They occurred in clumps or bands rather than as exceptionally tall individuals which stood out above their immediate neighbors.

Between fall 1951 and fall 1958, 323 superseedlings were selected from over 80 million seedlings produced at the nursery. Selections of each species were made over consecutive five-year periods — 210 loblolly from 1951 to 1955, 45 shortleaf from 1953 to 1957, and 68 white pine from 1954 to 1958.

The test plantation is located at the nursery. Control and superseedlings were planted alternately in each row and spaced eight feet apart. Height measurements were recorded at yearly intervals; diameter was obtained annually for loblolly and white pine selections after the fourth growing season, shortleaf after the fifth year.

Results

Sixty-nine percent of the superseedlings and their corresponding controls planted during the period 1951 to 1958 survive. Two-thirds of the superseedlings continue to outgrow controls in height and more than three-fourths are outgrowing controls in diameter *(Table 1)*. Percentage of superseedlings growing faster than controls in height averages 59 for loblolly, 55 for shortleaf and 89 for white pine. Percentage of selected trees exceeding controls in diameter averages 75 for loblolly, 65 for shortleaf, and 96 for white pine.

A chi-square test on number of superseedlings outgrowing controls at time of last measurement showed the selection method was effective for lololly pine when judged on the basis of diameter and for white pine when judged by either height or diameter. The method was not effective for loblolly height nor shortleaf height or diameter. The test was based on the null hypothesis that the ratio of superseedlings outgrowing controls to superseedlings growing less than controls would be 1 : 1. A chi-square test on number of superseedlings surpassing controls in terms of relative volume or D^2H, where D is diameter in inches at breast height and H is height in feet, showed significance for all three species. Thus when relative volume of the selections is considered the number outgrowing controls is significantly greater than would be expected due to chance alone.

Table 1. — Survival, Height and Diameter Growth of Super and Control Seedlings.

Year selected	Years observed	Surviving pairs	Pairs in which supers outgrew controls in: Height	Diameter	Height: Supers	Controls	Diameter breast high of: Supers	Controls
	No.	No.	No.	No.	Ft.	Ft.	In.	In.
			Loblolly Pine					
1951	10	19	9	11	30.7	30.1	6.1	5.6
1952	9	3	3	3	30.1	24.8	5.6	5.1
1953	8	22	14	21	26.8	25.1	6.0	5.1
1954	6	62	34	41	19.7	18.5	4.6	4.0
1955	5	39	25	33	15.3	14.0	3.4	2.9
			Shortleaf Pine					
1953	10	3	2	2	24.5	22.7	5.7	4.8
1954	9	5	4	4	21.3	18.6	4.4	3.8
1955	8	8	5	6	19.6	18.1	4.1	3.7
1956	7	4	0	2	14.6	16.5	2.8	2.3
1957	6	11	6	6	13.6	11.2	2.4	2.1
			White Pine					
1954	9	7	6	6	19.3	15.7	4.3	2.6
1955	8	7	6	6	18.5	15.0	3.6	2.7
1956	7	3	3	3	15.7	11.2	2.9	1.6
1957	6	13	12	13	13.3	9.8	2.2	1.4
1958	5	17	15	17	10.9	7.8	1.7	0.9

Actual growth differences between each surviving superseedling and its paired control were examined for each successive year of growth — from time of planting to the last measurement year. Growth was compared by grouping trees into age classes regardless of the year of planting. Number of trees varied by age classes with maximum frequency in the younger classes. For example, with loblolly selections there were 176 surviving pairs with one year of record and only 19 pairs with ten years.

Before analyzing height data, tree heights were adjusted by subtracting planted heights from each seedling. Analysis of growth was by Students "t" test on paired differences since only two treatments — superseedlings vs. controls — were involved. The "t" test showed that the select trees had made significantly greater height growth than the controls. For loblolly, differences in height growth were significant at the 1 percent level of probability through 6 years, and at the 5 percent level at 7 years. Differences were nonsignificant in the 8 to 10 year age group but number of trees in these classes were limited. For shortleaf, differences in height were significant at the 1 percent level through 6 years and at 5 percent for years 7 through 9. Height growth differences for white pine were the most consistent of all. Differences continued to be significant at the 1 percent level through 8 years. There were only 7 pairs in the 9-year class.

