# Hydroponic Vegetable Production
# **Media Options**

## Overview

When people look at hydroponic vegetable greenhouses, they see high tech agriculture at its best. Although still relying on good old sunshine, greenhouse growers are able to manage their climate through temperature and humidity controls as well as precision fertigation systems, $CO_2$ level control and the use of biological control agents. But just like conventional agriculture, greenhouse production starts from the ground up, and healthy roots from the beginning of the season through to the end, will ultimately determine the success of a crop.

The term "hydroponic" refers to the culture of plants in a nutrient solution without soil. For greenhouses the plants are grown in a substrate that provides a medium for root growth but is not relied upon for nutrient transfer by the plant. Although growers could grow in anything (sand, gravel, peat moss,) consistency from beginning of the season to end, plus consistency throughout an individual slab and from one slab to the other and its ability to provide air, water and cation exchange are really the key components to selecting a media to grow in. Product handling, disposal, cost and availability are other factors in media selection.

The basic hydroponic systems of greenhouses consist of the irrigation system, supplying each plant with the exact same amount of water through pressure compensated drippers, the media and the drainage retention system (either metal gutters or poly strips and ditches). The water is fed through the drip system with fertilizer and goes into the slab, which is basically a sausage shaped bag filled with the media of choice. Extra water is fed into the system so that every plant has enough, and the extra water still containing fertilizer is collected and reused.

## Sawdust Bags

Historically, growers have relied upon sawdust as their main media choice. Sawdust is a fairly stable media, is relatively inert in that it does not add or take away cations in the root zone, is (or was) abundant in BC, and most importantly is cheap. In the summer or fall, growers would bring in loads of sawdust and by hand, fill sausage shaped bags that would then be stored outside until being brought into the greenhouse at crop change. At the beginning of the season, sawdust has a nice open structure to provide good aeration and control in watering. The water flows through the media and therefore by limiting water, growers can quickly dry the bag out and steer the plants the direction they want them to grow. This is an especially important characteristic in growing tomatoes and peppers as light levels in January and February are not conducive to plants naturally wanting to make fruit. With the low amount of light, cloudy cool air temperatures and high humidity, the plants want to grow slow and lazy and make nice big leaves. By stressing the plant through drying out the slab, a grower is able to force the plant (ie: stress the plant) into a generative state that will result in early season flowers and fruit set. This early season steering will dictate how the plant grows for the rest of the year so it is essential that a grower achieves his goal. Sawdust does have a tendency to break down over the course of a season, which is a bit of a limitation, and growers need to be aware. As sawdust ages, the cellulose will break down due to microbial and mechanical activity in the root zone and the air content will decrease making it more difficult for the roots to remain healthy. The decreasing air content and thus higher water content limits the steering growers want and therefore a slab may take days or a week to dry out compared to a few hours at the beginning of the season; this can affect late season flower setting and fruit finishing. Unfortunately, sawdust availability has become somewhat precarious, especially in obtaining the desired fir or yellow cedar, as more local mills have closed over the last 10 years.

## Coco Slabs

As growers' hands have been forced due to the lack of sawdust in the market, the industry has looked at a number of other options with most settling on coco or coir slabs. Coco is a byproduct of the coconut industry in counties such as Sri Lanka and India which have an abundance of supply. Unfortunately the development of coco slabs has been a bit of a rocky road over the past 10 or so years, however through experience and an understanding of coco's characteristics, the industry has settled on specific quality characteristics. Before proceeding into a discussion on these characteristics, it is important to understand how coco slabs are packaged. Coco is brought in as prefilled bags (similar to sawdust), but these slabs are rectangular in shape and are compressed so to take up less space in containers when coming overseas. When water is added to the slabs, they quickly hydrate and form the desired shape of the slab (for example 100cm long x 15cm wide by 8cm high). A nice feature about coco is that the slabs are flat on the top so the plants don't lean or fall off (which could impact watering uniformity in the small transplant block), and planting holes and drainage holes are precut at the factory resulting in less labour and quick preparation of slabs.

The early days of coco use saw suppliers harvesting coco from old piles of husks in Sri Lanka. Although this material looked fine, after compression the slabs would not expand when hydrated and therefore would not have the air capacity as expected. Since then suppliers have learned that coco should not be more than a couple years old and likewise slabs should also not be kept in storage for more than a year or two. Coco expansion is an easy quality to see visually, however the most important feature cannot be seen beforehand so growers and suppliers have had to work on predetermined quality specifications. As with sawdust, fresh coco husks will break down during the season as it is composed of cellulose. If aged properly, the coco fiber will become lignified, which is critical in having consistency from the beginning to end of the season as it is less susceptible to degredation. In addition, lignified coco fiber will affect water droplet surface tension with the coco fibers spreading a water droplet over its surface area making it available to more root hairs. Coco slabs can be produced using different grades of material (ie crush, fiber, fine material) so manufacturers can customize air content, water content for specific crops or growing conditions.

