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Influence of Light, Medium, and Fertilization on Growth and Acclimatization of Ponytail Palm

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Abstract. **Ponytail palms (*Beaucarnea recurvata* L.) were grown in three media having similar water holding capacities but different porosities, under 70%, 50%, or 27% full sunlight and fertilized with each irrigation or once every three irrigations. Plants grown in media with lower porosities grew more than plants in a peat-lite medium but required more frequent irrigation. Plants grew less under 27% full sun than at the two higher light levels. Frequent fertilization did not increase plant size but decreased pH and increased electrical conductivity of the growth medium leachate substantially. Plant acclimatization increased with decreasing production light intensity and noncapillary porosity of the medium.**

Ponytail palm (*Beaucarnea recurvata* L.) has a swollen stem base with long, recurved leaves that make it an attractive foliage plant. Growing this species under heavy shade for interior use requires long production times and results in small plants. Low light level is suspected of being partially responsible for the stunted growth. Areca palm was reported to be shorter and of lower quality when production light level decreased from 60% to 40% and 20% full sun (9). Other factors, such as medium composition (1, 5) and nutrition (11), affect plant growth and also could be involved in growth responses of ponytail palm. Conover and Poole (4) found a significant interaction between light and fertility level in the growth of *Maranta leuconeura*. Increasing levels of fertilizer reduced yield of *M. leuconeura* under 80% shade but had no effect under 60% shade. Reduced light and fertility levels during production increased the acclimatization of *Ficus benjamina* (3, 8, 10). This study was initiated to determine the effects of light, container medium, and frequency of nutrient application on the growth and acclimatization of ponytail palm.

Three-month old ponytail palm seedlings, grown under 27% full sun, were planted in 150-mm plastic pots (2 liters in volume) on 29 Jan. 1985 using the following media: M1 (Sunshine mix #1, a peat-lite medium; Fisons, Vancouver, B.C., Canada); M2 [1 part Metro Mix 200 (a peat-lite medium; W.R. Grace and Co., Fogelsville, Pa.), 1 part Soil Conditioner (aged pine bark, <13 mm in diameter; Wonder Chemical Co., Livinston, Texas]; M3 (2 parts Metro Mix 200, 2 parts Soil Conditioner, 1 part builder's sand). All ingredients were measured by volume. No additional lime or micronutrients were added to these media. The water holding capacities of the media M1, M2, and M3 were 1033 g, 1076 g, and 1000 g of water per pot, respectively. Noncapillary porosities of the media were 19%, 16%, and 10% for M1, M2, and M3, respectively, determined by the method of Joiner and Conover (7).

All plants were maintained under 27% full sun for 3 weeks after potting to permit recovery from transplanting. Full sun was 1140 $\mu mol \cdot s^{-1} \cdot m^{-2}$ (PPF, 400–700 nm) on 28 Jan. and 2470 $\mu mol \cdot s^{-1} \cdot m^{-2}$ on 22 June. Two-thirds of the plants in each growing medium then were transferred to a shade house that provided a light level equivalent to 50% full sun. Half of these latter plants were transferred 18 weeks later to a shadehouse providing 30% full sun light.

Plants were watered when the surface of the medium became light in color and dry to the touch. All plants in the same medium within a light level were watered at the same time. Nutrition was supplied with a solution that contained 200 mg N/liter as obtained from a 20N–8.6P–16.6K water soluble fertilizer (W.R. Grace & Co.). Half of the plants in each light level/growing medium combination received the fertilizer solution with each watering (constant feed), the other half of the plants received the fertilizer solution at every third irrigation (intermittent feed). Within each light level, experimental units consisted of one plant per pot replicated eight times in a randomized complete block design. Polypropylene shade fabric was covered with plastic (0.15 mm; 6 mil) until 26 Mar.

On 26 Nov., 43 weeks after potting, plant width (the average of two measurements made horizontally at perpendicular angles to the main axis), height, and stem diameter (at the widest point) were measured. The total number of irrigations were recorded. Leachate (50–60 ml) was collected from each pot using the pour-through method (13) and analyzed for electrical conductivity (EC) (YSI Model 35 conductivity meter) and pH.

Plants were brought into the laboratory the following day for the determination of net carbon exchange rate (CER), which was taken to be a measure of the degree of acclimatization (6). Net CER was calculated from the initial and final CO_2 levels in a Plexiglas leaf chamber as measured by an ADC-225-MK3 infrared CO_2 gas analyzer (Analytical Development Co., Hoddesdon, England). Due to the difficulties of enclosing a fraction of an intact leaf in the leaf chamber without severely twisting the leaf, two successive 90-mm basal sections were taken from a middle leaf that was severed 40 mm above the base immediately before placing them into the leaf chamber (volume, 280 cm^3). Leaf sections were allowed to stay in the chamber for 3 min under 15 $\mu mol \cdot s^{-1} \cdot m^{-2}$ PPF supplied by cool white fluorescent tubes.

