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ECONOMICAL SPOT SEEDING AND PLANTING METHODS FOR PINES ON SAND PLAINS

by

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Summary In French

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Economical Spot Seeding and Planting Methods for Pines on Sand Plains

by

K. W. Horton[1] and R. J. McCormack[2]

INTRODUCTION

Sandy outwash plains and terraces with patches of aspen scrub and open heath are common throughout the Great Lakes-St. Lawrence Forest Region. Frequently the stumps of large pine, white or red (*Pinus strobus* L. and *P. resinosa* Ait.), may be found on these areas, testifying to the former presence of productive pine stands. Logging, often followed by wildfire, has eliminated or drastically reduced the pine in most cases.

Since these valley sites are in many cases the most accessible and the easiest sites for growing the valuable pines, it is important to find the most efficient means of securing pine regeneration. A natural seed source is often absent or inadequate, precluding natural regeneration. Direct seeding has been attempted to a very limited degree but the results have generally been disappointing and inconclusive. Planting of well-developed, usually 2-2 pine stock has been the only reliable method of regenerating such sites, and this is an expensive procedure.

With these points in mind, an experiment was established at the Petawawa Forest Experiment Station in Eastern Ontario to test five promising economical methods of artificial regeneration with four pine species in an effort to find the best alternative to the expensive method of planting transplanted stock. Three of the methods involved direct spot seeding with modifications, and the others involved planting of 1-0 and 2-0 seedling stock direct from the nursery seedbed. Direct seeding, if it could be demonstrated to be successful without expensive supplementary measures, would have an obvious economic advantage over planting methods. Seedbed planting stock would be advantageous over transplants in that it can be grown locally in small forest nurseries at little expense and is cheaper to handle.

The experiment was established in two separate but similar locations, each on a flat outwash plain with deep soil, a mixture of medium and fine sand. Drainage was uniformly excessive, the water table being well below the effective tree-rooting depth. In each locality a cover of poor-quality aspen (*Populus tremuloides* Michx., and *P. grandidentata* Michx.) some 40 years old, with a herbaceous ground vegetation dominated by bracken (*Pteridium aquilinum* (L.) Kuhn), and distributed in lightly-stocked patches, characterized the area. Between the patches was open heath vegetation consisting mainly of *Vaccinium, Comptonia* and *Carex* spp.

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FIGURE 1. An experimental area in an opening on the sand plain, characterized by a heath association.

FIGURE 2. A typical experimental area in a patch of aspen cover on the same sand plain as in Figure 1.

PROCEDURE

The experiment was arranged to test five regeneration methods using four pine species, white, red, jack (*Pinus banksiana* Lamb.), and Scots (*P. sylvestris* L.), in two cover conditions, open and aspen-covered, on otherwise similar physiographic sites in two localities. It was begun in the spring of 1954 and continued during the fall of 1954 and spring of 1955, replicating the methods and to a large extent the species.

Methods Tested

Methods tested were as follows:

Method A—Sowing 20 seeds on the surface of scarified spots.

Method B—Sowing 20 seeds on the surface of scarified spots, and covering with $\frac{1}{4}''$ of mineral soil.

Method C—Sowing 5 seeds in a spot scuffed by heel, with soil and humus kicked over seeds.

Method D—Planting 1-0 stock on scarified spots.

Method E—Planting 2-0 stock on scarified spots.

(Note—scarified spots of methods A, B, D, and E were all one foot square.)

Experimental Design

The experiment was conducted in 13 blocks, uniform with respect to soil and vegetation, and established in the two comparable locations, grouped as closely together as possible. Eight of them were in the open and five under aspen cover. Most were 90 by 150 feet in dimensions. There were no nearby seed trees from which natural seeding could occur.

Within each block there were 15 lines, six feet apart, constituting three replications of the five treatments (methods), assigned at random. Along each line at three-foot intervals, spots were scarified to mineral soil, and species were assigned to spots at random.

Treatments were applied first in early May, 1954, on certain whole blocks distributed in both localities; at this time only red and white pine material was available.Treatments were then repeated in October, 1954, and May, 1955, on the remaining blocks, using the four pine species.

Preparatory Treatments

The planting stock of Methods D and E was planted manually, one seedling per scarified spot in each case. It was obtained from the local station nursery and was not root-pruned or treated specially in any other way.

The seeds used in Methods A, B and C received certain treatments preparatory to sowing. White pine seeds sown in 1954 were stratified beforehand in moist sand for 60 days at 40°F, after which they showed an average germinative capacity of 57 per cent; those sown in the spring of 1955 were soaked overnight in a solution of ten drops of concentrated sulphuric acid to one litre of water, and the germinative capacity averaged 62 per cent. The same lot of seed was used in both cases. Seeds of the other three species were soaked in water the night before they were sown. Average germinative capacity of red pine was 100 per cent, jack pine 74 per cent, Scots pine 92 per cent, and white pine 57 to 62 per cent.

