DEVELOPMENT OF THE BRITISH COLUMBIA CONTAINER PROGRAM

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Abstract.--Small trials of Walters' 2 1/2-inch bullet were carried out in 1962, 1963 and 1965. In 1967 the Pacific Forest Research Centre began a three-year program of testing two species on the Coast and three in the Central Interior, in 2 1/2-inch and 4 1/2-inch Walters bullets and 9/16-inch Ontario tubes in comparison with standard 2-0 bare-root seedlings. The British Columbia Forest Service entered the program in 1968. The 'plug' concept and the styroblock-2 emerged rapidly and 17,000,000 seedlings are currently being grown.

The Reforestation Division of the British Columbia Forest Service operates eight nurseries varying in productive capacity from one to thirty-one million trees a year. Total productive acreage is 776 and combined annual bare-root capacity is 131 million trees. Seven of these nurseries have pilot scale or production container facilities with an additional capacity of seventeen million 'plugs' annually. Two more container facilities are planned.

After early testing commencing in 1931 planting on a project basis started in 1939. In 1941 a total 10,000 acres was planted by all agencies. Planting continued hovering around this figure until 1965 when acreage planted annually began to increase slowly. Since 1972 the increase has been quite rapid with 125,000 acres being planted in 1973. Currently there are in excess of 100 million trees which will be available for planting this fall and next spring. Seventeen million of these are in B.C./C.F.S. styroblocks.

The first trial of containerized planting in British Columbia was in April 1957 in the East Kootenay Ponderosa pine country. Ponderosa pine, Douglas fir and Engelmann spruce of 2-0, 2-1 and 2-2 age classes were transplanted into moist peat in one quart milk cartons. The cartons were then planted by mattock or auger method. One replication located on a barren gravelly-sand plain had 100% mortality in all treatments. On the other replicate planted on a heavily grazed stoney silt-loam, survival four growing seasons after planting for the trees in cartons was Ponderosa pine 70%, Douglas-fir 29% and Engelmann spruce 8% versus Ponderosa pine 99%, Douglas-fir 50% and Engelmann spruce 19% for the bare-root mattock planted controls. No further trials were done with milk cartons.

With the publication of 'The Planting Gun and Bullet: A New-Tree-Planting Technique' (Walters 1961) a new era in reforestation commenced.

A small cooperative trial was soon arranged between British Columbia Forest Products Ltd. and the Reforestation Division of the British Columbia Forest Service. On November 20, 1961 500 2 1/2-inch Walters bullets were sown to Douglas-fir and placed in a small unheated glasshouse at Duncan. The growing medium was a fertile silty loam nursery soil, with the bullets standing on a bed of moist peat. No fertilizer was added. They were hardened off outside for two weeks and field planted with a dibble on four different sites medium elevation in the company's Renfrew Division on April 18, 1962. Seedlings averaged 1 1/2 inches tall at planting date and some roots had emerged into the peat base. Standard 2-0 bare-root and fall sown 1-0 were used as controls. Fifty trees of each type were planted on each

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site. The Renfrew Division has a marine west Coast climate and the growing season was exceptionally favourable. Survival is indicated in Table I.

In May 1962 John Revel of the Research Division planted another 100 of these bullets at 2700 feet above sea level on a steep easterly slope in the hotter, drier Cowichan Valley (see Arnott, J.T. 1971) with no control bare-root. Survival of these bullets the following spring was 41 percent. Reasons for mortality were: burial 24 percent, drought and damping off 23 percent and competition from weeds in the bullets 12 percent.

These results were sufficiently encouraging that a second 500 bullets were sown in January 1963. This time fly screen was used as the bottom of a wooden tray and the bullets were held upright by chicken wire. British Columbia Forest Products again dibbled in these bullets on the same sites on April 29, 1963 (Revel 1963). Survival is shown in Table 2.

