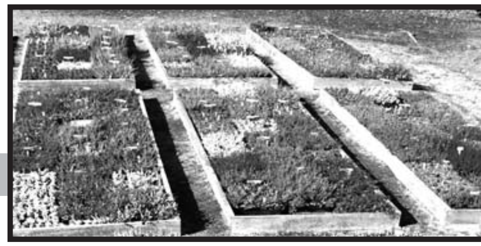
Virginia Cooperative Extension

2002



Horticulture

PUBLICATION 430-050

Getting Started in the Nursery Business

1. Nursery Production Options

*Gregory K. Eaton and Bonnie L. Appleton**

The nursery industry in Virginia has enjoyed an extended period of growth and expansion. Consequently, there is considerable interest in and some potential for new business opportunities in the industry. Another consequence of this period of economic growth is an increase in competition within the industry to supply the growing demand for landscape plants. Those interested in getting into the nursery business are strongly encouraged to invest their time and energy into learning as much as they can about the modern nursery industry, and the many options now available in nursery production, before they invest any money in facilities and operations.

Virginia's nursery industry has many more production options available today than when it began in the United States during the 1700's. The first trees produced were bareroot fruit trees, progressing to bareroot shade trees, and later to field-grown, balled-in-burlap (B&B) harvested trees. The container nursery industry started at the end of World War II with the production of small trees and a variety of shrubs in #10 metal fruit cans. The industry has now progressed to growing an extremely diverse number of annuals, herbaceous perennials, vines, ground covers, ornamental grasses, shrubs and trees. In particular, trees can be grown to much larger sizes in field production with the use of mechanical harvesting equipment (tree spades), and in wood and plastic containers of sizes of 200 gallons or larger.

In deciding whether to grow nursery stock in the field vs. containers, many factors should be considered relative to nursery design and capitalization. Some of these factors are summarized in the table below.

Table 1. Considerations for field versus container nurseries.

	Field (in-ground) nursery	Container nursery	Notes
Land area required	larger	Smaller	Relative to profitability of operation
Number of employees	1 per 5 – 10 acres	1 per acre	Field production has more seasonal employees
Economic return per acre	Lesser with fewer plants per acre and longer production cycle	Greater with more plants per acre and realized sooner	
Production cycle	Longer (1 – 6+ years)	Shorter (6 months – 2 + years)	
Production costs per acre	Lesser costs for site preparation, labor and maintenance	Greater investment in production area construction, containers, water, substrate, and larger labor force	
Intensity of management	Lower fertilization and irrigation requirements; mowing of fallow strips and weed control in planting rows	Daily irrigation; monitoring for blowover, weed control, rate of disease or insect spread, and protection from temperature extremes	
Seasonality	Periodic with limited harvest during periods of active growth	Year-round	Both types of production have some down time in winter

* Assistant Professor and Extension Specialist, Department of Horticulture, Virginia Tech; and Professor and Extension Specialist, Hampton Roads AREC, Virginia Tech

(Reviewed by Charles Conner and Charles Goodman, Virginia Cooperative Extension Agents, and Robert Wright, Professor of Horticulture, Virginia Tech)

