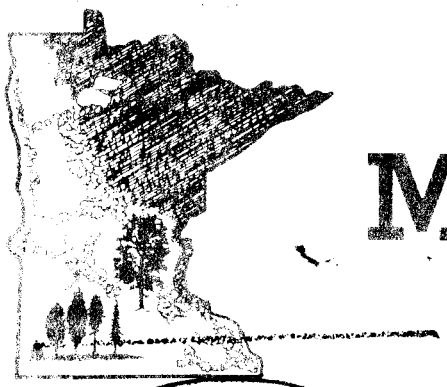

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Red Pine Tubeling Survival Related To Length of Cultural Period

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Background

A primary objective of tubeling[2/] development was to produce a tree in a short time period of from six to ten weeks that would survive and compete satisfactorily when field planted during the growing season. Planting trials have indicated that this may be possible with jack pine (Pinus banksiana, Lamb.) under the right conditions. However, results with red pine (Pinus resinosa, Ait.) have shown that satisfactory survival is very difficult to attain with trees of that age (Alm and Schantz-Hansen, 1972). It is evident that for the tubeling method to be successful, especially with species such as red pine, which have a relatively slow juvenile growth period, the cultural period must be extended.

Researchers elsewhere have reached the same conclusion as above (Waldron, 1972). The current trend in containerization, of which tubelings are but one type of system, is to substantially lengthen the cultural period. In some instances, with spruce, for example, an overwinter period is being used which extends the cultural period to nearly one year. The objective is to produce a larger tree which should ultimately ensure better survival and increase growth.

When the cultural period was only about ten weeks in length there was a minor problem with roots growing out the bottom of the tubes. However, with extension of the cultural period this problem increases as the roots continue to grow and often become intertwined on the bottom of the holding trays. This results in root damage at the time of planting as the containers are removed from the tray. It also interferes with the planting process as the containers tend to cling together. Some of the advantages of containerization such as elimination of root disturbance and increased planting speed are lost when this occurs.

An easy solution to the root elongation problem was suggested by Saul (1968) with copper coating of the holding tray bottom. This method efficiently stops root growth but introduces the possibility of cooper toxicity which can affect survival and growth of the trees. Hocking (1972) found that in a ten-week period copper content of seedling roots grown in copper coated trays increased over ten times that of control trees. Although Hocking's study showed a reduction in seedling growth, he suggested that the inhibitory influence would probably be limited to the seedling phase and did not affect field performance.

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2/Seedlings grown in 9/16-inch dia., 3-inch long plastic tubes, sometimes referred to as Ontario tubes.

Scarrat (1972) suggests air pruning of roots, accomplished by leaving air space below the containers by placing them on racks or wire screens. He indicates that this is a better way of controlling root elongation than using copper. This is probably especially true for the recently developed containerized systems which utilize containers with larger rooting systems than the small tubes used for tubelings; also for the systems which eliminate the container by growing the tree in a "soil plug".

Study Objectives and Methods

The primary objective of this study was to determine the effect of an extended cultural period on field survival of red pine tubelings. The tubelings were grown in copper coated trays for periods of 2 months[3/], 4 months and one year (overwintered). Field plantings were made in late June 1971 on clearcut strips located in a 90 to 100-year-old red pine stand on a good site in the Chippewa National Forest in Itasca County, Minnesota. The cut strips were 50 feet wide and the leave strips 16 feet wide. There were seven north-south oriented cut strips and four east-west cut strips. Three rows of ten tubelings were planted along each edge and in the center of four of the N-S strips and the four E-W strips. Each row consisted of a different age class of tubeling. This planting scheme resulted in 30 tubelings of each age class within each strip, and a total of 120 tubelings of each age class per orientation. Survival differences between strips within orientations, between locations within strips and between age classes within orientations were tested with an analysis of variance. Differences between the strip orientations were analyzed with a "t" test.

A secondary objective of the study was to determine copper content of different age classes grown in copper coated trays and attempt to relate this to differences in the field. Additional tubelings for this purpose were grown in copper coated and regular trays (control) in an environmentally controlled chamber with optimum temperatures. They were watered as needed but no fertilizer was used. At the end of a 2 month, 4 month and 6 month growing period a 100 tree sample was used for determination of copper content. Concentrations were determined on a Jarrell-Ash emission spectograph on duplicate 0.5 gm. subsamples dry ashed at 550°C. Prior to copper determination, the 100-tree sample was used for obtaining crown and root length measurements. Differences between age classes and between control and "cooper grown" tubelings were statistically analyzed with analysis of variance.

