Container-grown trees show response to fertilization at time of planting

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The application of various fertilizers to bare-root stock at planting time is not a new technique (2, 4). Studies reveal that such applications may increase tree-height growth (8), but can produce greater seedling mortality *(11, 12).*

The Canadian Forestry Service is presently growing and field testing many tree species in various container types (5, 3). A series of experimental plantations has been established to determine the effects of fertilizer application at the time of outplanting on growth and survival of container-grown stock. This note reports on some of the results.

Materials and Methods

Douglas-fir *(Pseudotsuga menziesii* (Mirb.) (Franco) and Sitka spruce *(Picea sitchensis* (Bong.) Carr.) seedlings for the fertilizer trial were grown at the Pacific Forest Research Centre, Victoria, B.C., in three types of containers; namely, the 2 1/2- and 4 1/2-inch Walters' bullet *(14, 15)* and the 9/16-inch Ontario tube *(1, 6).* Containers were filled with a California "C" soil mix (7). One or two seeds were sown per container and then covered with a layer of fine sand. Following seeding on May 3, 1967, the containers were placed in subirrigation tanks in an outdoor shadehouse where they were watered as necessary (fig. 1) . Because there was insufficient fertilizer in the California "C" soil mix to sustain satisfactory tree growth throughout the growing season, supplemental water-soluble fertilizers were added through the subirrigation system from July on. The two compounds used almost exclusively were the Plant Products Ltd.1 fertilizers 28-14-14 and 15-1530. The intention was to supply the seedlings with high levels of nitrogen through midsummer (2814-14) and to reduce nitrogen and increase potassium toward the end of the growing season (15-15-30). The seedlings were overwintered in the open shadehouse before outplanting on April 26, 1968. A description of the stock at that time is provided in table 1 and figure 2.

The location selected for the fertilizer trial was near Port Renfrew, on the west coast of southern Van

1 Trade name used for information only; no endorsement by the Canadian Forestry Service is implied.

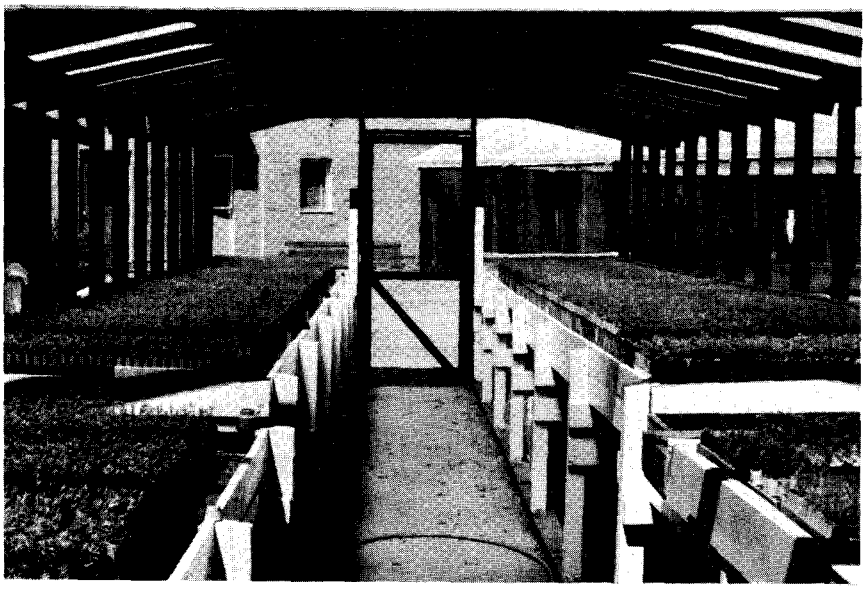


Figure 1.—Outdoor shadehouse with subirrigation tanks used for growing seedlings in Walters' bullets.

couver Island, Southern Pacific Coast Section, Coast Forest Region (9). The area, at 100 feet above sea level, consisted of recent alluvial deposits (associated with the San Juan River) overlying till deposits. It had a site index of 160-180, and originally supported a stand of alder, western hemlock, and Sitka spruce which, through past logging practices, had developed into pure alder cover. Soils ranged from single-grain sands to gravels.

