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Nursery Production and Landscape Establishment of *Arbutus menziesii*

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Abstract: The native Pacific madrone (*Arbutus menziesii*) has potential for use in water conserving landscapes but is considered difficult to produce and establish in landscapes. We transplanted madrone seedlings to 5.7 cm (2.25 in) liner pots, then to 3.8 liter (one-gallon) and 11.4 liter (3-gallon) containers filled with Douglas-fir (*Pseudotsuga menziesii*) bark and sharp sand (2:1 by volume) and grew them on a gravel nursery bed. Water was supplied as needed by overhead sprinkler irrigation. The plants grew readily and produced a fibrous root system. In April the madrones were transplanted into the landscape, watered-in and then not watered again. Spring of the first growing season (1990) was wet while July and August were dry. By fall all trees were living, and some had approximately a meter of new growth.

Many favorite landscape plants are native to areas of northern Europe and East Asia, regions that experience greater rainfall in the summer than the Pacific Northwest. Such plants must be irrigated to stay healthy during the aridity typical of Pacific Northwest summer months. This is increasingly a concern when water supplies become limited. Native plants, such as the Pacific madrone (*Arbutus menziesii*) are adapted to arid summers. They require less irrigation and should be ideal for drought tolerant landscapes (Kelley, *et al*. 1993).

Frequently associated with rocky hillsides along the Pacific coast, the Pacific madrone is common along the shores of Puget Sound and is the only broad-leaved evergreen native. Its crooked trunk and peeling bark make the madrone an attractive specimen tree in an informal landscape.

Northwest nursery growers have long avoided the madrone for production due to transplant failure. This may be due to unsuccessful experience with plants collected in the wild that could not tolerate the severe root disturbance caused by transplanting from nature. We undertook this study to investigate the possibility that madrones produced in containers could be successfully transplanted and established in the landscape.

METHODS

Nursery Production

The approach taken to successfully grow madrones in containers was not designed as a controlled experiment. Based on previous investigational experience with other ericaceous plants (Hummel, *et al*. 1990), we designed a production scheme that seemed most likely to yield good results.

Madrone seedlings were transplanted in early summer to 5.7 cm (2.25 in) mesh liner pots containing our standard nursery medium consisting of Douglas-fir (*Pseudotsuga menziesii*) bark and peat moss (4:1 by volume) and amended with micromax at the rate of 1038 g/m^3 (1.75 lb/ yd^3). The liners were grown on in a lath house with water and 200 parts per million [ppm nitrogen from Peter's 20-20-20 (NPK)] fertilizer applied as needed.

We moved the plants into successively larger containers [10.2 cm (4 in), 3.8 l (one-gallon), 11.4 l (3-gallon) and 19 l (5-gallon)] as they grew to sufficient size during the following spring and summer. The growing medium was a mixture Douglas-fir bark and sharp sand (2:1 by volume) amended with micromax (1.75 lb/yd^3). These containers were kept on a gravel nursery bed with water supplied as needed by overhead irrigation. During the warm and dry months of summer, 1.3 cm (0.5 in) of water was applied daily. Slow-release fertilizer was topdressed at the rate of 1.2 kg N/m^3 (2 lb N/yd^3).

Following this production system, plants grew readily and formed a dense fibrous root system in the container. We were able to raise large numbers of high quality trees with no noticeable mortality.

Landscape Establishment

Five madrones in each of 2.25 in (Plate 12-1), one-gallon and three-gallon containers were selected for transplanting in April 1990. Selected trees were pruned as needed to a uniform central leader prior to transplanting. The trees were randomized on 2.4 m centers in a full sun location in a field of Puyallup fine sandy loam soil at the Washington State University Experiment Station, Puyallup, Washington. According to standard recommendation (Harris 1992) planting holes were dug ~2 times the diameter of the rootball and just deep enough so that the plants were at the original soil level in the nursery. The rootballs were thoroughly cut, and roots straightened and spread during transplanting

Plate 12-1. Madrone sapling transplanted from a 2.25 in pot. Photo spring 1990.

to prevent circling roots (Maleike and Hummel 1990). Newly planted trees were thoroughly watered to settle the soil around the roots and a 76 cm diameter earth rim for a watering basin was constructed around each transplant (Maleike and Hummel 1990). Trees were watered immediately after transplant but received enough water from ambient rainfall so that additional irrigation was not considered necessary. Slow-release fertilizer was topdressed around each tree according to its container size at transplanting, and a wood chip mulch was placed over the plant area to help control weed growth. Trees were staked as necessary to maintain an upright trunk in 1990–91.

In October 1990, 5 replicate madrone trees from 4 in, one-gallon, 3-gallon and 5-gallon containers were transplanted to the same field location. Planting procedures and follow-up care for the fall transplanted trees were the same as described above for the spring transplanted trees. Five trees from 5-gallon containers also were transplanted in April 1991 so that the response of madrone trees to spring transplanting from that size could also be monitored. Again, planting procedures and follow-up care were the same as for the trees planted in April 1990. Plant survival, height, width and trunk caliper (30 cm above the ground) measurements were taken in 1990, '91 and '95. Analysis of variance (ANOVA) was performed on data collected in October 1990.

