FIELD PERFORMANCE OF CONTAINERIZED SEEDLINGS IN NORTH CAROLINA 1/

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Abstract.--A two year study was conducted in North Carolina to evaluate tubeling operational techniques developed in Ontario. They were found to be applicable with modifications to southern pine species. Best survival and growth after one growing season were obtained for summer planted loblolly and longleaf pine tubelings.

INTRODUCTION

The North Carolina Forest Service began in 1970 to investigate the possibilities of using containerized stock to extend the winter and spring planting season through the summer months. Summer planting would help provide full time employment for state forestation contractual planting crews and help meet the need for planting 40,000 acres annually on private non-industrial lands.

Because of the success of large scale tubeling outplantings by the Ontario Department of Lands and Forests between 1962 and 1971, a "Tubeling Operational Study" was initiated in the summer of 1972. The objective of this study was to evaluate operational techniques developed in Ontario in the production and planting of tubelings. I have been conducting this study for the past two years with loblolly, longleaf, slash, and white pine species, Fraser fir, and several hardwood species. For the sake of time, my remarks will be confined to the performance of loblolly and longleaf pine. Results of field performance tests are just becoming available. The data I will discuss were collected in the fall and winter of 1973 after the first growing season. In addition to the results from my tubeling studies, I will also present data on tests with root plugs grown in the Spencer Lemaire Ferdinand Book Planters.

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The Ontario Planting Hoe (garden hoes with 3/4 x 4 inch and 1 x 4 inch carriage bolts welded in center of blade) was used to plant the loblolly and longleaf pine tubelings. The Pottiputki and Spencer Lemaire Planting tools were used to plant all book-planter root plugs and also a few of the tubelings.

TUBELINGS

Loblolly Pine

Table 1 summarizes the production data and planting results for 12,600 loblolly pine tubelings planted at 8 different locations. Except for one batch, all tubelings were outplanted on cut over sites which had been site prepared. Batches were outplanted in July, August, September, October, November and December, 1972, and in April and July, 1973. The two summer batches were 7 to 9 weeks old, the two fall batches were 9 to 102 weeks old; and the winter batch was 17 weeks old. All batches except batch #6 were hardened-off outdoors from 3, to 52 weeks prior to being outplanted. It was hardened-off in the greenhouse for 5% weeks because of the danger of freezing outdoors.

The same seedlot with a germination test of 84% was used for all batches. Dry, untreated seed was tried for batches #4, #6 and #7, and germination was 73%, 68% and 79% respectively. This was almost as good as for stratified and cold-soaked seed. A peat soil mixture was used with the 3/4 x 4 inch Ontario split styrene tube. A % inch sand cover was placed on top of the seed.

Because tubeling parameters for loblolly and longleaf pine were unknown at the beginning

Table 1.--Loblolly Pine Tubeling Growth Data & Planting Results After One Growing Season

Batches	Green-House	Harden-Off	Age Planted	Ave. Top Height		Ave. Diam.	Ave. Dry Weight	Date Planted & Site P.	Trees Planted	Survival	Ave. Ht.	Frost Heaved 1"-2"	1-0 Bare Root Trees Comparison	
no.	weeks	weeks	weeks	in.	cm.	mm.	grams		no.	%	ft.	%	%	ft.
Test Batch (without mycorrhizae inoculum)								7/25/72 Disk-Beds						
	6	4	10	5.3	13.5	1.54	.282		350	87%	1.7		89	1.3
(with mycorrhizae inoculum batches 1-7A)								7/26/72 Disk-Beds		63% (54% deer grazed)				
1	5	4	9	6.1	15.6	1.62	.354		1,800		1.6		89	1.3
2	4½	3½	8	4.8	12.2	1.44	.187	8/25/72 KG-Piled	1,770	38% (drowned)	.7	26	96	.7
3	3	4	7	4.1	10.4	1.56	.183	9/26/72 KG-Furrow	1,550	15%	Mortality from washed sand covering trees			
3A	3	4	7	4.1	10.4	1.56	.183	10/7/72 Old Field	250	43% (cutworms)	.8			
4	4	5	9	4.1	10.4	1.30	.128	11/8/72 Chop-Bed	1,900	22% (Small tubelings)	.7	60	27	.9
5	7	3½	10½	4.7	11.9	1.10	.121	12/19/72 Burn Only	1,450	10%	Mortality from frozen trees			
6	11½	5½	17	8.9	22.6	1.60	.378	4/12/73 Disced	450	87%	.9		97	1.2
6A	11½	5½	17	8.9	22.6	1.60	.378	4/10/73 KG-Piled	750	90%	.7		93	1.2
6B	11½	5½	17	8.9	22.6	1.60	.378	4/30/73 KG-Piled	50	64%	.7		88	.9
6C	11½	5½	17	8.9	22.6	1.60	.378	4/30/73 KG-Piled	300	50%	.9		59	1.0
7	6	4	10	7.8	19.8	1.70	.477	7/5/73 KG-Piled	1,900	56%	.9	To measure winter of 1974		
7A	6	4	10	7.8	19.8	1.70	.477	7/6/73 Disked	100	83%	.6	To measure winter of 1974		

