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IN THIS ISSUE

EVALUATION OF POSTHARVEST TREATMENTS TO BULK CITRUS FOR ERADICATION OF THE GLASSY-WINGED SHARPSHOOTER

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Abstract

State regulations require that bulk citrus, leaving a geographic area infested with glassy-winged sharpshooter (GWSS) or transiting an area under an active government GWSS control program, be 100% free from this pest. Currently, there are no economically feasible postharvest treatment programs capable of cleaning up bulk citrus after harvest. We conducted five experiments to test Evergreen® (pyrethrins + piperonyl butoxide) and chlorine (sodium hypochlorite) as postharvest treatments for GWSS in bulk citrus. In drench experiments, Evergreen® provided some, but not complete control of GWSS. Chlorine had little or no effect on mortality even when sprayed directly on the insects. Two hours after treatment, fogging experiments with Evergreen® in a citrus degreening room resulted in 100% mortality of GWSS in cages outside of bins, but only 71 to 93% of GWSS inside bins.

Introduction

Management of glassy-winged sharpshooter (GWSS), *Homalodisca coagulata* Say, in California plays a critical role in California's battle against Pierce's disease of grapes. Federal, State, and County organizations have worked jointly to reduce pest densities in locations where it has become established, and to prevent its spread to new locations throughout the state.

In an effort to stop the spread of GWSS, restrictions on the movement of bulk citrus have been developed by the California Department of Food and Agriculture (CDFA). Bulk citrus cannot be shipped out of a current infested zone or transit an area under an active government control program without being certified free of this pest. To be in compliance, fruit must be from a field that has been monitored and deemed free from GWSS, or it must undergo some form of mitigation.

Acceptable postharvest mitigation strategies for GWSS include field packing, mechanical removal of GWSS (e.g., run fruit over brushes to remove debris and GWSS), or other means approved by the origin County Agricultural Commissioner. Field packing and brushing are impractical from an economic standpoint, and other means approved by the Agricultural Commissioner must be documented as efficacious.

The purpose of this research was to test several strategies for postharvest control of GWSS that individual growers claimed were efficacious. This research was done at the request of various citrus growers, County Agricultural Commissioners, and personnel at CDFA. The goal was to identify and validate a postharvest treatment for GWSS that could provide consistent, complete control of this pest in bulk citrus.

Materials, Methods and Results

Methods overview

Five experiments were conducted between December 2002 and October 2003 in Santa Paula, Ventura County and Bakersfield, Kern County, CA. On each date, GWSS were collected in the morning from citrus in the Santa Paula or Riverside areas by members of the CDFA Pierce's Disease program. Live GWSS were refrigerated and transported to research sites in Santa Paula to be used in the experiments.

In each experiment, live GWSS were randomly selected and placed into 12 by 12 inch mesh bags, or in 2.5 by 9 inch cricket cages (Long Wire Cricket Tube, Challenge Plastic Products, Inc., Edinburgh, IN). Bags or cages were chosen at random and strategically placed inside or outside of 1000 pound bins of lemons. Bins were then subjected to a wide range of treatments.

Each experiment was conducted on a different day throughout the year. All trials consisted of at least one treatment and a control, with each being replicated a minimum of 4 times.

Evaluation of postharvest drenches with Evergreen®

Evergreen® EC 60-6 (pyrethrins + piperonyl butoxide) (McLaughlin Gormley King Company, Golden Valley, MN) was evaluated as a drench over the top of citrus bins. Eight standard 1000# bins of lemons were each seeded with two bags of GWSS, one bag 1/3 down from the top and the other 1/3 up from the bottom. Four of the bins were treated with Evergreen® at the maximum label rate of 1.5 pt per bin in a solution containing 12 fl oz of Evergreen® per 100 gal water. Applications were made using a wand sprayer at 40 psi. The pesticide solution was observed dripping out of the bottom of the bins.

After treatments, all bins were loaded onto a commercial flatbed trailer and transported from Ventura to Kern County. Nine hours after treatment, bags of GWSS were recovered from the bins and evaluated.

Evergreen® treatments did not provide sufficient control of GWSS adults to warrant their use as a postharvest treatment of citrus (Table 1). Treated bins, compared to untreated bins, showed no differences in the number of live or dead GWSS, or in the overall percentage mortality. A significant difference was seen in the number of twitching GWSS, suggesting that Evergreen® did have some effect on these insects.

Data from treated bins (Table 2) showed that Evergreen® killed significantly more GWSS in the top third of the bin than in the bottom, but that even in the top there were still some live insects. While data do show that Evergreen® has some effectiveness, lack of complete control renders this treatment inadequate as a postharvest mitigation for potentially infested fruit.

