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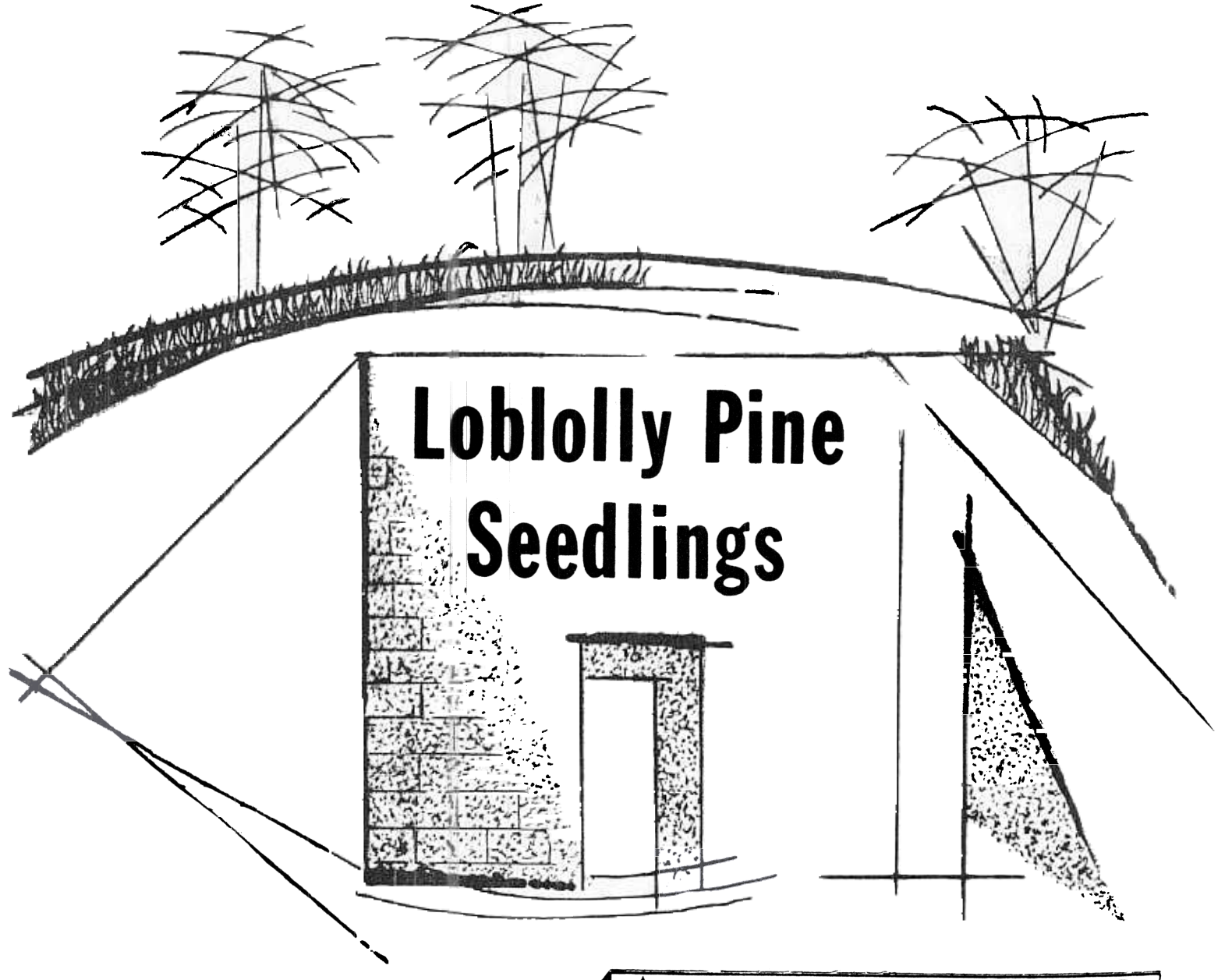

Virginia Division of Forestry
Department of Conservation and Economic Development

EFFECTIVENESS OF AN UNDERGROUND STORAGE UNIT FOR LOBLOLLY PINE SEEDLINGS

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ABSTRACT

An underground, seedling-storage unit was constructed on the Cumberland State Forest in the summer of 1965. A study was installed in 1966 and 1967 to evaluate the effectiveness of this unit compared to an unheated, open shed for storing loblolly pine seedlings.