of the study, attempts were made to produce and outplant a crop each month the year around. Growth measurements in Table 1 show a decreasing trend in the size of tubelings produced each succeeding month from May to November. A downward trend is also evident for winter crops. Consequently, parameters for minimum specifications were not determined until the start of the second summer's production in 1973. Minimum specifications established for the average loblolly tubeling are: (1) root length -4 inches, (10.2 cm); (2) top height - 5 inches (12.8 cm); (3) root collar diameter - 1/16 inch (1.55 mm); (4) and oven dry weight - .255 grams. Only three batches were grown to all of these specifications.

Best survival and growth were obtained with loblolly tubelings outplanted in July and August. Fall plantings in September, October and November did not result in satisfactory survival. However, this was due to uncontrolled factors and influences such as drowning, soil covering tubelings, cutworms, poor site preparation and sub-standard tubelings. Tubelings planted at the end of the growing season were more subject to frost heaving. Hardening-off outdoors during winter months is risky. The December batch was frozen while hardening-off outdoors.

Loblolly tubelings do survive well (83 to 97 percent) and do make good growth during the first growing season (up to one foot) when grown to the parameters described above and when outplanted during the summer months. The average height growth of Batch #1 exceeded the height of bare-rooted 1-0 stock by 0.3 foot at the end of the first growing season. Four batches (#2, #4, #6B, and #6C) were either equal or just slightly less in height growth than 1-0 seedlings.

Longleaf Pine

Table 2 summarizes the data and results for 11,000 longleaf pine tubelings planted at 10 different locations.

Three summer greenhouse batches were outplanted in July, August, and September 1972; two fall batches were outplanted in November and December; and two winter batches were outplanted in March and July 1973. The three summer batches were 7, 8, and 9 weeks old; the two fall batches were 10 1/2 weeks old; and the two winter batches were 10 to 15 weeks old. All batches except batch #6 were hardened-off outdoors from 3z to 7 weeks prior to being outplanted. Batch #6 was hardened-off in the greenhouse for 5 1/2 weeks because of the danger of freezing outdoors.

Dry de-winged seed with a germination test of 66% was used for all batches. The same soil media and sand seed cover were used for the longleaf pine in the 1 x 4 inch Ontario split styrene tube.

Growth measurements in Table 2 show a decreasing trend in the size of tubelings produced each succeeding month from May to December. Minimum specifications for the average longleaf tubeling were not determined until the start of the second summer's production in 1973. They are as follows: (1) root length - 4 inches (10.2 cm); (2) needle tip height - 4 inches (15.2 cm); (3) root collar diameter - .07 inch (2.45 mm); (4) and oven dry weight .390 grams. Only 4 batches (#3, #5, #6 and #7) met all of these specifications.

Difficulty was experienced with damping-off fungi (Fusarium and Pythium) in the 1973 summer batches - although weekly sprays of Captan 50W were applied. Captan used for pre-emergence control may have reduced the germination rate somewhat.

Best survival and growth were obtained with tubelings outplanted in March, July, and August. Fall plantings of longleaf tubelings in September, October, and November resulted in better survival than for loblolly pine. Longleaf tubelings were more subject to frost heaving than loblolly. Also those planted at the end of the growing season were most subject to frost heaving. Survival was poor for the tubelings planted in December, because they were frozen while hardening-off outdoors.

Longleaf tubelings survival of 76 to 97 percent exceeded that for all bare rooted 1-0 seedlings. Growth after the first growing season, when grown to the parameters described above and when outplanted during the summer months was about the same as for 1-0 stock.

BOOK PLANTERS

Two batches of loblolly and longleaf pine were grown in both tubes and Ferdinand Book Planters for comparison during the summer of 1973. Both the tubelings and root plugs at age 7 weeks had grown to the parameters described above. The first batch was one of the best batches of seedlings produced, whereas the second batch was one of the poorest batches.

