

PROGRESS IN NURSERY SELECTION OF LOBLOLLY, SHORTLEAF AND  
WHITE PINE SUPER-SEEDLINGS

by

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The selection of exceptionally tall individual pine seedlings from uniform seedbeds in the TVA Forest Nursery at Clinton, Tennessee, is now in its sixth year. The purpose of this project is to determine whether nursery selection is a feasible method of discovering genetically superior strains of forest trees. All "super-seedlings" are outplanted and kept under observation. Those continuing to show superiority will be preserved for propagation, breeding and seed production purposes. Since the last report on this study<sup>1/</sup> additional loblolly, shortleaf and white pine super-seedlings have been selected and annual remeasurements of older trees in the arboretum have been made. Some of the original super-seedlings of each species have continued to outgrow the controls. So far, comparisons have been made primarily on the basis of height growth, but ultimately other criteria such as form, branching habits, wood quality and resistance to disease and insect attack must also be taken into account.

Methods

Selection of 1-0 loblolly and shortleaf pine and 2-0 white pine seedlings was continued on the same basis as originally planned,<sup>2/</sup> Exceptionally tall seedlings were first tagged and their heights measured along with the heights of the 25 seedlings nearest each of the marked trees in the seedbeds, The average of each 25-seedling sample was computed and subtracted from the height of the corresponding tall seedling. Those with the greatest differences were chosen at a maximum rate of one out of every 200,000 seedlings in the seedbed and transplanted to the arboretum At the same time, control seedlings were selected--one from each 25-seedling sample and of approximately the same height as the computed average.

The study provides for selecting super-seedlings of each species over a five-year period. The last loblolly pine selections were made a year ago; the shortleaf pine will be completed next year; and the white pine, in 1958. So far, roughly 70,000,000 seedlings have been examined and 235 selections have been made (Table 1).

<sup>1/</sup> Ellertsen, Birger W, 1955. Selection of Pine Super-seedlings--an Exploratory Study. Forest Science 1 (2): 111-114.

<sup>2/</sup> Wieseheugel, E. G. 1952. Testing Tree Progeny and Appendix to Testing Tree Progeny. TVA Div. Forestry Relations, Technical Note 14.

The super-seedling arboretum is located at the TVA Forest Nursery in Clinton, Tennessee. The control- and super-seedlings are planted alternately in each row and are spaced eight feet apart. Height measurements are recorded at yearly intervals and special observations whenever unusual developments occur. For example, snow storms in late 1954 and early 1956 caused considerable damage in the plantation. Individual tree observations were recorded concerning the extent of damage and subsequent recovery. More recently, tip moth has become prevalent and appropriate records are being made.

No control or corrective measures have been taken to minimize the injury caused by various natural agents. For example, some of the tip moth damage could have been prevented by spraying or corrected by early pruning of multiple leaders. Snow damage could have been lessened by knocking heavy snow accumulations off the bent-over trees and propping up those which did not straighten up at once. The trees are permitted to develop without special attention on the premise that individuals subjected to a multiple selection process will be best suited for early propagation of seed orchard planting stock. At the same time, these trees along with others that have excelled only in certain respects will be available for cross-breeding purposes.

Last year a start was made in propagating additional stock of individual trees which have exhibited one or a combination of desirable characteristics.

#### Results and Discussion

Eighty-six percent of the super-seedlings planted during 1951 to 1955 are still alive (Table 1). Of this number, roughly five out of every eight have continued to outgrow the controls (Tables 2 and 3).

There are now ten groups of loblolly, shortleaf and white pine super-seedlings which have been in the arboretum for one or more years. In only two instances did the tallest super-seedling of a group immediately after planting maintain its relative height superiority in succeeding years. On the other hand, super-seedlings that outgrew the rest and became the tallest of their respective groups during the first growing season after outplanting generally maintained this relative height position in succeeding years. For example, loblolly pine super-seedling No. 11 selected in fall 1951 was surpassed by several others at the start. Yet it grew to be the tallest of the group the following year. It was still the tallest four years later in fall 1956 even though its terminal bud had been killed by tip moth in the intervening period and it now has a forked top.

