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Components of Sustainable Production Practices for Container Plant Nurseries

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Sustainable production practices in container plant nursery operations are methods developed to conserve or reduce natural resources needed to produce a crop. These include production practices aimed at reducing the levels of chemical fertilizers and pesticides; managing insects, diseases and weeds by utilizing an integrated pest management approach; reducing, reusing or recycling materials and supplies; increasing production efficiency; and using conservation practices aimed at reducing water consumption, managing runoff and controlling erosion. A listing of sustainable nursery production practices derived from literature review and selective nursery operation site visits in Florida and Georgia are provided.

Introduction

A survey of nursery and greenhouse plant growers found "going green" and "minimal or no negative impact on the environment" were definitions used to describe the term sustainability as it related to practices their businesses wanted to implement in the future (Dennis et al., 2010). The term "sustainability" has resulted from concerns over managing our planet's resources to meet our present needs and quality of life without damaging the ability of future generations to provide for themselves. Much of it has come about as a result of pollution concerns, increased usage of raw materials and energy consumption.

From an industrial point of view aimed at fulfilling market requirements, de Ron (1998) defines sustainable production as an activity resulting in products that meet the needs and wishes of the present society without compromising the ability of future generations to meet their need and wishes. It implies that sustainable production will minimize all kinds of waste as well as the use of natural resources, of raw materials and energy by continuously improving on production efficiency, quality, and the flexibility to bring a company closer to a state of sustainable (internal) production.

The 1990 Farm Bill approved by the U.S. Congress contains language that defined what sustainable agriculture is but it contains uncertainty or inexactness of meaning in the term's definition (Gold and Gates, 2007). To this end, specific industries, including segments of the green industry, have developed definitions for sustainable production. An example can be found in the floriculture industry where the Floriculture Sustainability Research Coalition defines sustainable floriculture production as one that aims to reduce environmental degradation, maintain agricultural productivity, promote economic viability, conserve resources and energy and maintain stable communities and quality of life (Dennis et al., 2010; Hall et al., 2010).

No matter which sustainability definition you choose to use, it has to be economically profitable, have a positive impact on natural resources and wildlife (the environment including protecting and recycling resources), and a social component of fairness to quality of life without damaging the ability of future generations to provide for themselves. Here we provide a preliminary listing of nursery and greenhouse sustainable production practices aimed at: reducing the levels of chemical fertilizers and pesticides; managing insects, diseases and weeds by utilizing an integrated pest management approach; reducing, reusing, or recycling materials and supplies; increasing production efficiency; and using conservation practices designed to reduce water consumption, manage runoff, and control erosion.

Participating container plant operations. Nursery and greenhouse operation site visits were conducted in north and central Florida, in north and south Georgia during mid-late 2010 and early 2011. Table 1 contains a list of participating container plant operations. At each location, growers were asked to demon-

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Table 1. Listing of participating nursery and greenhouse container plant production operations in north and central Florida and north and south Georgia.

Name of operation	Type of operation	Location
Athens Wholesale Nursery	Outdoor, shade, and greenhouse	North Georgia
Clinton Nurseries of Florida	Outdoor, shade, and greenhouse	North Florida
Evergreen Nursery	Outdoor, shade, and greenhouse	North Georgia
Grandiflora	Outdoor, shade, and greenhouse	North Florida
Hackney Nursery	Outdoor, shade, and greenhouse	North Florida
James Greenhouse	Strictly greenhouse	North Georgia
May Nursery	Outdoor, shade, and greenhouse	North Florida
Monrovia Growers Inc.	Outdoor, shade and greenhouse	South Georgia
Riverview Flower Farm	Outdoor, shade and greenhouse	Central Florida
Southeastern Growers	Field and outdoor	North Georgia

strate production practices including methods and techniques that they considered to be sustainable or that it added a sustainability dimension to their current production practices.

