

# Cold-Hardy Palms in Southwestern Ohio: Winter Damage, Mortality and Recovery

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Previous experiences suggested that several palm species could be grown successfully with minimal winter protection in southwestern Ohio. Here we report data on an expanded experimental design that included additional palms and several new experimental plots.

Francko (2000) reported preliminary data on first-year survivorship and vegetative growth of cold-hardy palms in SW Ohio, U.S.A. Palm survivorship, foliar damage, and subsequent recovery were analyzed through the 1999 growing season, the winter of 1999–2000, and the 2000 growing season. We also evaluated the efficacy of several published winter protection strategies and of a modified pot-planting technique in reducing winter damage and mortality.

## Materials and Methods

*Study Sites.* Detailed geographical and climatological information about the Miami University main campus and off-campus areas in Oxford, southwestern Ohio were reported in Francko (2000). Winter temperature minima data from 1989–90 through 1999–00 demonstrate that rural areas around Oxford, including home garden palm plots (WK sites: forest and near house; Francko 2000) are mid-Zone 6a microhabitats. Urbanized areas (campus and the small city of Oxford) are consistently 1.4–2.4°C (2.5–4.3°F) warmer and

represent Zone 6b microhabitats. Sheltered areas near large buildings on the Miami University campus, including the original Hardy Palm Demonstration Plot (HPDP), are consistently 5.0–6.7°C (9–12°F) warmer than rural areas and effectively Zone 7a to 7a/b microhabitats. In spring 1999 we established eight additional Zone 7a test plots on the Miami campus, expanded planting areas at the rural WK site, and integrated small-scale palm plantings into a church garden (Zone 6b) and a private residential landscape in Oxford (Zone 6a).

*Site Preparations and Palms Utilized:* Soils in the new plot areas, in contrast to the original HPDP, are reasonably fertile, circumneutral to slightly acidic clay-loam and were not amended extensively prior to installing plants. New planting beds at the WK site which were sited in compacted heavy clay were amended with compost, humus, and topsoil.

In our pilot study we focused on seedling-sized palms (Francko 2000). Nearly all of the new palms



planted in 1999 (N = 97) were larger-diameter specimens (3 to 15-gallon containers) purchased in Georgia, USA (Neotropic Nursery). Species included *Rhapidophyllum hystrix* (needle palm), *Sabal minor* (dwarf palmetto), *Sabal minor* "Louisiana" (blue-stem palmetto), *Trachycarpus fortunei* (Chinese windmill palm), *Trachycarpus takil* (Himalayan windmill palm), *Sabal palmetto* (cabbage palm), *Sabal etonia* (scrub palmetto), *Sabal bermudana* (Bermuda cabbage palm), and *Serenoa repens* (saw palmetto). In addition, we obtained bare-root seedlings of *Trachycarpus fortunei* "Norfolk" and "Greensboro" from Plant Delights Nursery in North Carolina. Finally, we purchased 7-gallon specimens of *Livistona chinensis* (Chinese fan palm) from a local discount store. A few specimens of *R. hystrix* (N = 5) and *S. minor* (N = 1) planted very late in the 1998 growing season (Francko 2000) were also included in the data matrix.

Palms were obtained and planted by the end of April 1999. Each palm was fertilized two times (early May and mid-July) with a granular, slow-release (3 month) fertilizer containing micro-nutrients. We attempted to provide a combination of rainfall and irrigation water equal to approximately 2.5 cm per week throughout the 1999 growing season and into the late fall and winter, but this proved problematic due to extreme drought and heat conditions.

*Pot-Planting and Winter Protection:* Tollefson (1999) provided evidence that pot-planting – setting a containerized palm directly into a planting hole without removing the container – may reduce root shock set-back and early mortality in larger palms, and encourages downward root growth through the lower drain holes of the container during the first growing season. He suggested that this planting technique could provide superior results for palms being grown near the limits of their hardiness range.

