lack of knowledge of its life cycle can actually improve the chances for the weevil's survival. Behavioral studies of *H. postica* have made it possible for the farmer to control this pest with the minimum of crop damage and money expenditure.

Important in the life cycle of *H. postica* are the time and location of oviposition. Females begin ripening during early spring, late spring and late fall.
time of oviposition the females will chew a small hole into a stem of *M. sativa* or *L. amplexicaule* (Lathief, Larr and Pass 1979). If ripening occurs during early spring the eggs will be deposited in dead stems. Live stems are the host for the eggs if the female ripens during late spring or late fall. Rusink (1976) observed one female laying 1500 eggs, but the average number of eggs laid by one female ranges from 600 to 800. This high fecundity shows the potential of *H. postica* to obtain population levels that could completely destroy a field.

After the eggs are deposited, the incubation time varies according to the weather. Warm, humid weather increases the rate of development of the embryo. Eggs that are laid in early summer hatch within four to ten days after oviposition. Fall-laid (November) eggs hatch in the spring (Manglitz and App 1957). In Michigan very few fall-laid eggs survive the harsh winters. In reality, the length of incubation varies according to the season laid, the temperature and the humidity.

After the period of incubation *H. postica* hatches into its most destructive phase. Directly after the emergence from the egg, the larva begins feeding on the buds of *M. sativa* for a period of two instars. After the two instars, the larva makes its way to the leaves where it will remove all tissue from the leaf except for the veins.
This stage has been observed to be the most damaging to alfalfa crops.

The weevil's large appetite during the larval stage prepares it for the period of pupation. At the peak of maturity the larva will spin a cocoon on the host plant. After a period of time, the cocoon drops to the ground. Nanglitz and App (1957) theorized that the dropping to the ground is a natural selective factor that protects the pupa from drying and from high summer temperatures. Like the egg, the pupa is a non-feeding stage: therefore the length of duration of this stage varies according to the type of weather. A quiet stage, the pupa does not directly affect the field's yield.

Emerging from the cocoon at different times of the year, adults feed only for a short period of time. Maryland farmers observe newly emerged adults from May to June (Huggans and Blickenstaff 1964). Mid-June through July is the period of emergence for adults in Michigan fields (Ruppel and Stehr 1975). Growers in both states observed more emerging and feeding activity during the warm cloudy and windless nights than during the cooler and windier nights. During the cool and windy nights the weevil may be found taking shelter at the base of *M. sativa*. The adults feeding on the leaves have little effect on the total yield because of the short period of time that the weevil is in the field. Characterized by emergence and
then an active feeding period, this stage of the life cycle is not a destructive stage because it lasts only a few weeks before the weevil leaves the field.

Following a short period of feeding many adults will migrate from the fields to field borders (Ruppel and Stehr 1974). This migration is thought to be initiated by the length of day. Manglitz and App (1957) observed adults in unharvested fields throughout the hot summer months. Migration from the field appears to be a search for shelter from the drying and the excessive heat of the sun. How *H. postica* selects its aestivation sites is questionable. Prokopy et. al. (1967) describe the weevils as poor fliers with their direction determined by the wind. After the wind-aided flight, Prokopy et. al. (1967) claim the weevils walk to areas more suitable for their survival. The aestivation period lasts about two months, but some weevils stay in the field borders until spring.

Following aestivation, most weevils will return to the alfalfa fields to feed from October to mid-November (Roberts et. al. 1978). Some adults will become sexually mature within fifteen to twenty days after returning to the field (Rusink 1976). In Michigan, many adults overwinter in the field borders and return to the field in the spring. Subsequently the weevils become sexually mature and lay eggs. Where *H. postica* overwinters may depend on where it is most protected from the weather.
Figure 1. A Visual Summary of the Life Cycle of *H. postica*. (Ruesink, 1976)
History of Migration

Originating in Europe, *H. postica* has spread both east and west. The alfalfa weevil crossed the ocean from Spain and was observed in Mexico in 1519. It then migrated to South America where it flourished in Chile. In 1851 it was discovered in the United States (Yakhoutov 1974). By 1968 *H. postica* appeared in small numbers in Michigan. One year later farmers felt the necessity to spray 6,000 acres of alfalfa to stop the infestation (Ruppel and Stehr 1974). Observed in fields of Europe, Asia, South America, Central America and North America, *H. postica* has become a worldwide pest.

