LABORATORY AND FIELD EVALUATIONS OF NEONICOTINOID INSECTICIDES AGAINST THE GLASSY-WINGED SHARPSHOOTER

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ABSTRACT
Admire and Platinum applications were compared in a Temecula vineyard. In previous trials conducted on both citrus and grapevines, we observed superior rates of uptake with Platinum despite lower application rates. In our most recent trial conducted in a Temecula vineyard, applications of Platinum at 11 fl oz/acre resulted in higher concentrations of active ingredient in the xylem fluid compared with applications of Admire at 16 fl oz/acre. Although peak levels of thiamethoxam declined more rapidly than imidacloprid, effective concentrations of both neonicotinoids persisted within vines during the season to provide adequate protection against glassy-winged sharpshooter (GWSS).

In studies conducted in two Coachella Valley vineyards, we found that the size girdling of vines at the time of Admire application did not impact the uptake of imidacloprid. At one vineyard, we did observe distinct differences in the overall levels of imidacloprid present within vines sampled at two distances from the irrigation pumps. Thus, during the course of application, vines nearest the injection source could receive significantly more insecticide than those further away.

Admire (32 fl oz/acre) applied to flood-irrigated citrus achieved threshold levels of imidacloprid within five weeks; these levels were then maintained for up to four months.

The binding capacity of Coachella vineyard soils was considerably lower compared with Temecula and Napa vineyard soils. In soil column studies, the imidacloprid elution profiles were very similar for Temecula and Napa soils. Dramatic differences in the uptake of imidacloprid following Admire applications in vineyards at these locations can be attributed to differences in irrigation practices.

INTRODUCTION
Studies began in 2001 to evaluate the performance of imidacloprid (Admire) and thiamethoxam (Platinum) against GWSS on mature citrus. The results from that work established that the effectiveness of both insecticides at suppressing insect populations was due to highly efficient uptake, within-tree distribution and persistence throughout the growing season (Castle et al., 2005). Imidacloprid has been the mainstay of area-wide treatment programs for the GWSS since these programs were initiated. In the aforementioned study, thiamethoxam was equally efficient at suppressing populations, but its uptake into trees was considerably faster. Both products persisted for several months. Similar studies have since been conducted to evaluate the behavior of these chemicals in grape vines located in Temecula and Coachella Valley vineyards. Our initial work with vines was designed to establish treatment schedules for Admire, which was registered for use in grape pest management (Byrne et al., 2005). We have optimized Admire treatment strategies for growers in Temecula vineyards – a carefully timed application of 16 fl oz/acre will protect vines for much of the season, allowing for an additional rate of 16 fl oz/acre if required later in the season. We have shown that at the time when the threat of GWSS migration into vineyards is at its peak, the titers of imidacloprid in the xylem fluid are sufficient to control the insects when applications have been made in late March and early April. The delays in uptake that were observed with Admire treatments to mature citrus did not occur in grapevines, thereby providing growers with the possibility of reacting quickly to an imminent outbreak. Uptake of thiamethoxam into vines was also efficient. The results from our study provided valuable information to growers regarding application rates and will result in better insecticide management for the Temecula Valley viticultural area. In Coachella Valley, we are currently evaluating application strategies for growers. Our work has highlighted the variability that exists between vineyards in terms of the uptake of neonicotinoids. Soil type seems to contribute significantly to this, and we are now investigating the interaction between soil type and irrigation.

In this report, we include data on (1) the uptake and persistence of imidacloprid (Admire) and thiamethoxam (Platinum) within grapevines in Temecula, (2) the impact of girdling on the uptake of imidacloprid in grapevines in the Coachella

Valley. (3) the uptake of imidacloprid applied to flood-irrigated citrus, and (4) the impact of soil type on insecticide movement in soils sampled from three vine growing regions.

OBJECTIVES

1. Determine the impact of soil type and irrigation on the uptake and residual persistence of imidacloprid and thiamethoxam.
2. Determine the best combination of application rates and number of applications of imidacloprid and thiamethoxam 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

Neonicotinoid uptake in Temecula vineyards

We evaluated the uptake of imidacloprid (Admire) and thiamethoxam (Platinum) over two years in the same vineyard (Sirah grapes) (Figure 1*)*. The profiles for Platinum (applied at 11 fl oz/acre) were similar in both years, and were characterized by a rapid increase of thiamethoxam to a peak level of ca. 500 ng imidacloprid/ml xylem fluid, followed by a relatively rapid decline in concentrations. Although Admire was applied at 16 fl oz/acre, peak imidacloprid levels were much lower than those measured for thiamethoxam. Nevertheless, imidacloprid concentrations present within vines remained above the desired threshold of 10 ng/ml xylem fluid during the trial period.

