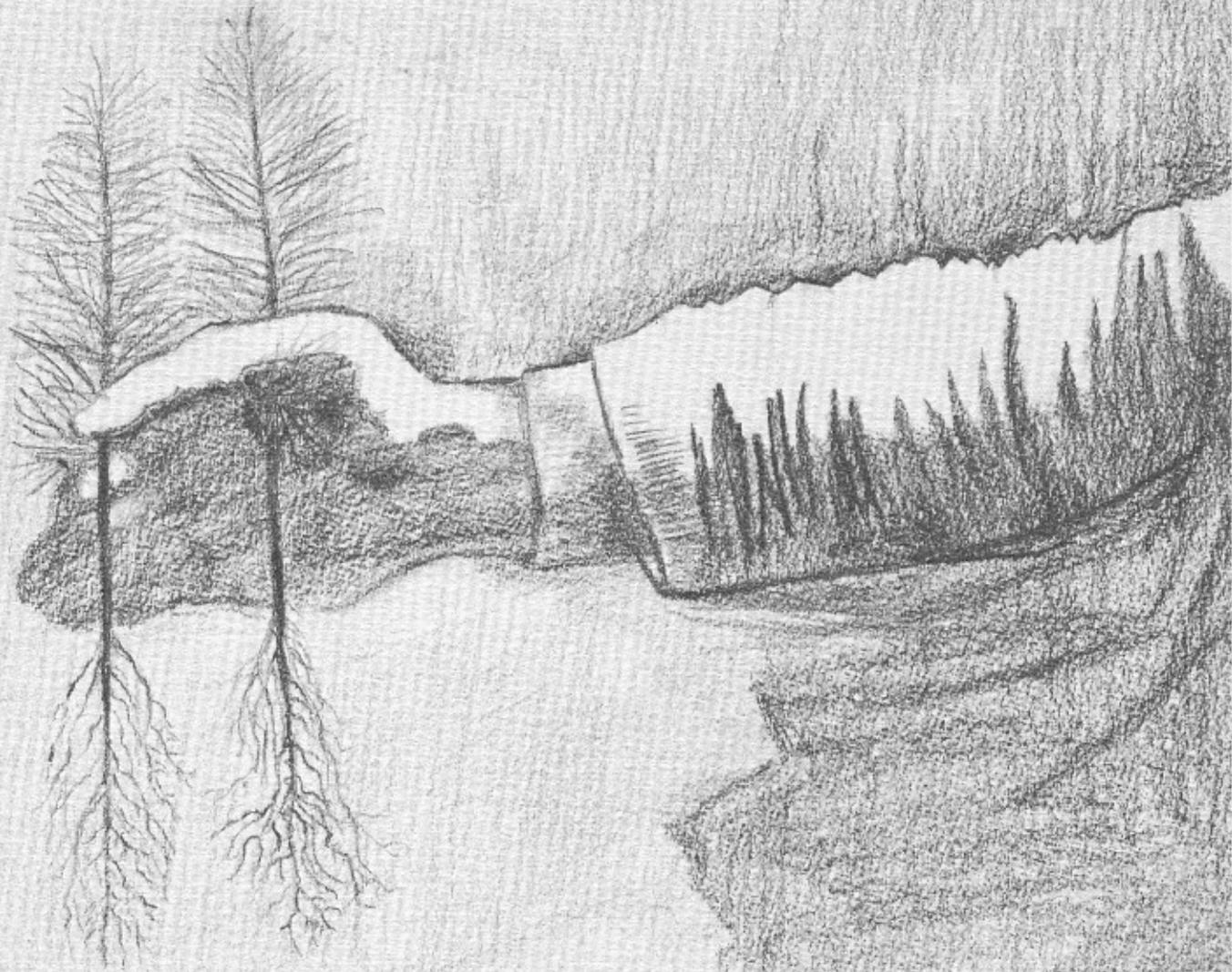


EXPOSURE, CLAY TREATMENT, and STORAGE of Loblolly pine seedlings



EFFECT of EXPOSURE, CLAY TREATMENT, and STORAGE on Survival and Growth of Loblolly Pine Seedlings

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ABSTRACT

The purpose was to study the effects of exposure, clay treatment, and storage on survival and growth of loblolly pine seedlings. Both clay treated (roots dipped in water suspension of kaolin clay) and untreated seedlings were planted. Seedling packages were stored for periods of 1, 3, and 5 weeks before planting. Immediately before planting, seedling roots were exposed to the sun and air for periods of 0, 30, 60, and 90 minutes.

