Propagation of *Phoenix dactylifera* Cultivars©

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Date palms are one the world's oldest cultivated crops, literally going back for several millennia. Two methods have traditionally been used for propagation; one sexual and one asexual. Sexual propagation from seeds has value for production of landscape palms and for breeding purposes for new cultivars. However, being dioecious in nature and due to the great genetic diversity of this plant when grown as a fruit crop asexual propagation from offshoots (small shoots growing from the trunk of the mother palm) has proven to be the most reliable method to keep fruit cultivars true to variety. As a woody monocotyledon date palms cannot be propagated by grafting.

A newer method of asexual propagation of date palms is tissue culture. This is still a controversial procedure as there are two distinct schools of thought regarding this procedure. One school being that it is a viable procedure greatly reducing the time required to come into fruit production as well as keeping the cultivar true to variety.

The other school of thought being that with this method of propagation they do not stay true to type. Both schools are recognized by equally credible authorities. Having no direct experience with this newer method of propagation I do not feel qualified to render a professional opinion either way.

Vegetative Propagation of Southwestern Plants: *Ambrosia deltoidea, Buddleja marrubifolia, Vauquelinia californica,* and *Vauquelinia corymbosa*©

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INTRODUCTION

Vegetative propagation of four species native to the Southwestern United States is described in the following experiments. *Buddleja marrubifolia* is a dependable shrub for the arid landscape because it tolerates poor soil, drought, and heat. The wooly butterfly bush is known to root from softwood cuttings during springtime when treated with IBA at 5000 ppm and in summer when treated with IBA at 3000 ppm (Nokes, 2001). Hardwood cuttings of some *Buddleja* species have been reported to root when taken in winter. *Vauquelinia californica* is a popular landscape shrub with evergreen, leathery leaves. Propagation by cutting is preferred, but rooting of cuttings has proven recalcitrant (Charles, 1961; Dehgan et al., 1977). Differences in rooting were found in response to season, clone, and IBA treatments, with no one treatment consistently superior (Smith, 1982). *Vauquelinia corymbosa*, an evergreen shrub with leaves narrower than those of *V. californica*, is currently underutilized in Southwestern landscapes. *Ambrosia deltoidea* is an undemanding low-growing shrub, important for revegetation and erosion control. No information regarding vegetative propagation has been published for *V. corymbosa* and *A. deltoidea.*

MATERIALS AND METHODS

Individual cuttings were placed in plug trays (128 plugs per tray with 25 ml volume) in a medium of medium-grade perlite and medium-grade vermiculite (1 : 1, v/v). Cuttings were considered rooted when they had one root of at least 0.5 cm length. A subjective category "commercially viable cuttings" was added, and only cuttings with multiple, healthy roots of more than 1 cm length were deemed appropriate for this category. Chemicals used in the following experiments were Dip 'N Grow (Astoria Pacific, Clackamas, Oregon) which contains 1% indole-3-butyric acid and 0.5% 1-naphthaleneacetic acid, Hormodin #1 (Geiger, Inc., Harleysville, Pennsylvania), which contains 0.1% indole-3-butyric acid (1000 ppm), and Hormodin 2, which contains 0.3% indole-3-butyric acid (3000 ppm).

Ambrosia deltoidea. Cuttings of *Ambrosia deltoidea* were collected from wild populations in Tucson on 14 Feb. 2001. Plants had completed their first flush of growth early due to heavy winter rains. Thirty cuttings each were randomly assigned to the following treatments: Dip 'N Grow at 0, 2500, or 5000 ppm, and bottom heat at 70, 80, or 90°F (21, 27, 32°C). Both tip and medial cuttings were exposed to the nine hormone/bottom heat combination treatments. Cuttings were maintained under intermittent mist (6 sec every 8 min during photoperiod) in a greenhouse at the University of Arizona in Tucson for 28 days. A second experiment started on 26 March 2001 and used only medial cuttings, 45 replications per treatment, as flowers were present on all shoot tips. Because of the increase in ambient temperature bottom heat treatments were 85°F (29,°C) or no bottom heat, and Dip 'N Grow was applied at 0, 2500, or 5000 ppm. Daily minimum and maximum media temperatures for the 85°F bottom heat treatment fluctuated between 78 and 88°F (25 and 31°C), those for the no bottom heat treatment oscillated between 57 and 80°F (14 and 27°C). Cuttings remained under intermittent mist for 25 days.