Dormant seedlings were lifted in mid-February and stored in both the unit and shed for 2, 4, 6, 8 and 10 weeks before planting. Non-dormant seedlings were lifted in mid-April and stored in both the unit and shed for 2, 4, and 6 weeks before planting.

In 1966, seedlings stored in the open shed survived as well as seedlings stored in the unit, with the exception of dormant seedlings stored 10 weeks. In 1967 the open shed was less effective. Seedlings stored in the shed survived as well as seedlings stored in the unit only for storage periods of 2 and 4 weeks.

Seedling heights at age 3 were related to the type of storage facility and length of storage in much the same way as seedling survival.

DESCRIPTION OF STORAGE FACILITIES

The underground storage unit, which will be referred to as the "unit", was constructed of cinder blocks in an excavation in the side of a bank (see Figure 1). The floor and roof are poured concrete. Soil was piled against the sides of the unit, and also over the roof to a depth of 1½ feet. There is a door in the front end which opens to the north. There is a vent in the door, and a vent in each end of the roof. The dimensions of the unit are 20 feet long, 12 feet wide, and 8 feet high. The capacity is 300 to 400 thousand loblolly pine seedlings.

The open-shed storage facility, which will be referred to as the "shed", is an equipment shed enclosed on 3 sides and open to the north. It is located about 200 yards from the underground storage unit.

Figure 1.

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DESCRIPTION OF STUDY

Identical studies were installed in 1966 and 1967, using loblolly pine seedlings. Fully dormant seedlings were lifted on February 15 and stored for periods of 2, 4, 6, 8, and 10 weeks before planting. Non-dormant seedlings, that had already started to grow in the nursery beds, were lifted on April 14 in 1966 and April 13 in 1967, and stored for periods of 2, 4, and 6 weeks before planting.

The schedule to plant every 2 weeks was followed fairly closely. Only 2 plantings were not made within 3 days of the target date. In 1966, non-dormant seedlings scheduled for 4 weeks' storage were actually stored an extra 7 days before planting; and in 1967, dormant seedlings scheduled for 2 weeks' storage were actually stored an extra 8 days before planting.

For each year, a uniform portion of a seedbed was reserved for the study, and both dormant and non-dormant seedlings were lifted from it. Seedlings were bundled in packages of 1,000.

Maximum-minimum thermometers were placed in both the unit and the shed, and temperatures were recorded daily except on weekends (see Appendix, Figures A and B). The underground unit was quite effective in reducing daily temperature fluctuations. Compared to the shed, maximum daily temperatures were lower and minimum temperatures higher in the unit.

Molding was not a problem in the storage unit. Seedling packages were examined each day, and if mold appeared on the outsides of the packages more ventilation was provided. In this way, growth of mold was effectively kept in check.

Each of the 16 treatments (an early lifting with 5 storage periods and a late lifting with 3 storage periods, for both storage facilities) were replicated 5 times in randomized blocks. Seedlings were planted in rows of 20, so that a total of 100 seedlings were planted for each treatment. Spacing was 3 by 3 feet.

Seedlings were planted by experienced tree planters on the same day they were removed from cold storage.

The planting site was cutover woodland prepared by light bulldozing for the 1966 study and by chopping and burning for the 1967 study. Both areas are fairly level.

The soil on the 1966 area is Altavista fine sandy loam, which is a moderately well drained terrace soil. The soil on the 1967 area is Tatum very fine sandy loam, which is a well drained upland soil.

Hardwood sprouts were chopped off during the second growing season to reduce the effect of hardwood competition on survival and growth.

MEASUREMENT

Survival and heights were measured each fall, through the third season. Survival changed very little after the first season. The results which follow are based on the third year measurements.