Another predetermined factor with huge implications is the EC (electrical conductivity) and the makeup of the EC in the slabs. Since coco plantations grow on the

coast, they feed heavily on salt water and or may be exposed to salt water. The result of this is coco slabs high in EC (anywhere from 6-10) with that composed mainly of sodium or chlorides which are harmful to plants. Growers have learned that in order for early rooting, it is important to purchase slabs that are either washed with water to lower the EC, or better yet, that are buffered to remove the salts. Buffering is the process where the coco is laid out and washed with a low EC solution of calcium or potassium nitrate. Both of these are stronger cations and will cause the coco to release the salts to be flushed out and bind to calcium or potassium instead. Even if a grower is purchasing washed slabs, it is always a good idea to water in with low EC calcium nitrate to flush out any salts.

Coco must be planned for since it is shipped from far overseas, so that is one limitation of the product. Also, due to the red colour of the fine coco particles and the initial salt leach, there are some environmental concerns of using coco, especially back in Ontario, however in BC it is not part of the discussion. Generally poor quality coco would be the limiting factor in BC, product with too many fines or not aged that result in "wet" coco that is difficult to dry out at the end of the season. Other than that, the cost of coco is fairly low and disposal is easy as it can be spread on land or used in soil or compost mixes.

## Rockwool

In Europe and eastern Canada, rockwool continues to be the main substrate in use. Rockwool is basalt rock that is super heated and then spun to product long fibers (picture cotton candy). The resulting product is similar to insulation with fibers being laid down either horizontally or vertically to tailor for water/air content or longevity of the slab (one year or multi year). These large blocks of material are then cut into slabs with a wetting and firming agent being added before the slabs are wrapped. The big advantage of rockwool is that it is a factory type product with the consistency of each slab being identical. With no variability between slabs or within slabs, growers are able to steer and maximize all their available tools.

Rockwool has been used sporadically in BC for the past 20 years, however there is only limited area on it currently. Despite the high quality nature of the product, cost and disposal are the main limitations to more usage. Rockwool is not able to be compressed, so despite the material volume being the same as coco, it takes up about 2-3 times as much space in a container and therefore a much higher shipping cost. Generally the cost of rockwool is double that of coco. Disposal is another issue with rockwool. Because the product will not break down on its own, it must be shipped to landfill with a high cost. Rockwool has been put on fields in the past, but it must be ground up and still some of the rockwool can be caught up in hay bales and other ag crops. Rockwool can be purchased as multi year slabs which would help reduce the overall cost, however, due to disease and virus pressure year to year, most growers would not be willing to take this risk. In Ontario there is much more rockwool in use than BC and this is due to recycling programs in place and proximity to production. There is some debate among BC growers on rockwool production. Despite it being a more consistent product, it generally has a higher water and lower air content than coco. This makes that early season steering a little more difficult so coco still has that early season advantage.

One area that we do see rockwool used is for plant propagation. Rockwool in this capacity is very consistent, easy to handle by watering and spacing equipment, and sturdy enough to handle shipping across Canada and the US. Because small differences at an early stage are so critically in producing an even crop of plants for transplant, the risk is still too great to deviate from Rockwool. Coco cubes and other products have been trialed however they are not being used widely.

## Other Considerations

Perlite, biochar, zeolite, and vermiculite are all soil mixing additives that have been tried by commercial growers as well. The main limitations of these all are cost related as they must be used for multiple years in order to pay off. Like rockwool, they can be steam sterilized to kill plant pathogens, however it is difficult to guarantee pathogen death. Viruses in particular can be very difficult to control.

There are a few more details to be aware of as well when making a decision on media.
Recirculation systems are used to conserve water and fertilizer in a greenhouse. The extra drain is collected in poly lined ditches or gutters and then sterilized before being mixed with fresh water and fertilizer. Although sawdust is nice and clean early on, coco can produce a red colour drain the first few weeks that cannot be sterilized with UV filtration. Rockwool overdrain can be collected fairly quickly and used so that is a factor to consider when assessing cost.

Soil microbes are an important part of greenhouse systems. Because all the media described above are sterile to begin with, beneficial microbes are often added early on to colonize the rootzone and suppress the establishment of pathogens. Both coco and sawdust are organic and will easily support these microbes, however rockwool tends to be a bit more difficult in establishing and maintaining beneficial early on. As the crop ages and the roots penetrate to more areas of the slab, it is much easier for them to develop and reproduce.

Rootzone drenching of pesticides can be a quick and effective way to control some pests in the greenhouse. Now these products are limited to those with highly systemic activity, but they are extremely valuable products and manufacturers are looking more and more towards this type of application. Because Rockwool is inert with no CEC, it will not bind up any pesticides, therefore whatever is added to the rootzone is available to the plant right away. With coco and sawdust, any rootzone drenches must be managed to ensure the pesticide is taken up by the plant and not trapped by the organic media. Adding pesticides to organic media as a drench when the plant is not active (evening) or when the media is dry, will result in poor uptake and efficacy of the product. Some strategies to maximize plant uptake in these organic mixes include adding in early in the day when the plants are active and doing it on the second or third watering of the day and adding an extra delay after this cycle to ensure the pesticide is taken up and not flushed out of the system.

As you can see, there are many things to consider when choosing a media for greenhouse use. So what's the common denominator in all this – profitability. A grower knows his style, his crop and his cost/profit model and will make the best decision based on these factors. Healthy plants equal healthy production and with a good input costing model, a healthy bottom line for the grower.

*Bradley Breedveld is a Greenhouse technical sales rep with Terralink Horticulture.*