

The Effects of Late Planting on Survival, Height Growth, and Vigor of Eastern White Pine

Kenneth R. Rexrode and Kenneth L. Carvell

Forester, WESTVACO Corporation, Luke, Md.; and Forest Ecologist, West Virginia University Agricultural and Forestry Experiment Station, Morgantown

2 + 0 white pine seedlings, when stored in a refrigerator, can be planted until mid-June in West Virginia without significant reductions in survival rates. Seedlings planted in July and August that survived were not hardened off at the first fall frost and had shorter needles.

Foresters soon learn that spring planting season should begin early, as soon as the frost has left the ground, since planting delays usually result in decreased survival and limited 1st-year height growth. In the southern Appalachians, the beginning of spring planting season varies from year to year, depending on the severity of late winter weather and how quickly lifting can begin at the nursery. Most tree planting, however, is done in March or early April.

There are several circumstances under which late spring planting is justified. Spring planting inevitably extends into May when the acreages are large and labor limited. Rainy weather may result in delays. Late planting is often justified when brush control is needed on the planting site. Foliage sprays, often the most economical brush control method, must be postponed until brush is in full leaf. Early June foliage

sprays, after foliage has reached full size, necessitate delaying planting until mid-or late June.

How drastically does late-June or July planting affect survival and height growth? Since summer droughts take their toll of seedlings when root systems have not become adequately reestablished, it can be presumed that survival would decline consistently with later planting dates. It is also important to know what effect late planting has on height growth. Do white pine seedlings, which normally cease height growth by July 1, forego height growth until the next year, or do they have a partial or even normal height growth period? Finally, does late planting result in a smaller number of lateral buds forming on new terminal shoots?

This experiment was designed to determine the effects of cold storage and late planting on white pine seedling survival, height growth, and bud set.

Literature Review

In Lake States studies, Stoeckeler (6) found that jack, red, and white pines all had 1st-year survivals of 95 percent or higher, whether stored for 1 or 5 weeks; however, prolonged cold storage reduced vigor and plant size because seedlings missed some of the best growing weather in late spring

and early summer. Loss in weight, due to respiration, from 5 weeks of cold storage was 20 to 42 percent and was greatest for jack pine, since it normally starts growth earlier in the spring.

Using white pine seedlings, Baldwin and Pleasonton (2) found that spring storage gave better results than fall storage. Seedlings survived well when planted as late as July. Aldhous and Atterson (1) state that survival rates of Sitka spruce and western hemlock, lifted in early March and stored in polyethylene bags at 2° C until planting in July and August, were high and similar to those planted in April.

Dierauf and Marler (3) studied loblolly pine seedlings lifted in January, February, and March and placed in cold storage for 40, 70, and 100 days before planting on March 1, April 1, May 3, June 1, and July 1. After three growing seasons, both survival and height growth had decreased with increasing times in cold storage. Both the June and July plantings had more delayed mortality than earlier plantings. Evidently, June- and July-planted seedlings were not established as well by the end of the first growing season as those planted earlier. Survival and height growth were also better for earlier plantings than for late plantings of comparable cold storage periods.

Study Location

This planting study was done in 1972 on an old field on the West Virginia University Forest in Preston County. The site, an eroded pasture, is typical of many areas on which coniferous plantations are established. Site conditions were fairly uniform throughout, with a thin herbaceous cover of poverty grass, broomsedge, goldenrods, and dewberry. Before planting, the study area was mowed to reduce the height of the herbaceous cover. Mowing was done again in mid-July.

Procedure

Sixteen hundred 2-0 white pine seedlings, from seeds collected in Pocahontas County, West Virginia, were divided into eight groups of 200 seedlings each. One group of seedlings was planted on April 15, 1972 (control); the remaining seven bundles were wrapped in polyethylene and placed in cold storage at 2° C. Relative humidity during storage was maintained at 90 to 95 percent to prevent drying and mold. Seedling bundles were opened weekly and moistened, and sufficient aeration was provided to retard fungus attack and heating up.

Beginning on May 12, 200 seedlings were dibble-planted at 2-week intervals; the final planting was made on August 4. Seedlings were planted in

20-seedling rows, and the rows for each planting date were selected at random.