Survival was strongly affected by exposure: the longer the exposure time the lower the survival, for clay treated as well as untreated seedlings. Clay treating did not improve survival of unexposed seedlings, but did result in modest improvements for exposed seedlings. In general, there was no tendency for survival to decrease with longer storage time.

Height growth of surviving seedlings was affected by exposure, clay treatment, and storage in much the same way as survival.

DESCRIPTION OF STUDY

Identical studies were installed on three different planting dates: March 1 and April 12, 1965, and March 21, 1966. Seedlings were lifted at the nursery 1, 3, and 5 weeks prior to planting, and all seedlings for a particular planting date were lifted from a uniform section of a seedling bed. Half of the seedlings were root-dipped in a thin, water-suspension of kaolin clay, then packaged in waterproof paper.² The other half of the seedlings were not dipped, and were packaged in a mixture of sphagnum moss and sawdust (see Figure 1).

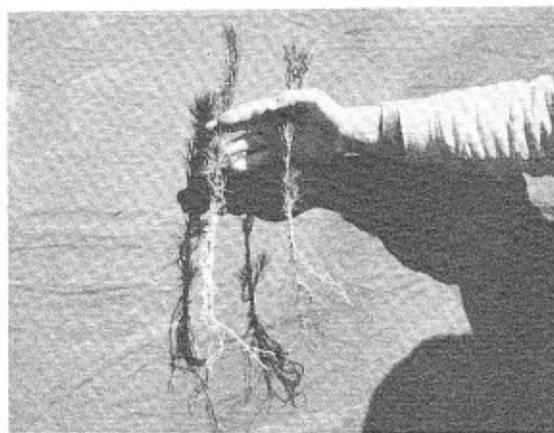


Figure 1. Clay treated seedling on left, untreated seedling on right

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2. Approximately three pounds of kaolin clay per 1,000 seedlings was applied. This rate of clay application, with packaging in waterproof paper, is now standard procedure at Virginia Division of Forestry nurseries.

The seedling packages were stored in an unheated shed. Clay treated seedlings were not watered while in the package. Untreated seedlings were watered every two weeks for the two plantings made in 1965, but were not watered for the planting made in 1966.

Seedlings were exposed by spreading them out on boards in the sun (see Figure 2). After the proper exposure period of 30, 60 or 90 minutes, seedlings were placed in canvas bags and immediately planted. Seedlings receiving "0" minutes exposure were taken out of the package, placed in canvas bags, and immediately planted so there was practically no exposure of the roots (see Figure 3).



Figure 2. Exposing seedlings (short lengths of 2 x 4 were used to prevent wind from scattering seedlings).



Figure 3. Planting seedlings, showing nature of planting site.

Rows of 20 seedlings each were planted in randomized blocks. There were 24 different treatments: three storage periods and four exposure periods for both clay treated and untreated seedlings. A single block consisted of 24 rows of 20 seedlings each, one row for each of the 24 treatments. Three blocks were installed on each of the three planting dates. One block was planted in the morning and two in the afternoon. A total of 1,440 seedlings were planted on each date.

Relative humidity, temperature, and wind velocity were recorded frequently while the planting was being done. This weather information is summarized in Table 1.