Weevil Management

Weevil management is an important issue because of environmental effects and field yield. Different control methods have been used. Shoemaker (1973) describes early harvesting before the larval stage, as an economically sound method of control. Early harvest allows the sun to dry the eggs and larvae that lay unprotected. Most farmers feel that this is the easiest and least costly control for the weevil. Some studies show that an early cut reduces the field value because of the missed growing period and loss of natural predators of *H. postica*. Pesticides are suggested when the population density of the alfalfa
weevil is high (Shoemaker 1973). The problem with insecticides is that they reduce the natural enemies of *H. postica* and can only be effective during specific stages of the weevil's life cycle. After using an insecticide, a grower can expect an increase of infestation because of fewer natural enemies. Figure 2 (Shoemaker 1976) visually shows the relationship of the amount of insecticide used and insects killed.

Figure 2. Insecticides vs insects killed

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Ruppel and Stehr (1974) describe control methods to be used when certain levels of infestation occur. Early cutting should be taken without spraying when \( \frac{1}{4} \) or less of the tips of alfalfa show damage at the time of the first flower buds and the alfalfa will be cut within a week, the numbers of the weevil are lower than those needed to justify spraying or many of the leaves have been skeletonized by the grubs. Ruppel and Stehr (1974) suggest the use of an insecticide at the time of the appearance of the first flower buds when some loss of yield of the first cutting can be tolerated, about \( \frac{1}{4} \) of the tips show damage of the alfalfa weevil grubs or the first cutting will not be taken for one week or more. A spray of carbofuran (Furadan) at \( \frac{1}{2} \) lb. active insecticide per acre is recommended during the appearance of the first flower buds when maximum yield protection is needed in the field, feeding of the adult or the easy observation of adults in the field or the first cutting will definitely be taken at late bud or first flower stage of the alfalfa.

Each program has its strengths and weaknesses. The first program is strongly recommended when possible although there is some loss of hay due to weevil feeding. The second program does not protect the alfalfa from early loss but does allow the grower to assure himself that
a spray is definitely needed before he applies an insecticide. The third program reduces the chance of early infestation but after two weeks leaves the field unprotected from reinfection. The drawback to this early spray is that one does not have solid guidelines for predicting the need to spray. For more information consult appendix A following the conclusion.

The most important steps of control as quoted from Ruppel and Stehr (1974) are as follows: "Learn to recognize the alfalfa weevil and its damage. Check your fields frequently for the weevil. Take the first cutting at late bud stage. Carefully select and apply insecticides if needed." It is with the above steps that alfalfa growers can maximally protect their investment.

Along with these steps the alfalfa farmer must realize there is a direct relationship between the growth of alfalfa and the growth of *H. postica*. If the conditions are beneficial for alfalfa growth they are also excellent for the alfalfa weevil (Shoemaker 1980). Factors that improve the growth of alfalfa are warm temperatures and high humidity, which are favorable for the weevil's eggs (Shoemaker 1980). Appropriate temperatures range from 12°C to 36°C. Hatching is eight times more rapid at thirty-six degrees centigrade than at twelve degrees centigrade (Koehler and Gyrisco 1961). Minimal incubation will occur at a slow rate between 10°C to 12°C. The growth of
*H. postica* and alfalfa are directly related to temperature and humidity.

*H. postica* is a very destructive pest that can completely eliminate alfalfa crops. This pest has certain needs for survival. The purpose of this thesis is to determine the habitat preference for the alfalfa weevil's site of aestivation.
CHAPTER II

METHODS

Field Selection

Four different alfalfa fields were used for this study. Two fields and their borders were used for final sampling. The other two were not sampled for two of the experiments because of the results of a preliminary sweeping. The reasons will be discussed later. Each field will be depicted by its size, location and how its margins were divided into sections.

