Management of Staining and Galling Associated with Oxhorn Bucida Trees in Florida

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Management of staining and galling associated with oxhorn bucida trees in Florida

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Abstract

The oxhorn bucida tree, *Bucida buceras* L. (Combretaceae), occurs widely in the southern Florida urban forest. It is commonly attacked by 2 arthropod species, an eriophyid mite, *Eriophyes buceras* Cromroy (Acari: Eriophyidae), and a caterpillar, *Garella* (*Characoma*) *nilotica* (Rogenhofer) (Lepidoptera: Nolidae). Caterpillar frass and mite-induced galls cause severe staining of sidewalks, streets, and vehicles underneath the tree canopy. The staining is so aesthetically annoying that dissatisfied homeowners remove the trees. Studies were conducted over a 4 yr period at 2 locations to evaluate systemic insecticide treatments against these pests. In Naples, during both 2013 and 2014, trees receiving dinotefuran soil–root drench or acephate trunk injections showed slightly reduced staining possibly due to caterpillar suppression. During 2015 and 2016 in Coral Gables, abamectin trunk injections resulted in excellent reduction in gall formation and staining. Abamectin trunk injections were most reliable in reducing property owner complaints and preserving the benefits of mature oxhorn bucida trees in the urban forest. This treatment represents an environmentally rational approach with none of the drawbacks associated with foliar applications or soil drenching.

Key Words: *Garella nilotica*; *Eriophyes*; abamectin; trunk injection; systemic insecticides

Resumen

El árbol del olivo negro, *Bucida buceras* L. (Combretaceae), se le encuentra ampliamente en el bosque urbano del sur de la Florida. Comunmente es atacado por dos artropodos, un ácaro de la familia Eriophyidae, *Eriophyes buceras* Cromroy (Acari: Eriophyidae) y el gusano, *Garella* (*Characoma*) *nilotica* (Rogenhofer) (Lepidoptera: Nolidae). El excremento del gusano y las gallas inducidas por los ácaros, causan severas manchas en las aceras, calles y vehiculos estacionados debajo de la copa de estos árboles. Estas manchas son tan antiesticas y molestas que los dueños de hogares estan disatisfechos y optan por quitar estos árboles. Se realizaron estudios por más de cuatro (4) años en dos localidades para evaluar los tratamientos de insecticidas sistematicos para combatir estos artropodos. En Naples, tanto en el 2013 como en 2014, los tres arboles que recibieron dinotefuran remojado de las raices en el suelo o inyecciones de acefato en el tronco del árbol, demostraron una ligera reducción en las manchas, posiblemente debido a la suppression de los gusanos. Durante del 2015 y 2016 en Coral Gables, las inyecciones de abamectin en los troncos resultaron en una excelente reducción en la formacion de agallas y manchas. Las inyecciones de abamection en los troncos fueron las mas confiables en reducir las quejas de los duenos de propiedades y preservar los beneficios de tenerárboles maduros del olivo negro en el bosque urbano. Este tratamiento representa un enfoque ambientalmente racional sin ninguno de los inconvenientes relacionados con las aplicaciones foliares o directamente en el suelo.

Palabras Clave: *Characoma nilotica*; *Eriophyes*; abamectin; injecciones al tronco; insecticidas sistematicos

Oxhorn bucida, *Bucida buceras* L. (Combretaceae), is a prevalent shade tree found in residential landscapes and along municipal streets in southern Florida, where it is also known as black olive tree, bullet wood tree, and others. In Coral Gables, Florida, more than 9,600 oxhorn bucida trees exist, which comprise up to 25% of the urban forest. Two arthropod pests primarily attack this species. The first is the bucida caterpillar, *Garella* (*Characoma*) *nilotica* (Rogenhofer) (Lepidoptera: Nolidae), which sporadically defoliates this species (including the popular small-leaf cultivar 'Shady Lady') in southwest Florida. With at least 2 generations per season, caterpillar feeding produces frass that causes rust-colored staining of sidewalks, streets, and objects under the canopy (Fig. 1). In addition to the feeding damage, the caterpillars create a nuisance by swinging down on silken threads in large numbers aggravating people under the canopy. This behavior has granted the caterpillar the moniker "bungee" caterpillar (Caldwell 2008, 2011).

