Root of success

Part 1: Choosing the right growing medium for healthier greenhouse crops

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Greenhouse crop production has changed dramatically over the past century. While soil was once the primary choice growing media, modern greenhouse and soilless systems now use a wide range of substrates such as coco coir, peat moss, rockwool, perlite, vermiculite, and bark. Each of these materials has its own strengths and limitations, and each affects plant growth in different ways. The physical properties of a substrate often influence root health more than the substrate itself.

Growers should understand what makes a growing medium work well. Every substrate has different physical and chemical properties that affect how roots receive water, oxygen, and nutrients. Finding the right balance between water retention and air space is essential for developing a healthy root system and supporting strong plant growth. When growers understand these basic principles, they can choose and manage growing media that best suit their crops and growing conditions.

In this series, we begin by discussing the physical characteristics of an effective substrate, the importance of water and air balance in the root zone and its influence on root health. These fundamentals form the focus of Part 1. In Part 2, we shift to the chemical and irrigation factors that interact with the medium, including pH, EC, and root-zone management.

The flowchart below demonstrates how various growing medium characteristics collectively influence healthy plant growth.

Growing Medium
↓
Water Holding Capacity
↓
Air Filled Porosity
↓
Root Oxygen
↓
Nutrient Uptake
↓
Plant Growth

ABOVE
Petunia plugs grown in a soilless growing medium with proper WHC and AFP. These plants exhibit very good root volume and spread.

CHARACTERISTICS OF AN EFFECTIVE GROWING MEDIUM

Growing media is like a home for plant roots. Just as humans need a home with fresh air, clean water, and enough space to live, plant roots also need air and water to grow and function properly. A healthy growing medium is characterized by a good balance of water, air, and nutrients, helping roots remain healthy.

Healthy roots require both water and oxygen for efficient nutrient uptake. Imagine wearing waterproof boots filled with water all day. Your feet would soon become uncomfortable because they cannot "breathe." Plant roots experience the same problem when the growing medium holds water for a long period. The air spaces become filled with water, reducing the amount of oxygen available in the root zone.

A well chosen growing medium gives roots the air, water, and structure they need to begin strong.

WATER-HOLDING CAPACITY (WHC)

Water-holding capacity (WHC) is one of the most important properties of any growing medium. A simple way to understand WHC is to imagine a pot filled with a growing medium. When you add a good amount of water until the growing medium becomes completely saturated, the excess water drains out from the bottom of the pot. The water that remains in the growing medium is its WHC. Plants use this stored water until the next irrigation.

Whereas, holding more water in the root zone is not always better for plants. Excess water reduces the air space available for oxygen, which roots need to respire and produce energy. Therefore, waterlogged conditions may reduce root activity, slow down plant growth, and increase the risk of root diseases. In contrast, growing media with very low WHC dries out very quickly, causing plants to wilt and requiring more frequent irrigation. The main objective is to maintain a balance by providing enough water storage in the growing medium while maintaining sufficient air-filled pore space.

WHC also depends on the particle size of the growing medium. Fine particles hold more water because the small spaces between them retain water against gravity. In contrast, coarse particles create larger pores, allowing water to drain more easily and resulting in a lower WHC. For instance, coco coir normally holds a good amount of water while still maintaining good aeration. Perlite, on the other hand, has a very low water-holding capacity, which is why it is commonly mixed with coco coir or peat moss to improve drainage and aeration.

MAINTAINING ROOT-ZONE OXYGEN

Air-filled porosity (AFP) is the percentage of air space present in a growing medium after it has been saturated with water and allowed to drain naturally. These air-filled pores act as pathways that allow oxygen to move into the root zone while carbon dioxide produced by root respiration moves out. Through respiration, roots produce the energy needed to absorb water and

nutrients, grow new root tissues, and support healthy plant development. This is why the amount of air remaining in a growing medium after irrigation is just as important as the amount of water it holds. Compaction over time can reduce AFP, even in substrates that initially provide good aeration.

Very low AFP creates waterlogged conditions, reducing oxygen around the roots and increasing the risk of poor growth and root diseases. Very high AFP holds less water, causing the growing medium to dry out quickly, leading to frequent irrigation and plant wilting.

