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Moderator, A. D. Folweiler

9. STATUS OF THE SUPER-SEEDLING STUDY AT TVA'S CLINTON FOREST NURSERY--FALL 1954

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In 1951 Tennessee Valley Authority began selecting unusually tall seedlings from seedbeds in its forest nursery at Clinton, Tennessee. Our intent is to follow the development of these super-seedlings to see whether some turn out to be exceptionally fast growing strains which can be used in breeding work and as a source of seed for improved forest nursery planting stock. So far, 174 loblolly, shortleaf and white pines have been selected. But the study is not old enough yet to provide significant or conclusive results.

The purpose of this report is to outline briefly the background of the study, describe how we make the selections, and relate what our experience has been to date.

Basis of Super-Seedling Study

Selection of exceptionally tall individuals from nursery seedbeds is an empirical approach, and it is one of several lines of attack used in an effort to improve the quality of forest planting stock. Seed source tests, now being conducted on a wide scale, will provide information on seed collection areas as related to planting sites. The location and special handling of good quality stands for select seed production should yield almost immediate benefits. Selection of outstanding individual trees for vegetative propagation and cross-pollination with other superior selections will build up a core of select plant material for ultimate large scale production of high quality seed. These selections are ordinarily sought in the woods where one has the advantage of observing fully developed trees. The principal advantage of nursery selection is its convenience and low cost. While we expect that a number of the apparently superior seedlings later will prove to be run-of-the-mill stock, the method is still worthwhile if only a few of the selections actually prove to be superior in growth or quality.

Although modern nursery practice has developed to a point where huge quantities of relatively uniform planting stock are produced each year, exceptionally tall individuals occasionally appear in the seedbeds. These oversize seedlings may result from any of several causes so they must be watched for several years before the inherently vigorous can be distinguished from the rest.

The possibility of exerting a positive influence on the production of future forests by nursery selection has been pointed out by Lindquist (5). Sherry (9), working with the longleaf pine in South Africa, selected the largest seedlings on planting trays and established two test plots, one containing vigorous and the other average or normal seedlings. After five years over 70 percent of the trees on the vigorous plot exceeded 20 feet while none in the normal plot had yet attained this height.

Hybrid vigor, seed size, and local variations in seedbed fertility are sometimes responsible for unusual seedling size. In Sherry's case some of the vigorous trees proved to be hybrids, although after five years seven true longleaf pines were as vigorous as the best of the hybrids. Aldrich-Blake (1 , 2), working with Corsican pine, and Gast (4) and Mitchell (6, 7), working with Scots and white pine, observed a direct relationship between seed weight and the weight of seedlings at the end of the first growing season. However, the difference in seedling size associated with original size of seed gradually wears off. Both Spurr (10) and Righter (8) observed that the effect of seed size on seedling size was at first pronounced but that it later diminished in contrast with the sustained effect of other factors associated with seed origin. Older studies reviewed by Baldwin (3) and the Forest Service, U. S. Department of Agriculture (12) indicate that seed size may affect the growth of pine up to the ninth year after planting. Tall seedlings resulting from local differences in seedbed fertility are distinguished from other super-seedlings in that they occur in clumps or bands rather than as exceptionally tall individuals that stand out above their immediate neighbors in the seedbed.

In spite of the fact that inherent vigor cannot be distinguished until after several years, it appears worthwhile to try nursery selection on a systematic basis. The purpose of the super-seedling study is to determine whether or not nursery selection is a practical method of segregating exceptionally vigorous strains of forest trees. Present plans call for continuing the selection of loblolly, shortleaf and white pine over a five year period, and following the development of these trees in arboretums during the succeeding five years, after which genetic differences ought to become discernable.

Selection of Super-Seedlings

Selection is made on the basis of height and is done in the fall immediately before lifting (13). Seedlings showing the greatest superiority over the average of adjacent seedlings are designated as super-seedlings. First, a general reconnaissance locates exceptionally tall seedlings. These are marked and measured, along with the heights of 25 adjacent seedlings. The average of each 25-seedling sample is then computed and subtracted from the height of its corresponding tall seedling. Those with the greatest difference, chosen at a rate of roughly one for every 200,000 seedlings 1/ in the seedbed, are considered super-seedlings and are transplanted to the arboretum. Each super-seedling is paired with a control or check seedling taken from the same spot in the seedbed and having approximately the computed average height of the 25-seedling sample.

During the past four seasons approximately 40 million loblolly, shortleaf, and white pine seedlings have been examined. From this number, we have selected 174 super-seedlings (Table 1). Since different seed lots handled in the nursery are kept separate throughout the various operations, the geographic origin of each super-seedling and control is known.

Preliminary Results

The most striking thing about the super-seedling plantation so far is the height variation that already exists in the older trees. Some of the super-seedlings have consistently outgrown their controls (Table 2). In one instance the ratio is almost two to one (Table 3). In other cases, super-seedlings have grown about the same or even slower than their controls.

In the case of the 2-0 white pine planting stock, tall seedlings occurred less often than in the other species and the final selections ran at a rate of about one for every 425,000 seedlings.

