Final Research Report
to
The Viticulture Consortium - East

Systemic insecticides for selective and targeted insect control in Michigan vineyards

Rufus Isaacs, Steve Van Timmeren and John C. Wise

Dept. of Entomology, Michigan State University, East Lansing, MI 48824
Trevor Nichols Research Complex, Fennville, MI 49408

Introduction

Systemic insecticides provide unique tools for grape growers in that once the insecticide is inside the plant tissues, it should provide a long duration of protection against various grape feeing pests such as leafhoppers and Japanese beetles. The neonicotinoid class contains a range of insecticides (e.g. Provado, Venom, Assail, Actara, Clutch) that can be applied to the foliage and others that can be applied to the roots (e.g. Admire, Venom, Platinum, Belay).

To get the soluble insecticide into the plant, it can be delivered through a drip irrigation system or sprayed directly on the vine. For soil applications, once the insecticide is absorbed by the roots it moves in the transpiration stream to the foliage. Insects feeding on treated vines then receive a dose of the insecticide, causing repellency or death. Potential benefits of this approach to insect control include: 1) longer duration of residual control against foliar pests, 2) protection of insecticide from wash-off, 3) control of multiple pest types with one application 4) low worker exposure to pesticide residues, and 5) reduced toxicity to natural enemies.

Systemic insecticides are increasingly being registered for use in vineyards, and this research was conducted to evaluate the registered insecticides and those with potential for future registration. The objectives of this study were as follows:

1. Compare soil-applied insecticides under vineyard conditions for control of leaf - feeding insects.
2. Determine the optimal time of application of soil insecticides.
3. Compare uptake of systemic insecticides into foliage.
4. Evaluate effects of tested insecticides on soil arthropods.

Methods

Methods are described in the original proposal and can be provided by a request to Rufus Isaacs, at isaacsr@msu.edu

Results

Chemigation at TNRC Vineyard Planting.

Results from clip cage experiments show significant differences in potato leafhopper mortality on mature leaves but not on young leaves (Fig. 1) (F_{mature} = 2.3; df_{mature} = 3, 12; P_{mature} = 0.13; F_{new} = 2.3; df_{new} = 3, 12; P_{new} < 0.003). On mature leaves, the highest percentage of dead and dying nymphs were found in thiamethoxam (Platinum) treatments, while the lowest percentage was found in untreated vines. While newly unfolded leaves showed no significant differences, the same trend of greater percentage of dead and dying nymphs in Platinum treatments was evident.

