Effect of Leaf Removal and Tie Up on Juvenile, Transplanted Canary Island Date Palms (*Phoenix canariensis*) and Queen Palms (*Syagrus romanzoffiana*)

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This study investigates the effect of removing leaves and tying up leaves when transplanting palms. Several combinations of leaf tie up and/or removal during transplanting did not affect establishment and survival of small, juvenile Canary Island date palms (*Phoenix canariensis* Hort. ex Chabaud) and queen palms (*Syagrus romanzoffiana* (Cham.) Becc.). For both species, complete leaf removal resulted in the least amount of new leaf and root growth. None of the combinations resulted in more new leaf or root growth or reduced leaf transpiration rates and leaf water potential than no leaf removal and no tie up. Leaf tie and/or removal appear to offer no benefit to transplanted, juvenile palms provided the root ball and backfill are kept moist.

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Palm trees are high-value and increasingly common components of landscapes wherever they can be grown. Large, older specimens are in great demand and command a premium price. Large specimen palms are usually dug and removed from one landscape site or from a commercial nursery field, and then transported and replanted at another site, creating an instant mature landscape.

Specimen palms are easy to transplant when compared to broad-leaved, dicotyledonous and coniferous trees. Only a small root ball is necessary when transplanting most palms because, as monocots, they have an adventitious root system composed of numerous fibrous primary roots that arise independently and periodically from the root initiation zone at the base of the stem (Tomlinson 1990). In California and Southwest USA it is standard industry practice for a root ball to extend from the trunk only about 15–30 cm when transplanting palms up to 20 meters tall with trunks 30–100 cm in diameter. The transplanted palm will grow and reestablish as long as it generates new roots in a timely manner.

Landscape contractors and nurserymen spend considerable resources and labor transplanting palms since removal of many of the leaves and tying up the remaining ones during the transplant operation are standard industry practices. These practices detract from the esthetic value of the newly transplanted palms but are purported by the landscape industry to reduce water loss and improve reestablishment. There is little research-based information on the effects of leaf removal or tie up when transplanting palms and the benefits of either practice are, thus, largely undocumented. The cost savings and esthetic improvement would be substantial if leaf removal and tie up could be eliminated. The objective of this experiment was to evaluate the effects of leaf removal and tie up on the survival of two commonly transplanted palm species.

Previous Work

Industry tradition and popular literature are replete with accounts of the benefits of leaf removal and tie up when transplanting palms. Broschat (1991) and Costonis (1995) showed that for species like the palmetto palm (*Sabal palmetto*), which usually must generate an entirely new root system when transplanted, complete leaf removal greatly improved survival rates because the practice reduced transpirational water loss.

1 (left). *Syagrus romanzoffiana* prior to root removal. Note tied-up leaves and metal ring to mark 15 cm diameter for root removal. Half leaves removed/tie up treatment [standard industry practice (SIP)].2 (right). *Syagrus romanzoffiana*, same plant from Figure 1, after root removal.

3 (left). *Phoenix canariensis*. Co-author Pittenger holds gas-powdered hedge shears used to remove roots. Half leaves removed/no tie up treatment.4 (right). *Phoenix canariensis*, same plant from Figure 3, six months after root removal and treatment showing new leaf and root growth.

In contrast, Broschat (1994) showed that transplanted pygmy date palms (*Phoenix roebelenii*) had higher new root and shoot growth and survival rates when most or all leaves were left on the palm provided there was sufficient irrigation. He predicted that most other species of palms would probably respond in a way similar to the pygmy date palm rather than to the palmetto palm. Broschat (1994) recommended that leaves should be untied after transplanting because research has shown no benefit from the practice in humid climates. He further suggested that the practice actually promotes disease by decreasing air flow through the canopy. However, he felt there might be some benefit from keeping the leaves tied up for several weeks to reduce transpirational water loss in arid climates.