The other pest that attacks this tree is an eriophyid mite, *Eriophyes buceras* Cromroy (Acari: Eriophyidae) (Denmark 1966). Feeding by the mites results in slim enlargements of the fruiting structure (flower ovary) which are 10- to 20-cm-long galls that resemble green beans (Fig. 2). The shape of galls may be linear or spiral; hence, the tree received the name oxhorn bucida (Nelson 1994). When the galls become moist, they release an oily, rust-colored staining substance. Bucida caterpillars, not only chew leaves but also feed internally by tunneling inside the mite galls. Staining produced by these pests may be so severe on driveways and cars that homeowners opt to have the tree removed. Field studies were conducted over 4 yr to evaluate the effectiveness of selected systemic insecticides in reducing feeding, and consequently in minimizing staining, associated with this caterpillar and mite.

Materials and Methods

2013 SOUTHWEST FLORIDA (NAPLES)

Oxhorn bucida cultivar 'Shady Lady' trees growing along streets in a residential community in Naples, Florida (26.25638°N, 81.77295°W),

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Fig. 1. Staining on street caused by the caterpillars and mites that feed on oxhorn bucida (black olive) trees.

Fig. 2. Bean-like galls caused by the eriophyid mites that feed on oxhorn bucida (black olive) flowers. Normal flower clusters in background. Note the piles of dark caterpillar frass ejected from holes in galls.

were used for this study. Trees averaged 28 cm trunk diameter at breast height (dbh) and were about 7.5 m tall. The treatments were applied either as soil drenches around the base of the trunk or as trunk injections. Soil drench solutions were mixed with 7.6 L water and applied with a watering can 25 cm out from the base of the tree and completely surrounding it. Trunk-injected treatments were administered using the Q-Connect™ harness system or the Q-Gun™ by Rainbow Treecare Scientific Advancements (Minnetonka, Minnesota). The former is used when making simultaneous injections into multiple holes and the latter is used for single injections; both are applied into predrilled holes. Injection pressure was 35 psi (241 kPa) and individual holes were drilled with 0.8-cm-high helix drill bits. Hole depth was approximately 5 cm; spacing was 15 cm apart around the trunk circumference and 46 cm above the soil line. Plugs were not used to seal the drill holes, which callused within a few months.

There were 8 treatments as follows: CVG-700 (proprietary) injected at 10 mL per 2.54 cm trunk dbh, applied 5 Nov 2012; CVG-700 + dimethylsulfoxide (DMSO) injected at 10 mL + 5% v/v per 2.54 cm trunk dbh, applied 5 Nov 2012; CVG-700 injected at 10 mL per 2.54 cm trunk dbh, applied 11 Mar 2013; CVG-700 + DMSO injected at 10 mL + 5% v/v per 2.54 cm trunk dbh, applied 11 Mar 2013; acephate (97%) drenched at 11.3 g + 250 mL water per 2.54 cm trunk dbh, applied 11 Mar 2013; dinotefuran (70 WSP = Water Soluble Powder) drenched at 17 g per 13 cm trunk dbh, applied 11 Mar 2013; acephate (97%) injected at 15 g + 100 mL water per 25 cm trunk dbh, applied 11 Mar 2013; and untreated controls for each date of treatment.

Gall density and staining were rated by 2 observers on 13 Jun, 8 Jul, and 12 Aug 2013. An additional evaluation for staining was conducted on 16 May 2013. Gall density was estimated by inspecting the canopy with binoculars from ground level and assigning values on a scale of 0 to 10 with 0 = no galls; 1 = 10% of canopy with galls; 2 = 20% of canopy with galls; to 10 = profuse or 100% of canopy with galls. Staining of sidewalks, streets, and other hardscape directly under the canopy was rated on a scale of 0 to 5 with 0 = none; 1 = very light; 2 = light; 3 = moderate; 4 = heavy; and 5 = severe and objectionable.

In the absence of precipitation, trees were irrigated with approximately 2.5 cm of water per week. A total of 78 cm of rainfall occurred during the study.

The experimental design was completely randomized with 4 replications (1 tree = 1 replicate) per treatment. Statistical analysis was conducted using MINITAB, version 17 (Minitab, Inc., College Station, Pennsylvania). Because the data were rankings and not continuous with a normal distribution, analysis was conducted with the nonparametric Kruskal–Wallis test (Conover 1980). Due to the presence of ranks of similar values, the H statistic (*F*) reported is the one adjusted for ties.