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1 (top). Palms at the HPDP, late summer 2000. Left to right; seedling *Trachycarpus fortunei*, three seedling *Rhapidophyllum hystrix* surrounding a sexually mature individual, sexually mature *S. minor* surrounded by three immature *Sabal minor*, and 1.5 m trunked *T. fortunei* installed in spring 2000.

2 (bottom). Palms in the HPDP alcove, late summer 2000. Foreground center/right are *Butia capitata* and *Washingtonia robusta* installed spring 2000. Background specimens of *T. fortunei*, *R. hystrix*, *S. palmetto*, and *S. bermudana* installed 1999. For scale, the *Musa basjoo* in the rear left is approximately 2.8 m tall.

To test this view, we employed a modified pot-planting technique in all containerized palms installed in 1999. Containers were slit ca. 5 cm down from the top, and the lower drain holes on the sides and bottoms of containers were carefully slit and expanded prior to placing the container in the ground. Care was taken not to cut or otherwise damage the root ball. The top of each container was also trimmed so that it was flush with the elevation of the root mass. After containers were set into the ground, planting holes were backfilled with soil, and fertilized and watered through the 1999 growing season as above.

Francko (2000) reported that minimal winter protection strategies (heavy mulching, use of antidesiccant sprays, snow cover) were effective in mitigating winter damage to palms grown either in Zone 6a or Zone 7a microhabitats. In contrast, burlap wind screens and heat cables draped loosely around the base of small palms were probably ineffective. In fall 1999 and through the winter months of 2000, we employed and evaluated two palm protection strategies cited in gardening books (e.g., Roth & Schrader 2000) and palm society newsletters (e.g., Hilley 1999) for growers located in USDA Zone 7 and warmer: 1) trunk/foliar wrapping with C9 Christmas lights (so-called "mini-lights), and 2) trunk/foliar wrapping with lightweight landscape fabric.

In mid-December 1999, palms located on the Miami campus and in off-campus plots were treated with antidesiccant spray (Wilt-Pruf), mulched heavily (ca. 5–8 cm), and crowns and crown cavities were treated with liquid copper-based fungicide to minimize fungal/bacterial leaf and crown rot. With the exception of *R. hystrix*, which has a clumping habit that makes wrapping difficult, approximately equal numbers of palms of each species were then either; 1) wrapped with C9 light strings at an approximate density of one string (50 lights) per meter of plant height, producing roughly 85 watts of heat energy m<sup>-3</sup> canopy volume, 2) wrapped with lights and then with a double layer of lightweight synthetic landscape fabric (ReMay), 3) wrapped with landscape fabric alone, or 4) left unwrapped as controls.

We used a variation of the third strategy to overwinter *Livistona chinensis* and evaluate its potential as a "deciduous" palm for Zone 6 and 7 cultivation. *Livistona chinensis* specimens at both the HPDP and at WK (N = 2 at each site) were allowed to undergo foliar senescence throughout the fall of 1999. By late December 1999 overnight temperatures had dropped below -12°C (10°F),

resulting in leaf necrosis down to the petiole/spear leaf bases. At this point, dead foliage was cut off, and plants were covered to ground level with a double layer of landscape fabric and then a loose covering of bark mulch. Preliminary experiments (Francko 2000) suggested that fabric/mulch coverings thus applied created an interior environment approximately 13–17°C (23–31°F) warmer than ambient air temperatures, and allowed enough light penetration and air circulation for palms to retain some green tissue through the winter months. Beginning in late March 2000, palms were gradually uncovered and shoot/foliar recovery was monitored throughout the 2000 growing season.

*Temperature Measurements:* Temperature data were collected in all plots to determine winter minima and quantify microclimatic variations (Francko 2000). Calibrated thermometers were mounted approximately 20 cm above ground level on wooden dowel rods. Thermometers with inside-outside probes were mounted so that the inside probe was within a fabric-wrapped palm or in the foliage of a plant wrapped with C9 lights. Care was taken to ensure that temperature probes were kept at least 5 cm away from the nearest light bulb. Temperatures were recorded approximately 30 min prior to dawn. A minimum of three thermometers were used at each site, and mean temperature data were recorded to the nearest degree F.

