# Review of Root Manipulation in Containers©

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Plants were not designed to grow in containers and, as a result, there are many potential problems growing plants in containers such as the possibility of poor quality root system and drainage aeration issues. This can lead to poor performance of plants at any time in their life even many years later.

In my opinion there are many root-related problems in standard containers that hold back plant performance. Problems like circling roots are some of the worst type of bad roots created in containers (Fig. 1).

Fig. 1. Typical problem of circling roots in a container.

I believe the objective should be to produce as natural a root system as possible with straight, non-circling or even deflected roots in the liner leading to a good long-term root system with lateral support/feeder roots and some straight roots going deeper to create support. The *Eucalyptus* transplant root system in Figure 2 is almost indistinguishable from a natural root system.

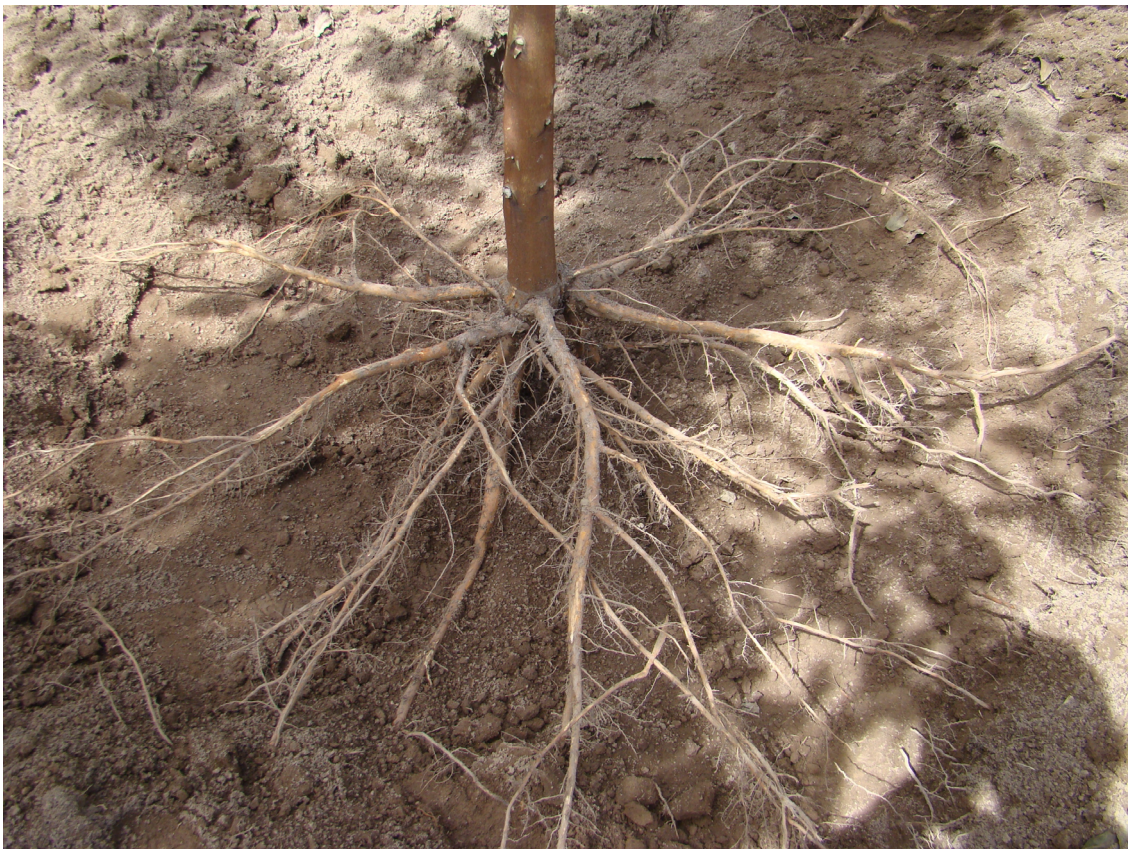

Fig. 2. Fantastic roots are possible with a container plant.

There have been many options to regular containers developed over the years with things such as copper treatment of containers, root trapping material on the inner wall of containers, and air pruning of the root system in containers. It would seem that air pruning is becoming the most popular method of doing this which is logical since there are no chemicals involved and it is a very natural process which allows for the reduction or elimination of bad quality roots, the increase in the total number of roots, and also the possibility of a better micro-climate in the pot.

Air pruning is a much misused term so buyer beware. Check what the offer really is as some people claim air pruning when it's not really happening. Plus, you can get air pruning just at the base of the cell or additionally up the side walls of the cell, the latter is more desirable in the short and long-term.

An example are Ellepots which are often said to air prune roots but this depends totally on what holding tray is used. The thermoformed type tray will create a useful air gap at the side of the Ellepot but not air pruning of the roots. If, however, an Ellepot is placed in a good air pruning tray where contact with the tray is minimal fully exposing roots to the air then air pruning can take place. Figure 3 shows a *Eucalyptus* liner grown in a good tray with air-pruned roots well up the side of the cell, not pretty but effective.

