A. Project title
Laboratory and Field Evaluations of Neonicotinoid Insecticides Against the Glassy-Winged Sharpshooter

B. CDFA contract number
03-0275

C. Time period covered by the progress report
November 2007 to March 2008.

D. Project leaders

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E. List of objectives and description of activities conducted to accomplish each objective
1. Determine regional differences in the uptake and persistence of imidacloprid and dinotefuran in grapevines in order to maximize protection of vineyards
2. Evaluate generic formulations of imidacloprid in grapevines
3. Develop an ELISA for the detection and quantification of dinotefuran residues within plant tissues

Objectives 1 and 2 have been completed – see the Symposium Proceedings Pages 98-100. Should other generic formulations of imidacloprid come on the market, we will evaluate them.

Objective 3 is still ongoing. A synthesis chemist is preparing the hapten that will be used to generate the antibody to dinotefuran. When the hapten is synthesized, Frank Byrne will conjugate it to the carrier protein and then send it to a commercial laboratory for Ab production.

F. Research accomplishments and results for each objective
Objective 1
Trials to evaluate the uptake of imidalcoprid and dinotefuran in vineyards located in three viticulture regions of California have been completed. In Coachella and Temecula Valley vineyards, two rates of Venom were evaluated – the full label rate (6 oz/acre) and half the label rate (3 oz/acre) - and the half label rate of Admire Pro. We used the half label rate of Admire Pro (7 fl oz/acre) because this rate achieved the desired 10 ppb threshold concentration in the xylem necessary to kill a sharpshooter (Byrne and Toscano, 2006). In Napa, we examined the same rates of Venom used in Coachella and Temecula, but used the full label rate of Admire Pro.

In an earlier study, both the half and full label rates resulted in poor uptake (Weber et al., 2005), so we chose the maximum rate for this study.

The uptake of imidacloprid in at the Napa vineyard was poor, corroborating our earlier findings (Weber et al., 2005). Of the 144 samples taken, only 1 vine recorded a value above the 10 ppb threshold. Most vines were below the detection limit of the ELISA (4 ppb). The uptake of imidacloprid in Coachella and Temecula was better, although levels were consistently better in Temecula. Levels in Coachella were marginally lower then the recommended threshold throughout most of the assessment. While we expected better concentrations, it is likely that the irrigation regime at this vineyard was not conducive to providing the desired levels of uptake. In Temecula, imidacloprid moved into vines quickly. There was a period, however, when levels dropped below the required threshold. This dip in concentration occurred when irrigation water was reduced. During the period when weekly irrigation was practiced, the uptake rose well above the threshold levels and the vines were well protected from PD.

Dinotefuran was detected in vines at each vineyard location, and the concentrations in the xylem were highest in vines treated at the full label rate. In Napa, dinotefuran levels rose quickly, suggesting that the uptake occurred at the time the treatments were made (the only time water was used in this vineyard). The rate of uptake in Coachella and Temecula was also rapid but more sustained, again suggesting the influence of the irrigation at these sites. In Temecula, the dip associated with imidacloprid uptake was evident at the lower rate of dinotefuran, but not at the high rate.

Objective 2

Admire Pro and Admire 2F formulations have been compared in a Coachella vineyard. The uptake and persistence profiles of these chemicals were the same, indicating that the formulation chemistry does not affect the performance of imidacloprid if the materials are applied correctly. In the same trial, we also included additional neonicotinoids, thiamethoxam and dinotefuran. The general profiles for the neonicotinoids were the same. Thiamethoxam and imidacloprid were applied at the same rates, and yet the thiamethoxam present within the vines was consistently higher. Dinotefuran was applied at half the rate of imidacloprid and thiamethoxam, and was still present at the same levels as imidacloprid. Our earlier data (Figure 1) showed that a higher application rate of dinotefuran would likely have matched that of thiamethoxam. The differences in uptake between imidacloprid and the other neonicotinoids is a reflection of their different water solubilities.

Objective 3

See Section E above.

G. Publications, reports, and presentations where the information generated from the research was presented

Pierce's Disease Research Symposium, Dec 12-14, 2007, San Diego California

- Proceedings article, Pages 98-100
- Poster presentation. Section 2 – Vector management

H. Research relevance statement, describing how this research will contribute towards solving the PD/GWSS problem in California

