GIRDLING PROMOTES ROOTING OF SLASH PINE CUTTINGS

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Abstract.--When cuttings from 12-year-old slash pines were taken 2 months after girdling and chemical treatment of branches in late July, 34 percent rooted in 3 months; but only 1 percent of the ungirdled cuttings rooted. Survival figures were 66 percent and 7 percent, respectively. Poor rooting and survival of control cuttings is ascribed to low food reserves leading to needle-base senescence and death. The girdling and chemical treatment presumably forces accumulation of food reserves and precallusing. Girdled cuttings with preformed root initials generally developed large root systems within : month.

Additional keywords: Vegetative propagation, growth substances, Pinus elliottii var. elliottii.

Many forest trees are being propagated from improved seed produced in clonal seed orchards. Grafting is used almost exclusively to establish the orchards because cuttings from trees old enough to show desirable traits are extremely difficult to root. An improved ability to root cuttings from both first and second generation select trees would enable tree improvement workers to achieve more rapid genetic gains. Other applications for rooting include building up clones for research purposes, compatible rootstock production, and clonal reforestation.

In an optimal environment, the principal limiting factors in pine rooting are growth substances to induce root initiation, food reserves for root growth and shoot metabolism, and fungal decay. A rooting powder (Hare 1974) supplies the needed growth substances, sucrose, and a fungicide. However, shoots from older trees have little storage tissue, and they cannot accumulate sufficient food reserves in the propagating bed because, as Cameron and Rook (1974) have shown, detached cuttings have a low rate of photosynthesis. When addditional CO_2 was provided to enhance photosynthesis, cuttings from 12- and 13-year-old pines rooted well in a growth chamber (Hare 1974). Since chamber operation is too costly for a large-scale production program, van Buitjenen et al. (1975) adapted the above techniques to a greenhouse, using plastic enclosures to contain the CO_2. However temperature buildup is a problem in summer, and CO_2 is expensive.

In the present study, greenhouse rooting of cuttings from 12-year-old slash pine (Pinus elliottii var. elliottii Englem.) was improved by girdling branches and applying chemicals to enhance accumulation of carbohydrate reserves and induce precallusing. This treatment was first reported by Thulin and Faulds (1968) on radiata pine (P. radiata D. Don.).

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MATERIALS AND METHODS

Cuttings were obtained from 96 vigorous trees in a slash pine provenance trial which had been planted in southern Mississippi in 1962 as single-tree plots from widely scattered sources throughout the South. Ortets were selected at random as to seed source. On each of two dates, July 30 and October 24, 1974, four shoots were tagged per ortet, two for girdling and two for controls. Shoots were chosen to provide 15-cm cuttings that were generally less than 1 year old but had some mature needles. Girdling was done by removing a 2-cm ring of bark 15 cm below the terminal bud, after which the distal portion of the wound was covered with a water paste of 1-1-10-10-1 rooting powder (see Appendix). The girdle was wrapped with saran film and aluminum foil. Two months later these shoots were severed at the distal end of the girdle. Control cuttings were cut 15 cm below their tip. All cuttings were placed in polyethylene bags for transport to the greenhouse. Cutting bases were moistened, dipped in the rooting powder, and inserted 5 cm deep in perlite-vermiculite medium. To avoid possible inhibition of root growth by auxin, girdled cuttings with preformed root initials were treated with 10 percent sucrose and captan in talc instead of the regular powder. Spacing was 10 by 10 cm, intermittent mist was controlled by evaporation from a screen, and bottom heating provided 27°C in the medium. Minimum air temperature was 16°C, and summer cooling was provided by a fan-and-pad system.

A split-plot design was repeated over two beds, each in a different greenhouse. Each bed had six blocks containing two plots, one girdled and one ungirdled; there were 16 cuttings per plot. Survival and rooting data were taken after 1, 2, and 3 months and expressed on a plot basis. Proportions were transformed to arc sine ✓proportion for analysis of variance. All tests of significance were at the 0.05 level of probability. Effects of season were not evaluated statistically.

