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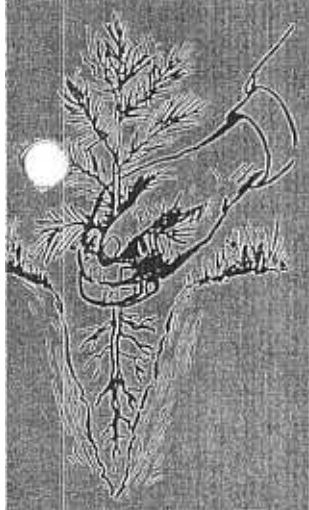
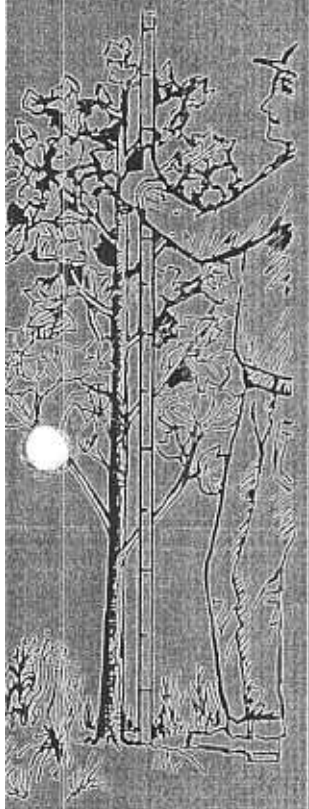
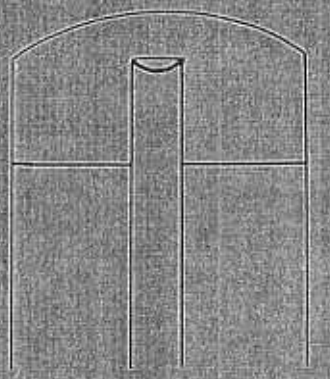
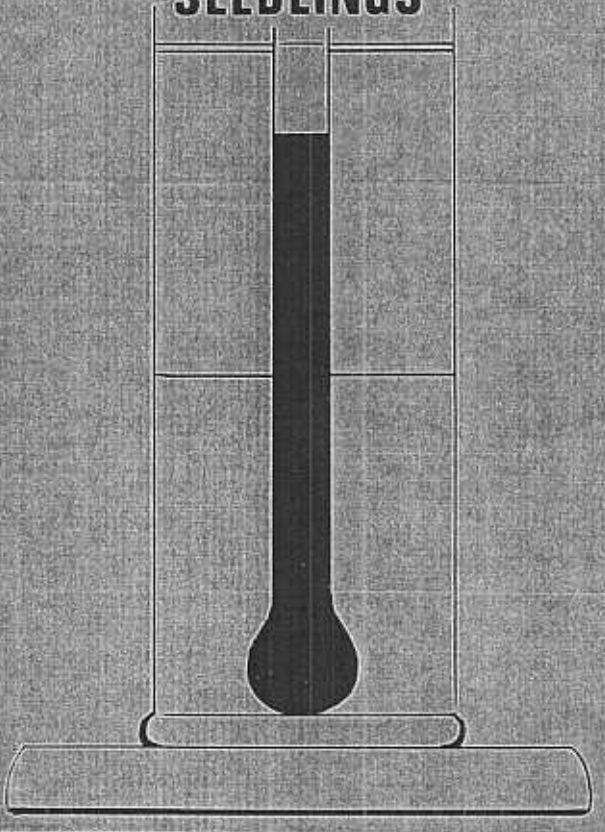






EFFECT OF FREEZING ON SURVIVAL OF LOBLOLLY PINE SEEDLINGS



Virginia Division of Forestry
Department of Conservation and Economic Development

EFFECT OF FREEZING ON SURVIVAL OF LOBLOLLY PINE SEEDLINGS

By: J. W. Garner and T. A. Dierauf

Abstract

Loblolly pine seedling packages were put out to freeze during two different cold spells that lasted two and three days, and during which temperatures dropped to 12° and 10° Fahrenheit, respectively. Frozen packages were allowed to thaw completely before handling. Frozen seedlings survived as well as unfrozen control seedlings when planted.

Introduction

Many thousands of seedlings froze in Virginia Division of Forestry storage facilities during early January of 1970. This prompted a small pilot study of the effect of freezing on survival during another cold spell later in the same month. Seedling packages were placed outdoors during a 3 day period when the temperature ranged down to 0 degrees Fahrenheit and never got above 30 degrees. The weather then warmed up, and the packages were left alone until they were completely thawed Survival of unfrozen seedlings from control packages was not significantly better than survival of the frozen seedlings.

Since it is not uncommon for seedlings to freeze in storage sheds and unheated buildings during periods of very cold weather, a larger study was installed the following year. This report describes and gives the results of this follow-up study.

Description of Study

The study involved three treatments

1. Seedling packages were frozen.
2. Seedling packages were frozen, with water added to the packages after they had thawed.
3. Seedling packages were not frozen.

Treatment 2 was included because in January of 1970, there seemed to be an "unusual" amount of water on the floor of several storage buildings after frozen seedlings had thawed. If freezing and thawing tend to cause loss of water from seedling packages, the addition of water after thawing, as in treatment 2, might be beneficial. The water was added by inserting a perforated pipe into the package.