These small early trials generated enough interest to stimulate a larger cooperative trial in 1965 (Illingworth 1967) under the auspices of the Reforestation Board of the Tree Farm Forestry Committee. Since one of the claims for the bullet concept was the extension of the planting season it was decided to plant in July. J. Walters seeded 25,000 2 1/2-inch styrene bullets at the University of British Columbia Research Forest, Haney, B.C. These yielded 16,000 Douglas-fir seedlings two months old on July 5. The nine cooperators dibbled these in on 28 separate plots on a wide variety of south coastal sites with appropriate provenances going to low and high elevation sites. Planting was completed during the period July 5 to 15. The summer of 1965 was unusually hot and dry, resulting in a first season survival of only 17 percent. Further losses occurring over winter and in the second summer reduced survival to from 6 to 9 percent. For those plots planted on steep country, bullets, whether carrying a live seedling or not, showed 30 percent eroded, 6 percent frost heaved and 26 percent buried. These effects were negligible on flat terrain.

This trial demonstrated that eight-week-old unacclimatized seedlings in bullets cannot be planted with success in midsummer on all sites. Unburned sites with partial shade or north and east aspects appear most favourable.

Although the results of this trial were disappointing they did not for long dampen the interest in the containerized seedling concept, particularly at the Pacific Forest Research Centre of the Canadian Forestry Service in Victoria. By the spring of 1967 the Liaison and Development Section there started growing Douglas-fir and Western hemlock in 22 and 4 1/2-inch Walters bullets and 9/16-inch Ontario tubes. These were grown in a wooden frame structure covered with Saran shade cloth. Bullets and tubes were stood, in plywood tanks which permitted sub-irrigation (Mathews 1971).

The original objective of this project (Arnott 1971) was to test Walters' bullets under realistic plantation conditions in comparison with the Ontario tubeling and standard 2-0 bare-root planting stock. Subsequently the original objective was considerably revised to extend the trials over a variety of sites for three successive years with a final assessment after five years.

By mid-summer it was evident that the fertilizer in the Cal "C" mix was not sufficient to maintain growth on the seedlings. Accordingly, soluble fertilizers were added to the sub-irrigation water, usually on a twice-a-week schedule. (Arnott 1971). Although this stock was small by present standards, subsequent outplanting trials with Douglas-fir and Western hemlock in 4 1/2-inch bullets proved to be superior in height and colour and survived much better than stock grown at the Haney Research Forest without supplemental fertilization (Arnott 1971).

After the initial outplanting trial of fertilized 4 1/2-inch bullets grown at the Pacific Forest Research Centre was completed in the fall of 1967 the 'plug' concept was introduced. In this treatment the seedlings are pulled from the bullet with the growing medium adhering to the roots and then planted with a dibble. In all subsequent trials the 'plug' treatment was included.

The results of this three-year trial have been amply documented (Arnott 1971) and will be further reported elsewhere in this symposium.

The most immediate results were the general acceptance of the 'plug' concept and the involvement of the British Columbia Forest Service in the testing of the container growing concept.

A liaison 'container committee' was set up with members from the P.F.R.C. Liaison and Development Section and the Reforestation Division of the Forest Service. Under the auspices of this committee a cooperative pilot container facility was set up at the Forest Service Koksilah Nursery at Duncan, B.C. This unit grew about 100,000 seedlings in 4 1/2-inch Walters bullets in 1968 which were stood in racks in plastic lined plywood tanks (Mathews 1971). Water and fertilizers were supplied by sub-irrigation and shade cloth was supported by

Table 1.--Survival of replicates of 2½-inch Walters bullets, standard 2-0 bare-root and fall sown 1-0 bare-root two years after outplanting. (Examined April 29, 1964)

Stock Class	Rep. #1	Rep. #2	Rep. #3	Rep. #4	Means
			Percent Survival		
2½-inch bullet	44	58	50	70	54
1-0 bare-root	64	62	52	76	66
2-0 bare-root	88	84	84	92	87

Table 2.--Survival of 2½-inch Walters bullets, standard 2-0 bare-root and fall sown 1-0 bare-root after one growing season (Examined October 10, 1963)

Stock Class	Rep. #1	Rep. #2	Rep. #3	Rep. #4	Means
			Percent Survival		
2½-inch bullet	74	84	74	94	81
1-0 bare-root	88	94	98	98	96
2-0 bare-root	88	92	84	96	90

hoops attahced to individual tanks.