Among the loblolly pine, tree No. 11 selected in 1951 so far has exhibited the fastest growth rate--16.6 feet in six years. Shortleaf pine No. 7 which grew 8.4 feet in four years and white pine No. 8 which grew 3.9 feet in three years are the outstanding selections of these species. These trees not only surpassed the heights of the control seedlings, but also the average heights of trees measured in plantations throughout the Tennessee Valley.

However, height is not the only criterion that can be used in evaluating the seedlings. Differences in branching habits are showing up. Some trees, particularly among the loblolly pine, have exhibited pronounced differences in their ability to withstand snow damage. Recently an increasing number of loblolly and shortleaf pine have been damaged by tip moth and some of the fastest growing trees have been attacked. Although it is too early to tell, a spacial watch is being kept for individual trees that may prove resistant or able to maintain a satisfactory growth habit and rapid rate of growth.

Loblolly pine is a southern species with a natural range that excludes most of the Tennessee Valley. However, experience has shown it is adapted to a wide range of sites and for the most part, grows faster than other species being planted in the Valley. On the other hand, loblolly pine is susceptible to snow and ice damage. In the super-seedling plantation, individual trees which sustained the heaviest damage were often rapid growing trees with relatively large limbs. Some trees appeared to be stiffer than others but in general, trees with shorter, smaller branches fared best. Trees that succumbed were weighted down and bent over by the snow. In one instance, the snow melted within a day and little permanent damage occurred. In the other storm, the snow froze and held some of the trees prone for several days. Of these, 15 percent have never recovered fully and are malformed to some degree.

It is felt that snow hardiness is a particularly important criterion in making selections for use within the Tennessee Valley. While the winters are not severe, occasional heavy snowfalls occur when the snow is wet and freezes on the trees. Loblolly pine super-seedling No. 10 is an example of a tree exhibiting snow hardiness and a relatively rapid rate of growth.

Some of the shortleaf pine seedlings were also bent over by the snow, but without lasting after effects. Actually the shortleaf pine seedlings were younger and smaller than some of the loblolly pine when the storms occurred. It also appears reasonable to assume that shortleaf pine is more hardy than loblolly pine in this respect. Individual shortleaf pine trees are showing tip moth damage just as the loblolly pine, but as yet an attempt to pick out resistant trees appears premature.

<sup>1/</sup> Allen, John C. 1953. A Half Century of Reforestation in the Tennessee Valley, Jour. Forestry 51 (2): 106-113.

There are indications that at least a portion of the shortleaf pine super-seedlings--more so than in the case of the other two species--are hybrid stock. These trees do not exhibit a typical shortleaf pine nor loblolly pine appearance but rather something in between.

The white pine has been the hardest species to select in the seedbeds. The seedlings were variable in size and many of the tallest trees tended to be spindly. The final selection was made on a dual basis where the tallest trees with the stoutest caliper were chosen. This resulted in fewer white pine super-seedlings being selected than either loblolly or shortleaf pine. To date, white pine super-seedlings have been picked at the rate of one out of every 357,000 as compared with a rate of 1:242,000 for shortleaf pine and 1:228,000 for loblolly pine. The principal comments regarding the white pine in the arboretum at this time are that the trees are thrifty and in a healthy condition and that the "supers stand out from the controls.

#### Summary

Since the last report on this study, 101 super-seedling selections of loblolly, shortleaf and white pine have been made bringing the total up to 285. The survival of super-seedlings planted through fall 1955 was 86 percent. Of this number, roughly five out of every eight have continued to outgrow the controls. The most rapid growing loblolly pine is tree No. 11 which grew 16.6 feet in six years. The shortleaf and white pine counterparts were tree No. 7 growing 8.4 feet in four years and tree No. 8 which grew 3,9 feet in three years, respectively.

Criteria in addition to height used in judging the trees include form and branching habits, resistance to snow damage and insect injury.

The study has yet to prove whether mass selection in the nursery seedbed is a feasible method of discovering genetically superior strains of forest trees. On the other hand, the method has not been disproved. At least a portion of the super-seedlings are continuing to outgrow their controls and to exhibit other desirable characteristics.

