Solutions for Pot-in-Pot

Root Escape, Root Circling, and Heat Shock at Harvest

by Dr. Carl E. Whitcomb

Heat, cold and blow-over have been major problems plaguing plant production in the unnatural environment of a man-made container since the beginning. Roots evolved in soil, generally protected further by an insulated mass of surface debris. Sensitivity to temperature extremes by plant roots appears to vary modestly among species. Installing a 'socket' pot in the ground, then inserting a production pot inside seemed like the golden answer. But up until now, in many locations it has turned out to be more akin to iron pyrites.

The technique was first tried with high expectations in 1973 and 74 (2). The two soils available were a clay loam and a sandy clay loam in which most species grew well. However, pot-in-pot studies during two growing seasons ended with dead plants following rainy periods, so was written off as a good idea that did not work. The concept next surfaced in 1990 when Lancaster Farms, near Suffolk, VA reported on their success with the concept in deep sand soils (3). Since that time we have watched with interest the assortment of successes, errors and problems that have come to light from this production procedure. (1, 4, 6).

Pot-in-pot has turned out to be a classic case of the 'good' news and the 'bad' news...
The 'good' news is:
a) Plants do not blow over,
b) Roots are kept cooler in summer and warmer in winter and more in line with their natural environment
c) More roots may be produced compared to above ground conventional plastic containers with some species.

The 'bad' news is:
a) Soils that drain well are a must,
b) Plants are still in conventional containers where roots circle and intertwine and are terrible by time of harvest,
c) Root escape through drain holes is a major problem that can create chaos at harvest and shock plants severely,
d) Techniques such as copper coated pots and release of Treflan from Biobarrier material have provided only moderate benefits to the root escape problem,
e) Once above ground at harvest and the sun hits the exposed side of black containers, root death can occur in as little as 15 minutes. With roots heavily concentrated against the inside wall of the plastic container, if a container is handled such that several sides are exposed to the sun, plant appearance and salability can be affected and rate of establishment in the landscape slowed or worse and
f) It appears that roots produced in a pot-in-pot system are more sensitive to heat compared to roots of the same species in above ground containers. Ruter (5) reported that pot-in-pot plants are more susceptible to root damage by high temperatures during post production handling compared to plants gown conventionally above ground. In the revised edition of Production of Landscape Plants II (9) it was noted that "Some mechanism is needed to stop roots from circling and to stimulate root branching. At this point in time, I know of no practical solution", and that "root escape is a major problem".

In 2000, a procedure for laminating certain fabrics with white polyethylene was developed. The initial tests were done by sewing the coated fabric into containers that fit into cavities of a cinder block. Tree seedlings of several species were allowed to grow for five months. No root escape occurred with most species and only a few thread-sized roots exited seams even with aggressive Catalpa. Root tips were trapped in the fabric which stimulated branching. Seedlings were then removed and planted into five gallon containers following removal of the fabric.

Catalpa, *Catalpa speciosa*, seedlings evaluated 10 days after transplanting, had produced huge numbers of roots averaging nine inches long (8), Figure 1. These results suggested that making a container from this material might solve the major problems of pot-in-pot.

Figure 1. When the white fabric RootTrapper® container was removed a very fibrous root system could be seen (above). Ten days following transplanting into five gallon containers, catalpa seedlings were removed and evaluated for root growth. Large numbers of roots had grown out from the original root ball and with some nine inches long (below).

Methods and Materials

On July 12, 2003, a study was established using Nursery Supplies 15 gallon, 6900T as the socket pot and production pot or with the production pot made of white root-tip-trapping material now called RootTrapper®. Growth medium was pine bark, peat and sand (3-1-1 by volume) amended with Micromax®, dolomite and Osmocote appropriate for the irrigation water used and soil temperatures. Containers were installed in a sandy loam soil with sufficient drainage and irrigation was by individual spray stakes, one per container. Species used in the study were three or five gallon; loblolly pine, *Pinus taeda*, crapemyrtle, *Lagerstroemia indica*, pecan, *Carya illinoensis*, shumard oak, *Quercus shumardi*, catalpa, *Catalpa bignonioides*, river birch, *Betula nigra* and bald cypress, *Taxodium distichum*. Treatments were replicated three, four or five times, depending on number of plants available for each species.