The objectives of the Reforestation Division at this time were primarily to find a solution to the problem of securing acceptable survival on high elevation clear cuts on the Coast and to lengthen the planting season. Outplanting trials were therefore designed with these objectives in mind. A program was drawn up to grow and test container grown stock as bullets and plugs in comparison with 2-0 bare-root and Pelton 'Mudpacks'. This later concept was developed by Norman Pelton (Tatlow 1969) in 1967 and consists of encasing the roots of nursery grown seedlings in a mixture of peat moss and clay and partially drying the resulting cylindrical 'mudpack'. These 'mudpacks' are dibbled into the ground in a manner similar to plugs. These Forest Service trials were established first on medium and high elevation sites on the south Mainland Coast and Later extended to the Interior. Results will be reported on elsewhere but there were several significant points which soon became evident. Container grown stock of coastal species canout be successfully acclimatized or overwintered on or near the planting site. The best season For planting container grown seedlings corresponds with that for bare-root - viz. early ;all and early spring. On an overall basis survival of 'plugs' is 10 to 15 percent better thou bare-root 2-0.

When the P.F.R.C. began growing container seedlings for testing on Vancouver Island in J967 they also started growing Interior Douglas-fir, Lodgepole pine and White spruce for field testing in the Central Interior. Results of these continuing trials will be reported elsewhere.

In 1969 the pilot facility at Duncan was doubled in size to 200,000 bullets and a new system was tested at P.F.R.C. Bullets were grown on an asphalt pad under shade cloth. Irrigation water and fertilizers were applied overhead through square-pattern sprinklers. This method produced stock comparable to that grown in sub-irrigation tanks.

During the winter of 1969-70 the Liaison and Development Section of the Canadian orestry Service in cooperation with the deforestation Division designed and got production started on the B.C./C.F.S. styroblock plug-mould-2. At the same time a joint production model styroblock nursery was prepared of Duncan. The design of this will be discussed elsewhere. This increased production at Duncan in 1970 to one million styroblock cavities plus 200,000 bullets in sub-irrigation tanks. At the same time 150,000 styroblock seedlings and 75,000 bullet seedlings were grown on a gravel base facility with overhead irrigation at the P.F.R.C. (Mathews 1971). This same year the growing medium was changed from the Cal "C" mix to a new mix of three parts commercial peat moss to one part horticultural grade vermiculite with a considerable saving in weight.

By the fall of 1970 growth results with styro-2 'plugs' were sufficiently encouraging that the Reforestation Division yielded to pressure from both the Forest Industry and the Forest Districts and decided to produce sufficient 'plugs' to provide wide scale plantings on a production basis. A new facility was constructed at the Forest Service's Surrey Nursery in the Lower Fraser Valley. This permitted a production of 980,000 seedlings in Walters' bullets and 6,420,000 in styroblock-2's.

In the early stages of the container program the development process was broken down into three phases (Kinghorn 1972) (Sjoberg 1972) as follows:

Phase I - exploratory research and testing to demonstrate the potential of new systems and to define objectives for refined experimentation and development.

Phase II - experimentation and development with pilot production of the most promising system.

Phase III- production with continued experimentation and development.

With the production of 7,400,000 containerized seedlings in 1971 I would suggest that Phase III had been reached. However, much experimentation and development was still required. Pilot container nurseries were established in the spring of 1971 throughout the interior of the province at Vernon in the south at Red Rock Nursery which is almost in the centre of the province and at Telkwa, the most northerly location, which is 150 miles from the Coast and at the same latitude as the southern tip of the Alaska panhandle. These pilot nurseries have three levels of environment:

1) fully controlled greenhouses;
2) semi-controlled structures with plastic or shade cloth;
3) uncontrolled open gravel pad.

The purpose of these nurseries is to compare quality and cost of container stock produced with replications grown near the south coast at Surrey.

