Entomology

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Section Editor

Dormant Applications of Horticultural Oil and Pyriproxyfen for Control of First Generation Japanese Maple Scale

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Index Words Armored scale, Lopholeucaspis japonica**,** 'Sun Valley' and 'Karpick' red maple, Acer rubrum

Significance to Industry Japanese maple scale (JMS), *Lopholeucaspis japonica* (Cockerell) (Hemiptera: Diaspididae), has become a significant pest in both container and field nursery production systems across the eastern United States (1, 2, 3). Current management recommendations for JMS are a combination of dormant oil applications to suppress first generation JMS populations followed by trunk sprays in late May or early June to kill newly emerged crawlers (1, 2, 3). One product that has been effective in previous field trials against JMS crawlers was the insect growth regulator (IGR) pyriproxyfen (1). Insect growth regulators interfere with the molting of insects from one life stage to the next. Most often these products are used to prevent immature insects from molting into the adult stage but they can also interfere with egg development in some insect species. We initiated this trial at the urging of the Tennessee nursery industry in order to determine whether a dormant season application of the IGR pyriproxyfen with horticultural oil would reduce egg development and/or egg hatch. If effective, a single pyriproxyfen plus horticultural oil application would reduce the amount of time and labor required by growers to manage this scale pest compared to two separate applications during early and late spring used in current management recommendations.

Nature of Work Japanese maple scale feeds on a wide host range of woody plants, including many high value deciduous trees and shrubs. It has been reported on plants in at least 28 families and 50 genera (4, 5). Japanese maple scale is an armored scale with purple soft-body covered by a white, waxy covering that appears similar to an oyster shell. Beneath their waxy armor, mature females shelter under a brown pupillarial cover - the shed exoskeleton of the second instar (2, 3). Armored scales do not feed on vascular tissue (xylem and phloem) as do soft scales, but instead feed directly on plant cell contents causing structural collapse of the tissues on which it feeds (2, 3). Damage is often not as severe as soft scales; however, extremely high infestation levels can lead to branch dieback and plant death (2, 3). When a scale dies, the scale cover can remain attached to the bark of the tree for many months. The presence of scale covers can result in rejection of nursery product for aesthetic reasons, regardless of whether the insects are dead. The protection conferred by the waxy armor, along with their feeding ecology and overlapping generations, makes this pest difficult to manage. Current control recommendations include a dormant oil treatment in the fall or early spring and summer application of insect growth regulators during crawler activity periods (1). Applications of systemic dinotefuran (Safari) and imidacloprid (Discus N/G) also provided some control in various tree species when applied in the spring one month prior to scale crawler activity (1, 3).

In this study, we tested our current dormant management recommendation (2% horticultural oil) against applications of oil combined with the IGR, pyriproxifen. In addition to the efficacy and timing of the oil/growth regulator combination, we evaluated the scale pressure on two cultivars of red maple (*Acer rubrum* L. - 'Sun Valley' and 'Karpick') with exposure to JMS in order to determine whether one cultivar was more resistant than the other.

'Sun Valley' red maple was propagated in summer 2011 and transplanted in spring of 2012 into #3 containers and then repotted into #15 containers in April 2013 with amended bark substrate. 'Karpick' red maple was purchased in #3 containers in April 2014 and immediately repotted into #15 containers. All plants were placed in a pot-in-pot system ('Sun Valley', 2013 and 'Karpick', 2014) until use in this study in March 2016. Trees were fertilized annually (2014-2016) with a top-dress application of 250 grams of Osmocote Pro 19-5-9 and irrigated daily with micro-spray stake irrigation.

On March 14, 2016, two observers rated trees (n = 250) for JMS pressure with the following scale: 0 = no visible scale; 1 = localized patch, 10 cm or less; 2 = large patch, over 10 cm; 3 = multiple patches/trunk and branches (up to 25% tree); 4 = up to 50% of tree; 5 = over 50% of tree. Scores for the two observers were averaged. After rating, a random selection of 20 trees with scale was sampled. Live and dead scale counts were recorded. The sex of each live scale was noted as well as the number of female scales containing eggs.

Four treatments were made to blocks of trees in the pot-in-pot yard. Treatments were assigned to tree blocks randomly. On March 17, treatment 1, a dormant oil application [2% horticultural oil (Ultra-Pure Oil®, St. Louis, MO, 20 ml/L)] was applied to runoff as the industry standard recommended practice (1, 3). Treatments 2, 3, and 4 consisted of a combination of 2% horticultural oil and pyriproxyfen (Fulcrum®, OHP, Inc., Mainland, PA, 0.95 ml/L) applied on either March 17, April 1, or April 13, respectively.
Egg production by newly mated females generally begins at the end of April, thus the three dates chosen (mid-March, early April and mid-April) provided a window for evaluating the optimal timing of pyriproxyfen.

