ROOTING CONIFER CUTTINGS WITH A FOG SYSTEM

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Crown Zellerbach has been rooting conifer cuttings, particularly western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), in a fog system since 1976. Crown's interest in the rooting of cuttings stems from ongoing research efforts in tree breeding, genetics, and physiology. For these types of research, vegetative propagation is an essential step. Grafting has been favored by foresters for vegetative propagation but grafting has the limitations of possible graft incompatibility and of rootstock influence on scion performance.

Rooting success of western hemlock cuttings has been reported from zero to near 100%. Sorenson and Campbell (5) reported 75% rooting using one-year old seedlings as donors. Rooting from juvenile donor plants (before onset of flowering) has been reported at 68% by Foster, *et al.* (3) and up to 95% by Boyd (1). Brix and Barker (2) found cuttings from mature (42 to 150 year old) donors to root at 43%. Foster, *et al.* (3) found cuttings from mature donors to root at about 34%.

Rooting success has not been universal. An appropriately controlled environment is critical to success. In 1975, Brix and Barker (2) summarized a number of experiments in a concise report, "Rooting Studies of Western Hemlock Cuttings", which remains the best single source on the subject. The studies reported covered time of cutting collection, rooting hormone trials, and rooting systems, among other topics. Brix and Barker (2) suggest that an appropriate rooting environment was a cold frame, shaded from direct sunlight, with no mist and no heat. They were working in Victoria, British Columbia, a somewhat different environment than the mid-Willamette Valley of Oregon. Brix and Barker obtained equally good results by enclosing a bench in plastic with periodic mist. Bottom heat showed no benefit. Our experience suggests a maximum high temperature of 28°C for successful rooting. There is evidence that photoperiod control and CO_2 enrichment are beneficial to rooting success in some hard-to-root cuttings (4,6). Boyd (1) suggests that high atmospheric humidity is essential and that rooting success in western hemlock is directly related to the degree of environmental controls.

In 1976, Crown Zellerbach set up the first iteration of our current system. In 1979, after a complete failure in 1978 due to excessive temperatures, the system was redesigned. Wood frame, vinyl-covered, chambers are set inside a greenhouse. Temperature inside the greenhouse is controlled by heaters, evaporative coolers, exhaust fans, and a movable side wall. There is no bottom heat. Humidity is controlled with fog or ultra-low volume mist nozzles. Water and CO_2 enriched air are mixed at the nozzle head. Separate lines for water and air are regulated by parallel solenoids and controlled with an interval timer. The photoperiod is extended to 18 hours. This system, with minor changes, is still in use.

Our results, since 1979, have been consistent for western hemlock rooting. Juvenile donor material roots at 60%. Mature donor material roots at 35%. Cyclical propagation improves rooting. There are differences among clones in rooting ability. The system as described has been used with success to root Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) and red alder (*Alnus oregona* Nutt. — Syn. *A. rubra* Bong.).

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VOICE: In computer controls for greenhouse environments can you have a control for the humidity without bringing in cold air?

HUGO WILDSCHUT: The answer is yes. A program can be written to cover any controls desired. It is a matter of components mostly. Whatever sensors are necessary can be put in.

IRENE BURDEN: Can these computer units be used satisfactorily in the very humid conditions in a greenhouse?

HUGO WILDSCHUT: Yes, certain units are hermetically sealed and will work well in very high humidity situations.

VOICE: What is the cost for the greenhouse computer units?

HUGH WILDSCHUT: From $300 to $2000, depending upon the complexity of the controls.

VOICE: What is the percent nitrogen in the Strawdust growing mix?

DICK TEUFEL: It has 1.34% actual nitrogen on a dry weight basis.

VOICE: How long does the Strawdust last in use?

DICK TEUFEL: We have had plants growing in it for 3 to 4 years and still have good aeration.

VOICE: How does Strawdust compare with sawdust as a soil amendent, pricewise?

DICK TEUFEL: It is more expensive than sawdust, but the Srawdust has a fertilizer component which makes it quite competitive. Strawdust current price is $16.50/cu. yd.

LES CLAY: In Wilbur Bluhm's cost studies for cuttings, he found that collecting cuttings away from the nursery was less costly than collecting at the nursery. How is this accounted for?

WILBUR BLUHM: This is due to maintenance costs of mother stock blocks at the nursery, not found when collecting away from the nursery.

VOICE: In your fog systems how much of a drip problem do you have from the nozzles?

TIMOTHY PRESS: If the pipe system is exactly horizontal and if there is a fog nozzle placed at the very end of the line, we practically eliminate any drip.

VOICE: Early fog systems had the problem of nozzles orifices clogging. How is this handled now?

TIMOTHY PRESS: It depends on the water source. If the water is high in calcium or iron salts it can be pretreated with either a chemical sequestrant or an electrostatic type treatment, either of which will hold the salts in solution so there is no scale build-up.

VOICE: What is the cost of operation of these fog units?

TIMOTHY PRESS: In fogging up to 7,000 sq. ft. the motor is a 1½ h.p. unit so it uses about 1½ kilowatts and at 5¢ per kw hr it would cost 7½¢ per hr to operate if run continuously, which you would do on a hot afternoon.

VOICE: What amount of cooling can you obtain with fog in a very humid environment as compared to a dry environment?

TIMOTHY PRESS: In theory you can always cool the air down to what is known as the "wet bulb" temperature, which varies considerably in different areas. In a very humid area, as southern Florida in the summer, the wet bulb temperature is about 80°F, so cooling only to 80°F can be obtained, but if ambient temperature is 90°F, 10° of cooling can be obtained.

TISSUE CULTURE PROPAGATION OF SELECTED MATURE CLONES OF *LIQUIDAMBAR STYRACIFLUA*

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Liquidambar styraciflua (sweetgum) is a desirable tree for the urban landscape. It possesses several qualities such as striking fall color, a pleasant form, attractively shaped leaves, and an ability to provide shade, which have made it increasingly popular as a street tree. However, sweetgum has several disadvantages which must be considered when selecting it for the urban landscape.

When sweetgum is grown from seedlings, the trees exhibit great variability in form and color. It also has an invasive root system that necessitates extensive and costly sidewalk repairs. Finally, grafting clonal scions onto seedling rootstocks as a means of overcoming variability is an expensive procedure, and results in higher costs for the growers, and consequently for the consumer.

Considering the popularity of sweetgum, it would be desirable to obain superior selections and propagate them clonally. However, sweetgum cuttings do not root easily (1) and thus must be produced by budding to maintain clonal selections. Not only is budding expensive, when scions are budded onto seedling rootstocks the rootstocks continue to impart some variability to the entire tree. Nonetheless there would be a value to budding, even if expensive, if a valuable rootstock could be identified and if it could be clonally produced.

Several trees in the San Francisco Bay area of California have recently been identified that possess superior fall color, delayed leaf drop, and non-invasive root systems, all of which would contribute favorably to an improved clone of *Liquidambar sytraciflua*.