PERFORMANCE OF CONTAINERIZED CONIFEROUS SEEDLINGS IN RECENT FOREST REGENERATION TRIALS IN OREGON AND WASHINGTON 1

Jerry R. Gutzwiler and Jack K. Winjum 2

Abstract.--In Oregon and Washington the number of containerized seedlings used in forest regeneration has increased from less than 0.5 million to approximately 20 million over the last three years. Survival and growth of the initial outplantings re generally poor; however, significant gains have been made through improvements in: 1) physiological condition of containerized stock, 2) nursery to field handling practices, 3) planting methods, and 4) site conditions.

The use of container-grown coniferous seedlings in forest regeneration continues to gain momentum each year in Oregon and Washington. In gathering data for this presentation we learned that thirteen organizations involved in reforestation with container seedlings, in the two states, had operationally planted approximately 20 million during the 1973-74 planting season, a substantial increase over the .5 million planted during 1970-71 in the same region. [3]

Though the often quoted advantages of improved planting rates and minimum root disturbance of outplanted container stock remain true, foresters will ultimately base their judgment of this regeneration concept on seedling field performance. In this brief update of field results we have screened many reports and will feature those in which container seedlings were compared side-by-side with bare root seedlings in field plantings. Both research and operational results are represented.

Though many container configuration/ systems have been developed in recent years, four have been used to produce the majority of the containerized stock grown in Oregon and Washington:

System	Length	Volume
R.L. Single Cell	12 cm. (4-3/4")	45.9 cm.^{3} (2.8 cu.in.)
Styroblock-2	11-1/2 cm. (4-1/2")	41.0 cm.^{3} (2.5 cu.in.)
TreeTainer	15 cm. (6")	45.9 cm.^{3} (2.8 cu.in.)
Walter's Bullet	11-1/2 cm. (4-1/2")	22.9 cm.^{3} (1.4 cu.in.)

Operational and research field experience with containerized seedlings has been focused primarily on five coniferous species native to the Pacific Northwest:

Abies procera	(Noble fir)
Picea sitchensis	(Sitka spruce)
Pinus ponderosa	(Ponderosa pine)
Pseudotsuga menziesii	(Douglas-fir)
Tsuga heterophylla	(Western hemlock)

Table 1 indicates which species have been outplanted as container stock by each of the thirteen companies and agencies that contributed data for this paper.

RESEARCH METHODS AND RESULTS

Research experiments generally involved a few hundred container seedlings carefully planted in a replicated design. Bare root seedlings of the same seed source were often

[1] Paper presented at North American Containerized Forest Tree Seedling Symposium, Denver, Colorado, August 26-29, 1974.

[2] Regeneration Research Forester and Forest Regeneration Research Manager, Weyerhaeuser Forest Research Center, Centralia, Washington.

[3] Frank A. Ter Bush. Personal communication, June 24, 1974. Division of State and Private Forestry, Pacific Northwest Resion, USDA Forest Service, Portland, Oregon.

planted concurrently to serve as a control. We have summarized survival results from 13 recent experiments conducted in Oregon and Washington in which container and bare root seedlings were compared (Tables 2 through 6). Note, locations of the trials have been classified as either "Coast" or "Cascade", referring to the mountain range nearest the trial site.

Table 1. -- Forestry organizations (Oregon and Washington) with recent container planting experience

Organization	Douglas-fir	Western Hemlock	Noble fir	Ponderosa pine	Sitka spruce
Crown Zellerbach Corp.	X	X			X
Georgia-Pacific Corp.	X				
International Paper Co.	X	X			
ITT Rayonier Inc.		X			
St. Regis Paper Co.				X	
Scott Paper Co.	X	X			
Starker Forests	X				
U.S.D.A. Forest Service	X	X	X	X	X
U.S.D.I. Bureau of Land Management	X				
U.S. Plywood	X				
Washington State Dept. of Natural Resources	X	X	X	X	X
Weyerhaeuser Co.	X	X	X	X	
Willamette Industries, Inc.	X	X			

Table 2. -- Research trials with container seedlings. U.S. Forest Service.

Species	Start Year	Location	First Year Survival %	
			Styroblock-2	2+0 Bare root
Douglas-fir[1]	71-72	Southwest Oregon		
		North Aspect	86	84
		South Aspect	49	55
Western Hemlock[2]	72-73	Oregon Coast (Interior)	97	92
			84	99
			85	85

[1]Peyton W. Owston. 1973. Field Performance of Containerized Seedlings in the Western United States. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station.

[2]Peyton W. Owston, personal communication, March 28, 1974. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station.