	Field (in-ground) nursery	Container nursery	Notes
Types and sizes of plants	Preferred production system for large caliper trees; limited holding time after harvest	More efficient production of small shrubs, annuals and perennials; plants can be repotted to larger containers if not sold	Recent hybrid production systems allow larger plant sizes in containers
Growing area preparation and maintenance	Generally less required. Unique concerns for removal of acreage from production for soil rebuild-ing, and replacement of soil removed by B&B harvesting	More extensive and expensive site preparation for drainage and water recycling. Container beds require a gravel, plastic or fabric covering	Important part of Best Management Practices (BMPs)
Irrigation	Irrigation not mandatory; irrigating will help establish liners and produce faster growth	Daily irrigation mandatory; 27,000 gallons per acre per day capacity recommended during peak production months	Both production systems can use drip or overhead irrigation; important part of BMPs
Fertilizer use and application	Less fertilizer per acre; usually broadcast applied; less labor intensive	Fertilizer topdressed by hand is labor intensive; substrate-incorporated fertilizer less labor intensive, but requires special equipment	Either system via irrigation (fertigation), with special injection equipment; controlled-release fertilizers recommended for both production systems; important part of BMPs
Weed control	Mechanical weed control via cultivation or hoeing in addition to chemical (herbicide) options	More difficult due to close plant spacing, favorable weed growth environment, weed seed introduction via irrigation and substrate, and less substrate buffering capacity against herbicide application errors; hand weeding and herbicide application are available	Weed control around production areas will help reduce weed pressure; important part of BMPs
Disease and insect control	Somewhat less intensive; larger plants require specialized equipment for pesticide delivery	More intensive due to greater insect and disease pressure; more difficult control applications due to higher plant densities and reduced air circulation	Regular monitoring or scouting will reduce problems in either system; important part of BMPs
Summer stress	Irrigation important to avoid drought; less concern for heat stress.	Greater summer heat stress due to high root zone temperatures in containers, and heat produced or reflected from container beds; may use shade structures or syringing (short cycle overhead irrigation)	
Overwintering	Little protection is generally required	From simply jamming containers together to protecting plants in heated overwintering structures	
Harvesting	Restricted to seasons when soil moisture is adequate and plants are dormant; plants are dug by hand or machine, bareroot or with soil ball; root protection required during holding (cold storage, heeling in, balling-in-burlap)	Any time by simply loading plants from their production beds	Improvements in irrigation and postharvest handling have allowed somesummer digging of field grown plants
Shipping	Bareroot field-grown plants can be bundled or boxed; large B&B plants spaced on trucks or tied to individual pallets	Containers can be stacked can-on-can, boxed or racked; lighter weight reduces shipping costs	Long distance shipping is possible for container-grown plants, but cost prohibitive for field grown B&B
Equipment needs	Requires more expensive machine-harvesting equipment; may require larger irrigation and spray equipment.	Production efficiency requires substrate mixing and container filling equipment.	

Table 2. Advantages and disadvantages of field versus container nurseries.

	Field (in-ground) nursery	Container nursery
Advantages	• Less labor intense • Less water needed • Root temperatures buffered by soil • Some plants, especially trees, grow better in the field • Better soil nutrient reserve and pH buffering • No plant blow-over • Easier control of pests (weeds, insects, diseases)	• Better control over factors affecting plant growth (substrate, irrigation, fertilization) • More marketing options (ways, sizes and times of year) • Higher plant densities • Ability to use sites unsuited to field production • Planting and harvesting time not weather dependent • Some plants easier to grow and/or harvest in containers • Lighter weight for handling and shipping
Disadvantages	• Less control over factors affecting plant growth • Smaller percent of plant's absorbing roots harvested (especially trees - often no more than 5% - 20%) • Less harvest time flexibility (generally only when dormant) • Lower plant densities • Planting and harvest weather dependent • Not all sites usable - field soil must have adequate moisture and drainage. • With B&B, heavy product and loss of field soil with product • Root pruning may be necessary	• Intensive management • Need for a large volume of higher quality water • Rapid nutrient depletion • More difficult control of pests (weed, insect, disease) • Lethal root temperatures (heat in summer, cold in winter) • Blow-over (labor intense; wastes topdressed materials) • Root circling/repotting frequency • Runoff (nutrients and herbicides)

Types of Field Production:

Bare root - Bare root production and harvesting is generally restricted to small groundcover, herbaceous perennial and ornamental grass divisions, and small deciduous shrubs and trees. Due to the potential for dessication, few evergreen shrubs or trees are harvested bare root, with the exception of small conifer liners for Christmas tree planting and reforestation. Bare root plants should only be planted, harvested and transplanted while dormant (late fall to early spring while not actively growing), thus limiting the time when they can be used. The biggest challenge in working with bare root plants is keeping the roots from drying out. A major advantage to using bare root plants is their light weight and relatively low cost. Also, because there are few producers of bare-root "liners" (seedlings or rooted cuttings) in Virginia, there is a market for bare-root liner products among Virginia growers of "finished" nursery stock.