Field one is located in Newton Township, T 3 S, R 7 W, in the southeast quarter of section three. A rectangular shaped field, field one is bordered on the west side by y½ Mile Road with a pasture on the east end; north and south ends are primarily bordered by corn fields. Approximate dimensions are 255 x 668 meters which covers an area of about 17.034 hectares.

Field two is near field one in Newton Township. Located on the south side of B Drive South, its coordinates are T 3 S and R 7 W in the southwest quarter of section 3. Field two has an approximate area of 4.4903 hectares. It is not considered a clean field because of the amount of grass interspersed among the alfalfa plants.

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Fields three and four were not extensively studied because of the absence of weevils located in the preliminary sweeps of the two fields. Field three is located on Two Mile Road in Leroy Township, T 3S, R 8W, in the southeast quarter of section 32. It covers an area of about 3 hectares. The fourth field is located in Athens Township, T 4S, R 4W, in the southeast quarter of section 16. Field four has an area of about 27 hectares.

Section Selection

The margin of each field was divided into sections. The criteria used to determine the sections were dominating vegetation and the position of the section relative to the field. Dominating vegetation was considered the most important criterion for dividing up the field borders. A section continued unless there was a drastic change in vegetation or direction of the border. The field borders were divided into sections so that some conclusions could be made about relationships of the H. postica and its habitat selection.

The margins of field one are divided into six sections as shown in figure 3. Section one is about 255 meters by 3 meters. A fence row dominated by pasture grass and interspersed with clover and alfalfa describes its flora. Three meters east of the field is a closely cropped pasture that shows heavy use. A row of large hickory,
black locust, butternut, pin oak and black cherry trees dominates the vegetation of section two. Pasture grass covers the ground around the trees. The section is 255 M. by 10 M. Section three is 668 M. by 3 M. This north end is dominated by pasture grasses, alfalfa, thistle, raspberry and a few sumac. North of this section is a well worn path for cows to go to pasture. Characterized by a thick stand of black oak, staghorn sumac and black cherry, section four is 123 M. x 20 M. The ground cover consists of raspberry, grasses and alfalfa. The fifth section has standing water in the center and is characterized by plants found in a swampy habitat. Protruding into the field about 125 M., its edge is about 280 M. Raspberry plants take up much of the area with some goldenrod and small quaking aspen, sassafras, staghorn sumac and black oak filling in the area. Similar to sections four and five, section six is on the south side of the field. Its dimensions are 500 M. x 10 M. Rows of black oak and black cherry trees are surrounded by grasses, staghorn sumac and some raspberries. On the other side of the border is a cornfield.
The field borders of field two are divided into five separate sections as shown in figure four. On the west side of the field, section one is dominated by pasture grass that is interspersed with alfalfa. Section one measures 208 M. x 10 M. West of the section is a pasture that is not in heavy use. The north end of the field is divided off into section two. It is 112 M. long and quite deep. Heavily wooded, section two is dominated by red oak and staghorn sumac and braken ferns along the edge. The third section measures 310 M. long. It is located on the northeast corner of the field. Dominated by grasses it exemplifies a typical field habitat. Section four is characterized by very short, broadleaf plants with many bare spots because of the heavily used trail. Some seemingly stunted alfalfa plants are found growing between the other plants. The section measures 83 M. x 20 M. Section five is dominated by grasses and alfalfa. It measures 260 M. by 208 M.
The map in figure 5 shows how field three was divided into six sections. Section one is 49 M. long along the north corner of the field. It is characterized by goldenrod and raspberries. Section two, in the northwest corner is like an open field. It has a 14 M. border and is dominated by mainly grasses, some goldenrod and a few raspberries. Wooded and shaded, section three is about 119 M. long. Sassafrass, black cherry and black oak dominate its vegetation. On the southwest side of the field, section four is a 251 M. by 10 M. strip. The dominant vegetation is black cherry, black oak and grasses. Section five is 251 M. by 2 M. A very thin strip, this plot is dominated by grasses and alfalfa around the fence in the center of the strip. Soybeans are grown northeast of the border. The southeast side of the field is section six. It is 120 M. by 5 M. and very similar in vegetation to section five.

