TUBELING RESEARCH PLANTINGS IN MINNESOTA 1/

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Abstract.--A series of jack pine and red pine tubeling planting studies in Minnesota explored feasibility of planting during the growing season, tested various site preparation treatments, and effect of extending the cultural period. Results reinforce need for control of vegetative competition and for a container with a greater rooting volume.

INTRODUCTION

Tubeling planting studies were established in Minnesota in 1967, 1968, 1970 and 1971 to evaluate feasibility of use. The studies were a cooperative effort between the University of Minnesota College of Forestry's Cloquet Forestry Center and The Northwest Paper Company of Cloquet, now a Division of Potlatch Corporation. The containers used were Ontario tubes which are 9/16 inch in diameter and 3 inches long.

The purpose of this paper is to outline the objectives of the various plantings and to present and discuss the survival results.

1967 PLANTING

The 1967 planting was designed to test the feasibility of planting tubelings throughout the growing season. Four different geographical locations were selected in northeastern Minnesota. Two species, jack pine (Pinus banksiana) and red pine (P. resinosa), were planted on five dates - June 1, July 1, August 1, September 1 and September 25. Two soil mixtures, reed-sedge peat and a mixture of the peat, perlite and sand in the ratio of 4:2:1.5, were used. A total of 8000 trees, 4000 of each species, 1000 at each location was planted in a random block design. The tubelings were about six weeks old when planted in the field. In this and all the other studies discussed in this paper, the planting was by hand, using a dibble welded onto a garden hoe.

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

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The four planting areas varied in type of site preparation and amount of vegetation as the following description indicates:

Cloquet - no site preparation; sparse sod cover, scattered overhead tree canopy, hazel (Corylus sp.) and grasses are main competitive species; soil is Omega fine and loamy fine sand.

Independence - burned in spring before planting; heavily revegetated with various shrubs, herbaceous species and grasses; soil is Onamia fine sandy loam.

Nickerson - burned three years and one year before planting; had least competing vegetation of any site; soil is Omega fine and loamy fine sand.

Eveleth - plantings made between windrowed slash piles; extensive soil disturbance in area; reinvasion with many herbaceous species; soil is Rabey loamy very fine sand.

Differences in survival between the soil mixtures were non-significant ($p = 0.05$) so results were combined (Table 1).

In general, results supported the premise of planting during at least a portion of the growing season. Survival for the June and July plantings and in some instances for the August plantings was significantly better than either of the September plantings. Also, at all locations, survival of jack pine with its relatively fast juvenile growth, was considerably better than the red pine.

Results from this study also stressed the importance of adequate site preparation with control of competing vegetation when using tubelings. The most successful plantings were on the Nickerson site which had been control burned twice. This site had the least vegetative competition of the four locations. The Independence planting had the poorest survival primarily

because of the invading grasses and low-growing herbs and shrubs resulting from the burn. Vegetative "smother" from leaves and dead vegetation falling on the tubelings at the end of the growing season resulted in about 48 percent of all knpwn mortality with the greatest occurence at he Independence and Cloquet sites.

Table 1. Survival percent after seven growing seasons for 1967 tubelings by location and planting date.

Planting Date	Location of Planting: Cloquet	Independence	Nickerson	Eveleth
	- - - - - Jack Pine - - - - -			
June 1	66 a 1/	52 a	92 a	64 a
July 1	66 a	58 a	90 a	63 a
Aug. 1	58 a	46 a	82 a	52 b
Sept. 1	42 a	24 b	26 b	6 c
Sept. 25	42 a	6 c	24 b	0
$\bar{x}$ All dates	55	37	63	37
$\bar{x}$ June-Aug.	63	52	88	60
$\bar{x}$ Sept.	42	15	25	3
	- - - - - Red Pine - - - - -			
June 1	54 a	18 a	88 a	23 a
July 1	27 b	16 a	74 b	30 a
Aug. 1	25 b	9 b	68 b	12 b
Sept. 1	22 b	0	26 c	9 b
Sept. 25	30 b	0	5 d	0
$\bar{x}$ All dates	31	9	52	15
$\bar{x}$ June-Aug.	35	14	76	21
$\bar{x}$ Sept.	26	0	16	4

1/ Values within a column and within a species followed by the same letter do not differ significantly at the .05 level.

1968 PLANTING

The 1968 study was designed to further test the feasibility of planting tubelings during the growing season. Different vegetative removal treatments were also established to evaluate their effect on survival and growth of tubelings.

In this and all of the follow studies, based on results from the 1967 planting, reed-sedge peat was used for loading the tubes with no mixture of sand or perlite.