On April 26, 2016, following all growth regulator applications, a tissue sample was taken from a sub-sample of trees in each treatment (n = 10). Egg counts (i.e., fecundity) were made by flipping over 5 live female scales per tree and counting the number of eggs beneath the scale cover.

Scale crawlers were monitored on trees in each treatment (n = 8) for 4 weeks beginning May 3rd and ending on May 30th using crawler strips made from 1 inch yellow vinyl tape coated in a thin layer of petroleum jelly. Crawlers were counted weekly and reported as crawlers/linear cm/day.

Results and Discussion On March 14, the scale population on the trees was evaluated. Scale pressure was higher on 'Karpick' red maples (mean score = 1.7 ± 0.1) than 'Sun Valley' red maples (mean score = 0.9 ± 0.1) ($\chi^2_{(1)}$ = 14.9, *P* = 0.0001). There were more female than male adult scales (female = 57% and male = 43% of total live scale, respectively; Z = 3.54, *P* = 0.0004). On average, 77.4 ± 2.4% scales were alive in mid-May. Unexpectedly, eggs were observed under the scale covers of approximately 10.4 ± 2.7% of live female scale covers, which suggests that in addition to overwintered 2nd instars, JMS developing in late fall in Tennessee may also overwinter as adults with eggs. Adult and egg overwintering might contribute to the long crawler period observed in Tennessee, if overwintered eggs hatch first followed by newly laid eggs.

Egg counts were made on April 26. Differences between treatments were observed (Figure1), but the treatments failed to prevent egg development by females. Scales treated with pyriproxyfen on March 15 and April 15 had fewer eggs than the March 15 horticultural oil standard treatment. However, scales treated on April 1 with pyriproxyfen had the same number of eggs as the March 15 horticultural oil standard treatment and more than the other two pyriproxyfen plus horticultural oil combination treatments (Figure1).

No differences in crawler numbers were detected among treatments during the first week of monitoring (May 3-10, Figure 2). Over the following three weeks, however, the 2% horticultural oil treatment had consistently higher crawler counts than the three combination oil + pyriproxyfen treatments (week 2: F = 6.74, df = 3, 27, *P* = 0.0016; week 3: F = 7.71, df = 3, 27, *P* = 0.0007; week 4: F = 2.8, df = 3, 27, *P* > 0.0491; Figure 2).

These results suggest pyriproxyfen applications have only a small impact on egg numbers by late April, but the IGR does negatively impact crawler development within the eggs and subsequent egg hatch. At peak crawler activity (week 3), crawler numbers were reduced by 93.7 - 97.4% in the combined dormant oil and pyriproxyfen treatments compared to the dormant oil industry standard. The timing of the pyriproxyfen does not appear to matter, so long as it occurs before the end of April when the bulk of egg laying happens. Based on our results, a combined dormant oil + pyriproxyfen application made between mid-March and mid-April appears to result in the same level of control as a pyriproxyfen application made directly to the crawler stage (1).

While we did not address the question in this study, it might be possible to apply pyriproxyfen to scales even earlier - in late winter on a warm day or even in late fall to prevent female 2nd instars from molting into adults. The timing of the final adult molt in spring is currently unknown, but based on anecdotal evidence from the current and previous studies, it is likely that overwintering female JMS molt to their final adult stage sometime in late February. The adult scales have a much waxier, white coating and are easier to see than the 2nd instars leading to a phenomenon where trees appear 'clean' in the fall and then 'covered in scales' in early spring. We suspect it is the final molt of the adult females that make the scales more apparent for an infestation that was already present the previous fall.