Table 1. Growth of ponytail palm and number of irrigations as a function of light level, growing medium and frequency of fertilizer application.[z]

Treatment	Plant width (mm)	Plant height (mm)	Stem diameter (mm)	No. of irrigations
Light (percent full sun)				
70	621 a	286 a	48 a	39 a
50	599 a	293 a	48 a	34 b
27	520 b	215 b	38 b	26 c
Medium[y]				
M1	522 b	243 b	42 b	28 c
M2	600 a	268 ab	45 ab	33 b
M3	611 a	284 a	47 a	38 a
Fertilizer				
Constant	570 a	262 a	45 a	33 a
Intermittent	589 a	267 a	45 a	33 a

[z]Mean separation within factors in columns by LSD at 5% level. There were no significant two- or three-factor interactions.
[y]See text for a description of medium composition.

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Table 2. Effect of light, medium, and frequency of fertilizer application on leachate pH and electrical conductivity, and on net carbon exchange rate of pony tail palm leaves.[z]

Treatment	pH	Electrical conductivity ($mS \cdot cm^{-1}$)	Net carbon exchange rate[y] ($mg \cdot dm^{-2} \cdot hr^{-1}$ of CO_2)
Light (% full sun)			
70	6.21 b	3.74 a	−0.72 c
50	6.18 b	3.65 a	−0.23 b
27	6.34 a	3.31 b	0.16 a
Medium[x]			
M1	6.30 b	3.52 ab	−0.54 b
M2	6.83 a	3.81 a	−0.27 ab
M3	5.60 c	3.38 b	0.02 a
Fertilizer			
Constant	5.67 b	4.24 a	−0.27 a
Intermittent	6.81 a	2.90 b	−0.26 a

[z]Mean separation within factors in columns by LSD at 5% level.
[y]Negative values indicate respiration greater than carbon fixation. Positive values represent net carbon uptake.
[x]See text for a description of medium composition.

Plants grown under 70% or 50% full sun were about equal size and both were larger than plants grown in 27% full sun (Table 1). Medium M1 produced plants that were significantly smaller than those grown in M3. Plants grown in M2 had longer leaves than those in M1 (no data presented), which resulted in wider plants than in M1, although height and stem diameter did not differ statistically in the two media. Plants grew equally well in M2 and M3.

Even though plants on constant feed received 3 times as much fertilizer as those on intermittent feed, plant growth was not affected by fertilizer rates (Table 1). Thus, intermittent fertilization provided adequate nutrition for ponytail palm growth. High fertilizer rates also did not enhance the growth or quality of *Syngonium podophyllum* 'White Butterfly' (2) and constant fertilization at high rates reduced growth in several plant species (4).

Frequency of irrigation increased with larger plants at higher light levels and with decreased porosities of the media (Table 1). *Lantana pictavi* 'Cream Craft' was found to have greater growth in a sand–peat medium having 5.6% noncapillary pore space than in a bark–perlite medium with nearly 40% pore space (7).

Plants used were seedlings, showing a wide range in leaf color, which might have caused the large variations in net carbon exchange rates measured under the low light level. Generally, plants produced under low light levels were better acclimatized for survival under interior light levels than those produced under high light, as shown by the more positive net CER (Table 2). Plants produced under 50% and 70% full sun were depleting carbon reserves under 15 $\mu mol \cdot s^{-1} \cdot m^{-2}$ PPF, whereas plants produced under 27% full sun maintained low rates of net carbon uptake under the same light level. Net CER increased as noncapillary pore space of the medium increased. Fertilizer rates had no effect on the net CER of ponytail palm but reportedly affected acclimatization in other species (8, 10).

There were differences in both pH and EC of the medium leachate due to the effect of light, medium, and fertilization frequency (Table 2), but the differences were not considered to be biologically significant. Medium M3 had a much lower pH than other media, probably due to the additional sand in M3 that reduced its buffering capacity. Increasing the fertilizer application frequency resulted in an increased EC and decreased pH of the leachate, which agrees with previous reports (11, 12). Ponytail palm appears to tolerate fairly high levels of soluble salts in the medium since there was no abnormal necrosis of leaf tips at the high fertility level.

Results suggest that ponytail palm should be grown in media with good aeration and short drying cycles for fast growth and high degree of acclimatization. Plants grew faster under 70% and 50% full sun than those under 27% full sun, but were less acclimatized. Better acclimatization for interior use of plants grown under higher light regimes has been achieved by increasing shade levels during the final weeks of production (6), a practice that may be applicable to ponytail palm. Fertilizing with water containing 200 ppm N from a 20N–8.6P–16K fertilizer once every third irrigation supplies adequate nutrients for good growth.

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