

Effect of Seed Source on Mycorrhizal Formation on Douglas Fir Seedlings

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IN THE study of Mycotrophy, certain variables encountered frequently lead to considerable confusion. Many of these variables can be eliminated or reduced to a minimum by growing the seedlings under controlled conditions. Thus, such important factors as light, temperature, moisture, *pH*, and substrata can be kept uniform. One factor that has not been given adequate consideration, however, is the importance of seed source to mycorrhizal formation.

Neglect of this factor may have an important bearing on the outcome of reforestation, since large quantities of seed of untested mycorrhizal capability are being sown in widely separated areas either by aerial seeding or by direct planting. Recent evidence (Linnemann, 1960; Wright, 1960) indicates that seed source has a marked influence on the formation of mycorrhizae on Douglas fir (*Pseudotsuga menziesii* Mirb., Franco).

Methods of Study

Douglas fir seedlings from numerous seed sources were provided from a provenance study (Ching and Bever, 1960) initiated by the Forest Research Laboratory in 1955 (Figure 1). The seedlings were grown in an Oregon state forest nursery, seven miles north of Corvallis, and did not receive special care, but were watered and cultivated the same as the other seedbeds. Each seed source was replicated four times in randomly distributed blocks of seedbed 4 by 32 feet in size. Seedlings for mycorrhizal studies were selected at random from composited lots at 11 months and monthly thereafter until the end of the second growing season. The roots were washed in running water to free them of excess soil and debris and submerged in water in a shallow container for examination under a low-power binocular microscope (13X). The entire root system of each randomly selected seedling was examined for mycorrhizae, but only occasionally for the Hartig net.

The same procedure for examination was repeated for Douglas fir seedlings in three additional localities from small, triplicated, randomized, circular field plots. Small tests in greenhouse also were made of Douglas fir seedlings

