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Effect of Seed Size on Douglas Fir Seedlings

by

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Oregon Forest Lands Research Center
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Forest Lands Research Center

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Develop the full potential of Oregon's timber resource by:

increasing productiveness of forest lands with improved forest practices.

improving timber quality through intensified management and superior tree selection.

reducing losses from fire, insects, and diseases—thus saving timber for products and jobs.

Keep development of the forest resource in harmony with development of other Oregon resources.

. . . Its Current Program

Seed production, collection, extraction, cleaning, storage, and germination.

Seedling production, establishment, and survival for new forests.

Growth and development of trees, quality of growth, and methods of thinning and harvesting to grow improved trees.

Study of forest fire behavior and fire weather to prevent fires.

Insect pests and their control, to save trees.

Disease control and prevention in Oregon forests.

Mammal damage and the controls to help regrowth.

Soils and their relationship to growth.

Development of improved forests through selection and breeding.

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Introduction

Increased importance of artificial regeneration in Douglas fir (Pseudotsuga taxifolia Poir) silviculture and more emphasis upon developing a superior planting stock have necessitated an increased understanding of the growth habits of Douglas fir seedlings. With nursery space at a premium, the nurseryman must sow his beds with seeds producing maximum quantity and top-quality growing stock. In tree breeding, successful experiments require elimination of factors that may mask true hereditary effects upon growth rates of seedlings. One obvious factor possibly affecting seedling size and vigor is the size of the seed employed in planting or experimentation. Many investigators have studied intensively the effects of seed size upon resulting agricultural crops but relatively little is known about such effects upon trees. This is especially true for tree seedlings two or more years old.

Table I summarizes some of the experimental work thus far undertaken. In addition, Baldwin (2) reviews the work of several investigators who found that seed size exerted a definite effect upon resultant seedling size during the first growing season in several species of Pinaceae. Eliason and Heit (3) found a non-significant relationship between Pinus sylvestris seed weight and its green seedling weight after two years, and between the seed weight and seedling height and diameter after three years. Spurr (8) states that: "The correlation between (seed) weight and shoot weight diminishes as the plant ages, but is still noticeable after three years." (For Pinus strobus.)

Table I: Relation of Seed Size to Seedling Development

Species	Relationship	Duration of Effect Years
European chestnut	+, -	---
Silver fir	+, -	2-4
European larch	+	1-4
Norway maple	+	3+
Russian mulberry	+	---
Durmast oak	+	2+
English oak	+	1+
Northern red oak	+	1+
Austrian pine	+	2-7
Chir pine	+	---
Scotch pine	+	2-6
Sal shorea	+	2-6
Norway spruce	+	2-7
Teak	+, 0	---

Woody-Plant Seed Manual, USDA Misc. Pub. No. 654

Collection and Storage of Experimental Seed

Seeds for this study were collected in the drainage of the North Santiam River at an elevation between 1,000 and 2,000 feet during the fall of 1954. The seeds were stored at 0 F until the spring of 1955.

Separation of Experimental Seed by Density

In May of 1955, fifty pounds of seed (approximately 2,000,000 seeds) were fractioned on a South Dakota Blower (plates 1 and 2). This machine divides seed lots on the basis of the density of each seed. At a given setting, the velocity of the rising column of air causes removal of the least dense, but not necessarily the lightest, seeds. Thus, fractions of increasingly dense seeds may be segregated as the velocity of the ascending column of air is increased. This procedure provides precise, reproducible fractions of any given seed lot.

The fifty pounds of seed were divided into three lots with approximately the following number of seeds per pound in each lot: heavy--37,000; medium--42,000; and light--47,000.[1] The mean weight of heavy seeds was approximately 28 per cent greater than that of light seeds. Probably the difference could have been increased by further fractioning of the seed. The heavy fraction represented about 20 per cent of the original lot; the light, 50 per cent. Since this study was designed to provide data applicable to large scale nursery operations, it was decided that any further refinement would be impracticable.

