Effects of Fertilization and Pruning on Canopy Leaf Number and Potassium Deficiency Symptom Severity in *Sabal palmetto*

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Potassium deficiency is the most common nutrient deficiency on landscape palms in the southeastern United States. Early symptoms appear as translucent yellow-orange and/or necrotic spotting on the oldest leaves (Broschat 1990). As the deficiency progresses, leaflet tip necrosis and frizzling develop, which eventually results in premature loss of the leaf (Fig. 1). Deficiency symptoms are most severe on the oldest leaves because potassium is mobile within the palm (Mengel & Kirkby 1982). Under conditions of deficiency, the palm is able to extract potassium from the oldest leaves and translocate it to the newly developing leaves, allowing growth to continue in the absence of sufficient potassium in the soil. Depending on the species and potassium deficiency severity, leaf death occurs from one to three months after necrosis is first observed on a particular leaf. In contrast, natural senescence of healthy, non-potassium-deficient older leaves occurs rapidly, with the oldest leaf being completely green one day, uniformly orange-brown the next day, and completely necrotic by the third or fourth day.

The number of leaves that a palm can support is a function of potassium deficiency severity. For example, the average *Cocos nucifera* in south Florida has a hemispherical canopy with about 13 leaves because of potassium deficiency (Broschat 1997). Potassium-sufficient *C. nucifera* have a full 360º canopy with 26 or more leaves. Similarly, the average *Phoenix canariensis* in south Florida has only about 65 leaves due to potassium deficiency, while potassium-sufficient specimens support canopies of 130 to 150 leaves (Broschat 1997). Severe potassium deficiency can be fatal to palms.

1. The orange discolored and partially necrotic older leaves on these *Sabal palmetto* are caused by potassium deficiency.

Because potassium-deficient older leaves are unsightly, there is a temptation to remove them. However, Broschat (1994) demonstrated that routine removal of potassium-deficient leaves resulted in a net reduction in the number of green leaves in the canopy of *Phoenix roebelenii*. Landscapers often remove some completely green leaves in addition to the unsightly symptomatic leaves believing that they can lengthen the time until they need to re-prune the palm. However, overpruning is known to reduce leaf size and windstorm resistance, in addition to being aesthetically unattractive (Calvez 1976, Chan & Duckett 1978, Mendoza et al. 1987, Oyama & Mendoza 1990). The purpose of this study was to examine the effects of severe pruning and fertilization on canopy leaf number and potassium deficiency symptom severity in *Sabal palmetto*. Our hypothesis was that fertilization would increase canopy leaf number and reduce visible potassium deficiency symptom severity while severe pruning would have the opposite effect.

Materials and Methods

Thirty *Sabal palmetto* having trunks 3 to 4 m tall were transplanted into a Bonneau fine sand soil in Gainesville, FL in 2004. They were spaced about 7 m apart. A similar planting was established on a Margate fine sand soil in Fort Lauderdale, FL in 2005. The root systems of all palms were isolated from each other by installing vertical 60 cm deep polypropylene fabric barriers midway between each palm. Treatments consisting of three fertilizer treatments and two pruning treatments in a factorial design were initiated in 2006.

Table 1. Effect of fertilizer type on number of total and green leaves, percent green leaves, and potassium (K) deficiency score for *Sabal palmetto* in Gainesville, Florida after three years of treatment.

Fertilizer	Total leaves	Green leaves	% Green leaves	K def. score*
None	29	14	57.0	4.40
16-0-8	27	14	57.8	4.25
8-2-12+4Mg	29	14	57.2	4.32

*0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms. Means were averaged across pruning treatments. All treatment effects were non-significant at P=0.05 level.

Table 2. Effect of fertilizer type on number of total and green leaves, percent green leaves, and potassium (K) deficiency score for *Sabal palmetto* in Fort Lauderdale, Florida after three years of treatment.

Fertilizer	Total leaves	Green leaves	% Green leaves	K def. score*
None	15.3	2.0	13.1	3.9
16-4-8	17.3	3.8	22.0	4.0
8-2-12+4Mg	17.0	3.9	22.9	4.1

*0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms. Means were averaged across pruning treatments. All treatment effects were non-significant at P=0.05 level.

Table 3. Effect of leaf pruning on number of total and green leaves, percent green leaves, and potassium (K) deficiency score for *Sabal palmetto* in Gainesville, Florida after three years of treatment.

Pruning	Total leaves	Green leaves	% Green leaves	K def. score*
Dead only	39 a[1]	14	36.3 b	3.89 b
Severe	18 b	14	78.3 a	4.76 a

[1] Means in a column with a different letter are statistically different at P<0.05. n=15

* 0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms. Means were averaged across fertilizer treatments.

Table 4. Effect of leaf pruning on number of total and green leaves, percent green leaves, and potassium (K) deficiency score for *Sabal palmetto* in Fort Lauderdale, Florida after three years of treatment.

Pruning	Total leaves	Green leaves	% Green leaves	K def. score*
Dead only	21.3 a[1]	2.3 b	11.5 b	3.67 b
Severe	11.9 b	4.2 a	34.4 a	4.29 a

[1] Means in a column with a different letter are statistically different at P<0.05. n=15

* 0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms. Means were averaged across fertilizer treatments.

Table 5. Effects of intensive fertilization on number of total and green leaves, percent green leaves, and potassium (K) deficiency score for *Sabal palmetto* in Fort Lauderdale, Florida after three years of treatment.

