ROOTING OF *ALNUS RUBRA* CUTTINGS[1]

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The growing interest in using nitrogen-fixing plants in forest management to increase wood production for timber, fiber, and energy has prompted us to study the feasibility of cloning superior selections of *alnus rubra* Bong. (red alder). This plant is a moderately fast growing and widely distributed nitrogen-fixing hardwood tree in the Pacific Northwest and ,stay be a useful silvicultural tool for maximizing yield in our forests.

The advantages of establishing clonal lines for agricultural plants has long been recognized. Some of our most favored fruit trees have been maintained for over a century through vegetative propagation of specific genotypes (*2*). Recently, the use of vegetative propagules in forestry has been investigated and recommended for the production of superior genotypes (*3, 4*).

Plants can be produced with little difficulty from seeds collected from genetically superior field-selected trees. However, for several reasons this method is not always desirable. First, a seed crop may not be available yearly from the selected tree. Second, the genetic expression of open-pollinated seed is difficult to predict. Third, individual variation may mask phenotypic expression. These disadvantages of propagation by seed can be overcome through vegetative cloning. Unlike seeds, cuttings are always available for producing plants of a known selection with minimum variability among individuals.

The only rooting trial of *A. rubra* found in the literature was by Zach (*5*) who, using plant hormones, reported a rooting success of 1.3 percent. To establish a more successful rooting methodology, we initiated our own investigations: reported in this paper is the most successful rooting method tested.

Materials and Methods

Cuttings 15 cm in length and 5 cm or less in diameter were collected from greenhouse grown seedlings (ca. 2 years old). All but the top three leaves were removed from the cutting to reduce transpiration. If the remaining leaves were large, two of them were crosscut in half to further reduce water loss. The basal ends of the cuttings were dipped for 10 seconds in hormone or a 2 percent ethanol solution and dusted with 10 percent benomyl.

Freshly prepared indole-3-butyric acid (IBA) solutions of different concentrations were used as the hormone. These solutions were prepared by first dissolving the IBA in a small volume of 2N sodium hydroxide mixed with 100 percent ethanol and diluted to the final concentration with distilled water (pH adjusted to 6.0). The final ethanol concentration was 2 percent. The fungicide benomyl was prepared by diluting a 50 percent commercial preparation to 10 percent by the addition of talc powder (*1*).

Following chemical treatment, the cuttings were set to a depth of 2-3 cm in horticultural-grade perlite, vermiculite and Lite-gro[2] (2:1 by volume) or perlite and vermiculite (2:1 by volume). Plastic 15x15 cm pots were used as containers, with 9 cuttings per pot.

Rooting trials were conducted under the following environmental conditions:

Condition No.	Temperature (day/night)	Humidity Control
1	22°/16° C greenhouse with 25° C bottom heat	Overhead mist[3]
11	25°/22° C growth chamber	Poly bags[4]

In condition I, a photoperiod was maintained by natural day

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[2]Lite-gro available from J. M. McConkey & Co. Inc., Box 309, Sumner, WA 98390.

[3]Pots were placed on a bottom heated (25° C) bench with an intermittent overhead mist of a 5-second timed spray every 12 minutes.

[4]Pots were covered individually with clear polyethylene bags vented for air circulation.

length (March-June) and supplemented with 16 hours of fluorescent lights (ca. 4,400 lux). Condition II utilized only fluorescent and incandescent lights (ca. 5,000 lux) for the 16 hour photoperiod.

Results and Discussion

Greenwood cuttings from *A. rubra* are readily rooted when treated with high concentrations of IBA and set in a warm, humid environment. Rooting percentages of greenwood cuttings treated with 4,000-8,000 ppm IBA and 10 percent benomyl were greater than 50 percent 6 weeks after treatment. Rooting percentages were similar using 4,000 or 8,000 ppm IBA (table 1) except in one trial (table 2), where the 4,000 ppm treatment rooted 46 percent less than the 8,000 ppm dip. However, cuttings treated with 8,000 ppm IBA produced more roots per cutting than those treated with the 4,000 ppm solution. In one trial rooting success increased 46 percent and number of roots per cutting 17 percent by treatment with 8,000 ppm IBA instead of the 4,000 ppm concentration. Treatment with 8,000 ppm IBA produced more well-branched roots than those cuttings treated with 4,000 ppm (fig. 1). The 10,000 ppm IBA treatment had an inhibiting effect on rooting in greenwood cuttings (table 1).

Benomyl is considered beneficial to cuttings because it inhibits fungal infection, thereby reduc-

Table 1.—*Effect of environmental and hormonal treatments on rooting percentages and number of cuttings with fewer or greater than 10 roots* [1]

Treatment	Number of cuttings with:		Rooting percentage
	>10 roots	<10 roots	
Condition No. I			
2 percent ethanol	0	5	44
10 percent benomyl	0	4	56
4,000 ppm IBA[2]	3	4	78
4,000 ppm IBA, 10 percent benomyl	12	2	78
8,000 ppm IBA	8	4	71
8,000 ppm IBA, 10 percent benomyl	14	4	82
10,000 ppm IBA, 10 percent benomyl	7	2	50
Condition No. II			
2 percent ethanol	0	0	0
10 percent benomyl	0	1	13
4,000 ppm IBA	5	2	78
4,000 ppm IBA, 10 percent benomyl	4	5	100
8,000 ppm IBA	7	0	78
8,000 ppm IBA, 10 percent benomyl	7	0	100

[1]Greenwood cuttings with leaves set in perlite:vermiculite:Lite-Gro (2:1:1 by volume) from 1- to 2-year-old greenhouse grown seedlings for 6 weeks. Condition I: 22°/16° C (day/night) with 25° C bottom heat and overhead mist. Condition II: 25°/22° C growth chamber.