This experimental area was made available by the Renfrew Logging Division of British Columbia Forest Products Ltd., who were testing methods of rehabilitating this highly productive bottomland from alder to coniferous species. The alder was logged in 1967 and the container seedlings for the fertilizer trial were planted on blade-scarified strips. The entire plantation was protected by a deer fence.

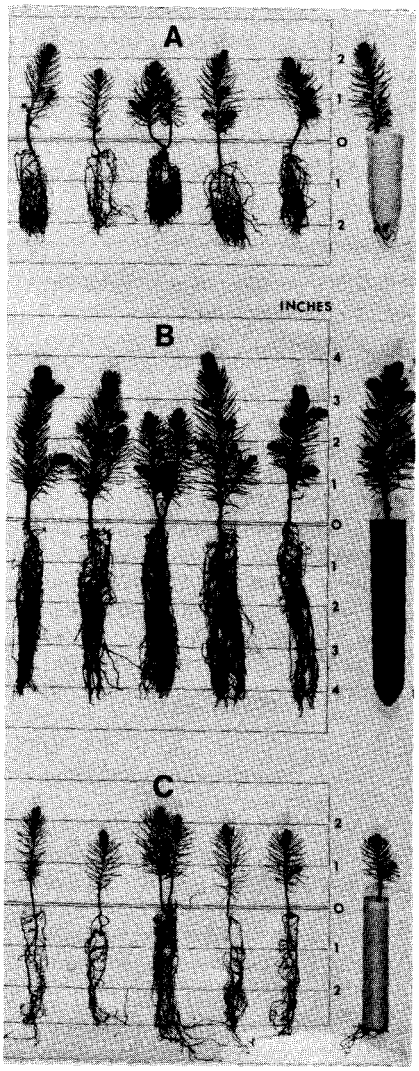
In addition to the 9/16-inch tube, the Sitka spruce seedlings were planted in 2 1/2- and 4 1/2-inch bullets, and as—2 1/2- and 4 1/2-inch plugs. Plug refers to a molded mixture of root and soil withdrawn from a container in which the tree is grown (13) ; in this case, the 2 1/2and 4 1/2-inch Walters' bullet. Consequently, both bullet and plug seedlings had identical characteristics (table 1) . The only difference was the presence of the container around the root system of the bullet-planted stock. Planted alongside bullet seedlings, the plug seedling permits a biological appraisal of the container influence on survival, height growth, and root development. All trees were planted systematically in lines, with 20 or more trees per line. Bullets were planted by a gun (14) and plugs and tubes with a dibble.

Fertilizer used in this experiment was hoof-and-horn meal (4-11-7), 15.7 g. of which was placed in 41/2inch Walters' bullets and dibbleplanted 3 inches away from the tree. The objective was to obtain a slow release of organic fertilizer through the holes and side opening of the bullet without suddenly releasing large quantities that might be detrimental to tree roots.

Results

Tree survival and growth rates were assessed in the fall of each year following planting. The results showed that fertilizer effects, in terms of survival, have been variable: substantial beneficial or adverse effects were not apparent (table 2) . On the other hand, by 1970 fertilizer application had sub

Figure 2.-One-year-old Sitka spruce seedlings grown in (A) 21/2-inch Walters' bullets, (B) 4 1/2-inch Walters' bullets, and (C) 9/16-inch Ontario tube.



