PROPAGATION OF QUERCUS SEEDLINGS IN BOTTOMLESS CONTAINERS WITH OSMOCOTE[1]

by Robert D. Hathaway and Carl E. Whitcomb [2]

Abstract. Shumard oak seedlings (Quercus shumardii) were grown in bottomless, square containers placed on a wire bench. The dominant tap root grew downward and was 'air pruned', producing a fibrous root system. Three heights of containers were cut from quart milk carton stock giving three volumes of media with the same surface area and three different drainage columns. Five rates of Osmocote 18-6-12, based on the surface area of the containers, were applied after the seedlings had emerged. Growth increased significantly with the three highest levels of Osmocote. Seedlings grown in the smallest container were not significantly different from those in the larger containers. Five replications were planted in 2 gallon (7572 cm^3) containers and grown for one year. Even though all seedlings were treated alike during this period, those which were propagated with higher fertility rates had an increased survival rate and faster growth suggesting that the nutritional state of liners, not necessarily age or size, strongly influences survival and future growth.

The ornamental nursery industry has greatly increased container production of woody ornamentals in the last 20 years. What started as a few acres of "tin can" nursery stock has now grown into a multi-million dollar enterprise. Many trees are transplanted from seed beds into containers and grown for 1-3 years prior to planting in the landscape. Most field-grown trees are also seeded in ground beds, then transplanted. The period of development from germination until the seedling can successfully compete with environmental factors is the most critical phase of growth.

Nurserymen provide a controlled environment and favorable conditions for seedlings in order to increase the survival rate and allow the tree to develop quickly until it can successfully compete for water, light and nutrients. Presently, most tree seed is germinated in a bed of native soil plus pine bark or other amendment and grown from 1-3 years. The seedlings are crowded and fertility is often low. At transplanting time, many nurserymen remove most of the top growth to balance the top with the reduced root system and force a new vigorous shoot to train for the primary tree stem. The amount of growth removed represents time and money which is lost during each pruning operation. The pruning also provides an easy entrance for many pests prior to healing.

The forestry industry has devoted vast resources to developing a containerized seedling concept to aid in rapid reforestation. "Test tube" seedling nurseries now produce millions of conifer seedlings annually. Some nurserymen are now using the forestry "test tube" system. However, the goals and economic aspects of the reforestation seedling does not parallel the seedling requirements for the nursery industry. The majority of forestry research on seedling production is directed toward mechanical planting of large numbers and is concerned mainly with softwood conifers. The projected return on the mature tree at harvest is also not comparable to the nursery industry due largely to the shorter period of growth required to produce a saleable tree in the nursery industry.

A five year old tree only starting its growth in a commercial forest may be worth a substantial sum as a landscape plant. The difference in time and money and the ultimate objective are greatly separated, thus the increased investment per plant can easily be justified.

Literature Review

Containers protect the root system and enable the seedling to be transplanted without the shock of root removal or disturbance. However, a container, by definition, *contains* the root system and can create other problems if the plant is not transplanted prior to the root system outgrowing the

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[2] Graduate Student and Associate Professor, respectively.

available space. This is most apparent in species with a dominant tap root which, when container grown, produces a malformed, contorted root system that causes slower growth and sometimes premature death (1,4).

Virtually all containers modify root structure and because of the many attributes of container-grown seedling production, problems found with some containers must be corrected or new concepts devised that will produce a sound system (5). The behavior of roots in a round container is part of the root girdling problem. When a growing root confronts a barrier it cannot penetrate, it turns or buckles and follows the contour of the barrier. In a cylindrical container, no direction other than cyclic is provided and the root starts a spiral growth pattern around the container.

Research by Davis and Whitcomb (3) has shown that by using a square, bottomless container on a wire bench, the roots grow out until contacting the sides, then proceed to the 90 degree corner and grow downward. As the roots reach the bottom of the container, they grow out into the atmosphere and are 'air pruned' by desiccation. This pruning of the taproot induces development of lateral roots which in turn are air-pruned as they reach the bottom. This results in the formation of a fibrous root mass with no spiral growth.

No data are available on how much deformity a root system can tolerate before growth is restricted or the structural support of the tree is damaged.

Root and shoot growth are interdependent and interregulated (7). Roots mechanically support the plant, absorb, and translocate water and mineral solutes, synthesize organic compounds (especially amino acids), and store manufactured foods. Thus, root malfunction, injury or death are reflected in reduced top growth (6).

Milk cartons have been used as a seedling container in the past but with the bottom intact. In 1970, Shreve (8) compared the growth of *Juglans nigra* seedlings in containers and bare root. Mortality was high among seedlings planted bare root, but survival of container-grown seedlings was about 80 per cent.