Twenty-five red pine tubelings were planted on four vegetative removal treatment plots replicated four times. One quadrant of each plot was planted on each of four selected planting dates - June 4, July 2, August land September 1. Twenty-five jack pine tubelings were planted on the same plots on two dates - August 1 and September 1. The tubelings varied from 6 to 8 weeks old at time of planting. The vegetative removal treatments were:

A. Check - no vegetative disturbance, average shrub stem density at time of planting was about 85,000 per acre of hazel (Corylus cornuta), serviceberry (Amelanchier app.) and cherry (Prunus pensylvanica; P. virginiana).
B. Shrubs removed - all shrub stems clipped at ground line.
C. All vegetation removed - all vegetation was clipped at ground line.
D. Mineral soil exposed - all vegetation clipped and the plot raked to remove ground litter and duff layer.

The soil type on the planting site is Omega loamy sand which is considered a good site for jack pine and medium for red pine. The entire area had been clearcut of jack pine in 1952 but was not reforested.

Survival for both species varied directly with the amount of vegetative competition removed as indicated in Table 2. Unlike the results from the 1967 planting, there was no significant difference in survival between planting dates. The relatively good survival for the September 1 planting might be attributed to an ample supply of rainfall (about 1.5 inches above normal for September) and good growing conditions during the fall season.

Table 2. Survival percent after six growing seasons for 1968 tubelings by planting date and treatment.

Planting Date	Vegetative Treatment 1/: A	B	C	D	Mean
	- - - - - Red Pine - - - - -				
June 4	6	19	30	59	28 a 2/
July 2	10	24	31	75	35 a
Aug. 1	17	21	35	76	37 a
Sept. 1	7	30	27	60	31 a
Mean	10 a	24 b	31 b	66 c	
	- - - - - Jack Pine - - - - -				
Aug. 1	15	52	60	80	52 a
Sept. 1	11	51	47	86	49 a
Mean	13 a	52 b	54 b	83 c	

1/ A = Check
B = Shrub stems removed
C = All vegetation removed
D = Mineral soil exposed

2/ Means within a row or column followed by the same letter do not differ at the .05 level.

It was noted that at least 80 percent of the mortality of both species had occurred by the beginning of the third growing season. Again, most of the mortality was caused by smothering from leaf fall, grasses, and lesser vegetation. Over 70 percent of the mortality on the check treatment plots was due to leaf fall from the dense shrub canopy. There was also evidence of spiraling root systems and interference with proper root development because of the rigid plastic container.

The results strongly reinforced the necessity of adequate site preparation when using small containerized seedlings such as tubelings. There was also reinforcement of the fact that with proper site conditions, the normal planting season could be extended into the summer months, probably into August, with reasonable success in Minnesota. There was an indication of need for more information on what constitutes a suitable planting site for tubelings and what site preparation methods are most desirable.

1970 PLANTING

In 1970 a study was designed to evaluate the effect of several site preparation treatments on tubeling survival.

Two cutover jack pine areas on Omega loamy sand soils were used for the study. One of the areas, which had been logged six years before the plantings were made, had a stem density of about 69,000 per acre of primarily hardwood shrubs but included about 4000 aspen (Populus tremuloides; P. grandidenta) per acre. It was evident that this type of area needed extensive site preparation treatment if tubelings were to be used successfully. The other area had been clearcut under the full-tree system the summer prior to planting. At time of planting there were about 4000 stems per acre of hardwood shrubs and aspen on this area.

On the first area four site preparation treatments were completed about two months prior to planting date except spraying which was done in August prior to the year of planting. The treatments were:

1. Burning - a control burn consumed all but the large stem material left from logging. It did not burn to mineral soil.

2. Spraying - a 50-50 mixture of 2,4-D and 2,4,5,-T at the rate of 2 lbs./acre was used.

3. Discing - the mineral soil was exposed and mixed with an Athens single disc pulled by a caterpillar tractor.

4. Scarifying - an SFI (Swedish Forest Institute) twin scarifier was used behind a rubber-tired, 4 wheel-drive skidder. This unit weighed about 3,300 lbs. and had scarifying arms which made scalps about 2 feet by 3 feet, 6 inches deep at a 7 foot spacing. The tubelings were planted on one of the slopes of the scalp, not in the bottom.

On this area, 25 jack pine and 25 red pine tubelings, from 8 to 12 weeks old were planted in four replications of each treatment3/ on June 20, July 20, and August 20, 1970.

On the more recently logged area, the only treatment was scarifying with the SFI unit. A 2-acre tract was scarified in late April and planted on June 5, 1970. Immediately adjacent to the treated area, a 4-acre tract was bar planted with 2-0 jack pine on May 7-11. The only site preparation was the full-tree logging. On each of these tracts a 200-tree random sample was staked for comparison purposes.

The scarifying treatment was the most effective in terms of survival as indicated in Table 3. There was little difference in survival between the burn, spray and disc treatments for either the jack pine or red pine. Planting date did not affect the red pine survival. However, with the jack pine the June plantings had highest survival followed by July and then August.

