LABORATORY AND FIELD EVALUATIONS OF IMIDACLOPRID, THIAMETHOXAM, AND ACETAMIPRID AGAINST THE GLASSY-WINGED SHARPSHOOTER ON GRAPEVINES

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ABSTRACT

In a comparison of Admire application rates in Temecula vineyards, a 16 oz. per acre treatment proved very effective at attaining xylem sap imidacloprid levels that were necessary to protect vines from sharpshooter feeding. An 8 oz. per acre rate proved to be too inconsistent in terms of the level of protection afforded, while a 32 oz. rate produced unnecessarily high levels of imidacloprid that did not extend the period of protection much beyond that afforded by the 16 oz. rate. In Coachella Valley vineyards, the 16 oz. rate produced levels of imidacloprid within the xylem sap that were extremely short-lived, raising concerns about the stability of this material within this region.

INTRODUCTION

The neonicotinoid insecticide imidacloprid (Admire) has played a significant role in reducing glassy-winged sharpshooter (GWSS) populations in citrus orchards and vineyards in Southern California area-wide management programs. In Temecula, where the first area-wide management program incorporating imidacloprid was initiated in response to a severe Pierces disease (PD) epidemic, remnant GWSS infestations are now associated primarily with untreated tracts of vegetation such as organic citrus, while densities in conventional orchards and vineyards are almost undetectable (Hix et al., 2002). In southern Kern County, GWSS population densities have been similarly reduced as a result of the General Beale Road project, while areas such as Riverside/Redlands that have not yet participated in area-wide management programs still retain high GWSS populations. More recently, the introduction of an area-wide program in Coachella Valley has demonstrated yet again the capacity of imidacloprid treatments to deal very effectively with GWSS infestations on both citrus and grapevines.

Upon completion of an earlier study investigating the uptake, distribution and persistence of systemic applications of two neonicotinoid insecticides, imidacloprid and thiamethoxam, in citrus trees and grapevines (Toscano et al., 2002), we identified several key areas of research that were still required. In this report, we include data from our studies on the uptake and distribution of imidacloprid within grapevines, focusing on the impact of vine age and application rate on the rate of uptake and persistence over time. Data are presented for vineyards in Temecula Valley and Coachella Valley.

OBJECTIVES

1. Determine the impact of soil type and irrigation on the uptake and residual persistence of imidacloprid and thiamethoxam in grapevines;
2. Determine the best combination of application rates and number of applications of imidacloprid in order to maximize and extend protection to vineyards;
3. Determine the absorption, distribution and residual persistence of foliar applications of acetamiprid within grapevines.

RESULTS

Admire Application Rates and Uptake/Persistence

In this component of the study, conducted in two Temecula Valley vineyards, we compared different application rates of Admire applied by drip chemigation at rates of 8, 16 and 32 oz. per acre. The primary goal was to determine the rate of uptake and persistence of the material in vines treated at each rate, thereby giving an indication of the degree of protection afforded grapevines. During the trials, xylem fluid was extracted using a pressure bomb on at least a weekly basis over a

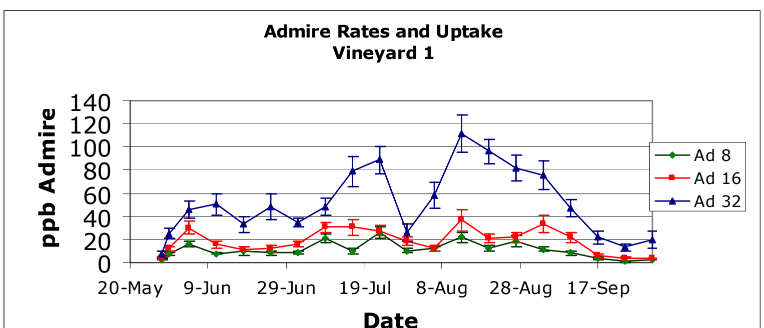

Figure 1. Profiles of imidacloprid titers in the xylem sap of grapevines treated with 8, 16 and 32 oz. per acre Admire on May 28th, 2003

4-month period and the titers of imidacloprid determined using an ELISA technique (Toscano et al., 2002).

