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Alleviating Urban Slash Pine Chlorosis

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Slash pines (*Pinus elliottii*) are common in south Florida urban landscapes. Their presence in housing developments may pre-date the home/apartment construction. At times, the tree foliage (needles) may develop a yellow cast (chlorosis), and eventually the tree may die. Foliage color was improved by injecting iron chelates into the root flare of affected trees.

In south Florida, slash pines, *Pinus elliottii*, grow from near sea level to higher elevations in a wide range of conditions, from wet sites to well-drained sandy soils and rocky limestone outcrops, and a south Florida variety has been identified (Carey, 1992). They often are found in urban areas either as landscape plantings, or as trees that existed prior to urban development. While slash pines commonly grow for several hundred years, yellowing (chlorotic), dying, and dead trees often are seen in urban settings. Speculation on reasons for their demise in urban settings include root disturbance and filling in over the roots during development, diseases, insects, and increases in soil pH which induce iron and manganese deficiencies (Gilman and Watson, 2014). This study only deals with iron deficiency.

Materials and Methods

Eight holes 3/8 inch in diameter by approximately 3 inches deep were drilled into the root flare (Costonis, 1981) of a chlorotic slash pine tree (Tree 1, Table 1) in Palm Springs FL, on 18 Feb. 2017. The holes were filed with a granular iron chelate (SGW Florida Live! Fe 13, Scott G. Williams L.L.C., Conyers, Ga.) and covered with roof cement (Gardner Wet-R-Dri Plastic Roof Cement, Gardner-Gibson Inc., Tampa FL.). The holes were empirically determined to hold about 10.5 g (~1/3 ounce) of the chelate mix. This tree, and seven other trees showing signs of chlorosis (Table 1), were treated in a similar fashion over the period from June 2017 through January 2018, but with varying hole sizes (Table 1), except that a powdered iron chelate mixture was utilized (Fig. 1). The chelate, SGW Wildfire Iron (Scott G. Williams, L.L.C., Conyers, GA) was a patented finely-ground mixture of iron EDTA (Ethylenediaminetetraacetic acid), iron NTA (Nitrilotriacetic acid), iron HEDTA (Hydroxyethylethylenediaminetriacetic acid), iron DTPA (diethylenetriaminepentaacetic acid), iron citrate, iron IDS (Iminodisuccinic acid), and iron lignosulfonate with a total iron content of 13% by weight. The holes were empirically determined to each hold approximately 9.0 g (~1/3 ounce) of the finely-ground chelate. The granular chelate used for tree 1 was formulated from the same chelate mix. Visual and photographic observations were made on all trees through May 2018 to determine changes in chlorotic appearance. Hurricane Irma impacted the trees on 10 Sept. 2017, causing some breaking and/or severing of limbs, and some defoliation. However, the damage was not lethal to any of the trees in the study. Soil samples were taken to a depth of approximately four inches in the vicinity of the root system of trees 1–5 on 5 Dec. 2017, and on 28 Apr. 2018, for the remainder of the trees. They were analyzed for pH (Central Florida Soil Lab, Bartow, FL.).

Fig. 1. (**Top**) Brushing iron chelate into a hole drilled into the root flare of a slash pine, *Pinus elliottii*, tree. The chelate was packed into the hole with the blunt end of the brush or with other implements. (**Bottom**) Holes covered with roof cement.

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Table 1. Slash pine, *Pinus elliottii*, tree location and treatment information.