Table 3. -- Research trials with container seedlings. Scott Paper Company.[1]

Species	Start Year	Location	Second Year Survival %	
			Plug (bullet)	Bullet
Douglas-fir	70-71	Washington Cascade		
		Winter	74	67
		Spring	66	61
Western Hemlock	71-72	Washington Cascade		
		Fall	90	74
		Spring	83	83

[1]John F. Couturie, personal communication, March 21, 1974. Scott Paper, Northwest Operations, Everett, Washington.

Table 4. -- Research trials with container seedlings. Georgia-Pacific Corporation[1] and U.S. Plywood.[2]

Species	Start Year	Location	Second Year Survival %	
			Styroblock-2	Bullet
Douglas-fir	71-72	Georgia-Pacific Oregon Cascade		
		Fall	70	38
		Winter	83	48
	71-72	U.S. Plywood Oregon Coast	78	67

[1]Phil Hahn, personal communication, June 5, 1974. Georgia-Pacific, Eugene, Oregon.

[2]Bob Lee, personal communication, March 18, 1974. U.S. Plywood, Lebanon, Oregon.

Table 5. -- Research trials with container seedlings. Weyerhaeuser Company.[1]

Species	Start Year	Location	Second Year Survival %	
			Styroblock-2	2+0 Bare root
Douglas-fir	71-72	Washington Cascade	52	79
		Oregon Cascade	77	37
		Washington Coast	87	78
		Oregon Coast	54	64

[1]Averages based on 200 container seedlings and 200 bare root originally planted in each location.

Table 6. -- Research trials with container seedlings. Willamette Industries, Inc.[1]

Species	Start Year	Location	Second Year Survival %		
			Bullet	Plug (Bullet)	Bare Root
Douglas-fir	71-72 (Fall)	Oregon Cascades	50	50	2+1 / 88
Douglas-fir	71-72 (Fall)	Oregon Coast (Interior)	81	83	1+1 / 72
Douglas-fir	71-72 (Fall)	Oregon Coast (Interior)	05	17	2+1 / 88
Douglas-fir	72-73 (Fall)	Oregon Cascades	37	38	2+1 / 84

[1]Robert L. McNitt, personal communication, June 21, 1974. Willamette Industries, Inc. Lebanon, Oregon.

OPERATIONAL METHODS AND RESULTS

These trials consist of larger numbers of seedlings (usually several thousand or more) being planted in an area where both container and bare root stock are outplanted as part of operational regeneration programs. Planting is accomplished by regular planting crews and survival is based upon observations of a few hundred staked seedlings and/or periodic land examinations (Tables 7 through 9).

Table 7. -- Operational trials with container seedlings. Crown Zellerbach Corporation.[1]

Species	Start Year	Location	First Year Survival %	
			TreeTainer	2+0 Bare Root
Douglas-fir	72-73	Washington Coast	80	60
		Oregon Coast	86	85
Western Hemlock	72-73	Oregon Coast	85	
Sitka Spruce	72-73	Oregon Coast	85	

[1]Ralph Duddles, personal communication, June 7, 1974. Crown Zellerbach Corp., Portland, Oregon.

Table 8. -- Operational trials with container seedlings. Publishers Paper Company.[1]

Species	Start Year	Location	First Year Survival %	
			Styroblock-2	Bare Root
Douglas-fir	71-72	Oregon Cascade	65	approx. 90
		Oregon Coast	<65	approx. 90
Western Hemlock	71-72	Oregon Cascade	30-85	
		Oregon Coast	<30-85	

[1]Troy K. Moore, personal communication, April 19, 1974. Publishers Paper Company, Oregon City, Oregon.

Table 9. -- Operational trials with container seedlings. U.S. Bureau of Land Management[1] and Weyerhaeuser Company.

Species	Start Year	Location	Second Year Survival %	
			Styroblock-2	2+0 Bare Root
Douglas-fir	71-72	Oregon Cascade, BLM	30	72
		Oregon Coast, BLM	36	79
		Oregon Coast, BLM	28	76
			RL Single Cell	
	72-73	Washington Cascade, Weyerhaeuser Company	58	98

[1]Charles Thomas, personal communication, March 18, 1974. USDI, Bureau of Land Management, Portland, Oregon.

DISCUSSION

Growth. In examining the available growth data from container seedlings versus bare root comparisons, neither appeared to be consistently superior to the other.