Removing at least half the leaves and tying up the remaining ones have long been common practices when severing offshoots of date palms (*Phoenix dactylifera*) from the mother tree and planting them out in the field. Growers state that this practice reduces water loss and facilitates handling. Nixon and Carpenter (1978) and Zaid (1999), two of the best known references on this subject, recommend this practice. Reuveni et al. (1972) reported that less severe leaf removal of offshoots did not improve rooting when planted in the traditional manner, but offshoots retaining all their leaves had higher rooting with overhead misting.

Most recently, Broschat and Meerow (2002) recommended that one-half to two-thirds of the leaves should be removed to minimize transpirational water loss in large, specimen-sized, field-grown palms but did not cite supporting data.

Materials and Methods

We conducted this experiment at the University of California South Coast Research and Extension Center (SCREC) in Irvine, which is in the south coastal plain of California and has a maritime Mediterranean climate. In August 2001 we purchased 30 68-liter (15-gallon), juvenile plants each of Canary Island date palms (*Phoenix canariensis*) and queen palms (*Syagrus romanzoffiana*), one species each from two local growers. Plants within each species were selected for uniform height, leaf number, stem caliper, root growth, and overall quality (Table 1). Plants of

Table 1. Ranges in height from soil line to top of leaves, leaf length, stem diameter, and number of leaves of juvenile, 68-liter (15-gallon) size plants of Canary Island date palms (*Phoenix canariensis*) and queen palms (*Syagrus romanzoffiana*), prior to transplanting, UC SCREC, Irvine, CA, 2001–2002.

Species	Height (cm)	Leaf Length (cm)	Stem Diameter (cm)	Leaf Number
Canary Island date palm	60–75	60–90	14	7
queen palm	180–220	80–110	10	3

both species were free of pests and diseases and had normal green leaves and roots to the sides and bottoms of the containers.

On August 14, 2001, we removed the palms from their containers and, using gas-powered hedge shears, clipped back the root balls to 7.5 cm from the center of the stem at its base, resulting in a cylindrical root ball about 15 cm in diameter and 30–38 cm long or deep. We estimated that at least 60% of the roots were removed. The procedure was designed to simulate transplanting palms where typically a large quantity of roots is removed. We immediately repotted each palm in the original container using Scott's Potting Medium, a peat-vermiculite soil-less potting mixture, and subjected them to one of five treatments:

All leaves removed

Half of the leaves removed/tie up [standard industry practice (SIP)]

Half of the leaves removed/no tie up

No leaves removed/tie up

No leaves removed/no tie up (control)

Treatments for each species were replicated six times and the containers with the palms were arranged in a randomized complete block design (5 treatments × 6 replications × 2 species = 60 palms total). Plants were placed in full sun and irrigated twice a week in the summer and once a week in the winter to maintain the soil water content at or near container capacity. The repotting and watering practices are very similar to those the landscape industry in California and the Southwest USA employ when transplanting palms, where sand or other nearly ideal backfill soil is used and trees are irrigated regularly to keep the root ball and backfill moist. No fertilizers or pesticides were applied before or during the experiment. Weeds were removed manually.

We measured mid-day leaf transpiration rate (LTR) and leaf water potential (LWP) of each palm using a steady-state porometer and a Scholander pressure chamber to provide estimates of plant water loss rate and physiological water status, respectively. We recorded LTRs immediately prior to and after treatments were imposed and at 1, 4, 8, 12, and 25 weeks after treatment (WAT). We recorded LWP at 1, 2, 4, 8, 12, and 25 WAT. Porometer readings and pressure chamber measurements were taken from the abaxial surface of one pinna each of three different leaves per plant and averaged. When canopies were tied up, only exposed outer leaves could be sampled for these measurements.

By late February, 2002, roots were emerging from the bottom of the containers. On March 1, 2002, we removed the palms from their containers, recorded the number of new leaves produced since the start of the trial, and clipped back the root balls to the same size that we had at the start of the project. The new leaves and harvested roots were dried and their weight (mass) recorded.

We subjected data to analysis of variance procedures and compared means for leaf dry mass, root dry mass, number of new leaves, LTR, and LWP using Fischer's Protected LSD Test.

