



Nursery & Garden Industry
Queensland

Growing Media for Container Production

An understanding of the physical, chemical and biological characteristics of a growing media can improve plant growth and the bottom line. This article looks at the characteristics of growing media and how these qualities can affect crops.

Growing media must be designed to allow normal root functions to take place by supplying adequate water, oxygen and nutrients to the root system. The growing media must be capable of physically supporting the plant, while providing sufficient stability to the container to prevent it easily toppling over, without being excessively heavy to lift, carry and transport.

Crop preference for air in growing media, the ability of plants to withstand dry conditions, the desirability of leaching, the variability of irrigation practices, and after sales requirements of the crop also need to be taken into account.

A good growing media will be uniform and consistent across all batches, and free of pests, diseases and weeds. There are many variables in growing media that can affect plant production, such as the physical components and their management, the air-filled porosity, fertiliser and



fungicide incorporation, and the addition of wetting agents and polymer gels.

*The **physical properties** of growing media that need to be considered are the amount of air, water and solids contained in the media.*

***Air-filled porosity (AFP)** is the percentage of the growing media occupied by air after the media has been saturated with water and allowed to drain.*

The AFP is influenced by the range of particle sizes in the growing media and provides oxygen for root respiration and microbial activity. More air in the growing media will improve root growth, but a higher AFP may require more frequent watering, and nutrient leaching may be increased. A growing media blend with a low AFP may require irrigation less often, but soon becomes waterlogged, resulting in slower growth and increased pest and disease incidence. A range of 13-30% AFP is considered to be acceptable for general nursery stock under EcoHort guidelines .

Container depth has a significant effect on AFP as, in shallow containers, the AFP is reduced due to the greater proportion of media occupied by the saturated media in the bottom of the container. AFP will also decrease during the growing cycle, but this can be compensated, to a degree, by the increased ability of the plant to extract water from the full volume of growing media in the container.

***Water holding capacity (WHC)** is a measure of the total amount of water held in the growing media. When the growing media is saturated, i.e. at container capacity, the smaller pores in the media will be filled with water, and the larger pores filled with air. Growing media blends consisting mainly of larger particle sizes have large pore spaces that do*



not hold water very well and require frequent irrigations. Increasing the amount of water a media holds can reduce the AFP. Therefore, a compromise has to be reached between good root growth and water holding capacity.

Knowing the WHC of a media can assist in determining irrigation schedules, as it gives a guide as to how much a growing media can be allowed to dry out before watering is required. Growing media must contain enough water to prevent stress at the irrigation frequency commonly used.

The amount of water held in a growing media also depends on the shape and height of the growing container. Taller containers will have a lower WHC than short containers due to the smaller proportion of the saturated growing media in the bottom of the container. EcoHort guidelines recommend a WHC of greater than 40%.

Wettability is a measure of the capacity of a growing media to absorb water after drying out. Growing media containing organic components can often become water repellent (hydrophobic) and be difficult to rewet after it has dried out completely. To reduce the risk of growing media becoming hydrophobic, running irrigation in multiple short runs (pulse irrigation) can increase the amount of water retained by the growing media. A wetting agent or coir fibre can also be added to improve rewetting. EcoHort guidelines recommend a wettability of less than 2 minutes as measured by the Australian Standard.

Water Retention Efficiency (WRE) is the ability of a growing media to retain water from an overhead irrigation. A media with a high WRE is able to hold more of the water applied, and therefore less is lost through leaching. EcoHort guidelines recommend a WRE of greater than 50%. More information on WRE can be found in the Nursery paper 2002-07 'Water retention efficiency of

potting mixes' which can be downloaded from the GIA website.

Bulk density is the measure of how heavy the growing media is, relative to its volume. This is affected by the components of the media as well as how much the media is compacted during potting. Increasing the bulk density of a growing media improves the stability of containers, but will usually reduce AFP. The bulk density of a growing media may also need to be taken into consideration when transporting plants due to its effect on the weight of containers.

Bulk density can be used as a quick measure of how evenly growing media has been mixed, by comparing the weight of samples of equal volume from a batch of growing media. The bulk density of a wet growing media should be less than 0.85 kg/L.

Shrinkage refers to the 'slumping' in the pot over time caused by decomposition of the organic components of the growing media. Shrinkage causes changes in porosity, affecting AFP, WHC, and bulk density, and results in unsteadiness of plants in the pot. If shrinkage rates are high plants should be staged more frequently.

Depending on the length of crop cycle, materials that decompose rapidly can lead to a large amount of shrinkage. Smaller organic particles break down more quickly than larger particles, and sawdust, bagasse and peanut shells shrink faster than barks, and should not be used in long term growing media. Sand and soil do not shrink, but these materials reduce the AFP of the media due to their fine particle size.