SEEDLING SURVIVAL

Survival data is given in Table 1 and illustrated in Figure 2.[2]

TABLE 1. SURVIVAL AFTER 3 GROWING SEASONS AND DIFFERENCES BETWEEN UNIT AND SHED STORED SEEDLING SURVIVAL

	Storage Period	1966 Study			1967 Study		
		Unit	Shed	Diff.	Unit	Shed	Diff.
				—percent—			
Dormant seedlings	2 weeks (3 wks. in 1967)	99	99	0	91	94	3
	4 weeks	97	98	1	93	91	2
	6 weeks	94	98	4	96	78	18*
	8 weeks	95	92	3	89	57	32**
	10 weeks	88	67	21**	85	32	53**
Non-dormant seedlings	2 weeks	95	89	6	67	61	6
	4 weeks (5 wks. in 1966)	92	87	5	69	60	9
	6 weeks	62	67	5	54	22	32**

NOTE: Asterisks denote differences that are statistically significant at the 5% (*) and 1% (**) levels.

COMPARISON OF STORAGE FACILITIES

In 1966 there was little difference in survival between seedlings stored in the unit and shed. The only important difference in favor of the storage unit was for dormant seedlings stored 10 weeks.

In 1967 the open shed was less effective. Starting with 6 weeks storage, there were considerable differences in survival of dormant seedlings in favor of the storage unit. Non-dormant seedlings stored 6 weeks in the unit also survived considerably better.

ABRUPT SURVIVAL DECREASE FOR NON-DORMANT SEEDLINGS

Survival of non-dormant seedlings was as good after 4 weeks as after 2 weeks' storage, but fell sharply between 4 and 6 weeks' storage. This occurred in both 1966 and 1967, for seedlings stored in the unit as well as the shed. Differences in survival between 4 and 6 weeks' storage are statistically significant at the 1% level for both unit and shed stored seedlings in 1966, and for shed stored seedlings in 1967. The difference for unit stored seedlings in 1967 was not statistically significant.

COMPARISON OF DORMANT AND NON-DORMANT SEEDLINGS

Comparisons between dormant and non-dormant seedlings should be made with caution, since non-dormant seedlings *must* be lifted later than dormant seedlings. In this study they were lifted 2 months later. Consequently, if dormant and non-dormant seedlings are compared for storage periods of 2, 4, and 6 weeks, the non-dormant seedlings were planted about 8 weeks later. It is also possible to compare dormant and non-dormant seedlings on a common planting date, April 25 in 1966, and April 27 in 1967, but on this date dormant seedlings had been stored 10 weeks and non-dormant seedings only 2 weeks. Such comparisons, therefore, indicate the effect not only of seedling dormancy, but also storage period or planting date.

2. Survival percents were transformed to arc sin and analyses of variance were made. Differences between treatments were tested using Duncan's New Multiple Range Test.