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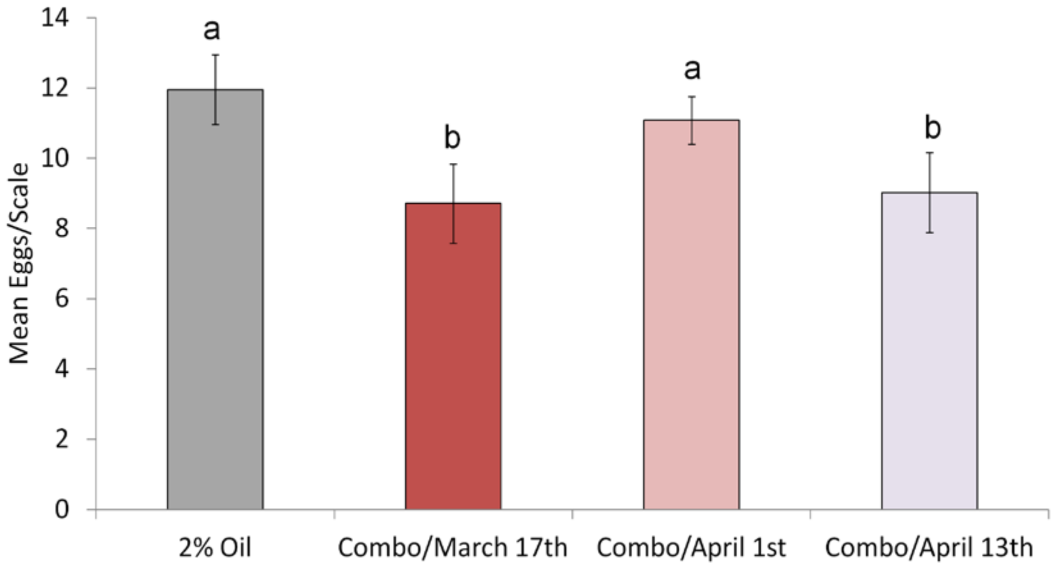

Figure 1. Egg deposition following industry standard dormant oil application (2%) and dormant oil + pyriproxyfen combination applications on the same day as dormant oil (March 17th) and on two later dates (Mean ± SEM).

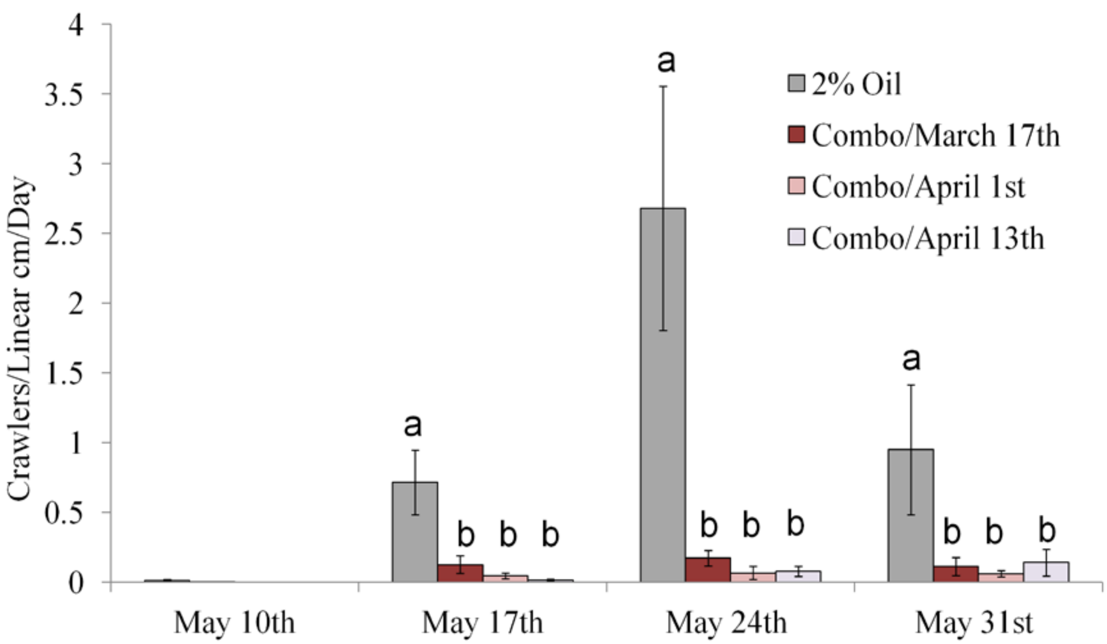

Figure 2. Crawler activity following industry standard dormant oil application (2%) and pyriproxyfen + dormant oil combination applications (Mean ± SEM).

Simplifying Scale Insect Management

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Index Words Armored scales, pit scales, soft scales, wax scales, felt scales, timing of insecticide applications, sticky traps for monitoring crawler emergence, insect growth regulator insecticides, systemic neonicotinoid insecticides

Significance to Industry The production of pest and disease free plants and their maintenance in the landscape takes a concerted effort to obtain the necessary knowledge and to put that knowledge into practice. The purpose of this document was to provide growers and landscape managers with some of the basic information that they will need to manage scales. The SNA Research Conference and its on-line Proceedings are a valuable source of information on many aspects of plant production and maintenance. Please share this valuable resource with others in the Green Industry.