A further evaluation of height growth of superseedlings and their controls was made by grouping trees into height classes, converting their frequency distributions to cumulative percentages and plotting them on probability paper. Lines of the plotted percentages permit ready comparison on the percent of trees in each group that grew more than or equal to the average. Loblolly data is for 154 seedling pairs after 5 growing seasons *(Figure 1)*. Total height averaged 15.4 feet for superseedlings and 13.8 feet for controls. While 68 percent of the loblolly superseedlings grew taller than the average control only 12 percent of the controls were taller than the average superseedling. Similar comparison of 39 pairs of shortleaf seedlings (at 5 years) showed 71 percent of the superseedlings outgrowing the 9.1-foot-high average control and only 10 percent of the controls taller than the 10.7-foot average superseedling *(Figure 2)*. For 47 pairs of 5-year-old white pine seedlings, supers averaged 9.6 feet and controls 6.7 feet *(Figure 3)*. Among these, 92 percent of the superseedlings grew taller than the average control and only 0.8 percent of the controls exceeded the average superseedling in height.

In general, superseedlings outgrowing controls in height also outgrew controls in diameter at breast height. In only a few instances did a superseedling have a diameter less than its shorter control. The rapid growth characteristics of selected trees are reflected in relative volume measurements — expressed as units of D^2H. Superiority of the superseedlings is illustrated for loblolly pine *(Figure 4)*, shortleaf *(Figure 5)*, and white pine *(Figure 6)*. A "t" test of volume differences between paired controls showed significance at the one percent level through 8 years for all three species. There were not enough trees in the older age classes for a good test of statistical reliability.

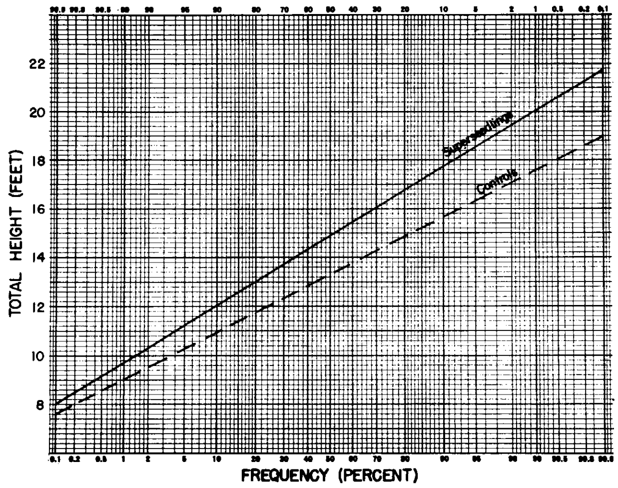

Figure 1. — Frequency distribution of heights of 154 pairs of loblolly pine at age 5 years.

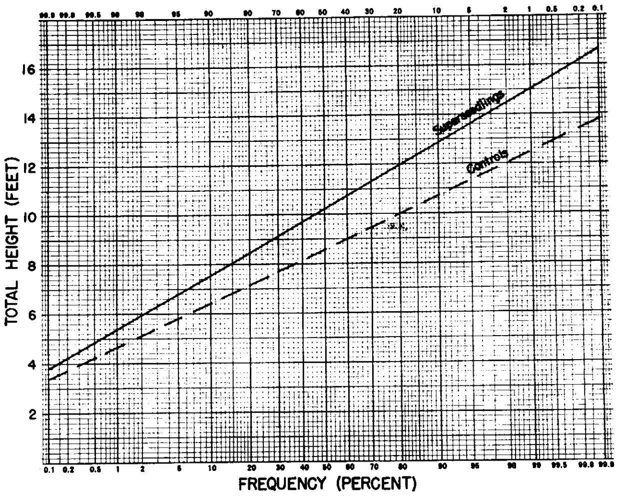

Figure 2. — Frequency distribution of heights of 39 pairs of shortleaf pine at age 5 years.