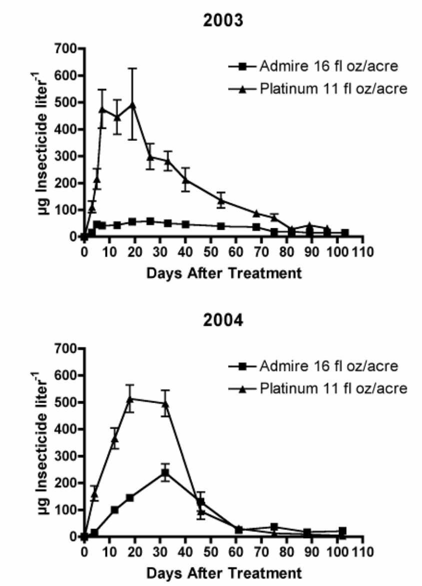

Figure 1. Uptake profiles for imidacloprid (applied as Admire at 16 fl oz/acre) and thiamethoxam (applied as Platinum at 11 fl oz/acre) in 2003 and 2004 at the same vineyard. On each sampling date, xylem fluid was extracted from the same vines (n=16 for both treatments). Values are means ±SEM.

Impact of irrigation on Admire uptake

The uptake of Admire applied during furrow irrigation of citrus was investigated in a commercial orchard (Figure 2). In a previous study (Castle et al., 2004), it was established that a minimum of 10 ppb (ng/ml xylem fluid) imidacloprid was required for effective control of GWSS. The trees in this study were treated with 32 fl oz per acre of Admire on April 14, 2004. The first xylem samples were extracted five weeks after the application. At this time, the average concentration of imidacloprid within the xylem was above the target threshold. Following the initial sampling, there was a steady increase in the imidacloprid levels up until the final samples were extracted on Oct 4. Based upon these results, furrow irrigation would seem to be a viable option for Admire application in orchards that still practice this method of irrigation.

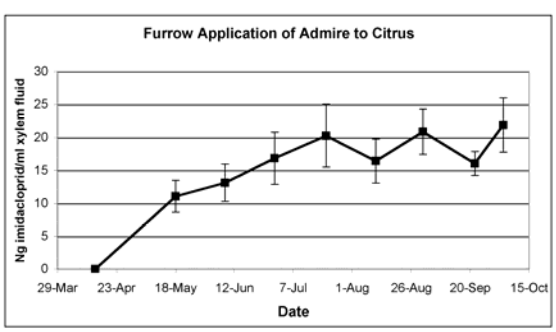

Figure 2. Uptake profiles for imidacloprid applied as Admire at 32 fl oz/acre during flood irrigation of citrus trees. On each sampling date, xylem fluid was extracted from two terminal branches from each of 12 trees. Values are means ±SEM.

Impact of girdling on the uptake of Admire in Coachella vineyards
In our 2004 report, we presented data that suggested a potential impact of size-girdling on the uptake of imidacloprid in Coachella Valley vineyards. In 2005, we conducted independent assessments at two vineyards to determine whether size-girdling of vines at the time of Admire treatments (by chemigation) had a deleterious effect on subsequent levels of imidacloprid present in xylem fluid (extracted from canes above the girdle) (Figures 3 and 4). At both locations, we replicated our experiment within each block, with 20 rows between replicates. For each replicate, girdled and ungirdled vines were sampled from each row to minimize inter-row variation.

In general, we did not observe any dramatic effect of girdling. At both vineyards, comparisons of girdled and ungirdled vines within the same replicate showed no significant differences. However, at one vineyard (Figure 4), there was a distinct separation of uptake profiles between replicates. At this time, we are not sure what caused this anomaly; however, we suspect that the closer proximity of replicate #2 (girdled and ungirdled) vines to the irrigation pumps (the injection source of the Admire) resulted in the delivery of higher amounts of Admire to these vines. At the other vineyard (Figure 3), we did not observe this phenomenon, despite the closer proximity of replicate #1 to the Admire injection source.