In early spring of 2002 we were unable to propagate cuttings from plants growing in the desert that were used as stock plants the previous year. Late winter rains were too scarce to produce new shoot growth. In May 2002 we had access to plants that accidentally received supplemental water and had produced ample shoots for propagation. Tip cuttings with a length of approximately 7.5 cm were prepared on 6 May 2002 as described above and the same cultural procedures as described above were used. Media temperature was maintained at an average of 83°F (28°C). Basal ends of plants were either dipped in water (control) or in Hormodin 1 (1000 ppm), Hormodin 2 (3000 ppm), Dip 'N Grow at 2500 ppm or 5000 ppm. Sixteen cuttings of each treatment were replicated in 6 blocks. Plants were evaluated as before on 3 June 2002.

Buddleja marrubifolia. Softwood cuttings of *Buddleja marrubifolia* approximately 7.5 cm long were taken from mature plants growing in Tucson on 25 Sept. 2001. Basal leaves and flower buds were removed with two pairs of leaves remaining at the apical part of the cutting. Stock plants were irrigated for general landscape maintenance. The basal end of cuttings was dipped in either water or Dip N' Grow at 2000, 4000, or 6000 ppm. Cuttings received mist irrigation during daylight hours for 6 sec every 8 min and bottom heat maintained media temperature at 90°F (32°C). Each treatment was replicated with 10 cuttings in 5 blocks each and rooting of cuttings was evaluated on 26 Oct. 2001, 31 days after the experiment was initiated.

For the second experiment cuttings were taken from the same plants as described above on 28 June 2002. Fertilization and supplemental irrigation were provided three weeks before harvesting cuttings to stimulate the growth of softwood as spring rainfall was well below average. Cutting preparation and cultural practices were the same as described above. Cuttings were randomly assigned to the following treatments: control was dipped in water, Dip 'N Grow at 2500 ppm, Hormodin #1 at 1000 ppm, or Hormodin #2 at 3000 ppm. Each of these treatments was placed either on a bench without shade cloth or under shade cloth. The roof of the greenhouse where propagation experiments were conducted was covered with a 45% shade cloth which resulted in 69% shade at the canopy level of plants. Additional shade provided for this experiment reduced light at canopy level 80% compared to outdoors. Once cuttings started to form callus or initiate roots, misting was reduced to 6 sec every 16 min. Thirty cuttings (10 cuttings in 3 blocks) were used for each treatment combination. Cuttings were inspected on 23 July 2002 for roots or callus, 26 days after the experiment was initiated. The third experiment was initiated on 4 Sept. 2002 and cuttings were evaluated for rooting 26 days later on 30 Sept. 2002. The experimental protocol as described in the second experiment was followed with the following treatments: control dipped in water, Dip 'N Grow at 1000 and 3000 ppm, Hormodin at 1000 and 3000 ppm, and 15 cuttings in three blocks each under the two shade regimes as described above.

Vauquelinia californica. For the first experiment cuttings of *V. californica* were collected on 5 July 2001 from three mature shrubs growing in Tucson. Cuttings were somewhat harder compared to typical softwood cuttings. Tip cuttings were approximately 7.5 cm to 10 cm long and leaves within 4 cm of the basal end as well as apical tips were removed. Misting was applied every 8 min for 10 sec during daylight hours. Basal ends of cuttings were treated with Dip 'N Grow at 0, 2000, 4000, or 6000 ppm and plants were either grown with or without bottom heat. Bottom heat was set to maintain 90°F (32°C) media temperature, while media temperature in trays without bottom heat was approximately 80°F (27°C). Sixteen cuttings of each treatment combination were replicated in three blocks. Plants were evaluated after 8 weeks for rooting as described above on 31 August 2001.

