Research Reports

Effect of Amended Backfill Soils When Planting Five Species of Palms

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SUMMARY. **In a study in southern California, five species of palms [king palm (*Archontophoenix cunninghamiana*), mediterranean fan palm (*Chamaerops humilis*), queen palm (*Syagrus romanzoffiana*), windmill palm (*Trachycarpus fortunei*), california fan palm (*Washingtonia filifera*)] grown in 1-gal containers were planted in 12 × 12 × 12-inch holes in sandy loam (five species) and in clay loam (two species) with the backfill amended using a commercially available, composted, nitrogen-stabilized douglas fir (*Pseudotsuga menziesii*) shavings product incorporated at 0%, 25%, and 50% by volume. After 18 months, all palms were fully established. Crown volume, stem diameter, visual quality, quantity of new leaves produced, and percent total nitrogen, potassium, and magnesium in leaves did not differ significantly among the three treatments for all species or among treatments within a species. Thus, in this study there was no benefit from amending the backfill with this type of organic amendment when planting palms.**

Palms are high-value and increasingly common components of landscapes wherever they can be grown. Landscape contractors, tree planters, and homeowners commonly amend backfill soil with organic matter when planting palms, a practice that significantly increases costs for labor and materials. However, there is no research-based information to indicate that this practice improves establishment of newly planted palms. Substantial resources could be saved by not amending the backfill soil.

Although amending backfill soil with organic matter is a common practice when planting trees and shrubs in the landscape, numerous studies on dicotyledonous trees and conifers with woody, branched root systems have shown that this practice is of no benefit and, in some cases, may actually be detrimental (Corley, 1984; Davies, 1987; Hodge, 1990; Ingram and Van De Werken, 1978; Ingram et al., 1980; Munday and Smith, 1979; Pellet, 1971; Smalley and Wood, 1995; Whitcomb, 1976, 1979, 1983, 1986; Wright and Milbocker, 1978).

Amending backfill soil with organic matter when planting palms, which are woody, arborescent monocots with fibrous, adventitious root systems, is also common, and the literature is replete with recommendations advocating this practice (Boyer, 1992; Jones, 1995, 1996; McCurrach, 1960; Menge and Brown, 1992; Muirhead, 1961; Smith, 1961, 1986; Stewart, 1981; Womble, 1989). Although providing no supporting data, several researchers recommended against amending the backfill soil when planting palms unless the surrounding site soil is similarly amended or the site has sandy, rocky soil with little or no silt or clay to hold water and nutrients (Broschat and Donselman, 1987; Donselman, 1981; Donselman and Broschat, 1984; Doughty, 1988; Meerow and Broschat, 1992).

The objective of this experiment was to determine the effect of amending backfill soil with organic matter on the growth of five palm species commonly used in the landscape in subtropical regions of the world.

Materials and methods

In July 2001 we planted palms grown in 1-gal containers at two sites in southern California in randomized complete-block designs, using Planting Compost # 1 (Aguinaga Fertilizer Co., Irvine, Calif.), which consists of composted, nitrogen-stabilized wood shavings, primarily douglas fir. We incorporated this commercially available product in the backfill soil at three rates by volume: 0%, 25%, and 50%. The experiment was completed 18 months later.

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
1	meq/100 g	$cmol \cdot kg^{-1}$	1
1	mmho/cm	$dS \cdot m^{-1}$	1
305.1517	oz/ft^2	$g \cdot m^{-2}$	0.0033
1	ppm	$mg \cdot kg^{-1}$	1

Table 1. Chemical and physical properties of unamended (0% by volume) and amended (25% and 50% by volume with composted douglas fir shavings) backfill soils at the beginning of the amended backfill study with king palm, mediterranean fan palm, queen palm, windmill palm, and california fan palm at the University of California, South Coast Research and Extension Center (SCREC), Irvine and County of Los Angeles public housing facility at Carmelitos, Long Beach, Calif., in July 2001. See University of California (2005) for references, descriptions, and explanations of the analytical methodology.

	pH	EC[z] ($dS\cdot m^{-1}$)	CEC[y] (meq/100 g)	N[x] (%)	NH_4-N[w]	NO_3-N[v]	P[u]	K[t]	Mg[s]	Ca[r]	B[q]
					ppm						
Backfill (% amendment)											
SCREC											
0	7.0	0.80	14.4	0.05	4.1	18.6	5.0	296	293	2700	0.3
25	7.0	0.98	12.1	0.07	0.8	14.5	6.3	309	268	2540	0.4
50	7.2	0.96	14.6	0.06	6.4	13.0	6.0	306	256	2300	0.5
Carmelitos											
0	7.2	0.98	26.1	0.14	6.5	22.1	24.6	284	598	4680	0.7
25	7.3	1.05	26.5	0.15	8.5	10.5	22.5	304	561	4800	1.5
50	7.3	1.10	28.4	0.15	6.5	10.8	17.6	301	537	4200	2.2

