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Fundamentals of Container Media Management, Part I

Physical Properties

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Introduction

The successful production and management of high quality container-grown plants requires an understanding of the unique environment found in containers and how it is affected by the physical and chemical properties of the growing media.

Compared with a plant growing in the field, a plant growing in a container is generally exposed to a rapidly fluctuating and stressful environment. The following examples illustrate this condition. During active growth, a plant can extract all the available water in a typical container in 1 or 2 days. After irrigation, the medium is saturated at the bottom of the container, and the roots located there are without air until the plant uses enough water to create air spaces. At the same time, as the medium dries, the salt concentration in the soil solution can increase to high levels. Nutrients, such as nitrogen and potassium, are lost to both plant uptake and leaching and may become rapidly depleted if they are not supplied periodically. Growing medium temperatures can sometimes fluctuate by as much as 30°F between day and night.

Some of these stressful conditions can be considered a direct consequence of the restricted volume of the medium having to meet the needs of a relatively large plant. The problem is not that the medium fails to meet these needs, but rather that the period during which it can is short. A sound management program is thus needed to adequately meet the needs of the plants and minimize stressful conditions.

Container Media Characteristics

A good growing medium is essential for the production of high quality container plants. In contrast to general field production, the volume of medium available per plant is limited and thus should have good physical and chemical characteristics that, when coupled with an intelligent management program, support optimum growth (Table 1). Physical properties are often considered more important to a container medium, because they can not be easily changed after ingredients have been placed in a container. Chemical properties, however, can be altered.

Physical properties

A good medium should drain rapidly after irrigation, and should ideally contain 10% (by volume) or more air space after draining (Table 2). Oxygen stress conditions are likely to develop at values lower than 10%. At the same time, a good medium should contain at least 50% water (by volume), and available water should be at least 30% (by volume). Wet weight (or volume weight) is another important physical property,

Table 1. Characteristics of a good container medium.

1. Good water-holding capacity	Physical property
2. Good aeration and drainage	Physical property
3. High permiability to water and air	Physical property
4. Light weight	Physical property
5. Good fertility	Chemical properties
6. Pasteurized	Management practice
7. Inexpensive	Costs (availability and transportation)

particularly when large plant containers are beinh handled in a nursery setting. Although it varies considerably, depending on the components of the mix, a value between 70 and 90 lb./cu.ft. is usually acceptable.

A mix should be designed to maximize both its water and air content, using the guidelines given for a good medium. Because good physical properties are not automatic when mixing two or more components, have the mix evaluated after its formulation. Although there are some rough methods to estimate these values on site, it is best to have the tests performed by a commercial laboratory. Once the values of physical properties have been determined, adjustments in the proportions of the mix can be made to meet the minimum requirements.

Particle Size of Medium Components

Most media used in ornamental plant production consist of a combination of inorganic and organic components. Some of the common inorganic materials include sands, vermiculite, perlite, calcined clay, pumice and other mineral by-products. Peat moss is one of the more popular organic components, followed by wood products (bark, sawdust, chips), composted organic matter, and such others as sludge, manure, straw, rice hulls, and peanut hulls. The use of mineral (field) soil as a component of container media is not particularly recommended for reasons that include heavy weight; non uniform particle size distribution and small pore size; poor drainage;

Table 2. Physical properties of an ideal container medium and of some commonly used media.

Medium	Total porosity (E)	Water Content (Pv)	Air Capacity (Ea)	Available Water (PV_a)	Wet Weight
	(% by volume)				(lb ft^{-3})
Ideal medium	**60–75**	**50–65**	**10–20**	**≥ 30**	**70–90**
Peat-Perlite	93	73	20	48	54
Peat-Vermiculite	94	81	13	60	62
UCMix*	73	62	11	44	71

Note: These values were determined sfter irrigation and drainage (container capacity) for a medium depth of 14-15 cm. (*) Peat-Sand-Redwood sawdust.

Table 3. Particle size guidelines for organic and inorganic amendments.

Particle diameter (mm)	Desirable Content (% by weight)
10–2	< 20
2–0.5	> 60 (100% ideal)
< 0.5	< 20

variable chemical properties; non sterile, potential carrier of insects; weeds and diseases. Soils may also contain chemical residues (pesticides) and undesirable high salt and toxic ion levels.

Adding organic amendments to a growing medium primarily improves its physical properties, such as increasing water-holding capacity and aeration, and decreasing wet weight. To accomplish this, the mix components should have a desirable particle size: For container media most of the particles in an amendment should be between 0.5 and 4 mm, with less than 20% below 0.5 mm (Table 3).

A sufficient quantity of organic amendment must be used to effect significant changes in physical properties. For most purposes there is little benefit in adding less than 40% amendment. In addition to the requirements for particle size distribution and rate of incorporation, an organic amendment should be stable with respect to decomposition. This will eliminate nitrogen draft problems and reductions in volume of the medium during the growing season.

Sand is a common component of nursery growing media used for ballast weight. This purpose may underestimate the potential impact it may have on the physical properties of the medium. Its use in a mix also requires an evaluation of particle size distribution. Natural sands are composed of particles that range in size from 2 to 0.05 mm, subdivided in five particle size classes (Table 4). A desirable sand for container production contains mainly medium and coarse particles, at least 70% by weight. The use of sands with a wide distribution of particle sizes (nearly equal percentages of each size) is undesirable, as

Table 4. Particle size distribution in a desirable horticultural sand.

Category	Size (mm)	Desirable Content (%)
Gravel	< 2	0
Very Coarse Sand	2–1	0–5
Coarse Sand	1–0.5	70–80*
Medium Sand	0.5–0.25	
Fine Sand	0.25–0.1	0–20
Very Fine Sand	0.1–0.05	0–2
Silt and Clay	< 0.05	0

*A dominant coarse sand fraction is preferred for shallow containers, whereas a dominant medium sand fraction is better for deep containers.

it will likely result in poorly aerated media. Sand use should be restricted to less than one-third of the mix volume, as it significantly increases the volume weight.

The particle size guidelines given here are not to be used as rigid specifications, but as a help in evaluating and selecting materials for a container medium. They do not guarantee an ideal mix. Only laboratory evaluation can confirm the quality of a medium.

References

The following books are some of the most relevant publications that provide good to extensive coverage in many aspects of container media management and may prove to be useful references for container nursery and greenhouse growers. The book sections dealing with physical properties are indicated in parentheses.

Bunt, A.C. 1988. Media and Mixes for Container-grown Plants. Unwin Hyman Ltd., Great Britain, 309 pages (Chapters 2 and 3).

Hendreck, K.A. and N.D. Black. 1989. Growing Media for Ornamental Plants and Turf. New South Wales Univ. Press, Australia (Very practical, simple, easy-to-read grower-oriented book with very useful information and tables).

Nelson, P.V. 1991. Greenhouse Operation and Management. 4th Edition. Prentice Hall, Englewood Cliffs, NJ, USA. 611 p. (Chapters 5 and 6).

Whitcomb, C.E. 1984. Plant Production in Containers. Lacebark Publications, Stillwater, OK, USA. 638 p. (Chapters 3 and 4).

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