In Vineyard I (Figure 1), which consisted of 4-year old Cabernet vines, the 8 oz per acre rate produced an average titer of imidacloprid within the xylem sap of about 10 ppb throughout the experimental period. This is close to the minimum level of material that we believe is necessary to give protection against GWSS feeding. At this low rate, however, many vines were not protected adequately, while others received very good protection. The 16 oz. per acre rate proved more effective in terms of maintaining xylem sap imidacloprid levels equal to or greater than the 10 ppb threshold. Vines remained protected for up to three months. During a similar trial in 2002 in the same vineyard (Toscano et al., 2002), a four month period of protection was afforded the same vines when they were treated with a 16 oz. per acre rate of Admire. In 2002, the vineyard had been treated one month earlier and this may have had a significant impact on the levels of imidacloprid taken up due to more active growth of the vines and a lower overall plant volume through which the material had to disperse (see later section on vine age).

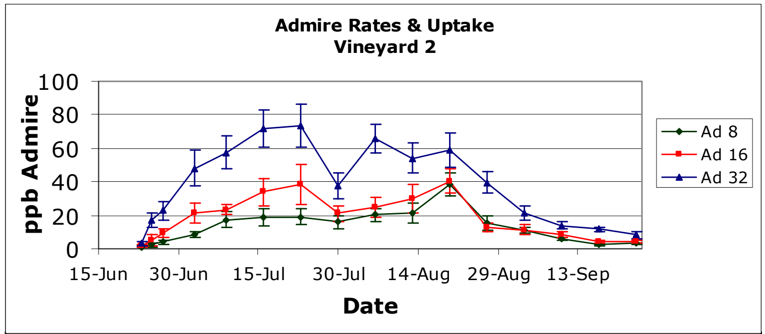

Figure 2. Profiles of imidacloprid titers in the xylem sap of grapevines treated with 8, 16 and 32 oz. per acre Admire on June 19th, 2003

In Vineyard II (Chardonnay grapes) vines were at least 20 years old. Similar rates were applied as in Vineyard I, and the progressive increases in application rates resulted in a concomitant rise in imidacloprid levels within the xylem sap. Although the initial rate of uptake was slower for all three rates in Vineyard II, the overall degree of protection attained from the 8 and 16 oz. rates were better. In both vineyards, the 32 oz. rate resulted in titers of imidacloprid within the xylem sap that were far in excess of those required to protect the vines from sharpshooter feeding.

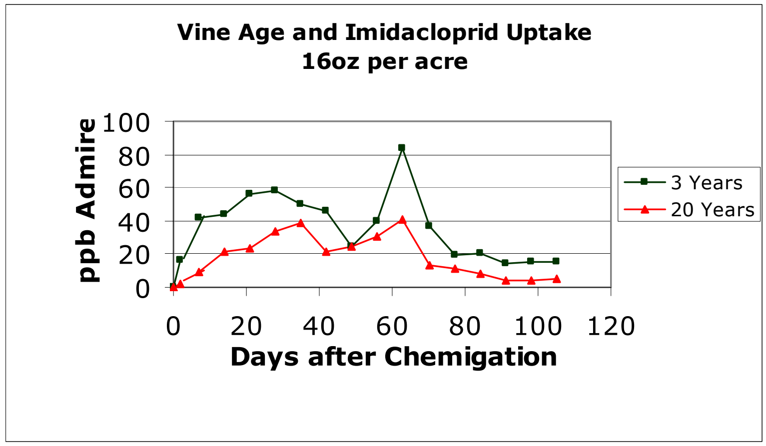

Figure 3. Profiles of imidacloprid titers in the xylem sap of 2-year old and 20-year old grapevines treated with 16 oz. per acre Admire on June 19th, 2003

