## PONDEROSA AND LODGEPOLE PINE ROOTING TRIALS

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Since J.P. van Buijtenen et al., (3) proved the rootability of loblolly and slash pine in a modified growth chamber, we decided to try similar techniques to root ponderosa and lodgepole pine.

If cuttings from juvenile and mature trees could be rooted, the cost and timing of the Forest Genetics Program at Klamath Falls could be reduced by (a) rooting of selected trees for the breeding orchard, (b) reduction of the breeding program, and (c) mass propagation of selected juvenile individuals. It was decided to test the rootability of cuttings from juvenile trees before cuttings from mature trees

### Methods

Cuttings were taken from seedling groups as in table 1. The 150 cuttings for group No. 1 were 6-12 cm in length and 0.2-0.5 cm in diameter. They were all summer shoots taken from (2-0) lodgepole pine. The 150 cuttings for group No. 2 were 6-12 cm in length and 0.3-0.7 cm in diameter. They were terminal shoots of (2-0) ponderosa pine. All cuttings were from seedlings growing at the Klamath Forest Nursery. No records were kept of the seedlings the cuttings were taken from.

The 200 cuttings for group No. 3 were 4-7 cm in length and 0.25-0.5 cm in diameter. The cuttings were the terminal shoots of ponderosa pine seedlings growing at the Klamath Forest Genetics Center (orchard). The seedlings were grown as progeny plugs at the Rochester Regeneration Facility for 6 months and planted at the Klamath Forest Genetics Center in May 1975. The seedlings were grown from open-pollinated seed from ponderosa pine plus trees. One cutting was taken from each of the 10 individuals per family, using 20 families. The family number was recorded.

Table 1.—*Origin of cuttings by species, age, and location*

| Group Number | Species | Age | Location | Number of Cuttings per family | Number of Individuals per family | Total Cuttings |
|---|---|---|---|---|---|---|
| 1 | LPP[1] | 2-0 | Nursery | 1 | 1 | 150 |
| 2 | PPI[2] | 2-0 | Nursery | 1 | 1 | 150 |
| 3 | PPI | 1-0 | Orchard | 20 | 10 | 200 |
| 4 | PPI | 3-0 | Site 4 | 20 | 5 | 400 |

[1]Lodgepole pine
[2]Ponderosa pine

The 400 cuttings for group No. 4 were 6-14 cm in length and 0.30-0.65 cm in diameter. The cuttings were the lateral shoots of surplus ponderosa pine progeny growing at the Klamath Forest Progeny Test Site #4. The seedlings were grown at the Rochester Regeneration Facility as plug seedlings in late 1972 and outplanted in May 1973. The seedlings were from the 20 fastest growing families at the test site based on third-year growth measurements. Four cuttings were taken from each of the five individuals in a family. The length, diameter, and location of the lateral (first, second, or third whorl) were recorded, as well as the seedlings the cuttings were taken from.

The cuttings were taken on December 22 and 23, 1975, and stuck on December 23 and 24, 1975. All cuttings were kept upright, wrapped in wet toweling, and packed in ice from the time of cutting until they were stuck.

Before the cuttings were stuck the needles from the bottom half of the cuttings were removed and the bottom 0.5 cm of the cutting was dipped in Hare's rooting powder (3). A hole was punched in the rooting medium and the cutting was inserted and firmly packed in the hole.

**The Rooting Method**

The method of rooting was a modified version of the method used by van Buijtenen (3). The methods were as follows:

**Temperature** 67°F (19.4° C)

**Bottom heat** 80° F (26.7° C)

**Day length** 20 hours

**Light** 100-foot candles

**Rooting medium** a 1:1 mixture of perlite and vermiculite

**Carbon dioxide** the CO, level was raised with CO, cylinders operating on a time clock.

**Hormones** Hare's rooting powder as described by van Buijtenen (3)

Mist Mistamatic Control System with Flora-Mist fogger was used to keep soil medium moist.

**Cooling** exhaust fan set for 70° F (20.1 ° C) and a super fogger fogged the chamber when the exhaust fan came on. This kept the relative humidity at near 100 percent and kept the chamber at the desired 67° F (19.4° C).