A second experiment with *V. californica* was initiated on 20 May 2002 and evaluated 40 days later on 28 June 2002. Plants were collected from the same shrubs as in 2001 and preparation of the typical softwood cuttings was performed as described above. Misting was applied during daylight hours every 8 min for 10 sec. Bottom heat was maintained at 85°F (29°C). The following treatments were used: control (dip in water), Hormodin 1 (1000 ppm), Hormodin 2 (3000 ppm), Hormodin 3 (8000 ppm), Dip 'N Grow at 2500 ppm or Dip 'N Grow at 5000 ppm. Each treatment was replicated with ten cuttings in 6 blocks.

Vauquelinia corymbosa. Cuttings of *V. corymbosa* were collected on 5 July 2001 from container plants growing outdoors in Tucson, AZ. Cuttings were approximately 7.5 cm to 10 cm long and leaves within 4 cm of the basal end and apical tips were removed. Media and propagation trays were the same as described above and misting was applied during daylight hours every 8 min for 10 sec. The basal end of cuttings was treated with Dip 'N Grow at 0, 2500, or 5000 ppm and plants were grown with bottom heat set at 85°F (29°C). Twelve cuttings of each treatment were replicated in three blocks. Plants were evaluated after 8 weeks for rooting as described above on 31 August 2001.

RESULTS AND DISCUSSION

Ambrosia deltoidea. Regardless of bottom heat, hormone treatment or type of cutting, 50% to 90% of cuttings from the first spring flush of *Ambrosia deltoidea* were rooted after 28 days. The percentage of commercially acceptable cuttings rose above 40% when cuttings were grown with 80 to 90°F (27 to 32°C) bottom heat and were treated with Dip 'N Grow at concentrations of 2500 to 5000 ppm. In the second experiment, bottom heat at 85ºF and Dip 'N Grow at 2500 or 5000 ppm were essential to obtain rooting percentages of 49% and 42%, respectively with 29% and 18% considered commercially acceptable. All other treatments yielded less than 15% rooted cuttings with few considered commercially acceptable.

Highest rooting percentage in 2002 was achieved with a treatment of Hormodin 1, and lowest rooting occurred on plants treated with Dip 'N Grow at 2500 ppm (Table 1). All treatments including the control resulted in 50 to 70% commercially acceptable cuttings.

Table 1. Effect of hormone treatment on rooting of *Ambrosia deltoidea* 29 days after cuttings were stuck on 6 May 2002.

Treatment	Rooted (%)	Unrooted (%)	Commercially acceptable (%)
Control	80.0 ab[z]	20.0 ab	60.1 a
Hormodin 1000 ppm	94.7 a	5.3 b	70.3 a
Hormodin 3000 ppm	70.8 ab	29.2 ab	50.0 a
Dip 'N Grow 2500 ppm	68.1 b	31.9 a	49.6 a
Dip 'N Grow 5000 ppm	70.4 ab	29.6 ab	51.5 a

[z] Means within a column followed by different letters are significantly different at $P<0.05$.

Results from the 2001 experiment had similar rooting percentages for plants treated with Dip 'N Grow (Hormodin was not used), but the 2002 experiment yielded much greater percentages of commercially acceptable plants with healthy, well developed root systems. The primary difference between the 2 years was that stock plants in 2002 were near a broken water line and had received ample water for a period of time, while those in 2001 had relied on natural rainfall. It appears that thorough irrigation of stock plants is essential to produce a first flush of new shoots that can be rooted easily. Maintaining media temperature around 85ºF and providing IBA or a combination of IBA and NAA may increase the percentage of commercially acceptable cuttings.