TABLE 1. WEATHER DATA

Date	Relative Humidity		Temperature		Wind
	At Start	Minimum	At Start	Maximum	
	— Percent —		— Degrees Fahrenheit —		
March 1, 1965	54	33	48	66	Gusts to 8 mph
April 12, 1965	32	19	60	68	Gusts to 20 mph
March 21, 1966	48	30	41	67	Gusts to 12 mph

All three plantings were made on the Appomattox State Forest on cutover woodland. Plots were cleared for planting by light bulldozing, and hardwood sprouts were cut down each year after planting to minimize hardwood competition. Soils on the plots belong to the Tatum and Nason soil series. These are well-drained soils with very fine sandy loam top soil.

MEASUREMENTS

Seedling survival and heights were obtained each year, at the end of the growing season, until the seedlings were three years old. Survival changed very little after the first year. The results that follow are based on the third-year measurements.

RESULTS AND DISCUSSION

SURVIVAL

Exposure reduced survival, of clay treated as well as untreated seedlings, as shown in Table 2 and Figure 4. The longer the exposure period the lower the survival. The effect of exposure was statistically significant for all three planting dates.³

TABLE 2. SURVIVAL PERCENT, AT END OF THIRD SEASON

Date	Storage	Root Treatment	Survival Percent			
			Exposure			
			0	30	60	90
March 1, 1965	1 week	clay treated	98	95	85	68
		untreated	93	83	80	57
	3 weeks	clay treated	98	95	92	87
		untreated	95	92	78	75
	5 weeks	clay treated	98	95	88	72
		untreated	100	72	72	72
April 12, 1965	1 week	clay treated	88	60	38	23
		untreated	87	52	33	23
	3 weeks	clay treated	90	62	37	35
		untreated	95	55	42	23
	5 weeks	clay treated	93	70	43	35
		untreated	88	47	35	32
March 21, 1966	1 week	clay treated	100	97	97	78
		untreated	98	75	60	55
	3 weeks	clay treated	100	97	78	60
		untreated	98	97	72	70
	5 weeks	clay treated	98	82	58	53
		untreated	100	78	68	57

3. Analyses of variance were made of arc sin percent survival and total height at the end of the third season. Significant treatment effects are shown in the table below. N.S. means not significant.

PLANTING DATE

	March 1, 1965		April 12, 1965		March 21, 1966	
	Survival	Height	Survival	Height	Survival	Height
Clay Treatment	.005	N. S.	N. S.	.025	.025	.025
Exposure	.005	.005	.005	.005	.005	.005
Storage	N. S.	N. S.	N. S.	N. S.	.005	N. S.
Treatment × Storage	N. S.	N. S.	N. S.	N. S.	.005	.005

