FINAL PERFORMANCE REPORT
FOREST SERVICE GRANT NO. 00-DG-11083150-500

Period covered by this report: September 1, 2000 through September 1, 2002

NOTE: Please review the following information and revise/complete as necessary.

Issued to: Clemson University

Address: Dept. of Forest Resources, 272 Lehotsky Hall, Box 0331, Clemson, SC 29634-0331

Congressional District Number: 3

Project Name: Feasibility of Planting Small, Bare Root Trees in Select Locations as an Alternative to Typical Community Tree Ordinance Planting Requirements

Contact Person/Principal Investigator:

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Date of Award: September 1, 2000

Grant Modifications: N/A

Date of Expiration: September 1, 2002

Funding: Federal Share: $15,750 plus **Grantee Share:** $20,480 = **Total Project:** $36,230

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_Please provide an abstract on your project and its results. This abstract will be posted on the NUCFAC internet site. (approximately 200 words or less).

Tree planting continues to be a major priority in urban and community forestry programs. Many municipal ordinances require a minimum of two-inch caliper trees or larger for planting in new developments because of the belief that large planting stock has greater survival rates and fewer losses from vandalism. However, the cost of these trees and their planting are major limiting factors in replanting the urban forest.

A study was established at two public sites in the Piedmont of South Carolina comparing survival and growth of bare-root (BR) whips and balled and burlap (B&B) red maple *(Acer rubrum* 'Red Sunset'). The study also evaluated the role of fertilization on survival, growth, health and appearance of newly planted trees.

Twelve BR trees (24%) and two (4%) B&B trees died within the first year and one B&B tree died in the third year. The majority of the tree failures were due to a flat-headed apple tree borer infestation at a cost of $72 and $190 plus labor, respectively. The infestation was greater on the B&B trees, but they had more trunk wood to withstand the attack prior to control. Better monitoring and earlier control would have prevented the loss. No trees were lost to vandalism.

Height growth was significantly greater on BR trees than on B&B trees. Fertilization significantly increased height growth of the BR, but not the B&B, trees. The results indicate the value of fertilizing at planting and a year following in urban soils, the cost-effectiveness of planting BR versus B&B trees, and the absence of loss from vandalism at some public sites.

Project objectives:
The primary objective of the project was to compare the purchasing and transplanting costs, growth rates, survivability, and degree of vandalism of 2.0- to 2.5-inch caliper B&B trees to those of 0.5- to 0.75-inch bare root trees installed in two heavily-used public sites (an elementary school and a park/recreation area).

Objectives met successfully:
All objectives were met. Additionally, information on the impact of fertilization on tree establishment, not originally included as a project objective, was obtained when fertilization at planting (school site) and one year following planting (both sites) was added to the treatments.

Objectives not met:
Information dissemination objectives have not been completely met to date.

List the major research or policy findings of your project.
Survival of BR trees was significantly less than B&B trees at the end of 2000 on both sites. A total of 12 BR trees died versus 2 B&B trees on the two sites in the first year after planting. Most trees died from an infestation of the flatheaded appletree borer *(Chrysobothris femorata)* that girdled the lower stems. No differences in losses occurred between fertilized and unfertilized trees on the school site. None of the trees on either site died as the result of vandalism.

Caliper growth was not significantly different between BR and B&B trees on either the school or park site after two years but height growth was significantly greater on BR trees than on B&B trees on both sites.

Fertilized trees had denser canopies and larger, greener leaves than unfertilized trees on the school site. Fertilization significantly increased caliper growth on BR and B&B trees on the school site in the first and second growing season but did not significantly influence caliper growth on trees on the park site in the second year when fertilization was performed. Fertilization significantly increased height growth on BR trees on the school site in the first and second growing season and on BR trees on the park site after the second growing season. Fertilization had no effect on height growth of B&B trees on either site. The incidence of flat-headed apple tree borers was significantly less on fertilized than unfertilized trees on the school site in the first year after planting.