Evaluation of postharvest drenches and direct sprays with chlorine

Drench experiment: Chlorine was evaluated as a drench over the top of standard lemon bins. Eight bins were each seeded with three mesh bags containing GWSS. Five gallons of a 20 ppm solution of Pac-Chlor® (10% sodium hypochlorite) (Pace International, LLC, Seattle, WA) were applied to the top surface of each of four lemon bins using a wan sprayer (fan-jet nozzle 8003) at 40 psi. The other four bins were left unsprayed. All bins were loaded onto a truck trailer and left in the orchard overnight.

In the morning, the truck transported the bins to Bakersfield where the GWSS were removed and evaluated (~22 hours after treatment). Data showed that there was 95.3 ± 3.1 percent mortality of GWSS in bins treated with Pac-Chlor®, and 93.9 ± 3.1 percent mortality in the control. These differences were not significant (*P*=0.76), and mortality in neither the treatment nor the control bins was complete.

Direct contact experiment: A second experiment was conducted to evaluate the effects of chlorine as a contact insecticide. To do so, a minimum of 10 GWSS were placed into each of 8 mesh bags. Four bags were sprayed to dripping with the 20 ppm solution of Pac-Chlor®, and four were left unsprayed as controls. A live impatiens plant was inserted into two of the control and two of the treated bags as a food supply. GWSS mortality in all bags was evaluated at 6 and at 19 hr after the application.

Table 3 shows the mortality of GWSS that were sprayed directly with the Pac-Chlor® solution and were then provided or not provided a food source. In all cases, average mortality of GWSS in bags with a food source was lower than in bags without food. At 6 hr after treatment, GWSS mortality in treated bins was less than 50% regardless of whether or not a food source was provided. By 19 hr after treatment, all treated GWSS that were not provided food were dead, whereas those with a food source only had 54.6 and 78.4% mortality for GWSS that were and were not provided food, respectively. This means that a direct application of chlorine had little effect on GWSS, and would lead to predictions that chlorine drenches to bins will not mitigate GWSS infestations in bulk citrus, even under the best of conditions.

Effects of postharvest fogging with Evergreen® on GWSS mortality in citrus bins

Two experiments evaluated the use of Evergreen® 60-6 as an ultra low volume fog in citrus packing house sweat rooms. In the first experiment on 8 May 2003, one cage with a minimum of 10 GWSS was placed into the center of each of 20 bins filled with lemons. Sixteen of the bins were arranged into four stacks of four and placed into a 72,000 sq ft degreening room. The remaining four bins were stacked and placed into an adjacent degreening room as untreated controls.

The experiment was repeated on 22 Oct 2003 with a few modifications. First, 8 bins of oranges were treated in addition to the 16 lemon bins. Second, one cage of GWSS was placed outside of the citrus bins into each of the four corners of the treatment degreening room to evaluate mortality outside of the citrus bins. Lastly, built-in fans in the degreening room (which were broken in the first experiment) were utilized during the treatment to maximize circulation within the room.

For both experiments, the treatment degreening room was fogged with Evergreen® 60-6. One part Evergreen® 60-6 was diluted with 11 parts water and applied through a Dyna-Fog® Cyclone ULV^{TM} (Curtis Dyna-Fog Ltd.) at a rate of 1 fl oz per 1,000 cu ft. The application took approximately 45 min, and the doors were left sealed for a total of 2 hr.

After the 2 hr period, GWSS in the cages were recovered and evaluated for mortality. Evaluations were conducted 2 hr and 9 hr after treatment for the first experiment, and 2 hr and 5 hr after treatment for the second experiment.

The effects of Evergreen® fogging on GWSS in lemon bins on 8 May are shown in Table 4. The average number of live GWSS in treated bins was less than the control, but live GWSS were still present in each of the 4 stacks of bins. Moribund and dead GWSS in each stack were higher in the treated bins than in the controls, and resulted in higher percentage mortality in all stacks of bins compared to the control. Despite increased mortality compared to the control, approximately one fourth of the GWSS in treated bins were still alive. By 9 hr after treatment, at least one GWSS was still alive in 8 of the 16 treated bins with mortality among each stack ranging from 87.9 to 97.2%, compared to 90.9% in the untreated controls.

Data were also analyzed to test for differences in GWSS mortality among bins at different heights in the stack (Table 5), but no significant differences were found.