The nutrient (elemental) properties of growing media are responsible for the nutritional health of the crop. pH, electrical conductivity (EC), and nitrogen are the major properties of concern in growing media, but other nutrients are also

important in providing a balanced nutritional programme to the crop.

pH is a measure of the concentration of hydrogen ions in a solution. High pH values have a low concentration of hydrogen ions and low pH values have a high number. pH is measured on a scale of 1 – 14, with the pH value 7 considered neutral, values less than 7 being acidic, and values more than 7 alkaline or basic. Each unit on the pH scale represents a change in concentration of hydrogen ions by a factor of 10. In practice, this means that it takes 10 times the amount of liming material to change the pH from 4 to 6 as it does from 4 to 5.

pH influences the availability of many nutrients, and therefore many crops are sensitive to pH. Plant pathogens are active over a range of different pHs, e.g. the incidence of Pythium increases above pH 5.9.

The pH of a growing media will change over time and consequently should be measured regularly. The pH of a growing media may be influenced by, the fertiliser program, the plant itself, water quality, irrigation volume and frequency, and the physical properties of the growing media.

Electrical Conductivity (EC) is a measure of the total concentration of electrically charged particles (ions) in a solution, and is a measure of the amount of soluble salt in the growing media. EC is measured using an EC meter, and is also referred to as total soluble salts. An EC meter measures the effects of the sum of all ions in a solution whether they be plant nutrients or not.

Increasing EC readings of a solution means an increasing concentration of ions in the solution making it more difficult for plants to absorb water. At extremely high EC readings, roots may lose water due to increased osmotic suction drawing water out of the roots, leading to root damage and plant death.

As all fertilisers used in nursery production are salts, EC can be used to give a broad indication of the nutritional status of a growing media. It is important to note that EC is not able to identify deficient or toxic levels of specific nutrients.

EC can be measured by extracting liquid from the growing media. The liquid extracts can be obtained using different methods, but to compare results over time it is important to use the same method every time the growing media is tested. The industry standard uses a 1:1.5 solution extract, i.e. 100 ml of growing media and 150 ml of distilled or deionised water.

The EC of your growing media should meet, but not exceed, the EC requirements of the crops grown. For a seedling media the EC should not exceed 1.5 dS/m using the 1:1.5 solution extract method. Some seedlings will not tolerate EC levels above 1 dS/m. For other crops the EC should not exceed 2.2 dS/m .

Nitrogen drawdown is a natural phenomenon seen in bark growing media which results in significant reduction in plant available nitrogen. This reduction is due to micro-organisms using the available nitrogen in the process of breaking down the organic components of the media and making it unavailable to the plant .

While there is always a degree of nitrogen drawdown it can be managed through using well composted organic materials and appropriate nitrogen applications.

Other nutrients also need to be provided in a growing media. In addition to the major nutrients (nitrogen, phosphorus, potassium, calcium, iron and magnesium) trace elements such as copper, zinc, manganese , boron, and molybdenum are most commonly provided through the growing media. Plant micro-nutrients may occur naturally in some growing media components but, where required, can be added to the growing media as a complete



micro-nutrient fertilizer, or as individual nutrients if required.

Growing media contains a variety of micro-organisms with a range of effects:

- beneficial to plants — various micro-organisms, rove beetles and hypoaspis mites
- harmful to plants—fungus gnats, scarabs, black vine weevil, mealybugs, weeds and plant pathogens (*Phytophthora*, *Pythium*)
- indirectly harmful to plants—weeds, and earthworms causing shrinkage of growing media
- harmful to humans—*Legionella* and *Thermoactinomyces*.

Growing media can also contain substances that are toxic to plants:

- toxic levels of nutrients
- pesticides— herbicides, fungicides, sterilants and insecticides
- heavy metals
- organic substances secreted by micro-organisms
- Organic toxins from growing media components, e.g. tannins.

Common organic growing media components:

Pine bark—available in a range of particle sizes. Needs to be composted or leached to remove toxins. Nitrogen drawdown can be a problem. Low cation exchange capacity (CEC) so has a limited

ability to retain nutrients.

Coir fibre—added at 10-20% to increase wettability and WHC. Available in a coarse chip and fine fibre. High water holding capacity (8-9 times its dry weight), good wettability and high CEC. Assists with lateral movement of water. Does not shrink excessively.

Sphagnum peat—different characteristics depending on the source. Highly porous and holds large quantities of air and water. Lightweight. Relatively high CEC. Low pH.

Common inorganic components:

Coal ash—Alkaline. Variable particle size. Used at 10-15% to lighten media.

Perlite—Porous. Sterile. No nutritional benefits. Low CEC and easily leached. Improves aeration.

Polystyrene—Lightweight plastic foam. Various sizes. No nutrient holding ability. Improves aeration and reduces bulk density.

Sand—Many types available. Variable particle sizes. Improves aeration, wetting and flowability. Heavy. Holds little water. Some sources can be high in salts or be alkaline. Washed river sands can contain root pathogens.

Vermiculite—Light, porous material. High water WHC and CEC. Can break down quickly.

Zeolite—Range of particle sizes. Stable physical properties and high CEC.

Further information on growing media can be found in the publication 'Container media management'. Demonstration videos on testing and evaluating growing media for are available on the NGIQ Technical Information Library and Australian Plant Production Standard websites.

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