Center for Crop Diversification
Martin-Gatton College of Agriculture, Food and Environment

Center for Crop Diversification Educator Resource
CCD-TA-02

# Selecting Growing Media for Soilless Systems

Casey Byrd[1], Arundathi Sharma[2], Qinglu Ying[3]

With the popularity of soilless growing systems, there are hundreds of growing medium options on the market. Ultimately, it is up to the grower to decide which product or brand best suits their needs and price point. Although this is by no means an exhaustive list, this publication presents a broad overview of popular growing medium components used in the horticultural industry along with pertinent characteristics to consider when selecting a medium.

## Key Characteristics of Growing Media

| Category | Characteristic | Description |
|---|---|---|
| Physical | Bulk Density | Refers to the dry weight of the substrate, divided by its volume. Measured in grams per centimeter cubed (g/cm3). |
| | Porosity | Refers to the percentage of void space in a given volume of substrate. Measured as a percentage (%). |
| | Air Content | Refers to the percentage of air contained in a given volume of substrate after it is saturated, and the free water has drained. The higher the air porosity, the more oxygen plant roots can acquire. |
| | Water Holding Capacity | Refers to the total proportion of water held in the substrate that is available for the root systems to access. This is determined by subtracting the permanent wilting point of the substrate by the field capacity. Presented as a percentage (%) of total substrate water content. |
| | Saturated Hydraulic Conductivity | Refers to the ease with which pores of a saturated growing media transmit water. It is an in-lab measurement used to characterize the rate at which water moves through completely saturated substrates. Measured in centimeters per second (cm/s). |
| Chemical | pH | Refers to the acidity or alkalinity of substrate. It is used as an indicator of nutrient availability and loss. Measured according to the pH scale which ranges from 0 to 14. Optimal pH is generally between 5.5 and 6.5 for hydroponic production. |
| | EC | Refers to the ease with which an electrical charge can pass through the substrate. Used as an indicator of nutrient content. Measured in milliSiemens per centimeter (mS/cm). |
| | Cation Exchange Capacity | Refers to the ability of growing substrates to hold and exchange positively charged ions. Substrates with a higher CEC will retain and exchange more nutrients. Measured in milliequivalents per 100 grams of growing medium |



[1]Casey Byrd Extension Agent for Ag & Natural Resources, University of Kentucky.
[2]Arundathi Sharma, Extension Associate University of Kentucky Department of Horticulture.
[3]Qinglu Ying, Ph.D, Assistant Extension Professor University of Kentucky Department of Horticulture.

# Key Characteristics of Growing Media cont...

| Category | Characteristic | Description |
|---|---|---|
| Biological | Organic Matter | Refers to the carbon-rich, organic constituents of substrate derived from living or organisms, like plant residues, animal manures, compost, wood chips and fiber, detritus, and humus. |
| | C:N Ratio | Refers to the ratio of carbon to nitrogen in organic matter that affects microbial activity and nutrient mobilization and availability |
| | Microbial Activity | Refers to both beneficial (e.g., mycorrhizae) and pathogenic microbes that could promote and harm plant development, respectively. |

Soilless growing media that are typically composed of a mix of organic and inorganic materials, which are selected for their ability to support plant growth by providing adequate aeration, drainage, water and nutrient retention, and root stability.

# Types of Growing Medium Components

| Components | Description | Pros | Cons |
|---|---|---|---|
| Peat Moss | Harvested from peat bogs, peat is the most common substrate component with low pH, light weight, good water retention and aeration. | Good water retention, low pH, slow decomposition | Non-renewable, hydrophobic when dry |
| Compost | Produced from waste products, compost contains high nutrient contents and beneficial microorganism, with potential issues include phytotoxicity, non-uniformity and availability | Nutrient Rich, microbial activity, water retention | High pH and salinity, inconsistent, heavy |
| Coco Coir | Derived from coconut husks, coco coir is a renewable substrate component with good water retention, aeration, and cation exchange capacity, though it may require buffering to remove excess salts. | Moisture Retention, renewable, good aeration, lightweight | Disintegrates, salinity and sodium levels, decomposition causing substrate shrinkage |
| Vermiculite | A naturally occurring, heat-expanded mineral, vermiculite has high water retention and cation exchange capacity but can compact over time, reducing aeration. | Sterile, pH neutral, lightweight | High water retention can lead to waterlogged conditions, compact over time reducing aeration |

| | | | |
|---|---|---|---|
| Wood Bark | Processed from tree bark, this component improves aeration and drainage while contributing to structural stability, though decomposition can lead to nitrogen immobilization. | Affordable, improve aeration, slow decomposition, renewable | Nutrient tie-up, inconsistent particle sizes, potential contaminants, limited water holding capacity |
| Wood Fiber | Mechanically or chemically processed from wood, wood fiber enhances aeration and drainage but may have variable decomposition rates and nutrient availability. | Lightweight, renewable, biodegradable | Nutrient tie-up, fast decomposition causing substrate shrinkage, inconsistent |
| Perlite | A heat-expanded volcanic glass, perlite provides excellent aeration and drainage, though it lacks nutrient retention and can generate dust that may pose health concerns. | Good aeration, light weight, pH neutral, non-decomposing | Limited water holding capacity, floating on the water, no nutrients |
| Rockwool | Manufactured from molten rock spun into fibers, rockwool has high water-holding capacity and aeration but is inert, requiring careful nutrient management and proper disposal due to its non-biodegradability. | Moisture retention, good drainage, sterile, light weight, uniform | Not biodegradable, require precise fertigation management, high costs, skin irritation |

**Additional Resources**

https://nursery-crop-extension.ca.uky.edu/content/soilless-substrate-management-nursery-crops

Barrett, G. E., Alexander, P. D., Robinson, J. S., & Bragg, N. C. (2016). Achieving environmentally sustainable growing media for soilless plant cultivation systems–A review. Scientia horticulturae, 212, 220-234.