To provide a check of seed loss due to rodents and birds, the seeds of one set of methods in each block were treated with red oxide of lead. This repellent has been used in Europe with considerable success. It was applied in the form of a dry powder coated on wet seed. Germination tests showed no significant

differences in germination between treated and untreated seed. For further comparison, three spots randomly selected on each line were protected by conical wire screens which transmitted 66 per cent of full sunlight according to measurements with a spherical illuminometer on a clear day.

Instrumentation

Instruments were used to compare local climatic trends through the 1954 growing season in the open blocks and the aspen-covered blocks of one locality. Piché evaporimeters were used to measure total evaporation and shielded maximum-minimum thermometers to measure temperature extremes. All instruments were located one foot above ground level. They were read three times weekly.

Records

For the recording of results, new germinants were marked with coloured plastic toothpicks at approximately weekly intervals during the germination period, and less frequently in late summer. All spots were tallied at least three times during the first summer and every subsequent September until 1959. A seed was considered to have germinated when the radicle entered the soil (surface-sown) or when the cotyledons emerged above the soil (depth-sown). Planted spots were tallied for seedling survival each September also. In 1959 all surviving seedlings representing all methods were measured for total height.

Analysis

In the analysis the data from both locations have been pooled in view of similarities, and that from different blocks combined to suit various comparisons.

The overall results in 1959, five to six years after initiation, are presented simply in histograph form. For this presentation the percentage survival and height were calculated for each species according to method and cover condition. Differences of practical significance are so evident that further analysis was not considered necessary.

In examining the effects of individual factors only the data for the first critical years, 1954 to 1956, are used. The analysis of each factor is based on comparisons of different combinations of the data as shown in each table. Only directly comparable combinations were adopted: for instance, if the comparison was between Method A, all species, and Method B, all species, then the relative proportions of the different species combined under each method were the same, and the relative proportions of treated and untreated seed in each combination were the same.

The data given in Tables 2 to 6, representing mean percentage germination and survival, arranged so that the effects of the individual factors of cover, method, species, season and seed treatment can be examined, were arrived at in the following manner:

1. The percentage germination and survival relative to the total number of spots treated was computed for each species on each line (a line being one replication of one method) in each block. Each percentage was considered one observation.
2. Blocks from both locations were variously grouped as indicated to suit the factor under examination, and all appropriate observations from comparable blocks were combined to calculate the mean percentages.

The number of spots and therefore of seeds or seedlings involved in any two means under comparison was usually similar, but not in every case, owing to inadvertent shortages in certain species. However, the number of observations from which the pair of mean percentages was calculated was always made equal by the design. It varied in each comparison depending on the number of blocks involved, generally ranging from 15 to 30 but in a few cases as low as 6.

The design of the experiment did not allow valid analyses of variance on the basis of pooled blocks, but the arrangement of data outlined above permitted the use of the t-test to determine the statistical significance of differences between means under comparison. Following convention, probabilities at the .05 level are considered significant, and at the .01 level, highly significant.

GENERAL RESULTS

The practical results of the trial as a whole can be seen in Figure 3. This is an illustration of survival, in terms of percentage of stocked spots in 1959 (5-6 years after establishment), and of average height after five years growth. It enables comparisons of methods, species, and cover conditions. Other factors which may have influenced the results, such as date of planting and protection of seed, apply evenly to all species and thus need not be separated for this general comparison. Separate factorial effects are dealt with later.

In brief, the seeding trials were unsuccessful. A minimum acceptable stocking of 50 per cent seems reasonable for the spot spacing involved, and by this standard all seeding methods with all species in both open and covered conditions failed, with one exception. The exception involved Scots pine in the depth-sown method (B) under aspen cover. This condition was the only one in which the other species approached worthwhile stocking as well. However, the poor showing in height growth discourages hope for the method's utility.

The planting trials are far more encouraging. The 2-0 planting stock (Method E) survived remarkably well in most cases. Understandably, considering exposure, the stocking in the open blocks was lower than under aspen, though not sufficiently to fall below the arbitrary 50 per cent standard except in the case of white pine. In average height growth, jack pine proved far superior to the other species both in the open and under cover. Scots pine came second. Growth of red and white pine, particularly in the open blocks, proved disappointing but the surviving stock had sufficient foliage to be considered promising.

1-0 stock was represented only by red and Scots pine, and only the latter showed promise. In both open and covered blocks it survived extremely well considering its frailty, and the height growth was fair.

EFFECTS OF INDIVIDUAL FACTORS

The practical results of the trials are now evident but it is also of interest to examine individually the major factors which influenced the course of germination and survival during the early critical years 1954 to 1956. Comparisons of survival in relation to the various factors are made between the two planting methods on the one hand, and the three seeding methods on the other. For the latter also, total germinaton is shown as a per cent of the total number of seeds sown.

