Vegetative Propagation of Rocky Mountain Douglas-fir by Stem Cuttings

Joseph F. Myers and George E. Howe

Nursery superintendent, USDA Forest Service, Coeur d'Alene Nursery, and regional geneticist, USDA Forest Service, Northern Region, Missoula, MT

*In October 1985, stem cuttings collected from 6,828 five-year-old Douglas-fir (*Pseudotsuga menziesii *var.* glauca *(Beissn.) Franco) of 457 families in 9 progeny test plantations in northern Idaho were treated and stuck for rooting in nursery mix in cells in a Coeur d'Alene nursery mist chamber. Tops were kept cool and the rooting zone warm. After 120 days the growing regime was gradually changed to a standard container rearing regime. Overall, 62% of the clones successfully rooted; 98.5% of the families rooted. Success was related to the condition of the ortet. The rooted cuttings were outplanted to two sites in northern Idaho in 1987. Survival was greater than 95% for the first two growing seasons at both sites. Plagiotropism was largely outgrown by the end of the second growing season at the more favorable site (a nursery transplant bed).* Tree Planters' Notes 41(3): 3 - 6 ; 1990.

Vegetative propagation has long been employed in tree improvement programs, principally in the form of grafting. Much attention has been focused on the promise of tissue culture but considerable development is still necessary before the promise can be fulfilled.

Rooted cuttings are a third form of vegetative propagation, and the one this paper considers. Vegetative propagation is beneficial for several reasons. Most importantly, the genotype of the ortet is transferred to the ramet (the ortet is the donor tree; the ramet is the cutting; all genetically identical plants are members of the same clone).

Rooting of woody plant cuttings has been discussed in books on propagation and in special review articles. These reviews clearly show that the anatomical and physiological conditions of the cuttings at the time of collection, before they are set out for rooting and during the rooting period, will affect their rooting behavior. The procedures involved from selection of cuttings to treatments of the rooted cuttings are discussed.

Rooted cuttings allow the production of large numbers of plants from genetically improved seedlots that are too limited to allow the use of normal nursery techniques for planting stock production. Cuttings of this type have foliage and must be rooted under moisture conditions that will prevent excessive drying, as they are usually slow to root, taking several months to a year. There is considerable variation among the different species within a genus. Cuttings taken from young ortets (< 10 years) root much more readily than those taken from older ortets. Treatments with root-promoting substances, particularly indolebutyric acid at relatively high concentrations, are usually beneficial in increasing the speed of rooting and the percentage of cuttings rooted and in obtaining heavier root systems.

Cuttings of evergreen conifers ordinarily are best taken between late fall and late winter. Rapid handling of the cuttings after the material is taken from the ortets is important. The cuttings are best rooted in a greenhouse with a relatively high light intensity and under conditions of high humidity or very light misting but without heavy wetting of the leaves. A bottom heat of 75 to 80 °F has shown good results. Mature terminal shoots of the previous season's growth are usually used. Cuttings are typically 4 to 8 inches long, with all the foliage removed from the lower half of the cutting.

Materials and Methods

Materials and timing. The ortets for this project were trees (of seed origin) in nine progeny test plantations in northern Idaho. The ortets were 5 years old (from seed) when ramets were collected in the fall of 1985. About 7 dormant laterals (1985 growth only) were snipped with pruning shears from selected trees in each of 457 families in the nine plantations. Cuttings were collected from a total of 6,828 trees.

The cuttings from each tree were immediately tagged and sealed along with wet paper toweling in a zipper-lock plastic sandwich bag, and delivered to the Forest Service

