WHAT IS THE HARDWOOD QUALITY NURSERY COOPERATIVE DOING?

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INTRODUCTION

Regenerating cut-over, abandoned, strip-mined, and federal government sponsored Conservation Reserve lands has increased the demand for bare-root hardwood seedlings in recent years. Many state nurseries in the northeastern United States have seen an increased demand for seedlings of high quality hardwood species such as red and white oak and black walnut. This increased demand has put more pressure on nurseries to produce quality seedlings that will not only survive after field planting but will also grow rapidly to gain control of the site.

In the past numerous plantations that have been established have failed for any of a number of reasons, some on which may be nursery related. Mother nature produces hundreds of seed per tree in a good seed year. These seeds are the product of genetic recombination that produces a wide variety of genotypes. Natural selection on the regeneration site produces major mortality because the genotypes are unable to compete.

We in the bare-root nursery profession have the ability, through cultural practices, to nurture many of the inferior genotypes into large good-looking seedlings. However, many of these seedlings are not able to compete any better on the planting sites. Our dilema is one of identifying the potentially competitive seedlings and culling the rest.

Present grading procedures use height and stem caliper of the top as criteria for determining quality seedlings. Little, if any, attention is paid to root system characteristics. It is imperative that a seedling leaving the nursery have a large trellis root system composed of numerous large first-order lateral roots. These lateral roots will provide the initiation sites for new second-order feeder roots that are so necessary for water and nutrient uptake. The production of large first-order lateral roots seems to be both genetically and culturally controlled.

Not only must the seedlings have a large number of laterals, but the root system must also be physiologically capable of regenerating roots. Root growth potential (RGP) in conifers is used as a measure of physiological seedling quality. The same concept may apply to hardwoods. Thus, there are two major issues in defining the role of roots in seedling quality. First is the production of a large lateral root system. Without these roots, the seedling has a minimal chance for field survival regardless of whether the few laterals are physiologically prepared to initiate second-order feeder roots. The other concern is whether root systems are physiologically able to

regenerate new roots when planted. This root regeneration response may be tied to hardening in the fall and may be affected by nursery practices such as long and short term storage.

Quantifying root morphological characteristics and verifying RGP will allow development of a grading system for bare-root hardwood seedling stock. Such a system would allow nurseries to deliver high-quality bare-root seedlings to the public.

To this end, a U.S. Forest Service Focus Funding Project was developed and submitted by the State Foresters of Illinois, Indiana, Iowa, Ohio and Missouri. The project was approved for a three year period starting in 1987.

COOP OBJECTIVES

The overall objective for this cooperative is to improve seedling quality by evaluating the impact of nursery cultural practices on root morphology and field performance. In addition, procedures for determining root regeneration potential will be evaluated. The project is aimed at quickly integrating existing and newly developed technologies into the nursery through demonstration and instruction.

More specific objectives include:

a. To work with red and white oak and black walnut.

b. To document root and shoot development and starch accumulation, over time, in the targeted species.

c. To identify frequency distributions of permanent first order lateral roots as influenced by seed source (half-sib seed lots) and nursery cultural practices such as seedling density, root pruning, top-pruning and fertilization.

d. To evaluate field performance (survival and early growth) of seedlings characterized in b.

e. To install root grading, in conjunction with objectives b and c, as an integral part of seedling grading at each nursery and provide the necessary training to assure that it is done properly.

f. To evaluate procedures for determining root growth potential.

g. To relate root growth potential to cultural treatments described in b.

h. To assist in technology transfer of root grading to field foresters through events such as field days, conferences and workshops.

FIRST YEAR WORK

During the first year, demonstrations on root pruning and seedling density were established at each nursery to assess the effect of these treatments on first-order lateral root production. Species used in the tests at each nursery are shown in Table 1.

Table 1. Species used at each nursery during year 1.

Illinois	Red oak, black walnut
Indiana	Red Oak
Iowa	Red oak, black walnut
Ohio	Red oak, white oak
Missouri	Red oak, black walnut

The frequency distribution of permanent first-order lateral roots on nursery run stock was also determined by measuring 500 seedlings per species from each nursery. A permanent first-order lateral root is defined as one that is 1 mm or more in diameter at its base. Preliminary assessment of the data suggests that about 50% of red oak seedlings have less than 2 permanent first-order lateral roots and only about 10-20% of the seedlings have more than 5 permanent first-order lateral roots. For white oak, about 50% of the crop has fewer than 4 permanent first-order laterals and about 15% have more than 7. Fifty percent of the walnut crop has 7 or fewer permanent first-order lateral roots and about 35% of the crop has 10 or more.

At present we don't know exactly how many first-order laterals are needed for competitive seedlings, but outplanting to be done in the spring of 1988 and other work being done around the country will give us a good estimate. We would guess that seedlings from any of the studied species should have between 5-10 permanent first-order laterals to become dominant trees in the plantation. Once we have established the range of roots needed for survival and good growth in the field we will be able to set grading standards.

In other work, done at the Iowa DNR Forest Nursery, seedling development of red oak was followed during the first growing season by excavating seedlings at 1-2 week intervals. During the first part of the growing season, seedlings were excavated every week, while during the second half of the season they were dug at 2 week intervals. Shoot height, root collar caliper, length of taproot, numbers of first-order and second-order laterals, and dry weights of roots, stems and leaves were determined. Samples of seedling roots with surrounding soil material intact were used to prepare thin sections to examine the roots in relation to soil characteristics.

This information is begin analyzed to develop a phenology for red oak. We will determine whether an episodic growth pattern (alternating root and shoot growth) is characteristic of oak. By establishing the phenology of the species we will be better able to prescribe when seedlings should be root pruned, irrigated and fertilized.

SECOND YEAR WORK

One of the major efforts during the second year will be to establish field plantations of seedlings from the treatment plots of the first year. Each seedling will be identified by number of permanent lateral roots and associated growth parameters. These field planted seedlings will be monitored for at least 3 years. During that time samples will be excavated to observe location and quantity of root initiation.

The other major effort will be to establish plots in each nursery with known seed sources of the target species to determine the importance of genetics in controlling lateral root production. These seedlings will be lifted the following spring and lateral roots and other growth parameters will be monitored.

At selected nurseries, portions of beds of the target species will be root pruned at various times during the growing season. Seedlings from the different pruning times will be observed for lateral root production and other growth parameters.

Part of the seedlings that were grown at each nursery under the density and root pruning treatments of the 1987 growing season will be planted in irrigated and non-irrigated beds at the Iowa State Forest Nursery. These seedlings will be lifted at regular intervals during the 1988 growing season to determine the timing and location of root initiation. Starch contents and other standard growth parameters will also be monitored.