Nature of Work Scale insects (scales) are one of the more problematic pest problems in the nursery and landscape. Scales have piercing-sucking mouthparts called a stylet (Figure 1) that can rupture plant cells and remove their contents. Damaged foliage results in a reduction in photosynthesis which can lead to a plant with lower carbohydrate storage in the roots causing a reduction of a ready source of energy when new growth is required. Without this energy source, plants cannot grow properly. Feeding damage from hundreds or even thousands of scales can stress plants by the destruction of plant cells and loss of plant fluids. This damage can manifest as chlorotic leaf tissue, sunken areas in plant tissue where cells collapse, branch die-back, and even plant death.

Scales, depending on species, environmental conditions and host quality, can lay varying numbers of eggs (1). Each adult female elongate hemlock scale can produce 1-24 eggs annually dependent on temperature and host (2) while tuliptree scale may produce over 3,000 young (3). If conditions are good for egg hatch and survival, populations can build rapidly. Some types of scales have only one generation per year while others have more than one generation per year. Knowledge of the biology of each scale species can aid tremendously in developing a strategy to manage the pest.

Low levels of scales are difficult to detect. This difficulty in detection could be due to their small size or cryptic nature. For this reason, low levels of scales can sometimes be found on plants for sale especially if close inspection is not done regularly. Once planted in the landscape, low infestations build on plants over time and are often not noticed until populations are approaching or exceeding damage levels.

There are many types of scales that commonly attack plants. Soft scales, wax scales, felt scales and the closely related mealybugs feed on fluid in the phloem vascular tissue of the plant. After digestion, copious amounts of fluid is excreted as sticky honeydew which primarily contains carbohydrates and amino acids. Tiny droplets of honeydew can coalesce forming larger drops which can drip on and cover lower leaves and other plant parts. Black sooty mold fungi grows on the honeydew and can obscure leaves and thus reduce photosynthesis. Whole plants and anything beneath them can turn black with sooty mold. The honeydew and sooty mold is also difficult to remove from automobiles, outdoor furniture etc. and is often the major complaint with these type scales in the landscape. Some of the common soft scales in the South include cottony camellia scale, tuliptree scale, magnolia scale, European fruit lecanium scale, oak lecanium scale, pine tortoise scale, kermes scale, and cottony maple scale. Common wax scales include Indian wax scale and Florida wax scale. Common felt scales include azalea bark scale and the new pest of crape myrtle, the crape myrtle bark scale (Figure 1).

Armored scales and pit scales do not produce honeydew and thus sooty mold is not associated with their infestations on plants (4). Armored scales are often more difficult to control than soft scales and the other previously mentioned types of scales. The armor or test is a protective cover composed of excreted wax (5), a non-waxy component and shed skins or exuviae incorporated during molting (6). For diagnostic purposes, the armor can be easily scraped off an infested branch or leaf with the tip of a knife to reveal the insect beneath (7). A few of the common armored scales in the South are oystershell scale, obscure scale, gloomy scale, euonymus scale, winged euonymus scale, juniper scale, pine needle scale, white peach scale, San Jose scale, and Japanese maple scale.

Most insecticide spray applications are applied to coincide with the emergence of the crawler or first instar stage from the eggs. The crawlers lack armor initially and are the most susceptible to direct contact by insecticide sprays. These tiny crawlers are also more susceptible to insecticide toxicity due to their less developed mixed oxidase systems that allow insects to metabolize chemicals including some insecticides. Crawlers move about for a short time before settling on the plant to start feeding. While meandering, they increase the probability of contacting the insecticide residue deposited on the plant and subsequently being killed. Crawlers start to form their armor prior to molting to the second instar stage. The armor thickens with successive molts and can shield the body of the insect from insecticide sprays. Thus, systemic or translaminar insecticides absorbed by the plant are often more effective at directly reaching the insect as it feeds. Armored scales use their stylet to penetrate, rupture and feed on the contents of various kinds of cells and thus do not ingest large quantities of fluid (6). Since soil or trunk applied systemic neonicotinoid insecticides move upward primarily in the xylem vascular tissue, these insecticides need to diffuse from the xylem to surrounding cells and intracellular spaces where armored scales are feeding. Dinotefuran (Safari 2G, Safari 20 SG, Zylam Liquid, Transtect 70 WSP) is one of the most water soluble of the neonicotinid insecticides. This high water solubility is thought to allow dinotefuran to move more easily from the xylem to the surrounding storage cells in which the armored scale feed.