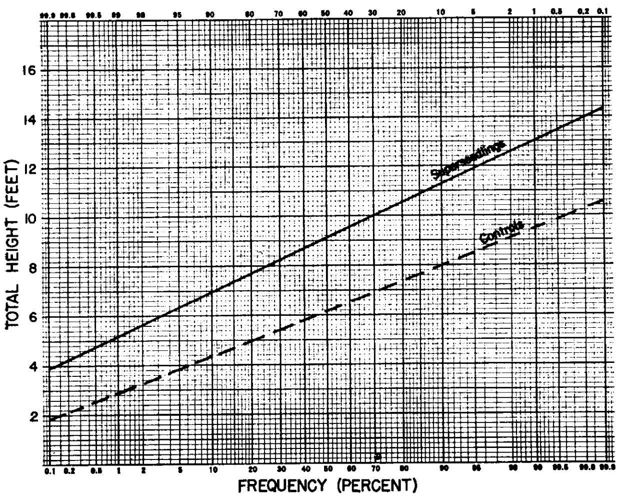

Figure 3. — Frequency distribution of heights of 47 pairs of white pine at age 5 years.

Discussion

Mortality

Plantation mortality has been about the same as that encountered in reforestation plantings in the region. First-year mortality of select seedlings totalled 9 percent. An additional loss of paired seedlings due to mortality among the controls amounted to 7 percent. Snow storms and other damage in the later life of the plantation caused an 11 percent loss. Four percent of the shortleaf superseedlings were not considered in this analysis because they did not appear typical of the species. A few give indications of being hybrids between loblolly and shortleaf pine, and observations on their future development will be continued.

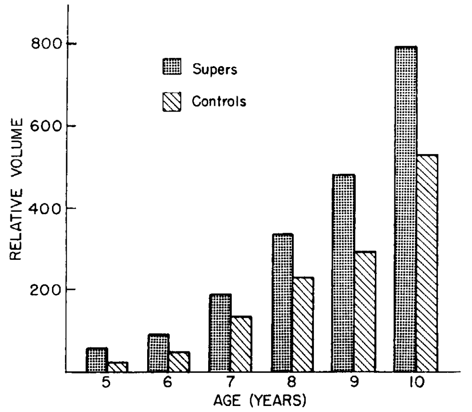

Figure 4. — Relative volumes of loblolly superseedlings and their controls by age classes (relative volume expressed as D^2H where D is DBH in inches and H is height in feet).

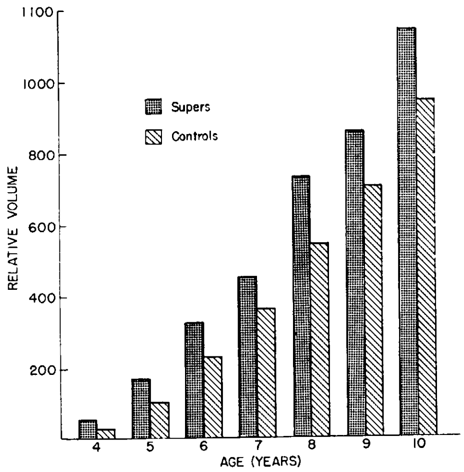

Figure 5. — Relative volumes of shortleaf pine superseedlings and their controls by age classes.

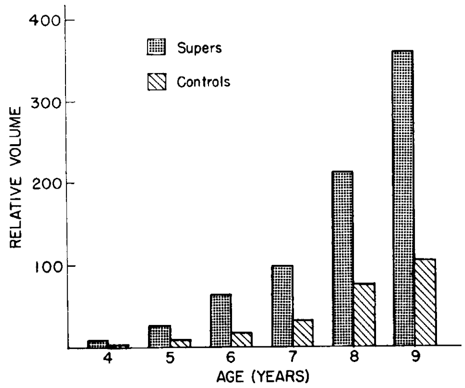

Figure 6. — Relative volumes of white pine superseedlings and their controls by age classes.