Table 1. Number of Seedlings Examined and Super-seedlings Selected from Nursery Seedbeds

| Species        | Year    | Number seedlings examined in seedbeds | Number Super-seedlings Selected and planted | Surviving Fall 1956 |
|----------------|---------|---------------------------------------|---|---------------------|
| Loblolly Pine  | 1951    | 6,412,000                             | 33  | 27                  |
|                | 1952    | 3,595,000                             | 18  | 9                   |
|                | 1953    | 6,289,000                             | 30  | 28                  |
|                | 1954    | 16,265,000                            | 78  | 70                  |
|                | 1955    | 15,314,000                            | 51  | 45                  |
|                | Total   | 47,875,000                            | 210   | 179                 |
| Shortleaf Pine | 1953    | 2,300,000                             | 10  | 10                  |
|                | 1954    | 1,735,000                             | 6   | 6                   |
|                | 1955    | 2,942,000                             | 13  | 12                  |
|                | 1956    | 3,672,000                             | 15  | 15                  |
|                | Total   | 10,649,000                            | 44  | 43                  |
| White Pine     | 1954    | 3,758,000                             | 9   | 7                   |
|                | 1955    | 4,003,000                             | 10  | 10                  |
|                | 1956    | 3,316,000                             | 12  | 12                  |
|                | Total   | 11,077,000                            | 31  | 29                  |
| All Species    | 1951-56 | 69,601,000                            | 285   | 251                 |

Table 2. Survival and Growth of Loblolly Pine Super and Control Seedling Selections

| Year Selected | Year Measured | Number of Super-seedlings |                  | Average height of seedlings, feet |         |                  |         | Tallest seedling |              |                   |
|---------------|---------------|---------------------------|------------------|-----------------------------------|---------|------------------|---------|------------------|--------------|-------------------|
|               |               | All                       | Outgrew Controls | All                               |         | Outgrew controls |         | Tree Number      | Height, feet |                   |
|               |               |                           |                  | Super                             | Control | Super            | Control |                  | Super        | Control           |
| 1951          | 1951          | 33                        | -                | 1.3                               | 0.6     | -                | -       | 17               | 1.7          | 0.7               |
|               | 1952          | 27                        | 10               | 1.7                               | 1.2     | 2.0              | 1.0     | 11               | 2.5          | .9                |
|               | 1953          | 27                        | 12               | 3.5                               | 2.9     | 4.0              | 2.6     | 15               | 4.9          | 2.5               |
|               | 1954          | 27                        | 12               | 6.2                               | 5.3     | 7.0              | 5.0     | 11               | 8.8          | 4.7               |
|               | 1955          | 27                        | 11               | 9.3                               | 8.6     | 10.2             | 7.9     | 11               | 12.3         | 7.9               |
|               | 1956          | 27                        | 10               | 13.0                              | 12.3    | 14.3             | 11.4    | 11               | 16.6         | 11.9              |
| 1952          | 1952          | 18                        | -                | 1.4                               | .7      | -                | -       | 44               | 1.6          | .8                |
|               | 1953          | 9                         | 6                | 2.1                               | 1.2     | 2.2              | 1.2     | 39               | 2.7          | 1.3 <sup>a/</sup> |
|               | 1954          | 9                         | 5                | 3.6                               | 2.7     | 3.9              | 2.8     | 45               | 4.5          | 2.8 <sup>a/</sup> |
|               | 1955          | 9                         | 5                | 6.2                               | 5.2     | 6.7              | 5.3     | 45               | 7.6          | 5.3 <sup>a/</sup> |
|               | 1956          | 9                         | 6                | 9.8                               | 8.2     | 10.2             | 8.1     | 45               | 11.0         | 8.1 <sup>a/</sup> |
| 1953          | 1953          | 30                        | -                | 1.3                               | .5      | -                | -       | 70               | 1.7          | .7                |
|               | 1954          | 29                        | 20               | 2.6                               | 1.5     | 2.7              | 1.4     | 72               | 3.6          | 1.4               |
|               | 1955          | 28                        | 23               | 5.3                               | 3.9     | 5.3              | 3.7     | 71               | 6.8          | 5.4               |
|               | 1956          | 28                        | 24               | 8.5                               | 6.8     | 8.7              | 6.6     | 72               | 10.5         | 6.7               |
| 1954          | 1954          | 78                        | -                | 1.3                               | .5      | -                | -       | 111              | 1.6          | .6                |
|               | 1955          | 70                        | 43               | 2.5                               | 1.5     | 2.6              | 1.5     | 113              | 3.7          | 1.6               |
|               | 1956          | 70                        | 50               | 5.0                               | 3.8     | 5.2              | 3.6     | 113              | 7.4          | 4.3               |
| 1955          | 1955          | 51                        | -                | 1.2                               | .5      | -                | -       | 197              | 1.7          | .7                |
|               | 1956          | 45                        | 18               | 1.9                               | 1.2     | 2.2              | 1.1     | 206              | 2.6          | 1.7               |