The timing of insecticide sprays to coincide with crawler emergence is made easier by deploying small sticky traps. Sticky traps for crawlers can be made by wrapping scale infested twigs with a couple wraps of double-sided cellophane tape. Single-sided tape such as electrical tape can be given a sticky outer surface by wiping a very thin layer of petroleum jelly on the tape after it has been wrapped on the twig. If the color of the predicted crawler is red (crape myrtle bark scale, pine needle scale), purple (Japanese maple scale) or other dark color, use white or some other contrasting light color tape. If the crawlers are light yellow, black tape might provide more contrast.

Mark your trap locations by tying a couple feet of colorful flagging tape to the twig. Check the sticky traps for crawler emergence a couple times each week if possible. Some types of scales will have most of the crawlers emerge within a day of each other. Others, such as Japanese maple scale, tend to emerge over several weeks. Put a new sticky trap on the twig five days after the initial crawler emergence. Check the trap in a couple days and make a second insecticide application if a new batch of crawlers are caught on the new sticky trap. Repeat with a new trap until new crawlers are no longer caught. Consult with your university Extension entomologist to determine if another generation is predicted to emerge in the coming weeks or months and place a new trap 2-4 weeks prior to the expected emergence. Continue to monitor regularly.

Spray applications targeting the crawler stage should utilize insecticides that are less toxic to beneficial insects whenever possible. One group of insecticides that are particularly well suited for a spray application are insect growth regulators (IGR). An IGR acts on the immature stage of the insect so that it becomes nonfunctional or dies before reaching adulthood. Two IGR insecticides that are particularly effective against immature scales are pyriproxifen (Distance IGR, Fulcrum) and buprofezin (Talus 70DF).

The systemic neonicotinoid insecticides have been a useful tool in managing established scale infestations. Most of these insecticides can be applied as a soil drench for root uptake or as a spray application to the above ground plant parts. The use of soil drench application has made timing less of a critical issue typically applied prior to when crawler emergence is anticipated. If a large tree is treated, the soil drench might need to be applied a month or two prior to crawler emergence to make sure that the insecticide has time to move up into the tree in sufficient amounts to control the scales.

Beneficial insects such as predaceous lady beetles and parasitoid wasps often achieve some level of scale control when they are not compromised by the non-judicious use of a broad-spectrum insecticide. Beneficial insects are often more sensitive to insecticide applications than the pest. When most of the beneficial insects are inadvertently killed, the surviving pest insects often reproduce without the regulatory effect of the beneficial insects. The resulting pest resurgence can result in pest populations that are even higher than when the insecticide was first applied. Thus, the non-judicious use of insecticide can sometimes make the pest problem worse than if no control actions were taken.

There has also been some concern about minute amounts of the systemic insecticide in treated plants being contained in the nectar and pollen. Potentially, this could cause acute or more likely subacute effects in pollinators that visit the flowers of treated plants. If this is a concern, consider using the neonicotinoid or other insecticide as a spray application after the bloom period of the plant. One negative of using a spray instead of a drench is the high potential for insecticide drift which can impact pollinators and other non-target insects with a lethal concentration of insecticide. High drift potential often precludes the use of insecticide sprays of medium to large trees in the landscape. If spraying is not a good option, consider using a faster moving neonicotinoid such as dinotefuran as a soil drench or a concentrated trunk spray after bloom. Either of these methods will quickly move the insecticide into the plant to be translocated upward in a short period of time.

One underutilized control option is the use of horticultural oil applications during the dormant period of the plant. Scale insects overwinter on the plant primarily as immature nymphs or adults (5). Targeting the overwintering stage of scales with horticultural oil will usually result in reduced spring populations. Also, many beneficial insects will not be adversely impacted by the horticultural oil since they may not be active and/or on the plant at that time of year. The horticultural oil solution is only toxic to the insects that it contacts when first sprayed (what you hit is what you get). The dried residue is not significantly toxic to scale or beneficial insects.

The dormant period gets shorter as you move south which compresses the window of opportunity to apply a horticultural oil spray. Also, since most insects become active when temperatures reach 50°F (10°C) or above, predators such as lady beetles may start to feed on scales and exert a level of control in the late winter or spring. Horticultural oil should not be used if significant populations of beneficial insects are found on the plant and are actively feeding on scales during the dormant or delayed dormant period of the plant.