	Mg[p]	Ca[o]	Na[n]	Cl[m]	OM[l]	Sand[k]	Silt[k]	Clay[k]
	(meq/L)				(%)			
Backfill (% amendment)								
SCREC								
0	1.6	5.2	0.7	1.3	0.84	68	19	13
25	1.8	6.2	1.6	2.1	2.32	82	17	1
50	1.6	5.6	2.7	2.5	4.91	70	19	11
Carmelitos								
0	1.9	4.1	4.5	0.7	3.81	33	40	27
25	2.1	4.9	5.0	1.5	4.88	29	45	26
50	2.1	4.9	4.9	2.2	10.77	33	43	24

[z]Electrical conductivity ($1\ dS\cdot m^{-1}$ = 1 mmho/cm).
[y]Cation exchange capacity (1 meq/100 g = $1\ cmol\cdot kg^{-1}$).
[x]Total nitrogen by weight.
[w]Extractable ammonium (1 ppm = $1\ mg\cdot kg^{-1}$).
[v]Nitrate.
[u]Extractable phosphorus.
[t]Exchangeable potassium.
[s]Exchangeable magnesium.
[r]Exchangeable calcium.
[q]Boron, saturated paste.
[p]Magnesium, saturated paste (1 meq/L = $0.5\ mmol\cdot L^{-1}$ or $12.2\ mg\cdot L^{-1}$).
[o]Calcium, saturated paste (1 meq/L = $0.5\ mmol\cdot L^{-1}$ or $20\ mg\cdot L^{-1}$).
[n]Sodium, saturated paste (1 meq/L = $1\ mmol\cdot L^{-1}$ or $23\ mg\cdot L^{-1}$).
[m]Chloride, saturated paste (1 meq/L = $1\ mmol\cdot L^{-1}$ or $35.5\ mg\cdot L^{-1}$).
[l]Organic matter by weight.
[k]By volume.

Some properties of the amendment, as determined by the University of California at Davis, Agriculture and Natural Resources Analytical Laboratory (University of California, 2005), included 88.7% organic matter (OM) by weight, 3400 ppm total nitrogen (N), 100 ppm phosphorus (P), 800 ppm potassium (K), 800 ppm magnesium (Mg), 200 ppm chlorine (Cl), 360 ppm sulfur (S), 880 ppm sodium (Na), and 17 ppm boron (B). While the Na content of the amendment was high, the amendment was diluted at least 50% or more by volume when preparing the backfill, and the levels in the amended backfill were much lower. Also, the palm species used are not highly sensitive to Na.

The two study sites have different soil types with different chemical and physical properties (Table 1). The University of California South Coast Research and Extension Center (SCREC) in Irvine has a San Emigdio sandy loam while the County of Los Angeles public housing facility at Carmelitos in Long Beach has a Ramona clay loam.

At SCREC we planted five species (king palm, mediterranean fan palm, queen palm, windmill palm, and california fan palm) on 15-ft centers in rows 10 ft apart. Each row was a block in which the five species and three treatments were completely randomized. There were 10 replicate rows or blocks. At Carmelitos we planted two species (queen palm and california fan palm) on 10-ft centers in rows 10 ft apart. Each row was a block in which the two species and three treatments were completely randomized. There were seven replicate rows.

We selected the palms for uniformity of size, health, and vigor. Percent total (by weight) N, K, and Mg from composite samples (30 per species) from middle pinnae of the newest, fully expanded leaf of all five species at the beginning of the study were within the general ranges established for palms (Mills and Jones, 1996) except for mediterranean fan palm and windmill palm, which were slightly low for Mg. However, the latter two species showed no symptoms of Mg deficiency. We determined N, K, and Mg leaf content because palms require these three elements in much greater amounts than other elements and they are the most frequently deficient (Broschat, 1990, 1994, 1999; Broschat and Donselman, 1985; Broschat and Meerow, 1990).

For each palm we dug a 12 × 12 × 12-inch hole and, using a portable, electric cement mixer, thoroughly mixed the appropriate volumes of excavated soil and amendment to make the three desired backfill soils (0%, 25%, and 50% of amendment by volume). We removed the palm from its container and planted it so the top of the root ball was at grade using one of the three backfill soils. This planting procedure and size of the planting hole simulate standard industry practices.

We recorded the number of new leaves, stem diameter at the soil line, crown volume, and visual quality (1 to 5, where 1 = 0%, 2 = 1% to 25%, 3 = 26% to 50%, 4 = 51% to 75%, and 5 = 76% to 100% of leaf area with normal green tissue, respectively) at the beginning of the study and then quarterly through Dec. 2002. Post-study chemical and physical analyses were performed on backfill soils obtained from the original 12 × 12 × 12-inch planting holes of five randomly selected samples each of the five species and three treatments at SCREC (75 samples) and five each of the two species and three treatments at Carmelitos (30 samples). Post-study analyses were performed on samples from the middle pinnae of the newest, fully expanded leaf of each individual palm in the experiment (150 at SCREC, 42 at Carmelitos) to determine percent total (by weight) N, K, and Mg.