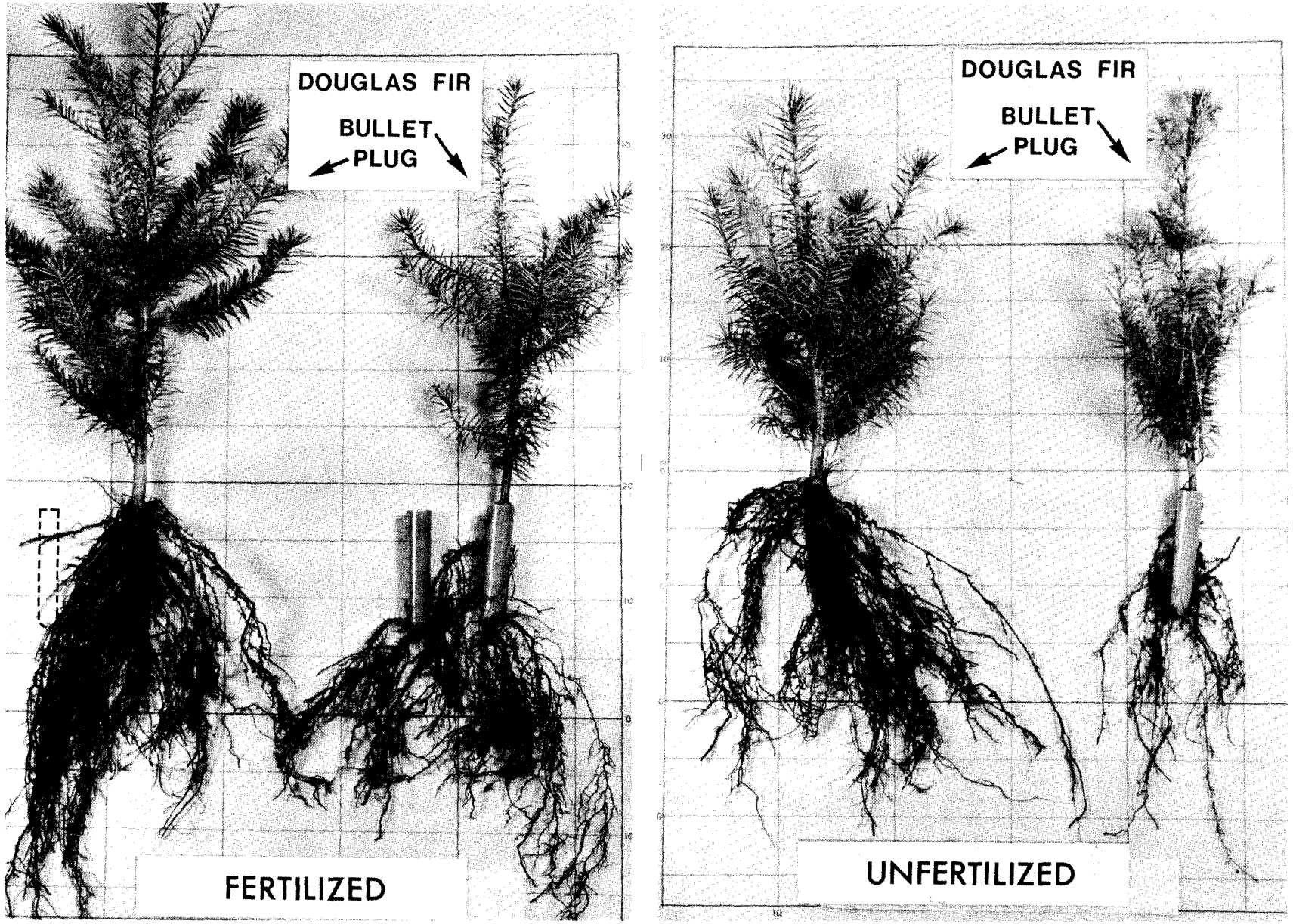


Figure 3.—A & B Fertilized and unfertilized Douglas-fir bullet and plug seedlings excavated 2 years after planting. Position of the bullet containing the fertilizer for the plug category is indicated by the dotted line. (Horizontal grid lines are spaced at 5 cm).

TABLE 1.—*Characteristics of container stock used in fertilizer trial at the time of planting*

Species	Container type	Shoot Length *cm*	Shoot Weight *mg*	Root Weight *mg*	Shoot/root ratio
Sitka spruce	4½" bullet [1]	8.8	512	327	1.55
	2½" bullet	5.0	189	124	1.53
	9/16" tube [2]	5.2	133	81	1.65
Douglas-fir	4½" bullet	12.8	586	309	1.90

[1] Trees grown in Walters' bullets.
[2] Trees grown in Ontario tubes.

stantially increased height growth in all three species, particularly the plug categories. The cumulative effect of fertilization and removal of the container was clearly demonstrated by the height growth of the fertilized plugs. Average heights at the end of each growing season for the fertilized and nonfertilized container groups for each species were analyzed statistically. As the Sitka spruce and Douglasfir populations had unequal variances, a nonparametric MannWhitney U-test for two independent samples was run (10).