2014 SOUTHWEST FLORIDA (NAPLES)

Oxhorn bucida cultivar 'Shady Lady' trees previously untreated and growing in the same neighborhood as the trees of the 2013 study were used. Drenches and trunk injections were conducted per the procedures followed in 2013. The following 5 treatments were applied on 6 Feb 2014: CVG-700 injected at 10 mL per 2.54 cm trunk dbh; acephate (97%) drenched at 11.3 g + 250 mL water per 2.54 cm trunk dbh; dinotefuran (70 WSP) drenched at 17 g per 13 cm trunk dbh; acephate (97%) injected at 15 g + 100 mL water per 25 cm trunk dbh; and untreated control.

Evaluations of gall density and staining were conducted similar to procedures followed in 2013. Two observers made the evaluations on 2 and 30 May 2014. Gall density was sparse and erratic; thus, these data were excluded from analysis. Only staining levels are reported in the results section. In the absence of precipitation, trees were irrigated with approximately 2.5 cm per week. A total of 15 cm of rainfall occurred during the study.

The experimental design was completely randomized with 4 replications per treatment. Statistical analysis was conducted per procedures used in 2013.

2015 SOUTHEAST FLORIDA (CORAL GABLES)

Mature oxhorn bucida street trees growing in Coral Gables, Florida (25.721490°N, 80.268384°W), were used for this study. It is estimated that the City of Coral Gables currently maintains 9,600 mature bucida trees. City officials are inundated annually with calls from homeowners complaining about the staining, and some requesting removal of the tree. Trees averaged 53 cm dbh and were approximately 10 to 12 m tall. Trunk injections and soil drenches were conducted per procedures followed in the previous 2 studies.

The following 8 treatments were applied on 3 Mar 2015: dinotefuran [T: trade name Transtect®] (70 WSP) high rate, drenched at 17 g per 13 cm trunk dbh; dinotefuran [T] (70 WSP) low rate, drenched at 17 g per 26 cm trunk dbh; dinotefuran [Z: trade name Zylam Liquid®] (10% liquid) high rate, drenched at 114 mL per 10 cm trunk dbh; dinotefuran [Z] (10% liquid) low rate, drenched at 114 mL per 26 cm trunk dbh; abamectin (2%) injected at 5 mL per 5 cm trunk dbh; dinotefuran [T]

(70 WSP) high rate, drench + abamectin injected at same rates as in 2014; dinotefuran [Z] (10% liquid) high rate, drench + abamectin (2%) injected at same rates as in 2014; and untreated control. Evaluations of staining and gall formation were done per procedures established in 2013, and were conducted on 6 May 2015, 15 Jun 2015, 6 Aug 2015, and 9 Sep 2015. These street trees were unirrigated. A total of 73 cm of rainfall occurred during the study.

The experimental design was completely randomized with 8 replications per treatment. Statistical analysis was conducted per procedures used in 2013.

2016 SOUTHEAST FLORIDA (CORAL GABLES)

Trees from the same population used in 2015 were used in this study with slight modifications in the treatments applied. Trunk injections and soil drenches were conducted per procedures followed in the previous 3 studies. The following 6 treatments were applied on 16 Mar 2016: emamectin benzoate (4%) injected at 8 mL per 2.54 cm trunk dbh; imidacloprid (21.4%) drenched at 6 mL per 2.54 cm trunk dbh; acephate (97%) injected at 15 g + 100 mL water per 25 cm trunk dbh; abamectin (2%) injected at 5 mL per 5 cm trunk dbh (this treatment was applied to trees also injected with abamectin in 2015); abamectin (2%) injected trees from 2015 were evaluated (though not re-treated) in 2016; and untreated control. Evaluations of staining and gall formation were done per procedures established in 2013, and conducted on 17 Jun, 8 and 29 Aug, and 31 Oct 2016. An additional evaluation for staining was conducted on 25 Apr 2016. These street trees were unirrigated. A total of 133 cm of rainfall occurred during the study.

The experimental design was completely randomized with 8 replications per treatment. Statistical analysis was conducted per procedures used in 2013.