Tree no.[1]	Location	Treatment date	Product[2]	Hole size, in.	No. holes	Root flare dia., in.	Inches per hole
1	3954 Dale Road	2/18/17	Fe 13 G	3/8	16	97	6.1
		9/29/17	WF-13 P	1/2	16	--	6.1
2	3083 Gulfstream Road	6/3/17	WF-13 P	7/16	14	90	6.4
3	Fairway 1 South course	8/23/17	WF-13 P	1/2	8	42	5.3
4	Fairway 1 South course	8/23/17	WF-13 P	1/2	10	58	5.8
5	Fairway 1 South course	11/30/17	WF-13 P	1/2	11	55	5.0
6	Green 2 West course	1/23/18	WF-13 P	1/2	9	66	7.3
7	Tee 18 South course	1/23/18	WF-13 P	1/2	11	73	6.3
8	Green 18 South course	1/31/18	WF-13 P	1/2	14	79	5.6

[1]Trees 1 and 2 located in Palm Springs, FL. Trees 3–8 located at Fountains Golf Course, Lake Worth, FL.
[2]Fe 13G is SGW Florida Live! Fe 13, Scott G. Williams L.L.C., Conyers, GA. WF-13P is SGW Wildfire Iron, Scott G. Williams, L.L.C., Conyers, GA.

Results and Discussion

Chlorosis declined rapidly in Tree 1 following the February treatment with the granular chelates (Fig. 2). Tree 2, which was treated with the powdered form of the chelates, also rapidly displayed a reduction in chlorosis (Fig. 3), and retained good color throughout the study period (Fig. 4). However, chlorosis returned on Tree 1, so it was retreated with the powdered form

Fig. 2. Slash pine, *Pinus elliottii*, Tree 1 (left) at time of iron chelate treatment in 18 Feb. 2017, and on 18 May 2017.

Fig. 3. Slash pine, *Pinus elliottii*, Tree 2 (third tree to the right) at time of iron chelate treatment on 3 June 2017 and on 16 July 2017.

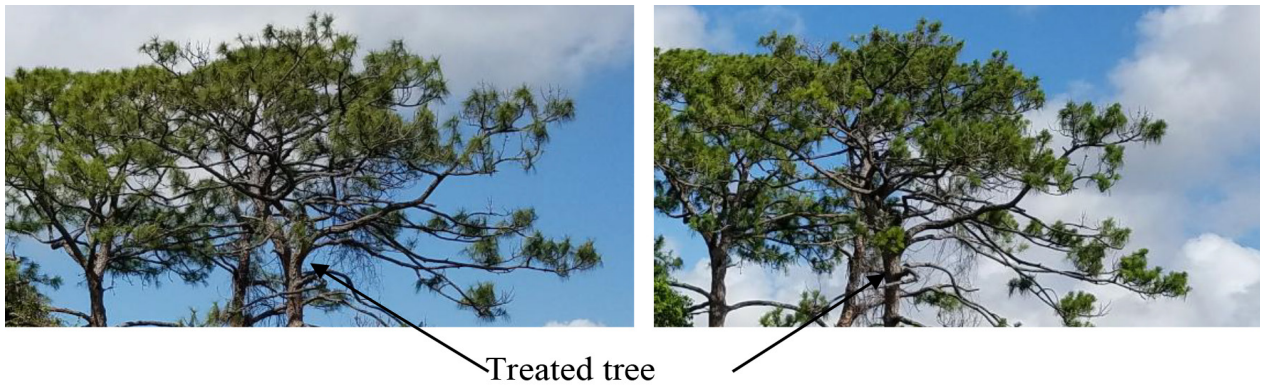

Fig. 4. Slash pine, *Pinus elliottii*, Tree 2 on March 2, 2018 (left photo), and on May 23, 2018 (right photo).

Fig. 5. Slash pine, *Pinus elliottii*, Tree 1 (left) 29 Sept. 2017 before second iron chelate treatment and (right) 17 May 2018.

