# CUTTING PROPAGATION OF *SEQUOIA SEMPERVIRENS* CULTIVARS

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**Abstract.** The introduction of several vegetatively propagated cultivars of *Sequoia sempervirens* (D. Don) Endl in recent years has resulted in vast improvements over the highly variable seed propagated specimens in ornamental use. Selected for superiority of growth habit, texture, and foliage color, these selected cultivars continue to gain in popularity in many areas for their use as landscape ornamentals The efficient, commercial cutting propagation of these selected cultivars requires the selection of the optimal type and concentration of rooting hormone for each cultivar.

Cuttings of three selected cultivars of *Sequoia sempervirens* were treated with a variety of rooting hormones and rooted in flats in a peat/perlite medium on oudoor rooting beds with full sun, bottom heat, and intermittent mist 'Majestic Beauty'™ rooted best with a combination of 3000 ppm IBA + 3000 ppm NAA. 'Santa Cruz' exhibited optimal rooting with 16,000 ppm IBA powder. 'Soquel' responded best with a combination of 6000 ppm IBA + 6000 ppm NAA.

## INTRODUCTION

*Sequoia sempervirens* (D. Don) Endl., or "coast redwood", has long been admired for the beauty of its bark, foliage, and pyramidal form, as well as the sheer majesty of centuries old specimens in a native setting. Rapid growth, adaptibility to a wide range of soil and environmental conditions, relatively pest-free habit, woodsy appearance, and natural heritage have made the coast redwood a popular selection for use in the landscape. During the past few years, the introduction of several vegetatively propagated cultivars for landscape use has resulted in some major improvements over seedling stock.

**Background.** *Sequoia sempervirens* grows native only within the summer fog belt of northern California and the southwestern portion of Oregon, rarely more than 30 miles from the coast, although it widely planted as an ornamental in western Oregon and all but the hottest areas of California. Rated hardy through Zone 7, plants are not common north of Virginia in the eastern states. Coast redwood trees have also been grown successfully as ornamentals in areas of Australia, England, France, Italy, New Zealand, South America, and Spain (1,2,4,5,6,16,21).

Specimens of *Sequoia* were first carried to England in 1795 and remained undescribed until 1823 when Lambert classified them as *Taxodium sempervirens* in the family Taxodiaceae. In 1847, Endlicher classified them into their own genus, *Sequoia*, and retained the species name. The genus was named for

Sequoyah, a Cherokee half-breed of Georgia, who originated the Cherokee alphabet. The species name refers to its evergreen character. The early Spanish Californians referred to it as "palo colorado", meaning "red tree". It is commonly known as "redwood" or "coast redwood" because of its beautiful pink or reddish colored heartwood. Closely related to *Sequoia* are *Sequoiadendron giganteum*, the big tree, or Sierra redwood, and *Metasequoia glyptostroboides*, the dawn redwood, a deciduous species (1,2,5,8,21).

**Use.** In the home garden, *Sequoia* performs well as a shade tree, a specimen tree, or in groups. Trees grow well with an abundance of water, will grow in or next to a lawn, and are tolerant of most soil types if water is provided. Plants grow best in full sun in most areas, but will tolerate partial shade. Under optimal conditions, tree may grow up to five feet per year (6,15,20,22).

*Sequoia* rarely is affected by insect or disease problems, and is not attacked by *Botryosphaeria ribis*, causing branch die-back, as is *Sequoiadendron* when stressed by heat, drought, or air pollution. Growth and appearance of *Sequoia* may be less than optimal due to a lack of water, lack of available iron, or competition from other trees (15,22).

In the landscape, *Sequoia* has been used extensively along expressways and as specimens, or in groves in parks and on golf courses. Certain cultivars do well when planted close and topped at least once a year to form a feathery hedge or large divider (20,22).

Redwood constitutes a major portion of the California lumber industry, being slower than many other woods to burn, relatively resistant to termite attack for many years, and unusually resistant to other insects and fungi. The presence of a substance called tannin in the wood appears to be responsible for this resistance, and is also responsible for imparting the reddish pigment to the wood. Extensive commercial use of redwood has for many years been the basis of concern for their conservation from educational, social, and inspirational points of view. Much land has been set aside for their preservation in the California State and National Park Systems (8,21).