Approach the management of scales from an integrated pest management (IPM) perspective. It is usually going to take more than one type of control to manage an infestation. Follow oil sprays made during the dormant period with crawler targeted sprays in the spring or summer (whenever crawlers become active). If more than one generation occurs, target the crawlers at each generation until a high level of control has been achieved. A soil applied systemic insecticide can be used as an alternative to crawler directed sprays. For hard to control scale infestations, a spring application of a soil applied systemic insecticide can be followed by a crawler directed IGR insecticide application for the emergence of each generation of crawlers. Consider using horticultural oil sprays each dormant period as a maintenance spray to keep scale populations low and easier to manage.

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Figure 1. Lateral view of crape myrtle bark scale, Acanthococcus (=*Eriococcus) lagerstroemiae* Kuwana (Hemiptera: Eriococcidae), with stylet visible.

Efficacy of Bifenthrin for Control of Imported Fire Ant in Whole Pine Tree Substrates

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Index Words *Solenopsis*, soilless substrate, container production, pine bark

Significance to the Industry Imported fire ants (IFA) are a significant pest in agricultural crops and are a health hazard for humans and other animals. Insecticide treatments have been developed for containerized nursery crops shipped outside of the quarantine area, yet container substrates can vary and may reduce effectiveness of treatments. In this study, whole pine tree (WPT) substrate incorporated with granular bifenthrin was evaluated for efficacy against hybrid and red IFA. We demonstrated WPT substrates treated with labeled rates (10 and 15 ppm) of bifenthrin provided excellent control of hybrid and red IFA after a six month period. The study will be continued for a total of 18 months to determine long term effectiveness.

Nature of Work Nursery crop producers in the IFA quarantine area are required to treat nursery stock being shipped out of the quarantine area. Approved IFA treatments for containerized nursery stock include dip, drench, and granular incorporation application methods depending on the selected product. Granular incorporation applications have a certification period up to 24 months depending on the dosage used, yet application rates are based on substrate bulk density (5). Granular incorporation is commonly used due to ease of application and extended certification period, but granular bifenthrin products are currently the only materials available for treating IFA via substrate incorporation.

The efficacy of substrate-incorporated granular products for IFA treatments were determined using pine bark (PB) substrates, but many nursery crop producers amend container substrates with other components including sand, compost, and wood-based materials. Wood-based materials sourced from pine tree (*Pinus taeda*) harvesting operations have become more readily available and increasingly used in substrates for container production. These materials vary greatly in particle size which can affect water and nutrient retention leading to reduced crop growth and quality, but these issues can be minimized by modifying substrate physical properties and adjusting fertilizer and irrigation practices (1, 2, 3). The effectiveness of substrate-applied insecticides has not been reported in wood-based substrates and nursery crop producers need to be assured the products will be effective regardless of the substrate used. The objective of this study was to evaluate the efficacy of substrate-incorporated bifenthrin for hybrid and red IFA in WPT substrates.

This study included non-amended PB and WPT substrates. Pine bark substrate was acquired locally (Auburn, AL) while WPT substrate was processed using an industrial hammer mill (Meteor Mill #40; Williams Patent Crusher and Pulverizer Co. Inc., St. Louis, MO) fitted with a 0.95-cm (0.38 in) screen. The two substrates were used alone (PB0 and WPT0) or uniformly incorporated with one of two rates [10 ppm (PB10; WPT10) or 15 ppm (PB15; WPT15) of granular bifenthrin (0.2% bifenthrin ; Talstar Nursery Granular, FMC Corp., Philadelphia, PA) using a skid-steer drum mixer (Star Industries, Fort Worth, TX). Substrate bulk density was determined prior to the study for PB [205 $kg{\cdot}m^{-3}$($345\ lb{\cdot}yd^{-3}$)] and WPT [171 $kg{\cdot}m^{-3}$ ($288\ lb{\cdot}yd^{-3}$)] to calculate bifenthrin application rates. On August 26, 2015, trade gallon (2.8 L) containers were filled with substrate, placed on an outdoor container production pad, and overhead irrigated every 2 days. Irrigation application rate was based on a 20-30% leaching fraction for each substrate, measured weekly for adjustments. There were a total of six treatments, each with six replications (six individual containers) per sampling date and arranged in a randomized block design. Substrate samples (20 ml per container) for IFA bioassays were collected at 0, 1, 3, and 6 months after incorporation (MAI) and a different set of containers were used at each sampling date.