Although BR trees exhibited mortality rates of 24% versus 6% for B&B trees in the first years following planting, the economic loss was less for BR than B&B. BR trees cost $6 each for a total of $72 in losses versus $95 per tree for a total of $285 for the B&B. Additionally, heavy equipment was needed for handling and planting the B&B trees while BR plants were easily handled by workers. Public agencies can tolerate greater losses that may occur from planting BR trees due to the much lower cost and ease of planting compared to larger stock. BR trees are also suitable in planting programs that rely on volunteers, many of whom are retired citizens and youth

The incidence of borers was significantly greater on the B&B trees, although the impact of the borers was much greater on BR trees. Borers completely girdled the BR trees probably due to the small sapwood surface area whereas the larger caliper trees tolerated the infestation and continued to grow. A more intensive inspection program is warranted on small BR plants compared to larger caliper stock in order to detect pests and other stress factors before mortality occurs.

While none of the tree losses resulted from vandalism, results may be different in highly populated urban areas such as business districts, inner city areas, and possibly residential streets. This study indicates that planting bare root whips is a consideration for schools, areas of parks that are not intensively used, highway rights-of-way and similar low use urban areas.

In addition to economy and ease of planting, small BR trees can be shipped long distances. This allows urban foresters more flexibility in choosing species in order to expand diversity within cities and tailor species to a site. With larger caliper stock, urban foresters are restricted to local availability or must pay high transportation costs to ship the heavier plant material long distance

The increased growth response from annual fertilization beginning at planting contradicts many other studies that indicate fertilization provides no growth response until trees become established. This positive response probably was due to the low fertility and low organic matter that was present on each site. The greatest growth response was received on BR material where there was no residual soil or nutrients that accompanied the plant material. Fertilization requirements at planting should be based on soil analysis of nutrient content, pH and organic matter rather than on generic recommendations pertaining to the time frame following planting.

The growth response from fertilization of BR and B&B trees at the park was somewhat less than that of the school trees in the second year of fertilization. The better response of the school trees may have been due to a "carryover" of nitrogen from fertilization during the preceding year or may have been due to the irrigation that the school trees received in the second year that did not occur on the park trees.

The fertilization application rate (61b of actual nitrogen per 1000 sq. ft.) represents the maximum rate recommended in the ANSI A-300 Standards for Fertilization of Landscape Trees. This rate was chosen to evaluate whether high nitrogen would cause any deleterious effects such as pest outbreaks and increased susceptibility to moisture stress which is sometimes sited as a potential effect of fertilization. For routine fertilization of new transplants, lower rates of fertilizer would probably yield similar benefits in terms of greater growth and reduced borer susceptibility.

If not apparent in the above, or if your project did not involve research, how did the project increase the knowledge we have about urban forestry? How did (will) the public benefit?
Explained above. If the approach of planting smaller caliper trees, monitoring pest issues, and utilizing early fertilization is adopted by communities where appropriate, the public can benefit by more trees with greater species diversity being planted and thriving at reduced public cost.

What recommendations might you make for community foresters or others who might benefit from your project?
Consider planting bare root "whips" in areas of moderately high public use such as schools, some parks, and highway rights-of way where vandalism problems will likely be low. Fertilize at planting and annually based on soil chemical analyses. Monitor closely for pest activity to avoid unnecessary injury. Reduced planting and establishment costs, along with rapid establishment, of bare root whips more than offset concerns about potential vandalism or other problems.

Attach copies of reports, publications, or videos. If your work has been published (journals, popular press, etc.), provide where they have been published or reported and how copies can be obtained.
None published at this time.

How were your results disseminated to the public?
To date presentations have been made to ISA chapter conferences and to state urban and community forestry conferences.

List the active partners (key individuals or organizations) involved in the project:
Dr. Bruce R. Fraedrich, Vice President/Research, Bartlett Tree Research Laboratories
Dr. Donald L. Ham, Department of Forest Resources, Clemson University
Dr. Judith D. Caldwell, Department of Horticulture, Clemson University
Ms. Susan T. Guynn, Environmental Mapping Manager, Anderson County, SC
Ms. Terri Van Zant, graduate student, Department of Horticulture, Clemson University

Photo or Illustration: If possible, please provide a photo or illustration for our use that summarizes or represents the project. Indicate how this illustration should be credited. Bartlett Tree Research Laboratories

If a no-cost time extension was granted for this project, why was it needed? N/A

How would you evaluate the grant process? What changes, if any, would you recommend? N/A