It should be noted that the 1970 growing season was considerably below normal for precipitation received. The month of August received only about 0.6 inch of rain which resulted in much of the mortality for both the July and August plantings.

Table 3. Survival rate after four growing seasons for 1970 tubelings by planting date and site preparation treatment.

Planting Date	Site Preparation Treatment: Burn	Spray	Disc	Scarify	Mean
	Red Pine				
June 20	20	40	30	–	30 a 1/
July 20	27	34	34	–	32 a
Aug. 20	42	36	43	–	40 a
Mean	32 a	36 a	36 a		
	Jack Pine				
June 20	70	79	71	90	78 a
July 20	34	65	46	72	54 b
Aug. 20	50	27	10	55	36 c
Mean	51 a	57 ab	42 a	72 b	
June 5	Jack pine tubeling plantings				91
May 7-11	2-0 Jack pine stock				76

1/ Means followed by the same letter within a column or row do not differ at the .05 level.

Table 3 also indicates that the jack pine tubelings planted in scarified scalps on the full-tree logged area had better survival than the 2-0 jack pine planted adjacent. The height of the 2-0 stock is above the general shrub canopy and no release will be needed. However, a release spray will be needed for the tubelings.

Results from this study pointed up the advantage of using the scalping treatment provided by

3/Red pine tubelings were not tested on the scarified treatment area.

the SFI unit. It also became evident that if red pine were going to be used successfully as tubelings either a larger container would have to be used or the culture period extended. Again, these study results reinforced the possibility of being able to use container-grown stock during the regular growing season.

1971 PLANTING

The objective of the 1971 study was based on the premise that in order to get satisfactory survival of red pine tubelings, a larger plant must be used. Red pine tubelings were grown over periods of two months, four months and one year (over-wintered). The growing tray bottoms were sprayed with copper to control root growth. These were planted in the field in late June to determine the effect of the various culture period lengths on survival.

The plantings were located on clearcut strips in a 90-to 100-year-old red pine stand on a good site. The cut strips were 50 feet wide and the leave strips 16 feet wide. Four strips each of a north-south and east-west orientation were used for the study. A row of tubelings of each age class was planted along each edge and in the center of each of the eight strips.

Copper content of trees grown for periods of two, four and six months in both copper coated and uncoated trays was also determined as part of this study.

Results show that field survival of red pine tubelings can be increased by lengthening the cultural period (Table 4). Irrespective of strip orientation, or row location, four-month-old and one-year-old tubelings had significantly better survival than two-month-old tubelings. The results also indicated that lengthening the cultural period from four months to one year did not significantly increase survival even though some of the individual row plantings of the one-year-old trees had substantially higher survival than the four-month-old trees.

The copper determinations showed an increase of copper content of root systems of over 20 times when trees were grown in copper coated trays as compared with those grown in uncoated trays. There were also indications of increased copper content in the crowns of the tubelings grown in the copper coated trays. However, there was no indication that the increased copper content adversely affected field survival.

Table 4. Survival rate after three growing seasons for 1971 red pine tubelings by age class, strip orientation and row location within strips.

North-South Strips				
Row Location	2 mo.	4 mo.	1 yr.	Mean
Rows on west edge	68	92	92	84 a 1/
Rows on east edge	50	75	85	70 ab
Center rows	52	60	72	61 b
Mean Survival	57 b	76 a	83 a	
East-West Strips				
Row Location	2 mo.	4 mo.	1 yr.	Mean
Rows on south edge	45	82	80	69 a
Rows on north edge	30	55	78	54 a
Center rows	52	70	88	70 a
Mean Survival	42 b	69 a	82 a	

1/ Means followed by the same letter do not differ significantly at the .05 level.

CONCLUSIONS

Results from this series of tubeling plantings indicate that the advantage of being able to plant containers during the normal growing season is very real and can be realized especially with species with a relatively fast juvenile growth such as jack pine. Adequate site preparation which removes or sets back the vegetative competition as much as possible is essential. Best success in these studies was attained with repeated burning and scarifying with an SFI scarifying unit. There is also indication that full-tree logging can provide adequate site preparation if regeneration follows immediately after logging before competition can become established.

These studies also indicate that the small plastic tubeling container is inadequate. The small tubes restrict root development and do not provide adequate rooting volume. Some of the more recently designed systems such as paper pots, BC/CFS Styrofoam blocks and Spencer-Lemaire plugs are advantageous in those aspects. For the past two years the Minnesota studies have included plantings with those types of containers.

Current studies are oriented towards the use of paper pots. They are large enough to provide adequate rooting volume for such species as red pine which need a longer cultural period. They also have the advantage of holding the soil plug mass together but disintegrating shortly after field planting.