*Quantifying Winter Foliar Damage:* Persons attempting to grow palms in marginal climates require information not only on minimum survival temperatures but also on the degree of foliar damage to be expected under defined, sub-lethal winter conditions. In the temperate palm literature, foliar damage is usually discussed using qualifiers such as “minor” or “severe” to describe foliar burn and leaf tissue death (reviewed by Francko, in press). In this study, we attempted to provide a semi-quantitative, relative estimate of winter foliar damage for various hardy palm species.

Winter damage in palm leaves often manifests itself in necrotic spotting, margin burn, and other localized and diffuse tissue damage difficult and very labor-intensive to quantify with leaf area meters, as well as complete necrosis of leaf tissue from the leaf tip toward the petiole. Our experimental palms are genotypically and thus phenotypically variable and our sample sizes are relatively small, making for inherently noisy foliar damage data sets. Accordingly, we elected to use a less quantitative but easier to employ method to assess leaf damage as a function of microclimate and winter-protection techniques.

Damage assessments of each individual palm were conducted in early April 2000, when all winter damage was easily visualized and before growing season recovery commenced. A numerical ranking of foliar damage was created by scoring each plant on the basis of leaf foliage killed (visual observation of the areal extent of brown and/or necrotic tissue) versus the total foliar area. The data were grouped into broad numerical rankings: 1 = essentially no foliar damage, 2 = 15% or less leaf tissue area killed, 3 = 15 to 30% killed, 4 = 30 to 75% killed, 5 = 75 to 90% killed, 6 = greater than 90% leaf destruction, but petiole bases green, and 7 = all above ground tissue killed. Numerical scores for each plant were interpolated to the nearest 0.5 unit. Data for all specimens were pooled by species and mean damage estimates were computed as a function of microclimate and winter protection. Individuals that lost spear leaves were also noted.

## Results and Discussion

*Microclimatic Variables:* The 1999 growing season and subsequent winter was the second year of a persistent La Nina event that markedly affected the SW Ohio climate. Extreme summer and fall heat stressed newly planted palms. Mean high temperatures for summer and fall were several degrees C above historical means, and temperatures reached or exceeded 37.8°C (100°F) in Oxford, Ohio on three occasions. A persistent drought occurred from mid-June through October 1999; during a six-week period in mid-summer no rainfall occurred. As noted in the Methods section, we attempted to provide approximately 2.5 cm of irrigation water per week to each experimental plot during the growing season, and with rare exceptions this goal was met.

Nonetheless, most palms were planted in full sun habitats or in shadier plots where root competition for moisture from established vegetation was extreme. Nearly all of our palms suffered visible drought stress during summer and early-mid fall 1999 (folding leaves, yellowing and premature leaf senescence) and entered the cooler months of fall and the winter season in less than ideal condition.

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3 (top). Relative growth of first year *Trachycarpus fortunei*. Specimen in front of meter stick was approximately the same size as the containerized individual in the foreground when installed in spring 2000.

4 (bottom). Regrowth of *Livistona chinensis* (early Oct 2000) after being killed back almost to ground level during winter 1999–2000. Keys on ground in front of plant illustrate scale.



This was especially true of 3-gallon-sized specimens of *Trachycarpus takil* (N = 11), which were just beginning to develop trunks. Several specimens lost their spear leaves during the summer and in all specimens approximately 30 to 70% of extant foliage was yellowed by October 1999. However, unless leaves were totally senesced prior to winter they were included as "live" tissue for purposes of winter foliar damage estimation the following spring.

Winter conditions in Oxford, Ohio during 1999–2000 were similar to those reported for 1998–99 (also a La Nina year; Francko 2000); relatively mild overall, but including a prolonged, extreme cold spell in January. From 16 to 31 Jan 2000, air temperatures in the coldest Zone 6a palm plots (WK site) remained below 0°C for all but a few hours. Beginning on 21 January, overnight low temperatures at the WK Forest site reached -18°C (0°F) or lower for eight consecutive nights, the longest sub-zero F event since at least 1983–84. The winter minimum of -24°C (-12°F) on 27 January 2000 was considerably lower than the average for the 1990s (-21.6°C/-6.8°F). As in previous years (Francko 2000), Miami University

campus plots represented much warmer microclimatic regimes, consistently 5° to 6°C (9° to 12°F) warmer than the WK site on the coldest nights.

