The effects of mulching on establishment of *Syagrus romanzoffiana* (Cham.) Becc., *Washingtonia robusta* H. Wendl. and *Archontophoenix cunninghamiana* (H. Wendl.) H. Wendl. & Drude in the landscape

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Abstract

Three palm species common to southern California landscapes were grown and established under mulch treatments. Turfgrass clippings and *Eucalyptus sideroxylon* mulches increased the growth of king and queen palms and increased survival of king palms. Although palms growing under fresh eucalyptus mulches did not display nutrient deficiency symptoms, Mexican fan palm and queen palm were not significantly benefited by mulch treatments. Mexican fan palm was not adversely affected by turfgrass growing around it. However, turfgrass significantly reduced queen and king palm growth and increased mortality of king palms during establishment. Turfgrass increased drought effects and decreased stomatal conductance of palms. Soils under turfgrass were significantly drier than mulched or unmulched soils. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Mulching; Landscape; Palm

1. Introduction

Palms are important landscape trees which have been used as street trees, ascent specimens in lawns, mass plantings, and as fruit-bearing trees (Jones,
1995). Palms are widely planted in landscapes and are often maintained in mixed landscapes that include turfgrass. Rapid establishment and growth of palms are desirable since many of these species do not mature for years or decades (Meerow, 1992). Although planting and care of landscape palms have steadily increased, there is little published information about their maintenance and cultural requirements. The benefits of mulching (weed control, growth increases, soil moisture conservation) have been established for shade trees and woody ornamental shrubs (Litzow and Pellet, 1983; Watson, 1988; Zajicek and Heilman, 1991; Harris et al., 1999); however, not many studies have been reported for palms.

Diversion of recyclable materials from landfill disposal sites is now a common practice worldwide. The impetus for our study arose from the increased use of “green-waste” for mulch and the potential effect of turfgrass on the growth and establishment of palms in landscapes. The utilization of “green-waste” mulches has steadily increased — yardwastes are now routinely used in landscapes; however, eucalyptus in fresh green-wastes is viewed by many horticulturists as a toxic feedstock because of its allelopathic potential as a living tree. Although eucalyptus mulches stimulated growth of California Sycamore (Downer and Faber, 1994), no information is available on the use of eucalyptus mulches around palms.

The competitive potential of turfgrasses (Festuca spp.) reduces shade tree establishment (Watson and Himelick, 1982; Watson, 1988) and turfgrass has allelopathic effects on trees (Walters and Gilmore, 1976), thus turfgrass removal around trees has become a widely accepted practice (Harris et al., 1999). The effects of turfgrass growing near palms are unknown.

This study characterizes the response of three palm species growing under two mulch treatments and grass competition. The objectives of the study are to demonstrate the viability of using fresh eucalyptus mulch on palms, and determine palm growth response to mulching and tall fescue competition.

2. Materials and methods

2.1. Experimental design and plantings

The experiment was a two-factor, factorial, randomized complete block design with seven replications. Palm species (three levels) and mulch treatment (four levels) comprised factors A and B, respectively. Washingtonia robusta (Mexican fan palm), Syagrus romanzoffiana (queen palm) and Archontophoenix cunninghamiana (king palm) were planted in rows every 10 m from number 1 to 3.61 l (1 gal) containers, into a Sorrento loam soil (fine-loamy, mixed, thermic calcic Haploxerolls) in Ventura, CA. Its chemical properties were as follows: pH, 7.2;
electrical conductivity (EC), 1.46 dS/m; ammonium nitrogen, 7.6 ppm; nitrate nitrogen, 36.7 ppm; total nitrogen, 0.088%; phosphorus, 88 ppm; potassium, 27 meq/l.