Pretreatment

The seeds were stored in a moist medium at from 34 F to 39 F (stratification) for six weeks. Random samples of each lot were secured for cutting tests (200 seeds per test) and laboratory germination test (400 seeds per test) (4). The heavy and medium fractions had 100 per cent sound seeds while the light fraction equaled 88 per cent sound. Heavy seed germination was 95 per cent as opposed to 90 per cent for the medium seeds and 82 per cent for the light. An even clearer indication of the greater vigor of the heavy seed may be seen by comparing germination rates after one week in the germinators. At this time the heavy seeds had 89 per cent germination; the medium, 75 per cent; and the light, 59 per cent.

Experimental Area

Nine adjoining beds, 350 feet long, in the Oregon State Forest Nursery near Corvallis, Oregon, were designated as the experimental area. The light-seed lot was drilled in four randomly selected beds; the medium, in three; and the heavy, in two. The beds, of eight rows each, were seeded at a rate of 62 seeds per foot on May 20, 1955.

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1. These figures are based on the weight of seeds only and correspond to the following data for seed lots commercially cleaned; i.e. with some foreign material; 32,000, 41,000, and 44,000.

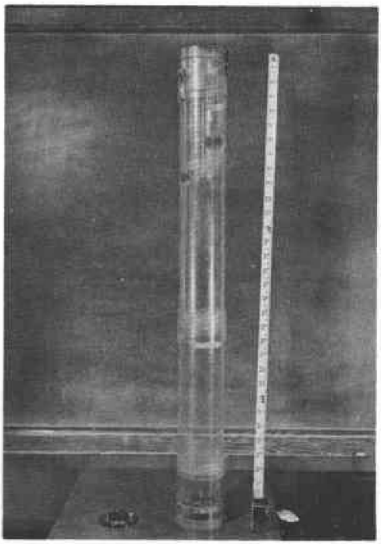

Plate 1. South Dakota Blower. Machine developed for cleaning agricultural seed with an ascending column of air. Separates seed on a density basis; light, blank seeds are trapped in cups at the upper end of tube while heavy, sound seeds remain in the lower reservoir.

Plate 2. Movable head controls air stream in tube. A uniform seed lot may be obtained by "blowing" small increments at identical time and wind settings.

Sampling and Measurement Procedure

In November 1955 samples of the one-year seedlings were harvested in the following manner:

1) Twelve randomly located, one-foot lengths of seedbed were selected for each treatment. (Bed number, row, and distance in feet from the end of the bed were assigned through use of a table of random numbers. Outside rows in each bed were not used to avoid possible border effects.) Because the beds did not appear uniformly fertile, half of the samples for each treatment were located in the upper end of the beds (Stratum I) and half in the lower end (Stratum II).

2) All seedlings in each foot of seedbed were dug up for laboratory examination.

In the laboratory the seedlings were carefully washed and the following data recorded:

1) Shoot length, length of roots, and total length of each seedling.

2) Number of living and dead seedlings in each sample.

3) Total weight of shoots and total weight of roots for living seedlings in each sample.

The seedlings were then stored for three months at 80 F and weighed at intervals until constant weights were reached. These weights were considered to be the "air-dry" weights of each seedling group and formed the basis for the data presented in tables in this report.

A procedure similar to that outlined above was followed in the fall of 1956 to sample and measure the two-year-old seedlings.

Results

Data presented in tables II to VI indicate the following facts:

1) Size and weight of resulting Douglas fir seedlings are not affected by the seed weights.

2) Heavy seeds produced approximately 50 per cent more living two-year-old seedlings for every seed sown than did the light seeds.

3) There was no correlation between seedling mortality and seedling size.

Discussion

Comparison of tables II and IV indicates considerable difference in the number of living two-year-old seedlings produced by the light seeds. Inasmuch as the data recorded in table II represent the total experimental population and not just a sample of it, they are obviously accurate. The disparity between the actual number of seedlings grown and the number estimated may be a sampling error due to the sporadic nature of the stocking of the beds sown with light seeds, Clumps of relatively thickly spaced seedlings were interspersed with completely vacant spaces. This stocking pattern was probably due to the seeds not being sown an absolutely uniform distance beneath the soil surface, and the light seeds (as previously noted) were not sufficiently vigorous to emerge from the soil in areas of deeper sowing.