**Selections.** Seedlings of *Sequoia sempervirens* tend to vary greatly in growth habit and in the color and texture of the foliage, these characteristics being determined principally by heredity and are exhibited by the tree throughout its life. The habit of growth may range from quite open to very dense, stiff and bristly to graceful and pendulous, and suckering heavily or little at all. Branches may be stiff or arching, and may grow at a slightly upward angle or almost straight down. The foliage

color may vary from light to dark green, or silvery glaucous blue to deep blue green (15,20,22).

Prior to the 1970's, almost all *Sequoia* plants on the market were seedlings; only occasionally were a few novelty forms found in small quantities with some unusual foliage color or with pendulous, prostrate, or dwarf growth habits. In recent years, numerous cutting-grown selections have been made for ornamental use such as 'Aptos Blue' with dense blue green foliage on horizontal branches, and 'Los Altos' with deep green foliage on slightly arching branches. Three outstanding new selections being grown by Monrovia Nursery Company are 'Majestic Beauty'™, 'Santa Cruz', and 'Soqel' (2,6,16,20,22).

'Majestic Beauty'™ is a seedling selection originating at Monrovia Nursery in California. This cultivar is highly favored for its delicate, glaucous, blue-green foliage on horizontal, spreading branches and pendulous branchlets (16).

'Santa Cruz' features soft-textured, light green foliage on branches which point slightly downward, and is reported to take shearing quite well. This cultivar was selected by Beeline Nursery and introduced through the Saratoga Horticultural Foundation (16,22).

'Soquel', also introduced through Saratoga, is prized for its fine-textured, dark-green foliage, blue-green on the underside, on horizontal to slightly ascending branchlets which turn up at the tips. The growth habit of this cultivar is somewhat more compact than other cultivars, and also tends to sucker less (6,16,22).

**Production.** In recent years, demand for *Sequoia sempervirens* as an ornamental has increased due to the availability of selected, cutting-grown cultivars. Although *Sequoia* is propagated readily and economically from seed, in some cases cutting propagation has totally replaced seed propagation due to the superiority of specific clonal selections over the more variable seedlings. *Sequoia* is also readily propagated by means of tissue culture when large quantities of selected clones are required for container production or reforestation plantings (11,16,23).

With the improved selections, a minimum of staking and pruning is required to produce a full, quality plant for sale in the retail market. Vegetatively propagated plants tend to develop a central leader with little or no training. (16)

Propagation of *Sequoia* cultivars fits in well with a standard conifer cutting propagation scheme. Cuttings are normally made in the late fall and winter. Cuttings root in approximately four to five months, with rooting percentages varying from one cultivar to another. After potting, liners are ready for

sale after an additional six months. Plants canned into one gallons are ready for sale after eight months. Production of finished five and 15 gal. requires an additional year in each stage (16,19).

## REVIEW OF LITERATURE

Relatively few formal studies have been conducted on the rooting of *Sequoia sempervirens*; more research has been conducted with the closely related species, *Sequoiadendron giganteum* and *Metasequoia glyptostroboides*. Jaroslavcev (12) reported that the most suitable time for taking cuttings of all three species was just prior to active growth. An inability to root *Sequoia* at any time of year was cited by Gil-Albert (10). Platt (18) reported that *Sequoiadendron* rooted best when cuttings were treated with 3000 ppm IBA (although the cuttings exhibited poor root development) while Wolford and Libby (24) indicated that 2000 ppm or 4000 ppm IBA and an organic propagation medium were optimum. Fins (9) found rooting of *Sequoiadendron* to be improved when cuttings were taken from juvenile growth and prepared with an angled basal cut, and when fertilizer was incorporated into the propagation medium under high mist conditions. An extended photoperiod was found by Baker (3) to improve rooting of *Metasequoia* under some conditions, while Lamb (14) indicated that sand alone was preferable over a sand/peat medium for propagation. Connor (7) reported that *Metasequoia* cuttings root well when dormant cuttings are prepared, placed in cold storage for 30 days, treated with 3000 ppm IBA, and rooted in a peat/perlite medium with bottom and intermittent mist.