Fertilization of container-grown plants presents many problems not encountered with field-grown nursery seedlings (2). Since containers limit the volume of medium available to hold moisture and nutrients, the precise management of these factors is critical. Natural soil is not used because other media have more desirable characteristics, i.e., water holding capacity, aeration and bulk density. Sphagnum peat, ground pine bark, vermiculite, perlite, sand and sandy loam soil in small amounts have been used in various proportions.

Different levels of nutrients in combination with the volume of medium per plant,, i.e., container size, has been significant in many studies of container-grown nursery plants (3, 10, 11, 12, 13). Liquid nutrient application is used almost exclusively in the forestry industry due to the high cost of slow release fertilizer systems and the desire to control nutrients during late season growth periods to influence the hardening off process and decrease freeze damage (9). Survival is strongly influenced by the seedling's ability to regenerate roots when transplanted (6). Survival may be dependent on seedling vigor, stored nutrients, physical condition, size and the root system which results from the type of container used during propagation (5).

Materials and Methods

Shumard oak was seeded May 26, 1975, in individual containers constructed of milk cartons 7 cm square. The cartons were cut 28, 21 and 14 cm long giving 3 different volumes of media (1360, 1016 and 676 cm^3) and thus 3 different drainage columns. The growing medium for the entire experiment (including germination) was a 2:1:1 mixture of bark, peat, and sand with 8 lbs. (4.75 kg) dolomite, 4 lbs. (2.38 kg) single superphosphate and 2.38 kg Perk (Kerr-McGee fertilizer company, Jacksonville, Florida, minor elements in sulfate form)/m^3. Containers were all bottomless and placed on a raised wire bench out-of-doors and watered by hand as necessary. Osmocote 18-6-12 was applied when the seedlings had the first pair of true leaves at rates of 0, 1.5, 3., 4.5, and 6 g/container (eq. to 0, 500, 1000, 1500, and 2000 lbs. (N/A/yr.). Data was taken 90 days after planting and one year later.

Each treatment was replicated 23 times. Fifteen replications were harvested after 90 days and 5 replications were selected at random and transplanted into 2 gallon containers with uniform conditions. The 2 gallon containers received 10 g Osmocote 18-6-12 (800 lbs. N/Acre/Year) after transplanting and 15 g of the same material (1200 lbs. N/Acre/Year) the following spring.

Results

At the end of the 90 days top growth, top weight, stem caliper and bud break increased significantly as the level of Osmocote increased above 1.5 g/container (Fig. 1, 2, 3, 4, 5). The 1.5 g rate was not significantly different than the untreated check at the end of 90 days. The average root weight remained nearly the same in all containers regardless of the level of Osmocote (Fig. 6). The increase in container volume from 676 to 1360 cm^3 did not significantly influence tree growth. One year after transplanting, the highest fertility level increased survival to 86% compared to the check (Fig. 7). Height of the trees after one year also increased in relation to level of Osmocote during the first 90 days (Fig. 8). It is noteworthy that the 500 lb. rate of Osmocote during the first 90 day propagation phase did not produce differences when compared to the control (0 lb. Osmocote). However, one year later these trees had substantially outgrown the controls. This suggests that the nutrition of the liner, not necessarily the size or age, is a critical factor in growth and survival.

These data show that nutrition of Shumard oak seedlings during early stages of growth has a dramatic effect on subsequent growth of the seedling tree and has a major impact on survival and growth following transplanting.

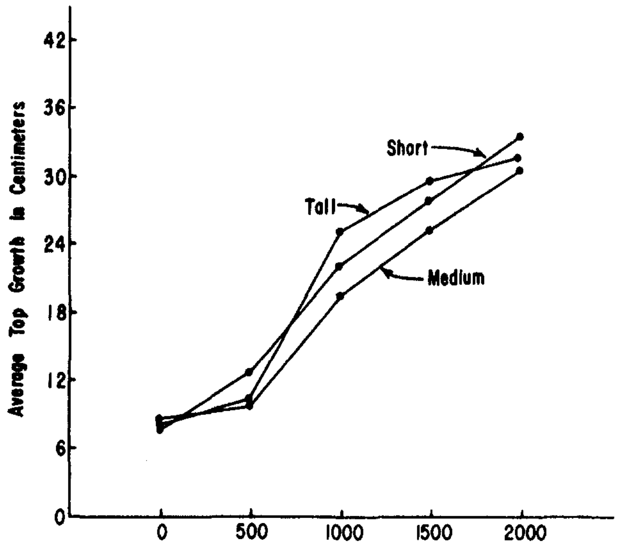

Figure 1. Effects of fertilizer levels and container height on top growth of Shumard oak seedlings (0, 1.5, 3, 4.5 and 6 grams/container).