Results

None of the treatments affected survival. All 60 palms survived and grew enough new leaves and roots to establish successfully. We also observed in both species that many of the severed roots resprouted just proximally of the cut.

Leaf and Root Growth

Canary Island date palms produced significantly more new leaves and new leaf and root mass than did queen palms (Table 2). However, no treatment affected the number of new leaves produced in either species. Also, no treatment resulted in greater new leaf or root mass than in the control (no leaf removal, no tie up) in either species (Table 3). In Canary Island date palms new root mass was reduced when leaves were tied up or when all

Table 2. Summary of randomized complete block statistical effects for two transplanted palms species (*Phoenix canariensis* and *Syagrus romanzoffiana*) and five leaf removal/tie up treatments, UC SCREC, Irvine, CA, 2001-2002.

Treatment	Leaf Dry Mass (g) [z]	Root Dry Mass (g)	No. New Leaves
Species (S)	***	***	***
Treatment (T)	***	***	NS
S × T	*	**	NS

[z] NS, *, **, *** = not significant and significant at $P \leq 0.05$, 0.01, 0.001 respectively.

Table 3. The effect of leaf removal and tie up on mean new leaf mass, root mass, and leaf number of transplanted Canary Island date palms (*Phoenix canariensis*) and queen palms (*Syagrus romanzoffiana*), UC SCREC, Irvine, CA, 2001-2002.

Treatments	Leaf Dry Mass (g) [z]	Root Dry Mass (g)	Leaf Number
	Phoenix canariensis		
all leaves removed	158C	129B	6.8
1/2 leaves removed, tie up (SIP)	248AB	176B	7.5
1/2 leaves removed, no tie up	251AB	254A	7.0
no leaves removed, tie up	222B	182B	7.0
no leaves removed, no tie up	286A	278A	7.3
LSD, P=0.05	56	60	NS
Summary of ANOVA[y, x]	**	***	NS
	Syagrus romanzoffiana		
all leaves removed	50	36B	1.5
1/2 leaves removed, tie up (SIP)	89	128A	2.0
1/2 leaves removed, no tie up	101	98AB	2.3
no leaves removed, tie up	91	162A	2.2
no leaves removed, no tie up	72	106A	2.0
LSD, P=0.05	NS	80	NS
Summary of ANOVA	NS	*	NS

[z] Means within a column followed by the same letter are not significantly different. Means compared using Fischer's Protected LSD Test.

[y] Randomized complete block statistical effects.

[x] NS, *, **, *** = not significant and significant at $P \leq 0.05$, 0.01, 0.001 respectively.

leaves were removed (Table 3). New leaf mass in Canary Island date palms was reduced when no leaves were removed but leaves were tied up and when all leaves were removed. In queen palms new root mass was reduced only when all leaves were removed while no treatment affected new leaf mass (Table 3).

Leaf Transpiration Rate (LTR)

Canary Island date palms transpired at significantly lower rates than did queen palms although both species responded similarly to each treatment (Table 4). LTRs declined immediately after application of treatments and transplanting, recovered to pre-treatment rates by the fourth WAT, then fell below the pre-treatment rates for the duration of the study.

LTRs did not differ among the treatments immediately after they were imposed, but at one WAT and for the remainder of the study, the control had a significantly lower LTR than the SIP.

Over the entire study period LTRs were highest in the SIP. Tying up leaves generally increased LTRs.

We were unable to measure the LTR of the all-leaves-removed treatment until the end of the study (simply because there was no emerged leaf), and it was not significantly different from the other treatments at that time.

Leaf Water Potential (LWP)

Canary Island date palms had significantly higher LWP than did queen palms during the last 18 weeks of the study although both species responded similarly to each treatment (Table 5). None of the treatments affected LWP during the critical period immediately after transplanting. Not until 12 WAT, when plants had begun to reestablish, were there treatment responses. Leaf tie up and complete leaf removal showed greater water stress at 12 and 25 WAT but over the entire study no treatment resulted in lower LWP than in the control.

