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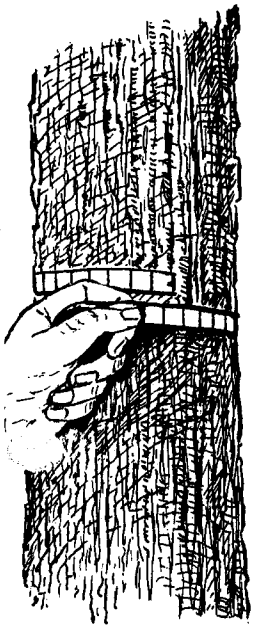
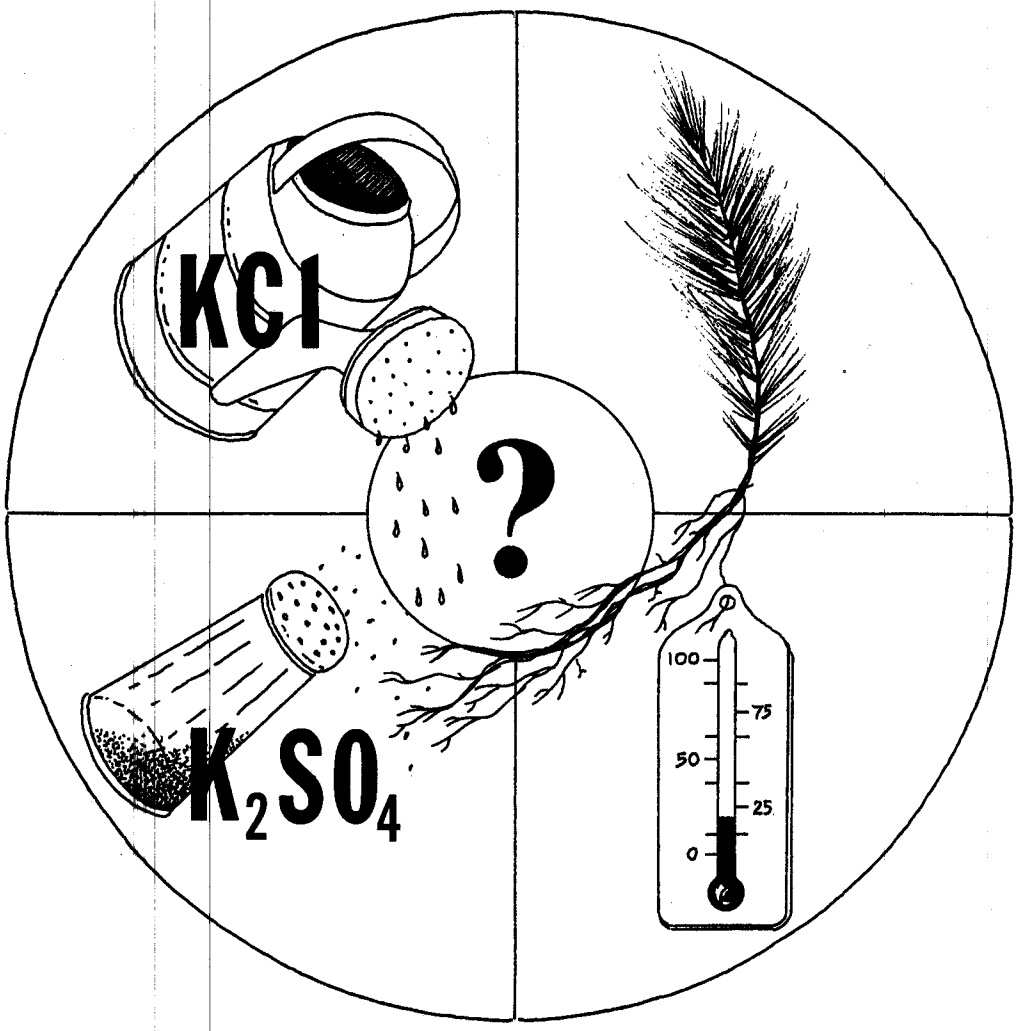