2.2. Mulch treatments

One of four treatments were applied to each palm replicate: (1) unmulched; (2) mulched with grass clippings; (3) mulched with eucalyptus chips; (4) planted with tall fescue (Festuca elatior L. ‘Bonzi’) turfgrass. Unmulched plots were maintained in a weed free condition by hoeing. Grass clippings of the above cultivar were initially obtained from a sod farm, subsequent applications were clipped from treatment four and placed on treatment two. Branches of Eucalyptus sideroxylon A. Cunn. ex Wools (2–4 cm diameter) were shredded to produce coarse chips and applied as mulch on the same day they were trimmed from the tree. No composting was performed on the eucalyptus or turfgrass clippings mulches. Tall fescue was seeded at 489 kg/ha. Mulches were applied in 2\(\times\)2 m\(^2\) plots and replenished annually for eucalyptus chips and quarterly for grass clippings mulch. Mulches were initially applied to 15 cm depth and on subsequent applications enough mulch was added to maintain the 15 cm depth. Palms were planted in March 1993, mulches were applied in May 1993.

2.3. Plot management

The plots were irrigated using pressure compensating micro-sprinklers and scheduled to replace reference evapotranspiration loss that was estimated with a Livingston atmometer (C&M Meteorological, Boulder). No fertilizers or herbicides were applied before or during the experiment.

Weed growth was absent in mulched plots, when an occasional weed was found it was removed by hand pulling. Eucalyptus and grass clippings mulch were equally effective weed control barriers.

2.4. Soil moisture sensing and transpiration monitoring

Soil moisture tension was monitored under the mulch treatments of the W. Robusta palms. Five replications of each mulch treatment were monitored at two depths with tensiometers constructed as described by Gaussoin et al. (1990). Tensiometer readings were recorded between irrigations during a planned dry-down period. During the dry-down period, 100 mm of reference evapotranspiration was measured between irrigations.

Transpiration was measured with a Licor 1600 autoporometer (Licor, Lincoln NB). Measurements were taken on the most recently expanded mature leaf of each species. Three leaves were measured on each palm and trees were measured
following the blocked experimental design. Readings were taken for approximately 1 h during midday. Stomatal conductance readings were taken near the end of an irrigation cycle after 100 mm of estimated evapotranspiration.

2.5. Growth measurements

Palm growth was monitored by recording measurements of the basal stem diameter, the total number of new leaves emerged since planting, and the overall volume of the palm as estimated by calculating the product of the palm height and crown span in two directions. Growth measurements were made on 19 July 1995.

2.6. Laboratory analyses

Mulch chemical qualities were analyzed by the Division of Agriculture and Natural Resources laboratory, University of California, Davis, CA. Representative tissue and soil samples were pooled from several plots for analysis of chemical qualities. Samples were taken 2 weeks after mulch application.

3. Results

3.1. Effects of mulches on palm growth and establishment

Mulches stimulated leaf production and increased palm stem calipers; however, tree volume was not significantly increased by mulch treatment (Table 1). Mexican fan palm grew larger (volume), more leaves and developed larger stems than queen or king palm. Growth restrictions (plant volume) were evident in turfgrass treated king palms and significant in turfgrass treated queen palms (Table 2). None of the treatments significantly altered the growth of Mexican fan palms. Basal calipers (BCs) of queen and king palms were reduced in turfgrass treated plots and king palm BC were increased by eucalyptus mulches compared to palms growing in unmulched soils (Table 2).

Only king palms died during the experiment. The highest mortality occurred in turfgrass plots; however, there was no palm mortality in mulch plots (Table 1).

3.2. Soil moisture tension under mulched plots and stomatal conductance

Turfgrass treatments resulted in the highest soil matric potentials in underlying soils (Fig. 1). Unmulched soils had matric potentials intermediate between turfgrass and mulch treated soils which had the lowest matric potentials (wettest
soil) of all treatments. Mulches did not differ significantly in their ability to maintain low soil matric potential.