Reducing the levels of chemical fertilizers and pesticides. Container plant production requires relatively high levels of chemical fertilizers and pesticides to produce a sellable crop. These chemicals can potentially be taken up by irrigation runoff and pollute surface and groundwater. This problem is recognized by the nursery and greenhouse industry and is being addressed by implementing best management practices and integrated pest management (IPM) strategies, including: applying more environmentally benign pest controls; releasing biological agents; removing infected plants; following sanitation practices to reduce plant pathogens (Latimer and Braman, 1997); monitoring nutrient concentration in the container substrate, water, and plant tissue; and storage of dry bulk materials on concrete pad protected from rainfall and flowing water (Yeager, 2007). Table 2 contains practices used by growers to reduce chemical fertilizer and pesticide levels considered to be sustainable in their production operation.

Managing insects, diseases, and weeds by utilizing an IPM approach. An integrated pest management (IPM) approach to prevent unacceptable levels of pest damage to a crop in itself is a sustainable production practice. It involves the judicious use of pesticides in combination with other pest management practices such as using resistant cultivars, building up populations of beneficial organisms, monitoring numbers of pests, developing treatment thresholds and using spot treatments of pesticides that are the least harmful to beneficial organisms, wildlife and the environment (Gold and Gates, 2007; Mizell and Short, 2009). Table 3 contains IPM and other alternative practices used by growers considered to be sustainable in their production operation.

Reducing, reusing, or recycling materials and supplies. The Oregon Association of Nurseries and the Oregon Environmental Council have developed a guide on Best Management Practices for Climate Friendly Nurseries in partnership with the Oregon State University and Ecos Consulting to help participating nurseries reduce energy, resource inputs and greenhouse gas (GHG) emissions while achieving greater economic efficiency and profitability. The guide contains a section on "Reuse and Recycling of All Wastes" that addresses reducing, reusing and recycling aimed at rethinking how nurseries can decrease the amount of solid and liquid waste—whether it is soil, plastic pots, or water—leaving the nursery operation that would lead to decrease overhead costs in the process (Rideout and Hensey, 2010). To this environmental mantra of reducing, reusing, and recycling, we would also like to add the term repurposing. Table 4 lists practices used by growers considered to be sustainable in their production operation that reduce, reuse, recycle or repurpose materials and supplies.

Increasing production efficiency. The Economics-Dictionary.com defines production efficiency as a situation in which the most production is achieved from the resources available to the producer. It can be a measure of labor productivity, fine tuning the management of resources, or any practices that increase competitiveness and profitability. Managing resources such as increasing irrigation efficiency or mechanization/automation are examples of increasing production efficiency. In a survey of Gulf State nursery and greenhouse operations, Coker et al. (2009) reported on the types and levels of automation/mechanization employed by nurseries, greenhouses, and combination nursery and greenhouse

Table 2. Practices used by growers to reduce chemical fertilizer and pesticide levels considered to be sustainable by participating nursery and greenhouse container plant production operations in north and central Florida and north and south Georgia.

Sustainable practice	Practice in place
Low-toxic synthetics	Use of soaps and oils
Botanical insecticides	Use of plant extracts such as bio-rationals and chemicals that disrupt an arthropod's life cycle instead of using synthetic insecticides
Mulching	Pine straw placed on tops of pots; pine straw acts as mulch and helps with weed control
Sanitation	Rouging of infected plant material Use of resistant cultivars

Table 3. IPM and other alternative practices used by growers considered to be sustainable by participating nursery and greenhouse container plant production operations in north and central Florida, north and south Georgia.

Sustainable	Practice in place
Scouting (everyday)	Results in reduced chemical application sprays to just treating localized areas or hot spots
Scouting (in-general)	Practicing IPM with a focus on scouting and understanding pest
Sanitation	Propagation tables are bleached between each crop that is potted

Table 4. Listing of practices used by growers considered to be sustainable in their production operation that reduces, reuses, recycles, or repurpose materials and supplies north and central Florida and north and south Georgia.