*Effect of C9 lights and Fabric Wrapping on Cold Exposure:* Air temperatures near the leaves of palms wrapped with landscape fabric and C9 lights, either singly or together, were significantly higher than those of unwrapped control palms, at both campus and WK sites. Fabric wrapping alone yielded inside-wrap temperatures that were 3.3–6.7°C (6–12°F) warmer than temperatures outside the wrapping; lower temperature gradients were noted under windy conditions. For wrapped palms in the HPDP and other campus sites, the minimum temperature to which foliage was exposed to was -15.0°C (5°F) compared with -19.4°C (-3°F) in unwrapped control plants. *Livistona chinensis* plants covered to ground level as described earlier were approximately 14°C (25°F) warmer than ambient throughout the duration of sub-zero F cold.

Palm foliar canopies wrapped with C9 lights alone were approximately 1.1–2.2°C (2–4°F) warmer than unwrapped plants in calm air, but thermal

**Table 1. Winter damage in first-year palms, Miami campus (Zone 7a) and WK/Oxford plots (Zone 6a/b), 1999–00. Assessments conducted using the following scale of leaf area destroyed: 1 = no damage, 2 = 15% or less destroyed, 3 = 15–30%, 4 = 30–75%, 5 = 75–90%, 6 = greater than 90%, but petiole bases green, 7 = all above ground tissue killed.**

Palm	Microclimate	Mean +/- SD (N)	# Losing Spear	# Dying
<i>R. hystrix</i>	7a	1.3 +/- 0.8 (18)	*	0
	6a/b	3.2 +/- 0.5 (7)	*	0
<i>S. "Louisiana"</i>	7a	2.8 +/- 0.8 (3)	0	0
	6a/b	4.0 +/- 0.5 (3)	0	0
<i>S. minor</i>	7a	2.8 +/- 0.9 (10)	0	0
	6a/b	5.0 +/- 0.5 (2)	0	0
<i>T. fortunei</i>	7a	4.8 +/- 0.9 (23)	10	3
	6a/b	5.7 +/- 1.0 (10)	1	0
<i>T. takil</i>	7a	5.3 +/- 1.1 (7)	6	3
	6a/b	5.9 +/- 1.0 (4)	2	1
<i>S. palmetto/</i>	7a	5.3 +/- 0.8 (7)	0	0
<i>S. bermudana/</i>	6b	7.0 (1)	1	0
<i>S. etonia</i>				
<i>S. repens</i>	7a	5.3 +/- 0.3 (2)	1	0
	6a/b	6.5 (1)	1	0
<i>L. chinensis</i>	7a	6.0 +/- 0.3 (2)	0	0
	6a/b	6.0 +/- 0.4 (2)	1	0

\* approximately 25% of leaf bases in these clumped palms lose their spears in year 1 and 2; all but one leaf base among all *R. hystrix* above regenerated a new spear.

enhancement was nil when sustained wind speeds exceeded a few km per hour. Not surprisingly, C9 lights coupled with an outer landscape fabric wrap produced the largest thermal gradient, ranging from 9.4–17.8°C (17–32°F) above ambient inside the wraps compared with unwrapped control palms. In the coldest WK sites, temperatures never dipped below -9.4°C (15°F) when lights were on, even when the outside air temperature dipped to -24°C (-12°F).

*Palm Survivorship, Damage, and Recovery:* Despite the warmer temperatures produced by C9 lights and fabric wraps, foliar damage assessment data in spring 2000 failed to produce any statistically significant differences ( $P < 0.05$ ; paired sample t-tests) between wrapped palms and unwrapped controls, for any of the treatment variations employed or for any taxa. Accordingly, Table 1 presents foliar damage indices for pooled samples of all treatments of each species collated by microclimate. Although there was less damage overall noted in plants sited in Zone 7a microclimates, these differences were statistically significant ( $P < 0.05$ ; paired sample t-tests) only in *Rhapidophyllum hystrix*.