Weather

Seasonal weather in its extreme fluctuations can be critical for both germination and early survival of pine seedlings, particularly on the outwash plain landtype which is thought of as having an extreme local climate, i.e., hot-by-day and cold-by-night. Moreover, the dry sands of this site make rainfall especially important. The precipitation data for the period May to September of the critical years 1954 to 1956 and the comparable 20-year average for the

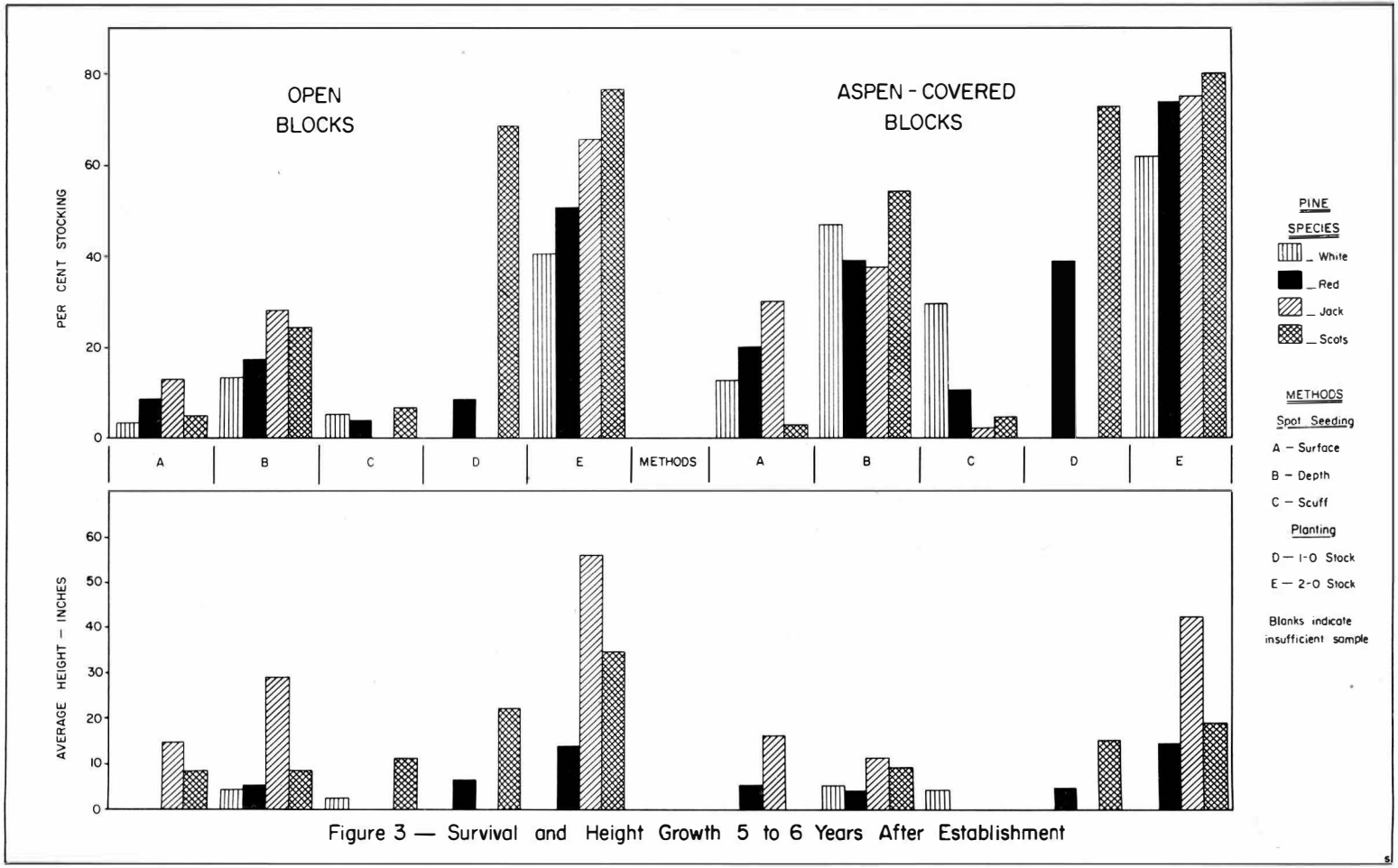


Figure 3 — Survival and Height Growth 5 to 6 Years After Establishment

Petawawa Forest Experiment Station (Table 1) show that the growing season of 1954, the first trial, was appreciably wetter than the average, whereas that of 1955 was much drier—in fact it was the driest in 50 years. 1956 was again wet. The effects of these yearly weather differences become evident in succeeding comparisons.