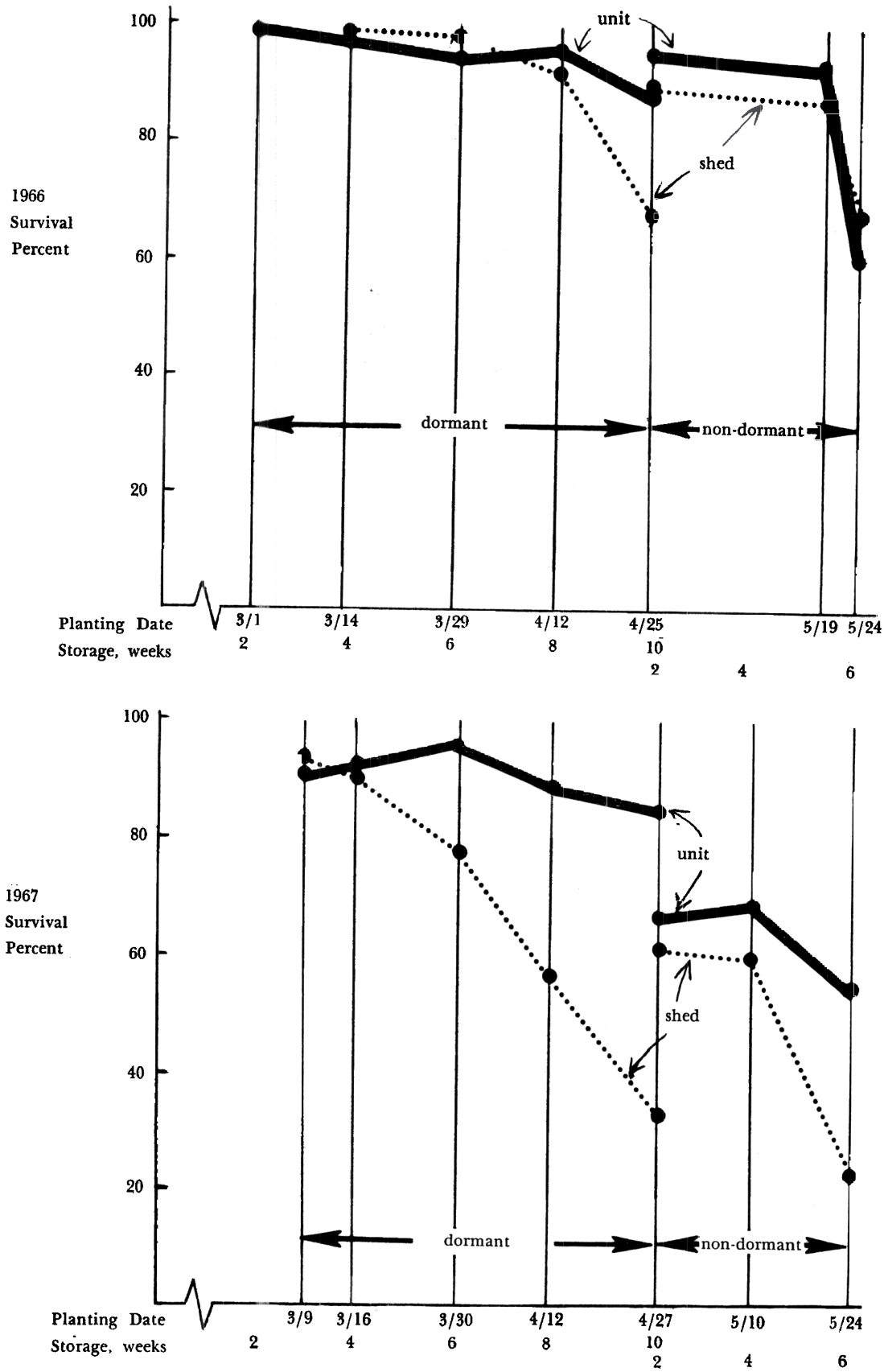


Figure 2. Survival after 3 growing seasons.

Table 2 compares dormant and non-dormant seedlings for storage periods of 2, 4, and 6 weeks. For these storage periods, dormant seedlings were planted in March and non-dormant in late April and May, so the differences in the table may be due to planting date as well as seedling dormancy.

TABLE 2. COMPARISON OF DORMANT AND NON-DORMANT SEEDLING SURVIVAL AFTER 3 GROWING SEASONS.

	1966 Study Weeks' Storage			1967 Study Weeks' Storage		
	2	4	6	2	4	6
	—percent—					
Unit, dormant	99	97	94	91	93	96
non-dormant	95	92	62	67	69	54
difference	4	5	32**	24**	24*	42**
Shed, dormant	99	98	98	94	91	78
non-dormant	89	87	67	61	60	22
difference	10*	11*	31**	33**	31**	56**

NOTE: Asterisks denote differences which are statistically significant at the 5% (*) and 1% (**) levels.

HEIGHT GROWTH

Third year average seedling heights are given in Table 3 and illustrated in Figure 3.[3] Height growth of *dormant* seedlings was affected by type of storage facility and length of storage in the same way as was survival. Height growth of *non-dormant* seedlings, however, did not closely follow the pattern of survival; for the 1966 study, there was a noticeable decrease in height between 4 and 6 weeks storage, but the decrease for the 1967 study was slight.