COMMON MEDIA COMPONENTS AND THEIR FUNCTIONS

No single growing medium can provide every characteristic needed for healthy plant growth. Some materials retain large amounts of water, while others improve drainage or increase air circulation around the roots. For this reason, commercial growing media are often blends of different components, each contributing unique physical and chemical properties to create a balanced root environment.

Coco Coir – Coco coir is produced from the fibrous husk of coconuts and has become one of the most popular growing media in greenhouse production. It offers an excellent balance between water retention and air-filled porosity, making it suitable for a wide range of crops, including tomatoes, cucumbers, peppers, strawberries, and cannabis. Its buffering capacity also helps stabilize nutrient availability during production. Coco coir also has a stable structure, good drainage, and can be reused if managed properly. However, because fresh coco coir may naturally contain sodium and potassium, it should be properly washed and buffered before use.

Peat moss – Peat moss is a natural growing medium made from partially decomposed moss. Peat moss has been used in greenhouse production for decades because of its excellent water-holding capacity and lightweight structure. It provides a consistent growing environment for seedlings and container-grown plants. However, peat alone can retain excessive water and reduce aeration, so it is commonly mixed with materials such as perlite or bark.

Perlite – Perlite is a lightweight volcanic mineral that is heated until it expands into white porous particles. Unlike peat or coco coir, perlite holds relatively little water but greatly improves drainage and air movement within the growing medium. It is often added to peat- or coco-based mixes to reduce compaction and improve root aeration, particularly for crops that are sensitive to waterlogged conditions.

Vermiculite – Vermiculite is another naturally occurring mineral that expands when heated. It has a much higher water- and nutrient-holding capacity than perlite and can temporarily retain nutrients such as potassium, calcium, and magnesium. Because it stays moist for longer periods, vermiculite is commonly used in seed germination and propagation mixes. However, excessive amounts may reduce air-filled porosity.

Bark – Composted bark, usually obtained from pine or other tree species, is widely used in nursery and ornamental crop production. Bark improves drainage, increases air space, and provides structural stability within the growing medium. Since fresh bark can temporarily tie up nitrogen during decomposition, composted bark is generally preferred for greenhouse use.

Rockwool – Rockwool is manufactured by melting volcanic rock and spinning it into fine fibres. It is widely used in hydroponic greenhouse systems because it is clean, uniform, and provides precise control over irrigation and nutrient management. Rockwool has excellent water distribution while maintaining sufficient air space for root growth. However, because it is an inert material, all nutrients must be supplied through the irrigation system. Because of its uniform physical properties, Rockwool is widely used in precision irrigation systems.

There is no universal "best" growing medium. The ideal substrate depends on the crop, container size, irrigation strategy, climate, and production system. Understanding the strengths and limitations of each component allows growers to design growing media that provide the best possible root environment for their specific crop.

A wellchosen growing medium gives roots the air, water, and structure they need to begin strong. But maintaining that environment requires ongoing attention to irrigation and nutrient chemistry. Before roots can thrive long-term, growers must understand how pH, EC, and moisture interact with the substrate. That's where Part 2 picks up in an upcoming issue of *Greenhouse Canada.*

Moisture Retention and Dryback Observation (100% Coco Coir, 2-Gallon Trial)

Day	Weight (g)	Daily Loss (g)	Total Loss (g)	Total Loss (%)	Observation
1	5212	-	0	0.0%	Fully saturated
2	4530	682	682	13.1%	No wilting
3	3920	610	1292	24.8%	No wilting
4	3503	417	1709	32.8%	No wilting
5	3017	486	2195	42.1%	Slight wilting observed

This table can be used as a guideline for irrigation. In order to keep plants in vegetative direction use 10 to 13% water loss and use higher weight loss for a generative direction. The observations above are derived from a trial conducted by the greenhouse team at GMTN's Kaleden, BC facility.

ABOVE

Cannabis plants grown in coir with WHC of 80% and AFP of 20%. Irrigation volumes need to be monitored daily.