Results

2013 SOUTHWEST FLORIDA (NAPLES)

Gall density and staining ratings are shown in Table 1. Overall, galling was low and did not exceed a rating of 5 except on 2 occasions. During the first evaluation on 16 May, staining was moderate to severe in all treatments, but the dinotefuran-treated trees tended to have less staining. Staining continued to be moderate for the next 4 wk, but the ratings dropped substantially in Jul. Staining remained at low levels through Aug; however, no galls and no staining were seen in early Sep, which led to termination of the study.

2014 SOUTHWEST FLORIDA (NAPLES)

Table 2 shows the stain ratings for the month of May. The dinotefuran-drenched and the acephate-injected trees showed less staining than the other treatments early in the month. This trend seemed to persist later in the month only with the acephate-injected trees. Gall abundance was very low and those data were not included.

2015 SOUTHEAST FLORIDA (CORAL GABLES)

Gall density ratings are shown in Table 3. Abamectin-treated trees had the least amount of gall formation, compared with other treatments. Similarly, those trees treated with abamectin showed the least amount of associated staining (Table 3). The latter was most pronounced on 6 Aug. Treatments containing dinotefuran Z also resulted in slightly fewer galls; however, this was not the case with the staining ratings.

2016 SOUTHEAST FLORIDA (CORAL GABLES)

Gall formation was low to none on all 5 rating dates (Table 4) in trees treated with abamectin (whether in 2015 alone, or in each of 2015 and 2016). Similarly, abamectin-treated trees caused noticeably less staining than other treatments on all dates (Table 4). Trees receiving the imidacloprid treatment also showed fewer galls, but not less staining.

Discussion

Gall abundance and degree of staining fluctuate from year to year and from tree to tree. Some trees bloom regularly at the same time each year, while others seem to bloom at different times. As a consequence of those variables, staining incidence will also vary from year to year. Other factors that may have affected stain ratings are homeowners power-washing the sidewalks and the occurrence of heavy precipitation. The latter was most

Table 1. Median gall ranks (0–10)[a] and median staining ranks (0–5)[a] of oxhorn bucida trees, *Bucida buceras* 'Shady Lady,' in Naples, Florida, 2013.

	16 May	13 Jun		8 Jul		12 Aug	
Treatment	Stain	Gall	Stain	Gall	Stain	Gall	Stain
Control	5	2	3	3	1	2	1.5
CVG-700[b]	4	2	2.5	3	1	2	1
CVG-700 + DMSO[b]	3	3	3	2	1.5	2	1.5
CVG-700[c]	4.5	6.5	4	3	1	2	1
CVG + DMSO[c]	4.5	2	3	2	1	2	2
Acephate drench[c]	3	3	3.5	2	1	2	1.5
Dinotefuran[c]	1	4	2	5.5	1	4	2
Acephate trunk injection[c]	5	5	3.5	4	1	4.5	2
Statistics							
H[d]	13.50	10.81	8.35	7.4	2.58	11.84	6.18
P[e]	0.061	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

[a]Gall ranks were on a scale of 0 = no galls to 10 = 100% of canopy with galls; staining ranks were on a scale of 0 = none to 5 = severe and objectionable.
[b]Applied 5 Nov 2012.
[c]Applied 11 Mar 2013.
[d]Kruskal–Wallis statistic adjusted for ties.
[e]N.S. = not significant.

Table 2. Median staining ranks (0–5)[a] of oxhorn bucida trees, *Bucida buceras* 'Shady Lady,' in Naples, Florida, 2014.

Treatment	2 May	30 May
Control	2.5	3
CVG-700[b]	2	2.5
Acephate drench	2.5	3
Dinotefuran	0.5	2
Acephate trunk injection	1	1
Statistics		
H[c]	11.56	8.12
P	0.021	0.087

[a]Staining ranks were on a scale of 0 = none to 5 = severe and objectionable.
[b]Proprietary product; all treatments applied 6 Feb 2014.
[c]Kruskal–Wallis statistic adjusted for ties.

noticeable in 2013, with the incidence of 25 cm of precipitation during the first week of Jul. Another consideration is the inherent varying degree in homeowners' aesthetic tolerance of staining. Some may accept low levels while others have zero tolerance for staining.