Conventional B&B - Shrubs and trees that are dug with a portion of their roots covered with a ball of soil are called balled-and-burlapped or balled-in-burlap (B&B) plants. B&B is the next step up from bare root harvest, and can be used for evergreen as well as deciduous plants, and for much larger plants than are harvested bare root. Most B&B harvesting, as with bare root, is done while plants are dormant, but recent improvements in holding and acclimating techniques (ways to prevent balls from drying out and ways to stimulate summer root growth) have allowed increased digging during the growing season. Some landscapers prefer to transplant B&B plants as opposed to container-grown plants to avoid some of the soil interface problems that develop when plants are container-grown in soilless substrate. B&B plants are heavy and awkward to handle. Hand harvesting requires trained staff, and mechanical harvesting requires hydraulic tree spades and other equipment.

Holding/marketing options - Bare root plants can be held in cold storage with their roots exposed or packed in damp moss or other material; they can also be process (or peat) balled where their roots are surrounded by organic matter that is then packaged to look like a root ball; they can also be *containerized* or potted in a container with soilless substrate. There are also many new (and largely untested) products that may reduce dessication of bare root plants during storage. These products may be root dips, gels, or clay products designed to maintain a high moisture environment around roots. Some field plants dug with a soil ball are put in containers instead of being burlapped (*field potted* - roses, azaleas), while some B&B plants, with fully burlapped root balls, are also *containerized*.

Types of Container Production:

Conventional containers - The container nursery industry started with #10 metal fruit cans, but now uses mainly blow or injection molded plastic containers in unstandardized sizes ranging from small propagation containers to production containers of 1 gallon to 200 gallon or more. Most production in Virginia occurs in 3, 5, 7, 10, 15 and 25 gallon containers. Some bare root and containerized field stock is put in fiber containers (pressed paper and/or peat).

Engineered containers - To help reduce or eliminate the problem of circling roots that often develop in smooth or slick walled plastic containers, a variety of containers have been designed that deflect or redirect roots via molded container wall baffles, or that kill root tips when roots encounter holes in the container walls (air root pruning). If conventional containers must be used, those with vertical ribs help reduce circling roots vs. those with horizontal ribs that encourage circling root formation. Soft-walled poly bag containers with gusseted bottoms are also a good solution to this problem.

Copper-coated containers and copper inserts - A copper-containing product has been developed (Spinout®) that can be applied to smooth container walls to reduce or eliminate root circling. The copper acts as a growth regulator, stunting the root tips as opposed to redirecting or killing them. Effective for one growing season in the container, normal root growth resumes when the container is removed and the plant transplanted into the landscape.

Low-profile container/The Accelerator® - The low profile container is a bottomless container that sits on plastic or woven ground cloth. It is wider and more shallow than conventional containers to encourage development of a shallow, broad root system that more closely mirrors natural root systems. Root circling is reduced in low-profile containers by air-root pruning at the container wall/plastic bed covering interface. Root circling is reduced in the commercially available The Accelerator® via holes in and corrugations of the aluminum container wall.

AGS - The Above Ground System (AGS) is a double container system for use above ground. A production container nests in a double-walled holder container that serves to insulate the plant's roots and buffer high and low temperature extremes. The AGS can have ballast added to prevent blow over, and is easier to harvest than the in-ground, double container (Pot-in-pot) system .

Hybrid Systems - Several "hybrid" production systems, combining advantages of field production with advantages of container production, have been developed. Most of these systems attempt to do one or more of the following: harvest more absorbing roots, prevent root deformation, keep root temperatures buffered, conserve moisture, prevent blow-over, increase ease of harvest, and reduce labor use.

In-ground fabric containers (grow bags) - In-ground fabric containers are made from porous synthetic fabrics (usually polypropylene). They permit exchange of moisture between in-container soil and the surrounding soil while preventing some or all of the plant's roots from growing outside the container. The earliest versions of the fabric containers were often difficult to remove at transplant due to large root penetration or root entanglement in the fabric's fibers. Fabric containers are now easier to remove due to fabric improvements, or the use of fabrics with small holes, copper impregnation, or a herbicide delivery system. Due to root restriction within the fabric container, drip irrigation is essential with fabric containers. Fabric containers are often removed prior to sale and the root balls containerized to assure that roots will not be restricted by non- removal of the fabric container when the plant is transplanted.