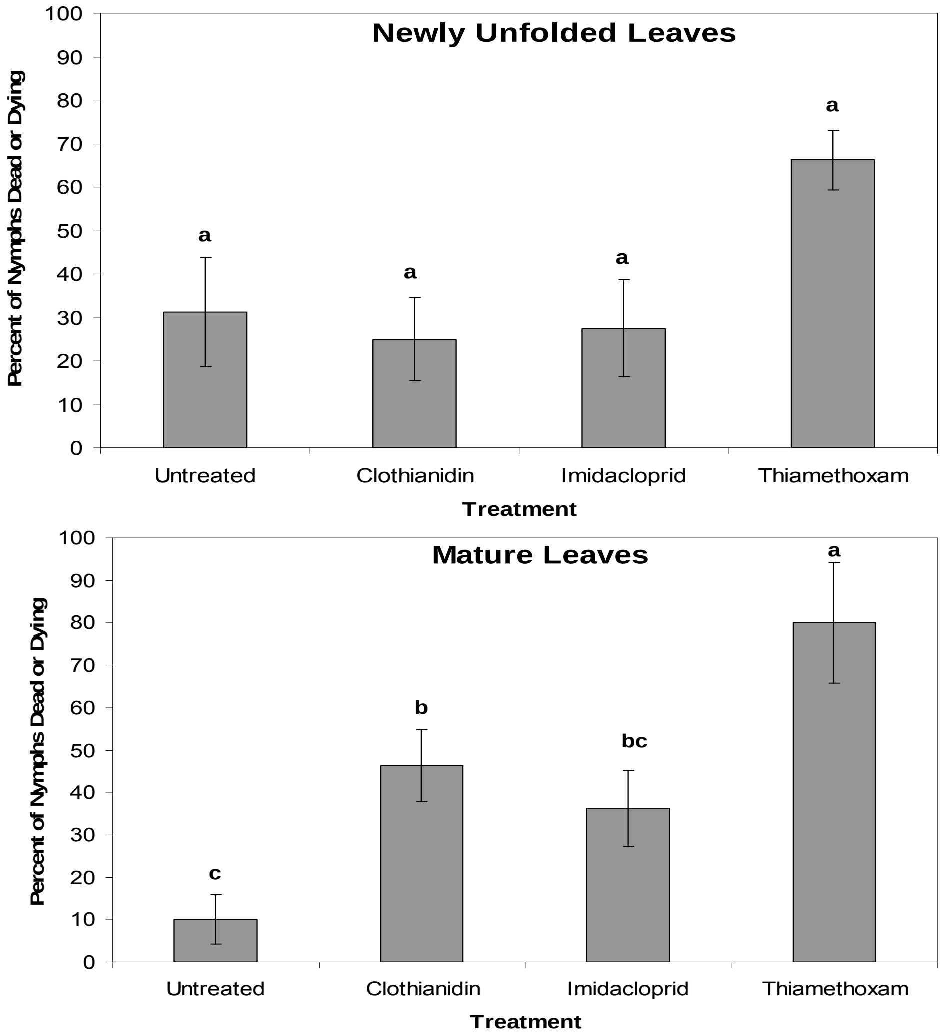

Figure 1. Percent of PLH nymphs that were dead or dying after overnight confinement on newly unfolded or mature grape leaves on vines treated with various chemicals via chemigation 25 days earlier. Percentages are presented ± SE and averages with the same letter are not significantly different at α=0.05.

Japanese beetle leaf-feeding bioassays showed significant reductions in leaf feeding in some of the treated plots over the course of the field season(Fig. 2) (df=3,12; $F_{3\ DAY}$=7.0; $P_{3\ DAY}$ =0.006; $F_{11\ DAY}$=4.8; $P_{11\ DAY}$ <0.02; $F_{17\ DAY}$=12.9; $P_{17\ DAY}$ <0.001; $F_{24\ DAY}$=29.0; $P_{24\ DAY}$ <0.001; $F_{31\ DAY}$=21.3; $P_{31\ DAY}$ <0.001; $F_{38\ DAY}$=16.8; $P_{38\ DAY}$ <0.001; $F_{45\ DAY}$=14.5; $P_{45\ DAY}$ <0.001; $F_{52\ DAY}$=7.6; $P_{52\ DAY}$ =0.004; $F_{60\ DAY}$=14.9; $P_{60\ DAY}$ <0.001; $F_{66\ DAY}$=3.1; $P_{66\ DAY}$ =0.066). Leaves from imidacloprid treatments had significantly lower feeding damage than each of the other treatments for all days except at 52 days after treatment where imidacloprid and thiamethoxam treatments were not significantly different, and at day 66 where there were no significant differences among any treatments. Clothianidin-treated leaves were not significantly different from untreated controls on any of the days through the season.