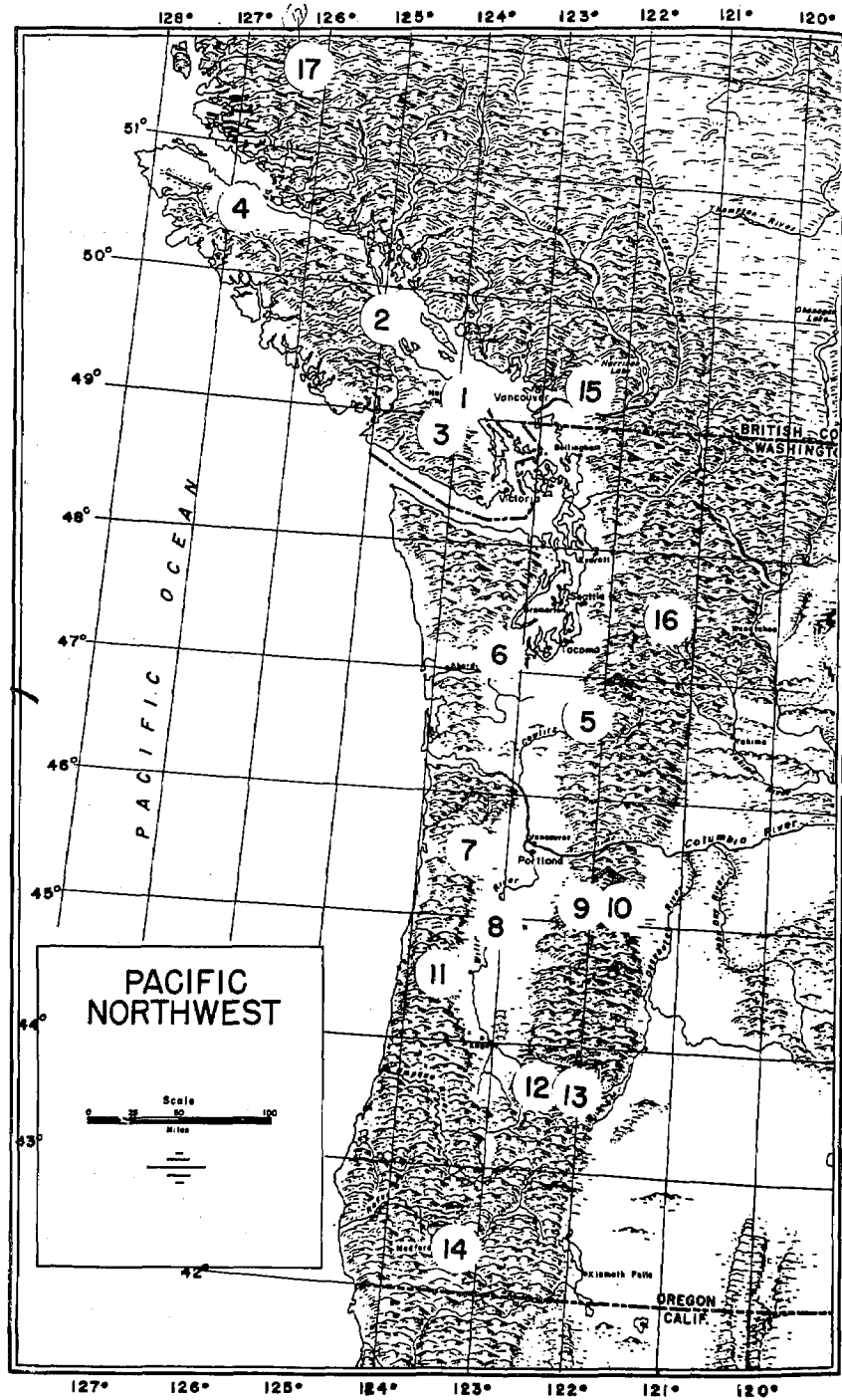


Figure 1. Locations of 17 sources of Douglas fir seed from which were grown seedlings studied for mycorrhizal formation.

from three different seed sources grown for 11 months in forest soil. To avoid bias, all examinations of roots were made by seed-source number, and were not classified as to location until all counts were completed.

Results of Study

Initial examinations of the roots of 11-month Douglas fir seedlings taken from stock of the provenance study showed significantly different mycorrhizal development (Table 1). Monthly examinations of selected sources were made

TABLE 1. SIGNIFICANCE OF MYCORRHIZAL COUNTS ON DOUGLAS FIR AS RELATED TO SEED SOURCE AT 11 MONTHS OF AGE

Seed source	Location	Elevation Feet	Mycorrhizae	
			Mean*	Mean square root**
<i>British Columbia</i>				
3	S. Vancouver Island	500- 800	8.7	1.74
15	Vancouver (near coast)	500- 700	25.7	5.14
17	Bella Coola (interior)	800-1100	21.3	4.25
<i>Washington</i>				
6	Shelton	100- 500	15.3	3.06
16	White River	3900-4000	15.3	3.06
<i>Oregon</i>				
7	Tillamook	1600-2000	10.5	2.62
8	Salem	200	8.6	1.73
9	Molalla (low)	1600-2000	16.3	3.26
10	Molalla (high)	3200-3800	27.2	5.44
12	Oakridge (low)	1800-2000	10.6	2.13
13	Oakridge (high)	2500-3000	19.3	3.86
14	Southern Oregon (Siskiyou Mt.)	2700-3000	0.0	0.0
Significant difference in mean square root [†]				
5% level				1.81
1% level				2.42

* Mean number for each seedling.

** Mean of the square roots of the number of mycorrhizae on individual seedlings.

[†] From analysis of variance.

thereafter until the seedlings were ready for field planting at two years of age. Differences in number of mycorrhizae were observed throughout, but these differences were not significant after the seedlings were more than one year of age (Table 2). The average numbers of mycorrhizae counted on seedlings from the selected seed sources are shown in Figure 2.

Mycorrhizal Formation on Douglas Fir Seedlings

TABLE 2. SIGNIFICANCE OF MYCORRHIZAL COUNTS ON DOUGLAS FIR AS RELATED TO SEED SOURCE AND SEEDLING AGE

Seed source	Mean square root*		
	1 year	1.5 years	2 years
3	1.90	14.43	16.34
15	3.72	16.37	15.27
17	2.88	13.70	11.38
6		18.27	14.77
8	2.52	14.93	13.13
10	5.36	20.10	16.37
14	0.34	14.20	10.12

Significant difference in mean square root

5% level	1.67	7.17	6.80
1% level	2.26	9.94	9.30

* Mean of the square roots of the number of mycorrhizae on individual seedlings.