The relative degree of leaf tissue damage we observed in palm species closely paralleled the consensus minimum survival temperatures for these species recorded in the literature (SEPEPS 1994, Walters 1998, Noblick 1998, Avent 2000, McKiness 2000, Francko 2000). Specimens of *R. hystrix*, generally recognized as the most cold-hardy palm species in terms of survival, were virtually undamaged by winter conditions on the Zone 7a-microclimate Miami campus, and approximately 1/3 of the foliage was winter burned on plants exposed to colder temperatures at WK sites. *Sabal minor* and *S. minor* "Louisiana" foliage was slightly more sensitive to cold than *R. hystrix* at both sites. Both *Trachycarpus fortunei* and *T. takil* were damaged to similar extents, with approximately 75 to 80% defoliation noted at both the campus and WK sites. Several plants lost their spear leaves. Although our sample size ( $N = 3$ ) was too small for statistical comparisons, *T. fortunei* sited in campus plots that never received direct afternoon sun were less damaged (approximately 25% foliar burn) than plants sited in full sun locations. *Sabal palmetto*, *S. etonia*, and *S. bermudana* specimens sited in full sun campus plots were almost completely defoliated, even when wrapped with landscape fabric, although one C9 light/fabric wrapped *S. palmetto* in the HPDP retained perhaps 25% of its green foliage through the winter. A single *S. etonia* growing in the same campus "shade" plot as *T. fortunei* above

retained significant green foliage, even though it served as an unwrapped control specimen. The single *S. etonia* grown at the WK site was defoliated and lost its spear and all green above ground tissue, despite the observation above that temperatures inside the foliar wraps did not drop below -9.4°C (15°F). Damage to *Serenoa repens* on campus was similar to that noted in *Trachycarpus* species, and the sole specimen of *S. repens* planted at WK was defoliated but retained green petiole bases.

*Recovery During 2000 Growing Season:* The 2000 growing season, in contrast to 1998 and 1999, produced near-ideal conditions for plant growth. Rainfall was slightly above average, mean high temperatures in summer were a few degrees C cooler than average, and the longest period of summer drought was approximately two weeks. Despite sometimes major foliar damage and, in some cases loss of spear leaves, all but seven of the plants survived and recovered in spring-summer 2000 (Table 1, Figs. 1 and 2). Palms began producing new leaves in mid-April 2000, and at that time we pruned damaged leaves to remove dead tissue. A few *Trachycarpus* specimens that survived the winter with fairly intact foliage lost their spear leaves well after the onset of warm weather. We suspected that this was caused by a fungal/bacterial infection in the crown cavity, and after a 2-week treatment with copper-based fungicide, these plants began to develop a new spear and subsequently recovered completely.

Although plant aspect and form are somewhat subjective criteria, sufficient regrowth had occurred by late May 2000 that palms at both the campus and WK sites looked normal and healthy to the casual observer. By late summer all surviving individuals of *R. hystrix*, *S. minor* (both varieties), *T. fortunei* and *T. takil* had visibly grown larger than they were at the end of the 1999 growing season (Fig. 3). In general *R. hystrix*, *S. minor* varieties, and *T. takil* produced three or four fully expanded leaves and an expanding spear by early October 2000. *T. fortunei* specimens grew four to six new leaves and a spear and added or developed 5 to 10 cm of new trunk.

*Sabal palmetto*, *S. etonia* and *S. bermudana* specimens on campus also added three to four new leaves and a spear during the summer and by the end of the growing season were approximately the same size or a bit larger that they were at the end of 1999. The containerized, completely defoliated, and spearless *S. etonia* specimen growing at the WK site was excavated in April 2000. Dead tissue was removed and the crown cavity was sprayed with copper-based fungicide. A nascent spear leaf began to grow from this plant

by early May. The palm was removed from its container and replanted in a different WK location. By the end of the 2000 growing season this palm was approximately a meter tall, with three fully expanded leaves and an expanding spear, although the first leaf to emerge in the spring remained severely stunted.

