EFFECT OF STORAGE ON VIGOR OF DOUGLAS-FIR STOCK

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Preliminary investigation have indicated that either storage temperature or the lack of a daily photoperiod during the storage period might be responsible for the reduced seedling vigor commonly noted after a period of cold storage. Accordingly, the following experiments were designed and conducted to investigate further the significance of the storage environment upon the subsequent survival potential of Douglas-fir planting stock.

Experiment 1. Seedlings are commonly stored at about 35° F., a temperature somewhat below that experienced by the roots and, except for brief intervals, by the shoots of seedlings lifted in the fall. Accordingly, the following study was conducted to determine if reducing the storage temperature gradually would be less harmful to the plants. Seedling population was medium elevation, 2-0 stock, lifted from the Elkton nursery on October 1, 1969.

Nine lots of fifty seedlings each were placed in polyethylene bags immediately after lifting and stored upright for six weeks in the dark at the temperature sequence shown in Table I. In all cases where plants experienced more than one storage temperature, they were moved from higher temperature to a lower one. After storage the seedlings were weighed, planted, and grown for six weeks at a constant 70° F. temperature with a twelve hour photoperiod. They were then harvested, weighed, and the number of active roots and seedling mortality recorded. It is clear that the seedlings stored at a constant 35° F. were the most vigorous after storage. The roots of all seedlings appeared healthy, but the shoots of plants stored at the warmer temperatures lost much of their foliage and generally had an unhealthy appearance after storage.

Experiment 2. Seedlings from the same population as above were planted immediately after lifting in boxes designed to be placed in water baths. Half the plants (80) were placed in a water bath maintained at approximately 57° F. (soil temperature at the six inch level when the plants were lifted); the second half were exposed to air temperature (approximately 35° F.). Thus half the plants had warm roots and cold tops, while the second half had both cold roots and tops during storage. Half of each of these populations was exposed to a nine hour photoperiod of approximately 600 foot candles daily. The second half was maintained in darkness for the entire storage period. After six weeks of storage, the boxes were transferred to a growth room maintained at a constant 70° F. with a twelve hour photoperiod daily. Six weeks later the seedlings were harvested and the data presented in Table II tallied.

It is clear that both the experimental treatments i.e. warm roots and a daily photoperiod, had a beneficial effect upon seedling vigor. However, it is equally clear that October 1 is generally considered a poor time to lift seedlings from the nursery, so the experiment was repeated with seedlings lifted in early January and again in late February. The results of these latter two trials are not as striking as those shown in Table II, but there is still evidence that seedlings benefit from a daily photoperiod during storage. Five of the eighty seedlings lifted in January and stored in the dark were dead or dying at time of harvest compared with one poor seedling in the population stored in the light. None of the seedlings lifted in February died, but the seedlings stored with a daily photoperiod broke their buds more rapidly than did those plants stored in the dark (same condition was true with January lifted plants). Inasmuch as the only seedling parameter which was shown to be related to drought survival in a recent study conducted at Oregon State. University was the speed of bud burst, this last observation may indicate increased survival potential for seedlings planted in the field. It is interesting to note that the plants lifted in January and February were not benefited by the storage with warm roots. Indeed, this treatment reduced subsequent seedling vigor somewhat. Such a result is, of course, consistent with the hypothesis that the root system is sensitive to sharp changes in temperature, as the nursery soil in January and February was much closer to 35° F. than it was to 57° F.

Experiment 3. Second year Douglas-fir seedlings were planted, a single seedling to a can, in cans approximately six inches in diameter by 10 inches tall in the spring of 1969. They were allowed to grow under natural conditions until August 1. At this time the population was divided randomly in half; one half was maintained under sixteen hour photoperiod (long photoperiod), the natural photoperiod supplemented by about 25 foot candles of incandescent light, and the second half, under a nine hour photoperiod (short photoperiod), until 15 October. The plants experienced natural conditions during this time except that the black-out device employed to create the short photoperiod raised the minima on clear nights about 4° F. On October 15, all plants were excavated, weighed, and half of each population replanted intact. The second half of each population had all active root tips pruned before replanting (in some cases over 100 active roots per plant were removed). Each of the now four populations was halved again, one half was stored for six weeks at 35° F. in the dark; the second half, was stored at the same temperature but with a daily photoperiod of about six hundred foot candles. Sufficient plants were provided for twenty seedlings for each of the final eight populations. After six weeks the plants were transferred to a growth room maintained at a constant 70° F. with a 12 hour daily photoperiod. After six weeks in this regime the plants were harvested and the data shown in Table III recorded.

It is apparent that again storage with a daily photoperiod both increased. seedling survival and the speed of bud burst. Further, it is clear that the effect of the daily photoperiod upon subsequent plant vigor was greater than that of pruning all the active root tips, certainly a more severe treatment than would be occasioned by the harvest operation of a reasonably prudent nursery.

All of the observations recorded during the second and third experiments indicated the favorable effect of a daily photoperiod upon subsequent seedling vigor. However, as noted above, some of the plants were lifted considerably earlier than is customary in nursery practice, and the storage periods employed may have been longer than average. Therefore, it is planned to repeat these studies this coming winter with larger populations of seedlings lifted at varying times during the normal lifting period and stored for several different periods. After storage, the plants will be planted under both controlled conditions as described above and in the field so that a determination of the effects of a daily photoperiod during storage upon subsequent seedling survival under field conditions may be made.

Table I

Effect of Storage Temperature Upon the Vigor of Dormant Douglas-fir Seedlings

Duration of Storage Temperature			Growth Response		
			Number of Dead Seedlings*	Mean Number of Active Roots/Living Seedling	Mean Growth Increment (%) for Living Seedling
6 weeks	-------	-------	46	32	- 26
3 weeks	3 weeks		34	36	- 21
2 weeks	2 weeks	2 weeks	35	29	- 19
3 weeks	-------	3 weeks	33	38	- 22
2 weeks	-------	4 weeks	23	39	- 12
-------	6 weeks	-------	32	44	- 18
-------	3 weeks	3 weeks	27	43	- 12
-------	2 weeks	4 weeks	22	36	- 14
-------	-------	6 weeks	23	39	- 16

* 50 seedlings in each original population.

Table II

Effect of Storage Conditions Upon the Vigor of Dormant Douglas-fir Seedlings

Growth Response	Treatment			
	Cold Roots		Warm Roots	
	Light*	Dark*	Light*	Dark*
Number of Dead Seedlings	2	18	0	4
No. of active roots per living seedling	46	48	40	45
Increment of Initial Weight (%) for living seedlings	0	- 9	- 6	- 7

* Initial population = 40 seedlings

Table III

Effect of Day Length, Daily Light Period During Storage, and Root Pruning Upon the Vigor of Dormant Douglas-fir Seedlings

Growth Response	Treatment					
	Pre-treatment		Storage		Roots	
	Long* Day	Short* Day	Light*	Dark*	Pruned*	Control*
Number of Dead Seedlings	11	0	2	9	6	5
Increment of Initial Weight (%)	- 9	+10	+3	-2	0	0
Total number of active roots	715	650	611	754	674	691
Total number of active buds	107	336	328	115	212	231
Total centimeters of new growth	137	626	652	111	325	438

* Initial population - 80 seedlings.