Fig. 3. A well-air-pruned *Eucalyptus* plant in a 35-mm Ellepot.

The question that has baffled me, therefore, is why are root manipulation containers such as air pruning containers probably used today by less than 1% of growers? If an air-pruning container was going to produce a much better root system people would want to use it, but this has not been the case to date for most nurseries.

My theory is that to be used widely within the industry a container needs to be not only able to produce fantastic roots but also be economical and practical. To date, many of the newer containers are expensive and also have not fitted in with normal nursery practices very well (e.g., they are not easy to use). I believe, therefore, that the challenge is for container suppliers to come up with economical and practical containers that produce great root systems.

Typically, air pruning containers are injection molded which means they are a long-life product and more expensive than a thermoformed tray. If, for example, an air-pruning tray is $4 and a thermoformed tray is $1, but only gets used once or twice then the cost per use is about $0.75 per use versus an air-pruning container that should last well over 20 uses and is, therefore, only a maximum of $0.20 per use. Thus, the injection molded container is considerably cheaper per use even if more expensive up front.

If you buy, say, 100,000 containers then even if they last a long time it is still a large up-front investment in cash terms versus a 1-trip cheaper product. However, in recent years this problem has been overcome with finance packages where the product can be leased over, say, a 5-year period. The result is that good trays can now be cheaper per use plus cheaper in cash-flow terms. Hopefully, this can overcome the economic barriers.

If plants are shipped out from the nursery in trays then the ability to be reused may not be practical so other 1-trip air-pruning trays need to be developed. If, however, plants can be pulled and packed or reused internally then the reusable propagation tray can remain on the nursery. One example here may again be with Ellepots that are essentially containers and can be shipped out easily without the tray in which they were grown.

Another angle to the acceptance of the “air-pruning” container is making it practical on the nursery. This means making it easy to use and fit in with current nursery and future nursery practices reducing labor and the amount of handling required. Some of the operations on the nursery that are affected are:

De-stacking
Filling
Stacking
Transplanting

| | |
|---|---|
| Grading | Transport in the nursery |
| Benching | Pulling and shipping |
| Rigidity of tray | Cleaning and sterilizing |

Here is a link to a video from a nursery in Uruguay using Ellepots for clonal *Eucalyptus* propagation which is pretty automated: (http://ellepot.dk/ellepot-videos/forestry/stora-enzos-nursery-montes-del-plata-in-uruguay-propagating-eucalyptus-with-the-ellepot-system.html).

The following list contains items that a good air-pruning container should improve on thus reducing unit cost price of plants propagated:

- Percentage take of cuttings (aeration/drainage)
- Uniformity of take
- Speed of take (30% reduction on *Eucalyptus*)
- Shelflife in container
- Tray cost and cash flow (leasing)
- De-stacking in nursery
- Grading and re-filling of trays
- Semi-automatic and automatic transplanting
- Percentage take and speed of establishment in next container size
- Faster top growth in next container
- Faster to fill container with roots
- Uniformity and grade out of plants
- Stability of plants after establishment

Just a small improvement in a few of the above can reduce unit price of plants and thus boost profits and get a plant with a great root system as a bonus.

**AIR PRUNING PROCESS**

I would now like to describe a little bit more by way of re-cap the air pruning process and some of the benefits it has on the root system. The animation on this link shows how air pruning works: <http://www.youtube.com/watch?v=iW_NkywQtoU&feature=youtu.be>. This air-pruning process multiplies the number of roots in the container resulting in:

- A very large quantity of young vigorous roots in the container.
- A large proportion of the roots are in the upper half of the container rather than the active roots just being at the base of the container.
- The container, by definition, is also very well-drained and aerated which seems to have given a big advantage to the health of the microclimate in the pot.
- Less defective bad roots in the container.
- Figure 3 shows a *Eucalyptus* plant in an Ellepot with air-pruned roots, a bit messy, but a great root system that will establish very well.

The theory, therefore, is that the large quantity of young roots will establish better when transplanted into a larger container or the field. Figure 4 shows a regular container alongside a container with air pruning at the base of the container and thirdly a container with air pruning up the side of the container as well.