*Serenoa repens* and *Livistona chinensis* specimens at both sites produced two or three new expanded leaves and an expanding spear per trunk during the 2000 growing season. In both species, plants grew to approximately 50% and 75% of the overall size they were at the end of the 1999 growing season, respectively. *Livistona chinensis* is seldom grown outdoors in areas colder than USDA Zone 8b (SEPEPS 1994, Riffle 1999). Our specimens were typical, greenhouse-grown 'tropical' plants with characteristically lush foliage. The observation that properly overwintered *L. chinensis* could recover from near complete defoliation to produce 50 cm-tall plants with a crown spread exceeding one meter (Fig. 4) suggests that this species and perhaps similar palms may have utility in temperate gardens as deciduous understory specimen plants.

**Efficacy of Pot Planting:** As noted above, pot-planted palms were severely drought stressed entering the winter season. Although C9 lights and fabric wraps reduced the level of cold exposure in our palms, enhanced thermal regimes did not translate into reduced foliar damage. It is possible that these two observations are interrelated and consistent with the view that our decision to pot-plant 1999 specimens adversely affected their viability during the 1999 growing season and into the winter season.

By expanding the lower drain holes and partially slitting the sides of containers we hoped to facilitate root growth into the surrounding soil. We also thought that this strategy would permit at least some capillary flow of water from surrounding soils into the containerized root mass. Some palm species, most notably *L. chinensis*, *R. hystrix* and *S. minor*, rooted rapidly through the lower drain holes and slit sides and were solidly anchored to the soil within 4 to 6 weeks after planting. Other species, including *T. fortunei*, *T. takil*, *S. palmetto*, *S. etonia* and *S. bermudana*, were clearly not well rooted even by the end of the 1999 growing season.

In spring 2000, we excavated dead specimens of *Trachycarpus* as the severely damaged WK specimen of *S. palmetto* described earlier. Root growth outside of the containers was nonexistent in every plant. These plants could access soil moisture only from within their containers and had not developed roots that extended below the

soil freeze line during the mid-January 2000 cold spell. Under such conditions, it was not surprising that summer drought stress and winter foliar injury or mortality occurred in many of our palms, even those protected by foliar wraps and C9 lights. With a frozen root zone, the warming effects of C9 lights and foliar wraps might actually have caused more harm than good, due to enhanced photosynthetic water demand in the relatively warm and well-lit leaves. Taken together, our data do not support efficacy of pot-planting in enhancing first-year palm survivorship or reducing damage, at least under the rigorous environmental conditions that characterized our 1999–2000 experimental season.

**Additional Considerations:** Although our data did not support the hypotheses that pot-planting or artificial heating and wrapping could significantly reduce winter injury and mortality in first-year palms, some additional considerations are necessary. In contrast to pilot-year data reported in Francko (2000), where palms were almost completely covered by drifted snow during the coldest periods of the winter, palms described here were covered only with a few cm of snow during the severe January freeze. In addition, the duration of the extreme cold event was much longer than that of 1998-99. Palm foliage was thus almost completely exposed for more than one week to the full effects of extremely cold air, very low wind chills, and in most cases full winter sun. Under these conditions C9 light wrapping may have been counterproductive in that they melted the snow that might have provided at least partial foliar and trunk insulation from sun and damaging winds. Strings of lights can provide a heat boost of several degrees C, thus protecting marginal palms under the short-duration, relatively minor freeze events characteristic of USDA Zone 7b and warmer locales. They may be much less effective in protecting newly planted palms under the more extreme and longer duration cold events in Zone 6.

It is also critical to note that our dataset deals solely with palms that have not been in the ground long enough to become well established and develop deep and vigorous root systems. After 3 to 4 growing seasons a well-established palm should possess a root zone that extends well below the typical soil freeze depth in winter, even in Zone 6 sites, and such plants would likely benefit from foliar wraps and other active-protection strategies.

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