Vine Age and Admire Uptake/Persistence

The most obvious effect of vine age on the uptake and persistence of Admire applied at 16 oz. per acre was in the rate of initial uptake (Figure 3). In a comparison of uptake into vines aged 2 and 20 years, the imidacloprid titers within xylem sap increased more rapidly in the younger vines. Titers were also consistently higher in the younger vines throughout the evaluation period. It should be noted, however, that the uptake dynamics of Admire applied at 8 and 16 oz. per acre to the 20-year old vines (Vineyard II, Figure 2) were similar, if not somewhat better, than in the 4-year old vines (Vineyard I, Figure 1). Thus, it appears that any 'age-effect' is more likely to be manifested in newly established vines which have substantially less 'volume' through which the insecticide must be transported

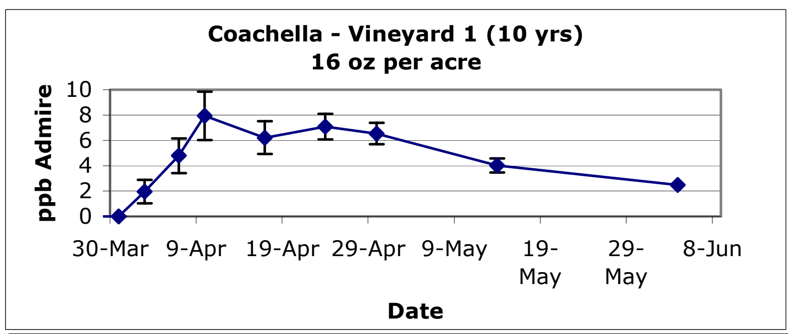

Figure 4. Profile of imidacloprid titers in the xylem sap of grapevines treated with 16 oz. per acre Admire on Mar 31st, 2003

Admire Applications in Coachella Valley

We monitored the levels of imidacloprid in the xylem sap of table grapevines treated with 16 oz. per acre in six vineyards in Coachella Valley. In this study, the growers applied the materials as part of their standard agronomic practices. In short, we found that the behavior of imidacloprid in this region was remarkably consistent. However, in comparison with the Temecula vineyards, the peak titers of imidacloprid within the xylem sap of Coachella grapevines were extremely low and the overall persistence of the material was very short (Figures 4

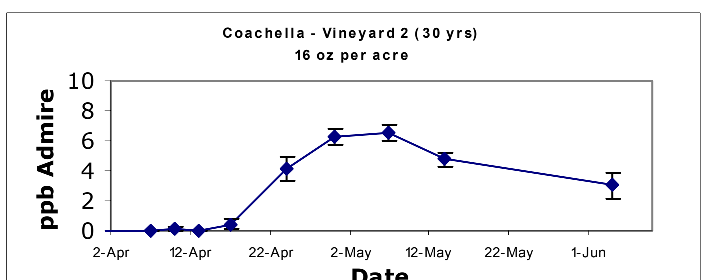

Figure 5. Profile of imidacloprid titers in the xylem sap of grapevines treated with 16 oz. per acre Admire on Apr 3rd, 2003

and 5). In each of the six vineyards tested, a single application of 16 oz. per acre of Admire resulted in xylem sap levels of no more than 8 ppb, which is very close to the critical level required for protection against sharpshooter feeding. In extremely old vines, there was also a significant delay in the initial uptake of material (Figure 5).

CONCLUSIONS

Our studies continue to provide growers with a better understanding of the behavior of Admire within vineyards in the Southern California area. Certainly, there are significant differences between the Temecula and Coachella Valley vineyards and we are investigating the possible causes of these anomalies in our remaining study objectives. What is becoming clear for Temecula

growers is that a single application of 32 oz. per acre is producing an unnecessarily high load of imidacloprid within the plant, whereas a 16 oz. rate can provide adequate control for almost the same period of time. An early season application of 16 oz. per acre, followed by a later application at the same rate, would appear to be the most attractive option for achieving effective xylem sap levels of imidacloprid for protection against sharpshooters. GWSS are known to feed on vines throughout the year, including during the winter dormant phase, so by using the two-16 oz. application strategy growers would be able to extend the window of protection well beyond that afforded to them with a single application of 32 oz. per acre.