TABLE 3. HEIGHT AFTER 3 GROWING SEASONS AND DIFFERENCES BETWEEN UNIT AND SHED STORED SEEDLING HEIGHTS

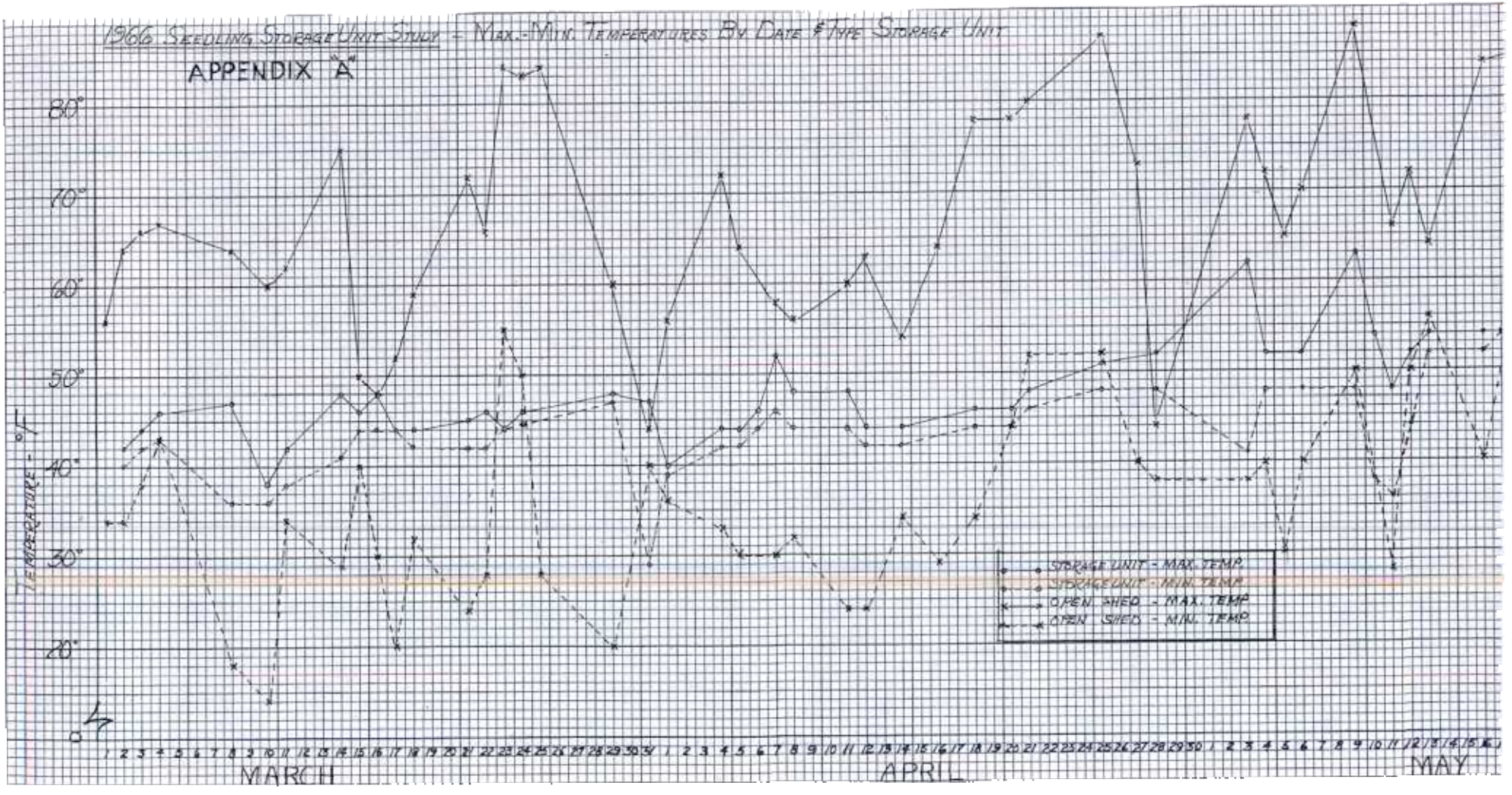
		1966 Study			1967 Study		
		Unit	Shed	Diff.	Unit	Shed	Diff.
		—feet—					
Dormant seedlings,	2 weeks (3 wks. in 1967)	5.0	4.6	.4	5.6	5.5	.1
	4 weeks	4.8	4.6	.2	5.5	5.7	.2
	6 weeks	4.5	4.6	.1	5.5	4.8	.7
	8 weeks	4.9	4.7	.2	5.2	4.5	.7
	10 weeks	4.3	3.5	.8*	4.9	3.5	1.4**
Non-dormant seedlings	2 weeks	5.2	4.3	.9**	4.1	4.3	.2
	4 weeks (5 wks. in 1966)	4.5	4.4	.1	4.2	3.9	.3
	6 weeks	3.5	3.9	.4	4.0	3.6	.4

NOTE: Asterisks denote differences which are statistically significant at the 5% (*) and 1% (**) levels.