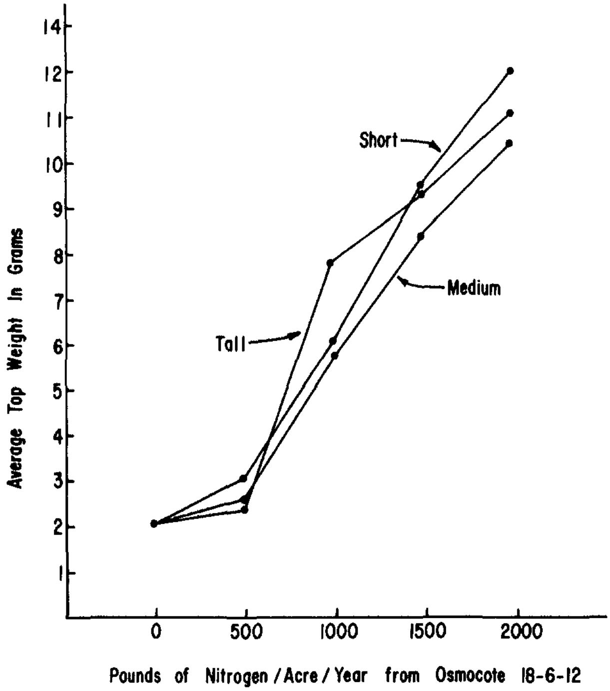

Figure 2. Effects of fertilizer levels and container height on top weight of Shumard oak seedlings (0, 1.5, 3, 4.5, and 6 grams/container).

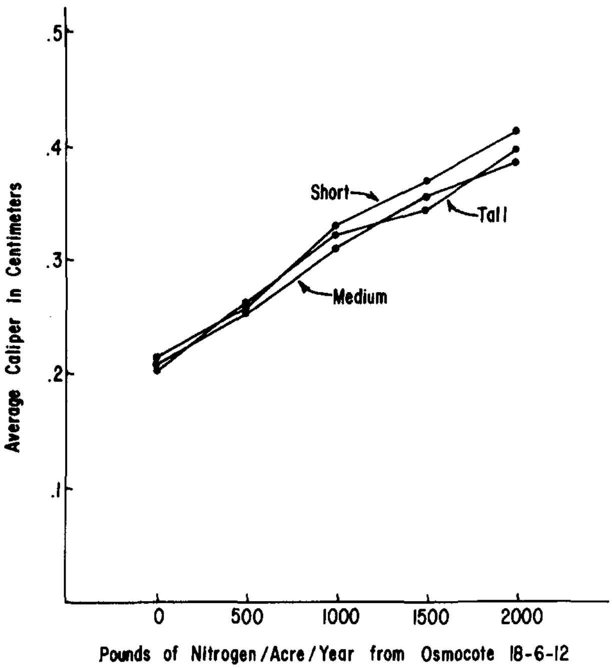

Figure 3. Effects of fertilizer levels and container height on stem caliper of Shumard oak seedlings.

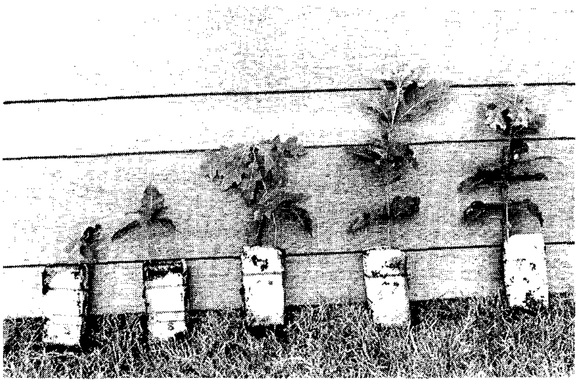

Figure 5. Effects of fertility treatments on growth of Shumard oak seedlings.

A=(control) no	**B=1.5 g Osmocote 18-6-12**	**(500 lbs N/A/Yr.)**
	C=3	**1000**
	D=4.5	**1500**
	E=6	**2000**

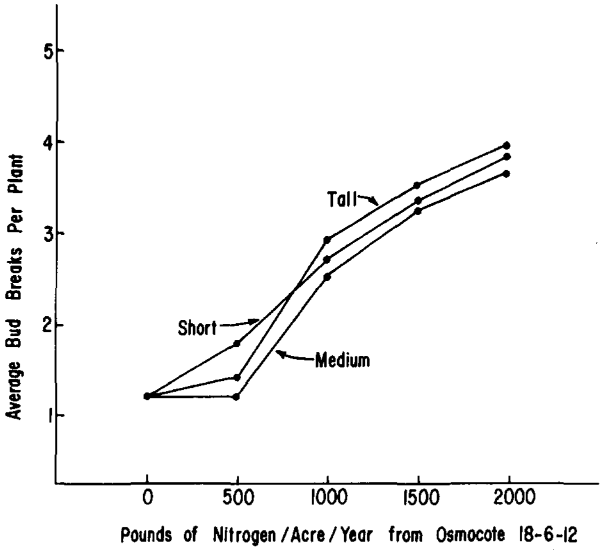

Figure 4. Effects of fertilizer levels and container height on bud break of Shumard oak seedlings.

