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REFRIGERATOR-CAR STORAGE OF LOBLOLLY PINE SEEDLINGS HIGHLY SUCCESSFUL

Hamlin L. Williston¹

SOUTHERN FOREST EXPERIMENT STATION

Cold storage of pine seedlings has become an accepted practice in the South. For the past 3 years the Yazoo-Little Tallahatchie Flood Prevention Project in north Mississippi has been using railroad refrigerator cars, parked on sidings, to store loblolly pine seedlings. This is a report of a 1963 study of survival and growth of stock that was outplanted after being held for 1, 5, and 9 weeks in refrigerator cars and in a cold-storage room.

METHODS

Fifteen kraft-polyethylene bags of loblolly seedlings (1,000 per bag) were received from the Ashe Nursery, Brooklyn, Mississippi, on January 9. Three bags were placed immediately in each of four refrigerator cars and three were put in a cold-storage room with the regular run of Project seedlings. The cars were on sidings at Oxford, Coffeeville, Oakland, and Batesville, Mississippi.

A thermocouple was installed in the center of one bag of seedlings at each of the five storage locations. Holes made in the bags by the wires were sealed with masking tape. Temp-



Figure 1.—Railroad refrigerator cars are convenient for storing bagged pine seedlings to extend planting seasons beyond nursery lifting dates.

¹ The author is in charge of the project on management of erosive watersheds. This project is maintained at Oxford, Mississippi, in cooperation with the University of Mississippi.

eratures were read three times a week with a potentiometer. Two additional thermocouples were placed in the top and bottom of one of the bags and read for 6 weeks to determine the variation within the bag. Wall thermometers in each storage unit were read whenever the thermocouples were. Recording hydrothermographs were placed in one car and in the cold storage room for a continuous record of temperature and humidity.

On January 18 one bag of seedlings was removed from each of the five storage places. Two hundred Grade I or II seedlings were selected from each bag and outplanted 50 to a plot in randomly selected plots. Similar outplantings were made on February 15 and March 15.

In late March, after rains had settled the soil, heights of the outplanted seedlings were measured and mortality and animal damage noted. First-year survival and heights were recorded in October.

RESULTS

Storage temperatures.—Air temperatures in the cars ranged from 26 to 68° F., with an average low of 28° and an average high of 56° during the 9 weeks. For 67 percent of the time they were lower than 40°. Temperatures in the bags were in the forties 68 percent of the time; the highest recorded was 68° on a day in March when the outdoor air was about 85°. In the middle of the bags of seedlings temperatures averaged 2° higher than just inside the bags and 6° higher than the air temperature in the cars.

In the cold-storage room average temperatures were several degrees higher than in the cars, ranging from 30 to 55° in the air and from 35 to 60° in the bags. Temperatures in the bags were lower than 50° for 55 percent of the time. Air temperatures in the room were below 40° only 31 percent of the time. It had been expected that the cold-storage room would provide colder and more even temperatures than the cars, but the refrigeration unit was too small.

In figure 2 car and bag temperatures are compared for a 9-week period. Bag temperatures were generally higher than the maximum car temperatures, probably because of heat generated by the seedlings. The fluctuations in minimum and maximum car temperatures

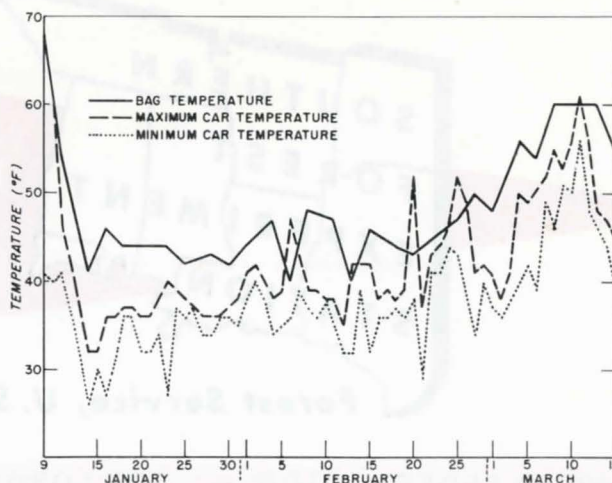


Figure 2.—Daily minimum and maximum air temperatures and periodic bag temperatures in a refrigerator car at Oxford, Mississippi.

are largely attributable to the influence of the outdoor air when the car doors were open during loading and unloading.