## MATERIALS AND METHODS

Experiments centered on the effects of selected types and concentrations of rooting hormones on the rooting of *Sequoia sempervirens*, cultivars 'Majestic Beauty'™, 'Santa Cruz', and 'Soquel'. The rooting hormones utilized were the auxins IBA (indole-3-butyric acid), NAA (α-naphthaleneacetic acid), combinations of IBA and NAA, and NOA (*B*-naphthoxyacetic acid). Auxins at concentrations of 3000 ppm, 6000 ppm, 8000 ppm, and the auxin combinations were prepared as solutions containing 55% methanol; IBA at concentrations of 16,000 ppm and 45,000 ppm were prepared as talc powders. (Refer to the data tables for the specific treatments utilized with each cultivar.)

Experiments were conducted over two consecutive seasons. Due to a limited amount of propagation material the first season, trials were limited to 'Santa Cruz' and 'Soquel', utilizing varying numbers of cuttings per treatment. The second season, formal trials were conducted with all three cultivars

based on information gained the first season utilizing three cutting flats per treatment stuck at the rate of 255 cuttings per flat.

Propagation material was collected from vigorous five-year-old stock plants in early February. Cuttings were prepared approximately 5 in. in length such that the outer tissue on the main stem on the cutting was brown at the base and green above. Side branchlets on the cuttings were trimmed back so that all cuttings were of an overall uniform size.

Prepared cuttings were washed and disinfected by immersing them for 5 sec. in a water bath containing 15 ppm chlorine followed by 5 sec. in 200 ppm Physan disinfectant. Cuttings then received a quick basal dip in their respective hormone treatments and were stuck into pasteurized flats containing 90% coarse perlite and 10% fine peat moss. Cutting flats were placed on outdoor heated concrete rooting beds in full sun with an average bottom heat temperature of 70°F and intermittent mist provided for 10 sec. every 12 to 30 minutes (depending on weather conditions).

After a rooting period of five months, bottom heat was discontinued and the mist frequency was gradually reduced during a two-week period to harden off the rooting cutting flats. The cuttings were then removed from the flats and the number of rooted cuttings and rooting percentages were determined.

## RESULTS

The first three months of the rooting period were marked principally by basal callus formation, while the majority of the rooting occurred during the final two months. Cuttings produced two to four long, branched roots, with little variation in the average sizes of the root systems being noted between one treatment and another.

**Table 1.** Effects of selected hormone treatments on the rooting of *Sequoia sempervirens* 'Majestic Beauty'™

| Treatment | Average No Rooted Per Flat +/− Std. Error[1] | Percent Rooted |
|---|---|---|
| 3000 ppm IBA | 20.0+/−11 0a[2] | 7.8% |
| 6000 ppm IBA | 31.5+/−0.5a | 12 4 |
| 16,000 ppm IBA powder | 37.0+/−5.0a | 14 5 |
| 3000 ppm NOA | 44.5+/−36.5a | 17 5 |
| 3000 ppm IBA + 3000 ppm NAA | 165.0+/−6 0b | 64.8 |
| 6000 ppm IBA + 6000 ppm NAA | 159 0+/−6 0b | 62 4 |

[1] 255 cuttings per flat. Three flats per treatment.
[2] Means followed by the same letter or letters are not significantly different at the 5% level (Duncan's Multiple Range Test)

**Table 2.** Effects of selected hormone treatments on the rooting of *Sequoia sempervirens* 'Santa Cruz' (Experiment 1)

| Treatment | No. Stuck | No. Rooted | Percent Rooted |
|---|---|---|---|
| 1000 ppm IBA | 390 | 69 | 17 7% |
| 3000 ppm IBA | 400 | 227 | 56 8 |
| 6000 ppm IBA | 510 | 261 | 51 2 |