Figure 5. Field Three
The fourth field is divided into five sections as shown in figure 6. About 441 M. long, section one is characterized by a few small black willow and goldenrod. The habitat of section two has little ground cover with many small trees along its 220 M. section. A farm lane borders the field with a row of large oak trees north of the lane representing section three. Section three is approximately 400 M. long with a depth of 30 M. Section four, 451 M. long, is made up of a mixture of short grasses and alfalfa. Six-hundred-six meters long, section five's vegetation consists of a dense sassafras, shagbark hickory, black cherry and black oak stand. Figure 6 shows how each section is divided in relationship to the field.

Figure 6. Field Four
Sampling Procedure

After the borders were sectioned, a ten by ten meter quadrat was randomly placed in each border that was large enough to contain a quadrat. Ten samples of soil were randomly collected from each quadrat. Borders that were not wide enough for a 10 by 10 meter quadrat were sampled by taking randomly ten soil samples from the entire border. Each sample was collected by twisting the bulb planter eleven centimeters into the soil. By carefully lifting the planter at an angle, the soil sample could be removed with most of the soil. Each sample was placed in a plastic sandwich bag with an identification tag and twisted shut. All ten samples were sifted through a screen and visually checked for weevils. After the visual check all ten samples were placed in a Berlese funnel for twenty-four hours. All fields and their margins were checked in the previously described manner.

A preliminary sweep was used to locate field borders that contained *H. postica*. Each plot was sampled for its complete length with an insect sweep net. After twenty sweeps, the insects collected were placed in a flat pan. Any weevils captured were recorded and released. Only the edge of the border was sampled. The purpose of the preliminary sweep was to determine if *H. postica* was in the area.
Emergence traps were located randomly in a wooded field border and a grass field border of field two. One trap was placed one meter from the edge of plot two into the wooded stand and one trap was placed one meter from the edge into the southern section of plot three. Each trap was checked once a week, from August 20 to September 22, 1980. Refer to appendix B for a description of emergence traps.

Each alfalfa field was sampled once a week from August first to the end of September. A ten meter by ten meter quadrat was randomly selected for each sampling period. The quadrat was swept with an insect net so that no area was covered twice or missed completely. After the sweep, the insects collected were placed into a plastic bag with moth crystals, and left for twenty-four hours before being identified. The purpose of this sweeping was to determine the time the weevils would return to the alfalfa fields.

A final sweep of the field borders was done in the following way: Each field border was swept in the afternoon so that the vegetation was dry. Sweeping dry vegetation seemed to be easier because the insects were not able to stick to the plants and the insect net when attempting to remove them. Insects taken from wet vegetation molded much quicker because of the added moisture. A twenty meter transect was set thirty-eight centimeters
from the edge of the field. The area was swept as close to the ground as the vegetation allowed. Overlapping of sweeps was reduced as much as possible. At the end of the transect the insects collected were placed into a plastic sandwich bag with moth crystals and an identifying tag. As many twenty meter transects were completed as the length of the section allowed. The weevils collected were identified later in the laboratory.
CHAPTER III

RESULTS

Soil Samples

No weevils were observed from the soil samples collected. Weevils were not observed by visual sorting or mechanical sifting. The Berlese funnel did not capture any weevils.

Preliminary Sweep

A preliminary sweep was made to determine if any weevils were to be found in the field margins. In the borders of fields one and two, H. postica was captured but in fields three and four no weevils were captured. Although no weevils were captured, a higher concentration of apnids were found to inhabit fields three and four than were found to inhabit fields one and two.

Table one lists the data collected from the preliminary sweeps of each of the field borders. High concentrations of weevils were found in borders that appear to have dense vegetation and that included grasses, alfalfa and trees. Sections of this type of habitat are found in field one, sections one and three. The second highest concentrations of weevils are found in borders with dense

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growths of grasses and raspberries. This type of habitat is located in section five of field one. Borders with grass and alfalfa contained the third highest concentration of weevils. These sections include sections two and four of field one and sections three and five of field two. Section six of field one also has a high frequency of weevil capture. Section six is dominated by trees and grasses. A few weevils were captured from section two of field two. Section two is strictly dominated by trees with some ground cover. No weevils were located in section four of field two. This border is characterized by short broadleaf plants.

