WHAT THE FOREST OWNER IS LOOKING FOR IN A PLANTABLE SEEDLING

Claude H. O'Gwynn
International Paper Company, Bainbridge, Georgia

As the demand for wood products goes steadily upward and our productive forest resource land base continues to dwindle, we are impressed with the urgent necessity for corresponding intensifications of our forest management practices. Throughout the Southeast, there is general acceptance of the plantation system as the best regeneration method (on sites to which it is adapted) toward the achievement of that objective.

Among the major advantages of this system are the opportunities it affords for the enhancement of both quantity and quality of the future forest resource. This dual improvement is possible because we can plant trees of better genetic potential for rapid growth as well as other useful characteristics at the same time that we approach optimum stocking levels through the control of numbers of trees and their distribution on a unit area of land. The maximum achievement of all these benefits is possible, however, only if we wisely apply the knowledge gained through research in every phase of this system of management. Of concern here is the cornerstone of that system: the nature of planting stock and what is known of its influence upon the success of our efforts to increase forest productivity.

Although there are still many unanswered questions which have a bearing on the attainment of this objective, there is a mounting fund of information, based on research, that relates the effects of nursery practices to the subsequent performance of planted trees. My purpose is not primarily concerned with the review of techniques and methods of nursery production, but it is inevitable that some of them be covered in a discussion of seedling quality.

There are perhaps areas of disagreement among forest owners about the specific characteristics of seedlings best adapted to their individual planting programs. These differences of concept are concerned more with seedling size and its relationship to successful plantation establishment over a range of varied soil conditions than to other qualities. However, when plantability is defined as the ability of a seedling to survive transplanting and to grow to maturity at an acceptable rate, there is general agreement'.

GENETIC QUALITY

Basic to a consideration of the plantability of a seedling is the genetic quality of the seed from which it grows. Even though the nursery manager often cannot exert direct control over the heredity of his crop, the importance of this attribute deserves emphasis. The information accumulating not only from basic studies of inheritance patterns, but also from progeny tests of seed orchard clones affirms the importance of genetic quality to the enhancement of forest productivity.

One way in which the nurseryman can measurably increase the genetically improved proportion of his crop is through the application of practices that optimize yields from seed of improved origin. The potential gains in productivity of such trees should warrant the sizing of seed (Muller, 1964), careful control of bed densities (Shoulders, 1961), and other measures to increase the number of plantable seedlings produced from each pound of seed.

Another way in which the nursery superintendent can increase the availability of genetically improved seedlings, when he supervises a seed orchard in conjunction with his nursery, is through the application of cultural practices such as nitrogen fertilization and effective insect control to maximize seed yields. Furthermore, insofar as he has control over the collection of wild seed, he can effect some measure of genetic improvement by persuading collectors to avoid parent trees of obviously poor quality.

GENERAL ATTRIBUTES OF SEEDLING PLANTABILITY

Plantability, as we have defined it, is affected by those characteristics of a seedling which determine: (1) its ability to withstand the injury associated with transplanting; (2) its proper insertion into the soil, (3) its ability to initiate new roots in an often adverse environment, and (4) its capacity to grow as rapidly as that environment will allow.

The first of these considerations is best fulfilled by minimizing the mechanical damage incurred by seedling roots during undercutting and lifting operations and by avoiding subsequent temperature extremes and losses of moisture from roots and tops. The packing requirement for maintaining adequate moisture levels is contingent upon the distance and mode of transport from nursery to planting sites and upon the length of storage time likely to be encountered between packing and planting. Ideally, coordinated daily scheduling of lifting and planting makes baling or packaging of seedlings uncecessary. Rarely, however, is it impossible to achieve such coordination because of excessive distances between nursery and planting sites, conflicts in lifting schedules, the effects of unfavorable weather, and equipment failures. In general, then, the forest owner requires seedlings packaged adequately to maintain them in good condition for an extended period of time. This is especially true of hardwoods destined for bottomland planting since high water often necessitates extended delays.