Nutrients The following liquid nutrient solution was applied once a day at the rate of 2.2 ml per cutting:

| Element | PPM |
|---|---|
| N | 1400 |
| P | 159 |
| K | 1373 |
| Ca | 933 |
| Mg | 250 |
| Fe | 100 |
| Zn | 0.5 |
| Mn | 5.0 |
| Cu | 0.2 |
| B | 5.0 |
| Mo | 0.1 |

**Fungicides** Fungicides were applied once each 6 days on a rotating schedule i.e., Monday (Benlate), Wednesday (Bravo), Friday (Captan), Sunday (Benlate), Tuesday (Bravo), etc. at the rate of 2.2 ml/cutting.

| Fungicide | Concentration |
|---|---|
| Benlate | .015 percent active |
| Bravo | .040 percent active |
| Captan | .19 percent active |

Antibiotics Streptomycin was used as needed to control bacterial growth.

The overall goal was to get maximum rooting in the shortest length of time.

**Rooting Chamber**

The rooting chamber was 3'x12'x5' high. The top was the fiberglass top of the greenhouse. The two sides were fiberglass walls. One side was the wooden wall of the head house. The last side was a wooden framework with three doors and was covered with polyvinyl because of its light transparency and high impermeability to CO,.

Both a 10-inch exhaust fan on the south end of the chamber and the super fogger on the north end were turned on whenever the temperature in the chamber reached 67° F (19.4° C). This kept the top temperature at 67° F (19.4° C) as well as keeping the relative humidity near 100 percent.

Four lines of copper tubing 6 inches apart were put in the bottom of the chamber, and hot water from a 10-gallon quick recovery hot water heater was used to keep the soil heat at 80° F (26.7° C).

Two 8-foot, high intensity fluorescent light bulbs and three 75-watt incandescent light bulbs were placed on a 20-hour-day length to provide the needed day length and proper wave lengths and intensities of light.

Four Flora-Mist foggers on 3foot spacings were suspended 18 inches above the top of the cuttings and activated with a mistamatic control system. The foggers kept the rooting medium at or near field capacity and also helped keep the relative humidity near 100 percent.

Four Flora-Mist foggers on 3foot spacings were suspended 6 inches below the irrigation line for CO, dispersion. The CO, was dispensed from a bottle and a solenoid was activated for 6 seconds every 3 minutes to release CO, into the chamber.

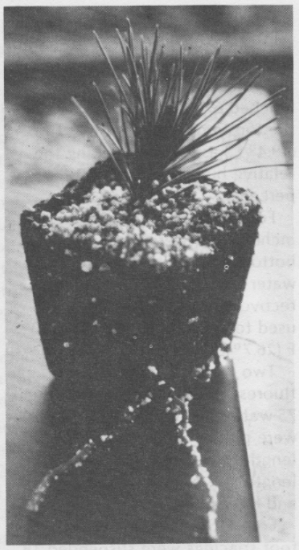

**Figure 1.** — *Ponderosa pine after 6 weeks.*

The pressure regulator on the bottle of $CO_2$ was set at 2.5 psi. $CO_2$ was provided the entire 20 hours that the lights were on.

The nutrients and fungicides were applied with a hand held 2gallon pump-up sprayer. On an operational basis they could be injected through the Flora-Mist foggers.

**Rooting Medium**

The benches contained about 2 inches of the rooting medium, a mixture of 50 percent perlite and 50 percent vermiculite as recommended by Hare (2). Peat pots 2.25'x2.25'x3" deep were filled with the rooting medium and placed in the bench. The medium was maintained at 80° F (26.7° C).