In the 22 Oct experiment, Evergreen® treatments resulted in significant increases in GWSS mortality compared to the untreated control (Table 6). There was 100% GWSS mortality located in treated cages left outside of the bins, but only 82.4% GWSS mortality in cages within the bins of fruit. Of the total 24 cages of GWSS in bins, 19 of them still had at least one GWSS capable of flying away when evaluated 2 hr after treatment.

By 5 hr after treatment (Table 7), treatments resulted in significant decreases in the number of live GWSS and the overall percentage mortality. Nevertheless, there was still at least one live GWSS in 3 of the 24 cages placed within bins.

Table 1. The effects of pre-shipment Evergreen® treatments on the viability of GWSS shipped from Santa Paula to Bakersfield.

	Mean GWSS per bag after shipment			
Treatment	Live	Twitching	Dead	Percent mortality
Evergreen®	3.0 a	3.2 a	13.9 A	69% a
Control	5.9 a	1.5 b	13.4 A	65% a
P	0.0626	0.0017	0.7017	0.4602

Column means followed by the same letter are not significantly different (Fisher's Protected LSD) at α = 0.05.

Table 2. The effects of bag location (top 1/3 vs. bottom 1/3 of the bin) on the efficacy of pre-shipment Evergreen® treatment on the viability of GWSS shipped from Santa Paula to Bakersfield.

	Mean GWSS per bag after shipment				
Bag Location	Live	Twitching	Live + twitching	Dead	Percent mortality
Top	1.3 a	2.9 a	4.1 a	16.4 a	80% a
Bottom	4.8 b	3.5 a	8.3 a	11.4 a	58% a
P	0.0046	0.7428	0.0683	0.0765	0.0655

Column means followed by the same letter are not significantly different (Fisher's Protected LSD) at α = 0.05.

Table 3. The effects of direct applications of Pac-Chlor® on the mortality of GWSS that were or were not provided a food source.

		% mortality ± standard error of the mean	
Treatment	Food source	6 hrs after application	19 hours after application
Pac-Chlor®	No	41.7 ± 25.0	100.0 ± 0.0
Control	No	59.5 ± 12.3	100.0 ± 0.0
Pac-Chlor®	Yes	33.3 ± 11.1	78.4 ± 11.7
Control	Yes	19.4 ± 0.6	54.6 ± 7.9

Means separation was not calculated due to the wide variance in SEM values.

Table 4. Effects of postharvest fogging with Evergreen® 60-6 on GWSS in lemon bins 2 hours after treatment.

		Mean GWSS per cage				
		2 hr after treatment				9 hr after treatment
Treatment	Number of cages	Live	Moribund	Dead	Percentage mortality[1]	Percentage mortality[1]
Evergreen	16	3.7 a	1.6 a	10.2 a	76.8 a	92.6 a
Control	4	15.5 b	0.3 a	0.3 b	3.4 b	90.9 a
P (0.05)		<0.0001	0.1592	0.0027	0.0002	0.7885

Column means followed by the same letter are not significantly different (Fisher's Protected LSD) at α = 0.05.

[1] Moribund GWSS were considered dead in the calculation of percentage mortality.

Table 5. Role of bin height on the effectiveness of Evergreen® fogging treatments to GWSS in lemon bins 2 hours after treatment.

	Mean GWSS per bag (2 hours after treatment)				
Bin height	Live	Moribund	Dead	Moribund + dead	Percentage mortality[1]
1(top)	2.0 a	0.5 a	16.0 a	16.5 a	89.0 a
2	5.8 a	1.5 a	8.5 a	10.0 a	62.8 a
3	4.5 a	1.8 a	8.3 a	9.8 a	72.3 a
4 (bottom)	2.5 a	2.7 a	8.0 a	11.0 a	83.3 a
P (0.05)	0.5288	0.4108	0.1097	0.1535	0.4513

Column means followed by the same letter are not significantly different (Fisher's Protected LSD) at α = 0.05.

[1] Moribund GWSS were considered dead in the calculation of percentage mortality.

Table 6. Effects of postharvest fogging with Evergreen® 60-6 on GWSS in citrus bins 2 hours after treatment, 22 Oct 2003.

		Mean GWSS per cage (2 hours after treatment)				
Location	number of cages	Live	Moribund	Dead	Moribund + dead	Percentage mortality[1]
In bins	24	4.0 a	18.3 A	2.0 a	20.3 a	82.4 a
Outside bins	4	0.0 a	20.5 A	6.8 b	27.3 a	100.0 a
Untreated	4	15.8 b	2.5 B	3.3 ab	5.8 b	29.1 b
P (0.05)		<0.0001	0.0006	0.0132	0.0022	<0.0001

Column means followed by the same letter are not significantly different (Fisher's Protected LSD) at α = 0.05.