Imported fire ant bioassays were conducted using protocols developed by the APHIS Center for Plant Health Science and Technology Biloxi Station (4). Hybrid IFA (*Solenopsis richteri* Forel) workers (20 per replication) were assayed at each sampling date, while red IFA (*Solenopsis invicta* Buren) alates (10 per replication) were assayed at 6 MAI. Hybrid IFA were collected from fire ant colonies in middle Tennessee, while red IFA were collected from colonies in Gainesville, FL. Imported fire ant survival was recorded at 7 and 14 days after sampling (DAS). Hybrid IFA were confirmed using Gas Chromatography - Mass Spectrometer (GC-MS) based on the profiles of worker venom alkaloids and cuticular hydrocarbons that define status as red IFA, black IFA or their hybrid (data not shown). Hybrid IFA survival data were analyzed with linear models using the GLIMMIX procedure of SAS (Version 9.3; SAS Institute, Inc., Cary, NC). Differences between treatment means were determined using the Shaffer-Simulated method ($P < 0.05$).

Results and Discussion Hybrid IFA survival was greater in WPT0 and PB0 compared with all the treated substrates for each sampling date (Table 1). At 7 DAS across all sampling dates, hybrid IFA survival ranged 98 to 99% in WPT0 and 76 to 83% in PB0. The lower survival in PB0 was not ideal, but may be attributed to differences in moisture content between the substrates during the assay period. The 10 and 15 ppm rates of bifenthrin were highly lethal for hybrid IFA at 7 DAS for both substrates at each sampling date. Red IFA survival was 95% for PB0 and WPT0 at 7 DAS (6 MAI) while treated substrates were highly lethal for red IFA at 14 DAS (<2%) (Table 2).

A clear delineation of IFA survival was made between treated and non-treated substrates, providing evidence that IFA (hybrid and red) could be effectively controlled in WPT substrates for six months using currently approved incorporation application rates of bifenthrin. The current study is still in progress and samples will be collected at 9, 12, 15, and 18 MAI to determine overall effectiveness and longevity of the treatments. Future efficacy trials of substrate-applied insecticides for control of other quarantine pests (such as Japanese Beetle) in WPT substrates would provide valuable information for nursery crop producers and regulatory officials.

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Table 1. Mean survival (%) of hybrid imported fire ant (*Solenopsis invicta* Buren) at 7 and 14 days after exposure to pine bark and whole pine tree substrates incorporated with bifenthrin (Talstar Nursery G; 0.2% bifenthrin) at 0, 10, or 15 ppm.

		0 MAI[z]		1 MAI		3 MAI		6 MAI	
Substrate	**Rate**	**7d**	14d	7d	14d	7d	14d	7d	14d
Pine bark	0	83 b[y]	59 b	82 b	61 b	79 b	71 b	76 b	68 b
	10	0 c	0 c	2.5 c	1 c	0 c	0 c	0 c	0 c
	15	0 c	0 c	0 c	0 c	0 c	0 c	0 c	0 c
Whole pine tree	0	98 a	87 a	98 a	88 a	99 a	97 a	99 a	99 a
	10	0 c	0 c	2 c	0 c	0 c	0 c	0 c	0 c
	15	0 c	0 c	0 c	0 c	0 c	0 c	0 c	0 c

[z] Months after incorporation (MAI).
[y] Means followed by different letters within columns indicate significant difference at $P < 0.05$ using the Shaffer-Simulated method.

Table 2. Mean survival (%) of red imported fire ant (*Solenopsis richteri* Forel) at 7 and 14 days after exposure to pine bark and whole pine tree substrates incorporated with bifenthrin (Talstar Nursery G; 0.2% bifenthrin) at 0, 10, or 15 ppm.

		6 MAI[z]	
Substrate	Rate	7d	14d
Pine bark	0	95	93.3
	10	6.67	0
	15	3.33	1.67
Whole pine tree	0	95	90
	10	1.67	0
	15	0	0

[z] Months after incorporation (MAI).

Evaluation of Bifenthrin in Controlling Tawny Crazy Ants (*Nylanderia fulva*) in Container Substrates

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Significance to the Industry *Nylandaria fulva* (Tawny Crazy Ant) is becoming a significant pest in the Southeast. *N. fulva* is native to South America and has been reported in every Gulf Coast state and Georgia. Similar to the Imported Fire Ant (*Solenopsis invicta*), *N. fulva* has the potential to be spread through movement of containerized plant material. In Alabama, *N. fulva* is limited to an isolated areas, Mobile and Baldwin Counties, however growers have expressed concerns about the potential problems that could occur if this ant invades their nurseries. The goal of this study was to evaluate if incorporation of the contact insecticide bifenthrin into the media would prevent *N. fulva* from infesting container plant material. This practice is already widely used to comply with the Federal Imported Fire Ant Quarantine (FIFAQ).

