RAPID GROWTH OF TREE SEEDLINGS IN BOTTOMLESS *CONTAINERS UNDER CONTINUOUS LIGHT*

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Since the discovery of photoperiod effects on plant growth and flowering in 1920 by Garner and Allard (1) it has been known in general that long days extend the vegetative growth phase of many woody plants, and conversely that short days are generally associated with the cessation of growth and the onset of dormancy in the fall (4). Exceptions to these generalizations were documented by USDA researchers in 1956, and the following year Nitsch (5) used 4 categories to classify woody plants according to photoperiodic response as follows:

A. Long days promote continuous growth while short days induce dormancy, as in *Weigela florida*.

B. Long days stimulate repeated periodic growth while short days will induce dormancy, as in *Quercus rubra*.

C. Long days promote continuous growth, but short days will not cause dormancy, as in *Juniperus horizontalis*.

D. Long days prolong the growing period, but plants eventually go dormant regardless of daylength, as in *Syringa vulgaris*.

It appears that the growth-promoting effect of long photoperiods may be especially effective on promoting growth when plants are in the seedling, or juvenile growth phase. Hanover and others (3) in Michigan have worked with this concept to speed growth of conifer, birch, and other seedlings with considerable success. They developed the accelerated optimal growth system, which uses long daylengths combined with optimum temperature, watering, fertilization, and even CO_2 enrichment of the greenhouse atmosphere to promote rapid seedling growth. Some commercially available pine seedlings are presently being produced using this system or something similar.

Also, in the last decade, there was considerable interest in various container systems other than the typical round pot, especially in sizes suitable for seedlings (6,7). These vary in configuration from the various plugs and "bullets", to "book" systems that open up to expose the elongated cells, to the inverted pyramid of the Speedling system, to various types of cell-pak trays, to the bottomless square milk cartons used by Gibson and Whitcomb (2). The complaint against the conventional round nursery container, of course, was that in species with a dominant tap root or strongly growing branch roots a malformed, crooked, coiled, or distorted root system was often produced. This could cause slower growth of the plant and possibly premature death in cases where root strangulation is severe. Gibson and Whitcomb (2) showed that by growing trees in square bottomless containers on a raised bench so as to obtain air pruning of root tips protruding out the bottom, a more fibrous root system was obtained due to the branching of the air-pruned roots.

The work we did at Tennessee was an effort to combine the growth-promoting effects of long days on tree seedlings with the improved root system resulting from air pruning in bottomless square containers. We carried these 6 species through the experimental setup: sweet gum, pin oak, golden rain tree, white birch, saucer magnolia, and Carolina cherry laurel. The first 4 were from seed obtained from a commercial source while the latter [illegible] were from locally collected seed that had been sown in an outdoor bed the previous fall. Seed was stratified as needed in damp sand in a cooler held at 33 to 38°F, then sown March 25 directly into the containers used. They were thinned later to one seedling per container. The containers were one quart paper milk cartons with a thin plastic skin. They were cut down to 5½ in. tall and divided into one group with the bottom cut out and another group with the bottoms left in but with drainage holes cut in the corners.

The soil mix was 3:1:1 pine bark:sand:peat. Amendments per cu. yd. were 15 lb 18-5-11 Osmocote; 4 lb Perk; 4 lb 0-20-0; and 8 lb dolomitic limestone. To hold the containers up off the existing greenhouse benches, we set up frames of 2- × 4-ft lumber and nailed hardware cloth as taut as possible over the frame. To keep the soil mix from sifting out of the bottomless containers, we set them up on top of a single layer of newspaper as they were being filled and placed on the mesh frame. Six of the 12 benches had continuous light furnished by fluorescent fixtures 18 in. above the container. Fixtures were raised as the plants grew. At night these lights gave 300 to 500 foot candles at the top of the plant. During the day they actually shaded the plants somewhat but the amount was not considered significant. Control benches were curtained off from the lights with black sateen cloth at night and thus were exposed to natural daylengths. Pad and fan cooling was used to help control temperatures. The recorded temperatures were from the mid-70's to mid-80's with an occasional high of 95 F°.

Each plant species was grown in the greenhouse until enough top growth and root development had occurred in most of the treatments to warrant planting out in the field or to 3-gal nursery containers. Actual time in the greenhouse was 84 days for the magnolia and cherry laurel seedlings, 105 days for birch, 112 days for golden rain tree, 116 for sweetgum, and 126 days for pin oak. Thus, field planting was in late July to early August in the summer of 1980, which was one of the hottest and driest summers experienced in Tennessee for decades. At the end of the growing season evaluations were recorded of height, caliper, straightness rating, fresh weight of top growth, and root quality rating. Responses to the photoperiod and bottomless container treatments will be discussed separately for each species.

