Better Understanding and Management of Tenlined June Beetle

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Abstract

This report covers a two year period (2009 & 2010). A method was developed to test the movement of an insecticide through a soil column to evaluate the effectiveness of chemical controls for tenlined June beetle (TLJB) grubs more than 30 inches below the soil surface. Results of the testing revealed that water alone may be as great a mortality agent as insecticides when grubs are submerged in water and when surrounded by soil. Further work is planned to better understand this phenomenon.

Laboratory tests were conducted with Movento™, Venom™, and Belay™ (same active ingredient as Clutch™) to evaluate their abilities to kill TLJB grubs. Movento™ had no effect on 3rd instar grubs. Venom™ and Belay™ were tested in addition to Admire™ 2 and compared to an untreated check.

This test is still on-going, but a 15-day post-treatment check indicated that all the control grubs were healthy and feeding; the Admire™ 2 exposed grubs all ceased feeding and 9 of 20 grubs appeared moribund (i.e., no appearance of life, but may still be alive); the Venom™ exposed grubs all remained alive, but only 5 in 20 were feeding; and all but one of the Belay™ treated grubs stopped feeding and one died. This study will continue for 60 days. However, the results look promising for clothianidin (Clutch™ or Belay™) as a control for TLJB grubs.

General Information

This report covers a two year period (2009 & 2010). Due to unexpected demands of my California DPR-funded Pest Management Alliance project on cling peaches during the summer of 2009, I was unable to make as much progress on this project during that time. I requested a no-cost extension (NCE) for this project that was approved on 30 November 2009. My initial employee focusing on this project, Dr. Xingeng Wang, left my laboratory in 2009, and I then had Dr. Hannah Nadel work on the project with assistance from my laboratory assistant, Ms. Martha Gerik. Both Nadel and Gerik left the laboratory at the end of December 2009, and over the last 12 months my Staff Research Associate, Mr. Andrew Molinar, assisted me.
Additionally, Dr. Elizabeth Fichtner, new UCCE Farm Advisor from Tulare County, provided assist with questions on soil science for this project.

**Objectives**

**Objective 1.** Field-test the use of Admire® in an orchard system

Before we tested Admire® in the field, we wanted to ensure our ability to move the product at least 36 inches down through sandy soil. We previously showed that we could move the product at least 10 vertical inches through a column of soil. If we could penetrate 36 vertical inches of soil, we should be able to contact the majority of the grubs that make up most field populations of the insect. We designed and constructed 36-inch soil columns (Fig. 1) that

![Method for 36 inch soil column testing](image)

**Fig. 1.** General method used to evaluate the movement of soil insecticides through a 36-inch column to kill 3rd instar tenlined June beetle grubs at the bottom of the column.

allowed us to address the challenges of moving an insecticide through more than 30 inches of soil in a vertical column so that the insecticide would contact tenlined June beetles (TLJB) at the bottom of the column with an adequate food source to feed surviving grubs over the observation period needed to assess the effectiveness of the insecticide trial.
A 36 inch column made of 6-inch PVC irrigation pipe was used in the test (Fig. 1). A 6-inch section of the column (i.e., a 6-inch cylinder) was removed and a container to hold TLJB grubs was designed. Mesh screen was attached to the bottom of the 6-inch cylinder. The 6-inch cylinder was filled with sandy soil. Five 3rd instar TLJB grubs were placed in the sand and small pieces of carrots were inserted into the sand to provide a food source for the grubs. A screen mesh was attached to the top of the 6-inch cylinder and it was attached to the bottom of the 30-inch column. Sand was then added to the empty 30-inch column until it was full. Then, the entire column was placed into a large, empty 55-gallon container. Water was then slowly added to the 55-gallon container so the water would seep into the combined 36-inch column to bring the sandy soil to water saturation. Because the level of the sand would drop in the column as the water was added, additional sand was poured into the column until it was full. Once the sand in the column was fully saturated, the water was drained from the 55-gallon container. This gave us a 36-inch column with water-saturated soil with the bottom 6 inches of soil holding five 3rd instar TLJB grubs and carrots for them to feed upon. The water-saturated sand columns were removed from the 55-gallon containers and the cylinders were positioned into about 3 inches of sand and stabilized so they would not fall over. Columns were held for 48 hours before treatments were applied. This allowed the sand to reach field capacity (i.e., maximum amount of water the soil can hold when not saturated).