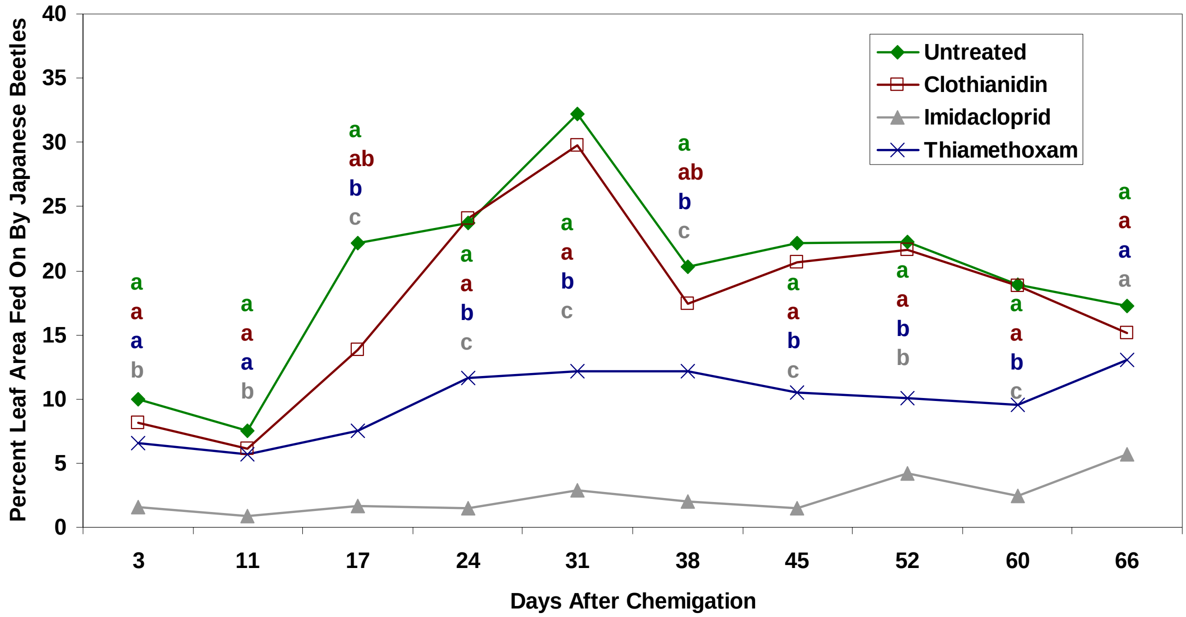

Figure 2. Percent of mature grape leaf surface area fed on by Japanese beetles in laboratory bioassays. Grape vines received various chemical treatments delivered by irrigation injection on 6 July 2007 and bioassays were conducted on a weekly basis for 66 days after application. Letters that are the same within each sampling date are not significantly different

Assessments of Japanese beetle feeding damage on grape leaves within the treated vineyard plots showed significant differences among the treatments that reflect the differences found in the laboratory bioassays (Fig. 3). Imidacloprid-treated vines had the lowest levels of feeding damage while clothianidin-treated vines were not significantly different from controls ($F=21.3$; $df=3, 12$; $P<0.001$).

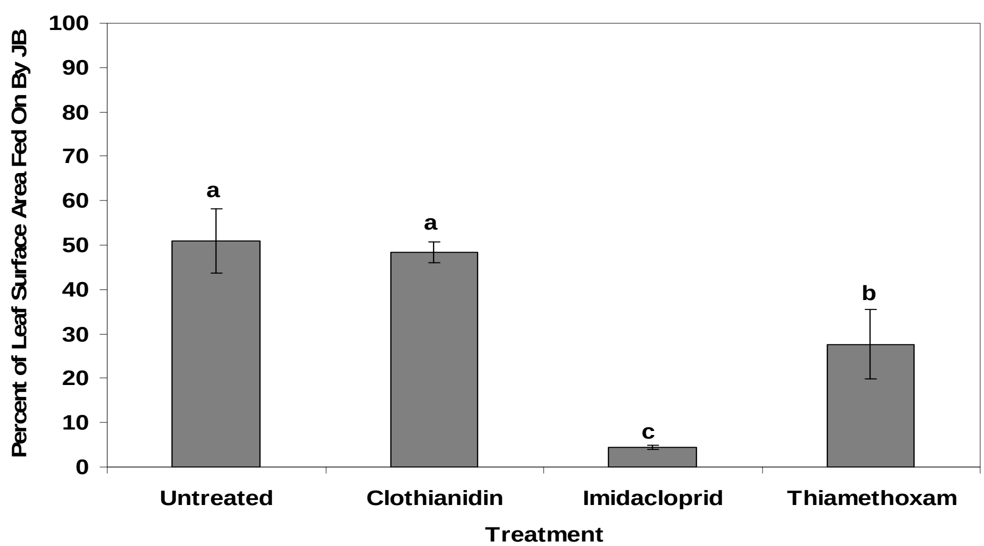

Figure 3. Percent of grape leaf surface area fed on by Japanese beetles on vines with roots treated with systemic insecticides. Chemical applications took place on 6 July and damage assessments took place on 10 August 2007. Percentages are presented ± SE and averages with the same letter are not significantly different at $\alpha=0.05$.