3. Analyses of variance were made of mean heights of surviving seedlings. Differences between treatments were tested using Duncan's New Multiple Range Test.

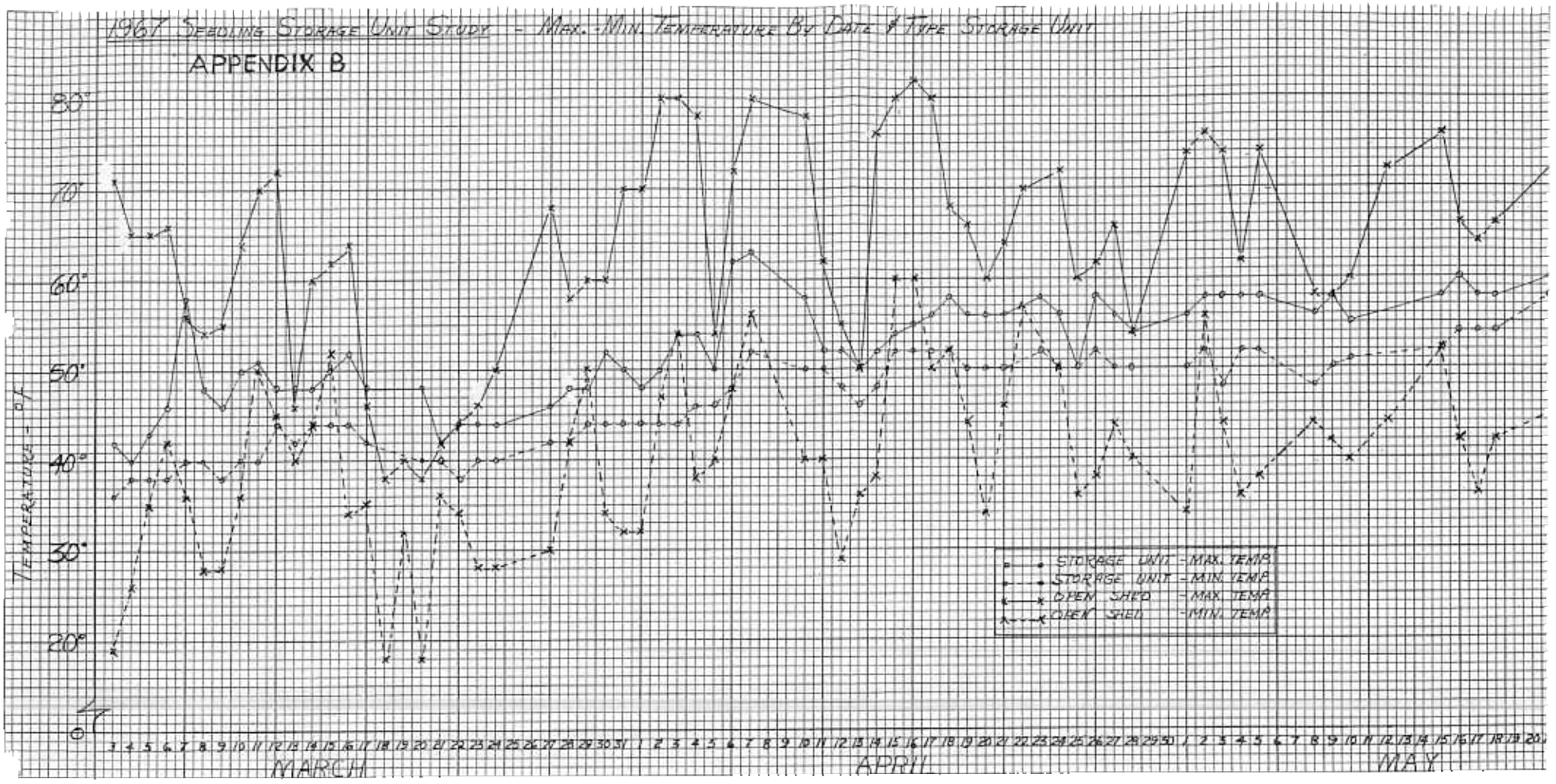
1966 Seedling Storage Unit Study - Max.-Min. Temperatures By Date & Type Storage Unit