Table 1
Preliminary Sweep Results

<table>
<thead>
<tr>
<th>Field</th>
<th>Section</th>
<th>Number of Weevils Captured</th>
<th>Description of Habitat</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>29</td>
<td>grass, alfalfa, trees</td>
<td>7/30/80</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>5</td>
<td>grass, alfalfa</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>32</td>
<td>grass, alfalfa, trees</td>
<td>7/31/80</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1</td>
<td>grass, alfalfa</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>1'</td>
<td>grass, raspberry</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>1'</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>grass, alfalfa</td>
<td>8/6/80</td>
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<tr>
<td>2</td>
<td></td>
<td>3</td>
<td>trees</td>
<td></td>
</tr>
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Table 1-Continued

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<th>Section</th>
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<th>Description of Habitat</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
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<td>3</td>
<td>6</td>
<td>grass, alfalfa</td>
<td>8/6/80</td>
</tr>
<tr>
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<td></td>
<td>0</td>
<td>short broadleaf</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>3</td>
<td>grass, alfalfa</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>grass, trees</td>
<td>8/4/80</td>
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<tr>
<td>2</td>
<td></td>
<td>0</td>
<td>grass</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0</td>
<td>trees, grass</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0</td>
<td>grass</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0</td>
<td>grass</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
<td>grass, trees</td>
<td>7/29/80</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0</td>
<td>trees</td>
<td>to</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0</td>
<td>trees, short broadleaf</td>
<td>7/30/80</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0</td>
<td>grass</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0</td>
<td>trees</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Weevils</td>
<td>106</td>
<td></td>
</tr>
</tbody>
</table>

Final Sweep

Table two describes the results of the final sweep of field one. Characterized by dense ground cover, sections one and four contain the highest concentration of weevils.
Table 2

Capture of Weevils on Field One
During 8/19/80-8/21/80

<table>
<thead>
<tr>
<th>Section</th>
<th>Twenty Meter Quadrat</th>
<th>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 Tot. Avg./Quad Weevil/M²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 1 0 2 0 1 1 8 1 x x x x x x x x x x 8 .8889 .117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 0 1 0 0 0 0 0 1 x x x x x x x x x x x x x x x x 2 .2857 .0376</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 1 0 0 1 1 1 1 2 0 2 1 2 1 2 0 0 0 0 13 .7222 .0950</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 1 1 1 x x x x x x x x x x x x x x x x x 3 1.0 .1316</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 0 0 0 0 0 1 0 0 0 0 0 1 0 1 0 x x x x 3 .2143 .0282</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 x 3 .1765 .0232</td>
</tr>
</tbody>
</table>

Note: x represents nonexisting quadrats. The chi square test exceeds the value of 5DF at 99% level.
Section one is dominated by grasses and alfalfa. Section four is dominated by trees, raspberries, grasses and alfalfa. Sections two, five and six contain the lowest concentration of weevils per square meter. Section two is dominated by grasses and raspberries. The main vegetation of section five are grasses and raspberries. Grasses and trees dominate section six. None of the last three sections described would be considered densely covered with vegetation.

The results of sweeping field two are described in table three. Section one has the highest density of weevils. Section one is dominated by alfalfa interspersed with grasses. The ground cover is considered to be very dense. The sweeping of sections two and five resulted in the second highest density of captured weevils. These sections are alike in that they are dominated by grasses and alfalfa. Although the vegetation of sections two and five are similar to section one, the vegetative density appears to be much greater in section one and has more alfalfa in it then do sections two and five. No weevils were located in sections two and four. A high density of trees with little ground cover characterizes the vegetation of section two. Section four is dominated by low broadleaf plants.

