Chemical Control of the Phantasma Scale, *Fiorinia phantasma* (Hemiptera: Diaspididae), Potential Pest of Palms and Ornamentals Plants in Florida

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Effective chemical control of armored scale insects involves selecting the right type of insecticide and timing of applications to control vulnerable stages while minimizing the impact on resident natural enemies (McClure 1977, McClure 1979, Sadof and Neal 1993, Juarez-Hernandez et al. 2014, Quesada and Sadof 2017, Quesada et al. 2018). Controlling armored scale insects is particularly challenging due to their feeding behavior and that most of their life stages are protected under coverings. Intracellular feeding behavior of armored scale insects makes them less susceptible to systemic insecticides compared to other scale insect species that feed continuously on phloem, as high concentrations of systemic chemicals do not reach parenchymal cells or vascular bundle tissues where armored scale insects usually feed (Sadof and Neal 1993, Juarez-Hernandez et al. 2014). Additionally, their nature of spending most of their life cycle in a relatively impervious wax cover makes them less susceptible to contact insecticides. Their susceptibility further decreases in pupillarial species, where adult females are encased within the second-instar shed skin like in *Fiorinia phantasma*. Crawlers are the most susceptible to contact insecticides as they do not have the protective coverings. Accurate timing of the application of contact insecticides is crucial because crawlers' susceptibility to contact insecticides can further decrease due to three reasons: 1) an increase in their age, 2) an increase in the period of their activity, and 3) a wax cover formation upon their settlement on foliage (Miller and Davidson 2005, Quesada and Sadof 2017, Quesada et al. 2018). In addition, the peak abundance of crawlers may coincide with the seasonal occurrence of natural enemies, and post-spray populations of armored scale insects can rebound quickly due to reduced natural enemies and increased plant growth (McClure 1977, McClure 1979). The combination of horticultural oils and insecticidal soap in place of conventional contact insecticides (i.e., pyrethroids) can help conserve resident natural enemies (Buss and Dale 2016, Quesada and Sadof 2017). A resurgence of armored scale insects populations can also occur due to reinfestation of sprayed foliage by crawlers from nearby trees treated with contact insecticides applied with incomplete coverage (McClure 1977). As *F. phantasma* is a new invasive species, effective management strategies are still being developed. However, four factors still should be considered when attempting chemical control of *F. phantasma*: 1) systemic insecticides could provide variable or sporadic control, 2) poor timing of contact insecticide applications could also lead to little or no control, 3) contact insecticide applications could disrupt the conservation of resident natural enemies, and 4) an incomplete coverage of contact insecticide applications could lead to *F. phantasma* proliferation (Ahmed 2018, Ahmed and Miller 2018, Ahmed et al. 2021a,b).

Every year the IR-4 program funds high-priority insecticide efficacy trials. A number of trials have been conducted on scale insects and mealybug pests. When asked about managing hard scale insects, we refer to the latest document produced by the IR-4 Environmental Horticulture Program called Scale and Mealybug Efficacy. The latest version of the mealybug and scale summary posted to the IR-4 website is November 30, 2020 (Palmer and Vea 2020). We use such reports to help make data-driven insecticide recommendations. Many of the studies on other pest groups are easy to use because the results aren't as variable as they are for hard scales. This variability in the results makes it difficult to decide which compounds should manage these scale insects. A few materials are listed in Table 1 that we recommend have utility in managing the phantasma scale, *F. phantasma*, based on trials conducted on a very similar pest called the tea scale, *F. theae.* The tea scale attacks many woody landscape ornamentals such holly, camellia, and boxwood and whereas the hosts of interest in the case of phantasma scale, *F. phantasma*, are predominantly palms. The difference in the vascular systems of palms and the woody ornamentals used in all of the efficacy trails we reviewed could significantly impact the validity of using tea scale data to predict the control of phantasma scale infesting palms. We selected insecticides showing efficacy values above 80% and provided in Table 1 with their labels detail. Please see Tables 66–74 for additional information.

Table 1 Potential insecticides against the phantasma scale in Florida.