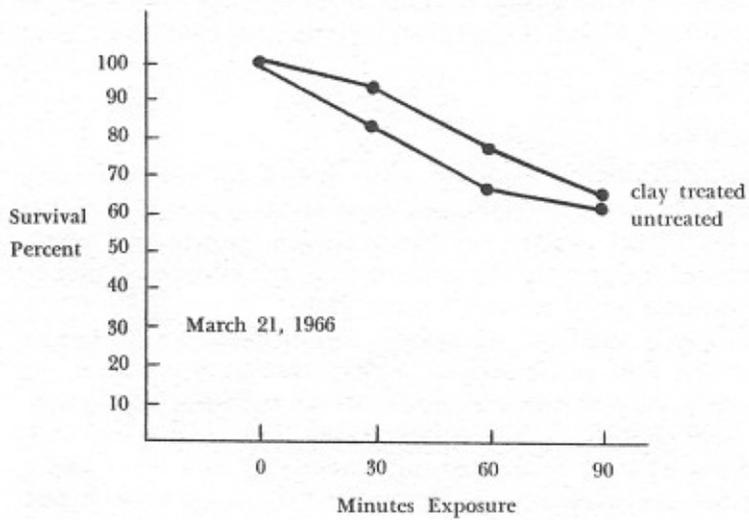
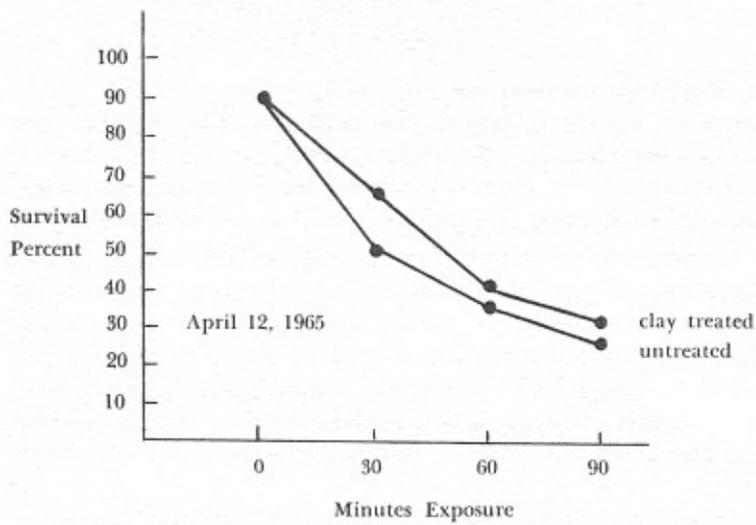
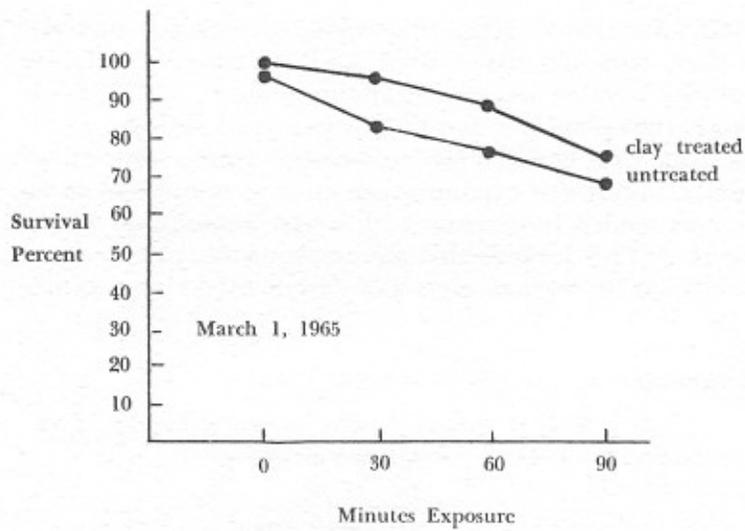


Figure 4. Survival percent: effect of exposure period on clay treated and untreated seedlings (storage periods combined).

Clay treated and untreated seedlings that were *not* exposed survived equally well, but after exposure clay treated seedlings survived slightly better. The effect of clay treating was statistically significant for the March 1, 1965, and March 21, 1966 plantings, but not for the April 12, 1965 planting. The differences in survival between clay treated and untreated seedlings were no greater after 90 minutes of exposure than after 30 minutes of exposure; in fact, differences tended to decrease with longer exposure as shown in Table 3 and Figure 4. This suggests that any tendency of the clay treatment to retard the rate of drying had generally ceased before 30 minutes of exposure.

TABLE 3. SURVIVAL DIFFERENCES FOR EXPOSED SEEDLINGS.

Planting Date	Survival Difference (clay treated minus untreated)		
	Minutes of Exposure		
	30	60	90
March 1, 1965	13	12	8
April 12, 1965	13	3	5
March 21, 1966	8	11	3

The effect of storage on survival was not consistent for the three planting dates, as shown in Figure 5, where the four exposure periods are combined. For the two plantings in 1965, differences related to storage were not statistically significant: there was no tendency for survival to decrease with longer storage, and in all cases clay treated seedlings survived somewhat better (from two to ten percentage points) than untreated.

Storage did have a significant effect with the 1966 planting. Clay treated seedlings stored one week survived 21 points better than untreated seedlings, but treated seedlings stored three and five weeks did not survive quite as well as untreated seedlings. The statistically significant improvement from clay treatment for this planting, is due entirely to this large difference for seedlings stored one week. No explanation can be offered for this large difference.