Fields three and four were not tested because of the absence of weevils in the preliminary sweeps.
Table 3

Capture of Weevils on Field Two
During 8/19/80-8/21/80

<table>
<thead>
<tr>
<th>Section</th>
<th>Twenty Meter Quadrat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>1</td>
<td>1 1 1 2 xx xx xx x 10</td>
</tr>
<tr>
<td>2</td>
<td>0 0 0 0 0 0 0 xx xx x 0</td>
</tr>
<tr>
<td>3</td>
<td>0 0 1 0 0 0 0 xx xx x 1</td>
</tr>
<tr>
<td>4</td>
<td>0 0 xx xx xx xx xx xx 0</td>
</tr>
<tr>
<td>5</td>
<td>1 0 0 0 0 0 0 0 0 0 1</td>
</tr>
</tbody>
</table>

Note: x represents nonexisting quadrats. The chi square test exceeds the value of 4DF at the 99% level.
Table four combines the data from fields one and two according to the dominating vegetation. The highest frequencies of capture are from those areas that had dense populations of grasses and alfalfa. A few weevils were located in areas dominated by grasses or grasses and raspberries. The lowest number of weevils captured were in areas of low density ground cover. These areas are represented by wooded areas with little ground cover and areas with short broadleaf ground cover.

Table 4

Frequency of Weevil Capture in Relation to Habitat Classification

<table>
<thead>
<tr>
<th>Classification of Habitat</th>
<th>Number of Quadrats</th>
<th>Frequency of Weevil Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Ground Cover</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Grass</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Grass-Alfalfa</td>
<td>43</td>
<td>39</td>
</tr>
<tr>
<td>Grass-Raspberry</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Grass-Tree</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>Tree</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>
Emergence Traps

Table five depicts the results of data collected from the emergence traps and the dates collected. The results, although they may be inconclusive because of tampering that occurred during the study, showed the emergence of weevils from the dense grassy area starting during the week of August 30, 1980. There was no emergence from the wooded area during the study period.

Table 5
Emergence Trap Results

<table>
<thead>
<tr>
<th>Date checked</th>
<th>North Wooded Area</th>
<th>North Grassy Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/20/80</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/21/80</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8/30/80</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>9/6/80</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>9/22/80</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Note: The chi square value exceeds the 95% level at 1DF.
Field Check

A randomly selected quadrat in each field was swept once a week during the study to determine when the weevils would begin to return to the field. *H. postica* was observed in fields one and two on August 20, 1980. No weevils were observed in fields three and four but a very high population of aphids were netted during each sampling.
CHAPTER IV

DISCUSSION

Introduction

Four methods of sampling were used to determine the habitat preference for aestivation of *H. postica*. These sampling procedures brought about two major conclusions. First, no weevils were located in soil samples which leads to the conclusion that weevils do not aestivate in the soil. The second conclusion is that there is a direct relationship of high weevil density and high density of ground cover if the ground cover is interspersed with alfalfa.

Soil Samples

The collection of soil samples showed no weevils located by hand separation of material or separation of living organisms by the Berlese funnel. Observations of the behavior of captured weevils show that typical movements of the weevils are slow and away from heat or strong light. With that in mind, it would be practically impossible for weevils to escape detection from both hand separation and the Berlese funnel. Although many *H. postica* were observed and captured in the same area that soil

31
samples were removed, no weevils were collected in the soil samples. Thus it is probable that *H. postica* was not aestivating in the top eleven centimeters of soil in the field borders.

**Preliminary Sweep**

The border of each field was given a preliminary sweeping with an insect net. Results of that sweeping showed weevils to be in borders of fields one and two but not fields three and four. Although field borders of three and four did not show any weevils, the only other difference from fields one and two was a high infestation of aphids in the fields.

Preliminary sweeping brought out a possible preference of *H. postica* for areas that have dense ground cover interspersed with alfalfa. All sections with a dense ground cover proved to have a higher frequency of weevils captured than those with a less dense ground cover. The major type of plants growing in the sections that had high capture rates are grasses and alfalfa. Sections one and three of field one characterized the typical high weevil capture frequency area. These sections contained grasses and alfalfa and provided dense ground cover that could protect the weevil from the sun's intense heat and from the predators of *H. postica*. 

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Areas that *H. postica* seemed to avoid were sections that did not have a dense ground cover. These sections would not have the type of vegetation that would protect the weevil from the sun or from predators.