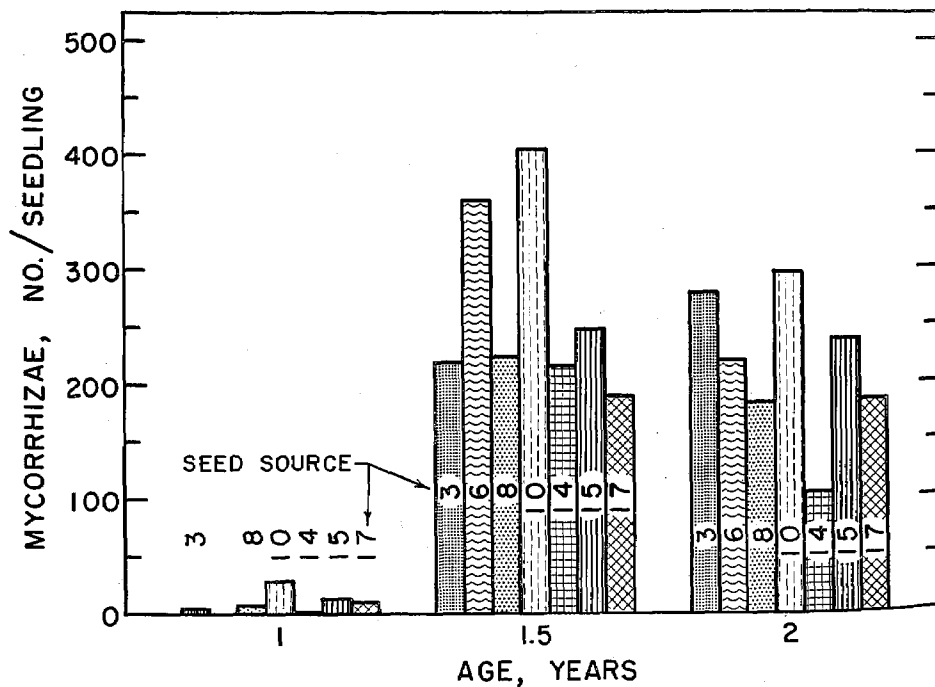


Figure 2. Average number of mycorrhizae counted on seedlings from some sources shown in Figure 1, at three different ages.



Figure 3. Left, dignitate mycorrhizae, *Cenococcum graniforme*; right, racemose mycorrhizae, unknown species.

No correlation was found between number of mycorrhizae and spread of roots, length of roots, number of laterals or number of so-called short roots.

The number and kind of mycorrhizae on seedlings of different seed sources have not yet been related satisfactorily to survival in the field, although indications are that seedlings which develop mycorrhizae early survive best in plantations.

Tests in greenhouse with Douglas fir grown for 11 months in unsterilized forest soil averaged 93.4 mycorrhizae for seed source No. 8, 127.8 for No. 17, and 62.0 for seed source No. 14. These averages were obtained from five-pot randomized replications grown under a maximum of 1200-foot-candle illumination maintained for 10 hours daily.

Ectotrophic mycorrhizae on one-year-old Douglas fir seedlings were mostly digitate and gray or black in color. The black mycorrhizae have been identified as *Cenococcum graniforme* (Saw.) Ferd & Winge. On two-year-old Douglas firs, racemose mycorrhizae as well as digitate types were common. White mycorrhizae also occurred frequently as well as the common gray and infrequent black forms (Figure 3).

Three additional tests on Douglas fir with the same seed sources were repeated in experimental plots located 20 miles farther north and 65 miles and 95 miles farther south. These tests so far have given similar results. Seed source No. 14 consistently has developed significantly fewer mycorrhizae than seed from other localities at the end of the first year.

These results are considered preliminary and not entirely conclusive. Further tests are needed on the same seed sources in several additional localities to determine the validity of these findings. Also, microscopic sections of randomly selected mycorrhizal and nonmycorrhizal roots are needed to establish firmly the presence or absence of the Hartig net.

Literature Cited

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