Survival. The broad averages tabulated in Table 10 indicate that container seedlings are presently inferior to bare root stock from the survival standpoint. In only eight of the 21 comparisons presented in the tables was container stock survival superior to bare root. It should be remembered, however, that these figures are based on the performance of stock that was grown and planted several years ago. Since that time much has been learned about container seedling culture and the general consensus is that today's container seedlings are far superior, in size and vigor at the time of outplanting, to those which were produced in earlier years. These improvements are expected in turn to yield better container field performance in the next few years. In other words, we are probably still low on the learning curve of plantation establishment with containerized stock.

Operations and research foresters who have worked with these initial field comparisons have suggested several reasons for lower survival of containerized seedlings versus bare root stock.

Table 10. -- Broad averages from survival percentages of container seedling trials in Oregon and Washington (derived from Tables 2 through 9).

Comparison	n*	Survival % and Std. Dev.			
		Container		Bare Root	
Research	13	66	±24	72	±21
Operations	7	54	±24	80	±12
Douglas-fir	17	57	±24	76	±15
W. Hemlock	3	88	± 6	90	± 6
Coast	13	67	±27	73	±21
Cascade	7	52	±16	78	±20
Oregon	16	60	±26	77	±16
Washington	4	69	±17	79	±16
71-72	13	55	±23	74	±15
72-73	7	75	±20	86	±13

*n = number of trials upon which each average is based.

1) Seedlings not fully developed: Containerized seedlings normally must have a firm stem with some woody tissue and be well hardened off to withstand any freezing weather expected in the first few weeks after outplanting. Root systems must be profuse enough in plug seedlings to maintain the growing medium and plug integrity until planting. Increased mortality has been noted where the root plug falls apart before planting.

2) Careless handling and planting: Containerized stock must be handled and planted carefully for high success in the same manner as bare root. Because they are more uniform in overall shape, planters may be more prone to think of the seedling in a mechanical rather than biological way leading to rougher handling and planting. The same result may also occur because of the faster planting rates with container seedlings.

3) Frost heaving: Frost heaving of fall planted container stock has been reported in several areas of Oregon and Washington where snow cover is intermittent during the winter months and below freezing temperatures occur frequently. It has been suggested that deeper planting; e.g., top of the plug 0.5-0.75 inch below the soil surface, and tighter heeling could reduce the effect of frost heaving.

4) Animal damage: Browsing and clipping by animals (deer, elk, and rabbits) usually results in more extensive damage to container seedlings than bare root stock, because the shoots of the former have been more succulent and generally lack lateral branches. To date no fully effective animal repellent has been developed to protect container stock; hence, many foresters prefer to plant more robust 1+1 or 2+1 bare root stock in areas characterized by high animal populations.

5) Competing vegetation: Initially, most container seedlings have an effective rooting depth of seven inches or less. If present, competing forbs and grasses also extensively occupy this zone and may seriously affect plantation survival through competition for

moisture during periods of drought. When competing vegetation is present on a site, it is desirable to scalp a microsite of sufficient size to prevent moisture competition during the first growing season, i.e., two to four feet in diameter depending on the rooting characteristics of the competing species (Cleary 1973).

SUMMARY

The production and quality of container stock has increased steadily in Oregon and Washington during this decade. Even though field performance of container seedlings has been generally inferior to bare root to date, some organizations predict that it will soon be the primary stock used in their regeneration programs. The premise for such predictions lies in the inherent advantages of the container seedling concept, including; high planting rates, extended planting season, shorter growing period, adaptability to mechanization, and, at least potentially, more favorable biological characteristics of the "plug" over bare-root stock. Research efforts have been intensified to solve the problems critical to the field performance of containerized stock. We have found that the degree of success or failure of container stock is highly dependent on certain site factors. Sites typified by intense vegetative competition and/or high animal populations have yielded the poorest container seedling performance. Conversely, best results with container stock have generally been achieved on sites free of vegetative competition, with minimal animal populations, on north slopes where adequate moisture remains available to the seedlings throughout the first summer.

In a few years, much has been learned about the container concept and its applicability to forest regeneration in Oregon and Washington. As container seedlings continue to be improved in quality and programs expand, more of the problems surrounding their use will be resolved. It seems valid to conclude, therefore, that in the next decade container planting will become a widely used and effective means of regenerating forest lands in Oregon and Washington.

LITERATURE CITATIONS

Cleary, Brian.
1973. Preliminary plug planting guidelines. Dept. of Forest Management, Oregon State University, Corvallis, Oregon.

Question: What were the dry weights of shoots and roots of the plug seedlings you tested and of those you now grow?

Gutzwiler: Top weight ranged from 0.7 to 1 gm, and root weight 0.4 to 0.6 gm. Shoot-root ratio ran from 1.5 to 2.5. The stock we are raising now has a caliper about twice that of the earlier stock.