The book planters were easy to handle when outplanted. The plugs pulled out easily, and the sphagnum peat and vermiculite media adhered to the plug quite well when the media was damp. The Pottiputki was used to plant the plugs.

Table 2.--Longleaf Pine Tubeling Growth Data & Planting Results After One Growing Season

Batches	Green-House	Harden-Off	Age Planted	Needle Height	Ave. Diam.	Ave. Dry Weight	Date Planted & Site P.	Trees Planted	Survival	Frost Heaved 1"-3"	Vigor Class 1/ 1	2	1-0 Bare Root Trees Comparison		
no.	weeks	weeks	weeks	in. cm.	mm.	grams		no.	%	%	%	%	%	1	2
1	3½	3½	7	5.7 14.4	2.22	.425	7/25/72 Disk-Bed	1,970	86	17	34	32	76	25	37
1A	3½	3½	7	5.7 14.4	2.22	.425	7/26/72 Disk-Bed	90	93	(not measured)					
2	3½	4	7½	4.0 10.2	2.22	.386	8/25/72 Disk-Furrow	1,850	96		19	38			
3	4	4	8	4.2 10.7	2.83	.502	9/26/72 KG-Furrow	1,460	84		33	16	68	9	26
4	3½	5½	9	3.6 9.1	2.94	.443	11/8/72 Chop-Bed	1,690	83	74	14	35	74	13	50
4A	3½	7	10½	(3.7) 9.4	(3.0)	(.450)	11/18/72 Chopped	140	87		6	10	62	15	38
5	7½	3	10½	4.6 11.6	2.61	.292	12/20/72 Seed Orchard	1,500	20						
6	14½	½	15	6.2 15.7	2.98	.715	3/27/73 KG & Piled	1,500	97	10	11	25			
7	6	4	10	5.4 13.7	3.50	.947	7/5/73 KG & Piled	750	76	23	41				
7A	6	4	10	5.4 13.7	3.50	.947	7/6/73 Disked	100	94		37				

1/ Tubelings classified by bud development and vigor as follows: 1. with buds 2. No bud but long needles and good color.

Because of a prolonged dry spell during August, September, and October, heavy mortality was expected to occur. Therefore, the study areas were sampled in April, 1974, to determine their survival rate prior to going through the first growing season. The survival was slightly better for the tubelings (70%) for the August planting than for the root plugs (65%). However, the root plugs survival (52%) was better for the September planting than for the tubelings (38%). Frost heaving occurred in the tubelings, but none occurred in the root plugs.

CONCLUSIONS

Although it will be another one to two years before final conclusions can be reached on the field performance of the containerized stock in these studies, some conclusions can be stated. They are as follows:

1. Operational greenhouse and planting techniques developed in Ontario are applicable with some modifications to the Southeastern climate and species.

2. The ability to produce a crop of loblolly, slash, and longleaf pine seedlings anytime of the year and on short notice can be done in greenhouses. Four greenhouse batches can be produced between April 1 and October 1.

3. The planting season can be successfully extended throughout the summer and early fall months for loblolly, slash, longleaf and white pines. Survival is equal or better for summer planted containerized stock than for winter and spring planted bare rooted stock. Better survival can be obtained with longleaf containerized stock than with bare rooted seedlings.

4. Height growth of containerized stock should be about the same as for bare rooted stock at the end of the second or third growing season.

5. Tubeling roots grow along the tray bottom and become intertwined whereas the air pruned roots of the book planters are contained within the container.

6. Root plugs should perform equally as well or better than tubelings in survival and growth. The air pruning of roots and the aeration and drainage which are provided by the open tray bottoms of the book planter is a decided advantage. The cost of the book planters is competitive with the tubes, because they can be reused at least 2 or 3 times.

7. The Pottiputki and Spencer Lemaire planting tools are easier and quicker to use than the Canadian hoe, and they do a better job with less soil compaction.

8. Planting costs should be less when using the Pottiputki than for the planting hoe. It is easier to make the hole and keep the hole from refilling with soil with the Pottiputki. Also it is not necessary to bend over to place the tree, for it is dropped down the tube handle of the Pottiputki. Although good results were obtained with the Spencer Lemaire planting tool, the depth of the hole varies and loose sandy soil falls back into the hole when using this tool.

Based upon the results and recommendations of this study, the North Carolina Forest Service is in the process of constructing the first two 422 x 72 foot glass greenhouses and headhouse complex to produce commercial crops of containerized seedlings. Approximately 1,300,000 containerized longleaf and loblolly pine seedlings are to be planted during the summer of 1975.