[2]4,000 ppm IBA equals approximately 20 mMolar concentration.

Table 2.—*Effect of environmental and hormonal treatments on rooting percentages and mean number of roots per cutting, condition No. II* [1]

Treatment	Mean number roots/cutting	Rooting percent
4,000 ppm IBA	8.5 ±9.4	44
4,000 ppm IBA, 10 percent benomyl	15.75±9.6	51
8,000 ppm IBA, 10 percent benomyl	19.0 ±9.2	95

[1]Greenwood cuttings with leaves set in perlite:vermiculite (2:1 by volume) from 1- to 2-year-old greenhouse grown seedlings for 6 weeks. Condition II: 25/22° C (day/night) growth chamber.

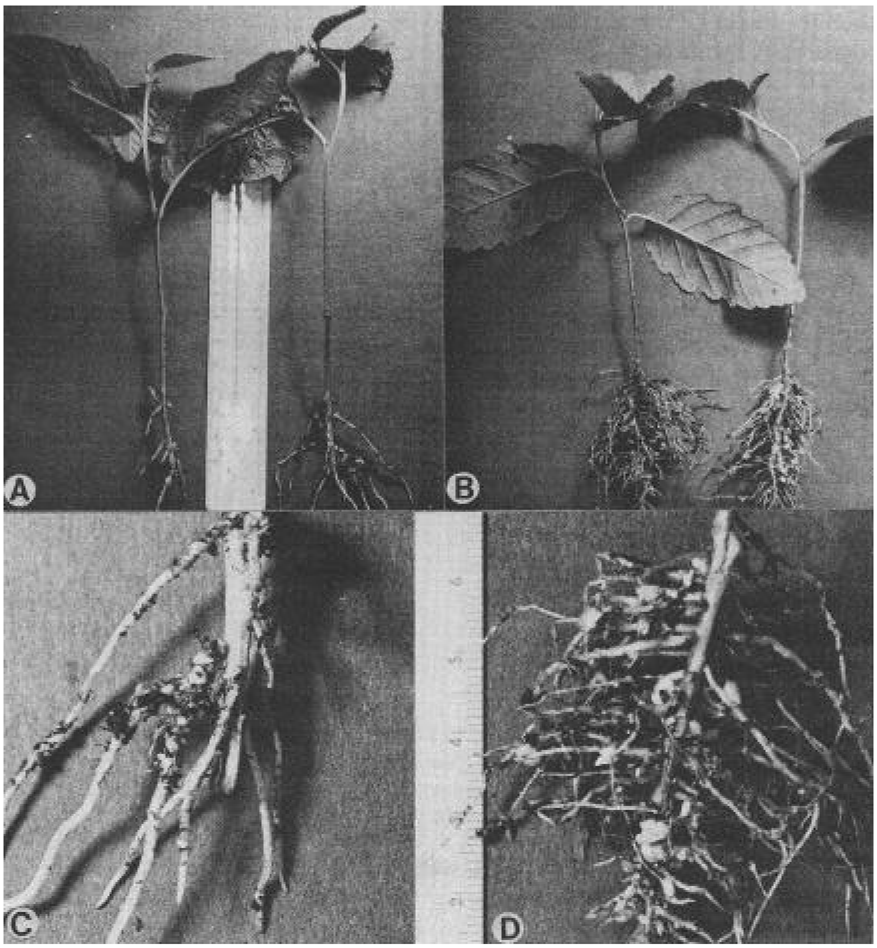

Figure 1.—*Rooting response after 6 weeks to different concentrations of IBA. Cuttings were dipped for 10 seconds in the IBA solutions and dusted with 10 percent benomyl. (A), (C): 4,000 ppm IBA; (B), (D): 8,000 ppm IBA.*

ing mortality. In our studies, rooting percentages were generally higher when we used a 10-percent benomyl treatment. Rooting success using benomyl increased 21 percent and 13 percent in comparison to the ethanol control.

Rooting response to the environmental conditions tested was variable. The cuttings responded to the environments differently depending on the concentration of IBA. Using no IBA rooting was best under the warm overhead mist environment (condition No. I). Further studies must be conducted to resolve the effect of environment on rooting *A. rubra* cuttings.

In summary, *A. rubra* can be vegetatively propagated by collecting greenwood cuttings from 1- to 3-year-old plants. Rooting is benefited by dipping the cuttings for 10 seconds in a 8,000 ppm IBA solution, dusting with 10 percent benomyl and setting in a well aerated planting mix. Cuttings rooted in 6 weeks when placed in a warm environment (22°-25° C day and 16°-22° C night) with high relative humidity and a 16 hour photoperiod.

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