Survival was related to weather conditions (refer to Table 1). Exposure was most harmful on April 12, 1965, when relative humidity dropped to a low of 19 percent and the wind gusted at times to 20 miles per hour. Exposure was least harmful on March 1, 1965, and the drying conditions were least severe on this date.

HEIGHT GROWTH

Height growth of surviving seedlings was affected by exposure, clay treatment, and storage in much the same way as survival, as shown in Table 4 and Figures 6 and 7. Exposure adversely affected height growth; the longer the exposure the poorer the growth. As with survival, the effect of exposure was statistically significant for all three planting dates.

Clay treatment had a small but statistically significant effect on height growth for the April 12, 1965 and March 21, 1966 plantings, but not for the March 1, 1965 planting. As with survival, however, the significant difference for the March 21, 1966 planting is due entirely to seedlings stored one week (clay treated seedlings were no taller than untreated seedlings for 3 and 5 weeks storage, but for one week storage clay treated seedlings were .8 feet taller).

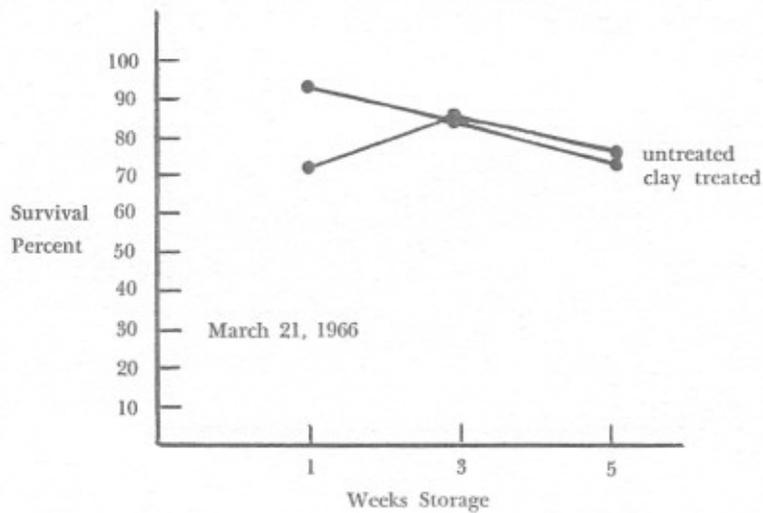
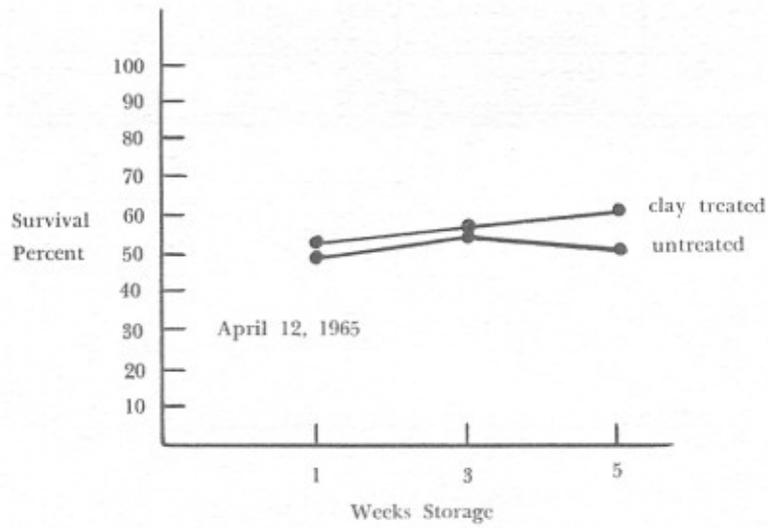
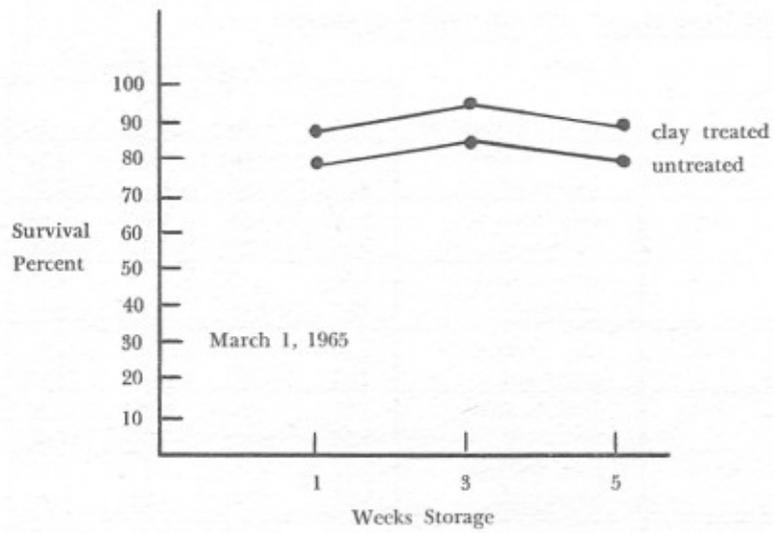