Fig. 6. Slash pine, *Pinus elliottii*, Tree 3 (left) before iron chelate treatment on 23 Aug 2017 and (right) on 23 May 2018.

of the chelate on 29 Sept. 2017. Color improved, and the tree color remained satisfactory throughout the study period (Fig. 5). Trees 3–8 were located at the Fountains Golf Course in western Lake Worth FL. Tree 3 was observed to be particularly chlorotic throughout Summer 2017 (Fig. 6). When looking south, it stood out relative to normal-appearing trees in the background. Following treatment on 23 Aug. 2017, color improved to the point that the tree blended into the background trees (Fig. 6). One of two adjoining trees was treated on 23 Aug. 2017. The root flares of these trees were covered with soil and mulch, so the treatment had to be made in the lower trunk. Neither tree was highly chlorotic, and both trees received hurricane damage, but over time color improved in the treated tree to the point that it was distinguishable from the untreated tree (Fig. 7).

Tree 5, located close to Trees 3 and 4, displayed considerable chlorosis. It was treated 30 Nov. 2017. Foliage color improved considerably and remained good throughout the study period (Fig. 8).

Tree 6 had a chlorotic and unthrifty appearance prior to treatment on 25 Jan. 2018, but color improved greatly over the next three months (Fig. 9). Tree 7 provided a similar, though perhaps

Fig. 7. Slash pine, *Pinus elliottii*, Tree 4 on left, treated with iron chelate on 23 Aug. 2017. Tree on right not treated. Photographed on 23 May 2018.

Fig. 8. Slash pine, *Pinus elliottii*, Tree 5 (left) prior to iron chelate treatment on 30 Nov. 2017, and (right) on 23 May 2018.

Fig. 9. Slash pine, *Pinus elliottii*, Tree 6, prior to iron chelate treatment on 25 Jan., 2018 (left), and on 23 May 2018 (right).

not quite as dramatic, response over the same relatively short time period (Fig. 10).

Tree 8 was interesting and eye-catching because it was one tree with a yellow canopy in a line of fairly normal pine trees with green canopies. It was treated on 25 Jan. 2018. By 23 May 2018, the canopy color difference was much less distinguishable (Fig. 11). In contrast, an untreated tree just left of center in Fig. 11 appeared to decline in appearance over the same time period.

Fig. 10. Slash pine, *Pinus elliottii*, Tree 7, prior to iron chelate treatment on 25 Jan. 2018 (left), and on 23 May 2018 (right).

Fig. 11. Slash pine, *Pinus elliottii*, Tree 8 prior to iron chelate treatment on 25 Jan. 2018 (upper photo), and on 23 May 2018 (lower photo). Treated tree is on far left.

Figure 12. Reduction in foliage chlorosis in slash pine, *Pinus elliottii*, trees following treatment with iron chelate on 31 Jan. 2018.

Table 2. Soil pH (0–4 inches depth) around slash pine, *Pinus elliottii*, trees at locations in Palm Springs and Lake Worth, FL.

Tree no.	Soil pH
1	6.8
2	6.6
3	6.9
4	6.2
5	5.9
6	5.7
7	7.2
8	7.4

Generally, responses were observed after several months, and became more striking after approximately four months (Fig. 12)

While excessively high soil pH has been attributed as a factor causing pine tree chlorosis (Gilman and Watson, 2014), soil pH only exceeded 7 in the vicinity of two trees in this study, and the soil around trees 5 and 6 was below pH 6 (Table 2).

Unquestionably, many factors can cause chlorosis and dying in slash pines. However, it is interesting to note that for all eight trees included in this study chlorosis was reverted by injecting a mixture of iron chelates into the root flare or lower trunk. Nevertheless, the study was only exploratory, and many questions remain.

1. How long will the responses last?
2. Will retreatment be required?
3. If retreatment is required, will it be effective, and not damage the trees?
4. What is the required amount of iron, number, diameter, depth of holes?
5. Are there easier or more effective ways of injecting the iron?
6. Are some iron sources more effective than others?

Of course, the method described for treating the trees is somewhat time consuming (approximately 20–30 min. per tree). However, if it corrects the problem for a substantial period, treatment requires considerably less effort than cutting down a dead tree, disposing of the tree, grinding the stump, and perhaps digging out the stump and refilling with soil to enable planting of a new tree.

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