Moisture loss from foliage (stomatal conductance) was significantly affected by palm species and mulch treatment (Table 3, main effects). While both main effects were significant, the treatment effect was significant in queen and king palms. Moisture loss from Mexican fan palms was not affected by mulch treatment. Turfgrass treated queen and king palms lost significantly less moisture

Table 1
Main effects of mulches on palm growth and mortality

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Leaves</th>
<th>Caliper</th>
<th>Volume</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmulched</td>
<td>23.2ab</td>
<td>23.7a</td>
<td>8.4a</td>
<td>2</td>
</tr>
<tr>
<td>Turfgrass</td>
<td>22.0b</td>
<td>20.4b</td>
<td>7.6a</td>
<td>3</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>25.7a</td>
<td>26.4a</td>
<td>11.3a</td>
<td>0</td>
</tr>
<tr>
<td>Turfgrass clippings</td>
<td>26.0a</td>
<td>26.4a</td>
<td>11.76a</td>
<td>0</td>
</tr>
<tr>
<td>Significance level</td>
<td>***</td>
<td>***</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Leaves</th>
<th>Caliper</th>
<th>Volume</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexican fan palm</td>
<td>53.3a</td>
<td>48.9a</td>
<td>23.03a</td>
<td>0</td>
</tr>
<tr>
<td>Queen palm</td>
<td>9.1b</td>
<td>8.4c</td>
<td>1.63b</td>
<td>0</td>
</tr>
<tr>
<td>King palm</td>
<td>10.3b</td>
<td>15.6b</td>
<td>4.63b</td>
<td>5</td>
</tr>
<tr>
<td>Significance level</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td></td>
</tr>
</tbody>
</table>

*aLeaves are the number of leaves produced by palms since mulching.
*bCaliper is the basal caliper (cm) measured at the widest point.
*cVolume is the size of the plant measured as height × width × length (m³).
*dMortality is the number of plants that died during the experiment in the given treatment.
*eSignificance of main effect measured by factorial ANOVA is \( P < 0.0001 \) (***) or not significantly different (NS). Means separated by Tukey’s HSD, \( P < 0.01 \).

Moisture loss from foliage (stomatal conductance) was significantly affected by palm species and mulch treatment (Table 3, main effects). While both main effects were significant, the treatment effect was significant in queen and king palms. Moisture loss from Mexican fan palms was not affected by mulch treatment. Turfgrass treated queen and king palms lost significantly less moisture

Table 2
Interaction means for growth of three palm species in various mulch treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Queen palm</th>
<th>King palm</th>
<th>Mexican fan palm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>BC</td>
<td>V</td>
</tr>
<tr>
<td>Bare soil</td>
<td>11</td>
<td>17.2</td>
<td>5.1</td>
</tr>
<tr>
<td>Turfgrass</td>
<td>8</td>
<td>9.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Eucalyptus mulch</td>
<td>11</td>
<td>18.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Clippings mulch</td>
<td>11</td>
<td>17.5</td>
<td>4.6</td>
</tr>
<tr>
<td>LSD(^{c})</td>
<td>2.7</td>
<td>3.8</td>
<td>2.2</td>
</tr>
</tbody>
</table>

\(^{a}\)Measurements from 19 July 1995.

\(^{b}\)L is the number of leaves produced since mulches were applied, BC is the basal caliper of the palm (cm), and V is the volume of space occupied (m³) by the palm.

\(^{c}\)LSD is the least significant difference value at \( P < 0.05 \).
than mulched or unmulched plants indicating a higher level of moisture stress in these treatments.

3.3. Mulch and soil qualities

The Sorrento loam soil has a suitable pH and salinity level for growth of most ornamental plants; however, the concentration of nitrogen and potassium are low. Although eucalyptus chips contain higher levels of N, P, and K than the field soil,