[1] Moribund GWSS were considered dead in the calculation of percentage mortality

Table 7. Effects of postharvest fogging with Evergreen® 60-6 on GWSS in citrus bins 5 hours after treatment, 22 Oct 2003.

		Mean GWSS per cage (5 hours after treatment)				
Location	number of cages	Live	Moribund	Dead	Moribund + dead	Percentage mortality[1]
In bins	24	0.1 a	3.1 A	20.7 a	23.8 a	99.5 a
Outside bins	4	0.0 a	1.0 A	26.5 a	27.5 a	100.0 a
Untreated	4	0.8 b	0.8 A	21.3 a	22.0 a	96.6 b
P (0.05)		0.0282	0.1732	0.3821	0.6258	0.0349

Column means followed by the same letter are not significantly different (Fisher's Protected LSD) at α = 0.05.

[1] Moribund GWSS were considered dead in the calculation of percentage mortality

Conclusions

Despite multiple experiments, data did not support claims that Evergreen® or chlorine (Pac-Chlor®) could be used as postharvest drenches or fogs for eradication of GWSS. While both of these products increased mortality in most cases, neither provided complete, 100% control. This leaves techniques such as fruit brushing, which is expensive and damaging to the fruit, or field packing as the only pre-shipment options currently available for postharvest sanitation of bulk citrus.

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ANTS IN YOUR VINEYARD?

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Abstract

We tested Argentine ant control in coastal winegrapes using insecticides in liquid sucrose baits. Plots treated with either 0.5% boric acid or 0.0001% thiamethoxam, delivered in a 25% sucrose water bait, showed significant reductions in ant activity and mealybug pest damage. Data are discussed with respect to commercial development of bait dispensers.

Key words: Argentine ant, mealybug, winegrape

Introduction

Do I have a mealybug problem or an ant problem? That's a question many of California's coastal winegrape growers have had to ask themselves. Over the past decade, there has been increasing economic loss from common mealybug species – the grape (*Pseudococcus maritimus* [Ehrhorn]), obscure (*P. viburni* [Signoret]), and longtailed (*P. longispinus* [Targioni-Tozzeti]) mealybug. All three species have been longtime residents of California and have occasionally caused economic damage. Previous studies suggested that natural enemies can keep mealybug densities below economically damaging levels, unless their effectiveness is disrupted by broad spectrum insecticides (Flaherty et al. 1992). While the past decade has seen changes in pesticide use, we believe that another major factor in the rise of mealybug pest problems has been a corresponding rise in Argentine ant (*Linepithema humile* [Mayr]) populations. The Argentine ant has become one of the more persistent, damaging and invasive insects in California. While most commonly considered as an urban pest, it can be found in any suitable habitat, typically where disturbed soil and available water are found. Vineyards provide both habitat requirements, and the Argentine ant appears to thrive in vineyard ecosystems.

Ants are known to tend honeydew-producing Homoptera and interfere with parasitoid activity (Way 1963, Barzman & Daane 2001). In California vineyards, researchers showed that the grape and obscure mealybug pest problems decreased when ants were either excluded by "stikum" trunk barriers (Daane et al. 2003) or attracted away from the vines by nectar-bearing cover crops (Bentley et. al. 2001). Neither technique is an economically viable solution for coastal vineyards. Furthermore, most of the effective ant control programs utilize contact insecticides, such as chlorpyrifos (Lorsban) (Moreno et al. 1987; Rust et al. 1996), so neither vineyard sustainability nor management costs are improved. For this reason, most growers target the mealybug. But is it an ant problem, a mealybug problem, or a mealybug problem caused by ants?

We sought to reduce Argentine ant densities using more sustainable control methods. We began a collaborative study with Drs. Mike Rust and John Klotz to test some of their Argentine ant controls that utilize small amounts of insecticides in sucrose water bait (Rust et al. 2000, 2003; Klotz et al. 2000, 2003). Our studies on sucrose baits began in 2000 and have been conducted in several Napa, Sonoma and San Luis Obispo County vineyards. Here, we report results from 2003 studies on two aspects of ant control: efficacy and the insecticide used.

Materials and Methods

Field impact of liquid baits. We tested the effectiveness of a liquid bait treatment of 0.0001% technical thiamethoxam (Syngenta, Greensboro, NC) in 25% sucrose water. Thiamethoxam is an "insect growth regulator" and this rate is far lower than that found in commercial flea collars. The test plot was in a 20 acre block of 'Pinot Noir' in Sonoma County. The two treatments, insecticide bait and untreated control, were set in a randomized complete block, with four blocks.