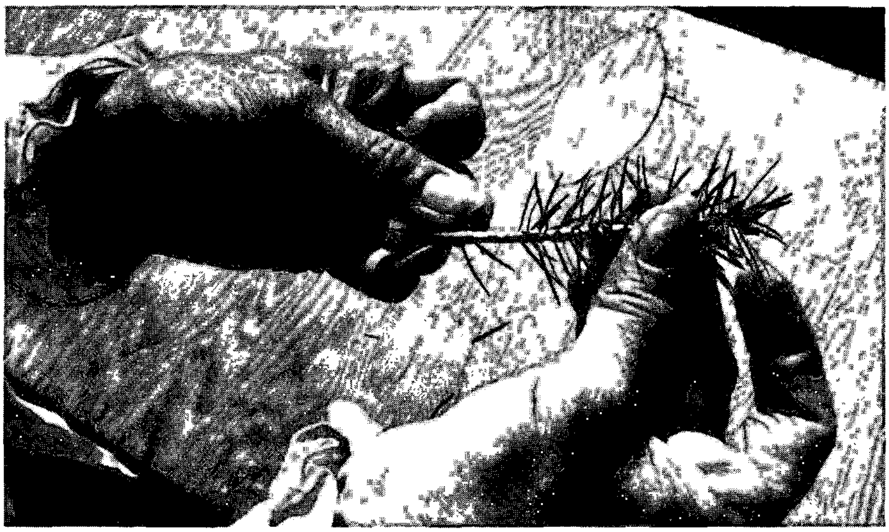

Figure 1—*Removing lower needles from cutting.*

Coeur d'Alene (Idaho) Nursery for rooting. Collectors had been instructed to collect cuttings that were a minimum of 6 inches long.

Based on previous experiments, all cuttings were collected starting the last week of October. The cuttings from the last plantation arrived at the nursery in mid-November.

Hormone treatment. Cuttings were processed and stuck as quickly as possible—no interim cold storage. Due to the poor quality of the current season's growth, the 6-inch minimum was waived. Needles were stripped from the basal third to half of the length to facilitate chemical treatment and insertion of the cuttings into the rooting medium (fig. 1). A healthy, intact terminal bud was a prerequisite to inclusion of the cutting in the program.

The basal end of each ramet was cut on the diagonal prior to hormone treatment (fig. 2). The stripped basal end was dipped in Hormidin No. 3 (MSD Agvet, Rahway, NJ), which is 0.8% IBA, active ingredient (fig. 3).

Rooting medium and container. From our previous studies, a forest nursery mix containing 50% vermiculite and 50% sphagnum peat moss was selected as the rooting medium. This material seemed to provide a good compromise of proper drainage and necessary water and nutrient-holding ability. The top one-half to three-fourths inch was filled with perlite to help inhibit growth of moss and algae. The container itself was a Ray Leach Super Cell, a 10-cubic-inch individual container. The advantage of individual cells is that dead or diseased material can be removed without affecting surrounding plants. A nail was used to form a planting spot so that the rooting hormone would not be rubbed off when the cutting was inserted into the rooting medium.

Propagation structure and environment. A standard double-layer quonset design greenhouse covered with two sheets of Monsanto Cloud 9 (Monsanto Co., Kearny, NJ), formed the basic structure. Inside the house, a concrete floor, block supports, and metal benches were used to support the containers in a manner to facilitate sanitation. Benches were four trays wide, with a mist line running down the center of each bench. Deflector-type spray nozzles were inserted in the lines. The mist system was divided into four zones to allow for maximum uniformity. The heating, cooling, and ventilation equipment was controlled by an Acme Growtron Controller (Acme Engineering, Muskogee, OK).

To avoid excessive desiccation of sticklings (the cuttings stuck in the rooting medium), both the rooting medium and the air were kept at high humidity by a soaking mist that was applied for 1 minute every hour during daylight. At night, the mist was applied once at midnight to avoid desiccation from the heaters. By starting the process in late fall and having the heat tubes running under the bench, the sticklings were maintained with a warm

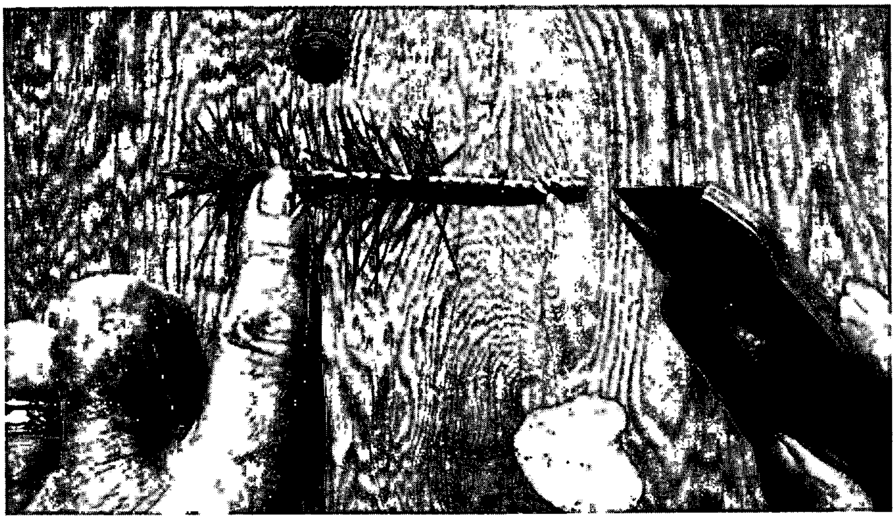

Figure 2—*Making the diagonal cut on the base of the cutting before hormone treatment.*