Plantation Damage

Form of many trees in the loblolly plantation was adversely affected by snow and ice damage and Nantucket pine tip moth (*Rhyacionia frustrana* Comst.) injury.

Greatest cause of damage was from snow storms. Heavy snows occurred in 1954, 1956, 1960 and later years. Nearly 50 inches fell in 1960 with three storms of 10 inches each. After the first 10-inch snow in January 1960, 35 percent of the loblolly superseedlings were bent 45° or more and one-fifth of these had over ¼ of their crowns broken out. Surprisingly, controls suffered the same kind and amount of damage. Many of the trees later returned to an upright position but the stems of some trees are now crooked.

On the plus side, 24 percent of the rapid growing loblolly superseedlings maintained a straight central stem to a top diameter of 1 to 1-½ inches, indicating a high resistance to snow and ice. Thirty-one percent of the controls remained undamaged. They have shorter and smaller branches than the more vigorous superseedlings.

Shortleaf pine superseedlings suffered moderately from snow; heaviest loss occurred in early 1963 when four of eight 1956 selections were badly bent and had to be removed. White pine was not affected.

Tip moth attacks contributed to forking and poor crown form. Observations in the fourth year showed tip moth had infested terminal buds of 30 percent of the superseedlings and 17 percent of the controls; injury diminished as the plantation grew taller.

Feasibility of method

After ten years of observation there is strong evidence that mass selection at the nursery stage is a feasible method for locating exceptionally fast-growing trees. Growth differences between superseedlings and their controls have been maintained beyond the point where early rapid growth associated with juvenile vigor and seed size show effect. This is especially true for the older trees.

While the overall value of nursery selection is assessed on the basis of averages, the work plan also provided for evaluating the performance of individual superseedlings. Control seedlings provide the measure in their standard deviation. Difference in height between each superseedling and its control was measured in terms of the standard deviation of all controls. An examination of 6-year growth differences on 109 paired selections of loblolly, 36 shortleaf and 30 white pine showed the number of trees exceeding the average height of controls by 1, 2, and 3 standard deviations as follows:

Species	Treatment	1s	2s	3s
Loblolly	Superseedlings	27	3	1
	Controls	11	1	0
Shortleaf	Superseedlings	8	1	1
	Controls	1	0	0
E. white	Superseedlings	23	12	2
	Controls	0	0	0

One superseedling each of loblolly and shortleaf pine and two white pine exceeded the average by 3 standard deviations. This required a height difference of 7.2 feet for loblolly, 8.3 feet for shortleaf and 6.4 feet for white pine.

The growth of trees in the test plantation, both superseedlings and controls, greatly exceeds the average growth of trees in Tennessee Valley reforestation plantings. While this is largely a matter of site, it indicates that conditions have been generally favorable for testing the development of the superseedlings. A few selections appeared promising enough at 5 years to justify increasing their number by grafting. In 1956 four loblolly superseedlings showing one or a combination of desirable traits were propagated for a clone bank and seed orchard. Ramets of two have produced female strobili although original trees in the test plantation have not. The two flowering selections were crossed with superior pines in the regular seed orchard program and first seed for a progeny test has been collected.

Figure 7. — Difference in height between white pine superseedling at left and its control, right, was 4.0 feet after 6 years. The superseedling exceeded control in diameter by 1.0 inches.

White pine superseedlings were selected as 2-0 stock. The percent of seedlings outgrowing controls was also highest for white pine (*Figure 7*), which may indicate that selecting seedlings at 2 years is more meaningful in terms of identifying outstanding trees. While it is not possible to select loblolly and shortleaf from seedbeds at 2 years, some further selection in the plantation is possible. As a followup, the two-year height of each tree in the test plantation was examined and the best ten percent of the loblolly and best 20 percent of shortleaf and white pine were identified. Their age-height relationships were then compared with that of all supers and all controls. The best 10 percent of the loblolly and 20 percent of the shortleaf stand out considerably above the average superseedlings throughout the life of the plantation. It suggests early selection in the plantation has value in isolating outstanding trees. The potential improvement will be greatest with selected or elite progeny. With white pine the best 20 percent is only slightly higher than for all supers, which demonstrates the validity of the initial selection.