ROOT SYSTEMS

The effects of several aspects of root system quality on survival and growth have been investigated. Among these factors, freedom from serious injury by root rot fungi is of fundamental importance. On the other hand, visible evidence of roots affected by mycorrhizal fungi has been found to enhance the survival of slash and loblolly pine seedlings, especially on severe planting sites (Shoulders, 1967, 1969). The adverse influences of breakage or pruning of roots shorter than five inches have also been documented (Wakely, 1954).

Because a large proportion of current pine plantation establishment is accomplished by machine, the quality of planting operations is dependent to a high degree on the morphology and mass of seedling root systems. It is not possible with planting machines in common use to tailor the dimensions of planting slits or holes to variations among seedlings in length or mass of roots. Uniformity of root length is essential to the vertical insertion of seedlings to the proper depty. Pruning of excessively long roots at the time of grading and packing is desirable to avoid additional exposure to drying conditions at planting sites.

Nursery bed root pruning of longlead seedlings in late summer has significantly improved survival (Shoulders, 1963). Reliable results in planting longleaf are dependent upon this practice.

SEEDLING GRADES

Numerous investigations of morphological and physiological characteristics of seedlings and their relationship to subsequent field performance have been reported. Most of these studies have shown that groundline stem diameter is a reliable indicator of seedling plantability, as defined by survival and growth potential. Southern pine seedlings of less than 1/8 inch diameter have consistently survived less well after field planting than those of larger diameter (Clark and Phares, 1961; Meekins, 1964; Burns and Brendemuhl, 1971). In similar tests of longleaf morphological grades, seedlings of 1/4 inch to 1/2 inch diameter have not only survived transplanting better than smaller ones but have also initiated height growth sooner (Shipman, 1960).

In a previously unreported study initiated in southwest Georgia in 1958, slash pine seedlings from two nurseries in Georgia and two in Florida were separated by morphological grade according to Wakeley's (op. cit.) specifications. Each of the three grades was planted in replicated row plots within nursery sources. Loblolly seedlings from an Alabama nursery were graded and planted according to the same design in a related study.

After one year, grade 1 seedlings from one of the Georgia sources survived less well than either of the other two grades. But in the other three slash pine sources, survival values were in agreement with the investigations previously cited: grade 1 survival was highest; grade 2, intermediate; and grade 3, lowest. In the loblolly source, no difference was found between grades 1 and 2; however, both were significantly higher in survival than grade 3. Although additional mortality had occurred in all sources by age 13, when both plantings were measured and thinned, there was not change in rank among grades within nursery sources.

At the time of thinning, growth rates ranged from 42 cubic feet per acre per year to 270 cubic feet per acre per year. In all sources of both species except the single Georgia nursery from which grade 1 survival was poor the weighted volume growth of grades 1 and 2 was significantly greater than that of grade 3. These results, together with those of a similar study in shortleaf pine (Clark and Phares, op. cit.) are convincing evidence of the longterm relationship between seedling grades and ultimate wood volume yields, and they attest to the undersirability of planting grade 3 seedlings.

There is no reported definition of the maximum diameter for optimum plantability of pine seedlings. A few tests have indicated that mortaility of very large seedlings is fairly high, although the growth of those that do survive is superior (Bengtson, 1963). Such trees are difficult to plant properly by mechanical methods; seedlings of uniform top as well as root length are more easily inserted to the proper depth in machine planting.

HARDWOODS

Although hardwoods are not yet being planted extensively, there is a growing interest among some landowners in the more intensive management of several species. As this concern increases and as genetically improved seed becomes available, artificial stand regeneration will inevitably assume a more important role. There is mounting evidence that successful hardwood plantations on most favorable sites are dependent upon either prior elimination or subsequent control of competing vegetation. Establishment costs are therefore substantially greater for hardwoods than for pine. Hardwood seedling quality, then, as it influences survival and growth, is even more important to the forest owner.