<sup>a/</sup> Estimated values based on all living controls of similar seed source and age since paired controls of super-seedlings 39, 41, 43 and 45 died during the first year.

Table 3. Survival and Growth of Shortleaf Pine and White Pine Super and Control Seedling Selections

| Year Selected         | Year Measured | Number of Super-seedlings |                  | Average height of seedlings, feet |         |                  |         | Tallest seedling |              |         |
|-----------------------|---------------|---------------------------|------------------|-----------------------------------|---------|------------------|---------|------------------|--------------|---------|
|                       |               | All                       | Outgrew Controls | All                               |         | Outgrew controls |         | Tree Number      | Height, feet |         |
|                       |               |                           |                  | Super                             | Control | Super            | Control |                  | Super        | Control |
| <u>Shortleaf Pine</u> |               |                           |                  |                                   |         |                  |         |                  |              |         |
| 1953                  | 1953          | 10                        | -                | 1.0                               | 0.4     | -                | -       | 7                | 1.2          | 0.6     |
|                       | 1954          | 10                        | 8                | 2.2                               | 1.2     | 2.3              | 1.2     | 7                | 3.0          | 1.5     |
|                       | 1955          | 10                        | 9                | 4.1                               | 2.6     | 4.2              | 2.6     | 7                | 6.1          | 3.4     |
|                       | 1956          | 10                        | 9                | 6.1                               | 4.0     | 6.4              | 4.0     | 7                | 8.4          | 5.3     |
| 1954                  | 1954          | 6                         | -                | 1.2                               | .5      | -                | -       | 14               | 1.5          | .6      |
|                       | 1955          | 6                         | 5                | 2.1                               | 1.1     | 2.1              | 1.0     | 11               | 2.4          | 1.3     |
|                       | 1956          | 6                         | 5                | 2.8                               | 1.8     | 2.8              | 1.6     | 11               | 3.6          | 2.3     |
| 1955                  | 1955          | 13                        | -                | 1.2                               | .5      | -                | -       | 28               | 1.4          | .6      |
|                       | 1956          | 12                        | 6                | 2.0                               | 1.1     | 2.2              | 1.0     | 25               | 2.8          | .9      |
| <u>White Pine</u>     |               |                           |                  |                                   |         |                  |         |                  |              |         |
| 1954                  | 1954          | 9                         | -                | 1.3                               | .6      | -                | -       | 8                | 1.5          | .7      |
|                       | 1955          | 7                         | 7                | 2.0                               | .7      | 2.0              | .7      | 8                | 2.7          | .9      |
|                       | 1956          | 7                         | 7                | 2.8                               | 1.1     | 2.8              | 1.1     | 8                | 3.9          | 1.6     |
| 1955                  | 1955          | 10                        | -                | 1.1                               | .4      | -                | -       | 15               | 1.3          | .5      |
|                       | 1956          | 10                        | 4                | 1.6                               | .8      | 1.7              | .7      | a/               | 1.7          | .8      |

a/ Super-seedlings 11, 13, 14 and 18 were all 1.7 feet tall. The average height of their paired controls was 0.8 feet.