The University of California at Davis, Agriculture and Natural Resources Analytical Laboratory (University of California, 2005) determined physical and chemical properties of the backfill (Table 1), and the N, K, and Mg content of palm leaf tissue.

Drip irrigation was used and scheduled to maintain soil moisture content near field capacity as determined by field inspection. Weeds were controlled using oxadiazon (Chipco Ronstar G; Bayer Environmental Science, Research Triangle Park, N.C.) pre-emergent herbicide at 20 $g \cdot m^{-2}$ once per year and hand weeding. Fertilizer was not applied.

Using Minitab Statistical Software (version13.32; Minitab Inc., State College, Pa.) we conducted analysis of variance tests and using Fisher's least significant difference test compared means for number of new leaves, stem diameter at base, crown volume, visual quality, and soil and plant tissue analyses among treatments for all species and among treatments within a single species. The latter was performed by running a two-way analysis of variance to test significance of treatments and replications within each species separately.

Results and discussion

At the conclusion of the study after 18 months all palms were fully established and had grown significantly. There were no significant differences in the cation exchange capacity or exchangeable K or Mg in the backfill soil in any treatments (Tables 1 and 2). Although percent total N in the backfill soil increased slightly over time (Tables 1 and 2), the amounts are still low. Percent total N was slightly higher only in the 50%-amended backfill soil at SCREC and was probably due to the high amount of organic matter and/or possibly root tissue inadvertently included in the sample.

In most cases organic matter decreased slightly over time (Tables 1 and 2) but generally remained significantly higher in the amended treatments. In the SCREC sandy loam soil, OM was greater only in the 50%-amended backfill soil at the conclusion of the study.

However, even the highest rate of amended backfill soil (50% by volume) resulted in no significant differences in growth. Indeed, there were no significant differences in crown volume, stem diameter, visual quality, and quantity of new leaves among treatments within a species or among treatments for all species throughout the 18 months of the experiment (data not shown).

Also, there were no significant differences in percent total N, K, and Mg in leaves among treatments for all species or among treatments within a species after 18 months. These amounts were within the general ranges established for palms (Mills and Jones, 1996) except for those of Mediterranean fan palm, windmill palm, and california fan palm at SCREC and california fan palm at Carmelitos, which were low in Mg, although they showed no deficiency symptoms.

While some of the older recommendations for palms specify the generous use of well-rotted animal manures as a major component of the amendment, the purported benefits obtained from these amendments are

Table 2. Effect of three rates (0%, 25%, and 50% by volume) of composted douglas fir shavings in the backfill soil on mean cation exchange capacity (CEC), organic matter (OM), nitrogen (N), potassium (K), and magnesium (Mg) at the conclusion of the amended backfill study with king palm, mediterranean fan palm, queen palm, windmill palm, and california fan palm at University of California, South Coast Research and Extension Center (SCREC), Irvine and County of Los Angeles public housing facility at Carmelitos, Long Beach, Calif., in Dec. 2002. See University of California (2005) for references, descriptions, and explanations of the analytical methodology.

	CEC[z] (meq/100 g)	OM[y] (%)	N[x] (%)	K[w] (ppm)	Mg[v] (ppm)
Backfill (% amendment)					
SCREC					
0	17.8	1.58 b[u]	0.08 b	226	468
25	17.9	2.14 b	0.08 b	222	476
50	18.2	3.86 a	0.12 a	227	481
Significance	NS	***	*	NS	NS
Carmelitos					
0	28.3	2.56 c	0.14	286	543
25	31.4	3.50 b	0.19	288	543
50	32.4	4.28 a	0.21	315	561
Significance	NS	**	NS	NS	NS

[z]Cation exchange capacity (1 meq/100 g = 1 $cmol \cdot kg^{-1}$).
[y]Organic matter by weight.
[x]Total nitrogen by weight.
[w]Exchangeable potassium (1 ppm = 1 $mg \cdot kg^{-1}$).
[v]Exchangeable magnesium.
[u]Means within a column at each site followed by the same or no letter are not significantly different. Means compared using Fisher's least significant difference test.
NS, *, **, ***Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

likely from the nitrogen and other nutrients in these animal manures.

Conclusion

There was no benefit from amending the backfill with composted, nitrogen-stabilized wood shavings when planting palms. While we cannot advocate the use of organic matter to amend the backfill soil when planting palms, we do encourage its use as a mulch, a practice shown to be beneficial to palm establishment and growth (Downer and Hodel, 2001).

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