A TEST TO INDUCE EARLIER DORMANCY



Virginia Division of Forestry
Department of Conservation and Economic Development

Two Tests of Potassium Fertilization to Induce Earlier Dormancy of Loblolly Seedlings

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ABSTRACT

Potassium fertilizer was applied in mid-September of 1976 and 1978 in an attempt to induce earlier dormancy of loblolly pine seedlings. The test of dormancy was the capacity of seedlings to store satisfactorily for two weeks. Seedlings were lifted between November 1 and December 1. In both years, potassium fertilizer had an adverse effect on survival of November lifted seedlings that were stored two weeks before planting.

INTRODUCTION

Loblolly pine seedlings do not become fully dormant at our New Kent Nursery until December 1. Earlier tests showed that seedlings lifted in October and November might survive well when planted within a day or two of lifting, but could not be stored satisfactorily for even two weeks in cold storage. We could extend our planting season if lifting could start before December 1, but to do so we would have to find some way to induce earlier dormancy.

It is generally believed that potassium fertilizer has a favorable effect on seedling dormancy, and late season application of potash is commonly prescribed. Our interest was in whether potash would cause dormancy to occur sooner. We installed studies in the fall of 1976 and 1978 to test this possibility.

PROCEDURE

1976 Study

We tested rates of 0, 100, and 200 pounds per acre of K_2O, applying sufficient muriate of potash (KCl) to achieve these rates. The muriate of potash, in solution, was applied to treatment plots with a watering can. The seedbeds already contained an average of about 100 pounds of K_2O per acre in mid-September when the study was started. Two dates of application were tested: September 16 and October 15. Seedlings were lifted on three dates: November 1, Nomvember 15, and December 1, and separate seedbed plots were installed for each lifting date. There were, therefore, a total of 18 different seedbed treatment plots: three rates of K_2O x two application dates x three lifting dates. Each plot was four feet long, so a full seedbed replication was 72 feet long. Three replications of these 18 treatment plots were installed, in separate seedbeds in different sections of the nursery. The seedbeds were irrigated for an hour after applying the muriate of potash.

The fall of 1976 was unusually cold in Virginia. Average minimum temperatures were 1.3, 4.9, and 6.3 degrees lower than normal in September, October, and November, respectively (at the Byrd Airport Weather Station,

about 20 miles west of the nursery). In the latter half of October the temperature fell below freezing on eight days at Byrd Field, and in November the temperature fell below freezing on all but nine days, including four days below 20 degrees. We felt that the October 15 application of KCl probably had little time to affect dormancy, and decided to drop it from the study.

On November 1, when the first lifting was made, seedlings were starting to take on the purplish cast of winter, however, there were no noticeable differences between check seedlings and seedlings receiving KCl. Seedlings were lifted in the morning. Some were planted in the field that afternoon and some were placed in cold storage until November 16.

The second lifting was made on the morning of November 16. Winter coloration was more intense, but there were still no visible differences between KCl treatments. Some seedlings were planted the same afternoon, and some were placed in cold storage until December 1.

The final lifting was made on December 1 in the afternoon, planting the next afternoon. We had to lift and plant in the afternoon because the soil was frozen in the morning. There were still no visible differences between KCl treatments; foliage color was uniform over all plots. Some seedlings were placed in cold storage until December 15.

A six inch wide sample (2 square feet) was lifted from the center of each seedbed plot. Seedbed density ranged from 32 to 62 seedlings per square foot in the 27 samples, and averaged 44. Equal numbers of seedlings from each seedbed sample were selected for planting on a well-drained, upland site on the Buckingham-Appomattox State Forest in the central piedmont. There were 18 treatments: three rates of K_2O x three lifting dates x two storage periods (0 and 2 weeks). A 20 seedling row of each treatment was planted in each of three randomized blocks.