Pot-in-pot (P&P) - This system uses two containers - a production container nested inside the holder (sleeve or stock or "socket") container, both sunk into the ground. This method of production has expanded rapidly in recent years. It has allowed predominantly container nursery operations to grow larger nursery stock, while still maintaining tight controls over irrigation, fertilization and other cultural practices of container production. Drainage of these in-ground pots is crucial and generally maintained by the placement of corrugated drain pipes beneath the rows of socket pots. Some form of micro-irrigation (drip or spray emitter) is necessary in this production method to avoid tremendous inefficiency in water delivery with overhead sprinklers when large containers are spaced far apart. Pot-in-pot production also buffers root zone temperatures from extremes and reduces blow over of larger, top-heavy trees because the containers are anchored in the ground.

Cellugro® System - This is a multiple plant production system for small plants and liners. Two sizes of Cellugro systems are available. One measures 8'x20' and holds 561 six-quart-sized (one gallon plus) plants, while the other holds 7 gallon plants. Both systems consist of a polyliner, a drainboard, and the expandable production cell unit. The system is installed either into the ground (approximately 8 inches deep) or set above ground with soil bermed around it. Not only are root temperatures buffered, but water consumption is dramatically reduced compared to above ground containers.

Cultural Considerations

Production sites

Field Production - The best sites for field production have moderate slope for air and water drainage, or if flat, have good internal soil water drainage. Soil types can vary from sandy soils for bare root production to silty-clay loams for holding root balls together for B&B production. Heavy clay soils should be avoided due to poor drainage and aeration, but can be improved by the addition of organic matter or several years of a green manure crop. Soil pH should range from 6 to 6.5 for most plants, lower (5 to 6) for acid-loving plants like azaleas. Soils should be tested for pH, P, K and certain micronutrients, and possible pesticide residues, depending on prior uses of the site.

Container Production - Site selection is less critical for container production. A container production bed can be built atop any soil type as long as drainage off the bed is achieved by way of a moderate natural slope or grading. Drainage is also important for the roadways between the beds so that vehicles and equipment have access year-round. Soil fertility level and pH are of no concern as they are for field production.

Production area preparation

Field Production - Soils should be tested to determine whether the pH needs adjusting, and if particular nutrients need to be incorporated prior to planting. For soil low in organic matter either incorporation of organic matter may be beneficial, or the field should be kept out of production for a year to grow a green manure crop (sudan-sorghum hybrids, etc.) for incorporation. In addition to incorporating pH adjustment materials, nutrients and organic matter, perennial weeds should be eliminated with fumigation or with a systemic herbicide, and then fields plowed and disced prior to planting. Most planting is done in the spring, with some also in the fall. On some sites, depending upon plant spacing, erosion potential and other factors, it may be desirable to establish a cover crop.

Container Production - When preparing container production areas, there are three main parts to plan - the actual production beds, the irrigation and excess water collection system, and the roads. How much grading is needed will depend upon the land's slope, the type of irrigation and drainage system to be used, the rate of percolation of heavy rain into the soil, and the type of bed covering to be used. If an impervious covering such as black plastic (poly or polyethylene) will be used, grading must drain all water off the bed. If gravel, clam shells or woven nursery cloth will be used, water must either drain through the soil beneath quickly enough that it does not puddle, or the ground should be graded.

A goal of all nurseries should be to catch and recycle all excess water (irrigation and rain). This may require construction of a drainage system and holding ponds. Some drainage systems are designed as part of the container beds, while others may be part of the roads.

Once general bed and drainage grading is complete, and any irrigation or catch ponds constructed, the soil should be stabilized to support equipment and prevent erosion. The soil may need sterilizing or treatment with herbicides to deal with weed problems. Materials (gravel, clam shells) may need to be applied for road beds. If irrigation will use buried lines, these should be installed before the container beds are constructed.

Container bed dimensions will depend on several factors: container sizes to be used; initial spacing and respacing requirements; cultural requirements (do you need to walk between containers to topdress fertilizer, or to hand weed); irrigation design and coverage; weight of growing substrate. Solid set irrigation allows less flexibility in bed dimensions than drip irrigation.