Trade Names (Manufacturer)	Active Ingredient(s)	MoA Class	Application Type	Label Rate (Landscape Ornamentals)	Minimum Application Interval (Days)
I. Efficacy values > 80% & legal to use on landscape ornamentals					
TriStar 8.5SL (Cleary)	Acetamiprid	4A	F	8.5–16.5 oz/100 gals	7
TriStar 70WSP (Cleary)	Acetamiprid	4A	F	2.0–4.0 water soluble packs/100 gals	7
Safari 20SG (Valent)	Dinotefuran	4A	F, D	4.0–8.0 oz/100 gals (F) 2.1–4.2 oz/10 DBH (D)	14–21 (F) 7(D)*
Safari 2G (Valent)	Dinotefuran	4A	D	2.0–4.0 oz/10 DBH (D)	**
Altus (Bayer)	Flupyradifurone	4D	F, D	10.5–14.0 fl oz/A (F) 21.0–28.0 fl oz/A (D)	7 (F) 365 (D)
Distance (Valent)	Pyriproxyfen	7C	F, D	8.0–12.0 fl oz/100 gals (F)	14–28
Ventigra (BASF)	Afidopyropen	9D	F	4.8–7.0 fl ozs/100 gals	7
Talus 70DF (SePRO)	Buprofezin	16	F	14.0 oz/A	***
Mainspring GNL (Syngenta)	Cyantraniliprole	28	F	2.0–8.0 fl oz /100 gal (F) 0.1250.25 fl oz/DBH (D)	7–14 (F) **** (D)
AzaGuard (BioSafe)	Azadirachtin	UN	F	10-15 fl oz/A	7–10
SuffOil-X (OMRI)	Mineral Oil	UNM	F	1.0–2.0 gals/100 gals	As Needed
Ultra-Pure Oil (BASF)	Mineral Oil	UNM	F	0.5–1.0 gals/100 gals	10–14#
Safe-T-Side (Monterey)	Petroleum Oil	UNM	F	2.5–5.0 tablespoons/gal	As Needed
II. Efficacy values >80% & NOT legal to use on landscape ornamentals but possibly legal to use in commercial nurseries					
Xxpire (Corteva)	Spinetoram + Sulfoxaflor	4c, 5	F	3.5 oz/100 gals (F)	14
Kontos (OHP)	Spirotetramat	23	D, F	1.7–3.4 fl oz/100 gals (F)	14-28 (F)
Sarisa (OHP)	Cyclaniliprole	28	F	16.4–27.0 fl oz/100 gals (F)	7*****

Table 1 Footnotes

Labels are hyperlinked with the rate for additional information. Some recommended combinations with efficacy values above 80% are Distance + Tristar, Sarisa + Capsil, Ventigra + Ultra-Pure Oil, XXpire 40WG + GF-2860

[#]Please read the label.

*Do not apply more than 2.7 lbs (0.54 lbs ai)/A of a nursery, landscape, or forest/year.

** Do not apply more than 27 Ibs (0.54 Ibs ai)/A of nursery or landscape per year.

***Make no more than two applications/crop/growing season, and do not apply more than 28.0 oz (1.76 Ibs)/A/growing cycle.

**** Do not apply more than 32 fl oz/A/year (equivalent to 0.4 lb of active ingredient/acre/year for crops and plants grown outdoors.

*****Do not apply more than 82 fl. oz /A/year.

Abbreviations:

A=acre, D=Drench, DBH= Diameter at Breast Height, fl oz=fluid ounce, F=Foliar, gals=gallons, MoA= Mode of action, oz=ounce, UN=Compounds of unknown or uncertain MoA, UNM=Non-specific mechanical and physical disruptors

Insecticide Rotation:

To reduce resistance development, do not use insecticides with the same MoA one after the other. Please see IRAC Classes online for additional information. Different colors represent different MoA in Table 1

Disclaimer:

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the University of Florida or United States Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable. All pesticides must be applies in strict accordance with their labels. Pay close attention to pollinator safety guidelines, legal use sites, rates and methods of application.

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