TABLE 1.—COMPARISON OF PRECIPITATION

	Average 1935–1954		1954		1955		1956	
	Total Precip.	Days with .01" +	Precip.	Days with .01" +	Precip.	Days with .01 "+	Precip.	Days with .01" +
May	2.60	9	3.73	13	0.94	11	4.81	12
June	3.39	12	7.16	15	1.11	6	2.21	9
July	3.11	11	3.07	12	3.32	8	6.45	15
August	3.20	9	3.06	13	2.52	10	7.33	14
September	3.06	10	5.12	16	0.92	6	1.78	12
5-month total	15.36	51	22.14	69	8.81	41	22.58	62

Cover

The contrast in cover conditions is evident in Figures 1 and 2. All open blocks were several chains from the nearest trees. All "covered" blocks were in uniform lightly-stocked aspen stands, about 40 years old and of low vigour.

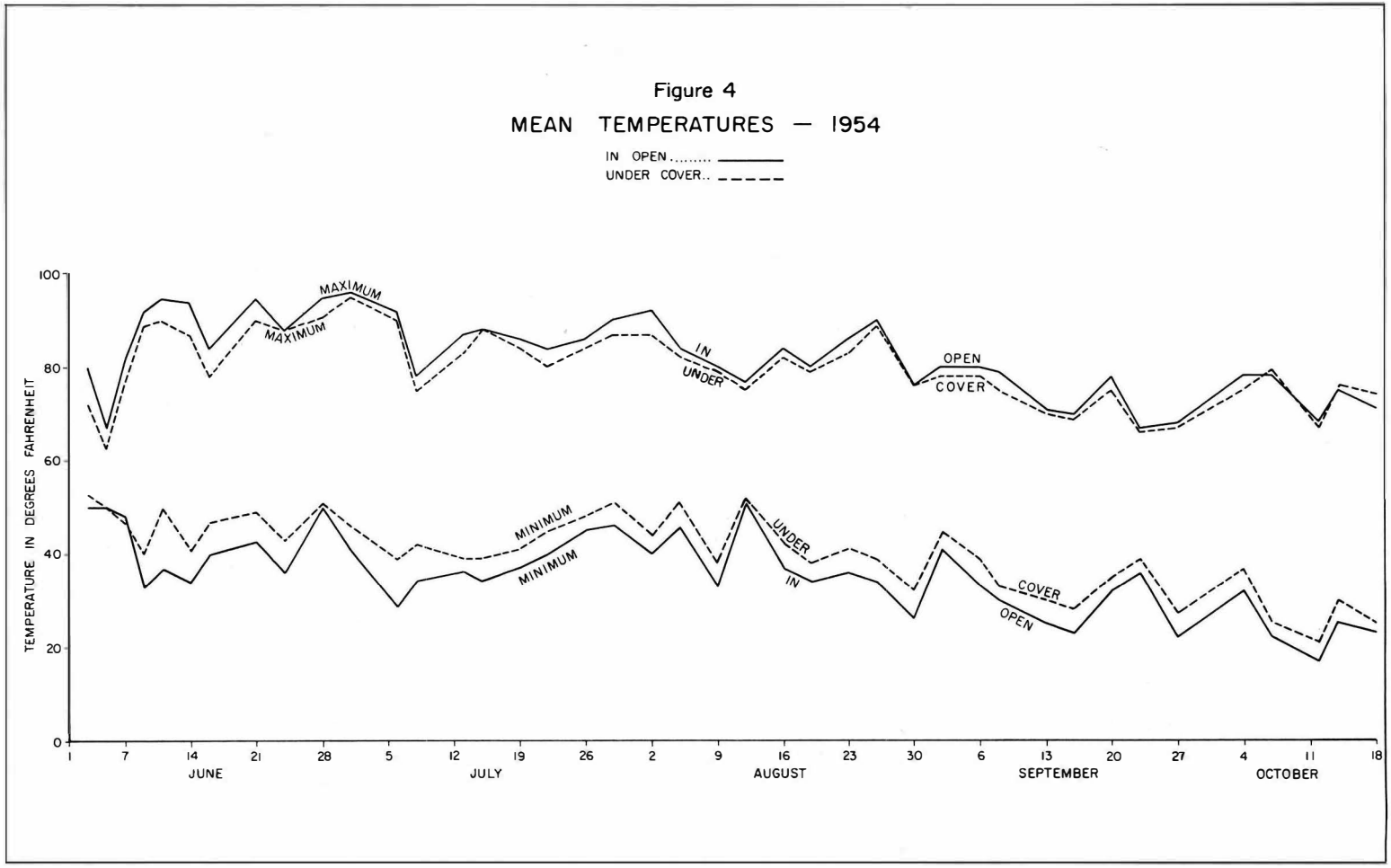
To obtain an objective comparison of the local climates, measurements of maximum-minimum temperatures and total evaporation were made regularly during the 1954 season in adjoining blocks representing both cover conditions. The average trends for each are shown in Figures 4 and 5 and, as one would expect, there are appreciable differences. Air temperatures one foot above ground are more moderate, especially the minima, and total evaporation throughout the season is considerably less under aspen cover than in the open. It must be remembered, too, that this was a particularly wet season; the differences would likely be much more pronounced in a relatively hot, dry year.