At the time of each planting, height growth of all previously established seedlings was measured, and a record was made of all dead seedlings. In early December, well after the first fall frost (October 2), a final measurement and evaluation was made of all seedlings.

Results

Table 1 presents data on survival, height growth, needle length, and bud set for each planting. Table 2 gives monthly rainfall and average monthly temperatures for the nearby Brandonville weather station.

Unfortunately, the results of any 1-year planting study strongly reflect the pattern of rainfall and temperature unique to that growing season; however, certain trends are apparent when measurement results are supplemented with weather data.

Although the April planting gave the highest percentage of survival, plantings through early June gave survival percentages acceptable to most foresters. The good survival for the June 7 planting date is probably attributable, in part, to the heavier-than-average June rainfall, which was well distributed throughout the month. The lower-than-average July rainfall took its toll of the late June and July plantings.

Regardless of planting date, all seedlings went through a relatively normal height growth period during the 8 weeks after planting. New growth of seedlings from the July 21 and August 4 plantings, however, failed to harden off sufficiently by the first killing frost on October 2, and new shoots and needles turned brown immediately after this frost. Field observations in 1973 indicated that many of the seedlings from these two plantings failed to put on normal height growth during the second growing season.

Although average needle length varied from one planting date to the next (table 1), these differences were not significant except for the August 4 planting, where lesser soil moisture and cool fall weather probably interfered with normal needle growth.

Average number of lateral buds surrounding the terminal bud has been suggested as an index of white pine seedlings vigor by Grafton and Carvell (4). They found that the number of laterals was significantly correlated with height growth the following year. It is of interest that the number of laterals in this study declined consistently with the later planting dates.

Summary

Two-year-old white pine seedlings were planted at 2-week

Table 1.—Number of surviving seedlings, mortality, survival percentage, height growth, needle length, and bud set for each planting date, based on December 1972 measurements¹

	—Date of Planting—							
	April 15 (Control)	May 12	May 26	June 7	June 23	July 7	July 21	August 4
Live seedlings	182	170	166*	170	129**	123**	84**	93**
Dead seedlings	18	30	34	30	71	77	116	107
Survival percentages	91.0	85.0	83.0	85.0	64.5	61.5	42.0	46.5
Total 1972 height growth in inches	2.90	3.74*	3.03	2.74	1.47*	1.86*	2.45*	2.55
Average needle length in inches	1.35	1.52	1.52	1.39	1.23	1.32	1.17	1.08*
Average number of lateral buds set on terminal shoot	6.12	6.05	5.66	5.27**	4.56**	4.94**	4.55**	3.70

¹ Statistical significance determined by T-tests.

* Differs from the control at the 0.05-percent level.

** Differs from the control at the 0.01-percent level.

Table 2.—1972 precipitation and temperatures by months with departure from normal (5,7)

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Total precipitation	5.88	2.89	7.91	2.38	4.33	1.91	3.49	5.79	6.89
Normal precipitation	4.20	4.40	4.66	4.70	4.38	3.51	2.94	3.12	3.68
Departure from normal	+1.68	-1.51	+3.25	-2.32	-0.05	-1.60	+0.55	+2.67	+3.21
Average temperature.	47.5	58.5	60.3	68.6	67.0	62.9	46.6	38.1	36.5
Normal average temperature	48.3	57.5	65.3	68.8	67.1	61.0	50.9	40.0	29.4
Departure from normal	-0.8	+1.0	-5.0	-0.2	-0.1	+1.9	-4.3	-1.9	+7.1

intervals throughout the growing season on an old field in northern West Virginia. Cold storage of seedlings until the day of planting gave satisfactory survival for plantings made as late as mid-June. Late June, July, and early August plantings had significantly lower survival percentages.

All seedlings went through a period of height growth regardless of how late in the season they were planted. Late July and August plantings, however, resulted in new growth that did not harden off sufficiently before the first fall frost.

There was a consistent decrease in needle length with later planting dates. This was attributed to the lesser soil moisture and cooler weather during their period of growth.

There was also a consistent and significant decrease in number of buds set for the later planting dates.

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