**Final Report to the Western Region IPM Center**
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**Project Title:** Development of a monitoring program for root weevils in blueberries and strawberries
**Type:** Addressing Western IPM Issues


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**Summary:**
Root weevils are the most destructive pest in many small fruit crops in the northwest. This project put traps in multiple strawberry and blueberry fields in Oregon and Washington during the 2007 and 2008 season and tested them against a traditional scouting method. One of the difficulties in controlling weevils is that the larvae do the damage, but with the move to less toxic controls there are control measures for adults only. This means that controls must be timed so they affect adults at emergence before they start egg laying. Another important issue for growers is knowing the weevil population level in the field. Since weevil adults hide during the day, the traditional method for estimating weevil populations has been to visual searches and counting larvae, a labor-intensive and time-consuming task involving digging and sieving at multiple sites within the field. Recent field tests with two adult weevil traps have not shown enough promise to consider their use as a substitute for digging and sieving as a way to estimate weevil population. However, they have shown use in timing emergence, thus allowing growers to apply the less toxic controls for adult weevils before eggs are laid.


## Introduction:

Fresh market and processed blueberries and strawberries are high value commodities in Washington and Oregon with an estimated production value of over $73 million in 2005. Root weevils are the most destructive pest in many small fruit crops in the northwest. Major commitments in time and resources on the part of both researchers and growers for many years have resulted in much progress in the understanding of this particular pest complex. However, economic losses and control expenses continue to be high and, in the case of strawberries, a primary limiting factor to the industry's economic viability. Conventional toxic pest control for the larvae was discontinued recently in favor of less toxic control for adult weevils. The traditional method of accessing weevil population, and thus need for control, was to dig and count larvae. However, this is a time-consuming and labor-intensive method. A critical obstacle to the effective control of weevils in northwest small fruits is the absence of a cost effective and accurate scouting protocol.

Over the past 18 months (covering two growing seasons), we have made weekly visits during the growing season to various small fruit fields (strawberries and blueberries) using two novel types of traps to capture adult weevils in a comparison with to the time consuming protocols developed by Peerbolt Crop Management (PCM) to monitor weevil larvae and adults (by digging for larvae and timed visual searches for adults). We have also used HOBO™ data loggers to monitor temperature in the field, downloading the data on a periodic basis. Results of weevil stage and abundance were given to cooperating growers so they could adjust their spray programs accordingly.

Both traps evaluated involved sticky plastic substrates in the base of the trap to capture adult weevils. Some also used bait consisting of small dried apple chips. Unfortunately, the bait attracted slugs, which ate them. One trap, the Exotior$^{TM}$ Black Vine Weevil Trap (see Figure 1 in the appendix) had been used successfully in container plant nurseries in 2006. The second trap, tested for the first time in 2007, is an inverted cone trap, with a trapping mechanism similar to the Exotior$^{TM}$ (see Figure 2). The second design was much less costly than the Exotior, making it more economically viable.

Objectives

Objective 1. Determine the efficiency of two weevil traps under varying field conditions in a wide range of geographic regions for signaling weevil activity in the spring.

> Traps were placed in a total of 28 fields throughout the Willamette Valley and in SW Washington in both seasons. One of the two types of trap could be useful in the future for determining weevil emergence.

Objective 2. Determine the weevil population of the trialed fields, the location of the weevil population within the fields.

> Scouting was performed in each field on a weekly basis with the scouts counting any adult weevils caught in the traps. They also did a visual search for adult weevils and surveyed and counted larvae and pupae, using the dig and sieve method. The numbers were charted and shared with the cooperating growers.

Objective 3. Precisely time insecticide applications to be most effective in controlling adult weevils prior to egg laying and determine the efficacy of the control measures.

> Cooperating growers were given reports within 12-48 hours of each scout's visit, detailing numbers of larvae and pupae counted as well as numbers of adult weevils caught in the traps or seen visually. Growers were able to take appropriate control measures based on those reports.

Objective 4.Develop weevil monitoring protocols in blueberries and adjust weevil monitoring protocols in strawberries as needed.

> The traditional methods will continue to be used since they hold the most promise for accessing weevil population in a field. We will continue to use the one trap that proved useful in this trial, as well as continue to test other methods for accessing adult weevil emergence.

Approach:

Traps were placed in a total of 28 fields throughout the Willamette Valley and in SW Washington in both seasons. While most fields were the same, some field locations were changed for the second season due to field removal or low weevil counts the first season. At each location, five Exotior$^{TM}$ and ten cone traps were arranged in each field in a systematic pattern. About five percent of the traps were damaged beyond repair during 2007, so protocols were adjusted in 2008 to four Exotior$^{TM}$ and nine cone traps in each field. Two HOBO$^{TM}$ data loggers were also put in each field to monitor soil and air temperatures to determine whether temperature correlations could be determine for larval development and adult weevil emergence.

Timed, visual inspections of adult weevils were conducted weekly, along with recording the adult weevil captures in the traps. Digging around plant roots and sieving for weevil larvae was also carried out during the inspection period. Weekly in-field data recording was made on a sampling sheet detailing the location and number of larvae, pupae and/or adults found.