Temperatures were again below normal in December, and January was the coldest on record. Average temperatures for January were 11.5 and 13.6 degrees below normal at the two weather stations closest to the outplanting. As if the cold weather wasn't enough, the period of January through September was unusually dry - the two weather stations had deficits of 8.64 and 11.98 inches for the nine month period. These deficits amounted to 26 and 38 percent of normal rainfall. Considering the cold temperatures and low precipitation, this was the worst season for planting in many years, and survival was severely affected.

1978 Study

We tested rates of 0 and 200 pounds per acre of K_2O, using two sources, KCl and K_2SO_4, to give three K_2O treatments. The KCl was again applied with a watering can and the K_2SO_4 with a salt shaker. K_2O was only applied one time, on the afternoon of September 14, and was irrigated in the next morning. The seedbeds used in the study only had about 30 pounds of K_2O per acre at this time.

Separate seedbed plots were installed for the same three lifting dates used in the 1976 study: November 1, November 15, and December 1. There were thus nine seedbed treatment plots: three K_2O treatments x three lifting dates. Seedbed plots were three feet long, so a full seedbed replication was 27 feet long. Three replications of these nine treatments were installed, in separate seedbeds in different sections of the nursery.

September and October of 1978 were unusually dry. We dropped the November 1 lifting because the soil was too dry to plant on the Buckingham-Appomattox State Forest. November and December had above normal rainfall, and rainfall was about normal in 1979. The winter of 1978-79 was colder than normal, but not as extreme as the winter of 1976-77. Overall, weather conditions were much more favorable for survival for the 1978 study than the 1976 study.

The first lifting was on November 16 and the immediate planting was done the next day. The second lifting and planting was done on December 1. On each lifting date some seedlings were placed in cold storage for planting two weeks later. As in 1976, there were no visible differences between seedlings treated and not treated with potassium fertilizer. The same procedure was used as in the 1976 study, lifting a six inch wide sample from the center of each seedbed plot. Seedbed density ranged from 34 to 58 seedlings per square foot in the 18 samples lifted (three potassium treatments x two lifting dates x three seedbed replications), and averaged 47.

Equal numbers of seedlings from each seedbed sample were selected for planting on the Buckingham-Appomattox State Forest, on a well-drained, upland site. There were 12 treatments: three potassium treatments x two lifting dates x two storage periods (0 and 2 weeks). A 20 seedling row of each treatment was planted in each of four randomized blocks.

RESULTS

Survival was tallied and seedling heights measured annually through three seasons in the field. Results after the third season are presented.

1976 Study

Overall survival was extremely low, averaging 40 percent (Table 1 and Figure 1). Some of the seedlings that survived the first season in the field were still so weak that a few actually were frost heaved during the second winter (January, February, and March of 1978 were unusually cold). Most seedlings that survived the first season, however, were still alive after three seasons; overall survival only decreased one percentage point between the end of the first and third seasons in the field.

Table 1. Average Survival by Lifting Date and K_2O Rates For Seedlings Planted Immediately and Stored Two Weeks[1/]

Lifted	K_2O	Not Stored	Stored	Means
11/1	0	55	23	39
	100	45	20	32
	200	58	13	36
	Means	53	19	36
11/15	0	42	35	38
	100	42	27	34
	200	48	25	37
	Means	44	29	36
12/1	0	42	63	52
	100	50	48	49
	200	42	50	46
	Means	44	54	49
Overall Means		47	34	40

Application of KCl on September 15 had the reverse effect of what we expected. KCl did not affect survival of seedlings planted the same day they were lifted (or the next day), but KCl reduced survival of seedlings stored two weeks.

Seedlings were not fully dormant and ready to be stored until the December 1 lifting, as has been the case in earlier studies at the New Kent Nursery. The better survival of stored than immediately planted seedlings from the December 1 lifting is perhaps explained by weather differences. Weather for the week to 10 days following planting was more favorable for the December 15 than December 1 planting - night time temperatures were not as low (the first half of December was extremely cold). and there was more rainfall.