Comments considered of importance but not covered above: N/A

This report was prepared by:
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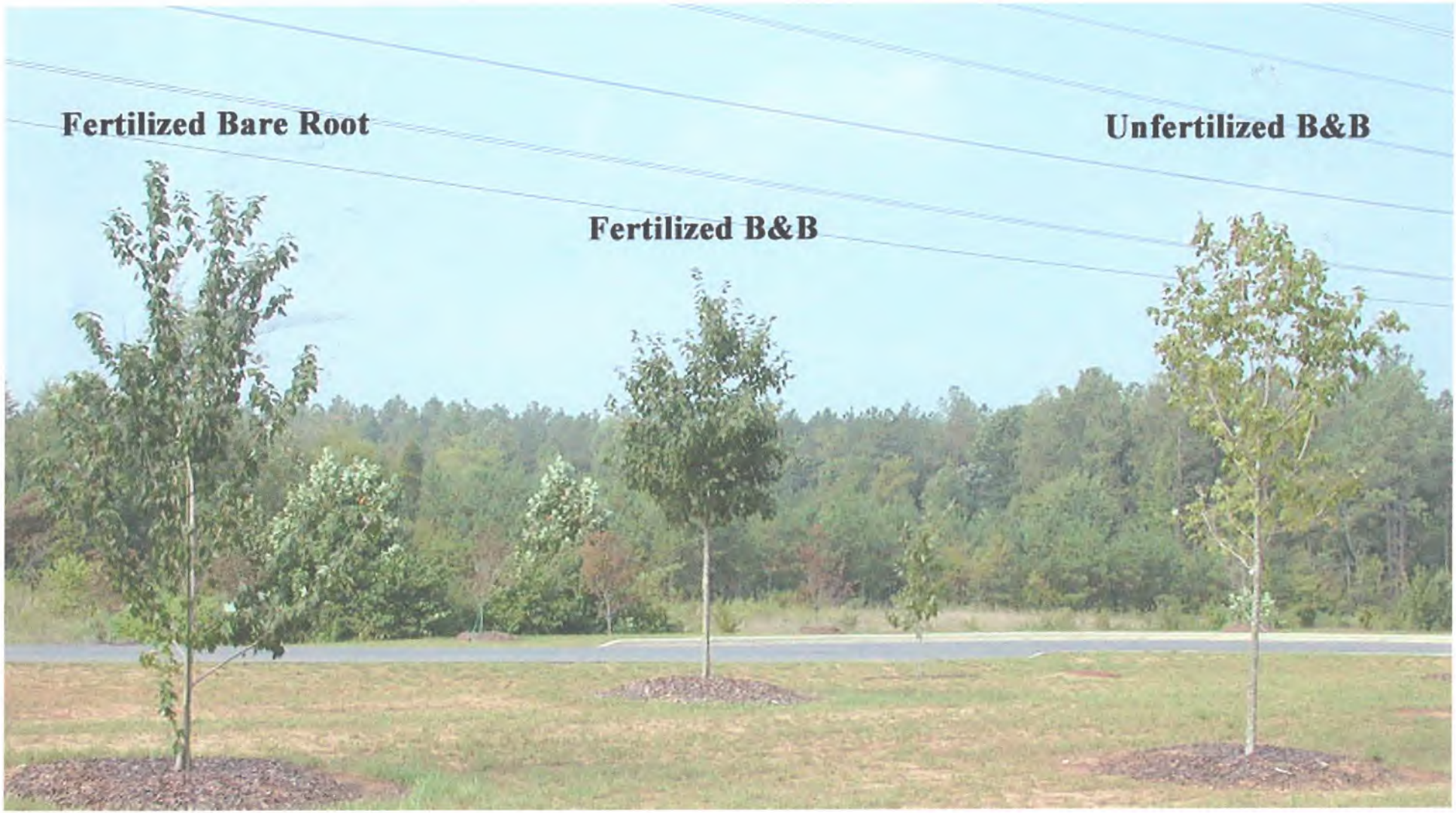
Date: January 13, 2003


Fertilized Bare Root
Fertilized B&B
Unfertilized B&B