Table 1. Super-Seedling Selections of Loblolly, Shortleaf and White Pine from Seedbeds in Clinton Forest Nursery, 1951- 1954

Species	Year	Number of Seed Sources	Number of Seedlings	
			Examined	Selected
Loblolly pine	1951	2	6,412,000	33
	1952	3	3,595,000	18
	1953	5	6,289,000	30
	1954	9	16,265,000	78
	Total	19	32,561,000	159
Shortleaf pine	1953	3	2,300,000	10
	1954	1	1,735,000	6
	Total	4	4,035,000	16
White pine	1954	3	3,758,000	9
All species	All	-	40,354,000	174

Table 2. Survival and Relative Growth Performance of Super-Seedling Selections

Year selected	Number of super-seedlings--1954			Number of seedlings originally selected
	Dead	Growing		
		Slower than controls	Faster than controls	
		Loblolly pine		
1951	6	15	12	33
1952	9	3	6	18
1953	1	8	21	30
1954	-	-	-	78
		Shortleaf pine		
1953	0	2	8	10
1954	-	-	-	6
		White pine		
1954	-	-	-	9

Table 3. Total Height of Super-Seedlings and Corresponding Paired Controls Measured at One-year Intervals

Year measured	Average total height of seedling, feet				Total height of best seedling, feet	
	All--1:200,000		Best fifth--1:million			
	Super	Control	Super	Control	Super	Control
			Loblolly Pine--1951 Selections			
1951	1.3	0.6	1.1	0.5	0.9	0.4
1952	1.7	1.2	2.0	.9	2.5	.9
1953	3.5	2.8	4.1	2.5	4.7	2.5
1954	6.2	5.4	7.3	4.7	8.8	4.7
			Loblolly Pine--1952 Selections			
1952	1.3	0.6	1.2	0.8	1.4	0.8
1953	2.1	1.2	2.1	1.2	2.0	1.3
1954	3.7	2.7	4.1	2.6	4.5	2.6
			Loblolly Pine--1953 Selections			
1953	1.3	0.5	1.2	0.5	1.1	0.4
1954	2.6	1.5	2.7	1.2	3.0	1.3
			Loblolly Pine--1954 Selections			
1954	1.3	0.5	-	-	-	-
			Shortleaf Pine--1953 Selections			
1953	1.0	0.4	1.1	0.5	1.0	0.4
1954	2.2	1.2	2.6	1.2	2.1	.8
			Shortleaf Pine--1954 Selections			
1954	1.2	0.5	-	-	-	-
			White Pine--1954 Selections			
1954	1.4	0.6	-	-	-	-

For example, 12 of the 27 surviving 1951 selections have continued to grow faster than the controls. The most vigorous trees of this group, representing roughly one of every million seedlings examined, average 7.3 feet in height in contrast to 4.7 feet for their paired controls. When all fast and slow growing selections are combined, super-seedlings average 6.2 feet and controls 5.4 feet. Similar groupings and height differences are also evident in the newer selections, though less

pronounced. Comparisons among the different super-seedlings are made on the basis of differences in height that existed between each seedling and the corresponding control at the end of the 1954 growing season. While the average difference was 0.8 foot for all 1951 selections, it was 2.6 feet for the best fifth and 4.1 feet for the best single selection. It is interesting to note that this tree did not stand out from the rest the first year, being only 0.9 foot in contrast with the average height of 1.3 feet for all super-seedlings. The same thing was observed in a number of other instances, as is evident in the data presented in Table 3.

The relatively high proportion of super-seedlings outgrown by their controls may be explained in part by the fact that the seed was not screened and kept distinct by size grades. In all probability a number of the paired selections were merely plants which happened to originate from an unusually large and an average size seed. This variation could be reduced in the future by screening all of the seed into two or three size groups. As a matter of fact, Zobel (11), in a similar study in Texas, is using seed graded to size in an effort to eliminate as many variables as possible.

Indications based on a casual inspection of the super-seedling arboretums are that we have not picked up any hybrids so far which might account for some of the vigorous growth. However, this aspect will be investigated more thoroughly when the super-seedlings get their first critical evaluation.

Future Plans

At the end of five years, the fifth-year height increment will be used to evaluate the super-seedlings. The difference between each super-seedling and its paired control, measured in terms of the standard deviation of all controls, will be assigned a rating on the basis of probability: 0 for greater than 0.1, 1 for less than 0.1, 2 for less than 0.01, 3 for less than 0.001, etc, At the same time we will obtain information on the chromosome number of each promising super-seedling.

Plans for continuing the study call for re-evaluations and thinnings at intervals of five years. Beginning the tenth year, super-seedlings with a rating of less than 2 and controls that are poorer than average by a probability of less than 0.01 will be removed. Checks threatening to interfere with the growth of super-seedlings rated 3 or better will also be removed.

As time goes on we may be able to improve our selection techniques. Certainly, in time we should have the evidence to show whether nursery selection is a feasible approach to the discovery of genetically fast-growing strains of forest trees.

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