Overall average height after three seasons in the field was only 3.2 feet, which reflects the stress the seedlings endured during the first year after planting. Seedlings that had been stored two weeks averaged .2 feet shorter than seedlings that had been planted immediately.[2/]

[1/] See last page of report for results of the analysis of variance.

[2/] An analysis of variance was performed on mean seedling heights, and none of the treatment effects or interactions were statistically significant.

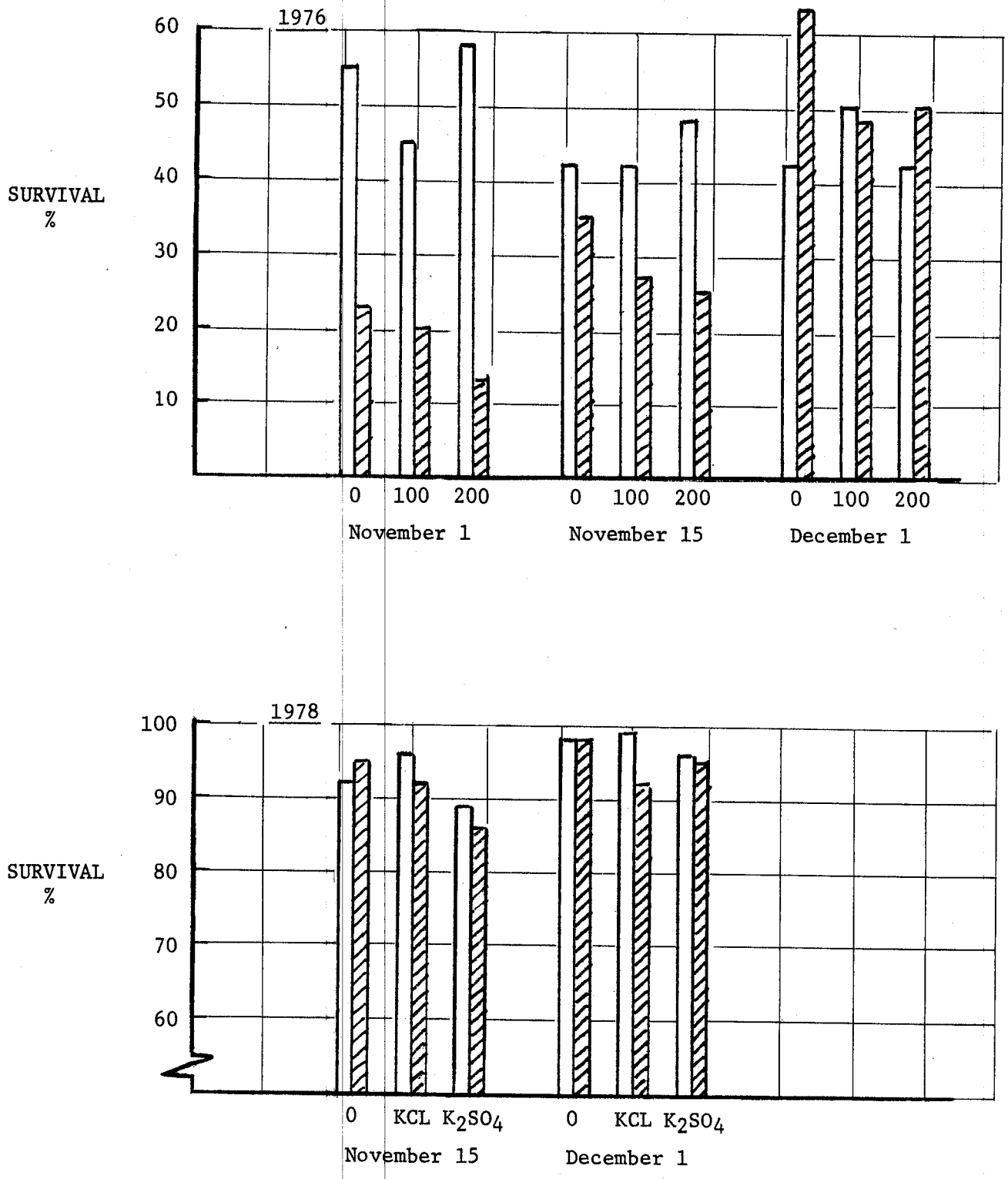

Figure 1. Average survival by lifting date and K_2O treatment. Clear bars are for seedlings planted immediately and cross-hatched bars are for seedlings stored two weeks.

1978 Study

Overall survival was unusually high, averaging 94 percent (Table 2 and Figure 1). For seedlings not treated with KCl or K_2SO_4, stored seedlings survived as well as immediately planted seedlings, but treatment with KCl and K_2SO_4 reduced survival of stored seedlings significantly.

Table 2. Average Survival by Lifting Dates and Potash Treatment For Seedlings Planted Immediately and Stored Two Weeks[1/]

Lifted	K_2O	Not Stored	Stored	Means
11/16	None	92	95	94
	KCl	96	92	94
	K_2SO_4	89	86	88
	Means	92	91	92
12/1	None	98	98	98
	KCl	99	92	96
	K_2SO_4	96	95	96
	Means	98	95	96
Overall Means		95	93	94

Seedlings apparently became dormant, and capable of storing, earlier this year than normal. Perhaps the lack of rainfall in September and October contributed to this.

Overall average height after three seaons in the field was 5.04 feet, with only slight differences between treatments and none that were statistically significant.

DISCUSSION