Fertilization

Field Production - Some fertilizers, generally containing phosphorus (P), potassium (K) and micronutrients (if needed), will be pre-plant incorporated, as well as lime to increase the pH. Nitrogen (N) fertilizers, which need to be applied for all field production due to the short soil life of N, may be incorporated pre-plant in organic or inorganic form, or may be banded or broadcast post-plant. Most fertilizers are applied in early spring, and then again in late summer or early fall. Fertilizer rates, ratios, ,etc. are dependent on many factors, including soil type and pH, type of plant, soil and leaf nutrient analysis tests, and other site and crop specific factors. Application rates generally range from 50 pounds to 200 pounds actual N per acre per year, with the lower rate being recommended to prevent ground water contamination. A common recommendation for field grown nursery stock is 60 pounds of N per acre per year, applied in three split applications (e.g. 20 pounds each in March, May, July). If a drip irrigation system is used, a water soluble fertilizer can be applied via the irrigation system (fertigation).

Container Production - All container-grown plants must be fertilized since very few nutrients are available from the production substrate. Fertilizer may either be a dry, slow release granular material or a liquid, and is generally a complete fertilizer (N-P-K) plus micronutrients. The dry granular materials can be applied either by incorporation into the production substrate prior to potting, can be placed or "dibbled" into the bottom of the planting hole, or can be "topdressed" or applied to the substrate surface. No one placement method has been found to be superior for all container-grown plants. Water soluble fertilizer is generally applied via the irrigation system, with many nurseries using a combination of dry and water soluble fertilizers.

In addition to a complete fertilizer plus micronutrients, additional phosphorus is often added, as well as lime to increase the pH or to provide an additional source of calcium and magnesium. Most granular fertilizers do not last an entire growing season and need to be reapplied around midsummer.

The use of controlled-release fertilizers (CRFs) has largely replaced the use of traditional granular fertilizers in nursery production. These products package nutrient salts in "capsules" of resin or polymer coating. The coating "controls" the release of nutrient salts via moisture content or temperature of the substrate. CRFs are available in several formulations to suit the nutrient requirements of different plants, and also are available with different coatings to provide nutrient release over different time frames (e.g. 4 month vs 12 month formulations). These products generally provide more consistent nutrient availability to plants over time than traditional granular fertilizers.

Regardless of the fertilizer source and formulation, regular analysis of the nutrient status of the production substrate is recommended in order to make adjustments before plant problems develop. An easy method to use, which was developed at Virginia Tech, is the "pour through" method. Details of the pour-through method of monitoring nutrients in containers will be addressed in a future Virginia Cooperative Extension publication, are available in Wright (1986, see references), and can be accessed through the web at: http://www.ces.ncsu.edu/depts/hort/nursery/cultural/topic4.htm

Irrigation

Field Production - Considerable field production is done without any supplemental irrigation, but this increases the potential for poor growth and survivability. Some fields are irrigated on an "as needed" basis with portable overhead systems (rainreels, moveable pipes, etc.), with the ideal situation being to have drip irrigation available for all plants. Water source, water quality, soil type, plant type and spacing, climate and topography must all be considered when designing an irrigation system, with each type of system having advantages and disadvantages.

Container Production - Irrigation is mandatory for container production, with irrigation often being applied daily during the growing season. It is generally recommended that 1 acre-inch, or 27,000 gallons of water, be maintained in storage for each acre of land under container production. While less than 1 inch per acre per day may be applied to container crops, the additional volume of water in storage is insurance for periods of excessive heat and drought, and to ensure irrigation water quality. Irrigation may be applied overhead, by drip or trickle systems, or by subsurface or capillary systems. Overhead irrigation uses the greatest volume of water while subsurface (rare in the U.S.) uses the least. A large volume of high quality water (low in salts, slightly acid pH, free of weed seeds, sediment, iron, etc.) must be available, and at a rate that allows daily or every other day irrigation. If water is not applied daily a "heavier" substrate (one with sand to create smaller water-holding pore spaces) is generally necessary. If irrigation runoff and rainwater is collected and recycled, the water may need chemical treatment to prevent disease problems. A new means of applying water overhead involves "pulse" irrigation involving several applications of smaller quanities of water per application. Pulsed irrigation uses less water and leaches less fertilizer.

Weed Control

Field Production - Many nursery fields are chemically treated or fumigated prior to planting to help control weed problems prior to planting. Weeds are also controlled by applying herbicides (both preemergent and postemergent), mulching, hand weeding, mowing, and cultivating.