In this test, we had 4 treatments which were:

1) no water added to the soil at field capacity in the column [untreated check];
2) 0.01 ml of Admire 2® [i.e., highest manufacturer-recommended rate for soil insects] added to the column;
3) 0.01 ml of Admire 2® added to the column plus 1324 ml (i.e., 3 inches of water) added 24 hours after the initial treatment; and
4) 1,324 ml (i.e. 3 inches of water) of water added to the column 24 hours after the initial treatment (to test the effect of extra water alone).

The insecticide and water (1,324 ml) were slowly added (over a 2 hour period) to the column so that the water would be evenly distributed through the column and not channel down the column. Treatments were replicated four times with five grubs per replication. The columns were left in place for 20 days before the 6-inch cylinders at the bottom of the columns were removed and checked to determine the treatment impacts on the grubs. Afterwards, three of the 30-inch columns (the two Admire treatments and the ‘extra water’ control) were re-infested from the top with five 3rd instar grubs each and these were allowed to dig their way down through the soil in the columns. These were not replicated.

The results achieved from the initial experiment were totally unexpected given our knowledge that 3rd instar TLJB grubs can live for weeks (> 8 weeks) without feeding. All of the 20 grubs used in the treatments died except for one (in the no extra water control), which lived for an additional 6 weeks, but stopped eating (we are still observing this individual). This means that the exposure to the water-saturated soil in the ‘extra water’ control was enough to kill the grubs without any need for an insecticide. We can also assume that the Admire treatment killed all the grubs, but it is uncertain how much the water had to do with that outcome. An earlier experiment we conducted with Admire in 2008, showed that the addition of extra water
following the initial soil treatment did increase mortality. The one surviving grub in the low water control, suggests that about 22 days in water saturated soil is what it takes to kill most of the grubs.

Those grubs that were allowed to burrow through the Admire-treated soil and the ‘extra water’ check column were collected 21 days after being released into the 30-inch columns (= 41 days after the soil was treated). At this point, the grubs that were released into the check column are feeding normally, but most of those placed into the Admire-treated soil have ceased feeding. We will continue to see how long the grubs will live. These results suggest that the grubs exposed to the Admire have been influenced by the insecticide.

We are developing methods to determine just how much water it takes to kill 3rd instar grubs and will be testing these as soon as possible. We are currently planning on re-doing the soil column test, using minimal water in the initial preparation. In the second testing, we will saturate the 30-inch soil column, but not the 6-inch cylinder containing the grubs, which will be attached to bottom of the 30-inch column after it is allowed to drain for 24 hours.

Objective 2. Laboratory and field test the potential of Mvento™, Venom™, and Clutch™ as a TJB control