Fertilizer	Total leaves	Green leaves	% Green leaves	K def. score*
None	22.9 b[1]	5.0 b	22.4	3.91
8-2-12-4Mg	31.9 a	7.6 a	24.8	3.94

[1]Means in a column with a different letter are statistically different at P<0.05. n=15

* 0=dead, 1=severe K deficiency, 3=moderate K deficiency, 5=no deficiency symptoms.

Fertilizer treatments were: 1) no fertilizer (controls); 2) 4.9 g N/m^2 from a 16–4–8 plus Fe and Mn mostly water soluble turf fertilizer (Lesco, Rocky River, OH) applied per palm every three months; or 3) 4.9 g N/m^2 from an 8–2–12–4Mg plus micronutrients controlled-release palm fertilizer (Nurserymens Sure Gro, Vero Beach, FL) applied per palm every three months. Fertilizers were broadcast over a 10 m^2 area surrounding each palm. Half of the palms in each fertilizer treatment were severely pruned once per year by removing all but three of the youngest leaves. The other half had only completely dead leaves removed at that time. The experimental design was completely randomized with five replicate palms per fertilizer/pruning treatment combination. All palms were irrigated twice per week with about 2 cm of water per application using raised rotary irrigation heads. Data were collected once per year just prior to pruning and consisted of counting the number of green, symptom-free leaves and the total number of leaves, as well as scoring the severity of the visual potassium deficiency symptoms on each leaf within each palm canopy. A 1 to 5 scale was used with 1 = severe potassium deficiency symptoms (more than 50% of leaf area necrotic), 3 = moderate potassium deficiency symptoms (20–50% necrotic) and 5 = completely green. This experiment was continued for three years after initiation of treatments. All data were subjected to two-way analysis of variance.

After three years of treatment the results from the first experiment did not support our hypothesis, so a second experiment was set up to test the hypothesis that intensive fertilization of unpruned palms would increase the number of green leaves and total number of leaves in the canopy but would not improve visual potassium deficiency symptom severity until the palm achieved a full 360º canopy. This experiment was conducted in Fort Lauderdale, only on the same block of *Sabal palmetto* used in the first experiment. To prepare the palms for a second experiment, no palms were pruned or fertilized for one year prior to initiating the new treatments. To facilitate treatments, a split plot experimental design was used with 15 replicate palms per treatment. Treatments were 1) no fertilizer (control) or 2) fertilization with 9.8 g N/m^2 from an 8–2–12–4 Mg plus micronutrients controlled-release palm fertilizer (Lesco, Rocky River, OH) applied per palm every six weeks. The fertilizer was broadcast over a 37 m^2 area per palm using a rotary spreader. Palms were never pruned in this experiment. Data were recorded once per year as in the first experiment for three years.

Results and Discussion

No two-way interactions were significant for either site. In the first experiment there were no differences after three years among fertilizer treatments in the number of green leaves, total number of leaves, percent of leaves that were green, and in potassium symptom severity score in either the Gainesville plot or the Fort Lauderdale plot (Tables 1 & 2). These results were unexpected and suggested that either the fertilization intensity was not high enough to significantly affect palm potassium status, the duration of the study was too short, or that the inclusion of pruning treatments in a factorial design was interfering with the fertilization effects.

Predictably, severe pruning significantly reduced the total number of leaves at both sites (Tables 3 & 4). It also resulted in more green leaves in the Fort Lauderdale palms and a higher percentage of leaves that were green at both sites. Severely pruned palms also had significantly less severe visual potassium deficiency symptoms than those having only dead leaves removed. This finding contradicts results obtained in *Phoenix roebelenii* where removal of potassium deficient leaves four times per year resulted in a net reduction in the number of green leaves in the canopy (Broschat 1994). This difference in response may be due to the fact that green leaves were also removed in the present study, resulting in a canopy with fewer leaves than the palm was capable of supporting with its existing soil and plant tissue potassium reserves. Because of the mobility of potassium within palm canopies, these remaining youngest leaves likely had the highest potassium concentrations, well above the threshold concentration for visible symptom expression (Amalu & Omoti 1988, Broschat 1997).

The results obtained from the first experiment suggested that a different model may be required to explain the observed response of potassium-deficient palms to fertilization. Thus, a second experiment was designed to test the hypothesis that intensive fertilization of unpruned palms would increase the number of green leaves and total number of leaves in the canopy but would not improve visual potassium deficiency symptom severity until the palm achieved a full 360º canopy. After three years of intensive fertilization, fertilized palms did, indeed, have significantly more green leaves and more total leaves than unfertilized palms (Table 5). However, fertilization had no effect on the percentage of leaves in the canopy that were green or the severity of the visual potassium deficiency symptoms.

In conclusion, these studies have demonstrated that severe pruning of *S. palmetto* reduces canopy leaf number to fewer leaves than the palm is capable of supporting, and, until canopy leaf number increases to that point, visible potassium deficiency symptoms will not be observed. In the absence of living leaf pruning, application of an appropriate palm fertilizer will gradually increase the number of green leaves and total leaves in the canopy, but will not reduce the severity of visible potassium deficiency symptoms until the palm has reached its maximum genetically-determined canopy leaf number. For most species of palms, that will likely be a 360º canopy. Finally, these experiments point out that elimination of visible potassium deficiency symptoms requires years of intensive fertilization although the canopy will gradually increase in leaf number in the mean time.

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