Blocks were 1.2 acre (15 rows by 70 vines) each and split into two treatment plots (5 rows of 70 vines), with five-row buffers separating each treatment plot and block. The bait solution was delivered in inverted 250-ml polypropylene centrifuge tubes (Corning Inc., NY) (Photo 1). A 2-cm diameter hole was drilled into the cap of each tube and covered with a permeable plastic mesh square (Weedblock, Easy Gardener Inc., Waco, TX) that allowed the ants to remove the bait solution on contact but prevented leaks. The "bait dispensers" were placed on vine trunks, attached with a loop of plastic flagging tape, with 17 bait dispensers spaced evenly across each plot (equivalent to 44 per acre). At 2 – 3 wk intervals, emptied bait dispensers were replaced.

Argentine ant populations were monitored using two methods, direct (visual counts), and indirect (assessment of feeding activity). Visual counts were conducted at 2 wk intervals. In each plot, we counted the number of ants moving on the cordon of 10 randomly selected vines during a 30 s period. Ant feeding activity was assessed by measuring the amount of 25% sucrose water removed by foraging ants from 50 ml "monitoring tubes," as described by Klotz et al., 2000. The monitoring tubes, which are essentially a smaller version of the bait dispensers, without the insecticide, were weighed before and after field placement and the amount of liquid removed in a 24 hr period (adjusted for evaporation) was determined at 1 – 4 wk intervals (depending upon seasonal period). The amount of sucrose water removed was used as a measure of feeding rate and relative population size. We used 23 monitoring tubes and 1 evaporation tube per plot.

Grape mealybug density was monitored each month on 10 vines per plot using visual counts of mealybugs, as described by Geiger and Daane (2001). Trunks, canes, and leaves were examined for 3 min per vine and the numbers of mealybugs were recorded. Mealybug crop damage was evaluated at harvest-time on 30 randomly selected vines per plot (6 per row). On each vine, three clusters were rated on a 0 – 3 scale where 0 = no mealybugs; 1 = some mealybugs and honeydew present; 2 = > 10 mealybugs, sooty mold and honeydew present; 3 = heavily infested, unharvestable clusters (Geiger & Daane 2001). Clusters in direct contact with woody parts of the vine were preferentially sampled, when available. Data are presented as percentage infestation, with data weighted by damage rating.

Comparison of active ingredients. We compared the effectiveness of three liquid bait treatments, delivered in 25% sucrose water, in a 20-acre 'Chardonnay' block in Napa County and a 10-acre chardonnay block in San Luis Obispo County. In each vineyard, 40-row by 40-vine blocks were established, set in a randomized complete block design, with four blocks. Each block was divided into four 5-row by 40-vine treatment plots, with 5-row buffers between treatments. Treatments were 0.0001% thiamethoxam, 0.0001% imidacloprid, 0.5% boric acid, and an unbaited control. Baits were delivered in the 250 ml bait dispensers, and ant feeding activity and mealybug density and cluster damage were measured, all as previously described.

Statistical analysis. Data are presented herein as means per treatment (± SEM). Mean values and statistical analyses were determined from mean values of each replicate (mean of means), which is a more rigorous analysis, with the exception of cluster damage in which treatment data were pooled across all replicates. Data from direct (visual) and indirect (monitoring tubes) measurements of ant density and mealybug visual counts were transformed (square root +1) because many values were "0". Seasonal treatment influences were analyzed using Repeated Measures Analysis of Variance (ANOVA). Treatment influence on cluster damage was determined by ANOVA, with treatment means separated using Tukey's HSD test (three or more treatments) or a *t*-test (two treatments).

Results

Field impact of liquid baits. Season-long ant numbers were significantly lower in the thiamethoxam treatment, as compared with the control, as measured by feeding activity (Fig. 1) and visual counts (Fig. 2). The seasonal means (± SEM) for feeding activity (g sucrose per day) were 2.6 ± 0.6 and 7.0 ± 1.0 for bait and control treatments, respectively, and the ant counts (ants per 30 s) were 1.4 ± 0.2 and 2.1 ± 0.2 for bait and control treatments, respectively. Seasonal mealybug density (Fig. 3) and crop damage (Fig. 4) were also significantly lower in the thiamethoxam treatment. The seasonal means (± SEM) for mealybugs (mealybug per 3 min visual search) were 0.52 ± 0.09 and 1.7 ± 0.2 for bait and control treatments, respectively.