We initially focused on the product Mvento™ (Spirotetramat) because of its potential ability to move from the plant canopy into the roots. We were hoping that this might be the “silver bullet” to manage TJB grubs. The senior P.I. was contacted by Bayer research entomologists regarding field tests that they were conducting with Mvento in almond orchards. One of the major questions that had not been answered was the actual efficacy of Mvento in killing TJB grubs. Thus, we designed two simple experiments to ask whether the product would kill the grubs in the absence of all the variables that impact field experiments. We used carrots as the host plant in these experiments. Part of this was because of the ease of working with carrots, which TJB grubs readily eat. Secondly, when we started the study, it was late fall and plum seedlings were unavailable until late winter. Thus, experiment 1 consisted of soaking carrot roots (i.e., the part that is consumed by humans) into three different concentrations of Mvento. We were advised by one Bayer entomologist that because the carrot was a root, it should absorb the Mvento. The concentrations that we used were the label rate (2 lbs ai/gallon of water), one fifth the label rate, and 5-fold the label rate. We added Dyne-amic as an adjuvant. Whole carrots were soaked for one hour in the solutions and then placed into holding cups with sandy loam soil. There was one 3rd instar TJB grub added to each cup with a treated carrot. We also had a control that was carrots that were not soaked. Each carrot represented a replication and we had 20 replications per treatment to give 80 total insects tested. Grubs were allowed to feed for 7 days and then they were transferred to another cup with a new untreated carrot. Carrots were changed weekly to ensure a good food source for the grubs. Grubs were observed for 4 weeks. No grubs died in the experiment and most of the grubs fed on the carrots offered. We concluded that either 1) Mvento did not kill TJB grubs or 2) the manner in which we tried to offer the Mvento via the carrot root was unsuitable for the mode of action of the product.
For experiment 2, we again used carrots. However, this time we planted 6 seedling carrots (about 5-6 inch roots) into large plastic containers (ca. 1 ft X 1.5 ft X 0.75 ft. in dimension) that were filled with sandy soil. The carrots were maintained for several weeks until a very good root mass had grown and the leafy tops were quite thick. Prior to treatments, the carrots were well watered and after one day, five 3rd instar TLJB grubs were placed into small holes (about the size of a human thumb) in the soil surface of each container. One grub was placed near each carrot to ensure a readily available food source and to reduce the chances of cannibalism. Two days later, after all grubs had tunneled into the soil, we treated the foliar tops of the carrots with Movento. Just as in experiment 1, we had 3 treatments and a control. Again, we used the label rate of Movento, one fifth the rate, and five-fold the rate. We added Dyne-amic as an adjuvant to the solutions. Four plastic containers of carrots were treated with each concentration of Movento using a hand mister applicator. The controls were treated with Dyne-amic alone. All plants were sprayed until run-off of the solutions. Application of the treatments was conducted on 18 December 2009. Plants were held in a greenhouse until 20 January 2010 at which time the plants were all removed from their containers and the numbers of live and dead grubs were counted and the numbers of fed-upon carrots were recorded. The grubs were not checked for about 4 weeks because it was expected that it would take considerable time for mortality based on previous tests with diazinon and imidacloprid. All grubs were checked among the various treatments and all grubs were alive and appeared healthy. However, not many carrots appeared to have been fed upon. This may be because it was very cool in the greenhouses and many of the grubs were rolled into tight balls when we excavated them. All grubs were transferred into small cups with untreated slices of carrots for them to feed on. Grubs were held until 21 April 2010. The final mortality count was: Control: 60%; 5X Movento: 50%; Label rate Movento: 25%; and 1/5 rate Movento: 45%. Thus, Movento did not kill the TLJB grubs.

Studies on dinofuran (Venom™) and clothianidin (Clutch™ or Belay™) were initiated in December 2010. The methods used followed those we used to initially determine the impact of Admire on TLJB grubs. Basically, each insecticide was diluted with water to the recommended label rates for soil feeding insects. One pound of sandy soil was added to a clean plastic container (700 ml). Fifty ml of treatment solution was applied to each container and was fully mixed with the soil. A piece of carrot and one grub were placed in the middle of the container. In addition to testing Venom™, and Belay™, an Admire™ 2 treatment was included as well as an untreated check. All tests were conducted in the greenhouse. The first check of grub mortality was taken 2-3 days of post-treatment, then at intervals of 5 days following the treatment. Each time a grub was checked, the carrot in each container was replaced if it was fed upon or if it started to decompose. Presently, we have only conducted checks up to 15 days post-treatment. At this time, we find that all the control grubs are healthy and feeding; the Admire™ 2 exposed grubs have all ceased feeding and 9 of 20 grubs appear moribund (i.e., no appearance of life, but may still be alive); the Venom™ exposed grubs all remain alive but only 5 in 20 are feeding; and all but one of the Belay™ treated grubs have stopped feeding and one has died. We will continue this study for 60 days. However, the results look promising for clothianidin (Clutch™ or Belay™) as a control for TLJB grubs.
Objective 3. Quantify the impacts of increased soil moisture on TLJB biology and mortality

See results reported under Obj. 1. We plan to continue studying the impact of water on grub mortality.

Objective 4. Evaluate new insecticides (Movento™ and Venom™) to suppress Pacific flat head borer larval infestations within trees

I reviewed available literature and recommendations on control of Pacific flat head borer (PFHB) and also discussed the matter with Dr. Eugene Hannon [presently Staff Entomologist, Fresno County Agricultural Commissioner’s Office] who conducted his Ph.D. research on control of tree borers in poplar trees Washington State. Dr. Hannon attempted to control borers in poplar with several systemic insecticides and was unsuccessful in all attempts. Additionally, the biology and ecology of the PFHB does not render it highly vulnerable to insecticide controls. Lastly, the implementation of an insecticide program for suppression of the borer stages of the PFHB would require the development of a monitoring program to identify which trees are infested. Until further methods are developed to monitor orchards for PFHB and deliver the insecticide to the borer stages, preventative measures (reduction of sunburn injury and maintenance of healthy trees) are the best option.