Using the compiled weekly data, adult emergence was charted and timed. Growers in most cases were contacted at least a week in advance in regard to timing of optimal insecticide applications. A continuation of weekly monitoring data was compiled after the insecticide application to monitor its efficacy. This information was also passed on to the growers for retreatment as needed.

Progress:

Differences of relative abundance by species and site/host plant were notable during the 2007 and 2008 seasons (Figure 3). The results of trapping showed that Exotior™ trap had slightly higher total captures than the cone trap, especially through the latter part of the season (Figure 4). The weevil species composition captured at each site varied. Black vine weevil, *Otiorhynchus sulcatus*, generally emerged two weeks earlier than the strawberry root weevil, *Otiorhynchus ovatus*. As in previous years, the incidence of rough strawberry root weevil, *Otiorhynchus rugosostriatus,* was less patterned and looks to be bimodal as previously reported by L. Tanigoshi. Pupation of black vine weevils occurred at least one week earlier than the rough strawberry root weevils (Figure 5).
When comparing trap captures to the HOBO™ data logger soil temperatures, a potential correlation between increased soil temperature and subsequent adult weevil appearance was noticed. In at least one strawberry field (Figure 6), an above 60°F soil temperature showed an increase in weevil trap captures. The results of Hobo readings lead us to believe that Hobo monitoring could become an additional modeling tool to accurately determined weevil emergence. However, we experienced some damage and/or malfunction with the Hobos and would need to find better methods to protect them.

NOTE: An assumption was made regarding the total pupation data based on past weevil species recovered. Black vine weevils were considered to be the largest size of larvae found, with medium sized larvae being the rough strawberry root weevil. Pupae data was not originally separated based on specific weevil species, rather a total number of pupae found each week. Therefore, the proportion of black vine and rough strawberry root larvae populations were used to calculate black vine and rough strawberry root weevil pupae populations.

Results:

There are a number of factors in evaluating weevil trapping. One consideration is the biology of the insect. Weevils avoid light and tend to dig. Successful trapping of weevils occurred inside the trap as well as under the trap. Half way through the 2008 season, a pitfall-like trap was created using a damaged cone trap to see whether the weevil's digging habit would entice it into the pit. Though this trap had minimal success during the short time it was in use, further research may be useful to determine if a pitfall-like form of trap might take advantage of the weevil digging habit.

The hobo data logger air/soil temperatures show a potential opportunity as a soil monitoring tool to become an additional modeling tool for accurate weevil emergence. However, further research should follow to determine exactly what field conditions affects larval development and adult emergence.

The traps proved useful for determining weevil presence in a field as well as the timing of adult weevil emergence. This is very useful in that the adults will begin egg laying approximately 30 days after emergence so insecticide applications need to be timed before egg laying begins. The traps were not accurate in estimating overall field weevil population levels as their counts were relatively low compared to the traditional, very time consuming and variable, methods of digging. and sampling by timed visual searches.

Impacts:

1. Innovations:

   Trapping weevils to time emergence, and thus time control, could become part of an IPM program in the future. The traps trialed in this project may not be the answer, but they have shown enough promise to suggest that finding a trap that works well should be pursued. If a trap system can be found that will accurately pin-point weevil emergence, it could be used in all blueberry and strawberry fields where weevils are a major pest. Estimating total potentially affected acreage is difficult. In the Northwest alone, there are approximately 8,300 acres of blueberries and 4,100 acres of strawberries.

2. Safeguarding human health and the environment:
   Growers use chemical sprays to control adult weevils in blueberries and strawberries: Malathion and bifenthrin being the most efficacious. It is important to time the applications so they are sprayed between weevil emergence and egg laying. Growers who do not know when that window is open, and do not know whether their field is relatively free of weevils or over-run, will spray more often in the hope of hitting their target. Traps can be a useful tool in an IPM approach to estimating emergence and population, thus encouraging growers to time their chemical applications, which would help to reduce the amount of pesticide use and its exposure to humans and the environment.
3. Economic benefits:
   The traditional method for scouting for weevil population and emergence is costly because it is time consuming and labor intensive. Anything that reduces that cost would benefit growers. The traps used in the project were also expensive; however, the trapping concept shows enough promise to consider it a potential cost-saving IPM tool for growers. We will in all likelihood continue to either use some of the project traps and/or work more diligently to find other trapping solutions. Whether those solutions would have the potential for commercialization is something we could not speculate on at this time.
4. Implementation of IPM:
   The use of scouting as part of an IPM tool for estimating weevil population and timing weevil emergence has show that it works well. Scouts trained in the Peerbolt Crop Management protocols were able to find adult weevils through a timed visual search, and to find pupae and larvae by digging and sieving. Using these methods on a number of strawberry and blueberry fields validates these protocols as a useful element in alerting growers to the window of opportunity for targeting adult weevils with low-risk applications.
5. The 2008 season was the first one in which PCM used its online scouting report and grower alert system. The success of the system, in which the project cooperating growers received emailed PDF reports within 12 to 48 hours of each scouting visit, is evident from the complimentary comments we received from those growers. The reports detailed the numbers of adult weevils, the number and size of weevil larvae, and the number of pupae found. In addition, the growers received recommendations for timing applications.