Humidity in the cars ranged from 20 to 100 percent and averaged about 69 percent. In the cold-storage room it ranged from 40 to 100 percent and averaged about 77.

Bag temperatures in °F. (B) in the cars were significantly related (0.01 level) to car temperatures (C). The simple linear regression equation was: $B = 16.37 + 0.7847 C$.

As car temperature rose the spread between car and bag temperatures decreased. For example:

<i>Car</i>	<i>Bag</i>
30°	40°
40°	48°
50°	56°
60°	63°

Seedling survival and growth.—For the January and February plantings, seedlings stored in cars survived somewhat better than those from the cold-storage room, but the differences were not statistically significant. For the March planting, survival was the same for both storage methods (table 1). Height growth was not significantly affected by storage method. Car-to-car variation in seedling performance was small.

Time of planting had a very significant effect (0.01 level) on both survival and height

Table 1.—Seedling survival and height at end of first growing season

Planting date	Storage duration	Seedling survival		Seedling height	
		Cars	Cold-storage room	Cars	Cold-storage room
	Weeks	— Percent —		— — Feet — —	
January 18	1	79	78	0.87	1.00
February 15	5	96	82	1.16	1.23
March 15	9	99	99	1.52	1.43

growth. Survival in October averaged 79 percent for the January planting, 93 percent for the February planting, and 99 percent for the March planting. Immediately after they were planted, seedlings averaged about 0.5 foot in height. By fall those planted in January averaged 0.90 foot, those planted in February 1.18 feet, and those planted in March 1.50 feet.

Seventeen percent of the seedlings were browsed by mules, cows, deer, and rabbits, but only 15 percent of the browsed trees died. Seedlings planted in January suffered the heaviest mortality, perhaps from the combined effect of 9 days of subfreezing weather in late January and the browsing. Summer mortality averaged only 2 percent despite an August-September drought.

Other studies in other years have shown similar increases in survival and height growth with late planting. Presumably storage does not make the seedlings more viable; it simply permits planting when hazards are lower and conditions for immediate root growth better. Seedlings can be lifted during cold weather when they are dormant and well hardened and stored until the weather is most favorable for planting.

STORAGE FACTS

Three years of experience and the results of this study have proven that storage of pine seedlings in refrigerator cars is economical and convenient. The Yazoo-Little Tallahatchie Project used 4 cars in 1962, 9 in 1963, and 16 in 1964.

In 1963, the Project stored 25,445,000 seedlings. The nine cars, which were used for an average of 96 days each, were obtained from the Illinois Central Railroad at a special rate, as they were in need of repairs for over-the-road service. Each car had 1,972 cubic feet of space and held a maximum of 750,000 seedlings. An average of 2,433 pounds of ice was used per car-week at a cost of \$0.012 per pound. (In 1962, when the winter was much warmer, 5,000 pounds of ice were used per car-week.) Racks for holding the seedlings were built of lumber at a cost of \$166 per car.

Storage cost per thousand seedlings in 1963 was about \$0.22. This value was a function not only of the number of seedlings stored but also of the duration of storage. Nearly 7 million seedlings were stored in one car at a cost of \$0.105 per thousand.

The refrigerator car's mobility is its greatest asset. Provided that ice does not have to be trucked too far, a car is convenient in many communities where commercial cold-storage rooms are lacking, and in many towns may provide cheaper storage than commercial rooms. It gives excellent protection against freezing temperatures and good protection against high temperatures, and it can usually be spotted in a convenient place.

Some cautions are in order. Salting the ice is necessary when the outside temperature gets much above 50°. Uniformity of bags or bales is essential in order to utilize the space to greatest advantage. To the extent feasible, cars should be loaded so that the seedlings longest in storage can be planted first.