Nature of Work Currently growers wishing to ship outside of the quarantine zone are required to treat for fire ants through one of the following four options (2):

1) Immersion or dip treatment (Field Grown)
2) Drench treatment (container grown)
3) Topical treatment (container grown)
4) Incorporation of granular insecticides into potting media (container grown)

The majority of container nurseries utilize the incorporation of bifenthrin to comply with federal imported fire ant quarantine regulations. Application rates are dependent on certification period and media bulk density. A continuous rate (> 2 years) of 25 ppm bifenthrin may be used if all Imported Fire Ant Free Nursery Program Regulations are met (2). Bifenthrin has been shown to repel *S. invicta* at 25 ppm (3). Through personal experience *N. fulva* was observed to be readily killed but not repelled when bifenthrin was applied to mineral soil as a barrier treatment in the landscape.

To evaluate incorporated bifenthrin effectiveness in the control of *N. fulva* in containerized plants, treated media was potted and placed in an infested area. The following treatments were potted on August 22, 2016: 0, 12.5 and 25 ppm bifenthrin (Talstar® Nursery Granular Insecticide, FMC Corporation, Philadelphia, PA). In addition to these treatments a local nursery requested that their common rate of bifenthrin be evaluated with media from their nursery that had been treated with 2.1 kg/m^3 (3.6 lbs./yd^3), estimated to be 15 ppm bifenthrin. The 0, 12.5, 15, and 25 ppm were placed under overhead irrigation for 240 days (August 22, 2015) to simulate leaching that would occur under normal nursery production. To evaluate freshly applied bifenthrin, two additional treatments with rates of 12.5 and 25 ppm were placed under irrigation for 14 days prior to initiating the study.

Treatments were potted in trade gallon nursery pots. The study was arranged in a randomized complete block design with 6 treatments and 26 blocks with each block placed in a 6 cell pot tray. The bottom of each cell was cut out to allow pot contact with the ground. On April 19, 2016, treatments were moved to the area infested with *N. fulva*. Blocks were randomly placed in wooded areas at the infested site. In order to provide harborage for ants, styrofoam plates were placed on the top of each container and held in place using a metal nail. The number of pots infested with *N. fulva* were counted at 30, 50 and 75 days after placing the containers in the infested area. Pots were deemed infested if ants were observed freely moving in and out of the pot drainage holes.

Results and Discussion *N. fulva*, when established, can have population densities so large that most accessible surface areas have ants present at some level. Due to overwhelming population densities, it was difficult to determine if ants were infesting pots or were present by chance. Ants and brood were observed between the pot and the pot tray across all treatments but were more prevalent in the treatment with 0 ppm bifenthrin and the media from the local nursery (Table 1). *N. fulva* were not observed nesting in soil under the foam plates throughout the study. Results from this study suggest that current bifenthrin rates used to comply with the Federal Imported Fire Ant Quarantine are not effective in repelling *N. fulva*. Future laboratory trials may provide better precision in determining if higher rates are more effective. More work is needed to evaluate other insecticides that could be incorporated into nursery media to repel or kill *N. fulva*. Currently incorporating a granular insecticide with a long residual is the least expensive treatment for controlling ant pests in container nurseries. Tefluthrin, chlorpyrifos, and fipronil are authorized as container treatments, but of those, only chlorypyrifos has commercial labels permitting its use in container production (1).

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Table 1. Percent of pots infested with *Nylanderia fulva* per treatment by sampling date.

Bifenthrin (ppm)[Z]	Leached/Fresh[Y]	30 DAP[X]	50 DAP	75 DAP
12.5	Fresh	38%	24%	46%
25	Fresh	38%	32%	50%
15[W]	Leached	69%	52%	73%
12.5	Leached	19%	24%	50%
25	Leached	42%	24%	31%
0	Leached	77%	56%	65%

[Z]Bifenthrin concentration calculated based on bulk density of media.

[Y]Leached treatments were placed under irrigation for 240 days and fresh 14 days prior to placement.

[X]DAP represents days after placement of pots in infested area.

[W]15 ppm was based on estimated bulk density of local nursery's potting media using their application rate of 2.1 kg/m^3.