Table 3
Stomatal conductance of three palm species under various mulches

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stomatal conductancea</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main effects</td>
<td>Queen palm</td>
<td>King palm</td>
<td>Mexican fan palm</td>
</tr>
<tr>
<td>Bare soil</td>
<td>264ab</td>
<td>280</td>
<td>143</td>
<td>404</td>
</tr>
<tr>
<td>Turfgrass</td>
<td>223b</td>
<td>284ab</td>
<td>132ab</td>
<td>377a</td>
</tr>
<tr>
<td>Eucalyptus mulch</td>
<td>304a</td>
<td>200b</td>
<td>74b</td>
<td>395a</td>
</tr>
<tr>
<td>Clippings mulch</td>
<td>313a</td>
<td>310ab</td>
<td>184a</td>
<td>417a</td>
</tr>
</tbody>
</table>

aStomatal conductance in mmol H2O m-2 s-1, average of three readings per tree and seven tree replications. Means in columns followed by the same letters are not significantly different according to Tukey’s HSD (P<0.01). Main effects for palm variety (row means) are all statistically different from each other according to Tukey’s HSD (P<0.05).
turfgrass clippings had the highest mineral nutrient concentrations of any mulch applied (Table 4).

4. Discussion

It is generally accepted that mulches benefit woody ornamental plantings by suppressing weeds and helping to conserve moisture that would otherwise be lost through evaporation and transpiration through competing weed species (Robinson, 1988). In our study, we used tall fescue turfgrass to act as competition. Our results suggest palms benefit from reduction of competition that mulches provide. Mulching alone did not always cause significant palm growth increases suggesting that weed control (lack of turfgrass) is the most important benefit to palm culture. Although Mexican fan palm was little affected by mulch treatments, king palms benefited from mulch applied near them in lieu of turfgrass or bare soil. The lack of treatment response from Mexican fan palms may be because of their rapid growth rates that enable their root systems to grow beyond the influence of mulched zones. *Washingtonia* was the fastest growing species in this study and is also known for its drought tolerance (Meerow, 1992). Mulch benefits may be superfluous to Mexican fan palm establishment.

Some palms require equal ratios of nitrogen and potassium for optimal growth (Meerow, 1990). Organic mulches slowly add significant amounts of macronutrients to soil as they mineralize (Stephensen and Schuster, 1945; Tukey and Schoff, 1963). Although rapidly decomposing, turfgrass clippings mulch supplies a high concentration of nitrogen and potassium to palm plantings. A disadvantage of turfgrass clippings as mulch is the frequent need to replenish the mulch due to decomposition. Tree trimmings mulches such as eucalyptus persist longer in landscapes than non-woody mulches made of herbaceous plants or turfgrass clippings. There were no symptoms of nitrogen (N) deficiency in the palms due to N loss (draft) from mulch decomposition. Since mixing with soil was avoided (mulches applied strictly to the soil surface), nitrogen draft to underlying soil is unlikely.

King palm, which is difficult to establish, benefited from mulch applications. Mortality of king palm associated with turfgrass and survival associated with

<table>
<thead>
<tr>
<th>Mulch</th>
<th>pH</th>
<th>EC (dS/m)</th>
<th>NH$_4$-N (ppm)</th>
<th>NO$_3$-N (ppm)</th>
<th>N$_{tot}$ (%)</th>
<th>P (ppm)</th>
<th>K (meq/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptus</td>
<td>5.7</td>
<td>4.3</td>
<td>138</td>
<td>2.1</td>
<td>0.966</td>
<td>428</td>
<td>25</td>
</tr>
<tr>
<td>Tall fescue clippings</td>
<td>5.8</td>
<td>12.8</td>
<td>2190</td>
<td>1.0</td>
<td>2.932</td>
<td>1330</td>
<td>101</td>
</tr>
</tbody>
</table>

Table 4
Chemical qualities of Eucalyptus and grass clippings mulches
mulch suggest that if water is limiting, palms may grow better in the absence of turfgrass with a thick organic mulch layer. Although some eucalyptus trees are allelopathic (del Moral and Muller, 1969, 1970), mulch made from eucalyptus branches is subject to immediate biological decay and is by definition (Rice, 1984), not an allelopathy source. Living turfgrass may pose a greater allelopathic threat to palm culture since the turfgrass is a living organism and is a known source of allelochemicals (Walters and Gilmore, 1976). Turfgrass also exerts competition for water and mineral nutrients. Turfgrass clippings and *E. sideroxylon* mulches enhance the culture of palms by providing an aesthetic weed free environment and helping to conserve soil moisture during early establishment.

**References**