Sustainable practice	Practice in place
Reducing	Results in reduced chemical application sprays due to just treating localized areas or hot spots
Reusing / Repurposing	Reusing liner trays for propagation and other uses such as stacking material; a buy-back and deposit system for landscapers and garden centers to allow plastic pot and tray reuse by grower
	Cleaning and folding greenhouse poly for re-use next year
	Clear "winter" polyethylene taken off greenhouses in the spring is often trimmed and reused on smaller greenhouses or end walls the following fall
	Office furniture purchased at surplus auctions
Recycling / Repurposing	Michigan recycler located for recycling poly
	"Sometimes we line swales with old poly and then cover with ground cloth. This is to help water to run through our swales, not be absorbed into them."
	Re-purposed hog farrowing facilities; these had concrete walls that were knocked down, broken up and pieces used for terracing, erosion control in ditches, etc…
	Converted old hog houses into propagation greenhouses
	Bottom heat applied through wastewater collection system formerly used for hogs (floors were slatted concrete so warm air rises and heats bottoms of trays)
	Triple-rinsed insecticide containers used for anti-freeze, oil and oil filters storage before recycling
	Recycle newspaper, aluminum can, empty plastic bottles, dead batteries, florescent light bulbs, cardboard, motor oil, oil filters, anti-freeze, oil-dry, and office paper. Employees are encouraged to use both sides of all white paper before it is finally re-cycled
	Old malfunctioning computers are broken down for parts and used for assembling additional workstations or repairing other computers and outdated computers and aging cell phones are sold on Craig's list, given to employees, or donated to local charities
	Car/truck salvage area for the purpose of using spare parts on other vehicles/tractors/wagons and purchasing of same model/make of cars/trucks so parts would be interchangeable
	Recycling and composting of potting media mix (from dead plants or donating older (unsold) plants) for sale to community
Combination of practices in one operation	Plants propagated in ground beds using sand amended with soil from their bare root operation that otherwise would be discarded. Plants grown in 1-gal containers are shipped bare root (saves on weight) with potting soil knocked off and put in ground beds. Pots are reused. Recycled newspaper is used to line boxes and as packing material to protect plants. Office waste paper is shredded and added to unmilled peat to use in shipping bare root plants.

operation. These included: substrate mixing; container filling; moving containers from potting to transport vehicle for movement through nursery; transporting containers to field; spacing containers; placing plants in field; picking plants and loading on transport vehicle at time of sale; removing plants from transport vehicles in holding area; loading plants onto delivery vehicles; plant pruning; fertilizer application. All of which to a greater or lesser degree added to increasing production efficiency. Similar practices were reported on Table 5.

Conservation practices designed to reducing water consumption, managing runoff and controlling erosion. The increase of population and infrastructure to support our daily living is creating water shortages throughout this county and in many parts of the world. Reducing water consumption, either voluntary or by mandate, can become a major dilemma for ornamental plant production operations. Emerging container plant irrigation technologies, such as micro-irrigation and sub-irrigation, are designed to utilize and conserve water more efficiently (Sharma et al., 2006). Other technologies, such as soil moisture sensors, are gaining greater acceptance as the cost and availability continues to become more affordable. Capturing and reusing irrigation runoff is a best management practices widely adopted by container plant production operations. Table 6 lists some of the technologies and conservation practices used by growers to reduce water consumption, manage runoff and control erosion.

Summary

Conventional nursery production relies heavily on the use of plastic containers, chemical pesticides, synthetic fertilizers and imported substrate ("potting soil") components. This reliance on non-indigenous and/or synthetic materials is costly as well as unsustainable. Social, economic and regulatory trends suggest nursery producers will be receptive to sustainable production methods. Higher oil prices are increasing the costs of fertilizers, pesticides, plastic containers and shipping. Climate change is becoming widely accepted and consumers are responding with the desire for all producers to reduce their carbon footprint. Federal regulations such as Worker Protection Standards, the Clean Water Act and regional irrigation restrictions have caused nursery producers to become more aware of and manage more judiciously their use of synthetic or resource-intensive production components

Table 5. Practices that increased production efficiency and considered to be sustainable by growers in north and central Florida and north and south Georgia.