Discussion

Broschat and Meerow (2000) stated that water stress is one of the most important causes of palm transplant failure. The rationale behind leaf removal and tie up when transplanting palms is that these practices should reduce water loss and prevent drying out of the plant until new roots grow and become functional. The results of our study differ from this theory and contradict recommendations in the popular literature, at least for smaller juvenile palms, because leaf removal and/or tie up did not affect survival of transplanted Canary Island date palms or queen palms. Furthermore, no treatment significantly improved the amount of new leaf or root growth or reduced the LTR and LWP of these species after transplanting. Indeed, the SIP actually had the highest LTR. Our findings suggest that the SIP when transplanting smaller juvenile palms may be unnecessary for optimal leaf and root growth, reestablishment, and survival if the root ball and backfill are kept moist.

In tied-up leaf canopies, outer leaves (the only leaves we were able to measure for these treatments) might have an elevated LTR but inner leaves might have a much lower LTR. If there are about equal numbers of outer and inner leaves, then tie up would not affect total water loss. Leaf tie up could increase the LTR of leaves on the outside of a tied up crown because the abaxial surface of the leaf is more directly exposed to the sun and wind. Tomlinson (1990) states, and our counts confirm (Table 6), that stomata are most abundant on the abaxial leaf surface in most palms but several genera, including *Phoenix*, have stomata equally numerous on both leaf surfaces. Thus, leaf tie up would expose more stomata to greater light and increased wind.

It should be stressed that increased LTR of the outer leaves in a tied up crown does not mean that these plants lost more total water than those that were untied. Furthermore, the LTR might be irrelevant to water stress when transplanting palms because in our study the LTR in any treatment was not significant enough to increase leaf water potential. Why the SIP actually had the highest LTR in our study is intriguing and certainly bears further investigation.

Transplanted palms need carbohydrates for root and shoot growth. They can obtain carbohydrates from photosynthesis or from starch stored in the trunk, or both. Leaf removal and/or tie up reduce the amount of leaf surface in which photosynthesis can occur. An unstated premise of the rationale behind leaf removal and tie up when transplanting palms is that this decrease in carbohydrate production is temporarily acceptable in order to reduce water loss, and that the palms can use starch stored in the trunk or stem until new leaves are produced. Our findings suggest that when transplanted palms are appropriately irrigated, reducing water loss is not important to their survival and establishment, and reducing leaf surface can actually reduce production of new leaf and root growth.

The findings and interpretation of our work support the earlier work of Broschat (1994). He showed that transplanted pygmy date palms (*Phoenix roebelenii*) had higher new root and shoot growth and survival rates when most or all leaves were left on the palm provided there was sufficient irrigation, but that complete leaf removal was best if the palms were water stressed. Although our results indicate that leaf removal and tie up when transplanting palms, especially small plants with little or no visible trunk or stem, might be unsound horticultural practices, there still are instances when these procedures are helpful. Broschat (1991) and Costonis (1995) showed that for species like the palmetto palm (*Sabal palmetto*), which usually must generate an entirely new root system when transplanted, complete leaf removal greatly improved survival rates. Broschat also

Table 4. The effect of palm species and leaf removal and tie up on mean transpiration rates of transplanted Canary Island date palms (*Phoenix canariensis*) and queen palms (*Syagrus romanzoffiana*) in g cm^{-2}s^{-1}, UC SCREC, Irvine, CA, 2001-2002.

	Immediate		Weeks After Treatment					
	Pre-Treatment[z]	Post-Treatment	1	4	8	12	25	overall
Species								
queen palm	4.18A	2.88A	3.61A	4.24A	4.02A	3.14A	1.53A	3.61A
Canary Island date palm	2.71B	2.29B	1.72B	2.82B	3.08B	2.50B	1.23B	2.49B
LSD, *P*=0.05	0.67	0.39	0.71	0.92	0.60	0.37	0.17	0.42
Treatments								
all leaves removed	—	—	—	—	—	—	1.54	—
1/2 leaves removed, tie up (SIP)	—	2.48	3.47A	4.25	4.35A	3.29A	1.44	3.57A
1/2 leaves removed, no tie up	—	2.44	2.92AB	3.55	3.44B	2.50B	1.30	2.97B
no leaves removed, tie up	—	2.47	2.45BC	3.37	3.60AB	3.12A	1.42	3.00AB
no leaves removed, no tie up	3.44	2.94	1.83C	2.95	2.81B	2.36B	1.21	2.72B
LSD, *P* = 0.05	—	NS	1.01	NS	0.84	0.52	NS	0.59
Summary of ANOVA[y, x]								
Species (S)	**	**	***	**	**	***	***	***
Treatment (T)	—	NS	*	NS	**	**	NS	*
S × T	—	NS	NS	NS	NS	NS	NS	NS