Abamectin appears to be a promising product for reducing gall formation and staining administered either on an annual or biennial basis. Even though the label lists some caterpillars, we did not collect specific data on caterpillar abundance. In addition, in 2015 and 2016, we did not observe caterpillars hanging from silken threads. Trunk injections, in general, are a more efficient delivery method than soil drenching and foliar application. One of the drenching advantages is ease of application; however, disadvantages include uncertain root interception, potential binding of the active ingredient to soil particles, and possible leaching into groundwater. Foliar application disadvantages include potential drift and effects on non-target organisms. The latter is especially true when applying neonicotinoids during bee foraging periods. During these field trials, very few bees were observed visiting oxhorn bucida flowers.

Dinotefuran slightly reduced staining in 2013 and 2014, whereas imidacloprid reduced gall formation in 2016. However, neither of these neonicotinoids is especially effective on caterpillars. Acephate trunk injection reduced staining in 2014. The reductions resulting from these products were minor and do not justify their use to eliminate staining.

We conclude that abamectin trunk injections were most reliable in addressing property owner complaints and preserving the benefits of mature oxhorn bucida trees to the urban forest. This method provides

Table 3. Median gall ranks (0–10)[a] and median staining ranks (0–5)[a] of oxhorn bucida trees, *Bucida buceras*, in Coral Gables, Florida, 2015.

	6 May		15 Jun		6 Aug		9 Sep	
Treatment	Gall	Stain	Gall	Stain	Gall	Stain	Gall	Stain
Control	1	1.5	0.5	1.5	2.5	3.5	0.5	1.5
Dinotefuran (T) high[b]	2	2	3	1	2	4.5	0	1
Dinotefuran (T) low	6	4	5.5	3	2	5	1	2.5
Dinotefuran (Z) high[c]	2	2	1.5	2	2	3.5	1	2
Dinotefuran (Z) low	0	1	0	1	3	3.5	0	1
Abamectin	0	0.5	0	1	1	1	0	0
Dinotefuran (T) high + abamectin	0	1	0	1	1	1	0	0.5
Dinotefuran (Z) high + abamectin	0	1	0	1	1	1	0	0
Statistics								
H[d]	21.92	7.62	15.69	8.76	12.26	28.24	16.84	13.69
P[e]	0.003	N.S.	0.028	N.S.	0.092	0.001	0.018	0.057

[a]Gall ranks were on a scale of 0 = no galls to 10 = 100% of canopy with galls; staining ranks were on a scale of 0 = none to 5 = severe and objectionable.
[b]Commercial formulation is Transtect®; all treatments applied 3 Mar 2015.
[c]Commercial formulation is Zylam Liquid®.
[d]Kruskal–Wallis statistic adjusted for ties.
[e]N.S. = not significant.

Table 4. Median gall ranks (0–10)\[a] and median stain ranks (0–5)[a] of oxhorn bucida trees, *Bucida buceras*, in Coral Gables, Florida, 2016.

	25 Apr	17 Jun		4 Aug		29 Aug		16 Sep		31 Oct	
Treatment[b]	Stain	Gall	Stain	Gall	Stain	Gall	Stain	Gall	Stain	Gall	Stain
Control	2	1	1	7.5	4	8	5	2.5	5	3.5	2
Emamectin benzoate	1.5	1	0	3	2	4	2	2	3	0	2
Imidacloprid	3	1	0	1	1	1	2	0	1	0	1
Acephate	2	2.5	1	3	2	2.5	3	4	3	2	2
Abamectin (2X)[c]	1	0	0	0	0	0	0	0.5	0	0	0
Abamectin (1X)[d]	1	0.5	0.5	0	0	0	1	0	0	0	0
Statistics											
H[e]	17.06	10.06	14.56	27.40	28.62	30.10	33.61	25.32	36.17	23.92	29.74
P[f]	0.004	N.S.	0.012	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

[a]Gall ranks were on a scale of 0 = no galls to 10 = 100% of canopy with galls; staining ranks were on a scale of 0 = none to 5 = severe and objectionable.
[b]All treatments applied 16 Mar 2016.
[c]Treated in 2015 and in 2016.
[d]Treated in 2015 only.
[e]Kruskal–Wallis statistic adjusted for ties.
[f]N.S. = not significant.

an environmentally rational approach to managing staining and can be implemented with ease and efficiency.

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