Comparison of active ingredients. There were significant, season-long differences among treatments in the level of ant feeding activity (df = 3,12, F = 5.055, *P* = 0.017). However, not all insecticide baits had the same impact on ant densities. The level of ant activity at monitoring tubes was significantly reduced in plots with boric acid and thiamethoxam, compared with the control treatment (Fig. 5). In the imidacloprid plots, however, ant activity did not differ significantly from the control. The different levels of ant activity are reflected in a significant difference in mealybug damage to clusters (Fig. 6). The seasonal means (± SEM) for feeding activity (g sucrose per day) were 0.73 ± 0.5, 0.86 ± 0.05, 0.94 ± 0.07, and 2.65 ± 0.13 for the thiamethoxam, boric acid, imidacloprid and control treatments, respectively.

Discussion

We used a thiamethoxam-laced sucrose bait to reduce season-long ant population densities. We conclude that small amounts of relatively non-toxic insecticides, delivered in a sucrose-bait, can reduce ant densities, as shown by other researchers (Rust et al. 2000, 2003; Klotz et al. 2000, 2003). Still, we do not believe that the use of a sucrose-baited insecticide is ready for wide-spread commercial use for the following reasons. First, the bait can be improved. In other studies, we found a similar reduction of ant activity at the monitoring tubes and bait dispensers from mid-April to July (Fig. 1). Ants were observed in the clusters during this period, closely tending the mealybugs inside. We hypothesize that the honeydew produced by mealybugs feeding inside the ripening grape clusters is far more attractive than the sucrose-bait solution. For this reason, we plan to study the mealybug-honeydew chemical composition during different times of the season to determine if we can develop a more attractive bait solution. Second, we used a rate of 44 dispensers per acre, with dispensers changed every 2 – 3 wk throughout the season. This strategy was far too labor-intensive, and research must continue to determine how many, how often, and where the dispensers should be placed for maximum efficiency. Information on ant foraging distances and better trap designs also is needed. Third, thiamethoxam is not currently registered for use in vineyards, so we need to look at alternate insecticides for vineyards and other crop systems. Alternative insecticides include boric acid and imidacloprid – both of which may be more easily registered for widespread use in vineyards (these insecticides are already used for other vineyard pests). We found that the imidacloprid bait solution was not as effective as either boric acid or thiamethoxam. The ineffectiveness of imidacloprid may be due to degradation when exposed to light (pers. comm., Bayer Crop Science), whereas thiamethoxam and boric acid do not undergo this degradation. Subsequent designs of the bait stations may require the incorporation of an opaque covering or colored (brown or amber) dispenser to protect the solution from photo degradation.

Finally, the level of crop protection must be discussed in reference to time and intensity. Data presented here are from vineyards where ant control trials have been ongoing for a full season or more. However, when dispensers were placed in vineyards for a shorter period (June – August), there was not a consistent reduction in ant densities. As for damage intensity, there was a recent history of very high ant densities and mealybug damage in both blocks studied. We have shown (2000-2003 data) that ant control programs have greatly helped reduce mealybug densities. In 2003, we found <1 mealybug per 3 min count and a damage rating of "<0.5," which is equivalent to <15% of the clusters with any visible signs of mealybug damage. In past years, that site had damage ratings between 1 – 2 and infestation rates >60% of the total grape clusters. Still, we do not believe that an early season (March – April) initiation of ant control measures can be relied upon to result in significantly lowered mealybug densities and crop damage in a single year. Ant control, especially with sucrose water baits, will be a multi-year control strategy.

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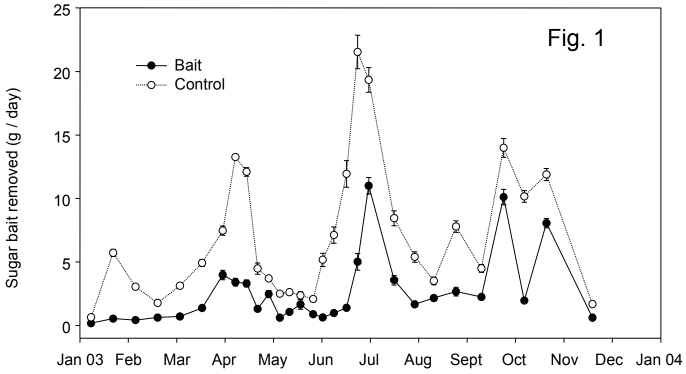

Fig. 1. Seasonal ant feeding activity, as measured by monitoring tubes, was significantly lower in plots receiving 0.0001% thiamethoxam delivered in a liquid bait of 25% sucrose water (Repeated measures ANOVA: df = 1,6, F = 31.22, P = 0.003).

