This article discusses some of the many benefits of a relatively new nursery stock container production system, pot-in-pot (PIP) growing. PIP production is a significant trend in the American nursery industry, and many growers throughout that country will continue to shift to this production method.

**Advantages**

PIP production eliminates the heat stress and root-killing temperatures conventional container culture sometimes experiences. Wind knocking plants over is another time-consuming and laborious drawback of conventional container culture. Wind-tipping is also detrimental to quality stock.
production as top-dressed fertilisers and media are knocked out of the pot and irrigation applications can be missed or delayed, resulting in drought-stressed plants. In conventional container production, winter cold protection for plant roots is also costly and time consuming.

The PIP system can also eliminate many of the problems associated with conventional field stock production. In conventional field production, a tremendous amount of soil is lost or ‘mined’ during harvesting balled-and-burlapped (B&B) in-ground stock. Conventional nursery field production also results in more soil compaction than in any other type of farming. In this article we will discuss how PIP production has addressed some of these conventional production difficulties and problems, and some of its pitfalls.

**Impact on heat stress**
The importance of keeping container substrate temperatures below 38°C is well documented; however, substrate temperatures in above-ground containers in the U.S. state of Oregon have been measured above 49°C. In the U.S. state of Florida and other southern U.S. states, temperatures as high as 58°C have been recorded. Normal root functioning ceases when root zone temperatures exceed 31°C for holly plants and at even lower temperatures for plants that are less heat tolerant.

In above-ground containers, the roots in the western quadrant of the container are often injured or killed by the high temperatures. In the PIP system, roots in the western quadrant were cooler than in above-ground pots. Plants that experienced high root zone temperatures suffered loss of chlorophyll and protein production in shoots. Research indicates this has a significant impact on overall plant health.

**Impact on drought stress**
PIP systems generally use drip irrigation with in-line emitters. Designs vary in delivery rates, however 2.3 litres per hour has been used with success. Because the root systems of PIP plants were contained, trees grown in the PIP system required less water than plants grown in conventional field culture. Irrigation was applied every two days to PIP plants for four hours at a time. Field-grown trees required watering for eight hours.

Shrubs in smaller diameter pot-in-pot containers at Klupenger Nursery and Greenhouses Inc., Aurora, Oregon, United States. Pot-in-pot production is growing rapidly in the United States, most commonly among growers of shade, fruit and flowering trees, though the system is suitable for shrub production as well.
It is estimated that harvesting B&B stock can result in the loss of 190 metric tons of soil per hectare during the removal of a hectare of 110cm diameter B&B trees. Soil removal due to ‘mining’ has enormous implications to the economic viability of a field nursery. PIP is one management practice that can reduce soil mining. Of course, PIP requires relatively permanent modifications to a nursery field that result in soil profile changes. If for some reason you reverted a field from PIP to conventional culture, the soil levels would be virtually unchanged.

### Impact on soil compaction

Performing intense field activities when soils are wet, results in soil compaction and reduced soil porosity. The overall effects of conventional nursery field culture result in the reduction of the soil’s productive potential and increased cost of production. Cover cropping reduces compaction by reducing the frequency of use of heavy equipment through ‘minimum tillage’ and by providing support to heavy equipment during wet weather. Compaction of nursery soils is much more harmful than growers

John Ruter, a horticulturist at the University of Georgia USA, evaluated cyclic (pulse) irrigation on water use and found cyclic (pulse) irrigation reduced the amount of water leached through the container in the PIP system by approximately 100 percent. The combination of soil insulation and trickle irrigation ensures essential moisture levels are maintained, eliminating the effects of drought stress that may occur in conventional container culture or even field situations.

The soil insulation also results in more root mass in PIP-produced plants. Therefore, PIP plants are better adapted to avoid drought stress in the nursery and after out-planting than conventional container-grown plants.

### Drainage important

Ruter notes that reducing the amount of water leached through the planted container also is important, since good drainage away from the holder pot is essential to the success of PIP. Sandy soils are well suited for PIP production. Growers need to take precautions if their sites have heavy soils that drain poorly.

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realize. Using PIP, compaction is minimized due to reduced need for heavy equipment to lift the stock. Compaction in the root zone is nil because of the use of artificial media.

Overcoming rooting out
One of the problems with PIP has been the rooting out of the plant from the planted container, through the holder pot into the surrounding soil. Rooting out results in plants having to be manually dug and root pruned before the planted container can be removed from the holder pot. Various products have been tested for their ability to prevent rooting out.

John Ruter has done most of the work in prevention of rooting out. He concluded in 1994 that Biobarrier (a geotextile fabric impregnated with the herbicide trifluralin) was the best treatment for control of rooting out, but also reduced plant growth. He also states that Spin Out (a commercial formulation of copper hydroxide painted onto the side walls of the holder pot) has been useful for reducing rooting out problems but does not eliminate them. Physical controls such as Environmentally Friendly Containers, water pruning and air pruning have had limited success with vigorous-rooting species.

He has continued his rooting out studies since 1994, looking at the rate of Biobarrier to reduce rooting out in vigorous-rooted species but not causing phytotoxicity. Recently he has been conducting trials with Spin Out-treated fabric bags such as Tex-R Agroliners. He concludes in 1997 that the Tex-R Agroliners do a good job of preventing rooting out of some vigorous-rooting plants and that the bags were easily removed from the root ball, since the roots were not growing through the fabric. The Agroliners are used as a bag-in-pot-in-pot production system.

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*Dr. Hannah Mathers is nursery crops regional extension agent with Oregon State University’s North Willamette Research and Extension Center in Aurora, Oregon.

She can be contacted by fax at +503-678-5986, or by e-mail at hannah.mathers@orst.edu.

Further reading