Buddleja marrubifolia: In the first experiment Dip 'N Grow at 2000 or 4000 ppm resulted in 90% rooting of cuttings after 31 days with a lower percentage of commercially viable cuttings (Table 2). Both 0 ppm and 6000 ppm resulted in lower rooting percentages. The combination of IBA and NAA at 2000 to 4000 ppm appears to successfully extend the season for rooting softwood cuttings of *B. marrubifolia* into fall.

In the second experiment all hormone treatments improved rooting percentage significantly over the control (Table 3). While there is no significant difference in rooting among hormone treatments, plants treated with 3000 ppm Hormodin had the lowest percentage of unrooted cuttings.

Table 2. Rooting response of *Buddleja marrubifolia* cuttings 31 days after treatment with different concentrations of hormone on 25 Sept.2001.

Dip 'N Grow (ppm)	Rooting (%)	Unrooted (%)	Commercially viable (%)
0	58 b[z]	42 a	28 a
2000	90 a	10 b	50 a
4000	90 a	10 b	62 a
6000	64 ab	36 ab	26 a

[z] Means within a column followed by different letters are significantly different at P<0.05.

Table 3. Effect of hormone treatments on rooting of *Buddleja marrubifolia* stuck on 28 June 2002 and maintained for 26 days under mist. Means are averaged over the two shade treatments and are calculated for 60 cuttings.

Dip 'N Grow (ppm)	Rooting (%)	Callused (%)	Unrooted (%)	Commercially viable (%)
Control	28.2 b[z]	22.8 a	48.9 a	13.6 b
Dip 'N Grow 2500 ppm	75.2 a	3.3 b	21.5 b	59.4 a
Hormodin 1000 ppm	74.1 a	9.7 b	16.2 bc	52.6 a
Hormodin 3000 ppm	93.3 a	3.3 b	3.3 c	73.5 a

[z] Means within a column followed by different letters are significantly different at P<0.05.

Table 4. Effect of hormone treatment and bottom heat on rooting of *Vauquelinia californica* cuttings stuck on 5 July 2001 and evaluated 8 weeks later.

Dip 'N Grow (ppm)	Rooting (%)	Callused (%)	Unrooted (%)	Commercially viable (%)
0	13.6 a[z]	43.1 a	43.1 a	1.04 a
2000	26.8 a	29.7 a	43.4 a	1.04 a
4000	12.5 a	45.5 a	42.0 a	2.08 a
6000	26.5 a	31.7 a	42.1 a	6.45 a
Bottom heat (°F)				
80	23.3 a[z]	41.2 a	35.4 b	3.75 a
90	16.3 a	33.8 a	49.9 a	1.56 a

[z] Means within a column followed by different letters are significantly different at P<0.05.

Table 5. Effect of hormone treatment on rooting of *Vauquelinia corymbosa* cuttings stuck July 5, 2001 and evaluated 8 weeks later.

Dip 'N Grow (ppm)	Rooting (%)	Callused (%)	Unrooted (%)	Commercially viable (%)
0	13.8 b[z]	22.2 a	63.9 a	5.5 b
2500	32.3 a	18.6 a	49.1 a	26.9 a
5000	44.4 a	13.9 a	41.7 a	36.1 a

[z] Means within a column followed by different letters are significantly different at P<0.05.

Rooting percentage in the third experiment ranged from 74% to 93% with no significant difference between treatments. Commercially acceptable rooting percentage was highest for Dip 'N Grow at 1000 ppm with 85% and lowest for the control treatment at 56%. All other treatments were not significantly different from these two values. Shade treatment had no effect on rooting in this experiment.

Shade treatment increased the percentage of commercially viable cuttings from 38% without shade to 61% with shade in the second experiment. The number of cuttings that were rooted, callused, or unrooted were not affected by shade. Light intensity in Tucson reaches maximum levels in June and remains high in July until the onset of summer rains and increased clouds. Additional shade seemed to be beneficial for quality of cuttings during the time of highest light intensity, similarly to other woody plants which showed improved rooting of cuttings under lower irradiance (Hartman et al., 2002). However, during the month of September the shade treatment did not confer additional benefits for rooting. This experiment confirms recommendations by Nokes (2001), but offers the additional potential of increasing commercially viable cuttings by reducing the light intensity in the propagation environment during the month of June.