Sustainable practice	Practice in place
Efficient production methods	Rebar network through holes of socket pots to prevent container blow over
	Wider path down center of each overwintering house to allow easy pulling of orders using small tractor with nursery wagon
	Converted to new irrigation heads that hang from tops of hoop houses, thus gaining more usable space in hoop houses
	Converted to clear plastic overwintering house which warms up faster allowing grower to finish a crop sooner to beat competition
	Similar types of crops grown (e.g. groundcovers or perennials) resulting in fewer distinctive production practices, pesticides, employee training, etc…
	Fewer container sizes used (two sizes of plug trays) resulting in more uniform production practices
	A nursery that ships in new frozen poultry boxes as they are cheaper in price and readily available: Plant orders are taken to the field where workers pack plants directly in to the boxes
Mechanization	By purchasing an "Elle Pot" machine, greenhouse operation eliminated supply issues
	Cleaning and folding poly for re-use next year
	Use of a machine to prune trays of plants and collect clippings for future propagation material
	Use of hanging racks, rolling racks and conveyors to move plants efficiently and quickly
Media substrate	Use of composted peanut hulls in soil mixes
	Use of nu-peat (composted yard waste) in potting mix instead of sphagnum peat or Florida peat

Table 6. Technologies and conservation practices used by growers to reduce water consumption, manage runoff and control erosion considered to be sustainable by growers in north and central Florida and north and south Georgia.

Sustainable practice	Practice in place
Ebb-and-flow system[z]	The ebb-and-flow system is very common and is quite familiar to most growers. The system consists of a shallow, molded plastic bench top which is flooded to water and fertilize the plants; when irrigation is complete the remaining solution drains from the bench and is pumped back to a storage tank for reuse
Greenhouse boom irrigation[y]	One of the most efficient methods of effectively delivering water to plants is via an overhead boom irrigator. A series of nozzles spaced across a length of pipe when activated applies a band of water that is remarkably uniform. Due to this uniformity, booms are able to apply water/chemical solutions far more efficiently than fixed sprinkler systems. When coupled to a motorized carrier riding on a track system, it truly becomes a low cost means of irrigating large areas in a relatively short time
Electronic SMS	Electronic soil-moisture sensor controlled irrigation with wireless connections to base station in the office. The grower can check the base station daily during summer months to determine the water status of plants with sensors, and actively used these sensors to schedule irrigation
Low volume irrigation	New overhead irrigation heads (using lower volume of water) than previous shrub heads (huge water savings), applying water more uniformly and more slowly (allowing better infiltration and absorption by the substrate and plant)
	Less fertilizer leaching (saving two pallets of fertilizer/year since less volume went through the containers)
	Drip irrigation line mounted along the tops of containers rows, dripping irrigation water directly into containers
	Capillary mat irrigation system
	Reduces runoff and potential soil erosion since much lower quantities of water is used
Capturing and reusing irrigation runoff	New fields designed and older ones adapted to catch and channel run-off back to a holding pond to capture and re-use the water we pump out of the ground as well as trapping our erratic rainfall
	System of ditches, weirs, retention ponds and artificial wetlands to carry, filter and store runoff for reuse
	Sand filter/rain gardens used to mitigate nutrients in runoff and erosion

[z] <http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/ghsubirr.html>.
[y] <http://www.spraytec.com/11/greenhouse-watering-systems-boom-irrigation>.

such as pesticides, water and fertilizers. Due to the competitive nature of the nursery business, producers need a solid business plan to be financially as well as environmentally sustainable.

Adoption of sustainable nursery production practices will promote financially sustainable businesses using environmentally sound agricultural practices. Marketing and/or cost advantages of sustainable production techniques may allow smaller nursery producers to effectively compete with larger producers that use conventional, synthetic components and economies of scale as their primary means of nursery production and business success. Practices that move producers towards sustainable production of nursery plants could foster the development of new specialty sustainable-production nurseries thus creating a new market niche for small and mid-size farms (i.e. "locally grown using sustainable methods") as well as promoting productivity and sustainability for limited resource farms. With the adoption of more sustainable practices, producers should also have the ability to reduce input costs related to fertilizers and chemicals as well as reduce potential point source nutrient and chemical pollution.

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