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# Douglas-Fir Seedling Grows 8 Feet Tall in Two Seasons

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*ABSTRACT.*—A 96-inch-tall coastal Douglas-fir (*Pseudotsuga menziesii* [Mirb.]Franco) seedling was grown from seed in two years. Greenhouse temperatures of 60° to 70° F, a six-month growing season, long day, adequate winter chilling, large pots, periodic fertilization, and frequent watering are thought to be contributors to the rapid growth.

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WHAT IS THE potential growth of young coastal Douglas-firs? Can they be made to grow as fast as young southern pines? Can Douglas-fir be grown to 2-0 size for field planting in one year? Such questions arise spontaneously when one looks at a 96-inch-tall, two-year-old seedling (Fig. 1). A 24-inch seedling grown in two years in the field or nursery would be considered large. The recent production of four giant seedlings, from 77 to 96 inches tall as 2-0's, has upset past notions of early growth.

The improved picture of potential juvenile growth was demonstrated by performance of hundreds of seedlings, grown from germination to age 6 months in a greenhouse at Corvallis, Oregon. Average height of six-month-old seedlings during each of the last three years was near 20 inches, and some seedlings have grown to 36 inches. Production of such rapid growth involved a six-month growing season, warm days and nights, 16-hour photoperiod, adequate root space, good soil, and ample water.

We became interested to see how large these six-

month-old seedlings of ordinary parentage would grow if they were repotted into larger cans and grown for a second season under the same greenhouse conditions. Four seedlings, 18 to 22 inches tall at the end of the first growing season, grew to 96, 88, 81, and 77 inches by October 1 of the second year.

The life history of the four seedlings began in the greenhouse when freshly germinated seeds were planted about March 20, 1966, into 3-inch-square "jiffy" pots. The pots contained a standard greenhouse soil mix (20 percent peat and 80 percent bottom-land loam). The seeds were obtained from four trees of no known genetic superiority. A commercial 6-10-4 mixture of N-P-K was applied at the start of growth, between the 4th and 5th months, at 13 months, and between the 16th and 17th months. The fertilizer application each year stimulated continued apical growth. Other tests with similar seedlings indicated that the seedlings would have ceased to elongate if not fertilized at those times. Temperatures were maintained at 60° F, night, and 70° F, day, except for some hot days when the greenhouse coolers were overtaxed and room temperatures rose to 80-90° F. Plants were watered whenever the upper surface of the soil became dry. Growth could have continued into October of both years since most trees were still actively growing at the end of September, but danger of frost damage, should seedlings be placed outdoors at a later date, necessitated removing the plants from the greenhouse at least 1 month prior to the first frost. The four winter-chilled plants were repotted in three-gallon cans in late March 1967.

Certain environmental conditions were probably more important than others. For example, winter chil-

# Photographic Interpretation of Canopy Density— A Different Approach

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**ABSTRACT.**—Projecting 35 mm negatives through a microfilm reader provides a simple and inexpensive picture upon which dot counts can be made to determine canopy density. A 12-fold enlargement creates a desirable dot/area ratio because dots on the grid are small in relation to the image of foliage and branch material upon which they do or do not fall.

PRACTICING FORESTERS in increasing numbers have come to think of aerial photographs as necessary tools for many of their management activities. Likewise, research foresters and other investigators have found photography to be an essential tool in many of their studies. Photos may be taken by simple, hand-held box-cameras. Or they may be taken by highly sophisticated cameras mounted on satellites or on powerful microscopes.

The usefulness of perpendicular or vertical photography is increasing in forestry. Vertical photographs, from the ground, of forest canopies are being used for a wide variety of purposes. Perhaps the most common use is to measure forest canopy density in studies of precipitation interception (1, 2, 3, 4, 5).

To determine canopy density over closely spaced terrestrial points, we took 200 vertical exposures and subsequently developed the analytical procedures described here. The approach differed from others in that the pictures were taken through a narrow-angle lens rather than a wide-angle lens, and density determinations were made on projected negatives rather than enlarged prints.

These pictures were taken in 1965, when the U. S. Forest Service began a study of the throughfall of rain (precipitation through a forest canopy) in plantations of redwood (*Sequoia sempervirens* [D. Don] Endl.), sugi (*Cryptomeria japonica* [L.f.] D. Don), Monterey cypress (*Cupressus macrocarpa* Hartweg ex Gordon), and tropical ash (*Fraxinus uhdei* [Wenzig] Lingelsheim) on the Kula Forest Reserve, Maui, Hawaii. A study plot consisting of 50 throughfall points was laid out in a stand of each species. The points were marked with metal stakes spaced 6.6 by 13.2 feet apart. Spacing was altered only if a tree trunk stood in the way. Distinct differences of canopy density between points within each stand as well as between species were obvious, but we wanted accurate measurement of these differences.

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Fig. 1.—A two-year-old, 8-foot-tall Douglas-fir seedling. The other seedlings are from right to left, respectively, 2-0 nursery grown, 1-0 nursery grown, and 1-0 greenhouse grown. For scale, note the meter stick between the first and second seedling from the left.

ling out-of-doors proved necessary. Similar one-year-old seedlings, kept in an unheated greenhouse during winter, failed to burst terminal buds or grew but briefly the second year. Also, ample root space was needed; other winter-chilled one-year-old seedlings, grown for the second year in 3-inch jiffy pots or transferred to No. 2 size cans, grew much less under the same greenhouse conditions than did those in larger cans. When fertilizer applications were ample in other 1st-year studies, there were no obvious differences between several different soil mixes. In evaluating the temperature factor, we suspect that the warm days and nights combined with long growing seasons and long days kept second-year growth about 12 inches per month for the tallest seedling. From this case history, we have no idea how nearly we approached the conditions necessary for maximum growth of Douglas-fir, but we assume some improvement is still possible.

Do these observations indicate practical application of treatments? One possibility is that 2-0-sized nursery seedlings can be grown in a single year by lengthening growing season, increasing night temperatures, lengthening photoperiod, and increasing spacing. A second possibility is that early testing of genetic influences on growth rate can be done from comparisons of seedlings grown at maximum rates. But the main conclusion may be that Douglas-fir seedlings, and perhaps seedlings of many other species, are presently expressing no more than a fraction of their true growth potential in nurseries or field locations. □