APPENDIX "A"



1967 Seedling Storage Unit Study - Max.-Min. Temperature By Date & Type Storage Unit

APPENDIX B



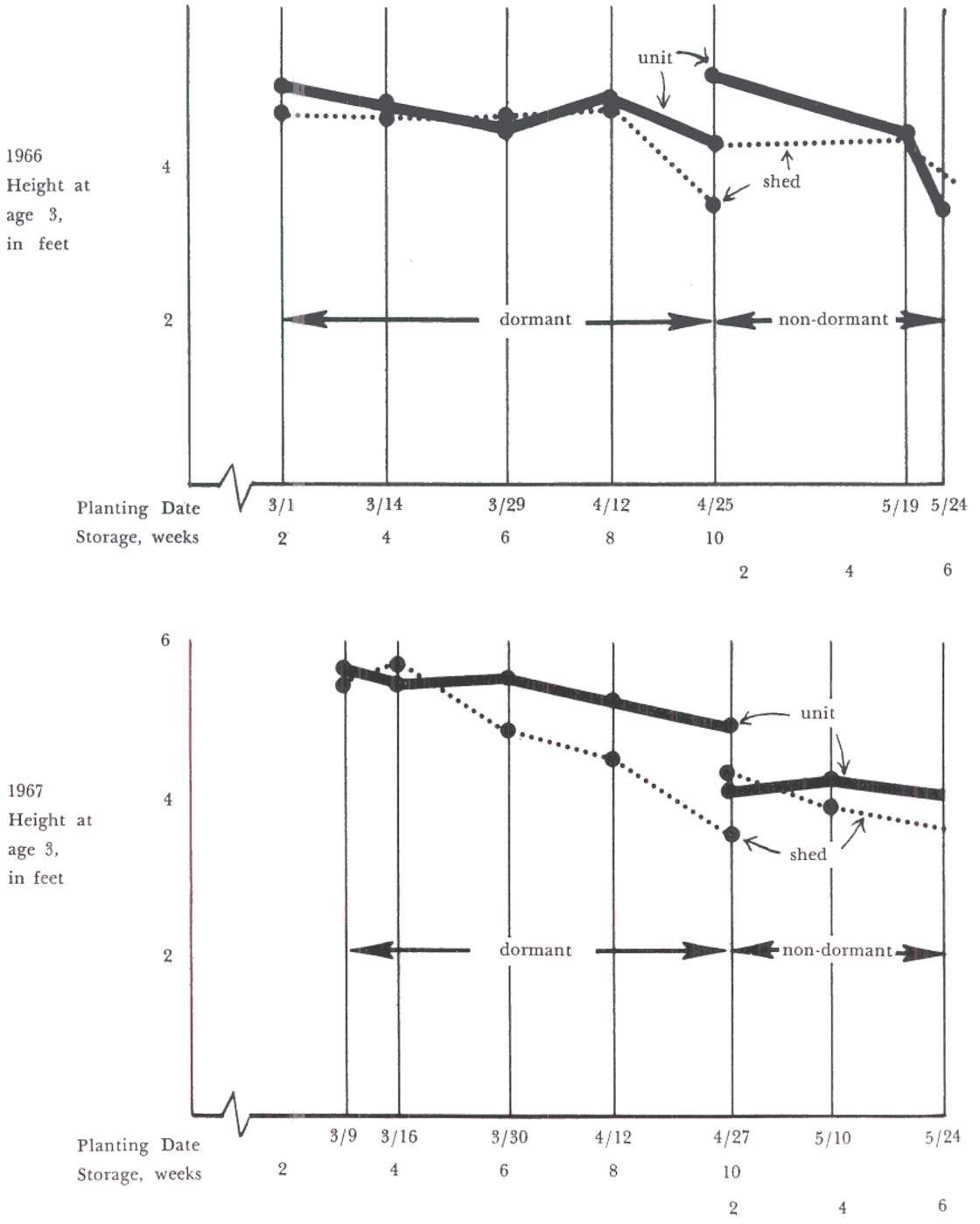


Figure 3. Height after 3 growing seasons.