Figure 5. Survival percent: effect of storage period on clay treated and untreated seedlings (exposure periods combined).

TABLE 4. SEEDLING HEIGHT, AT END OF THIRD SEASON.

Date	Storage	Root Treatment	Height in Feet			
			Exposure			
			0	30	60	90
March 1, 1965	1 week	clay treated	5.56	4.96	5.49	4.35
		untreated	5.68	4.95	4.50	4.50
	3 weeks	clay treated	5.56	5.34	4.85	4.68
		untreated	5.40	5.57	5.14	4.86
	5 weeks	clay treated	5.30	5.14	4.85	4.79
		untreated	5.21	5.14	4.91	4.51
April 12, 1965	1 week	clay treated	5.10	4.27	4.08	4.25
		untreated	4.63	4.31	3.43	3.26
	3 weeks	clay treated	5.33	4.66	4.23	3.70
		untreated	5.04	3.85	4.07	4.02
	5 weeks	clay treated	5.44	4.21	3.91	4.14
		untreated	5.23	4.27	4.52	3.72
March 21, 1966	1 week	clay treated	6.31	5.98	6.07	5.98
		untreated	6.43	4.91	5.07	4.81
	3 weeks	clay treated	6.41	5.66	5.60	5.26
		untreated	6.45	5.80	5.56	5.24
	5 weeks	clay treated	6.77	5.84	5.25	4.70
		untreated	6.57	5.22	5.62	5.29

