Cutting-Propagation Media: Cutting to the Chase©

Shiv Reddy
Sun Gro Horticulture, 15831 NE 8th St, Suite 100, Bellevue, Washington 98008
Email: shivr@sungro.com

INTRODUCTION

During crop production, cuttings of woody nursery crops or even herbaceous greenhouse crops are seldom planted directly in a growing medium in which the crops would be finished. Cuttings are first rooted in a propagation medium in propagation containers and grown in propagation houses. The cutting-propagation medium is thus an important part of the propagation process.

When you are a supplier of growing media, you face many queries concerning media for cuttings: Is the medium sterilized? Why not? My cuttings are rotting! Are fungus gnats coming in the media? Media smells! When should I feed the cuttings? Why are my "rhodies" not rooting as well as those I saw in Georgia?

You notice that the same growing medium produced very good roots at one grower and poor roots at another grower. You notice roots on blackberry proliferate like emails on your BlackBerry and magnolia keeps mum like your landline. You start wondering about the basis of these differences and whether a medium can remedy them to some extent. How can media serve as a conduit for the needs of cuttings?

Clearly, there are many variables: different plant species; leaf cuttings, stem cuttings; softwood, hardwood cuttings; propagation house styles; range of containers; hot and cold temperatures, and then range of medium components. There are, of course, cost considerations. All of these are important. Comprehending and transferring findings from one situation to another is not easy either. However, you want some common principles that can guide you through all this. Here is that attempt.

There are no medium recipes here. However, with an understanding of the mechanisms underlying cutting propagation and your growing conditions, you can intelligently decide on a suitable formula for your cutting medium and match your cultural practices to that medium.

ROOTING OR ROTTING

Conditions that are good for rooting of cuttings — warm temperature, high humidity, free moisture, and a wounded, young plant part — are unfortunately also good for the growth of fungi, fungus gnats, bacteria, etc. Naturally, we want to prevent the entry of these pathogens and pests into the propagation house. Prevention is better because most fungicides used to control pathogens also reduce rooting.

Using hygienic cutting media is one way to prevent pathogens. Articles on cuttings propagation indeed recommend sterilization of growing media to kill pathogens before its use. But, is this additional expensive step necessary anymore?

Botrytis is the pathogen that infects the cuttings the most. *Botrytis* is air, not soil-borne. The source of *Botryits* is often the mother plant or other neighboring plants.

Other rot-causing pathogens such as *Pythium*, *Rhizotonia*, *Phytophthora*, *Fusarium*, and *Thielaviopsis* are soil-borne. To prevent soil-borne pathogens, some growers steam-sterilize their cutting media. However, this is a hangover practice from the days when topsoil was used in the growing media. Topsoil generally has

pathogen inoculum. Components in soilless media such as peat moss, and coir, perlite have very low or no pathogen inoculum. Peat moss comes from locations that have no relation to horticultural plants or their diseases. Coir originates aboveground from coconuts and does not host soil-borne pathogens. Perlite is "popped" at very high temperatures that would kill all microorganisms. When tested, these components either don't show any pathogens or pathogen levels are so low that they don't require any action.

Some soilless medium components can be associated with diseases. Remember the concern about 5 years ago that *P. ramorum* in redwood or Douglas fir bark media could infest plants growing in those media? Though redwoods (actually their twigs) are hosts for *P. ramorum*, if contaminated, the pathogen can survive not just in redwood bark, sawdust, shavings, but also in any other tree bark, sawdust, and in peat moss, coir, or even in sand. Good growing medium manufacturers, therefore, test all their components to assure their media are not the source of diseases. These manufacturers source, procure, process, and transport their media under clean conditions to assure their mixes are hygienic. Such mixes don't have to be sterilized.

In fact, sterilization kills all microorganisms, not just pathogens, thus destroying the beneficial properties of soilless growing media. Say, in a peat, there is *Bacillus* that can produce antibiotics and suppress *Rhizoctonia*. After sterilization, there would be no *Bacillus* in the peat. If this sterilized peat is contaminated with *Rhizoctonia*, it would grow explosively in that peat without any suppressing *Bacillus* there.

Though a cutting-propagation medium from a reputable company helps in preventing pathogens entering through the medium, you want to prevent exposure of the medium to bare ground while storing it. Use new or sterilized containers. There were incidences of pathogen (for example, *Thielaviopsis*) infested media from old trays contaminating new media. Pathogens spread less when the cuttings are isolated spatially in growing media, like in individual cells in a tray.

GNATS GNAWING

Fungus gnats are a major pest during propagation. Their larva tunnel into the base of the cutting even before callus forms. Later, they chew on the callus and still later, chew the emerging roots too. Five to six years ago, there were reports of fungus gnats spontaneously generating in growing media! And a suggestion that the growing medium should be sterilized.

