

compared to peat pots at a cost of 2.3 cents each. The cell pak is a disposable unit. It is used once and discarded. We use 45,000 trays per year so it is very expensive to sterilize and store that number of units each year. Another advantage over peat pots is that the roots are not inhibited and grow into the surrounding medium very quickly.

SEEDLING PRODUCTION

Seedling production is through the use of both ground beds and containers. Ground beds are used for cultivars that can be transplanted bareroot. Cultivars that do not transplant very well are grown in containers on raised wire benches; air pruning is used to get a good fibrous root systems. The use of raised benches and containers is more costly than ground beds, therefore most of our seedling production is in ground beds.

BARE ROOT VS. MILK CARTON SEEDLINGS

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Historically, tree seedlings have been grown in raised ground beds in the field. High production densities and low production costs are associated with these methods of production.

Over several years a new concept in seedling production has emerged that warrants consideration by the nursery industry. In this system tree seedlings are produced in bottomless containers or "milk cartons." I have been asked to present the advantages and disadvantages of both systems. Some of the differences are included below:

BARE ROOT

Advantages: Relatively low initial cost, high production in limited area, light weight (shipping and handling), and ease of planting.

Disadvantages: Harvest season restricted, refrigerated storage required, one crop per season, greater transplant shock, certain species difficult to store, subject to spring frosts, weaker stems due to crowding, and more disease- and insect-prone due to crowding.

MILK CARTON (AIR ROOT PRUNED)

Advantages (1,2,3): Produces superior root system, higher quality liner, accelerated growth characteristics, much more flexibility in handling and transplanting, multiple crops per year, larger stem caliper.

Disadvantages: High initial cost, not commercially available, non-uniformity due to seedling variation, and crowding.

Although field-produced bare-root seedlings are the standard in the industry, alternatives are available. For example, conifers are grown in assorted containers, typically tubes or plugs, primarily for forestry applications. While these containers take advantage of the extended planting season and increased survival associated with container-grown seedlings, these types of containers do not develop a root system like a bottomless container. When tree seedlings are grown in bottomless containers, each time a root tip grows through the bottom of the medium and out into the air, the tip desiccates and dies. This has the effect of repeated root-tip pruning and is very effective in stimulating lateral branches, not only on the primary root but on secondary roots as well (1). The resulting root system primes the seedling for accelerated growth with little or no transplant shock. In addition to the superior root system of the milk-carton-grown seedling, the flexibility of planting and harvest as well as the ability to produce several crops per season are important advantages over field growing.

However, the merits of bare-root tree seedlings need to be mentioned. First and foremost is that they are less expensive to produce when compared to air-root-pruned seedlings. Often a high population can be grown per unit area ($>200,000/A$). This can be both good and bad. The incidence of pests and disease is increased due to these plant densities. In addition, this spacing does not allow for adequate stem strength to develop. This is often corrected by pruning the tree down to a 4 to 6 in. height, and forcing a lateral bud to be trained as the central leader. This technique is dependent on a good root system and proper timing for satisfactory results.

The use of bare-root tree seedlings as rootstocks in grafting has a long history. It is unlikely that milk-carton grown seedlings could become a viable substitute to bare-root seedlings due to the high degree of success and ease of handling, but container-grown seedlings could make some headway with the difficult-to-transplant items such as *Carya* and *Cornus*.

The ability to store bare-root tree seedlings successfully is somewhat species dependent. Cultivars that fall into this group are often left in the field and spring dug, but conditions do not always permit prompt digging as the field may be too wet or frozen. Cultivars that do not store well but are in demand by the nursery industry represent potential for milk-carton growing.

The development and refinement of the air-root-pruning container was conducted by Dr. Carl Whitcomb and his students (2,3). The objective of this research was to grow a tree seedling that maximized growth in the shortest possible time. These milk-carton seedlings were potted to larger containers to realize the potential of super seedlings.

This system of potting milk-carton-grown seedlings to larger containers takes maximum advantage of the potential of milk-carton-grown seedlings. Not until more container growers evaluate this system of production and achieve salable sizes in much less time than with bare-root seedlings, will the milk carton container reach its potential.

LITERATURE CITED

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TREES FROM CUTTINGS VS. THOSE FROM SEEDLINGS

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Much research has been conducted in recent years in an effort to obtain accelerated growth from plants. Some of the work has centered upon the development of a better root system through the utilization of different hormone combinations. Other research has focused upon the development of containers that encourage well-branched root systems without spiraling.

From my experience in the production of trees using both cuttings and seeds, I believe that accelerated growth can best be obtained by giving special attention to the development of a well-branched fibrous root system and to the timely shifting up of the liner. At Simpson Nurseries we grow trees from bareroot liners, seed, softwood cuttings, hardwood cuttings, and from buds and grafts. However, the softwood production of trees compared to seedling production in bottomless containers is emphasized in the following information.