Seedling survival over the first three years in comparable open and covered blocks is given in Table 2. After the wet season of 1954 there were no significant differences between open and covered conditions but after the dry year of 1955 stocking was significantly higher under cover in all categories compared, and these differences carried over with minor changes to the end of 1956.

It is apparent that the protection of a canopy is particularly important to the survival of 1-0 planted stock (Method D) during a dry year. Losses in the open-growing 2-0 stock (Method E) were not great enough to reduce the stocking per cent below the acceptable standard. As to the seeding methods, which have been combined for convenient comparison, there was no significant difference in germination between open and cover. The percentage of stocked spots was barely acceptable after the 1954 season in both cover conditions. Survival was significantly better under cover than in the open after 1955 but was well below standard.

Figure 4

MEAN TEMPERATURES — 1954



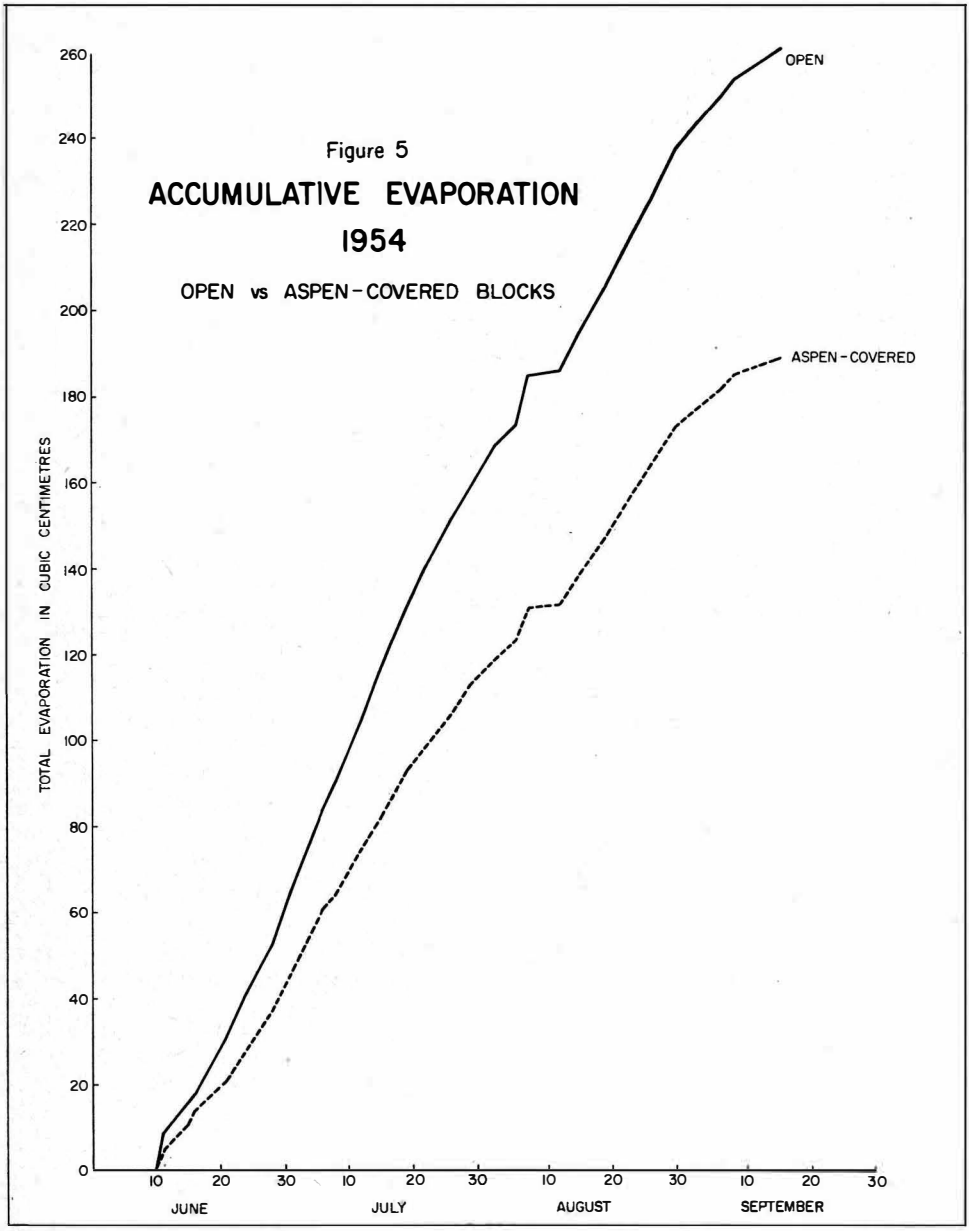


Figure 5
ACCUMULATIVE EVAPORATION
1954
OPEN vs ASPEN-COVERED BLOCKS
OPEN
ASPEN-COVERED
TOTAL EVAPORATION IN CUBIC CENTIMETRES
260
240
220
200
180
160
140
120
100
80
60
40
20
0
10
20
30
10
20
30
10
20
30
10
20
30
JUNE
JULY
AUGUST
SEPTEMBER