Side effects on soil arthropods

Berlese funnel samples taken from underneath treated vines and in adjacent row middles indicate no significant differences in arthropod abundance among treatments. Most arthropod groups were present at low levels with no clear differences between treatments. Collembolans were the most abundant soil arthropods at this site and no significant differences were found among treatments on any of the dates for either the under the vine samples.

Soil-Applied Insecticides at On-Farm Sites.

Insecticides applied through the drip irrigation system in a young irrigated vineyard during 2006 provided excellent control of potato leafhopper nymphs (Fig. 4) ($F=21.7$; $df=3, 12$; $P<0.001$). While there is some trend toward lower PLH abundance in some of the treated plots, when insecticides were banded under the vines and then irrigated with drip irrigation in more mature vineyards, no significant control of potato leafhopper nymphs was observed (Fig. 10B) ($F=1.6$; $df=4, 15$; $P=0.23$). Chemicals banded under the vines and then irrigated in via rainfall also did not show any significant control by the applied insecticides (Fig. 10C) ($F=2.1$; $df=4, 15$; $P=0.13$).

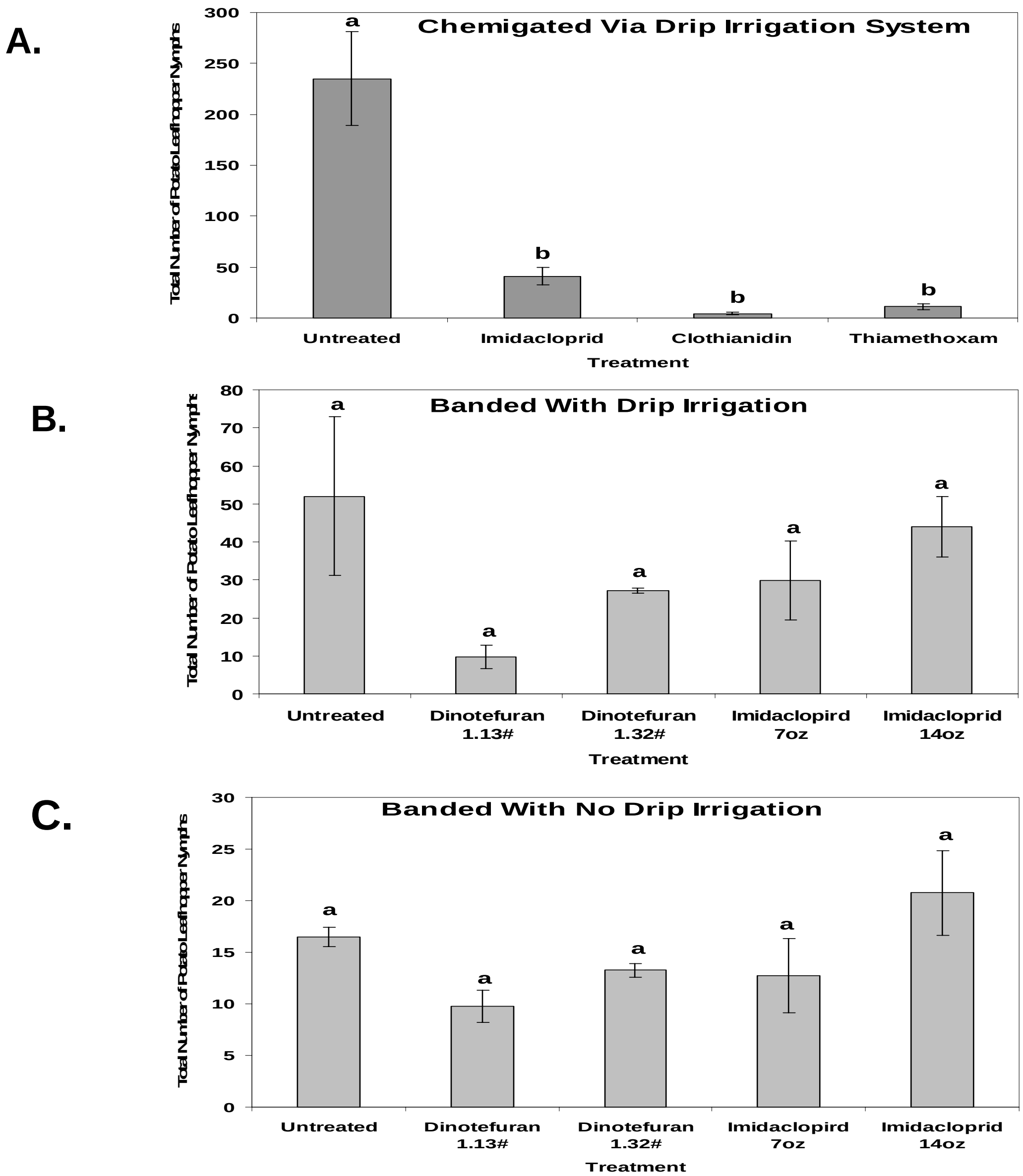

Figure 4. Total number of PLH nymphs on grape leaves during 2007 trials. Chemicals were applied by (A) chemigating through a drip irrigation system, (B) banding on the soil of drip-irrigated vines, or (C) banding on the soil of vines with no drip-irrigation. Means ± SE with the same letter are not significantly different.

Summary

Results from this study indicate that potato leafhoppers can be controlled effectively by insecticides applied via chemigation. Vineyard assessments in 2006 and clip cage experiments in 2007 indicate the chemigated systemic insecticides can provide up to a month of control against leafhoppers. This will be of particular use to Michigan winegrape growers who are susceptible to potato leafhopper over a long period of activity during the period of rapid shoot expansion in the spring.

Insecticide treatments were also able to provide protection against Japanese beetle feeding. Imidacloprid provided the most effective control of any of the neonicotinoids tested. Beetles ate a significantly lower percentage of grape leaves in laboratory bioassays and significantly lower amounts of feeding damage was found in vineyard assessments of vines treated in early July when they were assessed in early August. Thiamethoxam also provided some level of control, while clothianidin showed no significant differences from untreated controls.

