Longieaf pine genetics

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INTRODUCTION

There has been a movement of late toward the use of natural regeneration for iongieaf pine (*Pinus palustris* Mill.) as well as for other forest tree species. if you have a good natural stand, and have plenty of time, natural regeneration will result in a suitable stand, and genetics is not relevant.

Using natural regeneration can be risky, however. A good example is from the Southwide Southern Pine Seed Source Study (SSPSSS), iongleaf phase, established in the early 1950's (Wells and Wakeley 1970). The stands and trees from which seed was collected were carefully chosen to be representative of the genetic resource of the area. One of the seed sources, from southeastern Louisiana performed much below expectations in growth and survival after 10 years. Upon investigation, Wakeiey found that the area had been clear-cut in 1905, and that the stand seeded in from three, possibly four residual trees. Aliozyme analysis later showed that the source was indeed genetically challenged (Schmidtiing and Hipkins 1998).

If you don't have an existing stand of longleaf, or if that stand is genetically suspect (established with an unknown and perhaps foreign seed source, or from only a few residual trees), then some form of artificial regeneration is necessary, and genetics is relevant.

TREE IMPROVEMENT

Every important characteristic in longleaf pine is heritable to some degree. Genetic variation in iongieaf pine follows the pattern for other southern pines for most traits, making it suitable for genetic improvement. There are tree improvement programs for iongieaf pine in the NC State, Florida, and Western Gulf (TX A & M) cooperatives as well as in the US Forest Service (R-8), but these programs are minor compared to the effort in iobiolly (*P. taeda* L.) and slash (*P. elliottii* Engeim.) pines.

Traditional tree improvement programs involve selecting "plus" trees in the forest based on size, form, and branch characters. Age is determined by increment cores taken at breast height (4.5 ft) for comparison to similar-aged trees in the same stand. This system works very well for slash and iobioiiy pines, producing significant genetic gains'in the first round of selection. it is not very suitable for iongieaf pine, however, since variation in the "grass" stage makes it impossible to tell the true age of the tree, and therefore its true growth potential.

The "grass" stage is quite important genetically as well as siivicuituraiiy, and complicates the tree improvement program. Most of the tree improvement programs in iongieaf have shifted to a progeny test approach. Selection criteria are relaxed so that many vigorous, well-formed trees are included. Open pollinated seed are collected from these selections, and replicated plantings of seedlings are established to determine growth potential, including duration of the grass stage. These plantings are then rogued and thinned to convert them to seed orchards. This is a much more precise way of determining genetic potential and producing genetic gain, but takes a great deal of time to produce improved seed.

Early growth and survival is largely determined by the two most important inherited traits in longleaf, the duration of the grass stage, and resistance to brown-spot disease (*Mycosphaerella dearnessii* Barr). Both of these traits are strongly inherited, with heritabiiities around 50% (Snyder et al. 1977). Progeny testing for these traits is also simple, because the traits can be evaluated in open-pollinated seedlings within three or 4 years from seed, and most tree improvement programs emphasize these traits.

Duration of the grass stage and brown-spot disease are obviously related, as severe brown-spot infection will prevent height growth, sometimes for many years. Thus, there is a strong phenotypic or environmental correlation between brown-spot disease and duration of the grass stage. The genetic correlation between the two traits, on the other hand, is very low. This means that you can select and breed for one of the traits without affecting the other.

There are several different strategies, therefore, for overcoming the problems associated with the grass stage. You can breed for early height growth, and ignore brown-spot. If height growth occurs before brown-spot build-up, then there is no problem. Or, you can breed for brown-spot resistance, and height growth will not be delayed.

One danger in breeding for early height growth, is the possibility of incorporating loblolly pine genes. Longleaf pine hybridizes naturally with loblolly pine, the resulting hybrid is referred to as a Sonderegger pine (Chapman 1922). The hybrid seedlings begin height growth almost immediately after germination, and early growth is much better than for longleaf pine. The hybrid possesses many of the undesirable characteristics of loblolly pine, however, such as poor form and susceptibility to fusiform rust disease (*Cronartium quercuum* f. sp. *fusiforme*). Any longleaf seedling that begins height growth in the nursery is surely a hybrid. Breeding for early height growth subsequent to outplanting, however, can be accomplished without favoring loblolly genes (Lott et al. 1996).

SEED SOURCES

Unfortunately, only limited quantities of genetically improved longleaf pine are available. This is due to the small size and immaturity of longleaf pine tree improvement programs as well as the sporadic nature of good cone crops, a problem in the orchards just as it is in the forest. The most conservative approach to reforestation would be to use seed collected from healthy, vigorous local stands. There is little risk involved in using non-local seed, however, if certain guidelines are adhered to.

The most important factor influencing growth and survival in longleaf pine is climate, specifically average yearly minimum temperature (Schmidtling 1997, Schmidtling and Sluder 1995). This parameter has been used, not coincidentally, to determine plant hardiness zones (USDA 1990).

There is no ecotypic differentiation in the species, ie, stands from deep sand sites differ little genetically from stands on heavier soils. Unlike loblolly pine, there are no important differences between eastern and western sources. This basic difference between longleaf and loblolly pines is probably rooted in the Pleistocene geologic era. During the height of the Wisconsin Ice Age, 14,000 years before present, the south was occupied by a boreal forest. Patterns of genetic variation in allozymes indicates that longleaf resided In one refuge in south Texas/ north Mexico and migrated northward and eastward when the ice retreated (Schmidtling and Hipkins 1998). It is probable that loblolly pine originated from two refugia, one in the southwest near longleaf pine, and one in south Florida/ Caribbean.

The lack of east-west differences in longleaf pine simplifies seed transfer guidelines. I have divided the natural range of longleaf pine into five collection/planting zones (Figure). Seed may be collected from anywhere within a zone for planting in this zone. Seed from one zone warmer will result in an increase in growth, whereas seed from one zone colder will result in a decrease in growth compared to local sources. Seed should not be used from more than one zone distant.

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Figure of longleaf pine seed zones.