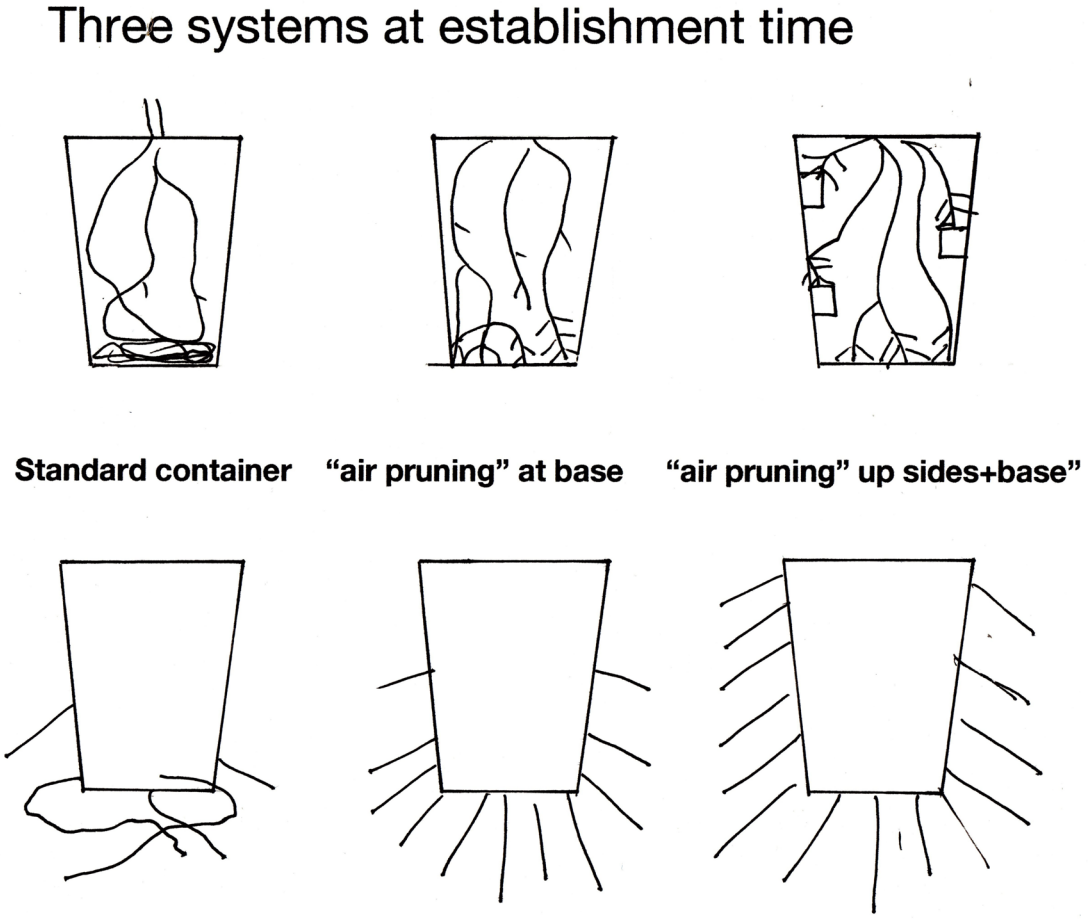


Fig. 4. Roots before and after planting with a regular pot, one with air pruning on the base and one with air pruning also up the sides of the pot.

I'm afraid to say that most of my observations are based on just that, observing what I see going around the nurseries and aiming to try and improve things. As yet there is little true science to this, but I'm pleased to say that there are some projects starting soon that will quantify some of the benefits of manipulated air-pruned root systems and establish some more scientific data.

Air-pruning container options are now available from a number of sources such as Nursery Source, Nursery Supplies, Stuewe, Blackmore, Rootmaker, and Proptek so check what suits you and perhaps do a trial. However, do the trial properly as air-pruning containers tend to require less water more often and trials are often spoiled when not treated properly. Air-pruning containers also need air movement to work and this means the containers are often smaller but this may well still have a larger active soil volume versus big pots with "dead" areas in them.

Check what suits you, do a good trial, convince yourself the system is right and the product is practical and economical then change.

**QUESTIONS AND ANSWERS**

Damian Sowa: We have to grow all our plants in styroblocks for insulation purposes, do you see any way of getting an air-pruning system in a styrofoam insulated block?

John Cooley: No.

Antonio Sanchez: What's the smallest size available for the air root-pruning (ARP) pot?

John Cooley: It depends on the configuration of the pot. For example, Ellepots get quite small and can be configured as an ARP pot. I would say that right now the smallest ARP pot is about 1½ in. across the top. More and more ARP pots will become available with

time. The limiting factor is that you need to have air flow around the root ball to achieve air pruning which limits the space you have. So, getting smaller gets to be more of a challenge.

Antonio Sanchez: What's the average price in the USA for a 1-gal container?

John Cooley: Different suppliers will have different prices. They'll probably be more expensive than the regular pots so you'll have to balance the cost with the added benefits.

Valerie Sikkema: How do you make the ARP pots work when the plants are sold at a retail nursery?

John Cooley: ARP pots do look a bit unsightly so the challenge is to wrap them with something before they're shipped.

Esteban Herrera: When was the data taken for determining mortality rates?

John Cooley: I'm not familiar with that data. That slide was used to illustrate the point that we have a great deal of data showing the response of plants to the ARP process.

Alan Elliot: Do you think there is a point where you can have too many roots in a container?

John Cooley: I think in terms of the number of roots in a container, you're absolutely correct. We've found that upon transplantation some roots are lost leaving the strongest ones to take over and become the roots that will grow out.