Shortleaf Pine INITIATIVE

Shortleaf Pine Tree Improvement

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Renewed economic and ecological interest, coupled with its wide adaptability and range in genetic diversity, makes shortleaf pine (Pinus echinata) an excellent candidate for continued tree improvement work. If range-wide restoration efforts of shortleaf pine are to be successful, tree improvement work by both state and federal agencies must continue.

Tree Improvement History

Shortleaf pine tree improvement programs were established in the early 1960s in response to an interest in the economic value of shortleaf. Genetic selection began in 1959-1967 and supported reforestation efforts in thirteen southeastern organizations: 9 state forestry agencies, 2 Federal agencies, and 2 private forest industries[2].

The largest shortleaf tree improvement program was originally developed for several National Forests in Arkansas, Missouri, and the southern Appalachians. At the time, the US Forest Service (USFS) opted to reforest with shortleaf instead of loblolly pine, likely because drier sites in these locations were more suitable for growing shortleaf. Following the development of selection and grading criteria for candidate trees, a formal breeding program began in 1959.

Across two USFS regions (R8 and R9), 12 geographic sources were identified. As an initial goal, fifty high quality trees were selected per geographic source based on superior visible characteristics. The original geographic sources were divided along state boundaries except for Arkansas and Oklahoma which had only 3 geographic sources.

First Generation Selections and Seed Orchard Establishment

Only the very best trees were considered for mother trees to create first generation seed orchards. Tree growth rate (diameter at breast height (dbh) and height), tree straightness (form class), disease resistance, pruning ability, specific gravity, and relative location were the criteria sought in these original superior tree selections. To establish the orchard trees, a clone of the parent tree is vegetatively reproduced by grafting a branch, called scion material, to a rootstock of another seedling. Five shortleaf pine seed orchard locations were established during the 1963-19702 by the USFS and state forestry agencies.

Seed production began about 10 years later. Approximately 45 years later, millions of genetically improved shortleaf pine seedlings have been planted using seed that originated from established and newer orchards (new orchards use original clones or crosses from parent trees).

In 1974, controlled crosses among orchard trees began. At this same time, progeny test plantings were installed to evaluate genetic improvement and susceptibility to littleleaf disease of the orchard trees. Unfortunately only one littleleaf test plot remains today[6].

During the 1980's, 125-150 progeny tests were planted on National Forest land. Many of these test plantings were measured at ages 1, 5, and 10 to gather performance data and genetic information. This data provided information on the original orchard parents and controlled crosses needed to rouge, or remove trees with undesirable or inferior genetic traits, from the orchards. Few of the tests have been used to advance shortleaf pine tree improvement beyond the first generation and only a fraction remain.

Genetic Gains from Breeding and Progeny Testing

Increased survival rates (20-25%) of improved seedlings over unimproved seedlings have been reported. Improved seedlings are thought to have better adaptability over a wider range of sites than unimproved seedlings because their parents originate from a wide range of habitats and gene combinations.

Volume gains of 10-15% have been reported from the first generation, unrouged seed orchards 3,5. Results from these early tests also revealed that tree height is a better selection criterion than diameter for volume at older ages. This may be because of high heritability at young ages and strong juvenile-mature genetic correlations1. It was found from the progeny tests that 17.8% and 37.6% gains in volume are already realized by ages 10 and 17, respectively. Early height growth may be an efficient predictor for volume production at older ages.

In the mid 1990s, just as the test plantings were beginning to yield significant results, the USFS halted any future efforts 5. There is renewed interest by a few eastern and western range states to revisit the older progeny test plantings. This work seeks to gather genetic material for second generation orchards and enhance the genetic material and diversity of current shortleaf pine orchards.

Second Generation Selections and Seed Orchard Establishment

In the western part of the range, Missouri and Arkansas cooperated to establish a second generation seed orchard on Ouachita National Forest. They selected the best 20% of families, using data from over 60 valid full-sib progeny tests established in the 1980's. In 2002, a full-sib progeny test was planted in Missouri that contains controlled crosses from the Mark Twain breeding program. There are plans to convert it to a seed orchard. Shortleaf pine tree improvement efforts have been well documented in the west. Current orchards provide a sustainable supply of seed from diverse families to support reforestation efforts in the western part of the shortleaf pine range.

In the eastern part of the range, the North Carolina Forest Service and US Forest Service cooperated to establish two second generation seed orchards in 2013. These orchards are located on National Forest land in Murphy, NC and on state-owned land in Morganton, NC. In the 1980's, 10 shortleaf pine progeny tests were planted on National Forest land in both the Piedmont and southern Appalachian regions. These tests contained full-sib crosses from parents in the first generation orchards. Data from eight of these progeny tests were measured, evaluated, and future selections were made in 2012.

The second generation orchard in Morganton, NC includes 265 newly grafted shortleaf ramets from 34 second generation families. The orchard also contains 37 of the best previously grafted first generation selections in 37 ramets from 18 families. This new orchard will contain 302 ramets while the US Forest Service orchard at Beech Creek will contain over 200 newly grafted shortleaf pine selections with 90 ramets from first generation families and 172 ramets from second generation families4. Both of these orchards will be well positioned in the next 10 years to provide a diversity of seed from various geographic sources. It will also provide generations of seedlings to meet any growing demands for shortleaf pine reforestation efforts.

References

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Shortleaf pine *(Pinus echinata)* forests and associated habitats contain extraordinary cultural, ecological, and economic value by providing wildlife habitat, recreational opportunities, enhanced water quality, and high value wood products. Despite these values and services, shortleaf pine has significantly declined across much of its 22-state range. These fact sheets provide tools and resources necessary for the restoration of shortleaf pine.