In contrast with pine, the largest seedlings, with minimum diameters of 3/8 inch or greater, of sycamore, sweetgum, black walnut, and bald cypress have not only grown faster during the first critical years after planting but have also survived better than intermediate ones (Briscoe, 1969; McElwee and Johnson, 1967; Williams, 1965; Klawitter, 1961). In a single report of two test plantings of yellow poplar Rodenback and Olson (1960) concluded that successful plantations of this species require seedlings of 1/4 inch minimum diameter. Large seedlings of all hardwoods tested have consistently survived better, been more resistant to rabbit clipping (Nugent, 1970), and grown faster than smaller ones in several investigations in hardwood species.

What the forest owner is looking for in a plantable seedling, whether pine or hardwood, is one which is of the best available genetic quality. He wants pines of minimum grade 2 with a high degree of uniformity, hardwoods of 3/8 inch minimum diameter, and all, free of disease. He wants seedlings with well proportioned root systems pruned to uniform length packaged to maintain moisture and viability. In essence, he is looking for seedlings which have the best potential for survival and growth after he plants them.

The trend of research results reported, thus far, clearly indicates that the nursery managers ability to produce seedlings above these minimum standards of size and quality is truly the conerstone of increased productivity of our future forests.

LITERATURE CITED

Bengtson, George W. 1963. Slash pine selected from nurserybeds: 8-year performance record. Jour. Forestry 61:422-425.

Briscoe, C. B. 1969. Establishment and early care of sycamore plantations. U.S.D.A. Forest Serv. South. Forest Exp. Sta. Res. Pap. SO-50, 18 pp.

Burns, Russell M. and Brendemuhl, R. H. 1971. Nursery bed density affects slash pine seedlings grade and grade indicates field performance. U.S.D.A. Forest Serv. Southeast. Forest Exp. Sta. Res. Pap. SE-77, 7 pp.

Clark, F. Bryand and Phares, Robert E. 1961. Graded stock means greater yields for shortleaf pine. U.S.D.A. Forest Serv. Cent. States Forest Exp. Sta. Tech. Pap. 181, 5 pp.

Johnson, John W. and McElwee, Robert L. 1967. Larger sweetgum seedlings and more vigorous two years after planting. U.S.D.A. Forest Serv. Tree Planters' Notes 18(4):24-27.

Jorgenson, J. R. and Shoulders, Eugene. 1967. Mycorrhizal root development vital to survival of slash pine nursery stock. U.S.D.A. Forest Serv. Tree Planters' Notes 18(2):7-11.

Klawitter, Ralph A. 1961. Seedling size affects early survival and height growth of planted cypress. U.S.D.A. Forest Serv. Southeast. Forest Exp. Sta. Res. Note 151, 2 pp.

Meekins, Earle H. 1964. A case for planting graded stock. U.S.D.A. Forest Serv. Tree Planters' Notes 66:7-8.

Muller, C. A. 1964. Production goals, cost reduction and quality stock production. Region 8 Forest Nurserymen's Conf. Proc. 1966:78-83.

Nugent, John A. 1970. Rabbits rarely clip hardwood seedlings. Int. Pap. Co., Southlands Exp. Forest, Tech. Note 31, 2 pp.

Rodenbach, Richard C. and Olson, David F. 1960. Grading yellow-poplar planting stock is important. U.S.D.A. Forest Serv. Southeast. Forest Serv. Res. Notes 147, 2 pp.

Shipman, R. D. 1960. Survival and growth of graded longleaf pine nursery stock. Jour. Forestry 58:28-42.

Shoulders, Eugene. 1961. Effect of nursery bed density on loblolly and slash pine seedlings. Jour. Forestry 59:576-579.

. 1963. Root-pruning southern pines in the nursery. U.S.D.A. Forest Serv. South. Forest Exp. Sta. Res. Pap. SO-5, 6 pp.

and Jorgenson, J. R. 1969. Mycorrhizae increase field survival of planted loblolly pine. U.S.D.A. Forest Serv. Tree Planters' Notes 20(1):14-17.

Wakely, Philip C. 1954. Planting the southern pines. U.S.D.A. Forest Serv. Agric. Monog. 18, 233 pp.

Williams Robert D. 1965. Plant large black walnut seedlings for best survival and growth. U.S.D.A. Forest Serv. Cent. States Exp. Sta. Res. Note CS-38, 5 pp.