**Table 3.** Effects of selected hormone treatments on the rooting of *Sequoia sempervirens* 'Santa Cruz' (Experiment 2)

| Treatment | Average No Rooted Per Flat +/− Std Error[1] | Percent Rooted |
|---|---|---|
| 3000 ppm IBA | 118 3+/−37 1a[2] | 46.4% |
| 8000 ppm IBA | 159.3+/−49 2a | 62 5 |
| 16,000 ppm IBA powder | 178 3+/−6 3a | 69.9 |
| 3000 ppm IBA + 3000 ppm NAA | 121 0+/−2 0a | 47.5 |
| 6000 ppm IBA + 6000 ppm NAA | 160 7+/−17 9a | 63 0 |

[1] 255 cuttings per flat. Three flats per treatment

[2] Means followed by the same letter or letters are not significantly different at the 5% level (Duncan's Multiple Range Test).

**Table 4.** Effects of selected hormone treatments on the rooting of *Sequoia sempervirens* 'Soquel' (Experiment 1).

| Treatment | No. Stuck | No. Rooted | Percent Rooted |
|---|---|---|---|
| 1000 ppm IBA | 400 | 6 | 1 5% |
| 3000 ppm IBA | 500 | 9 | 1.8 |
| 6000 ppm IBA | 400 | 14 | 3 5 |
| 3000 ppm NAA | 330 | 9 | 2 7 |
| 6000 ppm NAA | 345 | 66 | 19 1 |
| 3000 ppm IBA + 3000 ppm NAA | 215 | 80 | 37 2 |

**Table 5.** Effects of selected hormone treatments on the rooting of *Sequoia sempervirens* 'Soquel' (Experiment 2).

| Treatment | Average No Rooted Per Flat +/− Std Error[1] | Percent Rooted |
|---|---|---|
| 3000 ppm IBA + 3000 ppm NAA | 78 7+/−10 9ab[2] | 30.9% |
| 6000 ppm IBA + 6000 ppm NAA | 119 3+/−9.2a | 46 8 |
| 8000 ppm IBA | 65 3+/−4.6bc | 25.6 |
| 16,000 ppm IBA powder | 52.3+/−3.8bc | 20 5 |
| 45,000 ppm IBA powder | 56 3+/−6 2bc | 22 1 |

[1] 255 cuttings per flat. Three flats per treatment.

[2] Means followed by the same letter or letters are not significantly different at the 5% level (Duncan's Multiple Range Test)

## DISCUSSION

Results indicate that the optimum type and concentration of rooting hormone differs from one cultivar to another. In general, a combination of IBA and NAA, or IBA alone, in moderate to high concentrations will provide the best results. NAA alone, NOA, and low concentrations of IBA result in lower rooting percentages.

A combination of 3000 ppm IBA + 3000 ppm NAA was clearly the optimal treatment for 'Majestic Beauty'™; 16,000 ppm IBA powder was selected as the best treatment for 'Santa Cruz', while 8000 ppm IBA and 6000 ppm IBA + 6000 ppm NAA also gave good results with this cultivar. 'Soquel' responded best to a combination of 6000 ppm IBA + 6000 ppm NAA.

It appears that acceptable rooting of cuttings of selected cultivars of *Sequoia sempervirens* may be obtained if the optimal hormone treatment is determined. In addition, at the end of the rooting period, the callused, unrooted cuttings may be retreated with hormone and reset to stimulate additional rooting and increase the overall rooting percentage. The efficient volume production of superior cultivars for ornamental use should thus be possible in a conventional conifer cutting propagation program.

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## TWIG GRAFTING OF MACADAMIA

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Most of you have probably eaten the nuts from macadamia trees but I am sure some of you have never seen the trees. In recent years this fruit has created a lot of interest in San Diego County, California, and around the world. Its climatic requirements are similar to avocados and it has been used as a replant for avocado groves which have become unproductive from root rot. It is also being used as a dooryard tree both for the nuts and for its good looks. At present there is a great deal of interest in establishing macadamia production as an agricultural industry in southern California, as has been done in Hawaii and other subtropical and tropical areas.

There are two species of macadamias grown commercially. *Macadamia integrifolia*, the most popular species in Hawaii,