**Final Sweep**

The final sweep verified the data collected during the preliminary sweep. Tables two and three review the data showing higher densities of weevils in sections with thick ground cover and lower densities of weevils in sections with less ground cover. There appears to be a direct relationship between the population density of *H. postica* and the density of ground cover in the field borders. In field one, sections one, three and four; field two, section two the data shows high densities of weevils per square meter. In table three the data shows that in sections two and four no weevils were captured. Section four is dominated by short broadleaf plants that provide little ground cover. Section two is dominated by trees that block enough light to prevent the growth of much ground cover. Both of these sections do not give the weevil good protection while the previously mentioned sections (field one, sections one, three and four; field two, section two) do provide for the needs of *H. postica*. 

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Table four substantiates the previous data. Table four groups the sections according to classification of the section's dominating vegetation. The highest frequencies were found to be in sections that contained grasses and alfalfa. Based on personal observation alone, these sections appeared to have a denser ground cover than the other classifications. The lowest frequency of weevil capture was in two classifications, a section dominated by trees and a section dominated by short broadleaf plants. Both sections provided little ground cover. This data shows a preference of *H. postica* for the dense ground cover that includes grasses and alfalfa.

**Emergence Trap**

The emergence trap supports the conclusion with data that shows more weevils were found to emerge from sections that had a dense grass and alfalfa ground cover than from a section that is dominated by trees with little ground cover. Although the emergence trap data may not prove to be conclusive because of the continued tampering that occurred during the tests, the data did suggest a preference of *H. postica* for the denser grass and alfalfa section over the less dense wooded section.
Field Check

Each field was swept once a week to determine when *H. postica* returned to the field. Sweeps of the field were made from the beginning of August until September. The sweeping of fields one and two revealed that the weevils began returning during the week of August 20, 1980. Field two remained uncut during the growing season until a week before August 20th. Two conclusions can be made from the data collected. The first conclusion is that weevils will not always remain in uncut fields. The second conclusion is that some weevils do return to alfalfa fields prior to winter in Michigan.
CHAPTER V

CONCLUSION

This study has shown a tendency for *H. postica* to stay in borders that are dominated by the tall grasses and alfalfa and have a dense ground cover. Borders that have short vegetation do not support the weevil. Therefore it may be feasible for growers to keep borders mowed to force the weevil to select areas less suitable for its survival. This study has also brought up the possibility that *H. postica* may not truly be aestivating in the borders but actually may be feeding on plants of the borders. Observation of the weevils in the borders gives the appearance of feeding rather than aestivating. If the weevil is not aestivating, they may be susceptible to insecticides during the summer months. Finally, *H. postica* does return to Michigan alfalfa fields in late August or early September which counters Ruppel's and Stehr's findings in 1975.
APPENDIX A

WEEVIL CONTROL PROGRAMS BY RUPPEL AND STEHR

The control programs that follow are taken from the Extension Bulletin E-739, written by Robert F. Ruppel and Fredrick W. Stehr. Each program describes control methods to be used when certain levels of infestation occur.

Program 1

The first cutting should be taken as soon as practicable without spraying when:

(a) \( \frac{1}{2} \) or less of the tips show damage of the grubs at the time of the first flower buds and the alfalfa will be cut within a week;

or

(b) the numbers of the weevil are lower than those needed to justify spraying;

or

(c) many of the leaves have been skeletonized by the grubs.

Program 1a, early cutting without the application of insecticides, is strongly recommended when it is feasible. There may be some loss of hay to the weevil under this option, but this loss should be balanced against the cost, time, and trouble of spraying. Hay that is already badly damaged by the weevil should be cut as soon as
possible without spraying. A spray prior to cutting in these circumstances is wasted as the damage has already been done.

Program 2

A spray of one of the insecticides noted in Table 2 (table 2 of appendix A) is recommended at the time the first flower buds appear when:

(a) some loss of yield or the first cutting can be tolerated;

and

(b) about ½ of the tips show damage of the alfalfa weevil grubs;

and

(c) the first cutting will not be taken for one week or more.

This program will not protect the alfalfa from the early loss (about 1/6 ton of dry hay per acre) caused by the weevil. It does allow the grower to assure himself that a spray is definitely needed before he applies an insecticide and this program should fit many of Michigan's farming operations.