During the fall of 1971 two million Lodgepole pine styroblock-grown-seedlings were moved in the blocks from Surrey to Vernon for overwintering. This turned out to be a considerable undertaking and took two forty-foot semi-trailers six weeks to complete. These seedlings overwintered well in blocks which were set on the ground.

Part of the 1971 production was a crash program to provide stock to replace a severe failure in the Red Rock bare-root nursery attributed to a very cold spring. Several problems became evident and production was cut back to 3,300,000 container seedlings in 1972 to permit time to assess the situation and solve some of the problems.

The styroblock originally was designed to be taken to the planting site and carried in quarter-sections by the planter. These sections were discarded on the planting site and were very evident on a hillside. Cries of pollution soon arose. This, together with the expense and time required to transport blocks in racks on trucks led to the decision to re-package plugs at the nursery. The plugs are removed from the blocks and vitafilm is wrapped around the growing medium in bunches of 25 and heat sealed. These bundles are then packed upright in wax-dipped cardboard cartons holding 500 styro-2 plugs. This procedure has also opened up the option of recycling the styro-blocks. A good percentage have been used three times, thus substantially reducing the cost per cavity.

There was a problem with the first styro-blocks in that roots of some species, particularly Lodgepole pine, penetrated the foam. This was corrected by increasing the density of the blocks to 2.9 pounds per cubic foot and paying careful attention to good fusion of the beads. Maintenance of density is particularly important if blocks are to be recycled.

Another problem in the first styroblock-2's was root spiralling again, particularly with Lodgepole pine. The forming of four vertical ridges approximately two millimeters high on the wall of the cavity has largely corrected this.

As many know, western hemlock characteristically puts on a large part of its growth late in the season. This is a problem in that seedlings have not put on enough root growth to make the plugs extractable in the early fall when they can be planted with good results. Towards solving this problem three variations of Finnish type plastic greenhouses were erected at Duncan in the spring of 1972. Styro-block-2's were sown to Western hemlock March 22, pre-germinated for seven days at 60-65°F and then moved into these unheated houses or outside. All greenhouse-started stock was moved outside on July 6. Analysis at the end of the season showed greenhouse-started stock to be superior in height, root collar diameter and root growth to stock grown outdoors for the full season. These findings resulted in the decision to grow Western hemlock in controlled environment greenhouses. Two Arch II fibreglass covered propane heated houses were purchased and erected during the winter of 1972-73. Unfortunately, some minor electrical parts were slow in delivery and prevented full season utilization of these houses. However, enough experience was gained the first season that a third house was erected winter 1973-74. We hope to grow one million Western hemlock in these three 42 by 108-foot houses and produce at least two crops per year. The first crop would be moved out and hardened for early fall planting and the second over-wintered for spring planting.

One problem that has plagued the container program in British Columbia since we started carrying seedlings over the winter has been low temperature root damage to coastal species. Much of the stock planted in the early spring during the first years had dead or damaged root systems. Tests of winter storage methods carried out during the winter of 1972-73 indicated that container seedlings may be stored in cold rooms or outside under cover with good results. Coastal species will receive root damage at temperatures below 15°F. The problem is that they must be left out long enough to receive the chilling required for quick flushing but must not be subjected to temperature below this critical level.

In 1973 production of container seedlings was increased to 8,300,000 in B.C./C.F.S. styro-2 containers at four nurseries. In spite of delays an acceptable crop of container grown Western hemlock was produced in the Arch II greenhouses. However, considerable trouble was experienced in cold storing much of this stock due to an outbreak of botrytis which was aggravated by temperature up to 40°F in inadequately designed cold storage facilities.

This spring 20,650,000 cavities were sown in styroblock-2 and 2A's at eight locations throughout the province. These should yield close to 17,000,000 plantable plugs. This is the first year that requests for bare-root trees have been reduced because of increased availability of plugs.

This year has brought several innovations in our program. To fill our order for blocks on time a second moulding machine was required. The P.F.R.C. took advantage of this to redesign the styroblock-2 for more efficient use of space. This has been designated styroblock-2A. Although it has been available for several years, the styroblock-8 (125 cm3 or 7.63 ins.3) has only been used experimentally. This year an intermediate size cavity has been introduced in the form of the styroblock-4 (65 cm or 3.94 ins.3) and is being tested with various species. It is believed to have promise for the shallow rooted species such as the spruces and Western hemlock.