Table 12-1. Height and caliper increases measured on madrone planted to the field (April 18, 1990). The average height at transplant of madrones from the 2.25 in, one-gallon and 3-gallon containers were 7.9, 92 and 172 cm (3.1, 36.2 and 67.7 in), respectively. Average calipers at transplant were 12.2 and 20.2 mm (0.5 and 0.8 in) for madrones from the one- and 3-gallon containers, respectively. Means within columns followed by the same letter are not significiantly different (alpha = 0.05) based on a protected least significant difference test (LSD). Calipers of 2.25 in plants were not measured at transplant. Data for October 24, 1990.

Container size	Height increase (cm)	% height increase	Caliper increase (mm)	% caliper increase
2 1/4 inch (5.7 cm)	36.7 bz	464% a	--	--
1 gallon (3.8 liter)	87.2 a	100% b	11.2 a	93% a
3 gallon (11.4 liter)	54.4 ab	32% b	12.1 a	59% b

RESULTS AND DISCUSSION

The survival rate in October 1990 was 100% for all trees (regardless of initial size) transplanted in April 1990 (data not shown). ANOVA of growth data collected in October 1990 indicated that trees transplanted from one-gallon containers had a significantly greater height increase than trees transplanted from 2.25 in containers (Table 12-1). Trees transplanted from 2.25 in containers, however, had the greatest percent height increase. Height increase, percent height increase and caliper increase measured in the fall of 1990 were not significantly different for the one-gallon and 3-gallon transplants. Percent caliper increase was greater for trees transplanted from one-gallon containers (Table 12-1). The average height increase of one-gallon container-grown madrones was 87.2 cm, and a one-gallon transplant grew 125 cm during the first growing season.

The October 1990 results indicate that madrones readily establish in the field in Puyallup fine sandy loam soil. The rootballs were cut and roots straightened at planting time to prevent circling roots. This level of root disturbance does not cause noticeable detrimental effects on tree survival or growth. By October 1990, trees planted the previous April were thriving. The plants produced considerable new growth (Table 12-1).

Before transplanting to the field, we grew the containerized madrones at close spacing on the gravel nursery bed. In December 1990, the Puyallup area suffered a severe cold snap. Temperatures dipped as low as -15°C (5°F) at night followed by clear bright days with temperatures below freezing (Climatological Data Washington 1990). This winter freeze caused extensive sunscald damage (Hummel 1986) to madrone trunks and killed many of the plants. The loss of madrones to the December 1990 freeze (Table 12-2) was a disaster for our experimental design and precludes statistical analysis of the data collected in April of 1995.

Although we cannot make statistically valid comparisons, growth data for the surviving plants (Table 12-2) collected in April 1995, indicates that trees that survived the first winter in the ground grew to as much as 3.45 m in height with calipers to as much as 119 mm. The 1995 height measurements are difficult to interpret because, as the madrones in this study have grown, the trunks have leaned over and twisted (Plate 12-2). Such trunk architecture is commonly observed in native growing madrones. Developing production systems that discourage horizontal stem growth and/or selecting madrone genotypes

Plate 12-2. Madrones in 5 gallon containers ready for fall transplanting. The bent and crooked nature of stems is typical of madrone saplings grown in our study. Photo September 1990.

Table 12-2. The number of surviving madrone plants and their overall heights, widths and calipers. These madrones were transplanted from different sized containers on 3 different occasions. Five replicate plants per treatment were originally transplanted to the field. The freeze of December 1990 killed many of the plants in this experiment. Data for April 1995.

Transplant Date and Container Size	Number of Surviving Plants	Height (meters)	Width (meters)	Caliper (mm)
April 1990 transplant				
2.25 in (5.7 cm)	1	2.40	2.90	62
one-gallon (3.8 liter)	2	3.45	3.85	119
3-gallon (11.4 liter)	0	-	-	-
October 1990 transplant				
4 in (10 cm)	0	-	-	-
1-gallon (3.8 liter)	5	2.78	2.72	83
3-gallon (11.4 liter)	4	2.88	3.03	96
5-gallon (19 liter)	2	2.70	2.85	116
April 1991 transplant				
5-gallon (19 liter)	5	2.78	3.22	117

with a more upright growth habit and stronger stems are areas for future research.

It is interesting to note that by 1995 the heights, widths and calipers of surviving fall-planted one- and 3-gallon madrones are quite similar (Table 12-2). This suggests that the extra expense associated with growing madrone trees to 3-gallon size is not justified.

All of the trees planted in the spring of 1991 (after the December 1990 freeze) survived to 1995 (Table 12-2). This indicates how devastating the 1990 winter was to the madrones in our research. Unfortunately, this uncontrollable winter damage has seriously compromised our ability to make recommendations and reach conclusions based on this experiment.

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