Container Production - Weeds are far more difficult to control in container production than in field production due to close plant spacing and the fact that only hand weeding, substrate weed barriers, and herbicides can be used. It is very important that weed-free substrate, water and liners be used, and that weeds be controlled under and around all production beds.

Other Considerations

Field Production - Other important considerations in field production include liner sources, planting equipment, staking, top and root pruning, control of insects, diseases and wildlife (deer, bird, moles, voles, rabbits), harvest techniques (bareroot vs. B&B vs. containerized), harvesting and shipping equipment, and acclimation and holding techniques. Further information on some details of field production of nursery stock can be found on the web at: http://www.ces.ncsu.edu/depts/hort/nursery/cultural/topic11.htm

Container Production - Other important considerations in container production include liner sources, container types, sources and disposal, substrate sources, components and mixing/potting equipment, blow-over of containers/plants, sun protection of some plants during the summer (via trees, shade structures or extra irrigation), cold and wind protection of some plants during the winter (via straw, synthetic coverings, overwintering structures), pruning, control of insects and diseases; and container moving and shipping systems.

BMP's - The nursery industry, in order to be a good steward of the environment, has been developing a set of production guidelines know as Best Management Practices (BMPs). The Southern Nursery Association, in collaboration with regional research universities and the Environmental Protection Agency, published "Best Management Practices, Guide for Producing Container-Grown Plants" which outlines important environmental considerations of container nurseries (see references). BMPs include:

- selection and proper handling of container substrate components
- proper water source selection
- proper irrigation design and management
- runoff water collection and recycling
- Integrated Pest Management (IPM)
- proper pesticide use and storage
- proper nutrient selection and application
- nutrient monitoring

Bibliography

General reference -

Resources for Greenhouse and Nursery Operations and Operators. Joyce G. Latimer and Gregory K. Eaton. 2002. VCE Web Publication 430-104W.

Propagation references -

Plant Propagation, Principles and Practices (6th edition) by Hudson Hartmann, Dale Kester and Fred Davies, Jr. 1997. Prentice Hall.

Seeds of Woody Plants in North America by James Young and Cheryl Young. (Formerly USDA Forest Service Ag. Handbook 450) 1992. Dioscorides Press

The Reference Manual of Woody Plant Propagation by Michael Dirr and Charles Heuser. 1987. Varsity Press, Inc.

Nursery design and production references -

American Standard for Nursery Stock. 1996. American Association of Nurserymen.

Container Nursery Design by Bonnie Lee Appleton. 1986. American Nurseryman Publishing Company, Inc.

Best Management Practices, Guide for Producing Container-Grown Plants by Tom Yeager, Donna Fare, Charles Gilliam, Alex Niemiera, Ted Bilderback, and Ken Tilt, 1997. Southern Nurserymen's Association.

Nursery Management (3rd edition) by Harold Davidson, Roy Mecklenburg and Curtis Peterson. 1994. Prentice Hall.

Nursery Production (2nd edition) edited by Charles Heuser and Richard Stinson. 1989. Dept. of Ag. and Ext. Educ. Vol. 28, No. 1T and 1S, Penn State University.

Nursery Production Alternatives for Reduction or Elimination of Circling Tree Roots. Bonnie Appleton. 1993. Journal of Arboriculture 19(6):383-388.

Nursery Production Methods for Improving Tree Roots - An Update. Bonnie Appleton. 1995. Journal of Arboriculture 21(6):265-270.

Plant Production in Containers by Carl Whitcomb. 1984. Lacebark Publications Inc.

Production of Landscape Plants II (in the field). by Carl Whitcomb. 2001. Lacebark Publications, Inc.

The pour-through nutrient extraction procedure. Robert D. Wright. 1986. HortScience 21:227-229.

Trade publications -

American Nurseryman, 77 W. Washington Street, Suite 2100, Chicago, IL 60602-2904 1-800-621-5727; 312-782-5505; published semimonthly (24 issues per year) – fee.

NMPro (Nursery Management & Production), PO Box 1868, Fort Worth, TX 76101 1-800-946-6776; 817-882-4120; published monthly (12 issues per year) – free.