5

1.3

2.8

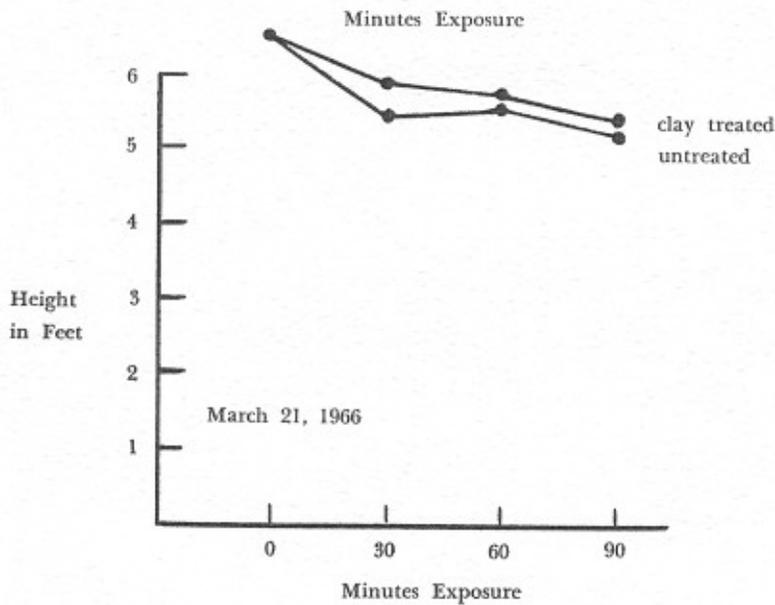
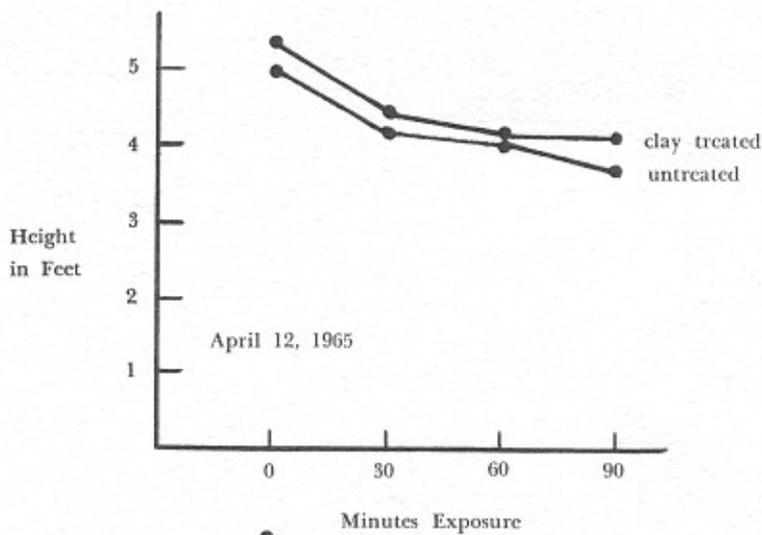
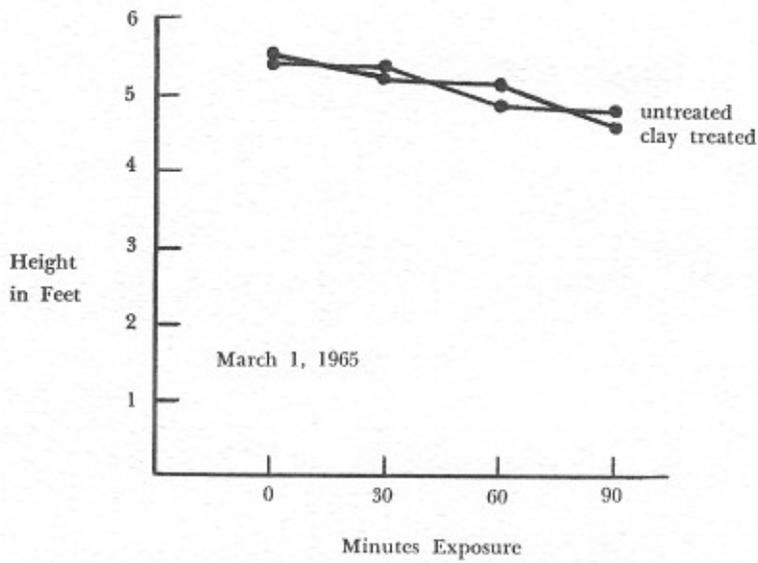


Figure 6. Seedlings height: effect of exposure period on clay treated and untreated seedlings (storage periods combined).