Seedbed selection is an inexpensive method for locating individuals with natural superiority in growth rate. Selected trees may exhibit other traits that can be detected at an early date to provide a broader genetic base for a breeding program. Results suggest greatest gain might be achieved if this technique were applied to (1) select seedling lots from seed production areas, seed orchards, and open- and cross-pollinated progeny from superior parent trees; and

(2) detection of outstanding trees in select test plantings after two years in field plantings.

Summary

Up to 10 years' growth records are now available on outplanted loblolly, shortleaf and eastern white pine superseedlings selected between 1951 and 1958 from uniform nursery seedbeds at TVA's Clinton Nursery. Purpose was to find out how these superseedlings would develop as compared with the mass of bed-run seedlings and evaluate nursery selection as a way of discovering genetically superior individuals. Sixty-nine percent of the superseedlings and their corresponding controls survive. In measurements up to 10 years, 65 percent of the selections maintained greater height and 78 percent greater diameter and relative volume than their controls. The number of superseedlings outgrowing controls in relative volume was significantly greater than expected by chance in all three species.

Growth of the best individuals of each species exceeded controls by more than 3 times the standard deviation of the control mean and will be propagated for progeny testing. Nursery bed selection shows promise as an economical and effective means of developing improved strains of pine.

Résumé

Titre de l'article: *Comportement des «super-plants» de Pinus taeda, Pinus echinata et Pinus strobus.*

Des «super-plants» de ces trois espèces ont été sélectionnés entre 1951 et 1958 dans des planches de pépinières homogènes à la Clinton Nursery de la TVA; on dispose maintenant des données à l'âge de 10 ans. Le but poursuivi était de voir comment ces «super-plants» se développaient par rapport à la masse des plants normaux et d'évaluer l'intérêt de la sélection en pépinière comme moyen de découvrir des individus génétiquement supérieurs. Soixante neuf de ces «super-plants» et leurs témoins correspondants ont survécu. Dans les mesures jusqu'à 10 ans, 65% des plants sélectionnés ont conservé leur avance en hauteur et 78% leur avance en diamètre et en volume. Le nombre des «super-plants» dépassant les témoins en volume est significativement supérieur à ce qu'on peut attendre par le simple jeu du hasard pour chacune des trois espèces.

La croissance des meilleurs individus dépasse les témoins de plus de 3 écarts-types de la moyenne des témoins; ils seront utilisés pour des tests de descendance. La sélection en pépinière apparaît ainsi comme un moyen économique et efficace de l'amélioration des pins.

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Über eine spontane Knospenmutation bei Populus alba var. pyramidalis Bge.

Von ENRIQUE MARCET

Institut für Waldbau der Eidg. Techn. Hochschule, Zürich

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Im Sommer 1962 ist im Pappelversuchsgarten „Glanzenberg" der ETH an einem fastigiaten Weißpappelklon spontan eine mutative Farbveränderung der Blätter aufgetreten. Da unseres Wissens bei *Populus alba* L. bisher nie eine derartige Blattmutante bekannt geworden ist, soll im folgenden kurz darüber berichtet werden.

Im Frühjahr 1957 erhielten wir von der Research Branch der Forestry Commission 10 Stecklinge eines Weißpappelklones aus der Pappelkollektion von Alice Holt Lodge. In der 1955 von dieser Institution herausgegebenen Pappel-Sortenliste ist der fragliche Klon als *Populus alba „bolleana H"* aufgeführt. Alice Holt Lodge hat ihn seinerseits 1954 von der Baumschule Hillier and Sons in Winchester erworben. Es handelt sich dabei um eine mäßig wüchsige, fastigiate Weißpappel mit tief gebuchteten, sowie schmal und spitz gelappten Langtriebblättern. Von den 10 erhaltenen Stecklingen haben sich 1957 in unserem Pappelversuchsgarten 5 bewurzelt. Unter der internen Bezeichnung '20.99'