On August 31, 2004, two plants of each species and each production container type were removed from the socket pot beginning at 1:30 pm on a clear sunny day when air temperature was 92 F (36C) and exposed for about 2.5 hours. Center of exposed side of containers were marked for future reference prior to replacement in the socket pots. Plants were maintained with normal watering and conditions until Sept. 8 when they were again removed for evaluation. By this time roots killed by heat were black and distinct in comparison to healthy roots. In addition, containers that had never been exposed to the sun were removed for comparison of root conditions.

Results and Discussion

Root escape occurred with all species with conventional pots, Table 1. Root escape also occurred with white RootTrapper® containers, with catalpa, crapemyrtle and river birch, however, there was a huge difference in numbers of roots and size of roots that escaped. For example, with catalpa in conventional pots, escape roots were 0.4 to 1.0 inches in diameter and completely filled some drain holes making removal of the containers challenging, whereas in white RootTrapper® containers escape roots were few and about 0.1 inch diameter or less, Figure 2. Escape roots were few and less than 0.1 inch for crapemyrtle and river birch with the white RootTrapper® containers. Further, roots were girdled where they grew through the vertical or bottom seam, restricting their growth and making their removal easy.

Table 1. Evaluation of Root Escape, Root Heat Damage, and Root Circling in Conventional Black Plastic Containers VS. White RootTrapper® Containers used as Production Pots in Pot-In-Pot.

	Root Escape Conventional Container	Root Escape RootTrapper	Root Heat Damage Conventional Container	Root Heat Damage RootTrapper	Root Circling Conventional Container	Root Circling RootTrapper
Loblolly Pine	10	1	10	1	10	1
Crapemyrtle	6	2	10	1	10	1
Pecan	6	1	10	1	10	1
ShumardOak	5	1	10	2	8	1
Catalpa	10	3	10	1	10	3
River Birch	6	2	10	1	9	1

Root Escape, Root Heat Damage, and Root Circling were rated on a scale of 1-10, where 1= none and 10= severe. Roots exposed to sun for 2.5 hours were compared to those never exposed to estimate damage. Values are averages of two or three replications.

Figure 2. Root escape was severe with conventional production pot and catalpa with three of six drain holes fully blocked in this example. Only a few roots had escaped the RootTrapper production pot at the seams and had made little growth outside the container (above). Loblolly pine also had extensive root escape in the conventional pot, but no roots escaped the RootTrapper® (below).

Root circling was extensive in conventional pots, with roots concentrated against the outside wall, Table 1. Root circling was nonexistent in the white RootTrapper® containers, with root branching throughout the container growth medium Figure 3. Sections cut from sides of rootballs showed many more roots distributed throughout the growth medium with RootTrapper® containers vs. conventional containers. Root distribution throughout the growth medium aids water and nutrient recovery and plant growth, plus, reduces root vulnerability to temperature extremes during harvest, shipping and storage.

Figure 3. Sections were cut into the root ball of catalpa trees in a V about four inches wide and four inches deep and from top to bottom using a hand saw. Note that roots in the conventional container were mostly on the outer surface and few roots were exposed in the growth medium (above). By contrast, few roots can be seen on the outer surface of the root ball after the RootTrapper® fabric was removed, but many roots can be seen back in the growth medium (below).

Root death following harvest and 2.5 hours exposure to sun was severe in all black conventional containers, Table 1, Figure 4. By contrast, roots against the inside surface of the white RootTrapper® fabric containers remained white and normal due to the 20 degree F (12 °C) reduction in temperature, Figure 5. In addition, since roots in the RootTrapper® containers were distributed throughout the growth medium and not concentrated at the inner wall, they were much less vulnerable to temperature extremes (Figure 3).