(1) *Koelreuteria paniculata* — golden rain tree

Seedlings of *K. paniculata* respond to continuous light by increased height growth over seedlings under natural photoperiod treatments. The most height growth occurred in the bottomless container, continuous light combination.

Bottomless container culture influenced root production and fresh weight of top growth. Seedlings started in bottomless containers had higher root quality ratings and were also heavier than seedlings started in containers with bottoms.

Every treatment produced good one-year seedlings. The best seedlings, however, consistently came from the 24-hour photoperiod and bottomless container combination.

(2) *Magnolia* × *soulangiana* — saucer magnolia

Magnolia × *soulangiana* seedlings from 24-hour photoperiod and bottomless containers were superior to seedlings in other treatments in height, amount of height growth after planting, and fresh weight of top growth. Plants started in bottomless containers had greater caliper than plants started in containers with bottoms. Also, seedlings started in bottomless containers had better root quality ratings at both growing locations.

Plants from natural photoperiod treatments were straighter than plants from continuous treatments.

It seems that propagation in bottomless containers is an effective method for *Magnolia* × *soulangiana* seedling production.

(3) *Betula pendula* — European white birch

B. pendula started in bottomless containers were taller, straighter, and had greater caliper, fresh weight of top growth, and better root quality ratings than those started in containers with bottoms.

Photoperiod treatments had no effect on height growth, contrary to expectations.

Field production of *B. pendula* produced better seedlings than 3-gal container production. Field plants had greater caliper and fresh weight than container plants.

Results would suggest that square, bottomless containers be used during the propagation period with resulting seedlings planted in field culture.

(4) *Liquidambar styraciflua* — sweet gum

L. styraciflua was the most unresponsive species tested as no significant effect in height, caliper, fresh weight, or straightness ratings from treatments occurred. Seedlings grew approximately the same in all treatment combinations at both growing locations.

L. styraciflua is easily propagated and grown by commercial nursery methods, thus there is no advantage in growing it by the methods tested.

(5) *Quercus palustris* — pin oak

Seedlings from 24-hour photoperiod treatments were taller (60.5 cm) than seedlings from natural photoperiod treatment (38.2 cm). The fresh weight and root quality ratings also suggested a positive response to continuous light.

Container type, either bottomless or with bottom, had no influence on height, caliper, fresh weight, or straightness rating of *Q. palustris*. The root quality rating of seedlings from bottomless containers was better than those from container with bottoms.

Continuous light is effective in stimulating increased growth of *Q. palustris* seedlings.

(6) *Prunus caroliniana* — Carolina laurel cherry

P. caroliniana responded to continuous light by increased height (39.1 cm to 34.0 cm) over seedlings from natural photoperiod treatments. Bottomless container culture affected no growth parameter other than root quality ratings.

The production of *P. caroliniana* seedlings under continuous light may be feasible although seedlings from all treatments made comparatively little height growth.

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USING A MICROCOMPUTER IN THE NURSERY BUSINESS

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My microcomputer was purchased to serve as a tool for learning about computers in general. Our company had reached a size and complexity level that made consideration of our own computer system necessary, but I really had no good basis for comparing the various features available. The $2500 spent on a micro seemed small compared to the $15,000 to $50,000 at stake for a complete business system.

Computer basics. A microcomputer is considered to be a desk top machine, as opposed to mini and main-frame computers, which require much more space and are many times more costly. The so-called "personal" computers are microcomputers. All computers, micros included, have certain features in common: a CPU, an I/O, a clock, and a memory. The CPU (central processing unit) does the work or calculations of the computer. The I/O (input/output) gets data to and from CPU. The clock times the various operations and makes sure the computer doesn't try to do two things at once. The memory stores information. Memory is of two types: ROM (read only memory) resides permanently in the computer and contains instructions and codes that cause the computer to operate in a certain way. RAM memory (random access memory) is temporary, and everything is lost when the power is turned off. RAM memory holds the programs and data being used at the moment. Microcomputers are often compared by the size of the RAM memory. My Apple II is a 48K, meaning it has 48,000 bytes of RAM storage capacity. Although these numbers really have little definitive meaning to the user, it is often implied that the bigger the RAM, the better the machine. RAM size becomes important when it limits the size of programs that can be run or data that can be handled. The 48K RAM is the