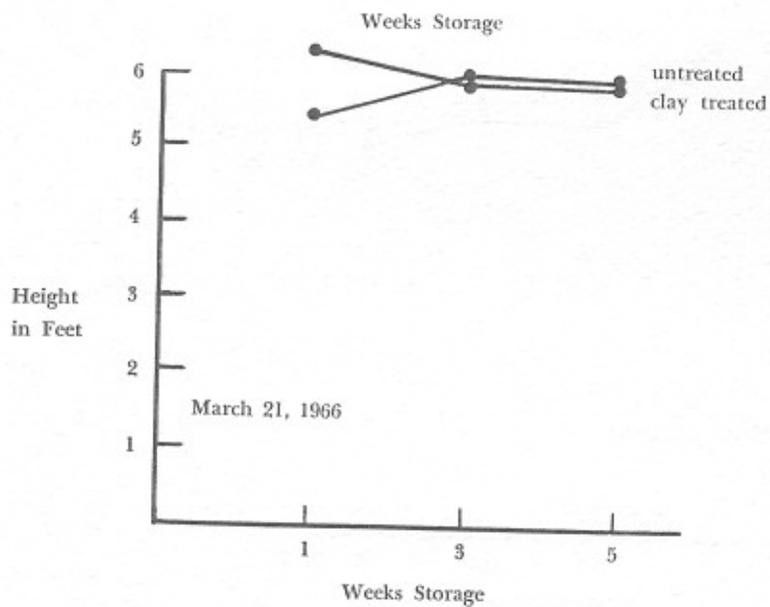
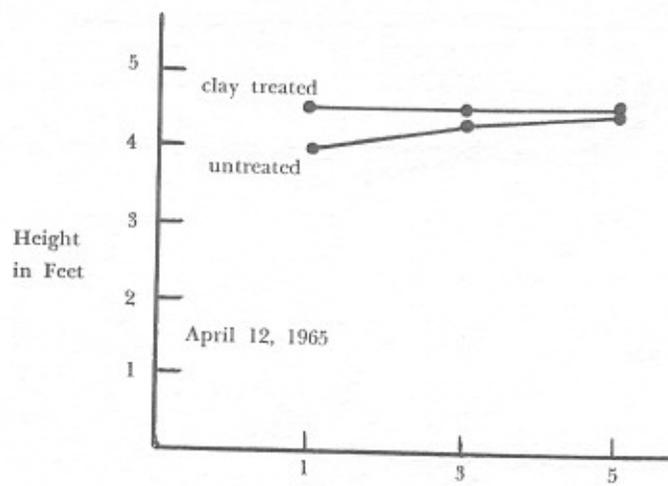
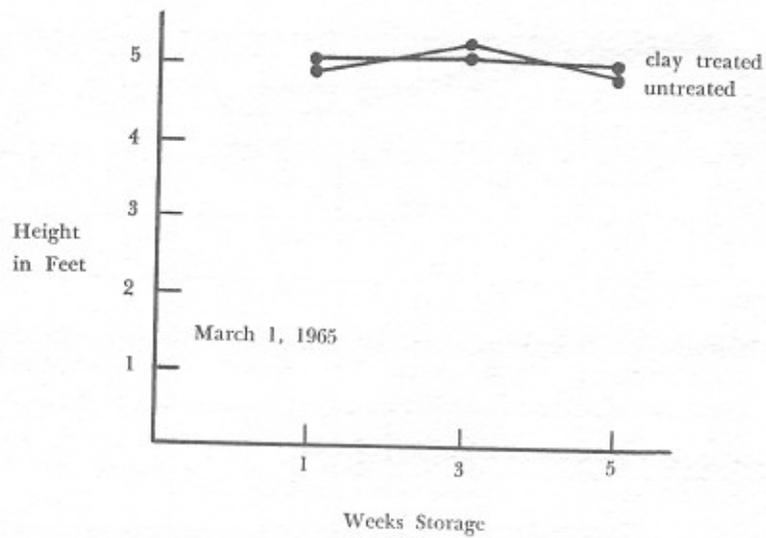


Figure 7. Seedling height: effect of storage period on clay treated and untreated seedlings (exposure periods combined).

CONCLUSIONS

1. Exposure of seedling roots during planting should be kept to a minimum. Exposure had a strong adverse effect on both survival and height growth, whether or not the seedlings were clay treated.
2. Utmost care should be taken on days of extreme weather conditions, as occurred with the April 12, 1965 planting. On this date, low relative humidity, strong winds, and warm temperatures resulted in unacceptable losses even after just 30 minutes of exposure.
3. Clay treated seedlings survived and grew better after exposure, but the improvement from clay treatment was not great. The same care should be used in handling clay treated seedlings as untreated seedlings.
4. Storage in an open shed for periods of up to 5 weeks did not adversely affect survival or growth.