Program 3

A spray of carbofuran (Furadan) at ½ lb. active insecticide per acre is recommended to the appearance of the first flower buds when:

(a) maximum yield protection is needed in the field;

and
(b) feeding of the adults or the adult weevils themselves are easily found in the field; and

(c) the first cutting will definitely be taken at late bud or first flower stage of the alfalfa.

This early spray with carboruran will protect the alfalfa from the weevil for two weeks following its application. Its control will break sharply after this time, leaving the alfalfa unprotected from reinestation by the weevil. This spray should, therefore, be applied no earlier than two weeks ahead of the planned cutting date. The drawback to this early spray is that we do not now have solid guidelines for predicting the need to spray at the time that the insecticide should be applied. There is a chance that sprays could be applied when they are not really needed. This problem must be balanced against the amount of adult damage in the field and the need for maximum production.
Table 1

Insecticides Recommended for Alfalfa Weevil Control

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Lbs. Active Insecticide/A</th>
<th>Days Between Applic. &amp; Harv.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>azinphosmethyl (Guthion)</td>
<td>½</td>
<td>16</td>
<td>hazardous</td>
</tr>
<tr>
<td>methyl parathion</td>
<td>¾</td>
<td>15</td>
<td>hazardous</td>
</tr>
<tr>
<td>Supracide</td>
<td>½</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>malathion plus methoxychlor</td>
<td>1+1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Imican</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>&quot;Alfa-Tox&quot;¹</td>
<td>2qts.¹</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>carbofuran (Furadan)</td>
<td>¾</td>
<td>7</td>
<td>hazardous</td>
</tr>
<tr>
<td>malathion</td>
<td>1½</td>
<td>0</td>
<td>ULV aerial spray</td>
</tr>
<tr>
<td>malathion</td>
<td>6/10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>carbaryl (Sevin)</td>
<td>1½</td>
<td>0</td>
<td>safest for honeybees</td>
</tr>
<tr>
<td>methoxychlor</td>
<td>1½</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

¹"Alfa-Tox" is a commercial mixture of diazinon and methoxychlor. The amount to be applied per acre is given in quarts of this commercial product.

(Continued from Ruppel and Stehr 1974)
Table 2

Effectiveness of Alfalfa Weevil Insecticides Against Other Pests of Alfalfa

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Pea Aphid</th>
<th>Spittlebug</th>
<th>Cut-, Army-, &amp; Green Cloverworms</th>
<th>Potato Leafhopper</th>
<th>Plant Bugs</th>
<th>Grasshoppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malathion</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Malathion plus methoxychlor</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Methyl parathion</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Carbaryl (Sevin)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Alfa-Tox</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Supracide</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Carbofuran (Furadan)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Methoxychlor</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Azinphosmethylethyl (Guthion)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>ULV Malathion</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Imidan</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

"+": Insecticide is known to be effective against the insect.
"-": Insecticide should not be used to control the alfalfa weevil if the other pest is present in the field.

(Continued from Ruppel and Stehr 1974)
APPENDIX B

EMERGENCE TRAP

A trap similar to Roberts' (1978) was built to fit the needs of this study. Availability and cost of materials used in Roberts' trap made it necessary to revise much of the design. Four 40 cm. by 2.5 cm. by 1 cm. plywood slats were used as the support for a typical pyramidal design. Each side of the pyramid was composed of galvanized screen that was cut into a shape of a trapezoid. The height of the trapezoid was 52 cm. and the uneven sides measured 5 cm. and 48 cm. The screen was stapled overlapping the plywood slats so there were equal amounts of screen extending past the top and bottom of the slat. The bottom of a seven ounce plastic drinking cup was removed so it formed a 6.5 cm. long funnel. The plastic cup was inverted and placed over the top of the pyramid formed by the screen. A canning jar and rim were placed over the top of the drinking cup. The rim fit extremely tight to the cup thus preventing any escape of captured insects. Refer to figure 7 for a diagram of the emergence trap.
Figure 7. Emergence Trap
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