Fungus gnats are not present originally at the time of manufacture in major media components such as peat, coir, and perlite. Fungus gnats can enter the medium later on. If a medium is stored near where fungus gnats are already present and the medium becomes wet and there are holes in the bag, female gnats can enter through these holes and lay eggs on the media. Even then, survival of larvae emerging from these eggs depends on whether there is any food in the media to support them.

So, do some media components support or even attract fungus gnats and some other media components deter fungus gnats? Coconut coir was initially promoted as a material that inhibits fungus gnats. Supposedly, fungus gnat larva are in the top couple of inches of the media and coir dries on the top, so this drying would inhibit fungus gnats. But when put to the test, it was found that coir doesn't inhibit fungus gnats anymore than peat moss. Diatomaceous earth is sometimes added to the media. The theory behind this addition is that sharp diatomaceous earth particles would rupture the fungus gnat larvae moving in the media. But when tested,

it was found that diatomaceous earth had no effect on fungus gnat larvae. Perhaps the anatomy of fungus gnat larva is not sensitive to diatomaceous earth.

Medium components that have not been composted properly seem to attract fungus gnats. The microbial activity during decomposition seems to attract fungus gnats.

The thing that attracts fungus gnats most is high moisture content of the medium, which is common during propagation. To control fungus gnats, therefore, letting the cutting-medium dry too much is not an easy option. One has to use other strategies as well, such as using insecticides.

GETTING DOWN IN THE WEEDS

Weeds can be another problem especially during propagation. If there are weed seeds in the cutting media, with moist conditions during propagation, the seeds germinate and grow vigorously and smother the cuttings. Weeds can also get diseases and then infect the cuttings.

Weed seeds used to come in topsoil or sand, which were used in growing media and killing these weed seeds was another reason why media used to be sterilized. Growing media components used nowadays are relatively weed-free and thus there is no need for sterilization. However, weed seeds in growing media cannot be ruled out completely. Peat bogs can have their own weeds. Even non-organic components like pumice or lava rock can have weed seeds if they are extracted from or near the crop land. Rice hulls can have viable rice seeds.

The weed-free nature of growing media depends on medium manufacturing practices. Transport practices can also contaminate media. For instance, if the previous load was wheat or barley and the truck was not cleaned properly before carrying the medium, these grains can contaminate it.

To prevent weeds in cutting media, choose a medium from a reputable manufacturer. At the propagation area, cover the medium during storage and remove any weeds growing inside and outside the propagation house so their seeds don't contaminate the medium.

STICKING UP

The texture of a cutting medium should hold a cutting when you stick the cutting into the medium and then continue to support the cutting to stand. This seems obvious till you see workers impulsively pushing cuttings deep and deeper into the medium when cuttings start to fall. Soon, the base of those cuttings would be in the perched water table, especially if the trays are shallow.

All media in all containers have perched water tables — the zone of saturated media at the bottom of the container. The height of this zone is the same whatever the height or width of the container is. So, the shorter the container, the higher the water table is in relation to the total height of the soil. Therefore, the chance of sticking a cutting in this water zone is even higher if the container is short.

Large particles, like large bark or wood chips, in a cutting medium do not support the cuttings well. Large particles also create air pockets around the cutting base and obstruct water movement in the medium and desiccate the cutting. A cutting medium, therefore, should be screened to remove large particles.

Particles in a cutting medium should be more uniform. Otherwise, smaller particles lodge in between larger particles and the medium becomes dense like concrete mix. Moisture expands the medium particles and the expansion reduces the nest-

ing of particles. Therefore, the media should have good moisture before the trays are filled and cuttings are stuck.

WATER OR AIR

This dilemma arises because, in a growing medium, in a given space at a given time, only water or only air can exist in the spaces between the particles. One would think there is no shortage of water available to the cuttings when one walks into propagation house and sees everything wet. However, cuttings can experience water deficits and, therefore, may root poorly.

Turgor is the driving force for plant growth including initiation and growth of roots. And water maintains the turgidity. Water stress is a huge limiting factor in rooting of cuttings. Indeed, mist systems have evolved to improve the turgidity of cuttings. Though mist systems reduce water loss from transpiration from cuttings, cuttings may not absorb much water from the mist. Cuttings absorb water from the rooting medium.

When we take a cutting from its mother plant, we cut off the cutting's water source. That cutting starts losing water and would die unless another water source is provided. The cutting can absorb water from the cut base, just like cut flowers. However, the cutting may not be able to take up and replace all the water that is lost, even in the first few days when freshly cut. After a few days, xylem vessels in the cutting base are blocked by the callus tissue anyway and the cutting's ability to take up water declines even further.

The ability of a cutting to absorb water depends on the water available to it from the growing medium. First, the texture of the medium should provide proper contact to the base of the cutting. Then, the medium should remain moist. As the cutting absorbs water, the water in the medium should move to the cutting base and be readily available. In all these respects, there are differences among media and you want to choose a medium considering the method of irrigation you use.