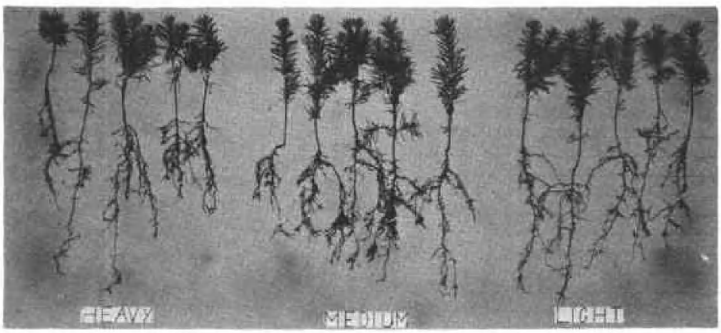

Plate 3. These two-year-old seedlings are typical of those produced by the different seed fractions during this study.

In addition to a tally of the total number of seedlings produced from each seed weight, a tally was also made for each seed weight of all seedlings whose tops exceeded four inches. This showed that 85 per cent of the seedlings produced by light seeds were over four inches tall; 83 per cent of the seedlings produced by medium seeds were taller than four inches; and 68 per cent of the seedlings produced by heavy seeds were over four inches in height. Even when samples determining seedling size indicated that the light seedlings were under greater competition than corresponding heavy seedlings, seedlings grown from the light seeds were larger than those grown from heavy seeds. It must therefore be concluded that the greater number of seedlings in beds sown with heavy seed did not cause their relatively inferior size.

Conclusions

Data presented in this report show that nurserymen cannot expect to produce larger seedlings merely by using the heaviest fraction of a given lot of Douglas fir seed. It is possible, however, to utilize the nursery area more completely by seeding the beds with seeds of the highest possible germinative vigor. A relatively small decrease in germinative vigor as measured by laboratory tests can mean a substantial reduction in crop seedlings in the nursery.

Table II: Total Nursery Tally of Two-year-old Seedlings Lifted from Experimental Beds

Seed weight	Total number of seedlings	Total number of feet of seedbed	Mean number of seedlings per foot of seedbed
Light.....	226,000	11,200	20.18
Medium.....	182,000	8,400	21.67
Heavy.....	172,000	5,600	30.71
Mean.....	-----	----	23.02

Table III: Seedling Mortality

Seed weight	Mortality		
	1955	1956	Total
	%	%	%
Light.....	3.2	9.8	13.0
Medium.....	4.8	12.1	17.9
Heavy.....	2.9	8.5	11.4

Table IV: Number of Living Seedlings per Sample Unit

One-year-old seedlings

Seed weight	Number of seedlings		
	Stratum		Average
	1	2	
Light.....	24.0	22.0	23.0
Medium.....	33.0	27.0	30.0
Heavy.....	40.0	32.0	36.0

Two-year-old seedlings

Seed weight	Number of seedlings		
	Stratum		Average
	1	2	
Light.....	35.0	28.0	31.0
Medium.....	27.0	23.0	25.0
Heavy.....	32.0	25.0	28.0

Table V: Total Seedling Weight (Root and Top)

One-year-old seedlings

Seed weight	Seedling weight		
	Stratum		Average
	1	2	
	Grams		Grams
Light.....	0.27	0.19	0.23
Medium.....	0.26	0.25	0.26
Heavy.....	0.34	0.22	0.28

Two-year-old seedlings

Seed weight	Seedling weight		
	Stratum		Average
	1	2	
	Grams		Grams
Light.....	1.05	0.98	1.02
Medium.....	1.30	1.11	1.22
Heavy.....	0.89	0.98	0.93

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Table VI: Total Seedling Length (Root and Top)

One-year-old seedlings

Seed weight	Seedling length		
	Stratum		Average
	1	2	
	Inches		Inches
Light.....	8.3	6.9	7.6
Medium.....	8.5	8.4	8.5
Heavy.....	9.0	7.3	8.3

Two-year-old seedlings

Seed weight	Seedling length		
	Stratum		Average
	1	2	
	Inches		Inches
Light.....	12.3	12.4	12.4
Medium.....	13.2	12.6	12.9
Heavy.....	11.7	12.1	11.9

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