Another departure has been the introduction of what we call shelter houses. These are rigid frame structures covered with fibreglass and having only manually controlled ridge and side vents for cooling. Although five were scheduled for this spring, delays in material delivery, etc. prevented them from being completed by sowing time and styroblocks intended for them were started in the open. We look to these structures to permit earlier sowing, provide extractable plugs approximately one month earlier and provide protection for stock that must be overwintered.

Travelling overhead booms with spray nozzles directly over blocks and lights where required, have replaced overhead irrigation and fertilization in greenhouses and shelter houses.

I have not said much about our objectives but they have broadened considerably since the beginning. One development which we hoped for has been the halving of the cost of planting as compared to the conventional bare-root mattock method. Doubling or tripling the rate also reduces the time required, permitting Planting at the optimum part of the season.

The underlying philosophy of the Reforestation Division has been to keep our options open. In addition to growing and continued testing of styroblock seedlings we are growing and test planting paper pots and the various designs of J. Walters' bullets that have recently become available. We will continue testing various environments and time schedules to develop optimum types of seedlings in relation to species and site requirements. In addition to this we are using approximately three million mudpacks a year on difficult sites such as unburned or scarified cutovers or areas with deep duff which are difficult to plant with bare-root and for which plugs are not yet available.

In order to be sure that we are not overlooking some obvious alternatives and to identify research priorities we are having the styroblock system examined and evaluated by a forester knowledgeable in the field from outside the province. A similar study is being done on the Pelton mudpack system.

In the final analysis our rating of any growing-planting system will be based on cost per established tree for the total system.

Much of the progress we have made in developing a container seedling system in B.C. can be attributed to the early promotion of the container concept by J. Walters, the excellent spirit of cooperation between the P.F.R.C. and the Reforestation Division, the excellent backup from the staff at the Research Centre and the contagious enthusiasm of all those connected with developing the system and producing container stock on an operational basis.

LITERATURE CITATIONS

Arnott, J.T.
1971. Progress report on field performance of Douglas-fir and Western hemlock container seedlings on Vancouver Isl., British Columbia. Canada, Dept. Environment, Can. For. Serv., Pacific For. Res. Cent., Info. Rep. BC-X-63. 59 pp. + appendices.

Illingworth, K.
1967. E.P. 644 Bullet Planting with Douglas-fir, Preliminary Trials 1965, British Columbia Forest Service, For. Res. Rev. 1967.

Kinghorn, J.M.
1972. Container planting program at the Pac. For. Res. Centre. In Waldron, R.M. ed. 1972. Proceedings of a workshop on container planting in Canada, Dept. Environment, Can. For. Serv., Dir. of Prog. Coord., Inf. Rep. DPC-X-2 pp. 7-9

Mathews, R.G.
1971. Container seedling production: a provisional manual. Canada, Dept. Environment, Can. For. Serv., Pac. For. Res. Cent., Info. Rep. BC-X-58. 57 pp.

Revel, W.J.
1963. Unpublished Report, British Columbia Forest Service, Research Division.

Sjoberg, N.E.
1972. Container planting program in British Columbia. In Waldron, R.M. ed. 1972. Proceedings of a workshop on container planting in Canada, Canada Dept. Environment, Can. For. Serv., Dir. of Prog. Coord., Inf. Rep. DPC-X-2. pp. 2-6

Tatlow, Rose
1969. Capsuled Tree Planting
The Truck Logger, Jan. 1969. pp. 26-27

van Eerden, E.
1972. Influences affecting container seedling performance near Prince George, B.C. In Waldron, R.M. ed. 1972. Proceedings of a workshop on container planting in Canada, Canada Dept. Environ., Can. For. Service, Dir. of Prog. Coord., Inf. Rep. DPC-X-2 pp. 92-100.

Walters, J.
1961. The planting gun and bullet: a new tree-planting technique. For. Chron. 37: 94-95.