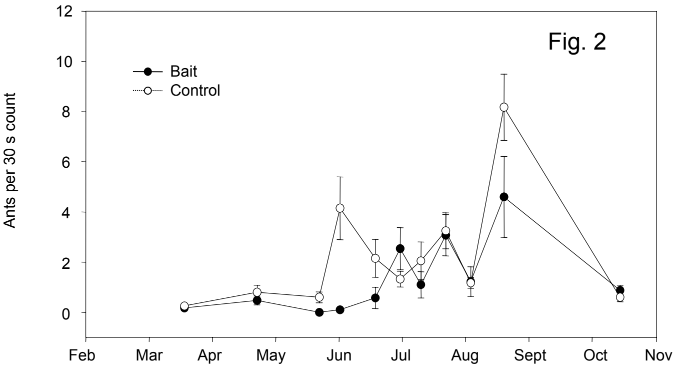

Fig. 2. Seasonal ant density, as measured by the number of ants foraging, was significantly lower in plots receiving 0.0001% thiamethoxam delivered in a liquid bait of 25% sucrose water (Repeated measures ANOVA: df = 1,6, F = 6.020, P = 0.050).

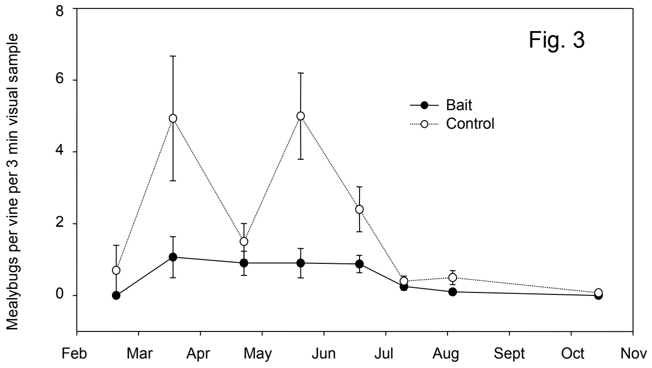

Fig. 3. Seasonal mealybug density, as measured by the number of mealybugs found during a timed search, was significantly lower in plots receiving 0.0001% thiamethoxam delivered in a liquid bait of 25% sucrose water (Repeated measures ANOVA: df = 1,6, F = 7.945, P = 0.030).

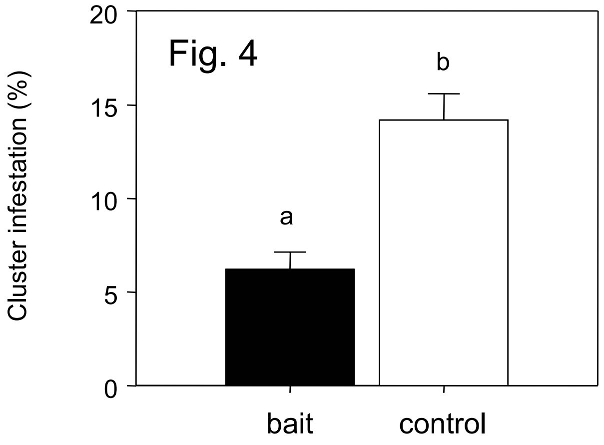

Fig. 4. Crop damage was significantly lower in plots receiving 0.0001% thiamethoxam delivered in a liquid bait of 25% sucrose water ($t = -4.718$, $P < 0.001$).

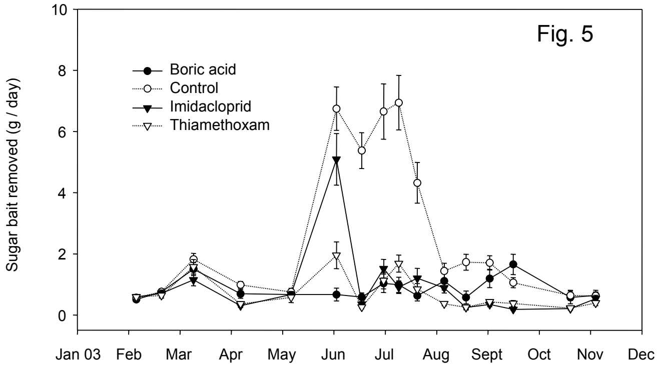

Fig. 5. There were significant season-long differences among treatments in the level of ant feeding activity (Repeated measures ANOVA: df = 3,12, $F = 5.055$, $P = 0.017$), with ant activity at monitoring tubes significantly reduced in plots with boric acid (df = 1,6, $F = 5.881$; $P = 0.049$) or thiamethoxam (df = 1,6, $F = 6.652$; $P = 0.42$); however, ant activity with imidacloprid did not differ significantly from the control (df = 1,6, $F = 4.926$, $P=0.068$).