Vauquelinia californica. Rooting percentage did not exceed 27% with even fewer cuttings commercially acceptable (Table 4). While more cuttings developed callus, no root initiation occurred within 8 weeks after cuttings were taken. Concentration of hormone treatment did not affect rooting or callusing of cuttings. Bottom heat at 90°F (32°C) resulted in a greater percentage of unrooted cuttings than those grown without supplemental heat (Table 3).

All treatments failed to produce roots or callus in the second experiment. This was surprising since the cuttings were in excellent condition and in what is generally considered a desirable softwood stage. No disease or insect problems were detected on cuttings.

Best results were achieved in a small preliminary experiment from September 25, 2000 until 1 Dec. 2000. Sixteen medial and tip cuttings each were treated with Dip 'N Grow at 0 or 5000 ppm, and bottom heat (85°F or 29°C) or no bottom heat (75°F or 24°C). Rooting percentage varied between 31% and 62% for this small sample. Smith (1982) found rooting percentages to range from 0 to 93% between clones, and IBA at 4000 and 8000 ppm caused superior root initiation in some experiments. She reported that more rooted cuttings were produced in May and June (44%), while rooting percentage declined in July (33%) and August (9%). While our greatest success in rooting rested with the preliminary experiment, we were unable to obtain rooting percentages greater than 30% in the later experiments. We still found Arizona rosewood (*V. californica*) a recalcitrant plant to root from cuttings and propose further experiments to investigate how the physiological status of the stock plants affect rooting of cuttings.

Vauquelinia corymbosa. Treatment with either concentration of hormone produced more commercially viable and more rooted cuttings than untreated controls (Table 5). Although hormone treatment improved the percentage of commercially viable cuttings, further venues to raise the number of acceptable cuttings need to be explored.

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Using Reclaimed Water in Production of Containerized Nursery Stock©

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Civano Nursery, located in the far-east side of Tucson, Arizona, has significantly reduced its water costs by converting from city potable water to city reclaimed water. In addition to the reduced water costs, the nursery is beginning to evaluate the potential nutritional benefits in hopes of further savings. The nursery is established within the community of Civano, a special community that has incorporated many self-sustaining concepts including the use of reclaimed water on common area and residential landscapes. The nursery was established within the community of Civano because the opportunities connected to the community and the future demand for a nursery/garden center in this expanding area of town.

Ground broke for the nursery in Fall 1997. Although the nursery was originally irrigated with potable water, the irrigation system was designed and installed in anticipation of the arrival of reclaimed water to the community. During Summer 1999, the reclaimed water meter was installed, and the nursery began conversion to the reclaimed water. Not knowing the full effects of the reclaimed water on the more than 500 species of plants grown at the nursery, a gradual conversion process was implemented.

The reclaimed water was first introduced to the larger stock, that was on a spray stake-type irrigation system. During the same season, a few experimental areas with overhead spray were set up to see the effects on the foliage of a few selected species. After consulting with colleagues and known experts, and the completion of these trials, it became obvious that the quality of the reclaimed water was suitable for irrigation. As of Summer 2000, the entire nursery is being irrigated with reclaimed water.

The nitrogen charge that is provided by the reclaimed water is a benefit currently being realized. Liquid feed levels have been reduced by 15% resulting in significant savings in fertilizer costs. Difficulties in maintaining proper pH, equipment failure, and mineral deposits on foliage are ongoing issues currently being managed.

By and large the benefits from the use of reclaimed water remain with the cost savings on irrigation and fertilizer. An added benefit is the positive image it creates in the community by no longer drawing from Tucson's precious natural water resource. Reclaimed water is a valuable alternative to the use of potable water in areas of decreasing natural water supplies.