[z] Means within a column followed by the same letter are not significantly different. Means compared using Fischer's Protected LSD Test.

[y] Randomized complete block statistical effects.

[x] NS, *, **, *** = not significant and significant at $P \leq 0.05$, 0.01, 0.001 respectively.

noted that most other species of palms will probably respond similarly to the pygmy date palm rather than to the palmetto palm.

Conclusion

Leaf tie up and/or removal did not affect establishment and survival of transplanted, small Canary Island date palms and queen palms when the root ball and backfill were kept moist. Based on our findings and the earlier work of Broschat (1994), the standard industry practice of removing some leaves and tying up the remaining ones seems to be no better than no leaves removed and no tie up when transplanting juvenile palms provided moisture content in the root ball and backfill is maintained near field capacity. No treatment increased survival or new leaf and root growth. While there is less leaf area for transpiration with leaf removal and tie up, transpiration occurs at a higher rate in the outer, exposed leaves. Little or nothing is gained from leaf removal and/or tie up although these practices greatly reduce the esthetics and function of transplanted juvenile palms. Thus, there is doubt that these standard industry practices are horticulturally sound. Leaf tie up is beneficial only to facilitate moving and minimize damage during the transplanting procedure. Additional work is needed to determine if our findings hold true when transplanting large, mature palms.

Acknowledgments

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Table 5. The effect of palm species and leaf removal and tie up on mean water potential of transplanted Canary Island date palms (*Phoenix canariensis*) and queen palms (*Syagrus romanzoffiana*) in MPa, UC SCREC, Irvine, CA, 2001-2002.

	Weeks After Treatment						
	1[z]	2	4	8	12	25	overall
Species							
Canary Island date palm	16.3	16.0	16.2	14.0A	17.0A	8.2A	14.1A
queen palm	14.2	15.3	15.0	12.1B	12.9B	7.1B	12.2B
LSD, P=0.05	NS	NS	NS	1.4	1.7	0.6	0.8
Treatments							
all leaves removed	—	—	—	—	—	8.5A	—
1/2 leaves removed, tie up (SIP)	14.9	15.1	15.3	13.3	18.3A	7.9AB	13.9
1/2 leaves removed, no tie up	16.2	15.9	14.5	12.1	12.5B	7.0C	12.2
no leaves removed, tie up	14.1	13.9	15.6	14.1	16.0A	7.6ABC	13.4
no leaves removed, no tie up	15.8	17.7	17.0	12.6	13.0B	7.4BC	13.1
LSD, P=0.05	NS	NS	NS	NS	2.4	0.9	NS
Summary of ANOVA[y, x]							
Species (S)	NS	NS	NS	*	***	***	***
Treatment (T)	NS	NS	NS	NS	***	*	NS
S × T	NS	NS	NS	NS	**	**	NS

[z] Means within a column followed by the same letter are not significantly different. Means compared using Fischer's Protected LSD Test.

[y] Randomized complete block statistical effects.

[x] NS, *, **, *** = not significant and significant at $P \leq 0.05, 0.01, 0.001$ respectively.

Table 6. Mean number of stomata per mm^2 on the adaxial and abaxial leaf surfaces of Canary Island date palm (*Phoenix canariensis*) and queen palm (*Syagrus romanzoffiana*), UC SCREC, Irvine, CA, 2001-2002.

	No. of Stomata	
Species	Adaxial Surface	Abaxial Surface
Canary Island date palm	5.5	212
queen palm	282	270

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