Nursery
FACTSHEET

BRITISH COLUMBIA | Ministry of Agriculture

July 2015

Importance of Aeration in Container Media

INTRODUCTION

Inadequate drainage and aeration of container media is a limiting factor in the production of quality nursery crops. In severe cases, this may lead or contribute to premature death of the plant.

Placing a particular growing medium in a container reduces its aeration porosity due to the phenomenon of a "perched' water table. Therefore, it is important that the nursery operator considers options to increase drainage and aeration of the medium and, in doing so, promote healthy and vigorous plant growth.

AERATION AND PLANT ROOTS

Plant roots, like other plant parts, require air for the process of respiration. This essential metabolic process is fundamental to living organisms, and involves oxygen from the air reacting with stored foods within the plant cells. This releases energy for essential plant functions, such as the uptake of mineral nutrients. Roots without adequate access to aeration and oxygen will result in plants that are weakened, exhibit slow growth and are predisposed to adverse environmental stresses, such as winter injury, pests and diseases.

Aeration is also necessary for the diffusion of carbon dioxide away from the roots to the soil surface. This gas is formed from the respiration of root cells and microorganisms, as well as from the decomposition of organic matter. The growing medium must be sufficiently porous to avoid the accumulation of carbon dioxide that can suffocate plant roots.

A lack of aeration caused by poor drainage leads to a wet, waterlogged condition that is ideal for the development of soil borne diseases, such as *Phytophthora* and *Pythium* that are responsible for devastating root rots and damping off. Under more aerated conditions these pathogens would normally be held in check.

SOIL POROSITY

Aeration is basically a function of soil porosity. Growing media consists of solid particles, such as peat or bark, as well as the pore spaces both between and within these particles. These pore spaces are categorized into either large pores, which normally are filled with air, and the smaller pores that are normally filled with water.

A good medium should have a total porosity in excess of 60-70%, measured as the volume of pore space compared to the total volume of growing medium. The aeration porosity, defined by the large pores, should be at least 20-25% and as high as 45% in warmer greenhouse conditions where there is increased demand for oxygen by roots, as well as an increased production of carbon dioxide.

Table 1. How to measure the porosity characteristics of a growing media, including total, aeration and water-holding porosities

Equipment

1. Container with a drainage hole at the bottom.
2. Plug or waterproof tape for sealing the drainage hole.
3. Graduated cylinder or some other way of measuring liquid volume.
4. Watertight pan that is wider than the bottom of the container.

Procedure

1. Seal the drainage hole in the container and fill it with water. Measure the volume of water in the container and record as "container volume."
2. Empty and dry the container and fill it with growing medium. Slowly saturate the growing medium by gradually pouring water onto the surface. Continue adding water over a period of several hours until the growing medium is completely saturated (the surface glistens). Record the total volume of water added as "total pore volume."
3. Place the container over the watertight pan and remove the seal from the container drain holes. Allow all the free water to drain out of the container (this may take several hours). Measure the amount of this drainage water and record as "aeration pore volume."

Use the following equations to compute total porosity, aeration porosity and water-holding porosity:

$$\textbf{Total porosity (\%)} = \frac{\text{total pore volume}}{\text{container volume}} \times 100\%$$

$$\textbf{Aeration porosity (\%)} = \frac{\text{aeration pore volume}}{\text{container volume}} \times 100\%$$

Water-holding porosity (%) = total porosity - aeration porosity

Table 1 shows how to calculate total, aeration and water-holding porosity. Although increasing aeration will result in a corresponding decrease in water retention, this is still a more preferred situation. It is always better to irrigate more frequently than to not have sufficient aeration in the medium.

The best way to achieve sufficient aeration is to select media ingredients of sufficiently large particle size (Table 2). There should be a sufficient proportion of coarse textured components in the size range of 1-2 mm. For example, a good quality, fibrous sphagnum peat moss should be used rather than a more decomposed, less fibrous type of peat moss, like hypnum.

The stability of a component in a nursery mix needs to be considered. Although sawdust in a mix results in high aeration porosity initially, its rapid decomposition would result in a dramatic decrease over time. Bark has a higher lignin content than sawdust, which makes it more resistant to decomposition. For this reason, bark should be used instead of sawdust. Inorganic components like perlite and vermiculite have the advantage of not being subject to decomposition, although the latter can lose much of its porosity through compaction.

PERCHED WATER TABLE

Placing a growing medium in a container creates the phenomenon of a "perched" water table at the bottom of the container, where all pore spaces are filled with water. This saturated situation, and resultant loss of aeration, occurs no matter how many drainage holes there are in the container. This is usually not a problem in a field situation, as the water table is usually relatively deep, as opposed to being almost at the surface in a shallow nursery flat.

CONTAINER DEPTH

The only way to reduce the effects of a perched water table is to increase the depth of the container. By increasing the depth of the container, the percentage of saturated medium at the bottom of the container is reduced. The deeper the container, the greater the overall aeration and the less the pores are filled with water. For example, the aeration porosity of a particular growing medium will be significantly higher in a 6 inch pot versus a much shallower plug tray (see Table 3).

Table 2. Comparison of the porosity for standard growing media components (Adapted from Johnson, 1968)

Component	Porosity (% by volume)		
	Water-holding	Aeration	Total
Sphagnum peat moss	58.8	25.4	84.2
Hypnum peat moss	59.3	12.4	71.7
Vermiculite	53.0	27.5	80.5
Perlite	47.3	29.8	77.1
Fir bark	15.0	54.7	69.7
Sand	33.7	2.5	36.2

Table 3. Effect of container depth on aeration and water content[1] (Adapted from Fonteno, 1987)

% of Total Pore Space	6 inch Pot	4 inch Pot	BP Cell	Plug Tray
% Aeration	21%	15%	9%	3%
% Water	49%	56%	61%	68%

[1] Growing medium used was a 3:1:1 mixture of pine bark, peat and sand

BP cell = Bedding plant cell (48/tray)

Plug tray = 273 plug tray

Increasing the depth of the container will increase the drainage and aeration. In many cases, economics preclude the use of deeper containers. Regardless, where saturated media is a problem, such as in propagation, the use of deeper containers should be considered.

This may make particular sense with difficult to establish species where excess water is not immediately taken up by roots. The increase in aeration and the concurrent reduction in water, especially at the surface, may improve rooting and reduce the presence of moisture dependent pests like algae, liverworts, moss and fungus gnats.

IMPROVING AERATION

The key to a quality nursery crop is the provision of adequate drainage and aeration in the growing medium. This can be achieved by using sufficiently coarse media components, deeper containers, and avoiding:

- finer components that may plug up the larger pore spaces,
- over mixing that will reduce the particle size of components,
- irrigation and handling practices that may compact growing media, and
- the use of components like sawdust that may decompose quickly and result in the loss of large pore spaces.

SUMMARY

Adequate aeration in a growing medium is critical to the growth of quality nursery crops. Aeration is essential for the infiltration of oxygen to the roots for respiration, as well as to allow for the dissipation of carbon dioxide to the soil surface. Realization of the importance of aeration is a key step in the formulation of a quality growing medium.

Placing a growing medium in a container reduces its aeration porosity due to the phenomenon of a “perched’ water table. To counter this, containers should be deep and media components sufficiently porous. The end result of adequate aeration is an overall healthier, more vigorous plant and one that is more resistant to environmental stresses such as winter injury, pests and diseases.

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