Cuttings are known to root even in pure hydroponic systems. Though water is more important for rooting of cuttings, the medium should not be like a paddy field. Air or oxygen in the medium should still reach the rooting zone. Root initiation itself may be less sensitive to oxygen, but the root growth that would occur soon will require oxygen.

MIST OR FOG

The type of medium that is used for cuttings depends on the misting system and the size of water droplets it produces. If it is an old misting system, the mist waters the medium too and keeps it wet. Frequent misting from such system over saturates the medium. In this case, use of a porous media that provides more aeration is better.

If it is fog, the water droplets are fine and remain in the air and do not really wet the medium. In this case, the medium used should be able to retain more water. Since fog does not wet the medium, moisten the medium before filling the trays and water the medium regularly during propagation.

Also, check whether the trays or pots (generally flat-bottomed ones) are forming a seal between them and the ground cloth, if any used. Such a seal reduces the movement of water out of the containers making the medium retain more water. Such a situation needs a medium with more aeration.

WHEN TO FEED

With regard to nutrition, rooting of cuttings is influenced more by their nutrition status at the time they were taken from their mother plants, rather than by their fertilization during rooting. Often, excessive nitrogen in the cuttings deters rooting. Boron seems essential for root initiation and elongation. Zinc is necessary for the synthesis of rooting hormone, auxin. Normally there should be adequate boron and zinc inside the cuttings. If the cuttings are malnourished, a light starter charge in the cutting media provides these and other nutrients like calcium that are poorly transported inside the cutting.

A cutting has set nutrients after separation from its parent plant. Part of these nutrients may even leach out of the cutting due to mist. Nutrients within the cutting do not remain static, however. Nutrients move to the cutting base because of the need for nutrients for developing root tissues there. Also, auxin hormone treatment, often applied to the cutting base, enhances movement of nutrients to the base.

Since nutrient absorption by a plant requires roots, cuttings without roots may not be able to take up nutrients. Therefore, there is little value in providing nutrients to the cuttings till cuttings initiate roots.

Nutrient uptake by roots is active (requires energy). Whether nutrients move into the cutting passively or whether nutrients move out of the cutting due to osmotic flow if the salt level in the medium solution is high, is not clear.

Once cuttings initiate roots, a low level of fertilization can be applied, so as not to damage the young roots, till they initiate new leaves and then regular fertilization is ideal.

Including a regular level of fertilizers in the cutting medium can result in: algal growth, leaching of nutrients out of the media if the mist is strong, build-up of salt level in the media if the mist is weak, shoots rather than roots growing fast and/or interference with plant hardening.

However, if your cuttings root quickly and you can't manage to fertilize promptly after rooting, then including a high-nitrogen based complete fertilizer at a low rate in the cutting medium helps.

INHIBITORS OR PROMOTERS

Do some media components release substances that inhibit or promote rooting of cuttings? Some fresh barks contain phenols that reduce rooting. Phenols and tannins in fresh redwood are a concern especially for bareroot rose transplants. Composting reduces these toxin levels. Composted, rather than fresh, bark or sawdust components are safer in cutting media as cuttings are more sensitive than older plants. Frequent misting can be used to wash off these toxins from the medium before roots emerge.

Excess manganese that is in some barks seems to reduce rooting. Excess manganese degrades the root promoting hormone auxin. Avoid any level higher than normal manganese.

There have been reports of positive (quicker and better) and negative (poor) growth impacts of coir on the rooting. Coir is not a consistent material and these differences may be related to the source and type of coir.

Auxins are often applied to the cuttings before planting to promote rooting. These auxins can be delivered through the cutting medium. This is similar to when peat

moss was treated with an auxin solution and then used for air layering of stems in early days. Auxin-fortified cutting media is a promising technique as it reduces worker exposure to these chemicals and saves labor costs.

SHAPE AND PULL

After cuttings root and are ready to transplant or ship, a cutting that can be pulled out of the container is desired. When you pull out a cutting, the medium surrounding the rootball should hold together. If roots have grown vigorously, they will help naturally. When roots have not grown very well, the root ball may break apart. However, some medium components can help in this respect.

Peat moss has natural substances that bind the particles together; therefore, it holds its shape better. This allows easier transplanting or shipping, even before roots are in the entire medium.

Peat also has a shrinkage character that comes to use in cutting media. When ready to transplant, if you let it dry a little, the medium shrinks away from the surrounding container wall. Such a loosened root ball facilitates the pulling and transplanting of the cutting plug.

SCOTCH AND SODA

A couple of interesting research papers I came across during my attempts to find things to add to the cutting medium to promote rooting are dilute ethanol and carbonated water. These substances were tried to influence organic nutrition by providing additional CO_2 to the cuttings. Wouldn't a combo be great? I think most plants — and most propagators — favor Johnny Walker Black and club soda! In conclusion, to paraphrase Johnnie Walker, keep propagating in the right growing medium!