TABLE 2.—COMPARISON OF COVERED AND OPEN BLOCKS

Planting Methods

Season Planted	Method	Pine Species	No. Planted		Survival Percentage					
					Sept. 1954		Sept. 1955		Sept. 1956	
			Cover	Open	Cover	Open	Cover	Open	Cover	Open
Spring '54	D	red	339	365	89	82	67 **	17	54 **	14
	E	red, white	342	370	87	82	80 *	65	76 *	63
Fall '54 and Spring '55	D	red	133	131	—	—	76 **	24	61 **	21
	E	red, jack	128	121	—	—	96 *	81	88 *	76

Seeding Methods

Season Sown	Method	Pine Species	No. Seeds Sown and Germination Percentage		Percentage of Stocked Spots					
					Sept. 1954		Sept. 1955		Sept. 1956	
			Cover	Open	Cover	Open	Cover	Open	Cover	Open
Spring 1954	A, B and C	red, white	14,390 (18%)	15,120 (19%)	51 —	53 —	38 ** —	18 —	31 ** —	14 —
Fall '54 and Spring '55	A, B and C	red, white, jack	9,110 (31%)	8,960 (23%)	— —	— —	35 * —	17 —	26 —	16 —

* Differences significant.
** Differences highly significant.
Note—only 10 blocks were used.

Methods

For the comparison of methods tested the two cover conditions and certain species were combined as shown in Table 3.

The 2-0 planting stock has demonstrated a high survival rate over the three years, significantly greater than the 1-0 stock, which suffered particularly from the dry year, 1955.

Depth seeding (Method B) gave significantly better results than the other seeding methods but the stocking level was sub-standard after the first year. Though germination per cent in the spring of 1954 was as high in Method C (scuffed spots) as in B, the survival on a stocked spot basis was inadequate. It is evident that the spot method of seeding, even with a protective thin soil layer, is not suitable for survival in especially dry seasons.

Species

In this analysis, as given in Table 4, the two cover conditions were combined, and methods were arranged in comparable groups.

Considering the 1-0 planting stock, survival of the Scots pine planted after the 1954 season was higher than that of comparable red pine. There were no other species available for comparison with the red pine planted in the spring of 1954, but it is noteworthy that this stock did not survive the dry year 1955 successfully.

TABLE 3.—COMPARISON OF METHODS[1]

Planting Methods

Season Planted	Pine Species	No. Planted		Percentage Survival by Year and Method					
				Sept. 1954		Sept. 1955		Sept. 1956	
		D	E	D	E	D	E	D	E
Spring 1954	red	948	471	81 *	92	36 **	75	29 **	69
Fall 1954 and Spring 1955	red, Scots	390	235	—	—	55 *	83	36 *	74

Seeding Methods

Season Sown	Pine Species	No. Seeds Sown and Germination Percentage			Percentage of Stocked Spots by Year and Method								
					Sept. 1954			Sept. 1955			Sept. 1956		
		A	B	C	A	B	C	A	B	C	A	B	C
Spring '54	red, white	18,020 (5%) **	17,540 (28%)	4,365 (26%) [2] **	34**	80**	47	18**	44**	21	15**	35**	14
Fall '54 and Spring '55	red, white jack, Scots	10,800 (5%) **	10,940 (44%) **	5,450 (26%) [2] **	—	—	—	13**	43**	8	9**	38**	5

[1] For detailed description of methods see "Procedure".
[2] Significance between C and A in germination; none in stocking.
* Differences significant.
** Differences highly significant.

As to the 2-0 stock, survival of the red pine planted in spring, 1954, was significantly better for the first two years than in comparable white pine, but both remained above standard in stocking after three years. Differences in survival among the red, jack and Scots pine planted after the 1954 season were not significant; again the stocking level was high in each species.

In brief, it appears that in the 1-0 stock Scots pine shows promise but red pine does not. In the 2-0 stock, there are no practical differences among species.

For species comparisons in the three seeding methods, the field germination figures were adjusted for specific germinative capacity as tested artificially. The result shows no significant differences among species in germination during the first year. The only noteworthy difference between species in per cent stocking showed up in 1955, when the white pine survival was significantly lower than the jack pine. Delayed germination accounts for the inconsistency of this trend in 1956.

Season

To check the relative effects of spring and fall treatment, replications were carried out within six blocks in October 1954 and April 1955. Covered and open blocks were combined for analysis (Table 5). In each of the planting methods, survival rates were very similar for both seasons planted. Seeding methods A, B and C in all species were combined for this comparison and all seed involved was treated with red lead before sowing. No significant differences were evident between spring and fall sowings, either in germination or stocking after two years.