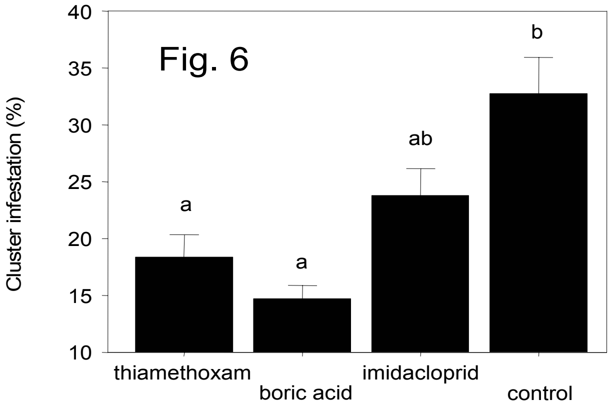

Fig. 6. Percentage of clusters infested with either mealybugs or their honeydew was significantly different among treatments (df = 3,322, $F = 11.81$, $P < 0.001$), with damage significantly lower in boric acid and thiamethoxam plots ($P < 0.05$), while the imidacloprid plot was not significantly different from the control.

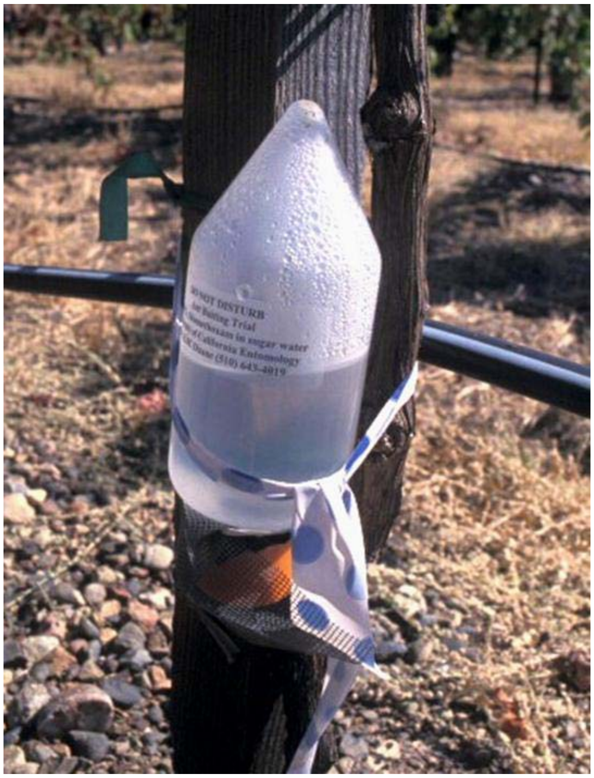

Photo 1. The bait solution (insecticide and 25% sucrose water) was delivered in 250-mL polypropylene tubes with a semi-permeable mesh covering the opening.

ABSTRACTS

WEED SCIENCE SOCIETY OF AMERICA, February 9-12, 2004, Kansas City, MO

Light environment under different grapevine row orientations and effects on black nightshade.

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Selection of row orientation during vineyard design might have important implications for future weed management. Row orientation may affect light quantity intercepted by grapevine (*Vitis vinifera* L.) canopies. This might alter the light environment of weeds, thus affecting their growth and development. We measured photosynthetically active radiation (PAR), and the growth and photosynthesis characteristics of potted black nightshade (*Solanum nigrum* L.) seedlings grown for 10 weeks (April to June), under rows of 'Selma Pete' grapevines trained to quadrilateral cordons on an open-gable trellis. Rows were oriented North-South (NS) or East-West (EW) in a randomized complete block design. In both row orientations, PAR at the weed canopy zone decreased as the vine canopy developed, but peak PAR was generally less than 75 $\mu mol \bullet m^{-2} \bullet sec^{-1}$ in EW rows, whereas in NS rows, PAR was between 200 to500 $\mu mol \bullet m^{-2} \bullet sec^{-1}$ in the morning and afternoon. The ratio of red to far-red light was also greater in EW rows than in NS rows in the morning and afternoon. Moreover, at those times, nightshades in EW rows had lower photosynthetic rates than nightshades in NS rows. Nightshade phenology was not affected by row direction, nor was stem or berry mass. Weeds growing in EW rows compensated for low light levels by producing larger, thinner leaves and they partitioned less resources to roots compared to weeds in NS.