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# Hydroponic Production of Edible Crops: Media Systems

*Authored by Chris Mullins, Extension Specialist, Virginia State University; Amber Vallotton, Extension Specialist, School of Plant and Environmental Sciences, Virginia Tech; Joyce Latimer, Professor and Extension Specialist, School of Plant and Environmental Sciences, Virginia Tech; Toni Sperry, Research Assistant, School of Plant and Environmental Sciences, Virginia Tech; Holly Scoggins, Associate Professor Emeritus, School of Plant and Environmental Sciences, Virginia Tech*

## Introduction

With the increasing number of controlled environment agriculture farms, Virginia Cooperative Extension (VCE) is working closely with specialty crop growers to address the challenges of establishing and managing hydroponic greenhouse operations. Growers interested in producing food crops in controlled environments can use several different types of hydroponic systems (Resh 2017).

One common type of hydroponic system is known as a media system and utilizes some type of containerized media to grow plants. This media or substrate is used primarily to anchor the plants while nutrient solution is delivered to the plants via sub-irrigation or top-irrigation (Figure 1). The terms media and substrate will be used interchangeably in this publication.

Figure 1. Examples of media systems using sub-irrigation with turmeric and ginger (left), and top-irrigation with cucumbers (right). (Chris Mullins, Virginia Cooperative Extension)

Other hydroponic systems, such as nutrient film technique (NFT) and deep-water culture (DWC) (see Mullins et al. 2023a, b), utilize transplants that are grown in some type of germination substrate. These seedlings can then easily be placed into a nutrient-only hydroponic system. The classic media systems, described in this publication, generally use the same germination procedures as other hydroponic systems, but the seedlings are transplanted into another or similar type media for growing to maturity (Figure 2).

Figure 2. Transplants being grown in a germination substrate (left), and seedlings transplanted into media for growing to maturity. (Chris Mullins, Virginia Cooperative Extension)

## Set-Up and Design

Media systems consist of a container which houses the substrate and plant along with a nutrient solution delivery system. These systems can recirculate nutrient solution (closed) or leach nutrient solution out of the system (open). The placement of media systems can be on the ground/floor of the facility or on raised benches/tables. Containers used in media systems can vary from pots to wooden beds. Some popular options include plastic channels, plastic or fabric media bags, intermediate bulk containers (IBC) and vertical growing towers (Figure 3). Growers should investigate the options that best fit their growing needs as the cost, space requirement, availability and plant suitability play a role in that decision.

Figure 3. Examples of different kinds of media containers. (Chris Mullins, Virginia Cooperative Extension)

## Media

In the early to mid-1900s, growers were utilizing substrates such as sand and gravel to grow plants. Now growers have more options. [Examples of common substrates]() for media hydroponic systems are peat/bark-based soilless media, mineral wool, expanded clay pellets, perlite, coconut fiber (coir) and growstones (Figure 4).

Figure 4. Some examples of common substrates. (Chris Mullins, Virginia Cooperative Extension)

When selecting a substrate, growers should consider cost, reusability, sustainability, and suitability for the particular crop being grown. A substrate should provide support, be easy to handle, provide good drainage while retaining water, be durable, have consistent chemical characteristics (for example pHand nutrient retention) and have the ability to hold nutrients (Garcia and Hughes 2020; Thakula et al. 2021).

## Water/Nutrient Availability

Media-based hydroponic systems may be either open or closed. There are several types of open and closed systems that use substrate filled containers (Figure 5). Generally, small greenhouse operators that produce fruiting crops such as tomatoes, peppers, and cucumbers use inexpensive, media-filled plastic bags in an open manner, whereas closed systems are used by many small-scale growers and hobbyists as a flood then drain arrangement.

Figure 5. An open system using media-filled plastic bags (left), and a closed system using a flood then drain arrangement (right). (Chris Mullins, Virginia Cooperative Extension)

An open media system would usually incorporate a drip irrigation component to supply nutrient solution to a substrate filled container where plants are growing (Figure 6). Nutrient addition is usually accomplished by using some type of fertilizer injection device. These devices add small amounts of premixed fertilizers to the irrigation water. The resulting nutrient solution is delivered to the plants/containers. Most often, nutrient solution that leaches from a container is not collected but instead drains away. In some systems, the leachate is collected but is not returned to the hydroponic system.