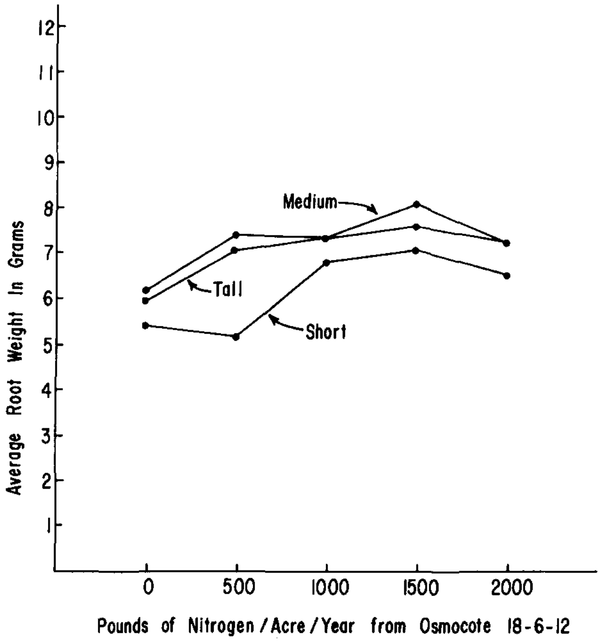

Figure 6. Effects of fertilizer levels and container height on root weight of Shumard oak seedlings.

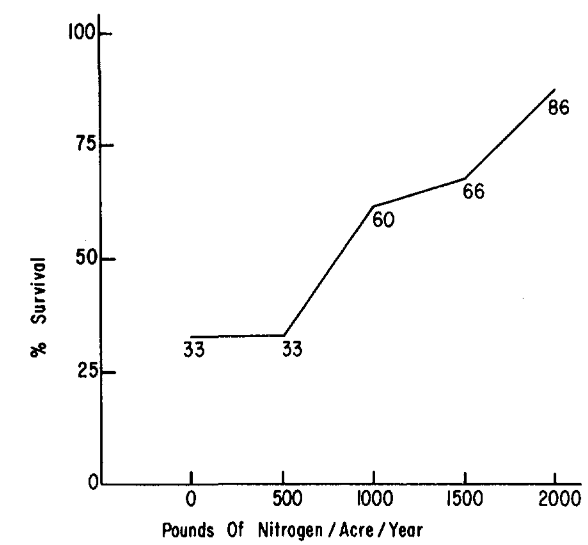

Figure 7. Survival of Shumard oak seedlings one year after planting liners in 2 gallon containers.

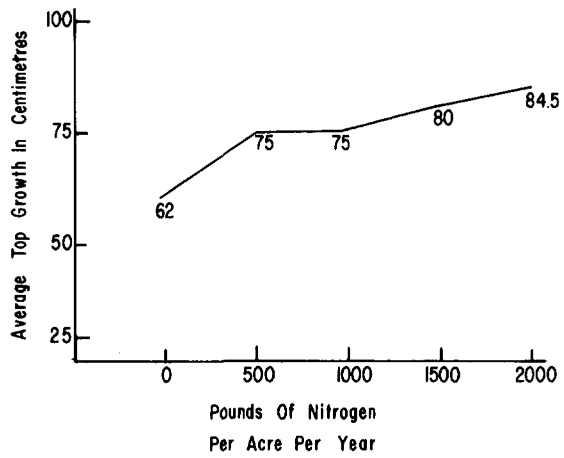

Figure 8. Average top growth of Shumard oak seedlings one year after end of 90 day propagation treatments (averaged over all three propagation container sizes).

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Department of Horticulture
Oklahoma State University
Stillwater, Oklahoma

ABSTRACT

Anonymous. 1977. **GM guide to 1977 horticultural chemicals.** Grounds Maintenance 12(3): 76-84.

Trade name, brand name, chemical name, and usages are given for chemicals in the following categories: fungicides and bactericides; herbicides; insecticides including miticides or acaricides; and soil fumigants including nematocides.