Fields, J. S., Owen Jr, J. S., Lamm, A., Altland, J., Jackson, B., Oki, L., & Criscione, K. S. (2023). Surveying North American specialty crop growers' current use of soilless substrates and future research and education needs. Agriculture, 13(9), 1727.

Ingram, Dewayne L., "Understanding Soilless Media Test Results and Their Implications on Nursery and Greenhouse Crop Management" (2014). Agriculture and Natural Resources Publications. 161. https://uknowledge.uky.edu/anr_reports/161

**Suggested Citation:**

Byrd, C., Sharma A. and Ying, Q.(2025). *Selecting Growing Media for Soilless Systems*. CCD-TA-02. Lexington, KY: Center for Crop Diversification, University of Kentucky Martin Gatton College of Agriculture, Food and Environment.

*Reviewed by University of Kentucky Horticulture Agents Macy Fawns and Amanda Sears.*

**April 2025**

# Instructor Module

This educational module is presented in partnership with the Appalachian Regional Commission (ARC). These activities are intended to provide inspiration for activities that supplement greenhouse technician/ management curriculums.

## Learning objective:

- Expose students to various growing medias used in the horticulture industry
- Connect observations of the media with pros and cons
- Understand physical and hydrological properties of different media

*Optional:* Practice EC/pH testing methods and review calibration

## Activity 1: Exploring Growing Medias

Items required:

- 4-6 different growing mediums
- Cup or 4 in pot for each sample for each student/group
- 1 disposable glove per student
- 1 disposable medical mask
- 1 custom activity sheet per student

*Optional:* EC/pH meter
*Optional:* 4-inch pots and saucers for pour over method

**Step 1:** Assign each growing media a number and provide a corresponding label for each growing media sample.
**Step 2:** Students will observe and touch each sample and identify which medium is associated with each number.
**Step 3:** Students record their findings .
**Step 4:** Instruct students to put water on the growing medium and record how absorbent it is.
*Optional:* If your classroom has an EC/pH meter, have students monitor the pH and EC of each media (using the pour through method) after it has soaked in water for a few minutes.

## **Activity 2:** Understand the water holding capacity and substrate moisture content

Items required:

- Scale
- Measuring Cup
- 4in draining pots
- 4-6 types of growing media

*Optional equipment*: 4-in-1 Garden Digital Soil Moisture Meter PH, Temperature, Sunlight Tester, Humidity Monitor Gardening Greenhouse Tool

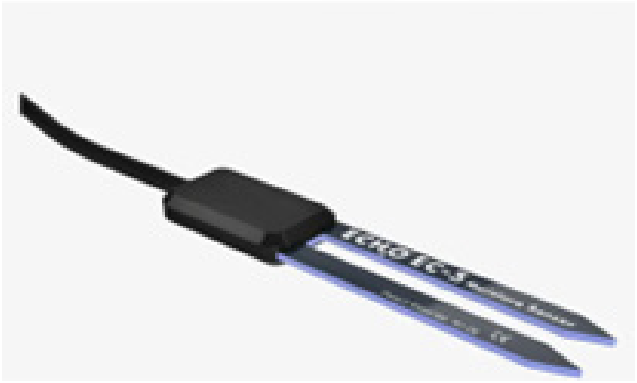
**Step 1:** Tare and weigh 1 cup of water and record the weight.

**Step 2:** Weigh the dry materials in a 4-inch pot and record the weight for each sample.

**Step 3:** Add 1 cup of water to each growing medium sample and let it sit for 3 minutes.

**Step 4:** Weigh the wet samples and record each weight.

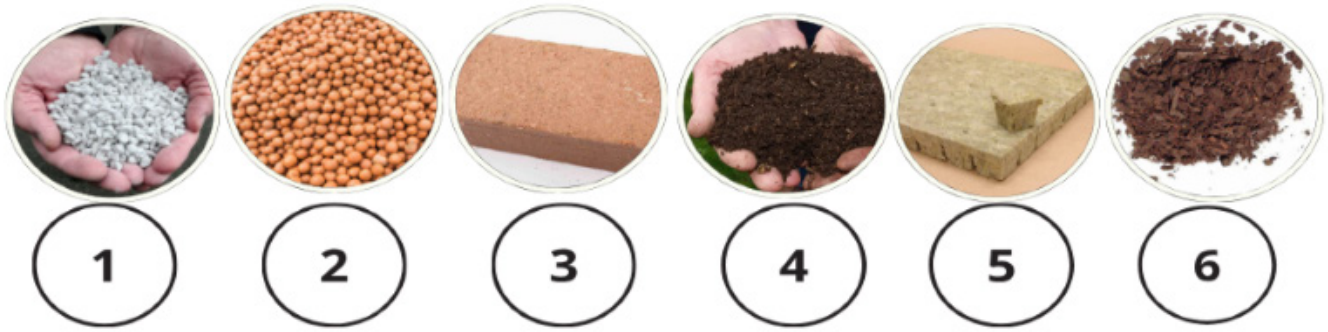
**Step 5:** Calculate! Deduct the weight of the ½ cup of water from each.



MODEL: TEROS 12


MODEL: ECH2O EC-5

# Example Handout for Activity




| Type | Number | Observations | Dry Weight | Wet Weight |
|---|---|---|---|---|
| Bark | | | | |
| Compost | | | | |
| Perlite | | | | |
| Coco Coir | | | | |
| Clay Pebble | | | | |
| Rock Wool | | | | |