**Table 2.** – *Rooting percent of ponderosa pine and lodgepole pine cuttings by age of ortet*

| Group Number | Species | Age | Total | Percent Callused | Percent Rooted | Percent Growing April 26 |
|---|---|---|---|---|---|---|
| 1 | LPP[1] | 2-0 | 150 | 62 | 40 | 37 |
| 2 | PPI[2] | 2-0 | 150 | 67 | 54 | 53 |
| 3 | PPI | 1-0 | 200 | 17 | 7 | 7 |
| 4 | PPI | 3-0 | 400 | 78 | 59 | 55 |

[1]Lodgepole pine
[2]Ponderosa pine

**Results and Discussion**

Table 2 shows the results as of April 26, 1976.

All trees were still green and succulent that were transplanted. The large mortality in the bed of Group No. 3 appeared to be because they were too succulent to survive under the high humidity and watering that was needed to sustain the older ponderosa.

Ninety-five percent of the mortality that occurred after transplanting occurred within 36 hours. Many cuttings simply dessicated and dropped out, due to the change of environment from a high humidity to a humidity of approximately 35 percent. A more gradual acclimation from the rooting chamber environment to the seedling greenhouse environment should have increased survival.

**Transplanting**

Due to space and timing constraints the cuttings were transplanted on March 10, 1976, (11 weeks) into 1-gallon pulp pots. A soil mixture of peat, perlite, vermiculite 1:2:2 with 3 pounds of 18-9-13 osmocote per yd' of soil mix was used. The transplanted cuttings were moved into a greenhouse used for growing of containerized seedlings. The sudden change in environment caused much mortality and only the well-rooted cuttings survived. We believe a longer rooting period and a more gradual hardening off of the cuttings before transplanting would have increased the rooting percentages.

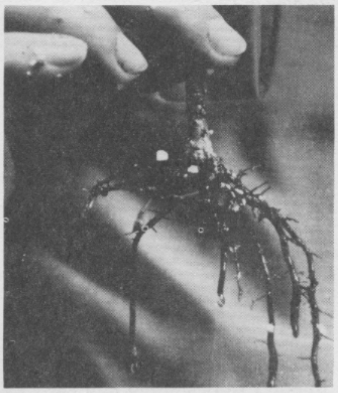

**Figure 2.** — *Lodgepole pine after 10 weeks.*

All dead cuttings were examined when they were removed from the seedling greenhouse and rated as (1) no callus or roots, (2) callused with or without roots no greater than 0.5 cm in length, and (3) roots greater than 0.5 cm in length. Cuttings still alive on April 26, 1976, had developed new buds and should survive to be outplanted.

The lodgepole pine in Group No. 1 did not start to callus until the seventh week in the rooting chamber and 3 weeks after the ponderosa pine had callused. Roots subsequently produced were thicker and shorter than those on ponderosa pine. The lodgepole pine also put on a 3-6 cm flush before they callused. Perhaps succulent cuttings in a perlite-peat soil mix with cooler

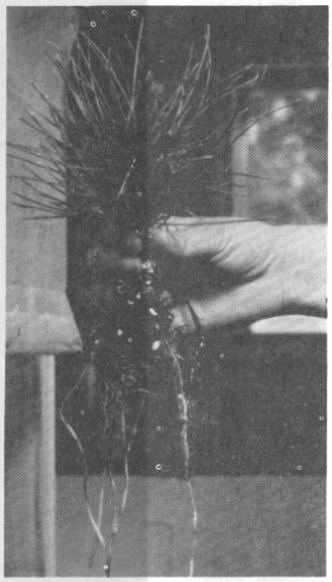

**Figure 3.** — *Ponderosa pine after 10 weeks.*

soil temperatures would root better. Size of the cuttings had no significant effect on their rootability.

Forty percent of the families in Group No. 3 rooted with 3 of 10 cuttings being the maximum rooted in any family.

In Group No. 4 cuttings, 100 percent of the families rooted with the range of rooting within a family from 3 of 20 to 19 of 20. The average rooting within families was 54.25 percent.

This trial was an all-out effort to obtain rooting of ponderosa pine and lodgepole pine cuttings from juvenile trees. Additional work is needed to determine (1) the most efficient environment for rooting, and (2) the rootability of mature cuttings.

Separate environments for cuttings of different ages and species is a must to control their different environmental needs during the rooting process if maximum rooting is desired.

**Literature Cited**


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