RESULTS AND DISCUSSION

Girdling and chemically treating shoots in late July strikingly improved rooting and reduced losses to needle senescence (Experiment 1, table 1). This

Table 1.--Effect of girdling on rooting and senescence of cuttings from 12-year-old slash pine

Experiment No.	Time in propagation bed	Rooted		Senescent and dead	
		Girdled and pretreated	Control	Girdled and pretreated	Control
	Months	Percent			
1[a/]	1	15.6*	0	1.2*	25.0
	2	26.9*	1.2	11.9*	74.4
	3	33.8*	1.2	34.4*	93.0
2[b/]	3	3.1	0.5	88.5	95.8

a/ Girdled July 30, taken Sep. 30.
b/ Girdled Oct. 24, taken Dec. 24.
*Girdled and control pair differs at the 0.05 level.

senescence starts as a yellowing of needle bases, progresses to browning of needles, and eventually kills the cutting. In Experiment 1, most of the ungirdled cuttings were dead or dying from needle-base senescence within 3 months, and only 1 percent had rooted. In contrast, 66 percent of the girdled cuttings were still healthy, and half of these had rooted. Microorganisms were not involved initially in the senescence syndrome, as the stem and distal portions of foliage were sound and healthy. Presumably, the dead tissue prevents movement of photosynthates, causing the stem to starve. Where carbohydrate reserves had been increased by girdling, premature senescence was not a serious problem.

In contrast to the July treatment, girdling in late October did not significantly promote rooting or reduce needle senescence (Experiment 2, table 1). Apparently, photosynthesis was too low during November and December to accumulate sufficient reserves above the girdle. Possibly more time between girdle and take would help in winter. Another deterring factor may have been low light intensity in the greenhouse. In a growth chamber, where photosynthesis was high, ungirdled cuttings from a December take rooted well (Hare 1974).

These seasonal differences in response to girdling are to be expected. Production and utilization of food reserves are controlled directly by season through light and temperature effects on photosynthesis and respiration. Season also indirectly affects reserve utilization through the presence of actively growing vegetative or floral sinks. Thus, the most effective season for girdling should be when light and temperature are near optimum, i.e., bright days and cool nights, and when active growth is limited, perhaps late summer.

In both these experiments, bed effects were negligible. This consistency of response between greenhouses lends credibility to the results and suggests that the rooting technique could be implemented on a large scale with confidence.

One minor problem was encountered in Experiment 1. Although girdling *per se* almost never killed the shoot, it did weaken the stem so that about 17 percent of the shoots were broken off, apparently in strong winds. Breakage did not occur in Experiment 2.

In Experiment 1, 97 percent of the girdled cuttings had callus after 3 months in the propagation bed compared to only 9 percent of the ungirdled. At time of taking, 13 percent of the girdled cuttings showed obvious root initials, which appeared as protuberances on the callus. All such cuttings rooted within 2 months, and most had large root systems with up to 30 main roots in just 1 month. Cuttings from older pines usually produce only a few roots and may not survive after planting (Boeijink and van Broekhuizen 1974). Therefore, the large root systems obtained from cuttings showing preformed initials may be important. Perhaps with more time between girdle and take, a higher percentage of this type of cutting could be produced during favorable seasons. One possible application involves girdling perhaps 10 times as many shoots as needed and then processing only those showing root initials. Valuable greenhouse space would be conserved, and propagating beds would be in use for only 1 or 2 months between takes.

Girdling, combined with application of a paste containing indolebutyric acid in talc, is now a standard pre-severance treatment on older radiata pine trees in New Zealand (Cameron and Rook 1974). It now appears that girdling plus chemical treatment should also be used, at the proper season, for rooting southern pines.

LITERATURE CITED

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APPENDIX

FORMULA FOR 1-1-10-10-1 ROOTING POWDER

Dissolve 1.0 gm IBA (indolebutyric acid), 1.0 gm PPZ (1-pheny1-3-methy1-5-pyrazolone, K & K Laboratories, Plainview, N.Y. 2/), and 1.1 gm Alar-90 (90% B-Nine, Naugatuck Chemical Co., Naugatuck, Conn.) in 70 ml anhydrous acetone; the Alar will not dissolve completely. Transfer quantitatively to 67 gm talc (Baker USP) in a bowl. Stir slurry constantly in a hood over gentle heat and under a gentle air stream until completely dry. Sift through a stack of sieves, to 60 mesh. Mix well with 20 gm sifted captan 50W (Orthocide 50) and 10 gm dried and sifted 10X confectionery sugar. Grind the final mixture in a large mortar and sift again.

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