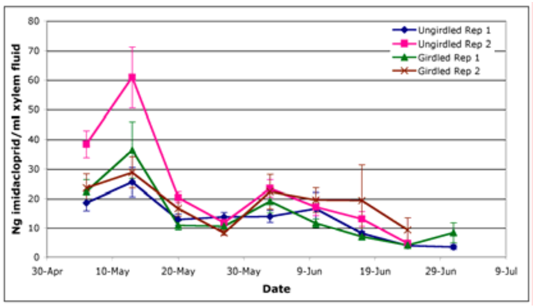

Figure 3. Uptake of imidacloprid into vines that were either size-girdled or not (ungirdled) at the time of the Admire application (application rate was 16 fl oz/acre). Girdled and ungirdled vines were sampled at two locations within the treated block. At each location (replicate), xylem fluid was extracted from 16 girdled and 16 ungirdled vines. The same vines were sampled on each sampling date throughout the trial. Each point is the mean ±SEM for 16 vines.

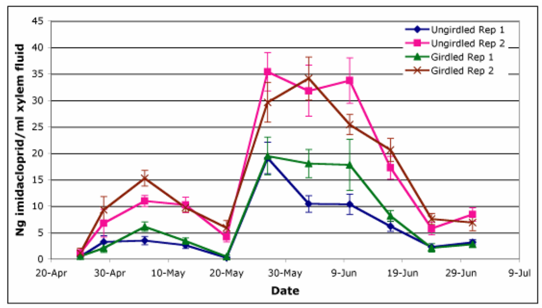

Figure 4. Uptake of imidacloprid into vines that were either size-girdled or not (ungirdled) at the time of the Admire application (application rate was 16 fl oz/acre). Girdled and ungirdled vines were sampled at two locations within the treated block. At each location (replicate), xylem fluid was extracted from 16 girdled and 16 ungirdled vines. The same vines were sampled on each sampling date throughout the trial. Each point is the mean ±SEM for 16 vines.

Effect of soil type on the movement of imidacloprid
In soil column studies, we measure the movement of insecticides through a column of soil (Figure 5). The elution profile can provide important information on the behavior of an insecticide in different soil types. In our vineyard studies, we have encountered two distinctive soil types. In Coachella Valley, the soils are generally sandy and have poor binding potential under the high irrigation load. In contrast, the Temecula Valley and Napa Valley soils have higher clay contents, with a greater capacity to bind insecticides. This increased binding capacity will retard the movement of imidacloprid downwards, holding the insecticide in the upper layers of the soil where it can be solubilized during irrigation and thus made available to the roots for uptake. Without irrigation, uptake is likely to be compromised, as we have observed from our studies in Temecula and Napa (the latter study was conducted by Ed Weber, UC Cooperative Extension, Napa). In the Napa study, irrigation was minimal compared with the Temecula study, and this probably accounted for the low levels of imidacloprid detected in the Napa Valley vines.

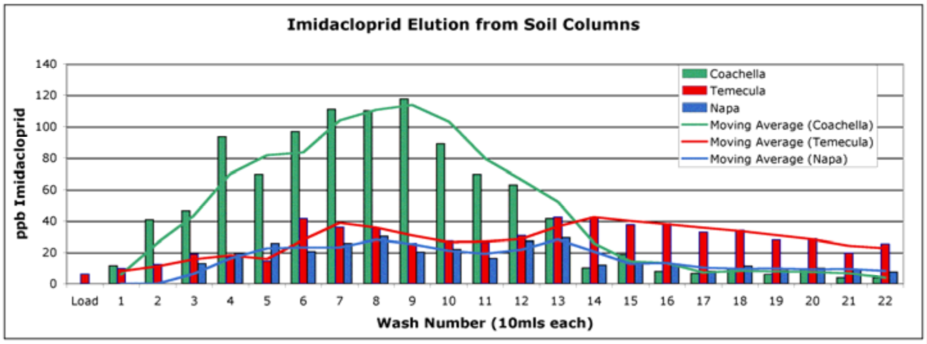

Figure 5. Elution of imidacloprid from soil columns prepared from Coachella, Temecula and Napa vineyard soils. Equal quantities of imidacloprid were loaded (in 10ml) onto the columns, which were then washed with successive 10ml volumes of water. As each 10ml wash was added to the top of the column, 10mls (the eluate) was displaced at the bottom. The imidacloprid content in each eluate was quantified by ELISA. The graph shows a typical elution profile for the soil types found in these vineyards.

CONCLUSIONS

Management of sharpshooter populations is key to minimizing the spread of Pierce's disease (PD). The neonicotinoids have been effective at achieving area-wide management of this important disease vector, resulting in a dramatic decrease in the incidence of PD. The value of our work has been in the optimization of several neonicotinoid insecticides for use in citrus orchards and vineyards. We have identified rates of insecticide necessary to protect vineyards from GWSS infestations. And, equally important, we have identified certain situations when soil type and irrigation practices are not compatible with their use. Our studies are ongoing with other members of the neonicotinoid insecticide class.

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FUNDING AGENCIES

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