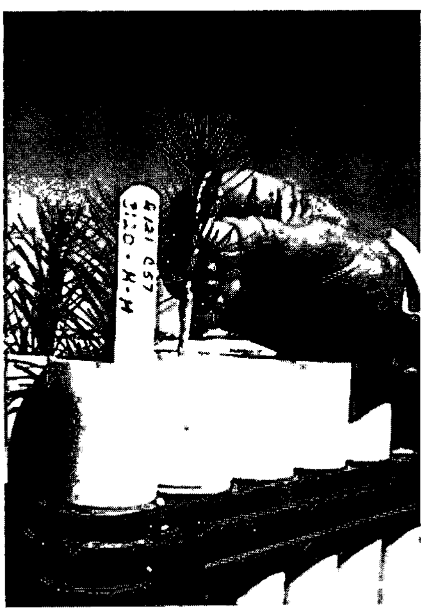

Figure 3—*Cutting immediately after dipping basal end in rooting compound.*

rooting medium and cool tops. Air temperature at plant height was 63 to 68 °F. No supplemental lighting was used during the rooting process. The sticklings were held in this environment for 120 days.

At the end of 120 days, misting was gradually reduced and the sticklings were placed on a seedling growing regime. This regime started with low nitrogen and high potassium and phosphorus levels. After 45 days, N levels were increased and P and K levels reduced. The first N level provided for root growth while the latter provided for top growth. Terminal buds began to elongate in late March and early April. We found that sticklings that successfully flushed had rooted.

Rooting Percentages and Variation Among Trees

In all, 45,219 cuttings were stuck. Of those, 18,215 rooted (table 1). This was a 40.3% success ratio. Short cutting length, poor vigor, and small bud size played a significant role in those sticklings which did not root. Family rootability ranged from 0 to 91.4%. The rate of rooting for the sticklings from the nine donor progeny test plantations ranged from 33 to 85%.

Outplantings

All healthy rooted cuttings were planted in the spring of 1987 at two sites in northern Idaho. The most vigorous of the trees were planted at the Dry Creek Tree Improvement Area near Clark Fork; the remainder were planted in a transplant bed at the Coeur d'Alene Nursery. Both plantings enjoyed high survival (> 95%) in the first two growing seasons.

At the time of planting, virtually all the rooted cuttings exhibited strong plagiotropic growth (the

Table 1—*Rooting success*

	Number	Percent
Families collected	457	—
Families producing rooted sticklings	450	98.5
Ortets collected	6,828	—
Clones represented by 2 or more ramets	4,234	62
Clones represented by 0 or 1 rooted	2,594	38

tendency to grow laterally, like branches), which persisted through the first growing season (1987) at both sites. By the middle of the 1988 growing season, we estimated that > 90% of the trees in the nursery transplant bed were growing strongly orthotropically (that is, tending to grow erect). Those at Dry Creek were less orthotropic even though the latter had been more vigorous when planted. Irrigation, nutrition, and weed control probably accounted for the differences in overcoming plagiotropism. The trees at the nursery were more frequently irrigated, fertilized, and weeded. These trees were also generally larger and more vigorous after two growing seasons.

Summary

A great variety of factors affect the rooting of Rocky Mountain Douglas-fir cuttings. The vigor of the ortet plays a significant role. Our impression was that the greatest factor in the success of rooting was the apparent vigor of the cuttings. The 1985 growing season had been quite droughty and many of the trees had produced only very short lateral shoots with sparse, short needles. The preponderance of rooting failures were in these cuttings.

The individual genetic makeup of the clone cannot be discounted. The handling between the time of collection and subsequent treatment is also a factor. Having the right facilities and managing them properly are essential. In addition to bottom heat and cooler air temperatures, it is critical that proper humidity be maintained, as well as good air circulation. Plagiotropic growth can easily contribute to the spread of disease problems. The procedures described in this report have now proven themselves using material from a wide variety of sources.

Plagiotropism in rooted cuttings from young ortets apparently can be expected to be largely outgrown in two growing seasons under good cultural conditions. If such conditions cannot be provided in the outplanting, the growers and users of rooted cutting should consider growing the trees for 1 year (or 2) in nursery transplant beds where appropriate treatments can be administered.