Results and Discussion

Survival at the end of the third growing season is shown in Table 1. There were significant differences in mean survival between age classes on both the N-S and the E-W oriented strips. Survival of the one-year-old and four-month-old tubelings did not differ significantly on either of the orientations. However, both of these age classes had significantly higher survival than the two-month-old trees.

Survival in the E-W strips did not differ significantly between row locations. However, the mean survival of the rows on the west edge of the N-S strips had significantly higher survival than the center rows but was no different from the rows on the east edge. A partial explanation for this difference might be that the center rows had less protective shading than the edge rows with a N-S orientation.

There were no significant differences in survival between the strip orientations within any of the age classes.

Only about 15 percent of the mortality could be attributed to a known cause. The area was heavily used by deer and 9 percent of the mortality was a result of browsing or smashing of the small trees. Another 6 percent mortality was caused by smothering from leaf fall primarily from invading hazel (Corylus sp.). It should be noted that row location within strips had no effect on the number of trees killed by either deer activity or leaf smother.

3/Refers to length of time between germination date and planting date.

Table 1. Average percent survival by strip orientation and location within strips at the end of the third growing season by age class.

Row Location	North-South Strips 2 mo.	4 mo.	1 yr.	Mean
Rows on west edge	68	92	92	84 a
Rows on east edge	50	75	85	70 ab
Center rows	52	60	72	61 b
Mean Survival	57 b[1/]	76 a	83 a	

Row Location	East-West Strips 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.

The root length data indicated that the copper coated trays were effective in controlling root elongation when the cultural period was extended (Table 2). Even with the two-month period there was a difference of 3 cm. between the average root length of tubelings grown in copper coated trays and those grown in the regular trays. This difference increased to 4.1 cm. with a four-month period and to 6.1 cm. with a six-month period. For all age classes the differences in average root length were significant between "copper-grown" and control tubelings. Crown length was not affected by the copper treatment as the differences between copper-grown and control tubelings were all non-significant.

As expected, there were substantial differences in copper content of the tubeling roots when grown in the treated trays as compared to the regular trays. The copper content of the copper-grown tubelings was nearly 40 times that of the control tubelings for the two-month-old class, about 60 times greater for the four-month-old age class and about 20 times greater for the six-month-old age class.

Copper content of roots almost doubled when the cultural period was increased from two to four months and increased about 20 percent between the four and six month period. There were also indications of increased copper content in the drowns of the tubelings grown in the copper coated trays. Copper content also increased with time in the control trees. However, in all instances the copper content was relatively small and the differences involved would likely have no effect on the tubelings.

Table 2. Crown and root data by age class for tubelings grown in copper-coated trays versus control.

Age Class	Treatment	Avg. Length (cm.) Crown	Root	Cu. Content (ppm)[1/] Crown	Root
2 mo's.	Copper	6.8 a[2/]	8.8 a	7.2 ab	300 b
	Control	6.5 a	11.8 b	3.7 d	8.1 a
4 mo's.	Copper	6.2 a	9.5 a	8.0 ab	540 c
	Control	6.5 a	13.6 b	5.4 c	9.0 a
6 mo's.	Copper	6.7 a	8.5 a	9.2 a	630 d
	Control	6.5 a	14.6 b	6.5 bc	34.5 a

[1/] Based on pooled 100 tree samples.

[2/] Values within a column followed by the same letter are not significantly different at .05 level.

Conclusions

Results from this study show that field survival of red pine tubelings can be increased by lengthening the cultural period. 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 are less clear in indicating whether or not it is worthwhile to hold red pine tubelings longer than a four-month period. Although the means of the one-year-old tubelings do not differ significantly from those of the four-month-old tubelings some of the individual row plantings do indicate a substantial improvement in survival. However, it does increase cost to overwinter tubelings and hold them for the additional time period. This study does not attempt to make an economic analysis but cost must be given consideration.

The results of the copper content determinations reinforced Hocking's (1972) report. The copper treatment effectively controlled root elongation in the trays. It also substantially increased copper content of the roots. The increase was directly related to length of cultural period. However, irrespective of the high copper content of the two older age classes, they still had better survival than the two-month-old tubelings.

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