Admire® insecticide (Bayer CropSciences) is being widely used in southern California for the control of the glassy-winged sharpshooter (GWSS) in grapes and citrus. Admire is a soil-applied neonicotinoid insecticide that delivers the active ingredient imidacloprid, which has been shown to be very effective against GWSS and other sucking insects. In northern California, Admire has also been used against populations of blue-green sharpshooters, as well as other pests. However, the decision by growers in northern California to use Admire has largely been influenced by the success of this chemical at protecting southern California vineyards from PD. The value of this product to growers in the north needs further evaluation. To date, most of the research on uptake and persistence of imidacloprid in grapevines has been done in southern California, where the climate is warm and the soils have relatively low clay content (Toscano and Byrne, 2005; Weber et al., 2004 and 2005). In the heavy soils and cooler climates common in North Coast vineyards, there are major questions about the effective use of soil applied neonicotinoid insecticides. In a 2004/5 study (Weber et al., 2004, 2005), we evaluated four treatment regimes for Admire in a North Coast chardonnay vineyard. Under the prevailing conditions of cool temperatures, loam soil (15% clay content) and limited irrigation, there was little uptake of imidacloprid and levels were never reached for effective control of sharpshooters. We concluded that limiting irrigation in order to manage vine growth and berry size for premium wine production may prevent the effective use of Admire in such cooler growing regions. The solution to this problem may lie with Venom® (Valent USA Corporation), a new product for use on grapevines with the active ingredient dinotefuran. It belongs to the same chemical class as imidacloprid, and has been shown in bioassays to be effective against GWSS. Like Admire, it is formulated for application through drip irrigation systems. However, with 80-fold greater solubility in water than imidacloprid, dinotefuran may have the potential to remain more available for uptake in vineyards with limited irrigation. Irrigation is the driving force behind the effective use of neonicotinoids as water is required to solubilize the insecticides for uptake into vines. This presents challenges to North Coast growers where current vineyard management practices often greatly curtail the use of applied water. In the absence of water, insecticides may bind tightly to clay particles and be absorbed into organic matter where degradation will take place. The proposed work will provide North Coast grape growers with valuable information about the best use of Admire and Venom to protect vineyards from Pierce's Disease. This information will be critical in the event that GWSS becomes established in this region, but will also have current value for use against blue-green sharpshooters.

In Coachella Valley vineyards, irrigation water is often used in excess to deal with the extremely high temperatures and to improve grape size and quality. Under conditions of high water use, there is an increased risk of leaching of chemical below the root zone of vines. Root balls are normally developed under the drip lines and excess water can push the insecticides beyond this zone, thereby compromising the efficacy of the application. With its greater water solubility, there is an increased likelihood of leaching of dinotefuran under the current irrigation practices. This project will evaluate imidacloprid and dinotefuran under field conditions in Coachella Valley vineyards to determine the best use strategy for these insecticides.

I. Summary in lay terms of the specific accomplishments of the research project

Currently, insecticides are the only reliable means of controlling GWSS populations and PD transmission in vineyards. The neonicotinoid insecticides are the most reliable because of their systemic activity. Systemic activity occurs after the insecticide is applied to the soil. During irrigation, it is absorbed by the vine roots and then distributed throughout the plant in the xylem system. The xylem is the water-conducting system in plants. The GWSS feeds from the xylem, and the neonicotinoids directly exploit their feeding habit. Since the xylem is present in all plant tissues, neonicotinoids have the potential to protect every part of the plant where the insect feeds. Our work determines how well the insecticides are working via this mode of action. We have shown that the uptake of the chemicals is not consistent between viticulture regions in California. Put simply, what works for one grower may not work for another. It is imperative that we understand how these insecticides are working under different agronomic conditions and climates, so that their use is optimized for the benefit of California viticulture. There are several neonicotinoid insecticides and each has its own unique properties. Their water solubility can vary greatly, and it is this property that we are studying in order to advise the industry on which neonicotinoid is more suited to a particular region. The results of this work show that dinotefuran uptake in Napa vineyards is superior to imidacloprid. If the levels of uptake are sufficient to kill a GWSS, then growers in this region will have an effective material with which to combat GWSS infestations.

J. Summary and status of intellectual property produced during this research project

Not applicable

Literature Cited

1. Byrne, F.J. and N.C. Toscano. 2006. Uptake and persistence of imidacloprid in grapevines treated by chemigation. Crop Protection 25: 831-834.

2. Toscano, N.C. and F.J. Byrne. 2005. Laboratory and field evaluations of neonicotinoid insecticides against the glassy-winged sharpshooter. *In* Proceedings of the Pierce's Disease Research Symposium, pp 380-383, San Diego Marriott Hotel and Marina, San Diego, California, Dec 5-7, 2005.

3. Weber, E., Byrne, F.J., and N.C. Toscano. 2004. Optimization of Admire applications in north coast vineyards. *In* Proceedings of the Pierce's Disease Research Symposium, pp 388-389, Coronado Island Marriott Resort, Coronado, California, Dec 7-10, 2004.

4. Weber, E., Byrne, F.J., and N.C. Toscano. 2005. Optimization of Admire applications in north coast vineyards. *In* Proceedings of the Pierce's Disease Research Symposium, pp 395-398, San Diego Marriott Hotel and Marina, San Diego, California, Dec 5-7, 2005.