Our data also suggest imidacloprid treatments reduce infestation by grape berry moth (data not shown). The percent of clusters infested with GBM in the imidacloprid treatments in 2007 was significantly lower than any of the other treatments. A similar trend was evident in 2006 but was not significant. Whether this is caused by direct toxicity of residues in berries to larvae or on leaves to adult moths is not clear and requires further investigation. The results of the residue analysis will be useful to interpret these data.

While insecticides applied via chemigation in our TNRC research vineyard provided excellent control of leafhoppers, other methods tested at commercial vineyards were not as effective. Banding insecticides on the soil under vines followed by either drip irrigation or rain provided no significant control against leafhoppers. This may reflect the difficulty getting the chemical into the root system on vines that have a well developed root system in which the majority of the roots are deep in the soil.

Outreach Activities

This project was highlighted at extension meetings throughout the project, including:

1. July 2006-07 Southwest Michigan Research and Extension Center Viticulture Days
2. Summer vineyard IPM workshops during 2006 and 2007 in southwest and northwest Michigan
3. Great Lakes Expo, December 2006 Winegrape Research update
4. Results of this project have been used to update the E-154 Fruit Management Guide publication from Michigan State University Extension.

Acknowledgements

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APPENDIX

Impact statement
This project has provided a thorough evaluation of systemic insecticides and their potential for use to combat insect pests in vineyards. Results are used to inform pesticide recommendations and to help growers make confident choices about the adoption of reduced-risk insecticides that can help minimize the impact of viticulture on worker health and the environment.

Publications
A manuscript based on this research is in development for submission to the Journal of Economic Entomology.