Seedlings were lifted and packed in 2,000 seedling packages.[1/] They were kept in the cold storage unit at the nursery until a period of severe freezing weather was predicted, and then 2/3 of the packages were placed outside to freeze. When the weather warmed and the frozen packages had completely thawed, all packages (including the unfrozen controls which had been kept in cold storage) were moved to an unheated building for another 3 to 5 weeks of storage before planting. The packages did not freeze in this unheated building.

1/ *Roots dipped in kaolin clay slurry, wrapped in absorbent paper, wrapped in waterproof paper, reinforced with veneer slats and, finally, strapped.*

The same study was done twice, during two different cold spells:

	Cold Spell	
	Jan. 19 & 20	Feb. 1, 2 & 3
Packed and put in cold storage	*1/7*	*1/27*
Put out to freeze	*1/19 & 1/20*	*2/1 to 2/3*
Thawing period	*1/21 & 1/22*	*2/4 to 2/7*
Put in unheated building	*1/23*	*2/8*
Dates planted (8 different tracts)	*2/11 to 2/23*	*3/2 to 3/16*
Time from packing to planting	*41 to 47 days*	*34 to 48 days*

Minimum and maximum temperatures (degrees Fahrenheit) were recorded next to the seedling packages during the cold spells:

	Temperature	
Date	Minimum	Maximum
January 19	*14*	*30*
January 20	*12*	*40*
February 1	*10*	*45*
February 2	*15*	*28*
February 3	*25*	*32*

Extra seedling packages were placed outside during each cold spell, and were broken open to observe depth of freezing. The packages froze completely, all the way to the center, during both cold spells.

For each cold spell, 24 packages of 2,000 seedlings were packed, 8 packages for each treatment. The planting was done by Division of Forestry personnel on 8 different tracts, widely scattered over eastern Virginia. There was one tract in each of 7 districts and one on the Buckingham State Forest (4 tracts in the Coastal Plain and 4 in the Piedmont). All tracts were cutover woodland that had been prepared for planting the summer before by prescribed burning with or without drum chopping.

On each of the 8 tracts, 5 replications of each treatment were planted in randomized blocks. A block contained a 20 seedling row of each of the 3 treatments. For each cold spell, a total of 2,400 seedlings were planted: 8 tracts x 5 blocks x 3 treatments x 20 seedlings/treatment/block. The plantings for each cold spell were made on the same tracts, side by side on 7 tracts and about 10 chains apart on the eighth tract.

From each 2,000 seedling package, 100 seedlings were planted. A 2,000 seedling package contains 40 bundles of 50 seedlings. The 100 seedlings planted were obtained by taking 2 and 3 seedlings (alternately) from each bundle of 50. No attempt was made to pick seedlings of a certain size; the selection was random.

Weight Loss During Storage

Seedling packages were weighed after packing and again about a month later to determine weight loss during storage. For the first cold spell, the packages were also weighed at the start of the cold spell and at the end of the thawing period to see if water loss was greater for the packages that froze and thawed than for the packages that remained in cold storage. The results of this weighing are given in Table 1. Three things are worth noting:

1. Total weight loss over a period of about a month was 10 to 12 pounds per package, or about 17 percent of the original package weight.

2. The rate of weight loss was much less during cold storage than during storage in the unheated building (compare 1/7 to 1/19 with 1/22 to 2/9 for the January 19 and 20 cold spell).

3. Freezing and thawing did increase water loss. During the 3 day period of freezing and thawing, the packages in cold storage lost an average of 0.3 pounds while the packages that froze and thawed lost an average of 1.9 pounds. (A "t" test showed the difference to be significant at the .001 level).

Table 1. Average weight and weight loss in pounds for 8 control and 8 frozen packages.

January 19 & 20 Cold Spell

		Control Packages		Frozen Packages	
Date	Period	Weight	Loss	Weight	Loss
1/7		64.0		69.8	
	12 days		1.7		2.7
1/19		62.3		67.1	
	3 days		0.3		1.9
1/22		62.0		65.2	
	18 days		9.1		7.3
2/9		52.9		57.9	
Total	33 days		11.1 (17%)		11.9 (17%)

February 1, 2, & 3 Cold Spell

		Control Packages		Frozen Packages	
Date	Period	Weight	Loss	Weight	Loss
1/27		62.4		61.6	
	30 days		11.5 (18%)		9.8 (16%)
2/26		50.9		51.8	

Results and Discussion

Survival after two growing seasons is given in Table 2. Considering average survival for all 8 tracts (8 packages per treatment) the treatments had no significant effect on survival for either cold spell.[2/]

Table 2. Percent survival after two seasons.

	January 19 & 20 Cold Spell			*February 1, 2 & 3 Cold Spell*		
	Control	*Frozen*	*Frozen + Water*	*Control*	*Frozen*	*Frozen + Water*
District 1	58	71	72	78	92	82
District 2	65	76	64	83	90	90
District 3	66	58	64	69	68	68
District 4	35	19	37	57	34	20
District 5	14	34	32	57	62	56
District 8	28	32	59	70	53	48
District 9	58	48	52	71	78	76
State Forest	52	63	44	65	77	81
Means for 8 packages	47	50	53	69	69	65

In these two tests, a single, short period of freezing, followed by complete thawing before handling, did not reduce survival. However, repeated freezing, or freezing for longer periods than occurred in this study, could be harmful (the Virginia Division of Forestry has two studies in progress in which frozen storage at approximately 20° Fahrenheit for one month resulted in almost complete mortality).

2/ Survival percents were transformed to arc sin and analyses of variance were made for each cold spell.