TABLE 4.—COMPARISON OF SPECIES

Planting Methods

Season Planted	Method	No. Planted	Pine Species	Survival Percentage		
				Sept. 1954	Sept. 1955	Sept. 1956
Spring '54	D	948	red	81	36	29
	E	471	red	91 **	75 *	68
		489	white	70	60	57
Fall '54 and Spring '55	D	297	red		33 *	25 *
		93	Scots		77	70
	E	145	red		80	68
		141	jack		82	76
		90	Scots		87	84

Seeding Methods

Season Sown	Method	No. Sown	Germination Percentage	Pine Species	Percentage of Stocked Spots		
					Sept. 1954	Sept. 1955	Sept. 1956
Spring 1954	A, B and C	26,995	22	red	56	31	25
		12,930	26	white	50	28	22
Fall '54 and Spring '55	A, B and C	6,950	24	red		22	15
		6,910	28	white		12	24
		6,850	29	jack		27 *	18
		6,480	32	Scots		22	16

* Differences significant.
** Differences highly significant.

TABLE 5.—COMPARISON OF SPRING AND FALL TRIALS

Method	Pine Species	No. Planted		Germination Percentage		Survival Percentage			
						Sept. 1955		Sept. 1956	
		Fall '54	Spring '55	Fall '54	Spring '55	Fall-Planted	Spring-Planted	Fall-Planted	Spring-Planted
Planting D	red, Scots	194	196	—	—	50	59	44	50
E	red, jack and Scots	189	187	—	—	81	85	75	77
Seeding A, B and C	red, white jack and Scots	9,050	9,120	21	28	14	22	13	19

Delayed Germination

It was found that there was a certain amount of germination delayed to the second or even third year after sowing. This occurred in all species, methods and seasons tested. It usually constituted less than one per cent of the total germination but in a few cases was appreciably higher. The tendency was most prevalent in white pine seed sown in early spring of the dry year 1955, of which almost 20 per cent germinated in the second year. If seeding were carried out later in a dry season, delayed germination might well be an important factor in influencing the results.

Seed Protection Treatment

In Table 6 the per cent germination and fall stocking of the 1954 season are shown for red and white pine in the three seeding methods. The data are from seven blocks in both cover conditions. Comparisons are possible between seed treated with red lead, untreated seed and screened seed.

TABLE 6.—COMPARISON OF SEED TREATMENT

Seed Treatment	Percentage of Seeds Germinated						Percentage of Spots Stocked—Sept. 1954					
	Method A		Method B		Method C		Method A		Method B		Method C	
	rP	wP	rP	wP	rP	wP	rP	wP	rP	wP	rP	wP
Treated with Red Lead	12	3	45	28	45	35	62	38	92	90	65	62
Untreated	3	1	25	15	17	19	29	16	79	67	35	43
Screened	85	41	85	60	75	53	100	89	100	100	97	85

An analysis of the differences of means of treated and untreated seed showed that the protective treatment with red lead led to significantly better germination per cent and stocking than no treatment in both species and all three methods. Except in Method A, surface sowing, germination of treated seed was more than sufficient for acceptable stocking in both red and white pine. Screening is not considered a practical method of seed protection but it does provide data on maximum protection useful for further comparison. Only depth sowing (Method B) with treated seed gave high stocking results approaching those of the screened spots.

CONCLUSIONS

Planting 1-0 and 2-0 Stock

Planting of 2-0 stock proved to be the best of all methods tested, generally giving a stocking of well over the 50 per cent considered acceptable. Planting of 1-0 stock proved promising with Scots pine but not with red pine. The nursery seedlings used in both methods were planted on small scarified spots but it is felt that this did not aid survival substantially, since minor vegetation quickly re-invaded or overgrew the spots. Careful planting may well have resulted in better-than-normal survival. 2-0 stock is recommended over 1-0 because it requires little additional expense to be produced, its survival and growth rate are superior, and it is better suited to machine-planting.

Spot Seeding Methods

While the overall stocking results of the three seeding methods tested were unacceptable, it is worth emphasizing that the year 1955 was exceptionally dry, so much so that it may be unrealistic to expect 50 per cent stocking. In any case, depth sowing in the aspen-covered blocks came close to this acceptable mark despite the drought, and therefore might well reach it in more favourable seasons. It is apparent that seeding on small scarified spots, particularly without supplementary protection, is not a reliable method. The small spots are susceptible to various adverse effects—they collect litter, they soon become overgrown by vegetation, they probably produce an extreme microclimate, and they encourage animal damage through the concentration of seed or seedlings. Larger scarified areas and wider broadcasting of seed would probably remedy these drawbacks.

Species Differences

In terms of survival there is little to choose among the four species tested. Within the three seeding methods there were no consistent specific differences of practical importance. The only appreciable difference within the planting methods was in the 1-0 stock where Scots pine proved much better than red pine in both cover conditions. White pine was somewhat inferior to the other three pines in the 2-0 stock category, particularly in the open blocks.