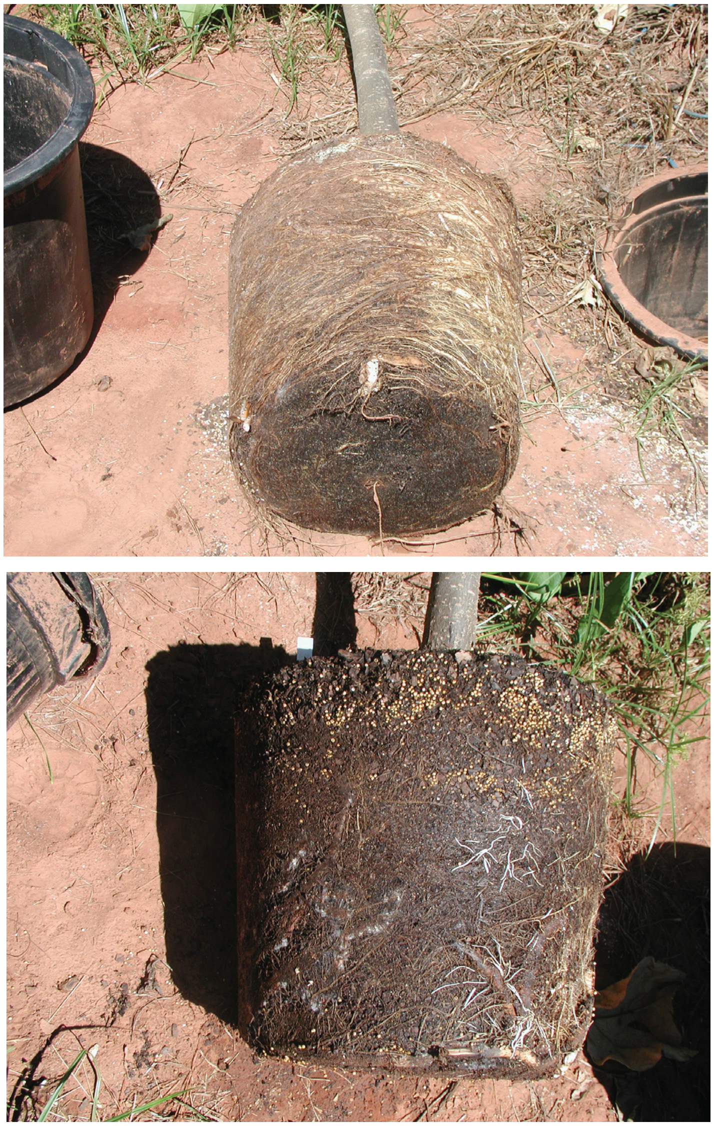

Figure 4. Catalpa roots in conventional black pots exposed for 2.5 hours were dead. Note the distinct line of root death. In a few cases roots were dead beyond the exposed area. Those roots had originated on the side of the container not exposed to the sun, extended through the exposed area and beyond. When the root was killed in the exposed area, the root extending beyond was killed as well (above). Roots as large as 0.4 inches exposed to the sun were killed, but only about the outer 2/3. Note the large root at lower right. New white roots had grown from tissue on the back side that had survived the heat and in just eight days (below).

Figure 5. With white RootTrapper® fabric containers, white root tips were present on the exposed side of the container and on the surface of the exposed growth medium (above). When the surface of the root ball was brushed to remove some growth medium, many additional white roots were observed (below).

Constructing the production pot of white RootTrapper® fabric solves three major problems of pot-in-pot production. It is important to note that drainage of water through the field soil outside the socket pot remains a critical ingredient and must not be overlooked when using this production procedure. Roots were present at the very bottom of all containers of both types of all species, which confirms growth medium used and drainage of soil on the site were satisfactory. It further suggests that drainage through the myriad of stitch holes in the vertical seam and bottom of the white RootTrapper® container was sufficient. If drainage of soil supporting the socket pot is even marginal, this technique is not recommended. Instead, above ground systems for protecting plants from blow over and insulating roots from heat and cold should be considered (7).

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