In these two studies, potassium fertilizer applied in mid-September had the reverse effect of what we expected. But we were only looking at one aspect of the possible effects of fall application of potash: whether potash would cause seedlings to become dormant earlier in the fall. These studies give no information on seedling quality and ability to store after they normally become dormant.

[1/] See last page of report for results of the analysis of variance

1/ Survival percents were transformed to arc sin and two analyses of variance were performed, one for the entire study and the other just for the seedlings stored two weeks:

1976 STUDY

Entire Study

Source	d.f.	Mean Square	F	Probability
Rate of KCl	2	50.82	1.75	.19
Lifting Date	2	401.32	13.81	4.1×10^{-5}
Storage	1	962.67	33.13	1.8×10^{-6}
Rate x Lifting	4	8.94	.31	.87
Rate x Storage	2	94.34	3.25	.05
Lifting x Storage	2	840.84	28.94	4.6×10^{-8}
R x L x S	4	43.07	1.48	.229
Blocks	2	1,792.71	61.70	
Error	34	29.06		

Stored Trees Only

Source	d.f.	Mean Square	F	Probability
Rate of KCl	2	132.05	5.30	.02
Lifting Date	2	1,159.75	46.51	2.2×10^{-7}
Rate x Lifting	4	20.38	.82	.53
Blocks	2	690.48	27.69	
Error	16	24.93		

1978 STUDY

Entire Study

Source	d.f.	Mean Square	F	Probability
K2O	2	170.53	4.37	.021
Lifting Date	1	427.45	10.95	.0023
Storage	1	108.60	2.78	.105
K2O x Lifting	2	33.04	.85	.44
K2O x Storage	2	151.47	3.88	.031
Lifting x Storage	1	59.05	1.51	.228
K x L x S	2	14.14	.36	.70
Blocks	3	34.48	.88	
Error	33	39.05		

Stored Trees Only

Source	d.f.	Mean Square	F	Probability
K2O	2	202.74	5.97	.012
Lifting Date	1	84.38	2.49	.136
K2O x Lifting	2	42.65	1.26	.313
Blocks	3	38.49	1.13	
Error	15	33.95		