From the standpoint of height growth, jack pine was the best species both in the open and under cover, and in seeding as well as planting methods. All things considered, it appears that jack and Scots pine are best suited to these sand plains regardless of the cover condition. Under aspen cover the jack pine would in all likelihood require release at an early age if vigour were to be maintained. Red pine showed relatively poor growth in all categories. It happens that extensive plantings of 2-2 red pine stock were carried out 25 years previously in parts of this area, and growth rate, in the openings particularly, was observed to be reasonably acceptable. This suggests that the better-developed transplanted seedling stock is preferable over 2-0 stock for red pine on this site.

Effects of Seasonal Weather and Cover

Seasonal weather is an important factor, as witnessed by the high germination and survival rates for the relatively wet growing season of 1954 compared with the greatly reduced rates after the exceptionally dry 1955. This influence is probably emphasized on the dry, sandy outwash plains under consideration, the local climate of which is characterized by extreme fluctuations in diurnal temperature.

A canopy of aspen exerts a modifying effect on the local climate, and this was a distinct advantage for seedling survival during the dry year; however, mortality from leaf smothering may offset this advantage in other years.

The time of application, whether in early May or October, made no significant difference in germination or survival in any of these tests. There is, however, a possibility of a considerable amount of delayed germination if seeding is left until late in the spring, particularly in white pine seed and particularly in a dry year. Pre-treatment stratification of the seed and sowing as early as possible in the spring would minimize this tendency for delay.

Seed Protection Treatment

The treatment of seed with red lead evidently was effective in repelling rodents and birds in 1954, since the germination and survival rates were significantly higher in treated than in untreated seeds. This repellent effect could not be shown for the 1955 spring sowings, perhaps because of the exceptional dryness which made many seeds crack and wither, and also increased delayed

germination. At any rate the cost of the treatment was negligible—about five cents per pound of seed—so that it or some alternative chemical treatment is well worth employing as a likely seed protective measure.

At the seedling stage several faunal causes of mortality were observed. Some seedlings were killed by rodents, birds, grasshoppers and cutworms which ate various parts, particularly of the cotyledonous plants. Locally, a few seedspots were ruined by the scratchings of skunks and dusting partridges. Deer browsing also caused a limited amount of damage. There is no feasible protection against all of these damage agents, and they may as well be accepted as normal regeneration hazards.

SUMMARY

An experiment was established in Eastern Ontario in 1954 to compare five economical spot seeding and planting methods of regenerating pines on sandy outwash sites in contrasting open heath and aspen-covered areas.

Planting of 2-0 stock of white, red, jack and Scots pine proved the best method, giving high survival rates. Planting of 1-0 stock was promising for Scots pine. Three spot-seeding methods tested were generally unsuccessful, although depth-sowing ($\frac{1}{4}$") on small scarified spots showed some promise under a light aspen canopy.

Jack pine showed the best height growth both in openings and under cover; growth of red and white pine was discouraging.

Seasonal weather influenced the results, with an exceptionally dry season greatly reducing survival. This effect was modified under the aspen cover. The dryness seemed to delay germination, particularly in white pine seed.

There were no significant differences between comparable spring and fall tests.

Treatment of seed with red lead, by repelling rodents and birds, improved the germination per cent at little cost.

RÉCAPITULATION

En 1954, une étude a été entreprise dans l'est de l'Ontario dans le but de comparer cinq méthodes économiques de semis par places et de plantation pour la régénération du pin en stations sableuses de délavage dans des régions contrastantes de landes à découvert et de peuplements de peuplier faux-tremble.

La plantation de sujets de 2-0 ans de pin blanc, de pin rouge, de pin gris et de pin sylvestre s'est montrée la meilleure, car elle a donné des taux élevés de survivance. La plantation de sujets de 1-0 an s'est montrée prometteuse dans le cas du pin sylvestre. Trois méthodes de semis par places mises à l'étude se sont montrées infructueuses de façon générale, même si l'ensemencement en profondeur ($\frac{1}{4}$ de pouce) dans de petites places scarifiées a connu un certain succès sous une faible voûte foliacée de peuplier faux-tremble.

Le pin gris a donné la meilleure croissance en hauteur, tant dans les clairières que dans les endroits couverts; la croissance du pin rouge et du pin blanc n'a pas été encourageante.

Les conditions météorologiques saisonnières ont influé sur les résultats, car une saison exceptionnellement sèche réduit de beaucoup la survivance. Cet effet est moins marqué cependant sous un couvert de peuplier faux-tremble. La sécheresse a semblé retarder la germination, en particulier celle des graines de pin blanc.

Il n'y a pas eu de différences importantes dans les résultats des essais comparables effectués au printemps ou à l'automne.

L'enrobage des graines avec du minium éloigne les rongeurs et les oiseaux et, par suite, améliore à peu de frais le pourcentage de germination.