Although the average heights of the fertilized Sitka spruce were almost always greater than those of the non-fertilized categories, the differences were only significant in four cases (table 2). However, the increase in height growth realized through fertilization of the Douglas-fir seedlings was significantly different from non-fertilized categories at the end of every growing season. Fertilization has almost doubled the height growth of Douglas-fir plug seedlings 3 years after planting.

Several sample trees excavated in the fall of 1969 showed roots growing into the bullet capsule containing the fertilizer (fig. 3). Furthermore, the roots of fertilized plug and bullet seedlings tended to concentrate beneath the capsule containing the hoof-and-horn meal. The differences were striking when compared to the normal root development of bullet- and plugplanted seedlings shown in the "unfertilized" samples.

The results of this study can only be applied to sites comparable to that on which the experiment was conducted. Further planting of container-grown Sitka spruce stock on comparable sites the following year showed a significant response to this type of fertilization. However, subsequent plantings, in the spring of 1969, of Douglas-fir bullet and plug seed
lings on rapidly drained sites of shallow, sandy loam soils at elevations above 3,000 feet on the east coast of southern Vancouver Island
showed no beneficial effects of fertilizer application. Lack of response could have been due to drought conditions following planting and during the summer.

TABLE 2.—*The effect of fertilizer application at the time of planting on the survival and height growth of Sitka spruce and Douglas-fir container-grown seedlings*

Species	Container type and Fertilizer treatment	Number of seedlings	Percent survival at the end of 1968	1969	1970	Average height (cm) at the end of 1968	1969	1970
Sitka spruce	4½" bullet — F. [1]	20	90	85	79	12.7* [2]	20.6	45.1
	— No F.	23	100	100	96	10.9	23.3	41.0
	4½" plug — F.	20	100	100	100	15.7*	30.1	57.5*
	— No F.	25	92	92	92	12.8	27.9	45.3
	2½" bullet — F.	20	100	85	75	5.5	14.4	26.9
	— No F.	25	92	92	92	5.0	12.4	22.4
	2½" plug — F.	20	100	100	100	6.7	18.5	33.8
	— No F.	25	100	100	100	5.8	16.4	28.2
	9/16" tube — F.	23	100	100	91	9.1	22.3	44.2*
	— No F.	25	96	92	92	9.1	23.0	35.9
Douglas-fir	4½" bullet — F.	20	100	95	95	14.5*	25.8*	46.6*
	— No F.	23	100	91	86	12.7	20.2	35.4
	4½" plug — F.	25	100	100	100	14.6*	31.3*	60.5**
	— No F.	19	100	100	100	12.3	22.0	34.8

[1] F. = Fertilizer treatment; No F. = No fertilizer treatment.
[2] Height difference from the non-fertilized category statistically significant at the 5 percent (*) and 1 percent (**) level, respectively.

Fertilization at the time of planting will be feasible in a container reforestation system when a satisfactory mechanical planter and delivery vehicle has been developed. The results of this trial show a potential for achieving rapid early growth of outplanted container seedlings and warrant further study.

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firm species and keep them fertilized deeply. If any unstable trees are growing close to structures, they should be removed or top pruned to reduce their height.

Already have your trees planted and growing? Here are some guidelines on what to do after the storm:

1. Remove hanging tops, branches, and leaning trees that create a hazard.

2. Avoid wounding trees with equipment when removing debris. Do not permit use of climbing spurs in pine trees unless absolutely essential.

3. Be prepared to do the necessary follow-up removal during the first two years after the storm. Weakened trees may die for several years if insects attack or drouth occurs.

4. In case of drouth water frequently.

(By Ed Kerr in The Progressive Farmer/ March 1972)