Figure 6. A fertilizer injection device being used to add premixed fertilizer to the irrigation water (left), and nutrient solution leachate collection basin under plant containers (right). (Chris Mullins, Virginia Cooperative Extension)

Closed media systems recirculate nutrient solution within the system (Figure 7). Most often a reservoir is positioned at the lowest point in the system and would include a submersible pump. The premixed nutrient solution in the reservoir is pumped to a substrate-filled container. The pump can also have a timer attached that floods when energized and drains when the power is off.

Figure 7. A submersible pump (left), and substrate-filled containers equipped with a supply tube (right). (Chris Mullins, Virginia Cooperative Extension)

Also, the container could be fitted with a standpipe arrangement or bell/U siphon that would return the nutrient solution back to the reservoir once the container has been flooded (Figure 8). Nutrient solution retention time at the root zone can be adjusted as needed.

Figure 8. Example of a pump (in bottom of blue reservoir) in which plants are fed with recirculating nutrient solution using a supply tube and siphon. (Chris Mullins, Virginia Cooperative Extension)

The above section describes the most common ways to deliver nutrient solution to crops in a media hydroponic system, however there are others. Growers should consider costs, system management, labor and crop selection when determining whether to use an open or closed system.

## Crops

Media hydroponic systems can be used to grow a variety of crops. Relative to other hydroponic systems, media systems are used more to produce fruiting crops. Tomatoes, peppers, cucumber, eggplant, strawberries and melons are most often grown in a media system, whereas leafy greens are more commonly grown in other hydroponic systems, although stack systems are oftn used for lettuce and herbs (Figure 9). Growers should consider market value/need, plant habit, maturity date and resistance to disease and physiological problems when selecting plant types and cultivars.

Figure 9. Examples of crops grown in media systems. (Amber Vallotton and Chris Mullins, Virginia Cooperative Extension)

## Nutrient Solution Management

Nutrient solution can be made by mixing fertilizers with water in the reservoir or utilizing a fertilizer proportioner. Water soluble powdered fertilizers and liquid premixed fertilizers are most often used. Fertilizer mixing instructions are given by fertilizer suppliers based on the crop being grown and are on the fertilizer packaging. Growers should consider a fertilizer program that provides all the necessary macro and micro elements needed for optimum growth.

One nutrient solution example would be to provide all the needed nutrients to the plants by using a complete fertilizer such as 8-15-36 along with calcium nitrate and magnesium sulfate. These fertilizers, mixed in the correct amounts based on the labeling instructions for the volume of water in the reservoir, should be mixed separately then added to the reservoir (Figure 10). After the addition of the fertilizer and agitation of the tank, the pump can be turned on to provide nutrient solution to the system.

Some water quality meters are necessary to the management of the nutrient solution in the system. Meters vary in price and quality. Growers should consider meter longevity, reliability, price and accuracy when purchasing. Electric conductivity (EC) and pH should be checked two to three times each week (Figure 10). EC measurement lets the grower know if the total amount of fertilizer in solution has changed over time. Adjustment of fertilizer strength, based on the EC reading of the solution, can be made through addition of stock fertilizer solution or water. The pH measurement lets the grower know about the acidic or basic nature of the solution, which can affect nutrient uptake by the plants. Most plants grown in these systems perform well at pH 5.5 to 6.2. Growers should consider the substrate pH as it can affect rootzone pH.

Figure 10. Using a meter to measure pH of the nutrient solution (left), and documenting pH, EC, and other measurements in a binder. (Chris Mullins and Amber Vallotton, Virginia Cooperative Extension)

## Conclusion

Media systems can be a great way to grow crops hydroponically. This publication gives a general overview of media systems, however potential growers should investigate specific options for their unique situation. Growers should consider contacting their local Cooperative Extension office for more information.

## References

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## Additional Resources

Cornell College of Agriculture and Life Science
https://cea.cals.cornell.edu/

Morgan, L. 2021. Open or Closed: What System is Best for You? *Maximum Yield*.

North Carolina State University
https://cals.ncsu.edu/horticultural-science/research/greenhouse-vegetable-production/

Ohio State University
https://u.osu.edu/greenhouse/hydroponic-crop-program-introduction/

Pennsylvania State Extension
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https://ceac.arizona.edu/

University of Hawaii
https://www.ctahr.hawaii.edu/oc/freepubs/pdf/bio-10.pdf

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