The titers of imidacloprid within the xylem sap of vines in Coachella Valley vineyards treated at 16 oz. per acre are of concern. Growers in this region are not receiving the same levels of protection for their vines as Temecula growers. We are investigating several possibilities that may account for these differences, particularly the impact of soil type.

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CHEMICAL CONTROL OF THE GLASSY-WINGED SHARPSHOOTER: ESTABLISHMENT OF BASELINE TOXICITY AND DEVELOPMENT OF MONITORING TECHNIQUES FOR DETECTION OF EARLY RESISTANCE TO INSECTICIDES.

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ABSTRACT
Our research focused primarily on chemical control of the glassy-winged sharpshooter, *Homolodisca coagulata*, a pest of citrus and grapes in California. A number of insecticides from various classes of chemistry were incorporated into this study to evaluate their effectiveness against this pest as well as to establish baseline susceptibility data to each insecticide. The use of insecticides involves some resistance risks in most pests. As such, part of our research was undertaken to monitor the occurrence of any shifts in susceptibility to the principal control agents by comparing the toxicity values for the last two years. Comparison of susceptibility shifts will enable us to analyze the practical implications of any tolerances detected by incorporating such information into well-coordinated recommendations for delaying or combating resistance development in future management programs of this pest.

INTRODUCTION
The first step in examining the effectiveness of insecticides against glassy-winged sharpshooter (GWSS) populations is to monitor for baseline susceptibility. Monitoring results will give comparisons for presence of any cross-resistance patterns between different classes of insecticides. The initial step for monitoring resistance is through development of appropriate bioassay techniques that can establish baseline susceptibility data among various populations. Our goal for the first year was to study the effectiveness of a spectrum of selected insecticides and determine regional differences, if any, to these insecticides. To accomplish this, simple and suitable bioassay techniques were developed to detect toxicological responses of the GWSS to various insecticides. Three techniques, petri-dish, Leaf-dip and Systemic bioassay techniques were described in the previous report (Toscano et al. 2001). Using these techniques, baseline data were determined to selected insecticides against the GWSS over a period of two years. The present report compares the toxicological responses of GWSS to a wide range of chemistry over the past two years.

Once baseline susceptibility data is established, any changes in susceptibility to insecticides through early detection can be invaluable in helping to curtail resistance from progressing to higher levels and frequencies. Knowledge on the rate of resistance development in GWSS to selected insecticides is lacking at the present time. It is well known that resistance does not evolve at the same rate for all pests that come under selection pressure. Many factors, whether genetic, biological/ecological or operational, can influence the rate at which resistance develops in a pest. In the case of GWSS, one method to estimate the potential for resistance risk is to artificially select resistant strains under greenhouse conditions.

In addition to conventional bioassay methods to measure the effectiveness of insecticides, we have proposed to measure biochemically the sensitivity levels of sharpshooter acetylcholinesterases (AChEs) to inhibition by organophosphate (OP) insecticides. Insensitivity of the AChE target-site can seriously impair the effectiveness of OPs in pest control programs. Monitoring populations of GWSS that have been exposed, directly or indirectly, to OPs such as Lorsban® (chlorpyrifos) will enable us to detect resistant AChE alleles should they arise.

OBJECTIVES
1. Develop reliable bioassay technique(s) to evaluate baseline toxicity of insecticides from major classes of insecticides against all life stages of GWSS.
2. Monitor all life stages of the GWSS populations collected from insecticide-treated citrus orchards and vineyards in Riverside, Redlands, San Joaquin Valley and Temecula to determine baseline susceptibility to various insecticides.
3. Investigate the rate of development of resistance to a selected organophosphate (OP), pyrethroid and a neonicotinoid by artificial selection in the greenhouse.
4. Develop electrophoretic techniques to identify esterase profiles in individual GWSS of all life stages including eggs.
5. Develop a microplate assay to measure the levels of sensitivity of GWSS acetylcholinesterase (AchE) variants to inhibition by organophosphate (OP) insecticides commonly used for their control.
6. Monitor GWSS populations throughout California to determine the degree of phenotype variation in esterase and AchE enzymes and how this relates to current pesticide practices.